SKRIFTER NR. 165

TOR BJÆRKE and SVEIN B. MANUM

Mesozoic Palynology of Svalbard - I.

The Rhaetian of Hopen, with a preliminary report on the Rhaetian and Jurassic of Kong Karls Land

NORSK POLARINSTITUTT
OSLO 1977

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The Rhaetian of Hopen, with a preliminary report on the Rhaetian and Jurassic of Kong Karls Land

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Manuscript received June 1976
Printed December 1977

Contents

Abstract

Two hundred samples of Mesozoic sediments from the island of Hopen, Svalbard, have been studied. 13 samples yielded rich palynomorph assemblages. 114 sporomorph and microplankton species have been recorded; 14 of the sporomorphs are new species. Relationships to Rhaetian assemblages from NW Europe and Arctic Canada are demonstrated.

The continental to marginal marine sediments show rapid horizontal and vertical facies changes. Assemblage composition, species diversity, preservation and palynomorph productivity are highly variable and apparently controlled by facies changes. Maximum species diversity occurs in the samples which contain microplankton.

Conflicting lithostratigraphic terminologies previously applied for Hopen are discussed and a correlation with the De Geerdalen and Wilhelmøya Formations known elsewhere in Svalbard is supported.

A preliminary study of samples from Kong Karls Land showed better palynomorph productivity and preservation than for Hopen. 52 sporomorph and 13 dinoflagellate species have been recorded. For the lower part of the sequence on Kongsøya a direct correlation with the Rhaetian of Hopen is indicated, while samples from higher up the sequence contain Middle and Upper Jurassic dinoflagellates.

Preface

This paper presents a revised and abbreviated version of a degree thesis submitted by Tor Bjærke to the University of Oslo in 1975. The work was carried out at the Geology Department of the University and forms part of a research project on the biostratigraphy of Norwegian continental shelf areas, financially supported by the Royal Norwegian Research Council for Science and Technology (Continental Shelf Division).

Following a reconnaissance study of material from Hopen and elsewhere in Svalbard collected during expeditions of the Norsk Polarinstitutt (the Norwegian Polar Institute), Tor Bjærke collected extensively on Hopen in July 1973. Some of the samples from Hopen included in the present paper and all the samples from Kong Karls Land were collected by Dr. D. Worsley, then of Norsk Polarinstitutt. We are grateful to Dr. Worsley and to the Norsk Polarinstitutt for providing this material.

We acknowledge financial support from the Continental Shelf Division towards field work on Hopen and subsequently towards various stages of preparation of this paper. Also we wish to thank A. S. Norske Fina for generous assistance with transport to Hopen, and Værvarslinga i Nord-Norge (Meteorological Service, Northern Norway) and the meteorological staff on Hopen for kind co-operation in connection with field work.

1. Introduction

The island of Hopen is situated on the southeastern corner of the Svalbard archipelago (76° 30′ N, 25° E, Figure 1). It has a characteristic linear shape (35 km long and about 3 km across) and is built up of almost horizontal strata producing a plateaux topography interrupted by low passes across the island. Iversenfjellet is the highest point reaching 370 m. Along most of the west coast, and in places along the east coast, the plateaux drop steeply into the sea. Easily eroded beds produce screes in the steep slopes and a thick talus cover where the beds are more stable. Good sections where sampling is safe are difficult to find. The plateaux have no outcrops and field work along the edges is extremely dangerous. The vegetation cover is poor and presents no difficulty during sampling. The island is surrounded by shallow waters some hundred meters out from the beach and landing is difficult.

Apart from the permanently manned Norwegian meteorological station in the southern part, human activity on the island has been low. Petroleum exploration has led to temporarily increased activities in recent years, particularly in 1971 and 1973, when A.S. Norske Fina drilled two wells, one in the northern and one in the southern part of the island.

A more detailed account of previous expedition activities has been given by SMITH, HARLAND and HUGHES (1975).

2. Geological setting

2.1 Regional framework

A brief summary of the geology is given below. Readers are referred to SMITH et al. (1975) for more detailed information.

Hopen forms an extension to the southeast of the low-metamorphosed, almost horizontal strata of epicontinental deposits in eastern Svalbard. These beds continue westwards into the Spitsbergen Trough where the sequence is most completely developed, comprising beds of Permo-Carboniferous, Mesozoic, and Tertiary age. Heavy folding took place, probably during Oligocene, along the west coast of Spitsbergen, decreasing rapidly in intensity eastwards and leaving the deposits on Hopen, Edgeøya and Barentsøya almost unaffected. Triassic sediments exposed on these islands are much less consolidated than

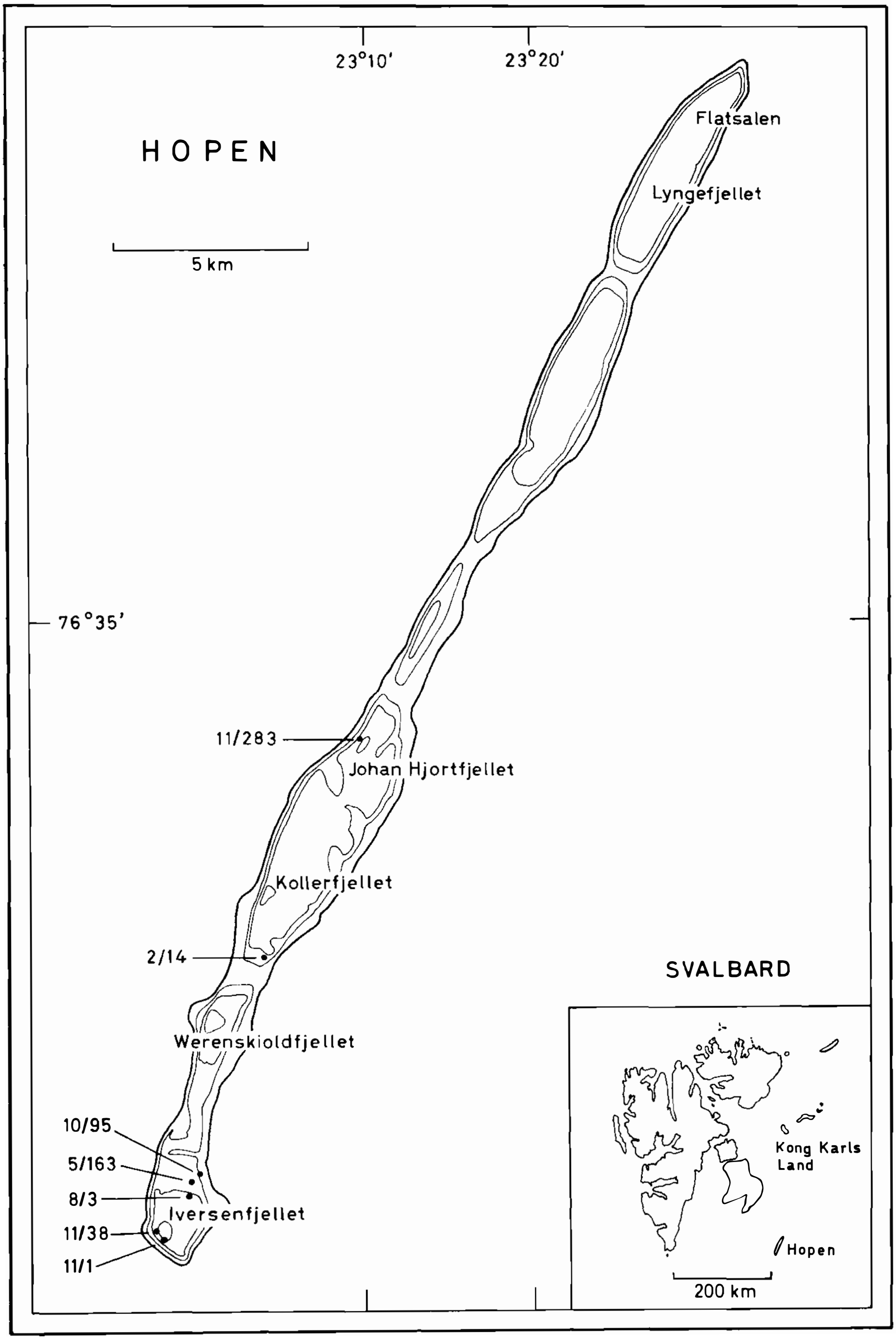


Fig. 1. *Hopen. Index map of Hopen and Kong Karls Land.*

strata of the same age further to the west. Still less affected are the Triassic, Jurassic and Cretaceous beds on Kong Karls Land, also belonging to the same sedimentary province (cfr. Chapter 5).

On Hopen, a sequence of some 460 m of shales, silt-stones and sandstones is exposed, all grey to black in colour and of rather monotonous appearance. Non-marine fluviatile and marginal marine facies are indicated by crossbedding and channelling, occurrence of coal lenses and horizons with marine bivalves. Lateral changes in lithologies have made subdivision of the sequence difficult.

2.2 Dating of the sequence

The beds on Hopen were until the late 1960's regarded as Cretaceous, based on their lithological similarity with the Lower Cretaceous beds on Spitsbergen (Orvin 1940). However, Nathorst (1894) and Høeg (**in** Iversen 1926) had suggested a Triassic age on the basis of plant macrofossils. Flood, Nagy and Winsnes (1971) suggested an Upper Triassic age based on a few macrofossil finds. Pcelina (1972) dated the sequence as Carnian to Norian, also on macrofossils, while Worsley (1973) suggested a correlation with the De Geerdalen and Wilhelmøya Formations and tentatively suggested a Rhaetian to lowermost Jurassic age.

Preliminary palynological investigations by Smith (1974) suggested that Rhaetian and possibly Norian and Hettangian beds are represented on Hopen. Smith et al. (1975) confirmed the existence of Rhaetian beds and maintained the suggestion that older Norian and younger Lower Jurassic beds are represented.

The present study supports the results of Smith et al. (1975) regarding the Rhaetian beds. However, we find no palynological evidence for Norian or Hettangian strata and also regard the evidence given by Smith et al. (1975) for beds of these stages as poor. (See discussion Chapter 4.)

2.3 Stratigraphy

Two conflicting views have been presented on the lithostratigraphic correlation of Hopen to other parts of Svalbard (Figure 2). Worsley (1973) suggested a correlation between the Hopen beds and the De Geerdalen and Wilhelmøya Formations, lithostratigraphic units defined elsewhere in Svalbard. Previously, Flood et al. (1971) had recognized the great similarity between the lower part of the Hopen succession and the De Geerdalen Formation on Edgeøya.

On the other hand, Smith et al. (1975) established a local lithostratigraphic terminology for Hopen by introducing three new formations. While their subdivision of the Hopen sequence agrees in general with that proposed by Worsley (l.c.), and their observations in fact support his comparison with the type section of the Wilhelmøya Formation, they rejected a correlation with formations established elsewhere in Svalbard because of the distant position of Hopen and the potential facies changes that may occur over this distance.

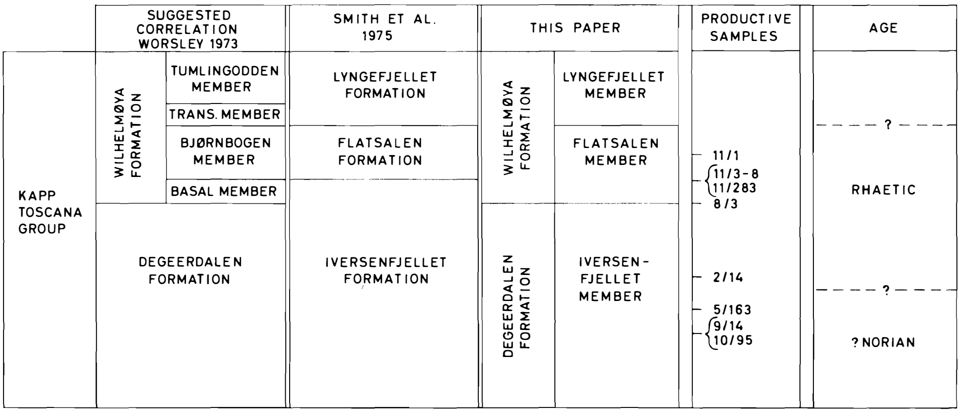


Fig. 2. *Lithostratigraphic units on Hopen and stratigraphic position of productive samples.*

We consider that the lithological similarities which unquestionably exist between Hopen and the other Svalbard areas are unnecessarily obscured by the creation of local formations for Hopen. SMITH (1975), in his redescription of the type section of the Wilhelmøya Formation, has further complicated the issue by reducing this formation to the rank of member within the De Geerdalen Formation, while still regarding equivalent beds on Hopen as foı mations. Thus the lithostratigraphic procedures applied by SMITH et al. (1975) and SMITH (1975) appear inconsistent.

In our opinion, the Wilhelmøya Formation should be maintained, and we assign the upper part of the Hopen sequence to this unit. We adopt the names of SMITH et al. (1975) for the local units but rank them as members, and we follow the subdivision of the sequence with one exception: the sandstone horizon forming the top of Iversenfjellet Formation as defined by SMITH et al. (1975), is here regarded as part of the Wilhelmøya Formation and included in the Flatsalen Member (Figure 2), in accordance with WORSLEY (1973). Palynological observations suggest that this sandstone represents commencement of the marine conditions characteristic of the Flatsalen Member. The beds which WORSLEY correlated with his Transitional Member of the Wilhelmøya Formation, are here included in the Lyngefjellet Member (Lyngefjellet Formation in SMITH et al. (1975)).

The Wilhelmøya Formation appears to represent a geological event which affected the entire eastern Svalbard region.

3. Palynology

3.1 Material

Field sampling was carried out during the summer of 1973 covering three sections at Kollerfjellet, Werenskioldfjellet and Iversenfjellet. Spot samples from additional localities collected by Messrs. B. FLOOD, J. NAGY, T. S. WINSNES, and D. WORSLEY of Norsk Polarinstitutt 1968 to 1972 were also studied. These collections cover the Iversenfjellet Member and the lower part of Flatsalen Member (Figure 2).

About 200 samples were processed but only 13 yielded workable assemblages. Location and stratigraphic distribution of productive samples are shown in Figures 1 and 2. All samples are from shale-silt lithologies except for the sample 10/95, which is a coal sample.

3.2 Preparation

Processing followed standard palynological techniques using HCl and HF followed by oxidation with Schulze's solution (maximum 8 minutes). Heavy liquid separation ($ZnBr_2$, sp. gr. 2.2) and sonification were carried out before screening through a 15 μ net. Residues were mounted in glycerol jelly as strew preparations.

3.3 Preservation

All samples yielded organic debris, carbonized tracheidal matter, and poorly preserved palynomorphs. Among the few samples producing workable assemblages, samples 10/95, 9/14, 2/14, 8/3, and 11/283 yielded well preserved palynomorphs associated with corroded specimens. Samples 5/163, 11/3-8 and 11/1 yielded identifiable material, but all grains are corroded.

Preservation appears in general to be controlled by facies. Sample 2/14 from about 150 m at Kollerfjellet gave excellently preserved material while sample 5/163 from the same horizon at Iversenfjellet yielded darkened palynomorphs with partly destroyed exines and imprints of minerals, probably pyrite. Samples 11/3-8 from about 325 m at Iversenfjellet have remarkably high concentrations of spores and pollen, but their morphological details are blurred by corrosion. Sample 11/283 yielded palynomorphs of the same preservation as observed in samples 11/3-8, but associated with well preserved specimens. Samples from the middle part of the Flatsalen Member yielded badly preserved dinoflagellates and spores with a characteristic "spongy" exine. This type of corrosion was not observed in the lower part of the Iversenfjellet Member. Exines with rosette scars and punctations are quite common, especially in samples 8/3, 11/283, 11/3-8 and 11/1, from the upper part of the Iversenfjellet Member and the Flatsalen Member (see Pl. 9, Figs. 13, 14).

It is somewhat difficult to use spore/pollen colour as indicator of thermal history of the sediments on Hopen since darkening also appears to have occurred as a result of other factors than heat (see above). However, the over-all impression gained from spore/pollen colour of un-oxidized preparations suggests a moderate thermal alteration, approximately equivalent to thermal index 3.0 on the Staplin (1969) scale.

3.4 Palynomorph distribution

Assemblages vary considerably both vertically and horizontally with regard to species diversity as well as relative frequency of species. This is illustrated in Table I. Some of the more important features are summarized below.

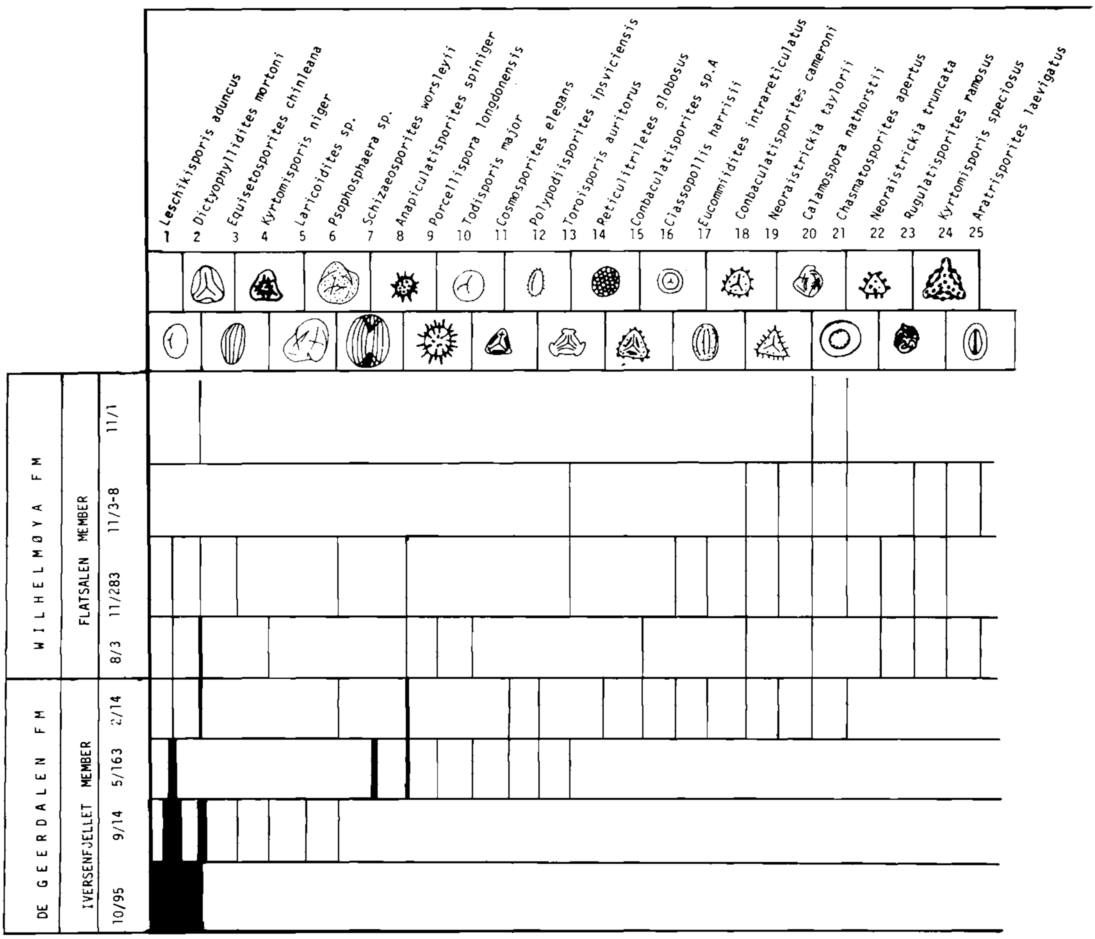


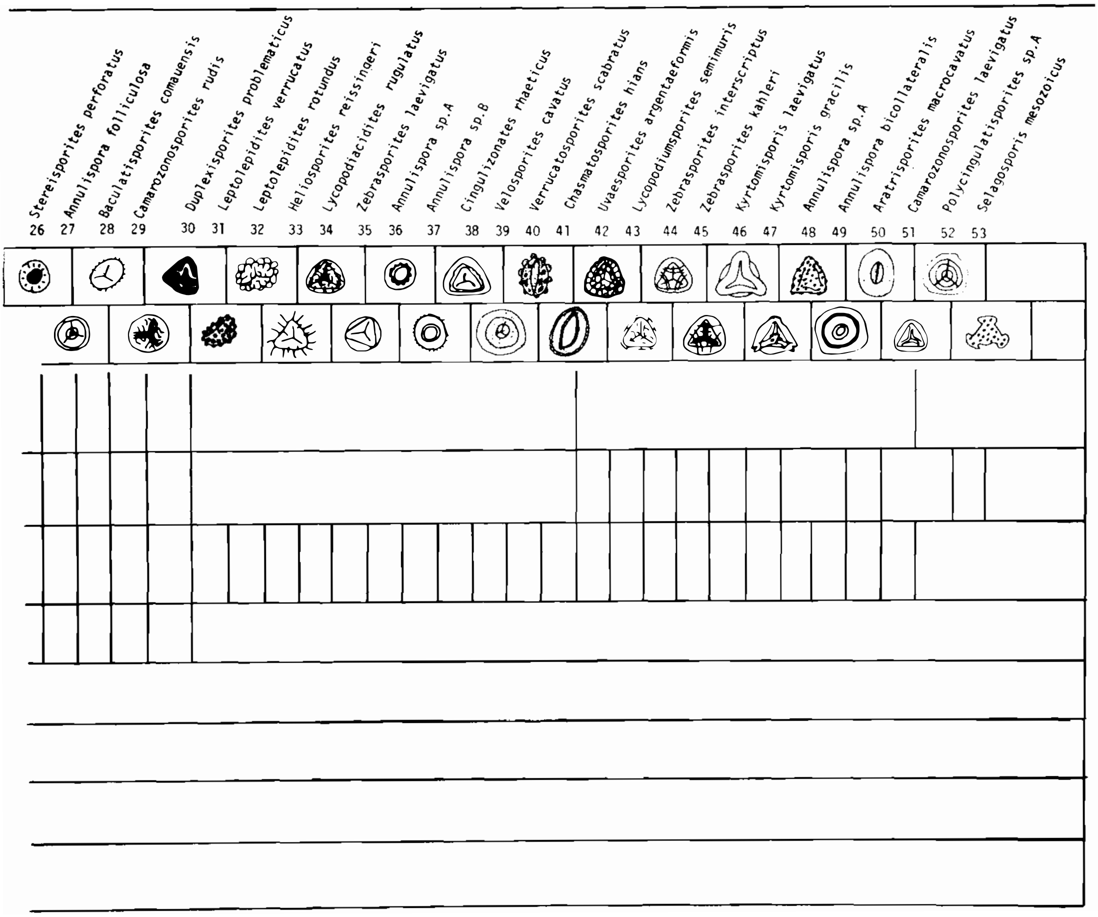
Table I. *Vertical distribution of selected palynomorphs on Hopen. Column widths indicate relative frequencies (intervals: < 5%, 5–10%, 10–30%, 30–60%, > 60%). Table continued on pp. 13 and 14.*

(1) The coal sample 10/95 from about 100 m at Iversenfjellet yielded only three species, *Leschikisporis aduncus* being completely dominant. The shale sample 9/14 from the same horizon yielded about 15 species with *L. aduncus* as the most common species associated with abundant *Colpectopollis ellipsoideus*, and *Laricoidites* and *Psophosphaera* spp.

(2) Samples 2/14 and 5/163 from about 150 m at Kollerfjellet and Iversenfjellet are dominated by *Parvisaccites radiatus* and *Schizaeoisporites worsleyi* respectively, which have not been observed in other samples. *Eucommiidites intrareticulatus* is a characteristic component of sample 2/14 but absent in sample 5/163. Sample 2/14 represents the lowermost occurrence of microplankton, while 5/163 contains no trace of marine indicators.

(3) Samples 11/283 and 11/3–8 yielded assemblages of mutually comparable composition containing microplankton and test linings of foraminifera.

(4) Sample 11/1 is dominated by dinoflagellates of *Rhaetogonyaulax rhaetica* affinity.



(5) High species diversity appears to be positively correlated with presence of marine palynomorphs. Thus, samples 10/95, 9/14, and 5/163 which contain no marine palynomorphs, gave few species, while samples from higher up the sequence have considerable amounts of marine plankton and all show greater species diversity.

The noted variations in assemblage composition are considered for a major part to be controlled by sedimentary facies and thus to reflect variations in contribution to the sediments of palynomorphs from local versus distant vegetation. Facies also appears to control preservation to a considerable extent. Therefore, ranges observed so far within the stratigraphic interval studied may have limited biostratigraphic value elsewhere, even in Hopen, since facies change laterally within short distances. Further studies are clearly necessary in order to establish the palynomorph ranges for this stratigraphic interval in Svalbard.

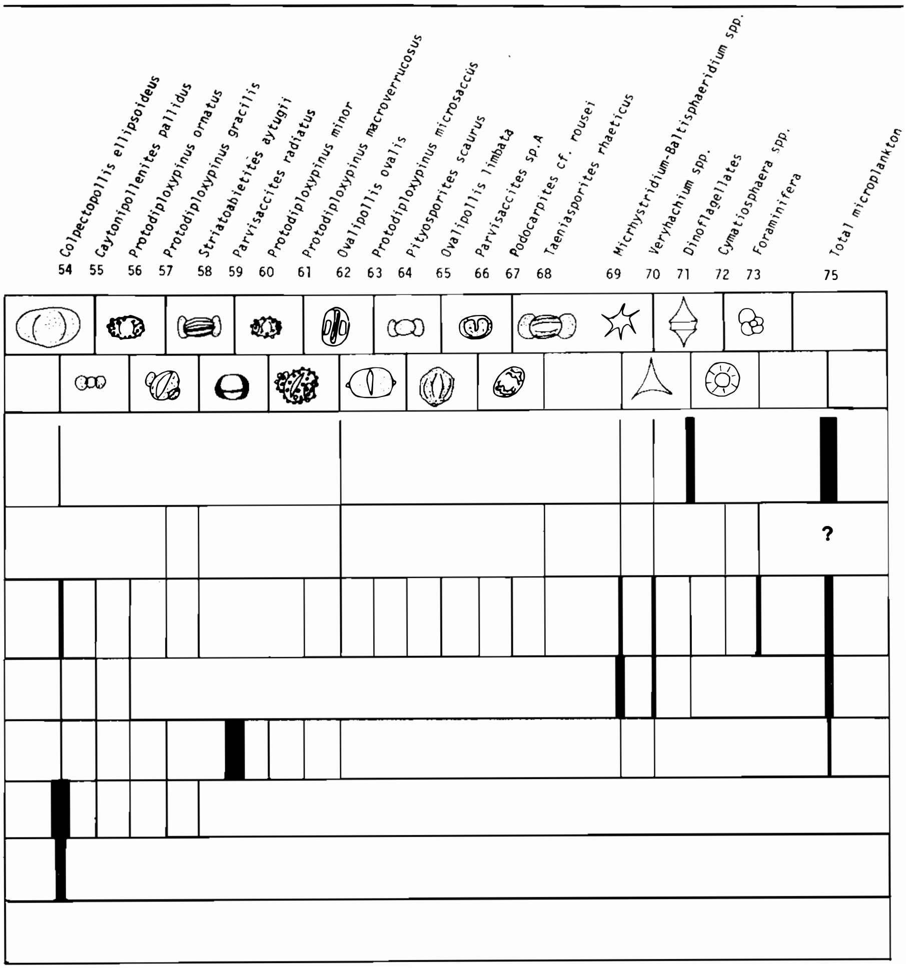


Table I., *continued.*

4. Palynological correlation

Dating of the Hopen material has to be based on comparison with distant basins, i.e. of N.W. Europe, Britain, and the Canadian Arctic, since palynological studies from closer areas are not available for comparison. The validity of such long-range sporomorph correlations rests on the assumption of contemporaneity of floral elements in geographically distant areas. Such correlations are questionable, since identical floral elements may occur in different areas at quite different times as a result of migrations.

For the time interval in question, Upper Triassic to Lower Jurassic, palaeobotanical data are as yet insufficient for an assessment of the effect of migrations on long-range correlations between N.W. Europe and Svalbard. With these reservations in mind, we go on to compare the assemblages from Hopen with other areas.

Assemblages from the approx. 100 m level (samples 10/95 and 9/14) lack species which are of stratigraphic significance in the European area. SMITH et al. (1975, p. 18–19) reported *Granuloperculatipollis rudis*, *Eucommiidites* sp., *Chasmatosporites* sp., and *Ricciisporites* sp. from this horizon and suggested a Norian age. However, we consider that the reported assemblage could just as well be Rhaetian. Absence of Rhaetian markers may be due to facies control which appears to be particularly strong at this level. In our view it cannot on present evidence be decided whether the age is Norian or Rhaetian.

Assemblages from about 150 m (samples 2/14 and 5/163) contain *Classopollis harrisii*, *Chasmatosporites apertus* and *Granuloperculatipollis rudis*. This horizon probably belongs to the Rhaetian, but the assemblage is unsatisfactory for a definitive dating.

Characteristic Rhaetian assemblages (cp. SCHULZ 1967, ORBELL 1973, MORBEY and NEVES 1974, MORBEY 1975) occur in the lowermost part of the Flatsalen Member (300 to 325 m at Iversenfjellet). Species used as Rhaetian markers in Britain, such as *Annulispora* (*Stereisporites*) *bicollateralis*, *Cingulizonates rhaeticus*, *Zebrasporites laevigatus*, *Uvaesporites argenteaeformis*, *Heliosporites reissingeri*, *Taeniasporites rhaeticus*, and *Ovalipollis limbatus*, are associated with other typical Upper Triassic species in these assemblages. *Selagosporis mesozoicus* and *Camarozonosporites laevigatus*, both stratigraphically restricted to the Rhaetian in Germany, are also present. Similar assemblages have been recorded from the Sverdrup Basin, Arctic Canada (MCGREGOR 1965, FELIX 1975) where they are restricted to the upper part of the Heiberg Formation dated as Rhaetian-lowermost Hettangian. (Known ranges for stratigraphically important species are shown in Table II.)

The stratigraphically highest sample studied by us, from the Flatsalen Member (sample 11/1), also contains an assemblage of Rhaetian composition. It is dominated by *Rhaetogonyaulax* cf. *rhaetica* and also contains some species seen in the lowermost part of the same member (see Table I). This agrees with observations made by SMITH et al. (1975).

We have not studied samples from the Lyngefjellet Member. From this member SMITH et al. (1975) reported five species which they considered restricted to it. However, three of these, *Chasmatosporites hians*, *Granulatisporites subgranulosus* and *Polycingulatisporites circulus*, we have seen in the lowermost part of the Flatsalen Member in a typical Rhaetian association. The remaining two, namely *Foraminisporis jurassicus* SCHULZ 1967 and *Limbosporites lundbladii* NILSSON 1958, we have not seen in the members below, but it is significant that they have been reported from the Rhaetian elsewhere (SMITH et al., Table 5). *Heliosporites reissingeri* which SMITH et al. recorded from the Lyngefjellet and Flatsalen Members, in our material extends into the lowermost part of the Flatsalen Member. One of the species mentioned above (*P. circulus*) has a Jurassic range elsewhere. We have noted two further species which elsewhere are known only from the Jurassic, namely *Leptolepidites verrucatus* and *L. rotundus*. On Hopen, however, they occur in the typical Rhaetian assemblages from the lowermost part of the Flatsalen Member. We consider, therefore, that the assemblage reported from the Lyngefjellet Member by SMITH et al. (1975) is insufficient to conclude a Hettangian age; it could as well be Rhaetian.

	PRE CARNIAN	CARNIAN	NORIAN	RHAETIC LOWER	RHAETIC MID.	RHAETIC UPPER	HETTANGIAN	POST HETTANG.	REFERENCES
1 Leschikisporis aduncus		—	—	—					Mädler 1964
2 Dictyophyllidites mortoni	—	—	—	—	—	—	—	—	Playford & Dettmann 1965
3 Equisetosporites chinleana	—	—	—						Smith et al. 1975
8 Anapiculatisporites spiniger ..		—	—	—	—	—	—	—	Smith et al. 1975
9 Porcellispora longdonensis		—	—						Scheuring 1970
11 Cosmosporites elegans				—	—	—	—		Nilsson 1958
16 Classopollis harrisii				—	—	—			Muir & v.Konijnenb.-v.Cittert1971
19 Neoraistrickia taylorii				—	—	—	—		Playford & Dettmann 1965
20 Calamospora nathorstii		—	—	—	—	—	—	—	Klaus 1960
21 Chasmatosporites apertus						—	—	—	Nilsson 1958, Smith et al. 1975
24 Kyrtomisporis speciosus					—	—			Smith et al. 1975
26 Stereisporites perforatus		—	—	—	—	—	—	—	deJersey 1970
27 Annulispora folliculosa		—	—	—	—	—	—	—	Smith et al. 1975
28 Baculatisporites comauensis ..		—	—	—	—	—	—	—	deJersey 1970
29 Camarozonosporites rudis		—	—	—	—	—	—	—	Smith et al. 1975
30 Duplexisporites problematicus		—	—	—	—	—	—	—	Playford & Dettmann 1965
31 Leptolepidites verrucatus							—	—	Dettmann 1963
32 Leptolepidites rotundus							—	—	Guy 1971
33 Heliosporites reissingeri				—	—	—			Orbell 1973
34 Lycopodiacidites rugulatus ..					—	—	—	—	SCHULZ 1967
35 Zebrasporites laevigatus					—	—			Schulz 1967
38 Cingulizonates rhaeticus					—	—	—		Schulz 1967
41 Chasmatosporites hians				—	—	—	—		Nilsson 1958
42 Uvaesporites argentaeformis ..			—	—	—	—	—	—	Tralau 1968
43 Lycopodiumsporites semimuris .				—	—	—	—		Levet carette 1964
44 Zebrasporites interscriptus ..		—	—	—	—	—	—	—	Smith et al. 1975
45 Zebrasporites kahleri		—	—	—	—	—			Schulz 1967
46 Kyrtomisporis laevigatus				—	—	—	—		Mädler 1964
49 Annulispora bicollateralis ...							—	—	Döring et al. 1965
51 Camarozonosporites laevigatus				—	—	—			Schulz 1967
53 Selagosporis mesozoicus					—				Schulz 1967
55 Caytonipollenites pallidus ...							—	—	Tralau 1968
57 Protodiploxypinus gracilis ...		—	—						Scheuring 1970
59 Parvisaccites radiatus								—	Couper 1958
62 Ovalipollis ovalis		—	—	—	—	—	—		Smith et al. 1975
64 Pityosporites scaurus				—	—	—	—	—	Schulz 1967
65 Ovalipollis limbata					—	—	—	—	Schulz 1967
68 Taeniasporites rhaeticus					—	—	—		Schulz 1967

Table II. *Known ranges of selected species occurring on Hopen.*

In conclusion, the age of the Flatsalen Member is regarded as Rhaetian, and this is probably also the age of the upper part of the Iversenfjellet Member. The ages of the lower part of the Iversenfjellet Member and of the Lyngefjellet Member are less certain. We consider as inconclusive the evidence for Norian and Hettangian ages for these Members respectively; the reported assemblages could as well be Rhaetian.

5. Notes on the palynostratigraphy of Kong Karls Land

5.1 Geology and material

The only published geological field observations are those by NATHORST (1901, 1910) and no formal lithostratigraphic subdivision of the sequence has been established so far. The succession on Kong Karls Land consists mainly of Jurassic sandstones, clays and shales capped by basalts and is consequently completely different from that on Hopen. NATHORST (1901) indicated two main faultlines forming a horst at western Kongsøya and eastern Svenskøya (Figure 3). This hoist includes a succession which has been dated Bathonian to Callovian (NATHORST 1901, 1910, FREBOLD 1935, BLÜTHGEN 1936) and a lower sandstone series with no macrofossils, suggested by FREBOLD (1935, p. 79) to be of Triassic age. In the western part of Svenskøya and the eastern part of Kongsøya, black shales are more prominent. These beds have been dated late Oxfordian, Kimmeridgian, and lower Volgian; they are overlain by Lower Cretaceous marls and tuffaceous sandstones with plant remains.

Samples from Kong Karls Land, collected by Dr. D. WORSLEY of Norsk Polarinstitutt in 1973, cover a section 155 m thick from the northern slope of Hårfagrehaugen, Kongsøya (Locality 1, Figure 3). Spot samples from higher up the section at Hårfagrehaugen as well as from Svenskøya north of Kapp Hammerfest (Locality 2), and from Tordenskioldberget (Locality 3) were also collected. Localities 2 and 3 are situated outside the horst indicated by NATHORST.

Previous workers on Kong Karls Land have described their sections in a very general way, and it is difficult to relate our sampling horizons exactly to the described stratigraphy. However, the section sampled at Hårfagrehaugen

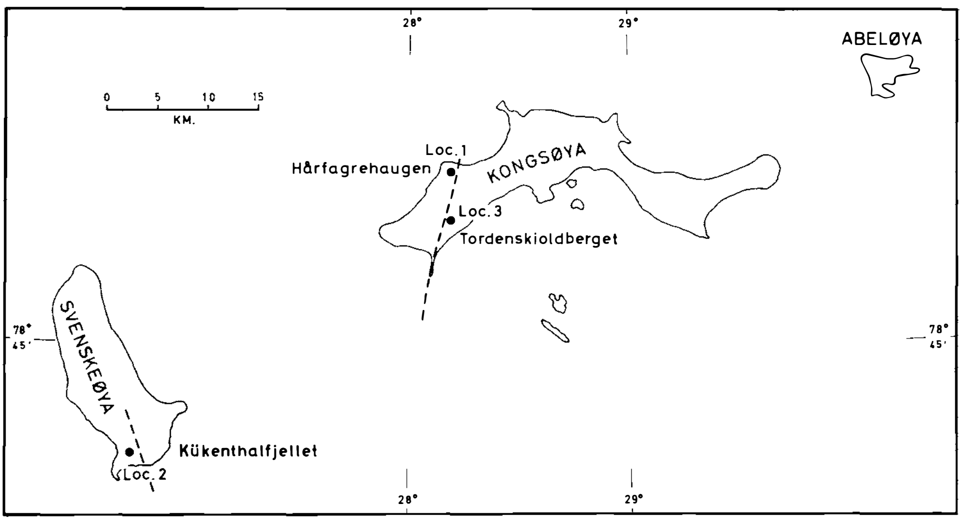


Fig. 3. *Kong Karls Land.*

below 80 m (Locality 1) belongs to the lower part of the sequence which has so far not been dated. The samples higher up in Hårfagrehaugen and those from Svenskøya (Locality 2) and Tordenskioldberget (Locality 3) are probably from horizons previously dated as Bathonian, Callovian and Oxfordian.

5.2 Palynomorph assemblages

Studies on Kong Karls Land material reported here are of preliminary nature. The observed palynomorphs have not been dealt with in the systematic part of this paper, but will form the subject of a more detailed study in preparation.

In contrast with the Hopen material, samples from Kong Karls Land are nearly all productive and generally yield better preserved palynomorphs. The species from Kong Karls Land are listed below.

List of species from Kong Karls Land

Species from Kong Karls Land also recorded from Hopen:

Biretisporites potoniei DELCOURT & SPRUMONT 1955
Deltoidospora neddeni (POTONIÉ) ORBELL 1973
Cyathidites minor COUPER 1953
Cyathidites australis COUPER 1953
Dictyophyllidites mortonii (deJERSEY) PLAYFORD & DETTMANN 1965
Uvaesporites argenteaeformis (BOLKHOVITINA) SCHULZ 1967
Anapiculatisporites spiniger (LESCHIK) REINHARDT 1962
Baculatisporites comauensis (COOKSON) POTONIÉ 1956
Neoraistrickia taylorii PLAYFORD & DETTMANN 1965
Leptolepidites verrucatus COUPER 1953
Granulatisporites cf. *subgranulatus* (COUPER) FISHER 1972
Stereisporites perforatus LESCHIK 1955
Selagosporis mesozoicus SCHULZ 1967
Lycopodiumsporites semimuris DANZE-CORSIN & LAVEINE 1963
Lycopodiacidites rugulatus (COUPER) SCHULZ 1967
Polycingulatisporites cf. *circulus* SIMONCSICS & KEDVES 1961
Annulispora folliculosa (ROGALSKA) deJERSEY 1959
Annulispora bicollateralis ROGALSKA 1956 n.comb.
Kyrtomisporis speciosus MÄDLER 1964
Kyrtomisporis gracilis n.sp.
Kyrtomisporis laevigatus MÄDLER 1964
Duplexisporites problematicus (COUPER) PLAYFORD & DETTMANN 1965
Limbosporites lundbladii NILSSON 1958
Ricciisporites tuberculatus LUNDBLAD 1959
Zebrasporites interscriptus KLAUS 1960
Zebrasporites laevigatus SCHULZ 1967
Cingulizonates rhaeticus (REINHARDT) SCHULZ 1967
Camarozonosporites rudis (LESCHIK) KLAUS 1960
Camarozonosporites laevigatus SCHULZ 1967
Velosporites sp.
Marattisporites scabratus COUPER 1958
Aratrisporites laevigatus n.sp.
Aratrisporites macrocavatus n.sp.
Aratrisporites fimbriatus KLAUS 1960
Ginkgocycadophytus granulatus deJERSEY 1964
Ovalipollis ovalis (KRUTZSCH) POCOCK & JANSONIUS 1969

Ovalipollis limbatus (Maljavkina) Pocock & Jansonius 1969
Classopollis cf. *harrisii* Muir & vanKonijnenburg-vanCittert 1970
Chasmatosporites apertus (Rogalska) Nilsson 1958
Chasmatosporites hians (Nilsson) Pocock & Jansonius 1969
Eucommiidites intrareticulatus n.sp.
Alisporites microreticulatus Reinhardt 1964
Caytonipollenites pallidus Couper 1958
Protodiploxypinus macroverrucosus n.sp.
Protodiploxypinus microsaccus n.sp.
Protodiploxypinus ornatus (Pautsch) n.comb.
Protodiploxypinus minor n.sp.
Taeniasporites rhaeticus Schulz 1967
Striatoabietites aytugii Visscher 1966
Rhaetogonyaulax rhaetica (Sarjeant) Loeblich & Loeblich 1968
Veryhachium reductum (Deunff) Jechowsky 1961
Micrhystridium spp.

Species recorded exclusively from Kong Karls Land:

Circulina meyeriana Klaus 1960
Corollina torosus (Reissinger) Klaus 1960
Cerebropollenites mesozoicus (Couper) Nilsson 1958
Gonyaulacysta jurassica Deflandre 1938
Gonyaulacysta jurassica var. *longicornis* Deflandre 1938
Nannoceratopsis pellucida Deflandre 1938
Sirmiodinium grossi (Alberti) Warren 1973
Hystrichosphaeridium spp.
Prolixosphaeridium sp.
Pareodinia ceratophora Deflandre 1947
Pareodinia sp.B of Wiggins 1973
Pareodinia spp.

Two essentially different groups of assemblages may be distinguished.

(1) The assemblages from the lowermost 80 m at Locality 1 are almost identical with assemblages from the lower part of Flatsalen Member on Hopen. The environment appears to be for the major part marginal marine, while some samples indicate continental conditions. *Limbosporites lundbladii* and *Ricciisporites tuberculatus* which occur in abundance in the Kong Karls Land samples were not observed in our material from Hopen in spite of intensive search, though Smith et al. (1975) recorded rare specimens of both species. This is not surprising, since our observations from Hopen have shown that species which dominate in one sample may be absent in stratigraphically very close samples.

(2) The assemblages obtained from the upper part of the section at Locality 1 and from Localities 2 and 3, are characterized by Jurassic dinoflagellates in association with abundant *Cerebropollenites mesozoicus* and bisaccate pollen.

5.3 Palynological correlation

The older assemblages obtained from the lowermost 80 m at Locality 1 are typically Rhaetian, and, as mentioned above, closely similar to the lower part of the Flatsalen Member on Hopen. They are also closely resembling assemblages described from the upper part of the Heiberg Formation in the Sverdrup

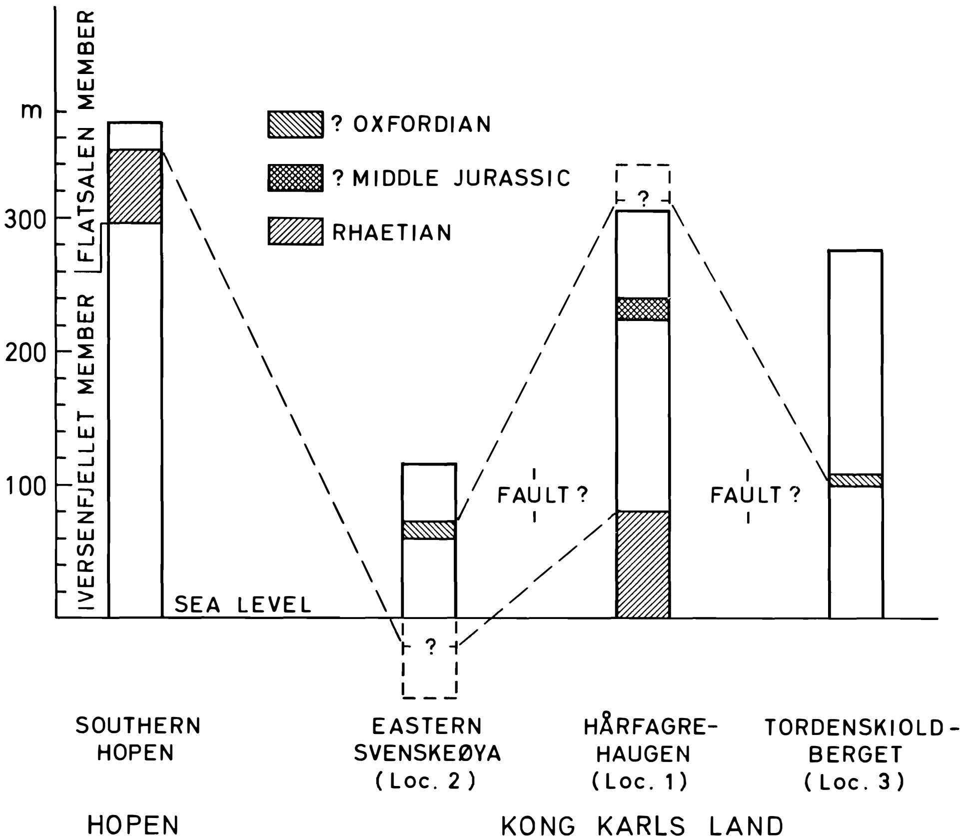


Fig. 4. *Correlation between Kong Karls Land and Hopen.*

Basin of Arctic Canada (McGregor 1965, Felix 1975). The younger assemblages from Kong Karls Land containing Jurassic dinoflagellates resemble assemblages from the Savik Formation of the Sverdrup Basin (Johnsen and Hills 1973, Felix 1975). Two of the stratigraphically most significant species in the Savik Formation, *Gonyaulacysta jurassica* var. *longicornis* and *Nannoceratopsis pellucida* are present in Kong Karls Land. *N. pellucida*, restricted to the Bathonian-Callovian in the Sverdrup Basin, has been recovered from Locality 1 at 222 m a.s.l. *G. jurassica* var. *longicornis*, restricted to the Oxfordian in the Sverdrup Basin, occurs in Locality 2 samples. Based on the Sverdrup Basin ranges for these species one may infer that the uppermost horizon sampled at Locality 1 is older than the beds sampled at Locality 2. This appears to agree with previous ages indicated by Nathorst (1910), Frebold (1935), and Blüthgen (1936). Figure 4 gives a summary of our correlations.

In comparison, it may be worth noting here that the Jurassic sequence at Agardhfjellet on the east coast of Spitsbergen has not yielded palynomorph assemblages comparable to those obtained from Kong Karls Land (Bjærke, Edwards and Thusu 1975). This supports the suggestion by Frebold (1935, p. 91) that part of the Middle Jurassic is lacking at Agardhfjellet. In Spitsbergen, like in Arctic Canada, there appears to be hiatuses in the Jurassic sequence which make correlations difficult.

6. Conclusions

The sediments on Hopen have been lithostratigraphically correlated with the DeGeerdalen and Wilhelmøya Formations defined elsewhere in Svalbard, as previously proposed by WORSLEY (1973). The local formations established by SMITH et al. (1975) for Hopen, have been reduced in rank to members.

The age of the middle part of the Hopen sequence (i.e. the Flatsalen Member) is concluded to be Rhaetian, based on comparison with assemblages from NW Europe and Arctic Canada. Whether the lower and upper parts of the sequence (lower part of Iversenfjellet Member and Lyngefjellet Member respectively) are also of Rhaetian or Norian and Hettangian age, can not be decided on present evidence.

Facies control of assemblage composition and preservation appears to be strong. Therefore, total palynomorph ranges can not be established on the basis of this material. A positive correlation between presence of marine palynomorphs and high sporomorph diversity is demonstrated.

Samples of the lower part of the sequence at Kongsøya, Kong Karls Land, contain assemblages identical with those from the Flatsalen Member (Wilhelmøya Formation) on Hopen. This interval on Kong Karls Land is therefore dated as Rhaetian. Samples from higher up the sequence on Kongsøya and from Svenskøya, Kong Karls Land, yielded dinoflagellate assemblages of Middle and Upper Jurassic age, consistent with ages previously suggested for this sequence.

7. Systematic palynology

The sporomorph taxa have been classified according to the morphographic system of POTONIÉ (1956–1970). Only new species have been fully described; for others comments only are offered when required for reasons of morphological interpretation or taxonomic discussion. References beyond those to original descriptions have been selected on the basis of their significance with regard to taxonomic or morphologic understanding of the species.

7.1 List of species

Anteturma SPORITES H. POTONIÉ 1893
Turma TRILETES (REINSCH) DETTMANN 1963
Subturma AZONOTRILETES (LUBER) DETTMANN 1963
Infraturma LAEVIGATI (BENNIE and KIDSTON) POTONIÉ 1956

Calamospora nathorstii (HALLE) KLAUS 1960; p. 26, Pl. 1, Fig. 1.
Cyathidites australis COUPER 1953; p. 26.
Cyathidites minor COUPER 1953; p. 26, Pl. 1, Fig. 2.
Biretisporites potoniei DELCOURT and SPRUMONT 1955; p. 26, Pl. 1, Fig. 4.
Sphagnumsporites australis (COOKSON) n. comb.; p. 26, Pl. 1, Fig. 6.

Sphagnumsporites robustus (LESCHIK) n. comb.; p. 27.
Granulatisporites cf. *subgranulosus* (COUPER) ORBELL 1973; p. 27.
Deltoidospora neddeni (POTONIÉ) ORBELL 1973; p. 27, Pl. 1, Fig. 7.
Stereisporites perforatus LESCHIK 1955; p. 27, Pl. 1, Fig. 3.
Dictyophyllidites mortonii (deJERSEY) PLAYFORD and DETTMANN 1965; p. 27, Pl. 1, Figs. 10, 14.
Concavisporites scabratus n. sp.; p. 28, Pl. 1, Fig. 5.
Concavisporites toralis (LESCHIK) NILSSON 1958; p. 28.
Concavisporites sp.; p. 28, Pl. 1, Figs. 8, 9.
Todisporis major COUPER 1958; p. 29.

Infraturma APICULATI (BENNIE and KIDSTON) POTONIÉ 1956

Leptolepidites rotundus TRALAU 1968; p. 29, Pl. 1, Figs. 11, 15.
Leptolepidites verrucatus COUPER 1953; p. 29, Pl. 1, Fig. 12.
Apiculatisporis parvispinosus (LESCHIK) SCHULZ 1962; p. 29.
Anapiculatisporites spiniger (LESCHIK) REINHARDT 1962; p. 29, Pl. 1, Fig. 13.
Baculatisporites comauensis (COOKSON) POTONIÉ 1956; p. 29.
Neoraistrickia truncata (COOKSON) POTONIÉ 1956; p. 30.
Neoraistrickia taylorii PLAYFORD and DETTMANN 1963; p. 30, Pl. 1, Fig. 17.
Heliosporites reissingeri (HARRIS) CHALONER 1969 ex MUIR and van KONIJNENBURG—van CITTERT 1970; p. 30.
Conbaculatisporites hopensis n. sp.; p. 30, Pl. 2, Figs. 1, 2.
Conbaculatisporites sp.; p. 30, Pl. 1, Fig. 16.
Porcellispora longdonensis SCHEURING 1970; p. 30, Pl. 2, Fig. 3.
Uvaesporites argenteaeformis (BOLKHOVITINA) SCHULZ 1967; p. 31, Pl. 2, Figs. 6, 8.

Infraturma MURORNATI POTONIÉ and KREMP 1954

Lycopodiumsporites cf. *clavatoides* COUPER 1958; p. 31.
Lycopodiumsporites semimuris DANZE-CORSIN and LAVEINE 1963, p. 31, Pl. 3, Figs. 1–3.
Lycopodiumsporites sp.; p. 31, Pl. 2, Figs. 4, 5.
Reticulitriletes globosus MÄDLER 1964; p. 32.
Cavatoretisporites obvius n. sp.; p. 32, Pl. 2, Figs. 7, 9; Pl. 3, Figs. 4, 5.
Rugulatisporites ramosus deJERSEY 1959; p. 32.
Rugulatisporites sp.; p. 33, Pl. 3, Fig. 8.
Lycopodiacidites rugulatus (COUPER) SCHULZ 1967; p. 33, Pl. 3, Figs. 6, 9.
Selagosporis mesozoicus SCHULZ 1967; p. 33, Pl. 3, Fig. 14.

Infraturma TRICRASSATI DETTMANN 1963

Zebrasporites laevigatus (SCHULZ) SCHULZ 1967; p. 33, Pl. 3, Fig. 10.
Zebrasporites interscriptus KLAUS 1960; p. 33, Pl. 3, Fig. 11.
Zebrasporites kahleri KLAUS 1960; p. 33, Pl. 3, Fig. 12.
cf. *Cosmosporites elegans* NILSSON 1958;p. 34, Pl. 3, Fig. 13.

Infraturma CINGULATI (Potonié and Klaus) Dettmann 1963

Camarozonosporites rudis (Leschik) Klaus 1960; p. 34, Pl. 3, Fig. 7.
Camarozonosporites laevigatus Schulz 1967; p. 34, Pl. 3, Figs. 15, 16.
Kyrtomisporis gracilis n. sp.; p. 34, Pl. 4, Figs. 8, 9.
Kyrtomisporis laevigatus Mädler 1964; p. 35, Pl. 4, Figs. 1, 2.
Kyrtomisporis niger n. sp.; p. 35, Pl. 4, Figs. 4, 6.
Kyrtomisporis speciosus Mädler 1964; p. 35, Pl. 4, Figs. 3, 5.
Duplexisporites problematicus (Couper) Playford and Dettmann 1963; p. 35, Pl. 5, Fig. 2.
Annulispora folliculosa (Rogalska) deJersey 1959; p. 36, Pl. 5, Figs. 3, 6.
Annulispora bicollateralis (Rogalska 1956) n. comb.; p. 36.
Annulispora sp. A; p. 36, Pl. 5, Figs. 1, 4.
Annulispora sp. B; p. 36, Pl. 5, Fig. 5.
Polycingulatisporites cf. *circulus* Simoncsics and Kedves 1961; p. 37.
Cingulizonates rhaeticus (Reinhardt) Schulz 1967; p. 37, Pl. 6, Fig. 5.
Densosporites sp.; p. 37, Pl. 5, Figs. 7, 8.
Velosporites cavatus n. sp.; p. 37, Pl. 5, Figs. 9, 10.
cf. *Velosporites* sp.; p. 38.

Turma MONOLETES Ibrahim 1933
Subturma AZONOMONOLETES Luber 1935
Infraturma LAEVIGATOMONOLETI Dybova and Jachowicz 1957

Leschikisporis aduncus (Leschik) Potonié 1958; p. 38.

Infraturma SCULPTATOMONOLETI Dybova and Jachowicz 1957

Polypodiisporites ipsviciensis (deJersey) Playford and Dettmann 1965; p. 38.
Marattisporites scabratus Couper 1958; p. 38.
Verrucatosporites scabratus n. sp.; p. 38, Pl. 6, Figs. 1–4.

Subturma ZONOMONOLETES Naumova 1939

Aratrisporites laevigatus n. sp.; p. 39, Pl. 6, Figs. 13, 16.
Aratrisporites macrocavatus n. sp.; p. 39, Pl. 6, Fig. 9.
Aratrisporites scabratus Klaus 1960; p. 39, Pl. 6, Figs. 6, 7.
Aratrisporites fimbriatus Klaus 1960; p. 40.
Aratrisporites parvispinosus Leschik 1955; p. 40.

Turma ALETES Ibrahim 1933
Subturma AZONALETES (Luber) Potonié and Kremp 1954
Infraturma PSILONAPITI Erdtman 1947

Psophosphaera sp.; p. 40.
Laricoidites sp.; p. 40.

Anteturma POLLENITES POTONIÉ 1931
Turma SACCITES ERDTMAN 1947
Subturma DISACCITES COOKSON

Striatoabietites aytugii VISSCHER 1966; p. 40, Pl. 6, Fig. 12.
Taeniasporites rhaeticus SCHULZ 1967; p. 40, Pl. 6, Fig. 15.
Protodiploxypinus gracilis SCHEURING 1970; p. 40, Pl. 7, Figs. 1, 4.
Protodiploxypinus macroverrucosus n. sp.; p. 40, Pl. 6, Fig. 10.
Protodiploxypinus microsaccus n. sp.; p. 41, Pl. 6, Figs. 8, 11, 14.
Protodiploxypinus minor n. sp.; p. 41, Pl. 7, Figs. 2, 3, 6, 7.
Protodiploxypinus ornatus (PAUTSCH 1973) n. comb.; p. 41, Pl. 7, Fig. 5.
Caytonipollenties pallidus COUPER 1958; p. 41, Pl. 7, Figs. 8, 11.
Pityosporites scaurus (NILSSON) SCHULZ 1967; p. 41, Pl. 8, Figs. 1, 2.
Parvisaccites radiatus COUPER 1958; p. 42, Pl. 8, Figs. 3–6.
Parvisaccites sp. A; p. 42, Pl. 7, Fig. 10.
Ovalipollis ovalis (KRUTZSCH) POCOCK and JANSONIUS 1969; p. 42, Pl. 7, Figs. 13, 14.
Ovalipollis limbatus (MALJAVKINA) POCOCK and JANSONIUS 1969; p. 42, Pl. 7, Fig. 9.
Podocarpites cf. *rousei* POCOCK 1970;
Alisporites microreticulatus REINHARDT 1964; p. 42, Pl. 7, Fig. 12.
Brachysaccus neomundanus (LESCHIK) MÄDLER 1964; p. 42.
Colpectopollis ellipsoideus VISSCHER 1966;
Tetrasaccus PANT 1954; p. 42, Pl. 8, Fig. 7.

Turma PLICATES NAUMOVA 1939
Subturma MONOCOLPATES IVERSEN and TROELS-SMITH 1950

Ginkgocycadophytus granulatus (deJERSEY) deJERSEY 1964; p. 43, Pl. 8, Fig. 12; Pl. 9, Fig. 13.
Ginkgocycadophytus nitidus (BALME) deJERSEY 1962; p. 43.
Chasmatosporites apertus NILSSON 1958; p. 43, Pl. 8, Fig. 9.
Chasmatosporites hians NILSSON 1958; p. 43, Pl. 8, Figs. 10, 11.

Turma POROSES (NAUMOVA) POTONIÉ 1960
Subturma MONOPORINES NAUMOVA 1939

Classopollis harrisii MUIR and vanKONIJNENBURG-vanCITTERT 1970; p. 43, Pl. 9, Figs. 4, 5.

Subturma POLYPLICATES (DAUGHERTY) POCOCK and JANSONIUS 1964

Equisetosporites cf. *steevesi* (JANSONIUS) deJERSEY 1968; p. 43, Pl. 8, Fig. 8.
Schizaeoisporites worsleyi n. sp.; p. 44, Pl. 8, Figs. 13, 14.

Subturma PRAECOLPATES POTONIÉ and KREMP 1954

Eucommiidites intrareticulatus n. sp.; p. 44, Pl. 9, Figs. 2, 3, 6, 7.

Class DINOPHYCEAE PASCHER

cf. *Shublikodinium armatum* WIGGINS 1973; p. 44.
cf. *Shublikodinium granulatum* WIGGINS 1973; p. 44.
Rhaetogonyaulax rhaetica (SARJEANT) LOEBLICH and LOEBLICH 1968; p. 44, Pl. 9, Fig. 8.
Pareodinia sp.; p. 44.

Group ACRITARCHA EVITT 1963
Subgroup ACANTHOMORPHITAE DOWNIE, EVITT and SARJEANT 1963

Micrhystridium deflandrei VALENSI.
Micrhystridium wattonensis WALL 1965.
Micrhystridium lymensis var. *gliscum* WALL 1965.
Micrhystridium aster SARJEANT 1967.
Micrhystridium circulum SCHÖN 1967.
Micrhystridium recurvatum VALENSI.
Baltisphaeridium aff. *polytrichium* VALENSI.
Baltisphaeridium infulatum WALL 1965.
Baltisphaeridium debilispinum WALL and DOWNIE 1963.
Baltisphaeridium sp.; Pl. 9, Fig. 9.

Subgroup POLYGONOMORPHITAE DOWNIE, EVITT and SARJEANT 1963

Veryhachium reductum (DEUNFF) JECHOWSKY 1961; Pl. 9, Fig. 11.
Veryhachium nasicum (STOCKMANS and WILLIERE) SCHARSCHMIDT 1963.

Subgroup NETROMORPHITAE DOWNIE, EVITT and SARJEANT 1963

Metaleiofusa bispinosa SCHÖN 1967.

Subgroup HERKOMORPHITAE DOWNIE, EVITT and SARJEANT 1963

Cymatiosphaera cf. *eupeplos* VALENSI 1953.
Cymatiosphaera sp. A WALL 1965.
Cymatiosphaera sp. B WALL 1965.

Subgroup PTEROMORPHITAE DOWNIE, EVITT and SARJEANT 1963

Pterospermopsis cf. *foveolata* LISTER 1968.

7.2 Descriptions

Genus *Calamospora* SCHOPF, WILSON and BENTALL 1944
Calamospora nathorstii (HALLE) KLAUS 1960
Pl. 1, Fig. 1

1908 HALLE, pl. 9, Figs. 4–9
1958 COUPER, p. 132 (*C. mesozoicus*)
1960 KLAUS, p. 116

Occurrence: Samples 2/14, 11/283, 11/3–8. Common.

Genus *Cyathidites* COUPER 1953
Cyathidites australis COUPER 1953

1953 COUPER, p. 27
1963 DETTMANN, p. 22

Occurrence: Samples 9/14, 2/14, 11/283, 11/3–8. Common.

Cyathidites minor COUPER 1953
Pl. 1, Fig. 2

1953 COUPER, p. 28
1963 DETTMANN, p. 22

Occurrence: Samples 5/163, 2/14, 8/3, 11/283, 11/3-8. Common.

Genus *Biretisporites* (DELCOURT and SPRUMONT) DELCOURT, DETTMANN and HUGHES 1963
Biretisporites potoniei DELCOURT and SPRUMONT 1955
Pl. 1, Fig. 4

1955 DELCOURT & SPRUMONT, p. 40 (*B. potoniaei*)
1963 DELCOURT, DETTMANN & HUGHES, p. 284

DELCOURT et al. (1963) concluded that *Psilatriletes pileolus* DELCOURT and SPRUMONT 1959 and *Punctatisporites nidosus* DELCOURT and SPRUMONT 1955 both are synonymous with *B. poteniei*. The characters originally used to differentiate these species are observed also in the present material. They appear to be the products of different modes of preservation.

B. potoniaei is obviously an orthographic error (derivation: POTONIÉ) and therefore corrected here.

Occurrence: Samples 5/163, 2/14, 11/283, 11/3–8. Common.

Genus *Sphagnumsporites* RAATZ 1937
Sphagnumsporites australis (COOKSON 1947) n. comb.
Pl. 1, Fig. 6

1947 COOKSON, p. 136 (*Trilites australis*)
1953 COOKSON, p. 463 (*Sphagnites australis*)
1957 BALME, p. 15 (*Sphagnites australis*)

POTONIÉ (1956, p. 18) proposed that the species assigned to *Sphagnites* by COOKSON (1953) should be referred to *Sphagnumsporites* RAATZ 1937. The transfer is herewith formalized.

Occurrence: Samples 11/283, 11/3–8. Common.

Sphagnumsporites robustus (LESCHIK 1955) n. comb.

1955 LESCHIK, p. 12 (*Laevigatosporites robustus*)

We follow POTONIÉ (1956, p. 23) who proposed that *Laevigatosporites* should be reserved for megaspores. *L. robustus* is therefore transferred to *Sphagnumsporites*.

Hopen specimens are somewhat smaller (28–30 μ) than the single specimen measured by LESCHIK (36 μ) but otherwise identical.

Occurrence: Samples 8/3, 11/283, 11/3–8. Rare.

Genus *Granulatisporites* (IBRAHIM) POTONIÉ and KREMP 1954

Granulatisporites cf. *subgranulosus* (COUPER) ORBELL 1973

1958 COUPER, p. 143 (*Concavisporites subgranulosus*)
1973 ORBELL, p. 7

Hopen specimens are considerably smaller (23–34 μ) than those measured by COUPER and ORBELL, a definite identification is therefore avoided.

Quite likely this rather indistinctive sporomorph represents several natural species with a wide spore size range.

Occurrence: Samples 8/3, 11/283. Rare.

Genus *Deltoidospora* MINER 1935

Deltoidospora neddeni (POTONIÉ) ORBELL 1973

Pl. 1, Fig. 7

1931 POTONIÉ, Pl. 1, Fig. 5 (al. *Sporonites neddeni*)
1973 ORBELL, p. 6

Occurrence: Sample 11/283. Rare.

Genus *Stereisporites* (PFLUG) deJERSEY 1964

Stereisporites is used in a wide sense by German workers (KRUTZSCH (1963), DÖRING et al. (1966)) so as to include among others *Annulispora* spp. We prefer to use *Stereisporites* in a restricted sence excluding *Annulispora*, as defined by deJERSEY (1964, p. 4, 5).

Stereisporites perforatus LESCHIK 1955

Pl. 1, Fig. 3

1955 LESCHIK, p. 10

Occurrence: Samples 8/3, 11/283, 11/3–8. Rare.

Genus *Dictyophyllidites* (COUPER) DETTMANN 1963

Dictyophyllidites mortonii (deJERSEY) PLAYFORD and DETTMANN 1965

Pl. 1, Figs. 10, 14

1959 deJERSEY, p. 354
1965 PLAYFORD & DETTMANN, p. 132

Specimens included here possess distinct laesural lips. This character serves to distinguish this genus from the morphologically similar *Concavisporites* (see below).

There is uncertainty as to whether or not some species referred to these genera possess laesural lips. For instance, the original descriptions of *C. crassexinus* NILSSON 1958 and *C. toralis* (LESCHIK) NILSSON 1958 have no reference to this character. Nevertheless, TRALAU (1968, p. 36) transferred *C. crassexinus* to *Dictyophyllidites*, thereby implying the presence of lips, apparently without consulting types. After examination of NILSSON's type we are able to confirm that TRALAU's implication is correct. TRALAU (l.c.) also considered *C. toralis* to be similar to *D. mortonii*. Reexamination of the holotype is necessary to confirm TRALAU's view. On the other hand, the present material contains many specimens which agree with the description of *C. toralis* and lack the lips. In the absence of evidence that *C. toralis* possesses lips, we retain its status as *Concavisporites*, and refer our Hopen specimens to *C. toralis* (see below).

Occurrence: Samples 9/14, 8/3, 11/283, 11/3–8. Common.

Genus *Concavisporites* PFLUG 1953

Concavisporites scabratus n. sp.

Pl. 1, Fig. 5 (holotype)

Diagnosis: Trilete spores, amb triangular, apices rounded, sides slightly concave to slightly convex. Laesurae distinct, between 3/4 and 4/5 of the radius. Tori distinct, c. 5 μ wide, fading towards apices. Exine distinctly scabrate in surface view; outer surface smooth (in optical section), inner surface rough, indicating a granular texture, which appears coarser along tori margins. Equatorial diameter 28–45 μ (10 specimens); holotype 39 μ.

Type loc.: Johan Hjortsfjell, Hopen, Svalbard, 283 m a.s.l.

Type hor.: Lower part of Flatsalen Member.

C. scabratus n. sp. resembles *C. tumidus* PLAYFORD (1965, p. 180) but is smaller, has less developed tori and more broadly rounded apices.

Occurrence: Sample 11/283. Common.

Concavisporites toralis (LESCHIK) NILSSON 1958

1955 LESCHIK, p. 12 (*Laevigatisporites toralis*)
1958 NILSSON, p. 34

This species resembles *Dictyophyllidites mortonii* but lacks the laesural lips (see discussion above).

Occurrence: Samples 9/14, 11/283, 11/3–8. Common.

Concavisporites sp.

Pl. 1, Figs. 8, 9

Description: Trilete spores, amb triangular, concave. Laesurae distinct, extending almost to equator. Tori distinct, following amb in polar view. Exine laevigate. Equatorial diameter 31–34 μ.

This spore is very similar to spores figured by GUY (1971, Pl. IV, Fig. 4, "cf. *Gleicheniidites senonicus* ROSS 1949") and by TRALAU (1968, Pl. X, Figs. 6, 7, *G. senonicus*) both from the Middle Jurassic of Scania.

Occurrence: Samples 11/283, 11/3–8. Rare.

Genus *Todisporites* COUPER 1958
Todisporites major COUPER 1958

1958 COUPER, p. 134

Size range of Hopen specimens is 45–73 μ, while that for the original material of *T. minor* is 34–50 μ. On present observations we see no clear distinction between our specimens and those described by COUPER.

Occurrence: Sample 5/163, 8/3. Rare.

Genus *Leptolepidites* COUPER 1953
Leptolepidites rotundus TRALAU 1968
Pl. 1, Figs. 11, 15

1968 TRALAU, p. 43
1971 GUY, p. 22

Occurrence: Sample 11/283. Rare.

Leptolepidites verrucatus COUPER 1953
Pl. 1, Fig. 12

1953 COUPER, p. 28
1963 DANZÉ & LAVEINE, p. 82 (*Leptolepidisporites verrucatus*)

Occurrence: Sample 11/283. Rare.

Genus *Apiculatisporis* POTONIÉ and KREMP 1956
Apiculatisporis parvispinosus (LESCHIK) SCHULZ 1962

1955 LESCHIK, p. 17
1962 SCHULZ, p. 312

Occurrence: Samples 9/14, 5/163, 8/3, 11/283, 11/3–8. Common.

Genus *Anapiculatisporites* POTONIÉ and KREMP 1954
Anapiculatisporites spiniger (LESCHIK) REINHARDT 1962
Pl. 1, Fig. 13

1955 LESCHIK, p. 18 (*Apiculatisporites spiniger*)
1962 REINHARDT, p. 707
1973 ORBELL, Pl. 3, Fig. 10

Occurrence: Samples 5/163, 2/14, 8/3, 11/283. Abundant.

Genus *Baculatisporites* THOMSON and PFLUG 1953
Baculatisporites comauensis (COOKSON) POTONIÉ 1956

1953 COOKSON, p. 470
1956 POTONIÉ, p. 33

Occurrence: Samples 8/3, 11/283, 11/3–8. Common.

Genus *Neoraistrickia* POTONIÉ 1956

There is uncertainty as to the status of *Neoraistrickia* versus *Cepulina* MALJAVKINA 1949 (see DETTMANN (1963), SCHULZ (1967), POTONIÉ (1970)). deJERSEY (1972, p. 17) maintained that reexamination of MALJAVKINA's material is necessary to solve the problem and suggested that meanwhile *Neoraistrickia* should be used. His view is followed here.

Neoraistrickia truncata (COOKSON) POTONIÉ 1956

1953 COOKSON, p. 471 (al. *Trilites truncatus*)
1956 POTONIÉ, p. 34

Occurrence: Samples 8/3, 11/283. Rare.

Neoraistrickia taylorii PLAYFORD and DETTMANN 1965
Pl. 1, Fig. 17

1965 PLAYFORD & DETTMANN, p. 138
1965 PLAYFORD, p. 185

Occurrence: Samples 2/14, 11/283, 11/3–8. Common.

Genus *Heliosporites* SCHULZ 1962

Heliosporites reissingeri (HARRIS) CHALONER 1969 ex MUIR and vanKONIJNENBURG-vanCITTERT 1970

1970 MUIR & vanKONIJNENBURG-vanCITTERT, p. 440

Occurrence: Sample 11/283. Rare.

Genus *Conbaculatisporites* KLAUS 1960

Conbaculatisporites hopensis n. sp.
Pl. 2, Figs. 1 (holotype), 2

Diagnosis: Trilete spores, amb triangular, apices broadly rounded, sides slightly concave to slightly convex. Laesurae simple, extending about 3/4 of the radius. Ornamentation baculate to echinate, fairly distantly and irregularly spaced, slightly denser at apices. Elements 2.5 μ high, usually between 0.5 and 1 μ across, occasionally up to 2.5 μ. Equatorial diameter 50–75 μ (10 specimens) holotype 65 μ.

Type loc.: Iversenfjellet, Hopen, Svalbard, 299 m a.s.l.

Type hor.: Lower part of Flatsalen Member.

The ornamentation distinguishes this species from all known species of *Conbaculatisporites*.

Occurrence: Sample 8/3. Rare.

Conbaculatisporites sp.
Pl. 1, Fig. 16

Description: Trilete spores, amb triangular, apices rounded. Laesurae distinct, simple, extending almost to equator. Laesurae bordered by arcuate thickenings or folds, 3–5 μ wide, fading towards apices. Ornamentation echinate, irregularly distributed, at apices denser elements 0.5–1.5 μ high, 1–2 μ wide at basis, spaced 2–6 μ. Diameter 35–42 μ.

This is a distinct form in our material and probably represents a new species.

Occurrence: Samples 2/14, 8/3. Common.

Genus *Porcellispora* SCHEURING 1970

Porcellispora longdonensis (CLARKE) SCHEURING 1970
Pl. 2, Fig. 3

1965 CLARKE, p. 299 (*Conbaculatisporites longdonensis*)
1970 SCHEURING, p. 103

Hopen specimens closely answer SCHEURING's description and fall within the size range observed in his material. Judging from SCHEURING's illustrations one is doubtful, however, whether his identification with CLARKE's species is correct. CLARKE's specimens are smaller (45–69 μ) than those of SCHEURING (60–85 μ).

Occurrence: Samples 5/163, 8/3. Rare.

Genus *Uvaesporites* DÖRING 1965

Uvaesporites argenteaeformis (BOLKHOVITINA) SCHULZ 1967

Pl. 2, Figs. 6, 8.

1953 BOLKHOVITINA, p. 51 (*Stenozonotriletes argenteaeformis*)
1967 SCHULZ, p. 560
1968 TRALAU, p. 68

SMITH et al. (1975) referred spores of the same morphology to *U. reissingeri* (REINHARDT) SMITH, HARLAND and HUGHES (1975). Their only reason for doing so was the different ages of the type material, *U. argenteaeformis* having been described from Cretaceous material and *U. reissingeri* (al. *Triletes reissingeri*) from the Rhaetian. We consider this insufficient to separate the two species and therefore use *U. argenteaeformis* which has priority.

Occurrence: Sample 11/283. Rare.

Genus *Lycopodiumsporites* (THIERGART) DELCOURT and SPRUMONT 1955

Lycopodiumsporites cf. *clavatoides* COUPER 1958

1958 COUPER, p. 132

Hopen specimens show more variation than *L. clavatoides* COUPER grading into forms with a lower reticulum, resembling *L. austroclavatoides* (COOKSON) POTONIÉ (1956). Most specimens are badly preserved and the reticulum often destroyed. Forms like those figured by MCGREGOR (1965 Pl. II, Figs. 38–40, 45 and Pl. III, Figs. 47, 48) from the Upper Triassic of Arctic Canada occur.

Occurrence: Samples 8/3, 11/283, 11/3–8. Rare.

Lycopodiumsporites semimuris (DANZÉ-CORSIN and LAVEINE) REISER and WILLIAMS 1969

Pl. 3, Figs. 1–3

1963 DANZÉ-CORSIN & LAVEINE, p. 79 (*Lycopodiumisporites semimuris*)
1965 MCGREGOR, p. 16
1969 REISER & WILLIAMS, p. 7

Occurrence: Samples 11/283, 11/3–8. Rare.

Lycopodiumsporites sp.

Pl. 2, Figs. 4, 5

Description: Trilete spores, amb triangular, slightly convex, apices rounded. Laesurae distinct, simple, extending almost to equator. Proximal surface laevigate, sometimes with small pits. Distal surface irregularly reticulate, luminae 3–5 μ wide, muri less than 1 μ high and about 2–3 μ thick. The reticulum fades towards equator and does not show along equatorial outline. Exine appears rather thick, but thickness difficult to measure. Diameter 30–40 μ.

Occurrence: Samples 11/283, 11/3–8. Rare.

Genus *Reticulitriletes* MÄDLER 1964
Reticulitriletes globosus MÄDLER 1964

1964 MÄDLER, p. 76, 77.

A single, well preserved specimen was found, diameter 64 μ.

Occurrence: Sample 2/14.

Genus *Cavatoretisporites* n. gen.

Diagnosis: Trilete, cavate miospores. Spore wall distinctly double except in proximal polar area. Outer wall reticulate, inner wall lacking ornamentation.

Genotype: Cavatoretisporites obvius n. sp.

Remarks: We consider that cavate spores should be separated from non-cavate equivalents on the generic level. For further discussion see under *C. obvius*.

Cavatoretisporites obvius n. sp.
Pl. 2, Figs. 7, 9 (holotype); Pl. 3, Figs. 4, 5

Diagnosis: Trilete, cavate spores. Spore wall distinctly double except in the region of the laesurae. Laesurae distinct, extending to equator of inner body. Overall external shape sub-circular, that of inner body rounded triangular. Outer wall slightly over 0.5 μ thick, reticulate except in proximal contact areas, muri 5–8 μ high, lumina 4–10 μ across. Inner wall laevigate, thickness 0.5 μ. Overall diameter (reticulum included) 39–56 μ (10 specimens); holotype 46×55 μ, inner body 30 μ.

Type loc.: Johan Hjortsfjell, Hopen, Svalbard, 283 m a.s.l.

Type hor.: Lower part of Flatsalen Member.

The basic morphology of this spore is clear: There are two separate walls except in the proximal polar area. However, when it comes to the significance of this feature and the terminology to be applied, the matter becomes complicated. Terminology applied to analogous structures is usually loaded with developmental interpretations which in fossil material can not be verified.

The taxonomic significance attached to double spore walls varies. While some workers appear to neglect the feature (for instance SCHULZ 1967), others may use it as criterion for suprageneric distinction at various levels (DETTMANN 1963; HART and HARRISON 1973). We consider that the feature described for this species justifies distinction from other genera under *Murornati*, and have therefore established a new genus. However, we are not inclined to follow DETTMANN (1963) who used the feature to distinguish taxa at much higher level. As for terminology, we have chosen a neutral approach, avoiding existing terms.

Occurrence: Sample 11/283. Rare.

Genus *Rugulatisporites* THOMSON and PFLUG 1953
Rugulatisporites ramosus deJERSEY 1959

1959 deJERSEY, p. 357

Occurrence: Samples 8/3, 11/283, 11/3–8. Rare.

Rugulatisporites sp.
Pl. 3, Fig. 8

Description: Trilete spores, amb circular. Laesurae simple, extending 1/2 to 2/3 of the radius. Proximal face laevigate, sometimes pitted. Equatorially and distally with a dense, rugulate ornamentation, elements about 1 μ wide and less than 1 μ high. Diameter 34–37 μ.

Occurrence: Samples 11/283, 11/3–8. Rare.

Genus *Lycopodiacidites* (COUPER) POTONIÉ 1956
Lycopodiacidites rugulatus (COUPER) SCHULZ 1967
Pl. 3, Figs. 6,9

1953 COUPER, p. 147 (*Perotriletes rugulatus*)
1967 SCHULZ, p. 573

Occurrence: Sample 11/283. Single specimen observed.

Genus *Selagosporis* KRUTZSCH 1963
Selagosporis mesozoicus SCHULZ 1967
Pl. 3, Fig. 14

1967 SCHULZ, p. 568

Occurrence: Sample 11/3–8. Single specimen observed.

Genus *Zebrasporites* (KLAUS) SCHULZ 1967
Zebrasporites laevigatus (SCHULZ) SCHULZ 1967
Pl. 3, Fig. 10

1962 SCHULZ, p. 310 (*Thuringiasporites laevigatus*)
1967 SCHULZ, p. 589

Occurrence: Sample 11/283. Rare.

Zebrasporites interscriptus (THIERGART) KLAUS 1960
Pl. 3, Fig. 11

1949 THIERGART, p. 13 (*Sporites interscriptus*)
1960 KLAUS, p. 139
1973 ORBELL, Pl. 1, Fig. 3

Occurrence: Samples 11/283, 11/3–8. Common.

Zebrasporites kahleri KLAUS 1960
Pl. 3, Fig. 12

1960 KLAUS, p. 138

Z. kahleri is distinguished from *Z. interscriptus* by possessing laesural thickenings and a coarser distal ornamentation (Klaus). The characters are clear in the present material and they are also seen in the material published by SCHULZ (1967), who, however, apparently misidentified typical *Z. kahleri* as *Z. interscriptus* (Pl. XV, Figs. 8, 9). Our specimens and those of Schulz are slightly smaller than those of Klaus (28 to 37 μ versus 42 to 50 μ).

Occurrence: Samples 11/283, 11/3–8. Rare.

Genus *Cosmoporites* NILSSON 1958

The exact morphology of this genus is not quite clear. We consider that folds on the distal face were misinterpreted by Nilsson as endexine features (compare description below).

cf. *Cosmoporites elegans* NILSSON 1958
Pl. 3, Fig. 13

1958 NILSSON, p. 37

Description: Trilete spores, amb triangular, sides concave, with distinct tori. Laesurae reaching equator, bordered by narrow lips, 1 μ broad. Tori interradially 2.5 μ–4 μ broad, narrowing and fading towards apices. Outer torus margin parallels or coincides with the equator in interradial areas. Folds occur on the distal face in symmetric positions at each amb apex, approximately opposite ends of tori. Exine laevigate. Equatorial diameter 20–34 μ (6 specimens).

Over-all appearance corresponds to the illustration of *C. elegans* in NILSSON (1958, Pl. 1, Fig. 18). The features interpreted as endexine invaginations at the apices by NILSSON are considered to be folds on the distal face as also observed in the present material. Unfortunately this interpretation cannot be confirmed, since the holotype is lost.

Occurrence: Samples 2/14, 9/14, 5/163, 11/283. Rare.

Genus *Camarozonosporites* (POTONIÉ) KLAUS 1960
Camarozonosporites rudis (LESCHIK) KLAUS 1960
Pl. 3, Fig. 7

1955 LESCHIK, Pl. 1, Fig. 15 (*Verrucosisporites rudis*)
1960 KLAUS, p. 136

Occurrence: Samples 8/3, 11/283, 11/3–8. Common.

Camarozonosporites laevigatus SCHULZ 1967
Pl. 3, Figs. 15, 16

1967 SCHULZ, p. 572

Occurrence: Sample 11/283. Rare.

Genus *Kyrtomisporis* MÄDLER 1964
Kyrtomisporis gracilis n. sp.
Pl. 4, Figs. 8, 9 (holotype)

Diagnosis: Trilete spores, amb rounded triangular. Laesurae simple, bordered by narrow thickenings, extending about 3/4 of the spore radius. Proximal face with tori extending more or less beyond apices to form protrusions, tori margins distinct and slightly sinuous, 4 to 5 μ wide. Cingulum faint, 4 to 8 μ broad, broadest interradially. Distal polar area with a few prominent warts, ridges 2 to 3 μ wide and up to 9 μ long. Surface chagrenate to laevigate. Diameter 48 to 56 μ (10 specimens).

Type loc.: Iversenfjellet, Hopen, Svalbard, 325 m a.s.l.

Type hor.: Lower part of Flatsalen Member.

K. gracilis resembles *K. speciosus* but is distinguished from it by the character of the distal ornamentation.

Occurrence: Samples 11/283, 11/3–8. Rare.

Kyrtomisporis laevigatus Mädler 1964
Pl. 4, Figs. 1, 2

1964 Mädler, p. 188

Occurrence: Samples 11/283, 11/3–8. Rare.

Kyrtomisporis niger n. sp.
Pl. 4, Figs. 4 (holotype), 6

Diagnosis: Trilete spores, amb rounded triangular. Laesurae distinct, bordered by thickenings. Proximal face with distinct tori, enclosing laesurae and forming prominent apices. Outline of tori undulating due to variations in width between 2 and 5 μ. Cingulum 3 to 5 μ wide. Distal face with 5 to 7 low, faint ridges, 3 to 5 μ wide which traverse between interradials and fuse with cingulum. Surface chagrenate to laevigate. Diameter 39–60 μ (15 specimens), holotype 57 μ.

Type loc.: Iversenfjellet, Hopen, Svalbard, 95 m a.s.l.

Type hor.: Lower part of Iversenfjellet Member.

The distal ornamentation distinguishes this species from *K. laevigatus* Mädler 1964.

Occurrence: Samples 9/14, 8/3, 11/3–8. Common.

Kyrtomisporis speciosus Mädler 1964
Pl. 4, Figs. 3, 5, 7

1964 Mädler, p. 188

Hopen specimens have a wider size range (36–60 μ) than indicated by Mädler (50–56 μ).

Occurrence: Samples 8/3, 11/283, 11/3–8. Common.

Genus *Duplexisporites* (Deak) Playford and Dettmann 1965
Duplexisporites problematicus (Couper) Playford and Dettmann 1965
Pl. 5, Fig. 2

1958 Couper, p. 146 (*Cingulatisporites problematicus*)
1958 Nilsson, p. 43 (*Corrugatisporites scanicus*).
1965 Playford & Dettmann, p. 139–140.

C. scanicus appears identical with *D. problematicus* and is therefore treated here as a later synonym in accordance with Tralau (1968, p. 27). We consider also *D. gyratus* (Playford and Dettmann 1965) to be conspecific with *D. problematicus*, since the difference in ornamentation used to distinguish *D. gyratus* clearly falls within the range of variation observed in the present material and which has also been observed by others (Couper 1958, Pl. 24, Figs. 12, 13).

This species was referred to *Contignisporites* by Döring (1965), while Playford and Dettmann (1965) referred it to *Duplexisporites*. Since it appears that *D. problematicus* lacks the parallel arrangement of muri which is a characteristic of *Contignisporites*, we follow Playford and Dettmann.

Occurrence: Samples 8/3, 11/283, 11/3–8. Common.

Genus *Annulispora* deJERSEY 1959
Annuuispora folliculosa (ROGALSKA) deJERSEY 1959
Pl. 5, Figs. 3, 6.

1954 ROGALSKA, p. 26 (*Sporites folliculosus*)
1959 deJERSEY, p. 358

Variations observed in the diameter of the distal thickening appear to be a product of compression. Consequently, the separation of *A. folliculosa* and *A. microannulata* by deJERSEY (1962) based on a difference in this diameter is hardly tenable (compare also PLAYFORD and CORNELIUS 1967, Pl. II, Figs. 5, 6).

Some specimens show faint radial structures on the distal surface, between the annular thickening and the cingulum, sometimes fusing with the cingulum. This feature appears to represent a certain stage of corrosion. Corrosion also makes some specimens appear oınamented.

Occurrence: Sample 8/3, 11/283, 11/3–8. Common.

Annulispora bicollateralis ROGALSKA 1956 n. comb.

1956 ROGALSKA, Pl. XXIX, Figs. 4–6. (*Sporites bicollateralis*)
1966 SCHULZ *In*: DÖRING et al. p. 79 (*Stereisporites bicollateralis*)

The specimens of ROGALSKA possess the annular thickening which is a generic criterion of *Annulispora* (see also p. 27). MORBEY (1975) transferred this species to *Polycingulatisporites*, as he emended the genus to cover *Annulispora*, which we consider rather unfortunate. We decline this emendation including the transfer of *A. bicollateralis* to *Polycingulatisporites*.

Occurrence: Samples 11/283, 11/3–8. Rare.

Annulispora sp. A
Pl. 5, Figs. 1, 4

Description: Trilete spores, corresponding to *A. folliculosa* (ROGALSKA) deJERSEY 1959 except for the outer margin of the distal thickening which possesses blunt radial protrusions.

This form appears distinct, but we have not established a new species since only two specimens have been observed.

Occurrence: Sample 11/283. Two specimens recorded.

Annulispora sp. B
Pl. 5, Fig. 5

Description: Resembling *A. bicollateralis* but distinguished by having faint radial ridges between the distal ring and the cingulum and closely spaced echinae 0.5–1 μ high along the zona margin. Equatorial diameter 27 μ.

This is a distinct form, but a new species is not established because only one specimen has been observed.

Occurrence: Sample 11/283. Single specimen recorded.

Genus *Polycingulatisporites* SIMONCSICS and KEDVES 1961
Polycingulatisporites cf. *circulus* SIMONCSICS and KEDVES 1961

1961 SIMONCSICS & KEDVES, p. 34

Identification is uncertain because the two specimens recorded are poorly preserved.

Occurrence: Sample 11/3–8. Two specimens recorded.

Genus *Cingulizonates* (DYBOVA and JACHOWICZ) BUTTERWORTH, JANSONIUS, SMITH and STAPLIN 1964
Cingulizonates rhaeticus (REINHARDT) SCHULZ 1967
Pl. 6, Fig. 5

1962 REINHARDT, p. 709 (*Aequitriradites rhaeticus*)
1967 SCHULZ, p. 584

The single specimen seen has a somewhat corroded zona, otherwise it corresponds to the description given by SCHULZ (1967). The two-layered spore wall structure observed in the Hopen specimen is apparent also in SCHULZ's figures but not mentioned in his description.

Occurrence: Sample 11/283. Single specimen recorded.

Genus *Densosporites* (BERRY) POTONIÉ and KREMP 1954
Densosporites sp.
Pl. 5, Figs. 7, 8

Description: Trilete zonate spores. Amb rounded triangular. Laesurae extending to inner margin of zona, simple. Ornamentation of foveolae less than 1 μ in diameter and about 1 μ apart. Zona about 8 μ wide, with radial thickenings which fuse to form a thickened outer margin. Equatorial diameter 49–54 μ.

Occurrence: Sample 11/283. Rare.

Genus *Velosporites* HUGHES and PLAYFORD 1961

Remarks: HUGHES and PLAYFORD described *Velosporites* as saccate. Cavate would probably be a more proper term since the morphology is completely different from that in true saccate pollen. This morphology is also different from that in hymenate spores (HART and HARRISON (1973, p. 68) whose "pseudozona" is an impression caused by the contour of the outer wall extending beyond the inner wall as seen in polar view. In *Velosporites*, however, the outer wall produces a real zona.

Velosporites cavatus n. sp.
Pl. 5, Figs. 9, 10 (holotype)

Diagnosis: Trilete, cavate spores with zona. Amb rounded triangular to subcircular. Spore wall double. Inner wall chagrenate, 0.5–1 μ thick, separated from the outer wall distally and equatorially, attached proximally. Outer wall forming a flange-like zona, 10 to 20 μ wide, laevigate to scabrate. Outer wall on the proximal face laevigate, on the distal face densely verrucate, including the inner margin of the zona, height of verrucae 1 to 1.5 μ, bases irregular, 3 to 6 μ in diameter. Equatorial diameter 48 to 76 μ (10 specimens); holotype 53 μ.

Type loc.: Johan Hjortsfjell, Hopen, Svalbard, 283 m a.s.l.

Type hor.: Lower part of Flatsalen Member.

The inner body is folded in some specimens. In some cases the verrucate ornamentation is composed of a few larger elements with much smaller elements in between.

A remarkable feature of this species is the outer wall which envelopes the central body and possesses a clearly defined zona. The same basic morphology is seen in *Velosporites triquetrus* (LANTZ) DETTMANN 1963. (The morphology differs from that in hymenate spores, see discussion under genus.)

Occurrence: Sample 11/283. Rare.

cf. *Velosporites* sp.

Common in samples 8/3, 11/283, 11/3–8 are spores of the same general morphology as *Velosporites* whose preservation is too poor to allow a closer identification.

Genus *Leschikisporis* POTONIÉ 1958

Leschikisporis aduncus (LESCHIK) POTONIÉ 1958

1955 LESCHIK, p. 27, 31 (*Punctatosporites aduncus, P. rimosus, P. percussus*)
1958 POTONIÉ, p. 18
1964a MÄDLER, p. 102
1966 MILLER, p. 224 (*Circlettisporites dawsonensis*)

In this species the laesura varies from monolet to a seemingly trilete scar. POTONIÉ (1958) suggested that this is a partly reduced trilete laesura. MÄDLER's (1964) interpretation of this feature was a pseudo-trilete laesura formed secondarily by folding. The Hopen material provides no solution to this problem.

Occurrence: Samples 10/95, 9/14, 5/163, 2/14, 8/3. Common.

Genus *Polypodiisporites* (POTONIÉ and GELLETICH) POTONIÉ 1956

Polypodiisporites ipsviciensis (deJERSEY) PLAYFORD and DETTMANN 1965

1962 deJERSEY, p. 7 (*Verrucososporites ipsviciensis*)
1965 PLAYFORD & DETTMANN, p. 150

Occurrence: Samples 5/163, 2/14. Rare.

Genus *Marattisporites* COUPER 1958

Marattisporites scabratus COUPER 1958

1958 COUPER, p. 133

Occurrence: Samples 10/95, 5/163. Rare.

Genus *Verrucatosporites* (THOMSON and PFLUG) POTONIÉ 1956

Verrucatosporites scabratus n. sp.

Pl. 6, Figs. 1, 2 (holotype), 3, 4

Diagnosis: Monolete spores, amb oval to subcircular. Laesurae extending 3/4 of major axis, simple. Entire exine covered by distinct hemispheiical verrucae, 4–10 μ in diameter. Verrucae and interstices scabrate occasionally with small verrucae, 1–2 μ in diameter. Size 39–52 μ along major axis (14 specimens); holotype 42 μ.

Type loc.: Johan Hjortsfjell, Hopen, Svalbard, 283 m a.s.l.

Type hor.: Lower part of Flatsalen Member.

V. scabratus n. sp. differs from *Ricciisporites tuberculatus* LUNDBLAD 1959 by never occurring in tetrades and having a different ornamentation. *Polypodiisporites* POTONIÉ 1956 has a denser ornamentation consisting of smaller elements. *Verrucatosporites alienus* THOMSON and PFLUG 1953 possesses smaller and more numerous sculptural elements.

Occurrence: Sample 11/283. Rare.

Genus *Aratrisporites* (LESCHIK) PLAYFORD and DETTMANN 1965

The emended description of PLAYFORD and DETTMANN is used here, treating *Saturnisporites* KLAUS 1960 as a synonym of *Aratrisporites*.

Aratrisporites laevigatus n. sp.
Pl. 6, Figs. 13 (holotype), 16

Diagnosis: Monolete, cavate spores, amb ellipsoidal. The delicate outer wall forms a pseudo-zona around the thicker inner wall. Both inner and outer wall laevigate. The pseudo-zona about 3 μ wide, regular. The laesurae bordered by thickened lips, 1 to 2 μ wide, not extending into the pseudo-zona. Length 42 to 60 μ (11 specimens), holotype 54 μ.

Type loc.: Iversenfjellet, Hopen, Svalbard, 325 m a.s.l.

Type hor.: Lower part of Flatsalen Member

Folds often occur at ends of laesurae affecting the pseudo-zona, which is otherwise rarely folded. The outer wall is often partly or completely torn or missing (Pl. 6, Fig. 16). The different thickness of the two walls make the pseudo-zona appear much lighter than the central part of the spore. All specimens are observed in polar view, indicating an originally shorter polar axis.

Occurrence: Samples 8/3, 11/3–8. Rare.

Aratrisporites macrocavatus n. sp.
Pl. 6, Fig. 9 (holotype)

Diagnosis: Monolete, cavate spores, amb broadly ellipsoidal to subcircular. The outer wall forming a pseudo-zona around the inner body whose longer axis is 1/3 to 2/3 of over-all major axis. Outer wall scabrate. Inner and outer walls about 1 μ thick. Laesurae sinuous. Length of major axis 37–84 μ (24 specimens), holotype 58 μ.

Type loc.: Johan Hjortsfjell, Hopen, Svalbard, 283 m a.s.l.

Type hor.: Lower part of Flatsalen Member

Occurrence: Samples 11/283, 11/3–8. Rare.

Aratrisporites scabratus KLAUS 1960
Pl. 6, Figs. 6, 7

1960 KLAUS, p. 147

Occurrence: Sample 2/14. Rare.

Aratrisporites spp.

In addition to the species of *Aratrisporites* named above, *A. parvispinosus* LESCHIK 1955 and *A. fimbriatus* KLAUS 1960 were observed in samples 11/283 and 11/3–8.

Genus *Psophosphaera* (NAUMOVA) POTONIÉ 1958

Psophosphaera sp.

Grains referable to *Psophosphaera* occur commonly in samples 9/14, 2/14, and 11/283. Amb often subcircular but variable because of accidental folds. Spore wall thin, scabrate. No aperture observed. Diameter 48 to 76 μ.

Genus *Laricoidites* POTONIÉ, THOMSON and THIERGART 1950

Laricoidites sp.

Spherical spores with a thin, undifferentiated wall without aperture. Surface laevigate, often pitted by corrosion. Numerous accidental folds occur. Diameter 62 to 155 μ. Common in sample 9/14.

Genus *Striatoabietites* (SEDOVA) HART 1964

Striatoabietites aytugii VISSCHER 1966

Pl. 6, Fig. 12

1966 VISSCHER, p. 359

One aberrant specimen with four sacci has been observed.

Occurrence: Samples 8/3, 11/283, 11/3–8. Rare.

Genus *Taeniasporites* (LESCHIK) JANSONIUS 1962

Taeniasporites rhaeticus SCHULZ 1967

Pl. 6, Fig. 15

1967 SCHULZ, p. 597

Occurrence: Samples 11/283, 11/3–8. Common.

Genus *Protodiploxypinus* (SAMOILOWICH) SCHEURING 1970

Protodiploxypinus gracilis SCHEURING 1970

Pl. 7, Figs. 1, 4

1970 SCHEURING, p. 70

Occurrence: Samples 2/14, 8/3, 11/283. Common.

Protodiploxypinus macroverrucosus n. sp.

Pl. 6, Fig. 10 (holotype)

Diagnosis: Bisaccate pollen, central body subcircular, sulcus extending across central body. Sacci almost spherical, 10–20 μ in diameter, distally attached. Body and sacci covered by verrucae, 2–4 μ high with irregular bases, 1–3 μ in diameter. Diameter of central body 40–70 μ (7 specimens); holotype 56 μ.

Type loc.: Werenskioldfjellet, Hopen, Svalbard, 150 m a.s.l.

Type hor.: Iversenfjellet Member

P. macroverrucosus n. sp. resembles *P. decus* SCHEURING (1970) which, however, lacks the ornamentation on the sacci. Also, the verrucae are more prominent and somewhat larger.

Occurrence: Samples 2/14, 8/3, 11/283. Rare.

Protodiploxypinus microsaccus n. sp.

Pl. 6, Figs. 8, 11, 14 (holotype Figs. 11, 14)

Diagnosis: Bisaccate pollen, amb ellipsoidal. Sacci small, reminding of tubercles. Sulcus extending across central body. Exine 2 μ thick, imperfectly intrareticulate, occasionally grading into a scabrate structure. Sacci distally attached, close to equator. Surface of sacci laevigate. Central body 37 to 59 × 48 to 70 μ (7 specimens). Holotype 46 × 59 μ.

Type loc.: Johan Hjortsfjell, Hopen, Svalbard, 283 m a.s.l.

Type hor.: Lower part of Flatsalen Member

Occurrence: Sample 11/283. Rare.

Protodiploxypinus minor n. sp.

Pl. 7, Figs. 2 (holotype), 3, 6, 7

Diagnosis: Bisaccate pollen, amb oval. Sulcus extending across central body. Sacci small, 5–8 μ in diameter, hemispherical to almost spherical, distally attached. Central body covered by hemispherical verrucae 0.5–1.5 μ across. Central body 25–40 μ long (8 specimens); holotype 31 μ.

Type loc.: Werenskioldfjellet, Hopen, Svalbard, 150 m a.s.l.

Type hor.: Iversenfjellet Member

Occurrence: Sample 2/14. Common.

Protodiploxypinus ornatus PAUTSCH 1973 n. comb.

Pl. 7, Fig. 5

1973 PAUTSCH, p. 139 (*Granisaccus ornatus*)

SCHEURING (1970) included *Granisaccus* MÄDLER 1964 in *Protodiploxypinus* (SAMOILOVICH) SCHEURING 1970. We agree with SCHEURING (1970) that ornamentation is insufficient for separation on generic level. *Granisaccus ornatus* is therefore transferred to *Protodiploxypinus*.

Occurrence: Samples 5/163, 2/14, 8/3, 11/283, 11/3–8. Common.

Genus *Caytonipollenites* COUPER 1958

Caytonipollenites pallidus (REISSINGER) COUPER 1958

Pl. 7, Figs. 8, 11

1950 REISSINGER, p. 109 (*Pityopollenites pallidus*)

1958 COUPER, p. 150

Occurrence: Samples 5/163, 2/14, 8/3, 11/283. Common.

Genus *Pityosporites* (SEWARD) MANUM 1960

Pityosporites scaurus (NILSSON) SCHULZ 1967

Pl. 8, Figs. 1, 2

1958 NILSSON, p. 87 (*Taedaepollenites scaurus*)

1967 SCHULZ, p. 595

1968 TRALAU, p. 87

Occurrence: Sample 11/283. Rare.

Genus *Parvisaccites* Couper 1958
Parvisaccites radiatus Couper 1958
Pl. 8, Figs. 3–6

1958 Couper, p. 154
Occurrence: Sample 2/14. Abundant.

Parvisaccites sp. A
Pl. 7, Fig. 10

Occurrence: Sample 11/283. Rare.

Genus *Ovalipollis* (Krutzsch) Pocock and Jansonius 1969

The morphology of *Ovalipollis* has been subject to some discussion. Observations on the present material support the view of Pocock and Jansonius (1969) that the tenuitates and the sulcus are situated on opposite faces of the grain, the sulcus being distal. It is possible that the tenuitates are formed where the individual pollen grains are in contact with the two closest neighbours in the tetrad.

Ovalipollis ovalis (Krutzsch) Pocock and Jansonius 1969
Pl. 7, Figs. 13, 14

1955 Krutzsch, p. 70
1969 Pocock & Jansonius, p. 158
Occurrence: Samples 2/14, 11/283, 11/3–8. Common.

Ovalipollis limbatus (Maljavkina) Pocock and Jansonius 1969
Pl. 7, Fig. 9

1949 Maljavkina, p. 110 (*Quadraeculina limbata*, *Q. anellaeformis*)
1958 Nilsson, p. 58 (*Chasmatosporites radiatus*)
1969 Pocock & Jansonius, p. 163
1970 Pocock, p. 96
1971 Guy, p. 61 (*Parvisaccites enigmatus*)
Occurrence: Sample 11/283. Rare.

Genus *Alisporites* Daugherty 1941
Alisporites microreticulatus Reinhardt 1964
Pl. 7, Fig. 12

1964 Reinhardt, p. 54
Occurrence: Samples 2/14, 5/163, 11/283. Common.

Genus *Brachysaccus* Mädler 1964
Brachysaccus neomundanus (Leschik) Mädler 1964

1955 Leschik, p. 63 (*Pityosporites neomundanus*)
1964 Mädler, p. 116
Occurrence: Sample 9/14, 5/163, 8/3. Abundant.

Group Tetrasaccus Pant 1954
Pl. 8, Fig. 7

Occurrence: Sample 9/14. Rare.

Genus *Ginkgocycadophytus* (Samoilovich) deJersey 1962

This genus is difficult to distinguish from *Cycadopites* (Wodehouse) Wilson and Webster 1946, *Monosulcites* (Erdtman) Couper 1953 and *Punctatomonocolpites* Pierce 1961, and they are more or less overlapping. Sulcus shape is usually of no value as a diagnostic feature since preservation (compression) causes considerable variation. *Ginkgocycadophytus* is here used in its broad sense as defined by deJersey (1962, p. 12).

Ginkgocycadophytus granulatus deJersey 1964
Pl. 8, Fig. 12; Pl. 9, Fig. 13

1964 deJersey, p. 10
Occurrence: Samples 9/14, 2/14, 11/283, 11/3–8. Rare.

Ginkgocycadophytus nitidus (Balme) deJersey 1962

1957 Balme, p. 30 (*Entylissa nitidus*)
1962 deJersey, p. 12
Occurrence: Samples 9/14, 2/14, 11/283, 11/3–8. Common.

Genus *Chasmatosporites* (Nilsson) Pocock and Jansonius 1969
Chasmatosporites apertus (Rogalska) Nilsson 1958
Pl. 8, Fig. 9

1954 Rogalska, p. 45
1958 Nilsson, p. 56
1967 Schulz, p. 602
1968 Tralau, p. 77
Occurrence: Samples 2/14, 11/283. Rare.

Chasmatosporites hians Nilsson 1958
Pl 8, Figs. 10, 11

1958 Nilsson, p. 55
1968 Tralau, p. 78
Occurrence: Samples 11/283, 11/3–8, 11/1. Common.

Genus *Classopollis* (Pflug) Pocock and Jansonius 1961
Classopollis harrisii Muir and vanKonijnenburg-vanCittert 1970
Pl. 9, Figs. 4, 5

1970 Muir & vanKonijnenburg-vanCittert, p. 437
Occurrence: Samples 2/14, 11/283. Rare.

Genus *Equisetosporites* (Daugherty) Pocock and Jansonius 1964
Equisetosporites cf. *steevesi* (Jansonius) deJersey 1958
Pl. 8, Fig. 8

1962 Jansonius, p. 77
1968 deJersey, p. 20

Smith et al. (1975) identified *E. chinleana* in Hopen (Iversenfjellet Member) and attached some stratigraphic significance to it, since this species would appear to indicate a Norian age. However, the definite identification of either

E. chinleana or *E. steevsi* in the Hopen material appears to us problematic because of the state of preservation of the grains.

Occurrence: Sample 9/14. Rare.

Genus *Schizaeoisporites* (POTONIÉ 1951) KRUTZSCH 1959

Schizaeoisporites worsleyi n. sp.

Pl. 8, Figs. 13, 14 (holotype); Pl. 9, Fig. 1

Diagnosis: Monosulcate pollen, bean-shaped to almost spherical. Sulcoid area scabrate to laevigate. Proximal face with 10 to 17 regular muri, about 3 μ wide, 1 to 2 μ high, parallel major spore axis and fusing at each end. Overall size 56 to 73 μ (20 specimens); holotype 62 (laterally compressed).

Type loc.: Iversenfjellet, Hopen, Svalbard, 163 m a.s.l.

Type hor.: Iversenfjellet Member

The sulcoid area is usually difficult to observe because it is compressed against the heavily sculptured proximal face.

Occurrence: Sample 5/163. Abundant.

Genus *Eucommiidites* ERDTMAN 1948

Eucommiidites intrareticulatus n. sp.

Pl. 9, Figs. 2, 3 (holotype), 6, 7

Diagnosis: Pollen with three sulci, amb ellipsoidal, median sulcus extending almost the length of the grain, width varying. Exine about 2 μ thick, intrapunctate to intrareticulate. Intrareticulum well developed proximally, lumina about 2 μ. Length of major axis 39 to 68 μ (19 specimens); holotype 64 μ.

Type loc.: Werenskioldfjellet, Hopen, Svalbard, 157 m a.s.l.

Type hor.: Iversenfjellet Member

This species differs from all known species of *Eucommiidites* in its distinctive wall structure.

Occurrence: Samples 2/14, 11/283. Common.

DINOPHYCEAE

Comments: *Rhaetogonyaulax* cf. *rhaetica* (Pl. 9, Fig. 8) occurs abundantly in sample 11/1. A few specimens probably belonging to *Shublikodinium armatum* and *S. granulatum* were observed from sample 11/283, where *Pareodinia* sp. also occurs rarely.

ACRITARCHA

Comments: Several species belonging to the genera *Micrhystridium*, *Baltisphaeridium* (Pl. 9, Fig. 9), *Veryhachium* (Pl. 9, Fig. 11), *Cymatiosphaera* and *Pterospermopsis* were recorded. Sample 11/283 produced the most diverse assemblage.

FORAMINIFERA

Comments: Uniserial, biserial and coiled inner linings of foraminifera (Pl. 9, Fig. 10) occur in samples 2/14, 8/3, 11/283, 11/3-8.

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Plates

Specimens are preserved in permanent strew preparations. Their locations on the slides are indicated by the mechanical stage coordinates of Leitz Dialux microscope No. 80292 belonging to Institutt for Geologi, University of Oslo. All preparations of figured specimens are stored in the type collection of Universitetets Paleontologiske Museum, Oslo.

PLATE 1

×1000 (except Fig. 10)

Fig. 1. *Calamospora nathorstii* (Halle) Klaus 1960 .... (p. 26)
Sample 11/283, slide 22, coord. 47.3–99.0.

Fig. 2. *Cyathidites minor* Couper 1953 .... (p. 26)
Sample 2/14, slide 12, coord. 28.2–91.6.

Fig. 3. *Stereisporites perforatus* Leschik 1955 .... (p. 27)
Sample 11/5, slide 9, coord. 52.4–106.1.

Fig. 4. *Biretisporites potoniei* Delcourt and Sprumont 1955 .... (p. 26)
Sample 8/3, slide UL/1, coord. 34.9–111.9.

Fig. 5. *Concavisporites scabratus* n. sp. Holotype .... (p. 28)
Sample 11/283, slide 22, coord. 42.9–109.6.

Fig. 6. *Sphagnumsporites australis* Cookson 1953 n. comb. .... (p. 26)
Sample 11/5, slide 5, coord. 54.1–114.2.

Fig. 7. *Deltoidospora neddeni* (Potonié) Orbell 1973 .... (p. 27)
Sample 11/283, slide 15, coord. 27.6–114.3.

Figs. 8, 9. *Concavisporites* sp. .... (p. 28)
Sample 11/283, slide 22, coord. 42.9–109.6.
Fig. 8: equatorial focus; Fig. 9: proximal focus.

Fig. 10. *Dictyophyllidites mortonii* (Couper) Dettmann 1963.................. (p. 27)
×500. Sample 9/14, slide 02, coord. 35.9–98.5.

Figs. 11, 15. *Leptolepidites rotundus* Tralau 1968 .... (p. 29)
Sample 11/283, slide 1, coord. 38.1–97.5.

Fig. 12. *Leptolepidites verrucatus* Couper 1953 .... (p. 29)
Sample 11/283, slide 14, coord. 27.8–98.9.

Fig. 13. *Anapiculatisporites spiniger* (Leschik) Reinhardt 1961................ (p. 29)
Sample 2/14, slide 1, coord. 21.6–113.2.

Fig. 14. *Dictyophyllidites mortonii* (deJersey) Playford and Dettmann 1965. ... (p. 27)
Sample 11/5, slide 1, coord. 23.2–107.2.

Fig. 16. *Conbaculatisporites* sp. .... (p. 30)
Sample 2/14, slide 15, coord. 20.5–113.6.

Fig. 17. *Neoraistrickia taylorii* Playford and Dettmann 1965 .... (p. 30)
Sample 8/3, slide UL/1, coord. 33.4–114.3.

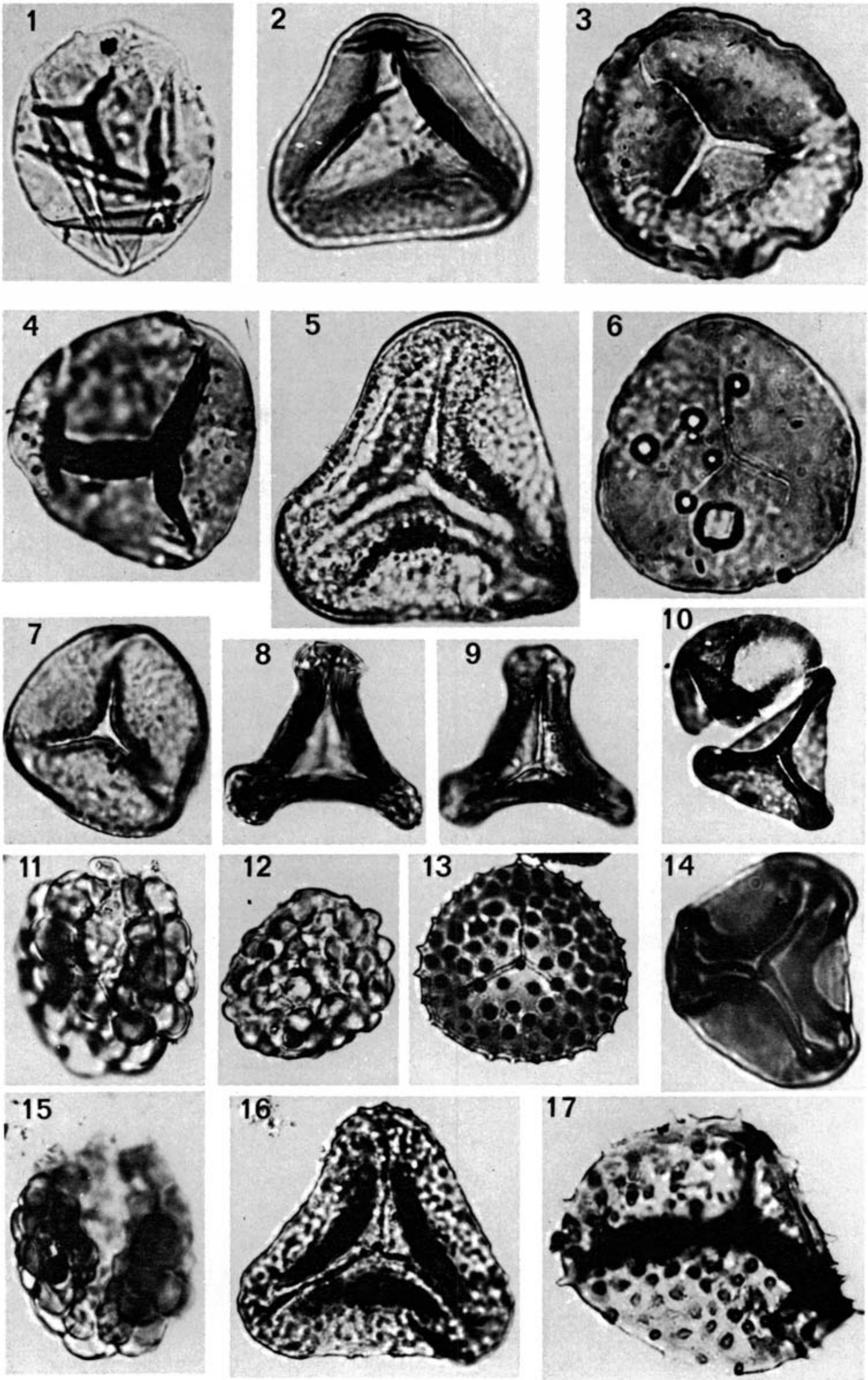
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PLATE 2

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Fig. 1.	*Conbaculatisporites hopensis* n. sp. Holotype. . . . . Sample 8/3, slide 6, coord. 44.0–113.6.	(p. 30)
Fig. 2.	*Conbaculatisporites hopensis* n. sp. . . . . Sample 8/3, slide UL/4, coord. 31.1–92.4.	(p. 30)
Fig. 3.	*Porcellispora longdonensis* SCHEURING 1970 . . . . Sample 8/3, slide UL/2, coord. 49.6–99.7.	(p. 30)
Figs. 4, 5.	*Lycopodiumsporites* sp. . . . . Sample 11/7, slide 6, coord. 42.8–107.4. Fig. 5. Distal focus.	(p. 31)
Figs. 6, 8.	*Uvaesporites argenteaeformis* (BOLCHOVITINA) SCHULZ 1967 . . . . Sample 11/283, slide 23, coord. 32.0–108.5.	(p. 31)
Figs. 7, 9.	*Cavatoretisporites obvius* n. sp. Holotype . . . . Sample 11/283, slide 23, coord. 31.8–108.5. Fig. 7. Focus on proximal face and inner body, Fig. 9. Distal focus	(p. 31)

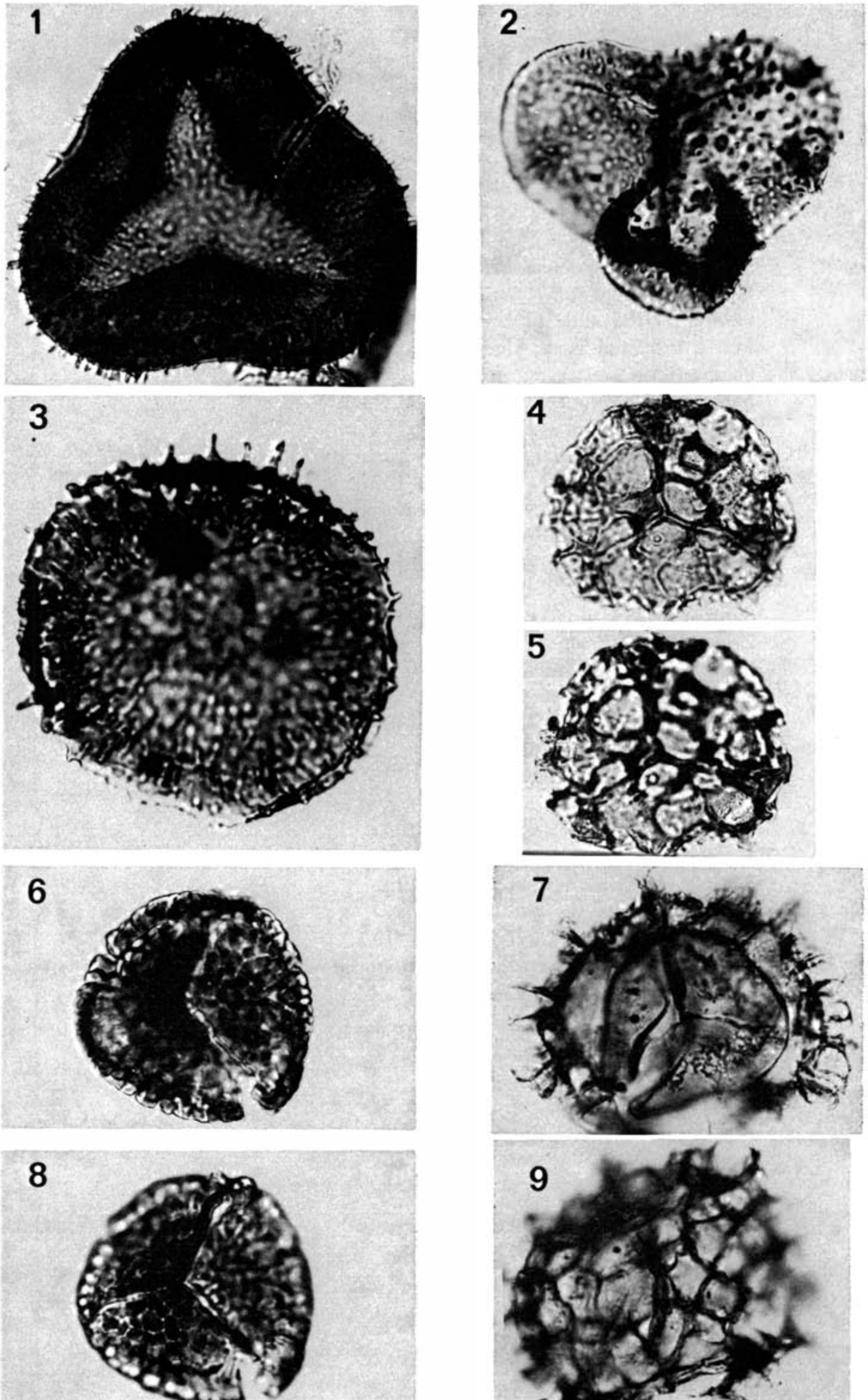
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PLATE 3

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Figs. 1, 2, 3. *Lycopodiumsporites semimuris* (Danzé-Corsin and Laveine) Reiser and Williams 1968 .... (p. 31)
Sample 11/183, slide 13, coord. 43.9–109.7.
Fig. 1. Proximal focus; Fig. 2. Equatorial focus; Fig. 3. Distal focus.

Figs. 4, 5. *Cavatoretisporites obvius* n. sp. .... (p. 32)
Sample 11/283, slide 13, coord. 45.4–114.1.
Fig. 4. Proximal focus; Fig. 5. Distal focus.

Figs. 6, 9. *Lycopodiacidites rugulatus* (Couper) Schulz 1967 .... (p. 33)
Sample 11/283, slide 1, coord. 35.0–107.5.
Fig. 6. Proximal focus; Fig. 9. Equatorial focus.

Fig. 7. *Camarozonosporites rudis* (Leschik) Klaus 1960........ (p. 34)
Sample 11/283, slide 1, coord. 28.0–106.7. Distal focus.

Fig. 8. *Rugulatisporites* sp. .... (p. 33)
Sample 11/283, slide 1, coord. 35.0–104.5.

Fig. 10. *Zebrasporites laevigatus* (Schulz) Schulz 1967........ (p. 33)
Sample 11/283, slide 23, coord. 40.0–110.8.

Fig. 11. *Zebrasporites interscriptus* Klaus 1960........ (p. 33)
Sample 11/283, slide 2, coord. 40.0–107.5.

Fig. 12. *Zebrasporites kahleri* Klaus 1960........ (p. 33)
Sample 11/7, slide 4, coord. 21.8–100.0.

Fig. 13. cf. *Cosmosporites elegans* Nilsson 1958........ (p. 34)
Sample 2/14, slide 15, coord. 42.1–109.6.

Fig. 14. *Selagosporis mesozoicus* Schulz 1967 .... (p. 33)
Sample 11/5, slide 1, coord. 39.7–114.2.

Figs. 15, 16. *Camarozonosporites laevigatus* Schulz 1967........ (p. 34)
Sample 11/283, slide 2, coord. 38.4–110.5.
Fig. 15. Proximal focus; Fig. 16. Equatorial focus.

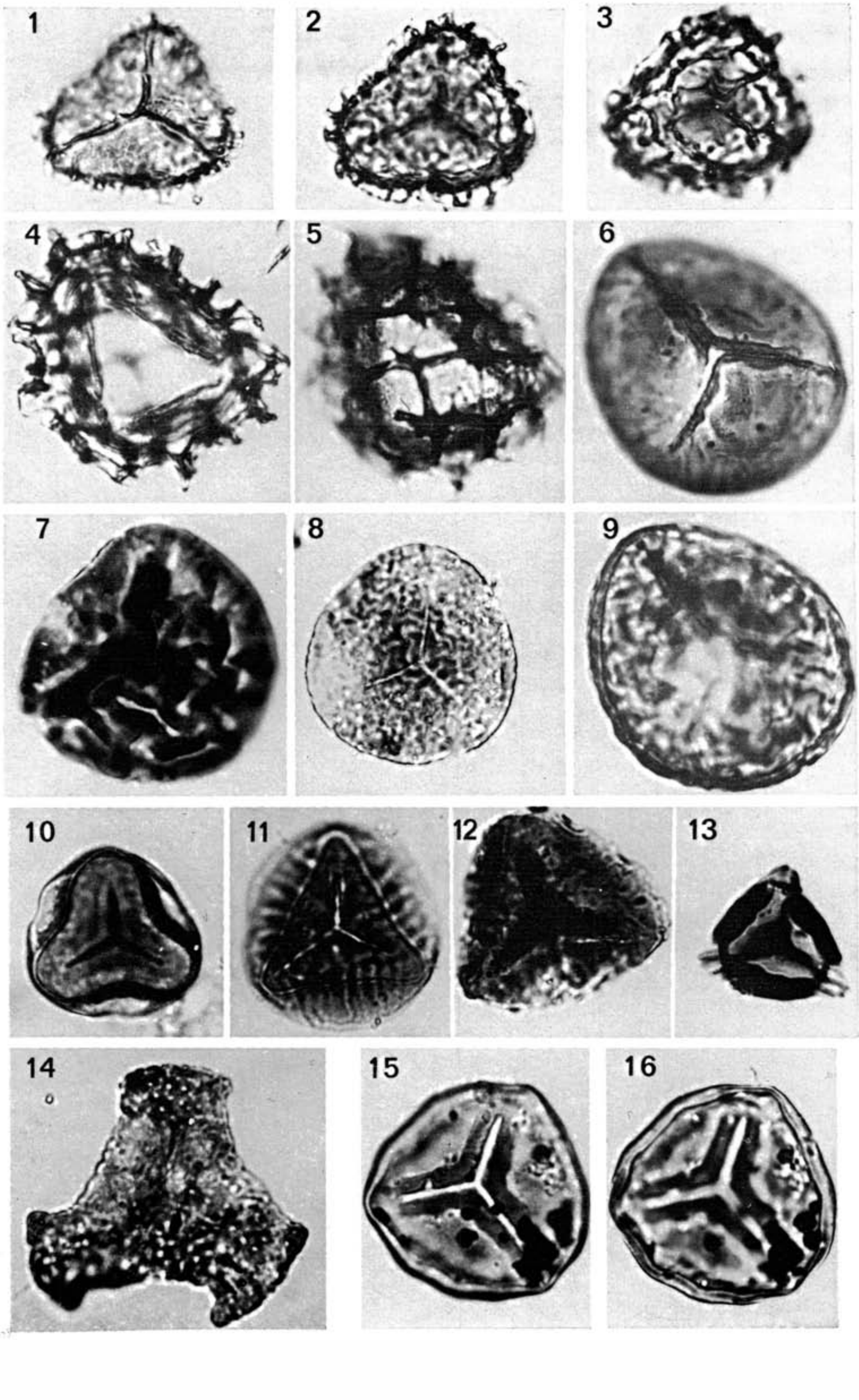
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PLATE 4

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Figs. 1, 2. *Kyrtomisporis laevigatus* MÄDLER 1964 .... (p. 35)
Sample 11/283, slide 11, coord. 29.8–113.1.
Fig. 1. Equatorial focus; Fig. 2. Proximal focus.

Fig. 3. *Kyrtomisporis speciosus* MÄDLER 1964 .... (p. 35)
Sample 11/5, slide 5, coord. 54.4–103.0.

Fig. 4. *Kyrtomisporis niger* n. sp. Holotype .... (p. 35)
Sample 9/14, slide 0/1, coord. 46.4–91.6.

Fig. 5. *Kyrtomisporis speciosus* MÄDLER 1964 .... (p. 35)
Sample 11/5, slide 11, coord. 30.9–108.3.

Fig. 6. *Kyrtomisporis niger* n. sp. .... (p. 35)
Sample 9/14, slide 0/2, coord. 26.3–94.6.
Lateral compression.

Fig. 7. *Kyrtomisporis speciosus* MÄDLER 1964 .... (p. 35)
Sample 11/5, slide 5, coord. 24.3–104.4.

Figs. 8, 9. *Kyrtomisporis gracilis* n. sp. Holotype .... (p. 34)
Sample 11/5, slide 7, coord. 24.5–100.3.
Fig. 8. Distal focus; Fig. 9. Proximal focus.

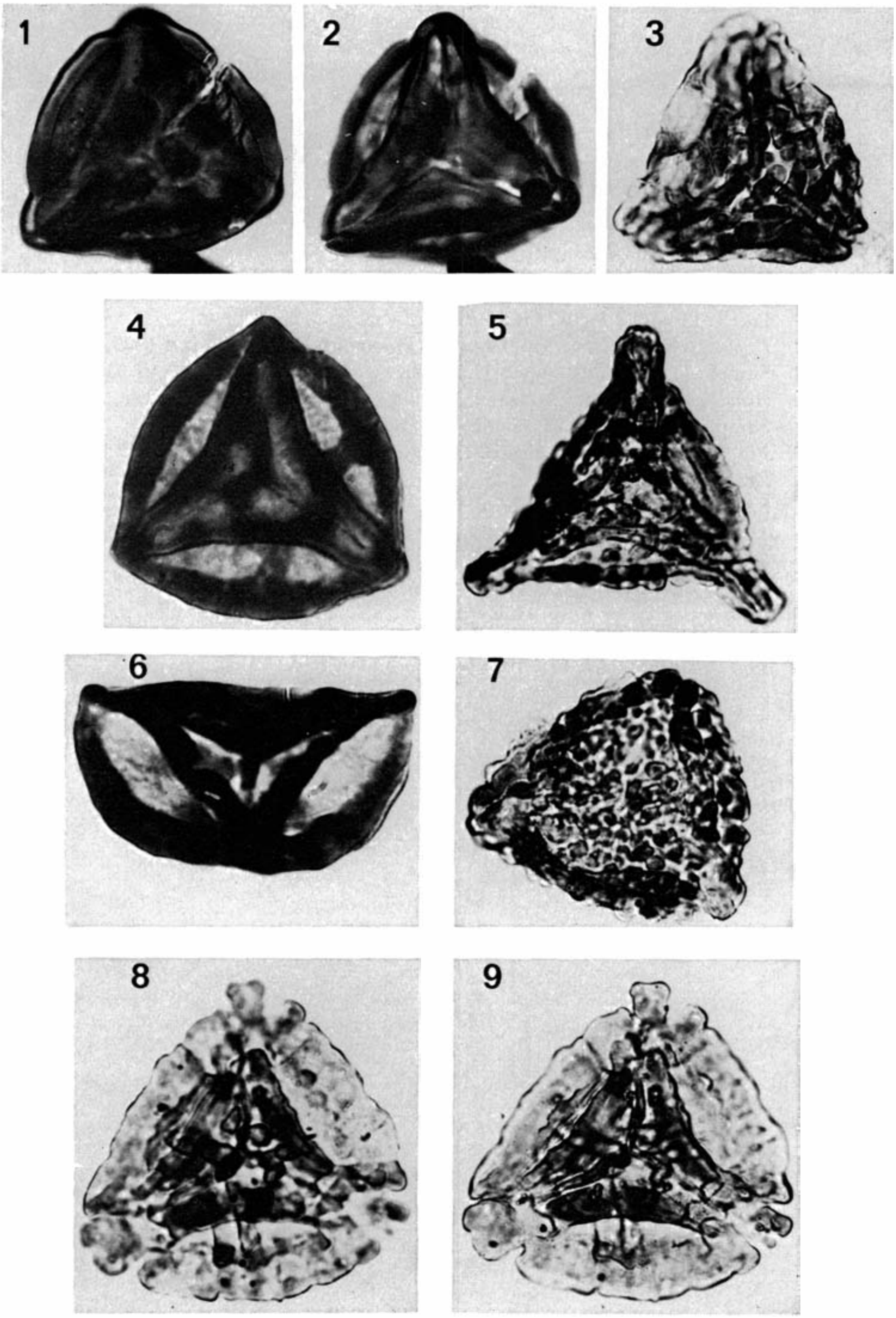

PLATE 5

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Figs. 1, 4. *Annulispora* sp. A .... (p. 36)
Sample 11/283, slide 5, coord. 30.0–106.6.
Fig. 1. Proximal focus; Fig. 4. Distal focus.

Fig. 2. *Duplexisporites problematicus* (COUPER) PLAYFORD and DETTMANN 1965. . (p. 35)
Sample 11/5, slide 5, coord. 53.5–108.7.

Figs. 3, 6. *Annulispora folliculosa* (ROGALSKA) deJERSEY 1959 .... (p. 36)
Sample 11/283, slide 23, coord. 44.8–106.6.
Fig. 3. Proximal focus; Fig. 6. Distal focus.

Fig. 5. *Annulispora* sp. B .... (p. 36)
Sample 11/283, slide 20, coord. 34.9–113.3.

Figs. 7, 8. *Densosporites* sp. .... (p. 37)
Sample 11/283, slide 24, coord. 41.1–95.4.
Fig. 7. Equatorial focus; Fig. 8. Distal focus.

Figs. 9, 10. *Velosporites cavatus* n. sp. Holotype................................ (p. 37)
Sample 11/283, slide 12, coord. 39.5–91.2.
Fig. 9. Distal focus; Fig. 10. Focus on inner body.

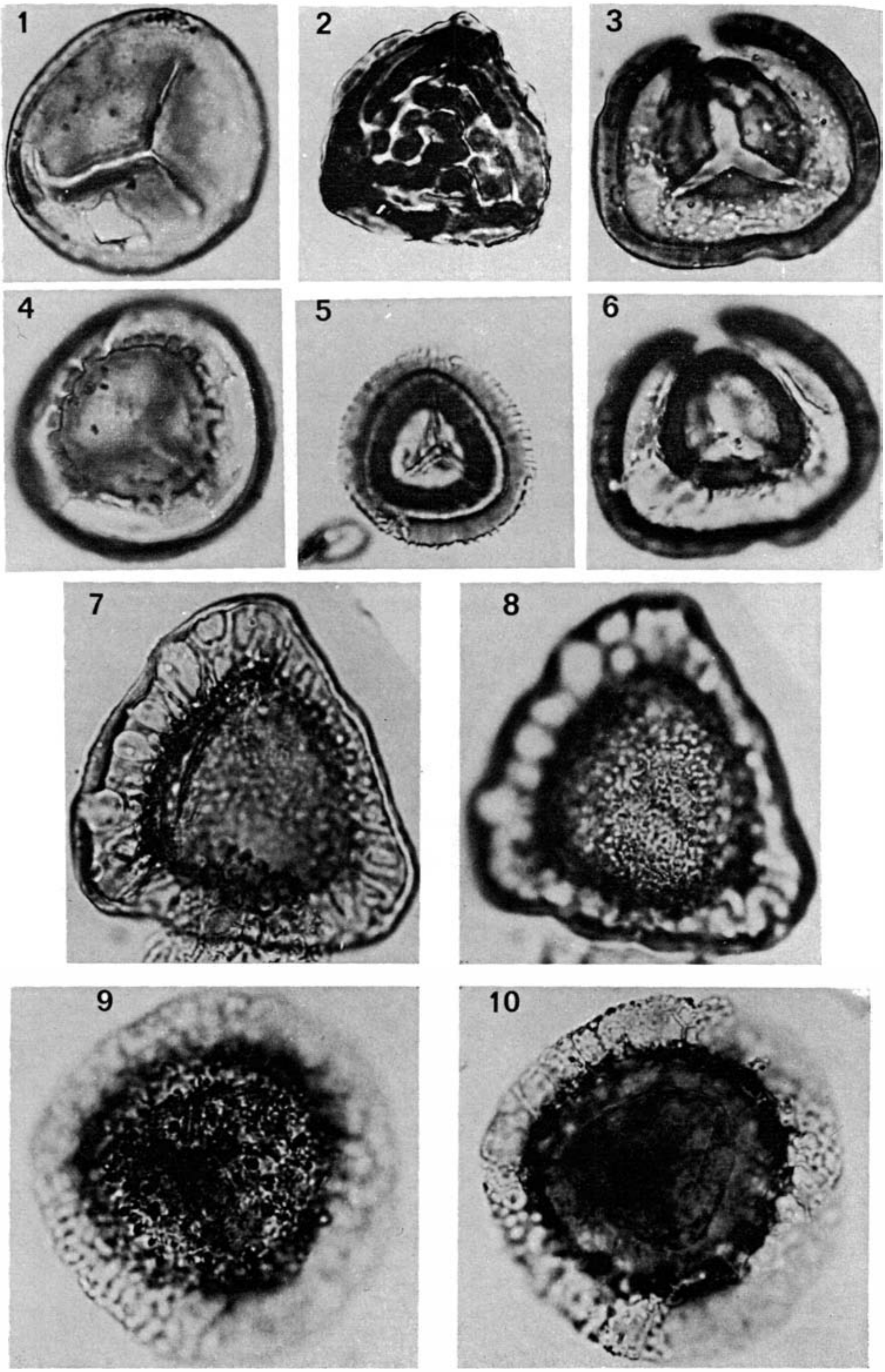
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PLATE 6

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Figs. 1, 2. *Verrucatosporites scabratus* n. sp. Holotype .... (p. 38)
Sample 11/283, slide 2, coord. 31.8–99.2.

Figs. 3, 4. *Verrucatosporites scabratus* n. sp. .... (p. 38)
Sample 11/283, slide 20, coord. 30.4–113.3.
Fig. 3. Distal focus; Fig. 4. Equatorial focus.

Fig. 5. *Cingulizonates rhaeticus* (REINHARDT) SCHULZ 1967 .... (p. 37)
Sample 11/283, slide 6, coord. 29.8–97.9.

Figs. 6, 7. *Aratrisporites scabratus* KLAUS 1960 .... (p. 39)
Sample 2/14, slide 15, coord. 20.8–113.7.
Fig. 6. Proximal focus; Fig. 7. Equatorial focus.

Fig. 8. *Protodiploxypinus microsaccus* n. sp. .... (p. 41)
Sample 11/283, slide 2, coord. 30.2–96.2.

Fig. 9. *Aratrisporites macrocavatus* n. sp. Holotype .... (p. 39)
Sample 11/283, slide 2, coord. 45.7–105.2.

Fig. 10. *Protodiploxypinus macroverrucosus* n. sp. Holotype .... (p. 40)
Sample 2/14, slide 13, coord. 31.7–102.1.

Figs. 11, 14. *Protodiploxypinus microsaccus* n. sp. Holotype .... (p. 41)
Sample 11/283, slide 23, coord. 27.3–108.0.

Fig. 12. *Striatoabietites aytugii* VISSCHER 1966 .... (p. 40)
Sample 11/283, slide 23, coord. 49.4–110.5.

Fig. 13. *Aratrisporites laevigatus* n. sp. Holotype .... (p. 39)
Sample 11/8, slide 2, coord. 51.4–103.9.

Fig. 15. *Taeniasporites rhaeticus* SCHULZ 1967 .... (p. 40)
Sample 11/283, slide 6, coord. 29.1–105.6.

Fig. 16. *Aratrisporites laevigatus* n. sp. .... (p. 39)
Sample 8/3, slide UL/2, coord. 36.7–93.3.

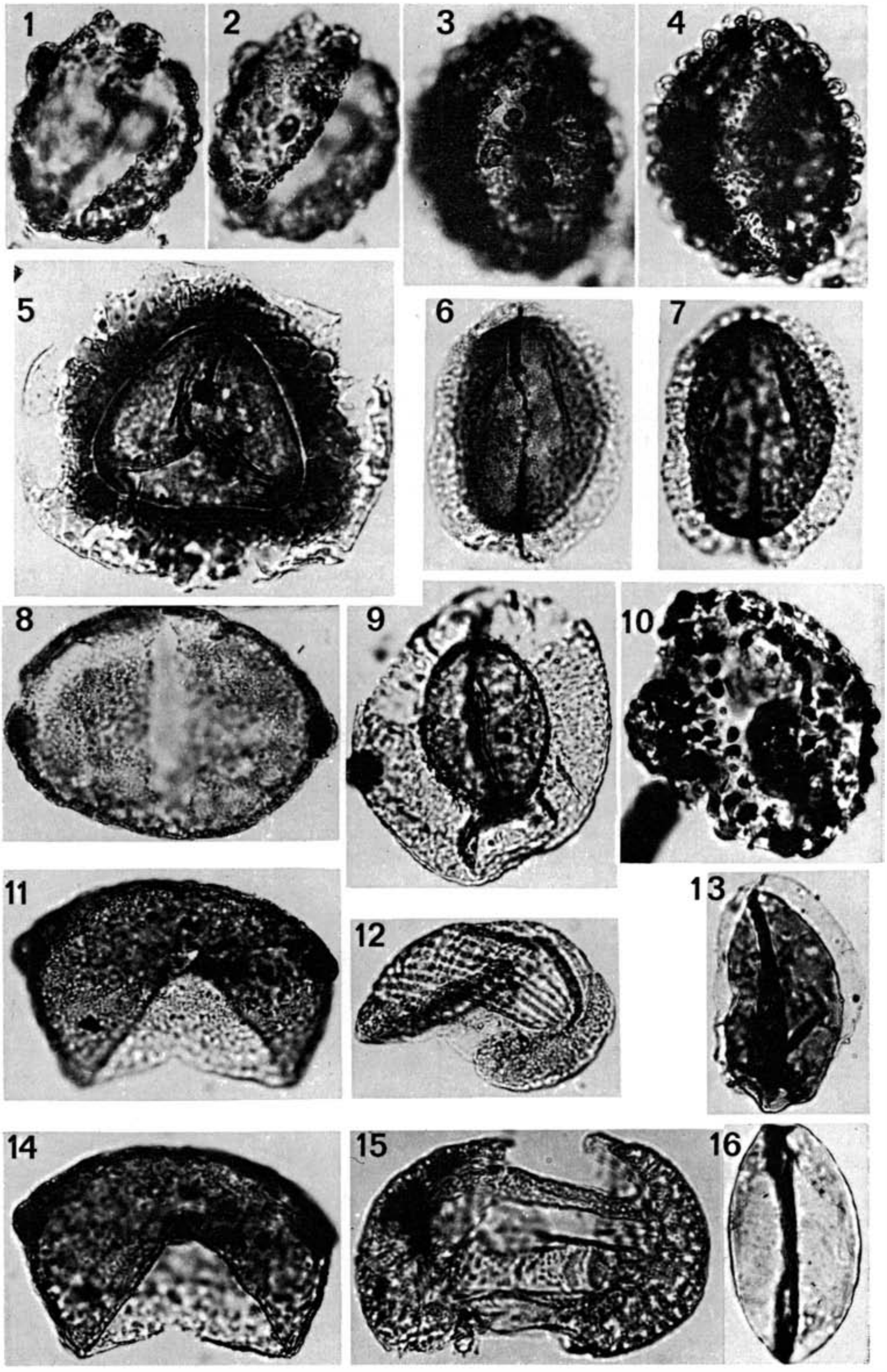
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PLATE 7
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Figs. 1, 4. *Protodiploxypinus gracilis* SCHEURING 1970 .... (p. 40)
Sample 11/283, slide 2, coord. 30.7–105.0.

Fig. 2. *Protodiploxypinus minor* n. sp. Holotype .... (p. 41)
Sample 2/14, slide 13, coord. 51.9–107.5.

Fig. 3. *Protodiploxypinus minor* n. sp. .... (p. 41)
Sample 2/14, slide 18, coord. 34.4–104.8.

Fig. 5. *Protodiploxypinus ornatus* PAUTSCH 1973 n. comb. .... (p. 41)
Sample 2/14, slide 12, coord. 38.5–101.3.

Figs. 6, 7. *Protodiploxypinus minor* n. sp. .... (p. 41)
Sample 2/14, slide 18, coord. 39.0–110.3.

Fig. 8. *Caytonipollenites pallidus* (REISSINGER) COUPER 1958.................. (p. 41)
Sample 2/14, slide 12, coord. 25.2–108.8.

Fig. 9. *Ovalipollis limbatus* (MALJAVKINA 1949) POCOCK and JANSONIUS 1969.. (p. 42)
Sample 11/283, slide 11, coord. 48.4–92.8.

Fig. 10. *Parvisaccites* sp. A.. (p. 42)
Sample 11/283, slide 22, coord. 47.6–101.1.

Fig. 11. *Caytonipollenites pallidus* (REISSINGER) COUPER 1958.................. (p. 41)
Sample 2/14, slide 15, coord. 20.7–111.8.

Fig. 12. *Alisporites microreticulatus* REINHARDT 1964 .... (p. 41)
Sample 11/283, slide 12, coord. 31.2–111.4.

Fig. 13. *Ovalipollis ovalis* (KRUTZSCH 1955) POCOCK and JANSONIUS 1969 ...... (p. 42)
Sample 11/283, slide 22, coord. 42.9–109.6.

Fig. 14. *Ovalipollis ovalis* (KRUTZSCH 1955) POCOCK and JANSONIUS 1969 ...... (p. 42)
Sample 2/14, slide 18, coord. 24.1–109.5.

PLATE 7

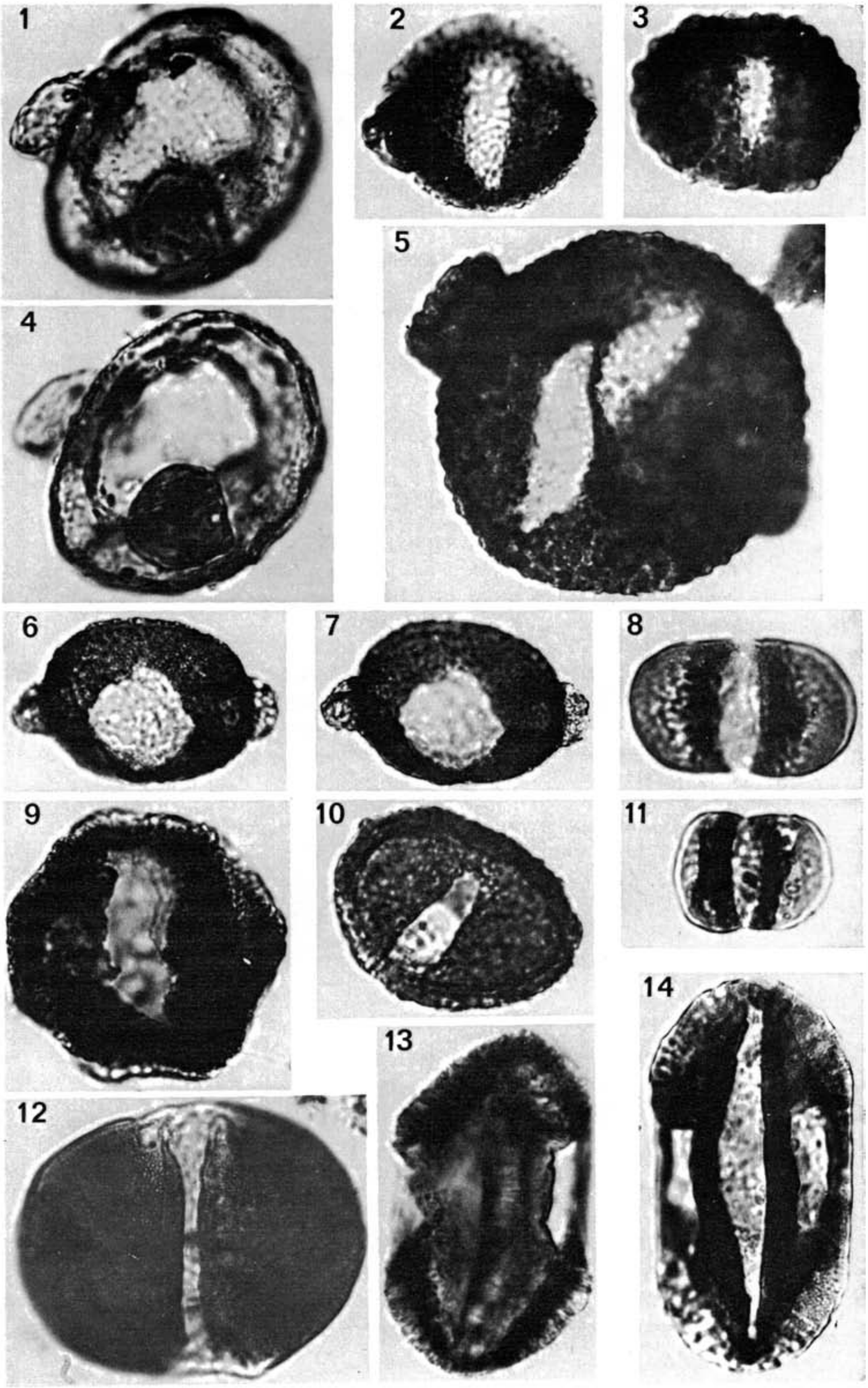

PLATE 8

×750

Figs. 1, 2.	*Pityosporites scaurus* (NILSSON 1958) SCHULZ 1967	(p. 41)
	Sample 11/283, slide 16, coord. 31.9–93.8	
	Fig. 1. Focus on outline of central body; Fig. 2. Focus on sacci.	
Figs. 3, 6.	*Parvisaccites radiatus* COUPER 1958	(p. 42)
	Sample 11/283, slide 2, coord. 45.1–100.7.	
	Lateral compression.	
Fig. 4.	*Parvisaccites radiatus* COUPER 1958	(p. 42)
	Sample 2/14, slide 15, coord. 24.6–98.2.	
Fig. 5.	*Parvisaccites radiatus* COUPER 1958	(p. 42)
	Sample 2/14, slide 13, coord. 44.5–96.4.	
Fig. 7.	Tetrasaccus PANT 1954	(p. 42)
	Sample 9/14, slide 0/5, coord. 47.6–107.6.	
Fig. 8.	*Equisetosporites* cf. *steevesi* (JANSONIUS) deJERSEY 1968	(p. 43)
	Sample 9/14, slide 0/1, coord. 51.2–91.8.	
Fig. 9.	*Chasmatosporites apertus* (ROGALSKA) NILSSON 1958	(p. 43)
	Sample 11/283, slide 11, coord. 26.7–99.9.	
Figs. 10, 11.	*Chasmatosporites hians* NILSSON 1958	(p. 43)
	Sample 11/283, slide 6, coord. 30.6–104.9.	
	Fig. 10. Distal focus; Fig. 11. Focus on ornamentation.	
Fig. 12.	*Ginkgocycadophytus granulatus* deJERSEY 1964	(p. 43)
	Sample 2/14, slide 9, coord. 44.1–93.9.	
Figs. 13, 14.	*Schizaeoisporites worsleyi* n. sp. Holotype	(p. 44)
	Sample 5/163, slide 3, coord. 32.0–106.9.	

PLATE 8

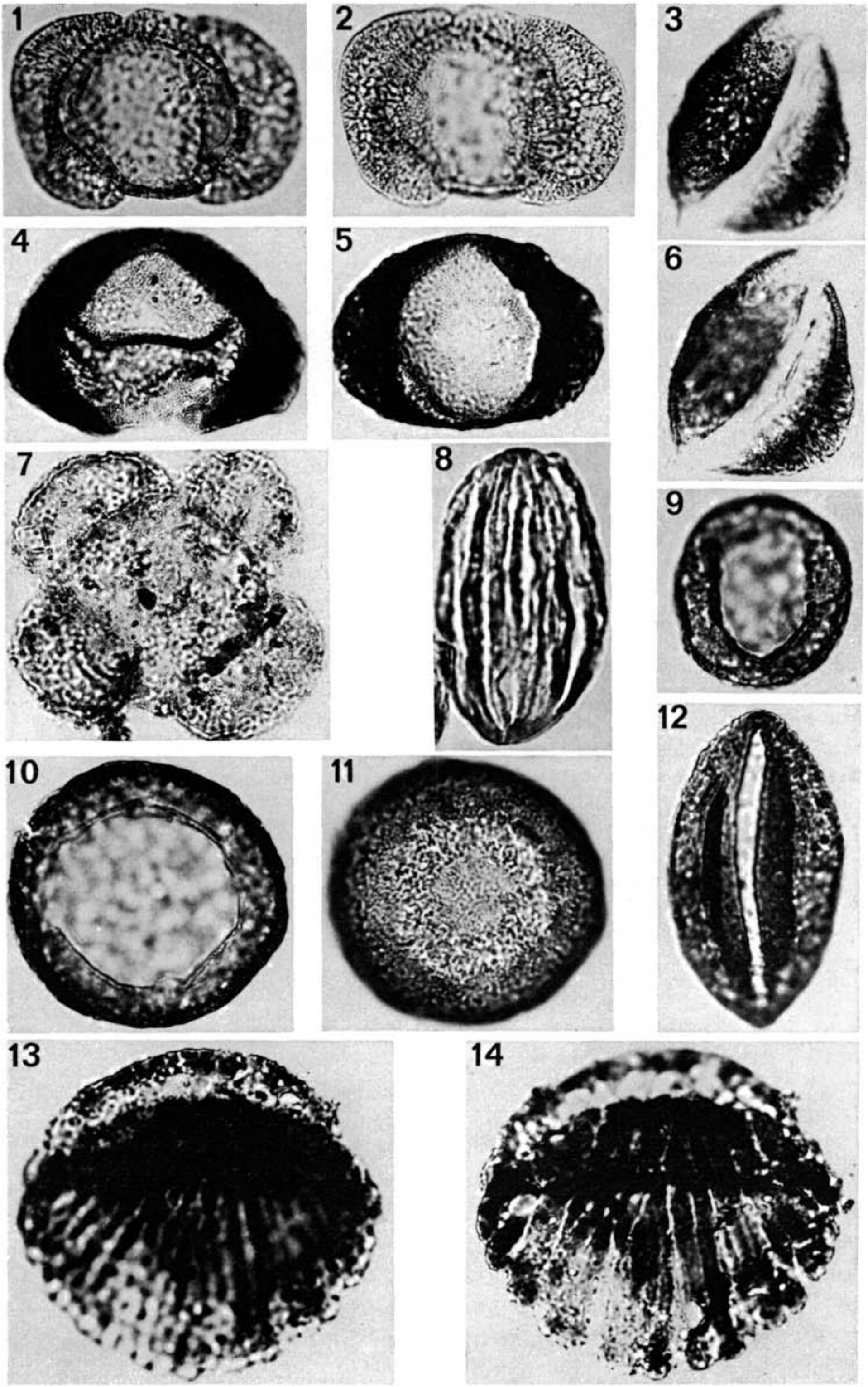

PLATE 9

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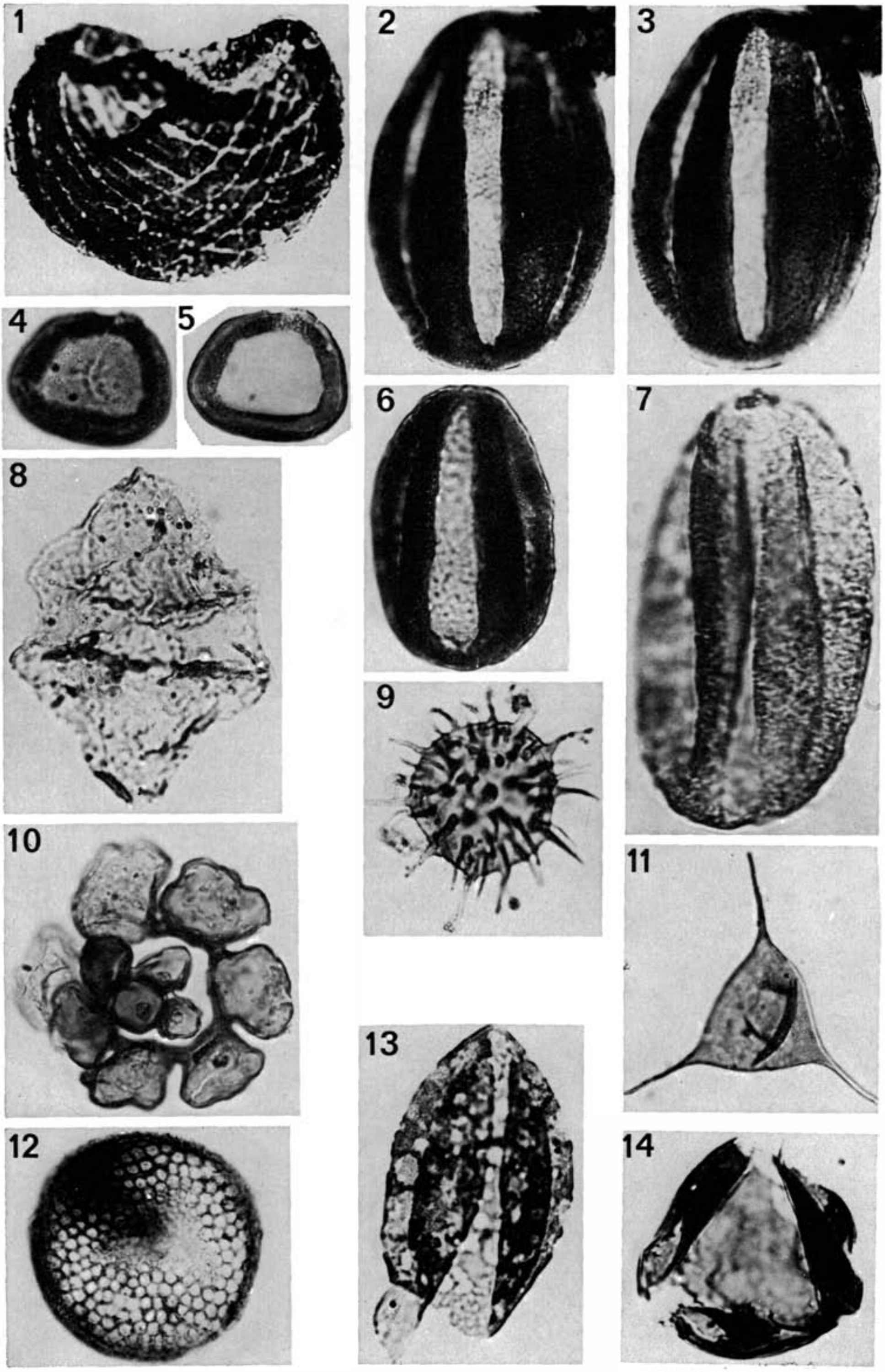
Fig. 1.	*Schizaeoisporites worsleyi* n. sp. . . . . Sample 5/163, slide 7, coord. 31.3–111.1. Oblique compression.	(p. 44)
Figs. 2, 3.	*Eucommiidites intrareticulatus* n. sp. Holotype . . . . Sample 2/14, slide 18, coord. 48.4–96.7.	(p. 44)
Figs. 4, 5.	*Classopollis harrisii* MUIR and vanKONIJNENBURG-vanCITTERT 1970 . . . . Sample 11/283, slide 8, coord. 47.6–97.2 Fig. 4. Proximal focus; Fig. 5. Distal focus.	(p. 43)
Fig. 6.	*Eucommiidites intrareticulatus* n. sp. . . . . Sample 2/14, slide 12, coord. 40.6–99.2.	(p. 44)
Fig. 7.	*Eucommiidites intrareticulatus* n. sp. . . . . Sample 11/283, slide 11, coord. 48.3–105.8.	(p. 44)
Fig. 8.	*Rhaetogonyaulax* cf. *rhaetica* (SARJEANT) LOEBLICH and LOEBLICH 1968. . Sample 11/5, slide 5, coord. 54.6–103.1.	(p. 44)
Fig. 9.	*Baltisphaeridium* sp. . . . . Sample 11/283, slide 2, coord. 30.8–105.8.	(p. 44)
Fig. 10.	Inner lining of foraminifer. . . . . Sample 11/283, slide 23, coord. 30.2–93.7.	(p. 44)
Fig. 11.	*Veryhachium reductum* (DEUNFF) JECHOWSKY 1961 . . . . Sample 2/14, slide 12, coord. 40.0–91.0.	(p. 44)
Fig. 12.	*Incertae sedis* . . . . Sample 11/7, slide 1, coord. 33.2–96.7.	
Fig. 13.	*Ginkgocycadophtus granulatus* deJERSEY 1964 . . . . Sample 2/14, slide 15, coord. 19.9–100.6. Specimen damaged by microbial attack.	(p. 43)
Fig. 14.	*Cyathidites* sp. . . . . Specimen damaged by microbial attack.	

PLATE 9



A.s John Grieg