LEIDSE GEOLOGISCHE MEDEDELINGEN, deel 35, pp. 209—276, separate published 19-1-'66

PALYNOLOGY OF UPPERMOST JURASSIC AND LOWERMOST CRETACEOUS STRATA IN THE EASTERN NETHERLANDS

BY

D. BURGER

CONTENTS

ABSTRACT

The present investigation is a systematical treatment of the sporomorphs from strata at the Jurassic-Cretaceous boundary in the eastern Netherlands Twente area, and an attempt to apply palynology to detailed stratigraphical study, by making use of quantitative pollen analyses. The rock samples used have been derived from two drilled sections in the eastern Netherlands, each of them representing the uppermost Jurassic and lowermost Cretaceous. The sediments are part of the sequence belonging to the Mesozoic Lower Saxon Basin; they contain the so-called "Wealden" beds, the age of which is not exactly known. Two pollen diagrams were composed from the analyses and show major pollen fluctuations, which are most probably to be regarded as a consequence of long-range oscillations of vegetational belts near the western border of the Lower Saxon Basin.

The purpose of the investigation has been to establish the time-stratigraphical position of the "Wealden" more precisely and furthermore, to establish major quantitative frequency changes in the pollen flora at the Jurassic-Cretaceous boundary. For this purpose the diagrams have been divided into nine pollen zones R to Z, based on first and last occurrence of sporomorph species. The "Wealden" section contains nearly three zones (V to X).

Recent correlation in several European stratigraphical sequences, based on ostracods, have shown that the Jurassic-Cretaceous boundary in the Dutch-German stratigraphy may be located between the base of the Serpulite and the upper limit of ostracod zone "Wealden" 4, with strong indications that it might even be placed in a much less extended interval, ranging from the uppermost Serpulite to the base of ostracod zone "Wealden" 2, that is to say from the base of pollen zone V to the base of pollen zone W.

The present investigation in the field of palynology takes also into consideration the rhythmic fluctuations, shown in the pollen diagrams from the eastern Netherlands. Similar fluctuations were recorded in the pollen flora from Maastrichtian and Paleocene strata in Colombia, South America. They are attributed to regular oscillations of the climate at time-intervals of approximately 2.3 million years and 7 million years. These rhythmic fluctuations were also recorded in the sedimentary history of the Eastern Cordillera in Colombia during the Cretaceous; they are assumed to originate from regular sea-level oscillations, taking place synchronously with the Cretaceous ages at time-intervals of around 7 million years.

Applying this theoretical time-scale to the pollen diagrams from the eastern Netherlands, it might be possible to attribute the rhythmic oscillations, shown in the Dutch pollen flora, to time-intervals of approximately 2.3 million years. In this case the Berriasian occupies 3 cycles immediately underneath the Valanginian, that is to say the pollen zones X and W, and possibly also zone V. The Jurassic-Cretaceous boundary might then be located at the base of zone W or the base of zone V. This agrees with a major change in the quantitative and qualitative composition of the pollen flora, and with the results of the correlation based on ostracods.

I. INTRODUCTION

The present work is the result of a palynological investigation of two boring sections, Tubbergen 6 and Enschede 2, situated in the eastern Netherlands Twente area. We are very grateful to the N.V. Nederlandse Aardolie Maatschappij (N.A.M.) in Oldenzaal, who made this investigation possible by placing the drilled samples (all cores) to our disposal.

1. *Purpose of the investigation*

The stratigraphical columns belonging to the drilled sections embrace time-intervals, roughly estimated on 12 million years for section Enschede 2 and 16 million years for section Tubbergen 6 (based on theoretical time estimations; see Chapter III section 8-9), they consist of uppermost Jurassic and lowermost Cretaceous deposits.

During these times the eastern Netherlands were located at the western border of the German Lower Saxon Basin, where beds with a particular "Wealden" facies were laid down, occupying a good deal of our stratigraphical columns. These "Wealden" beds present several problems, particularly on stratigraphy. The purposes of this investigation are:

1. To treat systematically the sporomorph contents of our material.
2. To establish eventual microfloral differences between the Jurassic and the Cretaceous involved.
3. To establish, if possible, pollen zones, especially in the "Wealden" deposits and obtain in this way possibly additional information on the problem of the exact position of the Jurassic-Cretaceous boundary.
4. To come to a general account of the vegetational history at the western border of the Lower Saxon Basin in Upper Jurassic and Lower Cretaceous times.

2. *Preparation of samples and slides*

The samples consist of shales, marls, sandstones and pure or impure limestones. About 2–3 cm^3 of each sample was crushed in a mortar into small fragments and treated with HCl to remove the limestone component. Then the residuum was washed out with water and alcohol. The next step was to stir the residuum thoroughly in a mixture of bromoform and alcohol (s.g. 2.0) and put the tubes in an ultrasonic machine for about 5 minutes. During the separation the centrifuge was given a capacity of about 4000 r.p.m. for about 30 minutes, in order to get rid of all mineral substance. Then the float was poured off and the separation was repeated in order to extract all botanical contents from the material. Next the float was washed out twice with alcohol and dripped carefully on a warm slide in the middle of a molten drop of glycerine-jelly. The last trace of alcohol disappeared while the float was carefully stirred with the glycerine-jelly to a homogeneous mass. Then the cover-glass was mounted and the slide put aside to cool off. From each sample two slides were prepared. In order to keep the pollen and spores in a most favourable condition we have avoided to use any agressive chemicals during the preparation.

3. *Counting techniques*

We counted 200 sporomorphs in one slide of each sample, thereby including *Classopollis* in the total of the pollen flora. Besides that we counted 200 sporomorphs, without taking *Classopollis* into consideration. After this we went through the whole section another time to check the first results, this time taking the other slide of each sample. The pollen diagrams are based on the last countings, eventually completed with the results of the first countings, in the case of seldom occurring spores, which are easily overlooked.

In some slides we could not reach more than total of 100, due to the scarcity of the pollen flora. These spectra are specially marked in the pollen diagrams.

4. *Optical and photographical equipment*

We made the countings with a Leitz Dialux binocular microscope (laboratory number PO 20), objectives 25 ×, 45 × and 100 ×, oculars GF 10 ×. We took the photographs with a Periplan 100 × objective and Periplan oculars of 6 ×, 8 × and 10 ×. The microscope light was filtered through a green glass in order to obtain a monochromatic effect. We used AGFA Isopan IFF 13° Din film and AGFA B-5 photograph paper. The photographs were taken with a Leica camera mounted on the photo-tube of the Dialux. The magnification of the plates is 1500 ×, except for fig. 1 of Pl. 37.

5. *Acknowledgments*

We wish to thank Prof. Dr. A. Brouwer and Dr. Th. van der Hammen for being greatly interested in our research and giving much valuable advice about several stratigraphical and palynological aspects of the investigation.

We are also grateful to Miss M. Elkhuizen, who prepared the microscopic slides, and to Messrs. F. J. J. van Heyst and T. A. Wymstra for their help with the preparation of the manuscript. Miss J. K. Geervliet and Miss J. J. Visser typed the text of the manuscript, and Mr. J. F. Savage of the Geological Institute very kindly criticized the English text.

We are also much obliged to Mr. J. Hoogedoorn for the quality of the photographs, and to Messrs. J. J. Bink and B. Lieffering for drawing the diagrams and other figures.

II. HISTORICAL GEOLOGY

1. *Historical review*

In these lines we shall briefly discuss the general aspects of the Mesozoic geological history in the Netherlands, thereby paying more attention to those aspects which are important for the stratigraphical development in the eastern Netherlands Twente area. From this development, closely related to the tectonic activities of the Alpine orogeny, we may deduce a picture of the surface geology and the palaeogeography during the times around the Jurassic-Cretaceous boundary. During these times, which are the subject of our study, the Twente area was located at the western border of the German Lower Saxon Basin.

The Mesozoic geological history in the Netherlands can be subdivided in sedimentary cycles, interrupted by relatively short phases of tectonic activity (Boigk 1960, Haanstra 1963). The first major cycle, going back as far as the Permian, was broken off by the Early Kimmerian phase of the Alpine orogeny at the end of the Keuper. The Dutch submarine massif was subdued to a slight upheaval and the subsequent erosion of Keuper strata was not of great importance, except in the Denekamp area in northern Twente, where Keuper and Muschelkalk are not present.

This old erosion surface was transgressed during the Liassic, and the second sedimentary cycle is believed to have undergone only small disturbances up to the Lower Malm. Then the sequence was broken off by the Late Kimmerian tectonic phase, which caused an uplift of the whole Dutch region. The newly shaped topography was accentuated by the Mid-Netherlands Ridge, with a NW-SE orientation and acting as a barrier, separating a northeastern and a southwestern basin (text-fig. 1). We shall only discuss the sediments in the northeastern basin at the western periphery of the German Lower Saxon Basin, where the bore-holes Tubbergen 6 and Enschede 2 are located.

The palaeogeography of this region at the beginning of the third sedimentary cycle is illustrated in text-fig. 2. The western border of the Lower Saxon Basin was formed by the Dutch Triassic Massif, the southwestern border by the Rhenish Massif. The first transgressive sediments were deposited particularly in fresh to brackish water, while a few marine intercalations occur (Haanstra 1963). The uppermost Jurassic sediments, Münder Marls, Serpulite and possibly the lower part of the "Wealden" have a carbonate facies, while the more off-shore deposits are more argillaceous. In the Twente area limestones were mostly deposited (text-fig. 2), in general thinly developed and easily eroded (Pannekoek 1956). The "Wealden" in the Dutch-German area is restricted to brackish-limnic (possible deltaic) deposits, marking some local changes in the sedimentation. The transgressive tendencies, which had more or less come to stagnation, started anew near the end of the "Wealden", (text-fig. 3 and 4), so that the overlying Middle-Valanginian deposits are marine.

The stratigraphical terminology, which has been used for the sediments of the Lower Saxon Basin, is derived from German literature, especially since about 1940. From the Purbeck upwards the stratigraphy is developed identically both in Germany and in the eastern Netherlands. At the end of this chapter the Dutch-German

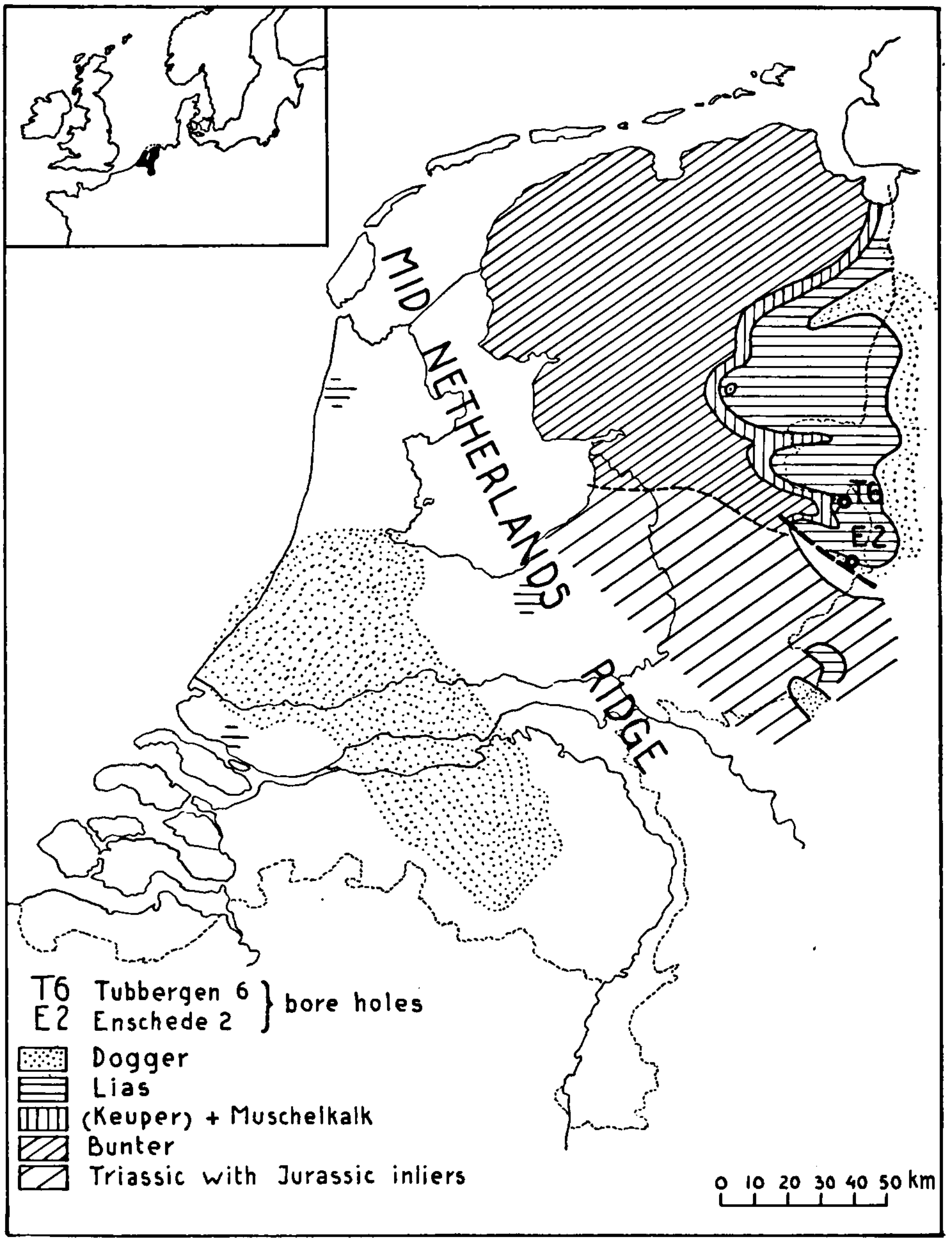

Fig. 1. Late Kimmerian erosion surface in the Netherlands (from Haanstra 1963).

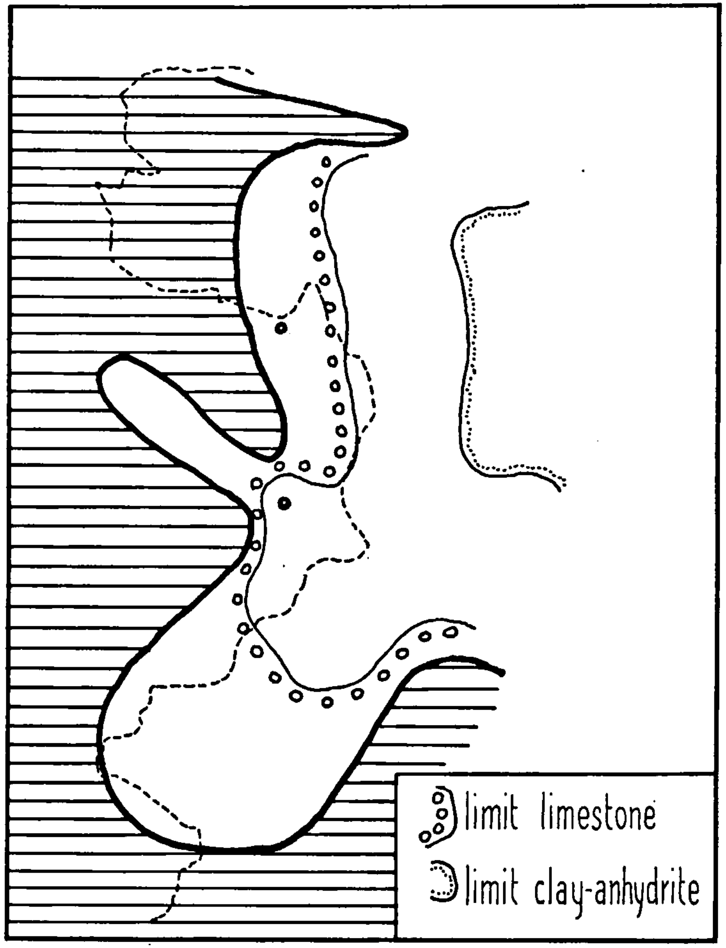

Fig. 2. Palaeogeographic map of the Twente area during the Serpulite (from Schott 1951).

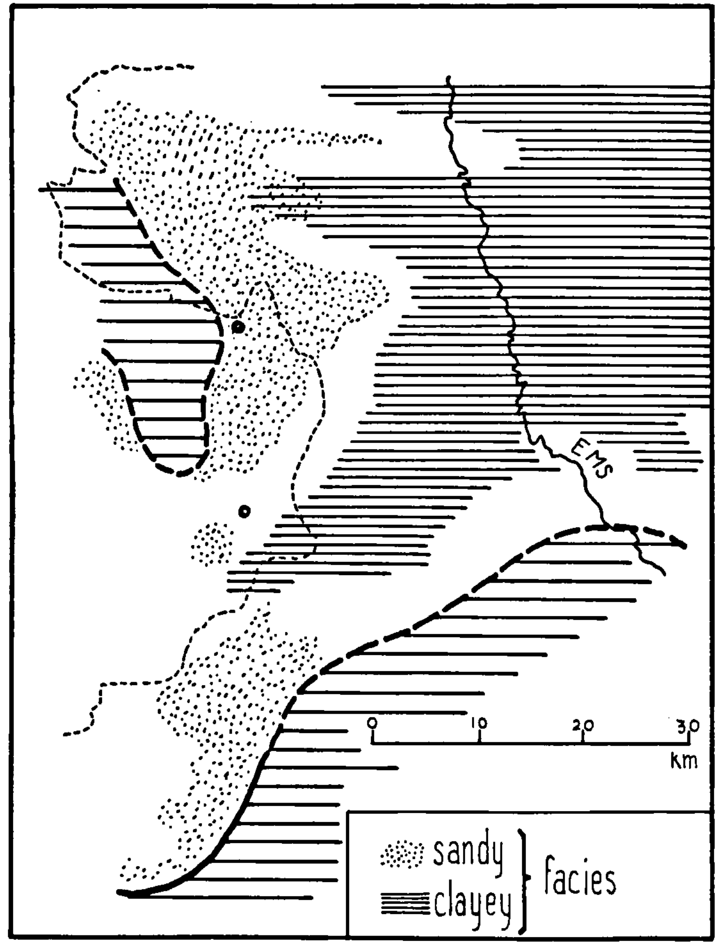

Fig. 3. Palaeogeographic map of the Twente area during the "Wealden" (from Wolburg 1953).

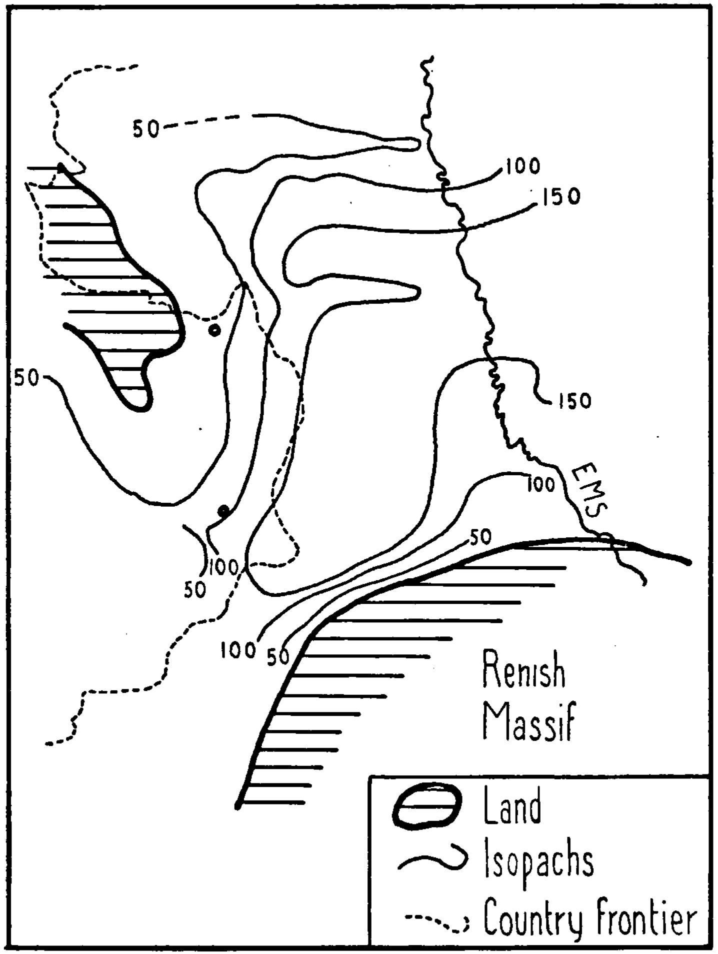

Fig. 4. Palaeogeographic map of the Twente area during the Valanginian (from Wolburg 1953).

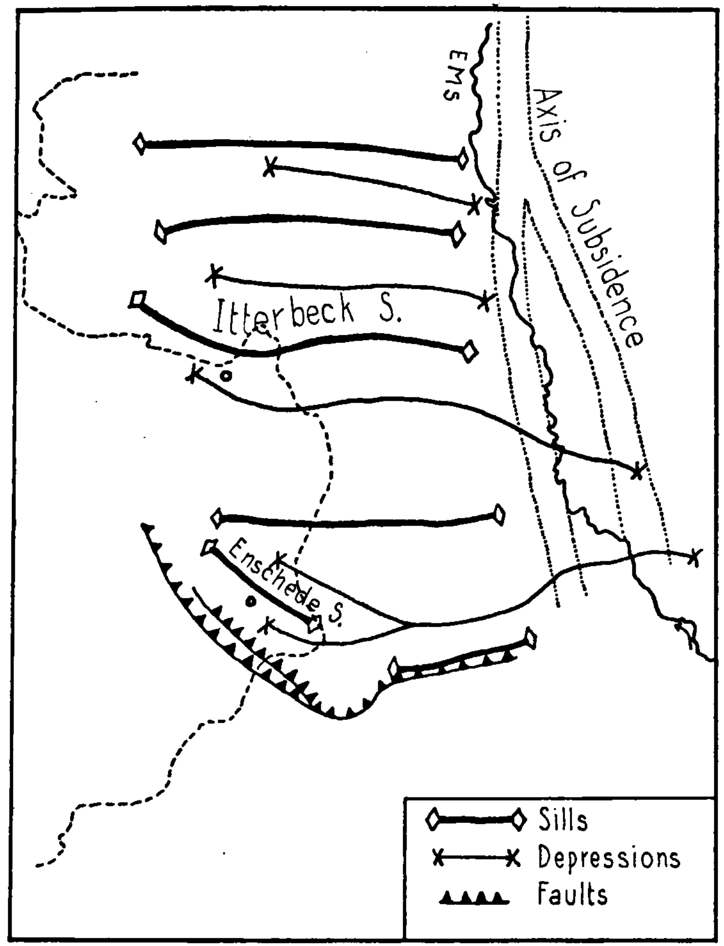

Fig. 5. Palaeotectonic map of the Twente area (from Wolburg 1953).

stratigraphy will be compared with the international subdivision. The German "Wealden" derives its name from the English Wealden Beds, which were developed in a similar continental facies.

However, unlike the English and other Wealden deposits the Dutch-German "Wealden" is considered as a time-rock-unit, although only valuable in the Dutch-German region. In order to distinguish it from other European sequences the name is put between quotation-marks.

2. *Regional stratigraphy*

The geological history around the Jurassic-Cretaceous boundary in north-western Germany is treated in detail by Wolburg (1949, 1953) and Boigk (1960). The Late Kimmerian tectonic phase was manifested by an axis of subsidence in the Emsland, with a north-south orientation, parallel with the Dutch frontier (text-fig. 5). The movements gave rise to a series of partly submarine saddles or "Schwellen" in the region of the Dutch frontier, which extended more or less eastwards into the basin. These saddles, building tongue-shaped upheavals on the seabottom are supposed to be formed as a consequence of local retardation in a stronger subsiding region. Shallow-water limestones were deposited on top of them, while the surrounding deeper parts were characterized by more argillaceous deposits.

The Tubbergen 6 bore hole is located at the southern flank of the "Schwelle von Itterbeck". At this place the transgressive layers of the Serpulite were deposited on a Liassic erosion surface under apparently quiet circumstances. The rapid westward thinning of the strata indicates the immediate nearness of the coast line. The Münder Marls may also be developed very thinly in a few places. The transition to the "Wealden" is assumed to be concordant and the whole "Wealden" is represented, although relatively thin. The overlying marine Valanginian beds are not distinctly different from the "Wealden", we have to do with a gradual subsidence of the surface. The land is assumed to have formed a peninsula or land-tongue, becoming narrower while the Valanginian sea inundated both flanks. The westward trend of the transgression could clearly be retraced by microfossils (Wolburg 1953).

The Enschede 2 borehole is located near the top of the Enschede-Epe Schwelle about 20 km south of Tubbergen 6. The stratigraphical development here is more complicated, because there are many indications of tectonic activity during the Late Kimmerian phase which disturbed the sedimentary succession (text-fig. 5). Several boring sections in this area gave a disturbed and incoherent picture of the stratigraphy. Although in boring Enschede 2 the Uppermost Jurassic and lowermost Cretaceous are more or less completely represented, the Jurassic and lower "Wealden" are absent in the nearby borehole Enschede 1, so that "Wealden" 4 directly overlies Lower Triassic strata (Wolburg 1953).

The section of Enschede 2 of which the samples have been investigated stops at the upper boundary of the "Wealden", so that we cannot give a palynological record of the Valanginian transgression, during which the land tongue of the Enschede-Epe Schwelle disappeared in the southwards advancing sea (text-fig. 4).

3. *Correlations with other European sequences*

It is our purpose to select from the pollen diagrams any records which might serve as indicators for the position of the Jurassic-Cretaceous boundary in the Dutch-German "Wealden" strata. In order to make any statements on the position of this boundary it is first necessary to consider the stratigraphy of the type sequence in which this boundary is established.

The type section of the uppermost Jurassic or Tithonian in southeastern France is divided into a lower, middle and upper part, based on ammonites (text-fig. 6). The overlying Berriasian or Lower Valanginian is also divided in three parts. The type section of the lowermost Cretaceous is formed by the Valanginian in Switzerland; here the underlying strata possess "Portlandian" and "Purbeckian" facies. Intercalations of the same "Purbeckian" strata occur within the lower Berriasian in southeastern France (Bartenstein 1962). The base of the Swiss Valanginian must therefore be placed somewhere in the Middle Berriasian, so that the French and the Swiss Lower Valanginian do not correspond to the same time-interval.

Although there are more problems to solve, especially concerning the basal strata of the Tithonian (Enay 1964), it is accepted that the Jurassic-Cretaceous boundary is fixed between Tithonian and Berriasian, that is to say between the upper ammonite horizon of *Berriasella chaperi*, *B. aizyensis*, *Dalmaciceras djanelidzei* and the lower horizon of *Berriasella paramencilata* and *B. grandis* (Kilian 1908, Mazenot 1939). For this reason the Swiss Valanginian is not suitable as a type section for the base of the Lower Cretaceous. If the name Valanginian (sensu lato) has to be maintained for the lowermost Cretaceous (Colloque de Stratigraphie sur le Crétacé Inférieur en

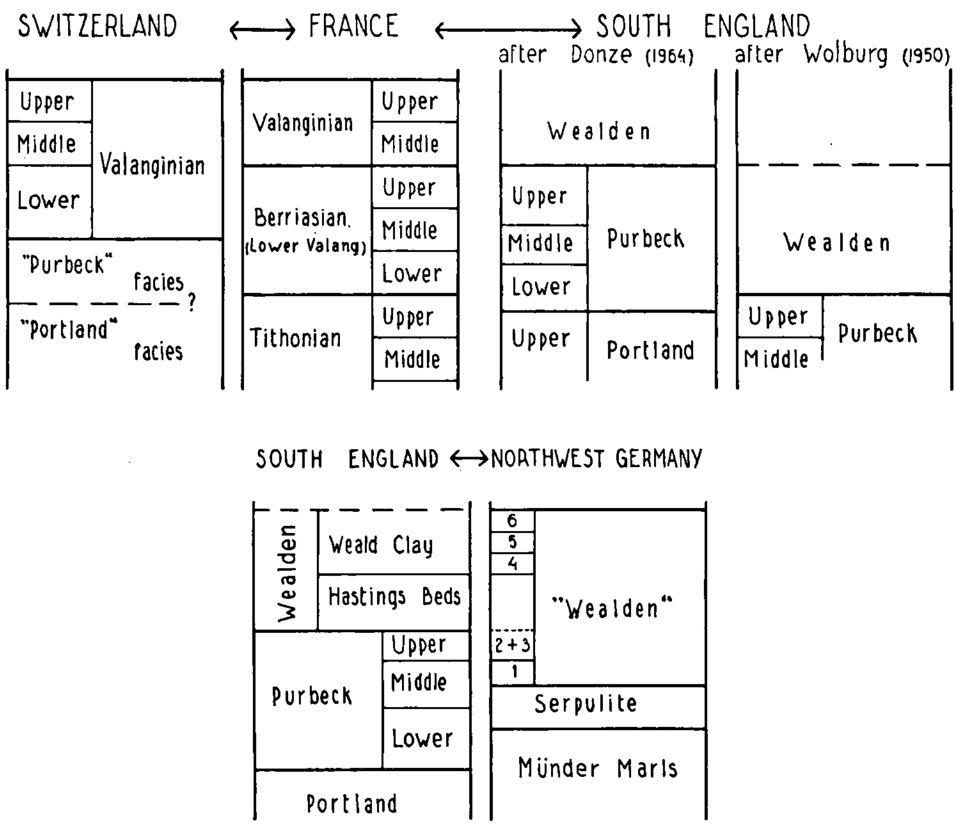

Fig. 6. Correlations of most important stratigraphical sections around the Jurassic-Cretaceous boundary in western Europe.

France 1963), it should comprise all strata between the base of the Berriasian and the upper boundary of the Swiss Valanginian, the Berriasian being a substage of the Valanginian sensu lato.

Many problems arise if a direct correlation is carried out between the marine type sections in southeastern France and the limnic-littoral sections of the Lower Saxon Basin, in which ammonites are absent. Neither are there contact beds known, between the Boreal and Tethys provinces, as the connection was cut off before the Portland. Nevertheless this correlation is of fundamental importance for our purpose. It seems that the only way in which this might be accomplished is to correlate each of the two sections with a third section, which should be related on palaeogeographical grounds and the formation of which should by preference be influenced by the same events, may be tectonically or climatologically.

Such a key position is found in the stratigraphy of southern England, where the type section of the Wealden is located (text-fig. 6). In England the subdivision of the Upper Jurassic, derived from d'Orbigny-Arkell, shows that the marine, ammonite-bearing Portlandian is overlain by brackish Purbeck strata, in which only lamellibranchs are found. The Wealden consists of the Hastings Beds and the Weald Clay (Kirkaldy 1963). In this section the base of the Cretaceous has always been assumed to be located between Upper Purbeck and Hastings Beds (Allen 1955).

Thanks to the ammonite stratigraphy it has been possible to correlate the Jurassic of southeastern France and South England adequately. The difficulties start with the fact that the English Purbeck, characterized by a littoral facies, does not contain ammonites at all. Nor is it possible either to carry out direct correlations in contact areas, thereby using the intermediate position of the Basin of Paris, because the connection of this Basin with southeastern France was cut off already in Upper Portland times.

During the last few decades many investigators have used ostracods for correlation purposes. Ostracod investigations in the Swiss-French areas have been carried out by Anderson, Grekoff, Donze and many others, which resulted in a more precisely defined junction of Jurassic and Cretaceous. Comparative ostracod investigations between the Alpine regions and southern England have led to the following major results (text-fig. 6):

(1) Wolburg (1950) states that the Upper Purbeck is more or less contemporaneous with the Upper Tithonian.

(2) Bartenstein & Burri (1954) come to the conclusion that the Middle Purbeck is more or less contemporaneous with the Upper Tithonian. Bartenstein (1959) even supposes that the Purbeck might be placed completely above the boundary between Tithonian and Berriasian.

(3) Donze (1964) correlates the Portland and lowermost Purbeck with the Tithonian and the upper limit of the Purbeck with the upper limit of the Berriasian.

We have to start from these data when we consider the time-relations between the English and the Dutch-German stratigraphy. As stated before, the Upper Jurassic sedimentary sequence in the eastern Netherlands is formed by the basal Münder Marls, covered by the Serpulite (text-fig. 6) and the "Wealden" strata.

The German "Wealden" has been investigated on ostracods by Wolburg (1949). Hereby six major zones are distinguished, of which "Wealden" 1 to 5 are considered as fresh-water deposits, while "Wealden" 6 forms a brackish passage zone to the overlying marine strata. The stratigraphical relation between this sequence and South England has been subject of several studies, which mostly show a remarkable agreement. Wolburg (1950) compares part of the Serpulite and "Wealden" 1 with the Middle Purbeck, "Wealden" 2 and 3 (pro parte) could be placed in the Upper Purbeck. As the strata which cover the "Wealden" 6 are of Mid-Valanginian age, Wolburg regards "Wealden" 4 to 6 to belong to the Lower Valanginian.

Besides these results, direct correlations between the Alpine region and the Lower Saxon Basin by Bartenstein (1962, 1965) show that the Serpulite should belong somewhere in the Lower Berriasian and consequently the whole of the German "Wealden" in the remaining part of the Berriasian.

Correlations between England and Germany have also been attempted on lithological grounds by Allen and Wolburg. Allen (1955) takes into account Late Kimmerian tectonic activities in England, France and Germany with their consequences. The English-German correlation is reproduced here with some additions:

	England	Germany
3. Initial transgression	Hastings?	(post "Wealden" 6)
2. Arrival of coarse detritus	a. Early Hastings Beds	around "Wealden" 3 (Deister Sandstone).
	b. Late Middle Purbeck	base "Wealden" 1 (Osnabrück Sandstone).
1. Earth movements	?	between Lower & Middle Purbeck

In Germany the first major transgression took place at the transition of "Wealden" 6 to the marine Middle Valanginian; we have added this in the scheme between brackets. Allen suggests that the deposition of the Early Hastings Beds and the Deister Sandstone would have started roughly in the same time.

Similar conclusions have been drawn by Wolburg (1950). The Hastings Sandstone and the "Wealden" Hauptsandstein ("Wealden" 3) would have been formed in the same time-interval, accompanied by a minor regression and relief building of the hinterland. (Ostracod stratigraphy of bore-hole E-2 see Bischoff & Wolburg 1963).

4. *Conclusions*

When all data mentioned in the foregoing sections are combined, it appears to remain impossible to locate definitely the Jurassic-Cretaceous boundary in the Dutch-German area; the main obstacle turns out to be the exact age of the English Purbeck. We have seen that the opinions hereabout fluctuate between two extremes: either the Purbeck might form the top of the English Jurassic (Wolburg 1950, Allen 1955) or the Purbeck should be considered as Lower Cretaceous (d'Orbigny 1850, Bartenstein 1962).

In the course of all comparative micropalaeontological investigations between France and England there is a trend to consider the English Purbeck not any more as a separate unit, but as a substage of the Portland. There is also a growing tendency to regard larger and larger portions of the Purbeck to belong to the Lower Cretaceous. In view of the recent investigations by Donze the opinions of Wolburg and Allen would become less probable.

Ostracod investigations in the Dutch Wealden strata have been carried out by Sung (1955), who came to the provisional conclusion that the Jurassic-Cretaceous boundary might be situated about half-way in "Wealden" 3. Bartenstein and Burri (1954), taking the correlations of Wolburg (1950) into account, consider the base of "Wealden" 2 as contemporaneous with the base of the Berriasian. However, as Wolburg (1949) mentions the occurrence of marine ostracods in the center of the Lower Saxon Basin during "Wealden" 3–4 times, Bartenstein and Burri do not fix the Jurassic-Cretaceous boundary more definitely than between base "Wealden" 2 and top "Wealden" 4.

Regarding the data available from the literature, the most important of which are mentioned above, it appears that the most large extent in which the Jurassic-Cretaceous boundary might possibly be placed, reaches from about base of the Serpulite up to the top of "Wealden" 4. However, many investigators have come to a much narrower extent, which is ranging from Upper Serpulite to base "Wealden" 2.

In the next chapter these provisional results will be compared with the pollen-stratigraphical development in the Twente area, compiled from the pollen diagrams.

III. THE DEVELOPMENT OF THE POLLEN FLORA

1. *Composition of the pollen diagrams*

The samples of bore hole Tubbergen 6 comprise a sedimentary sequence, ranging from a depth of 678.5 m to 560 m and spaced 0.5 m apart. The samples of bore hole Enschede 2 are spaced about 2 m apart, ranging from the 550–552 m interval to the 104–106 m interval. From both sections a pollen diagram could be made. From the data of the quantitative pollen investigations two different types of survey diagrams were composed, showing the mutual relations of several sporomorph groups. Besides this there are also frequency curves set out for each separate species. Each diagram or curve is provided with a number in such a way that equal numbers correspond to identical subjects in both pollen diagrams.

The lithology of the sections is shown in column 1. Column 2 gives the ostracod stratigraphy as established by the N.A.M., while column 3 gives the pollen zones, which are based on the corresponding diagrams. Survey diagram 5 represents the schematical history of the total pollen flora with special reference to the part of *Classopollis* in it. The dominating influence of *Classopollis* upon the other elements of the pollen flora, particularly in the pre-"Wealden" sections of the diagrams, completely obscures several other features which might be of importance. Pocock (1962) states in a study of Canadian strata at the Jurassic-Cretaceous boundary, that there are strong indications that *Classopollis* might have grown in coastal regions with a locally abundant, but in terms of distribution unimportant pollen production. In view of the near-coast location of bore holes Enschede and Tubbergen it is questionable whether *Classopollis* would be proportionally represented in diagram 5. As it may be of importance to consider the changes in the pollen flora without the (possible) local influence of the coastal vegetation, we have not incorporated *Classopollis* in the percentage calculations of the pollen spectra, by taking the sum of all other components on 100 %. The results are shown in survey diagram 6. The following curves 7 to 96 represent the frequencies of all separate sporomorphs described in Chapter IV. These curves are based on the percentage calculations of diagram 6 and set out on the same scale.

The appearance and disappearance of species are shown in a separate chart (diagram 1). The vertical ranges in this chart are combined from both pollen diagrams and based on first and last occurrence of the species. On these data also the subdivision in pollen zones is based, using letters (see column 3). The second feature is the occurrence of fluctuations in the single curves and in the survey diagrams, provided with numbers. These fluctuations partly correspond to the pollen zones, and partly subdivide these zones. In the last case they are indicated by numbers (e.g. U-1, U-2 etc.).

In the description of these features the following annotation has been used: when referring to an oscillation in the curve of one particular species the pollen diagram (T-6 or E-2) is mentioned first, followed by the pollen zone involved and finally by the number of the graph. With the annotation T-6/U-3/62 is meant the major oscillation of *Peromonolites fragilis* (graph 62) in diagram Tubbergen 6, subzone U-3. When necessary, the spores mentioned are accompanied by the number of their curve.

2. *Pollen zones*

These zones are used for a basal division of the diagrams as they characterize the essential changes in the vegetational history. It is not yet known whether the zones may appear to be useful over a wider area; they are introduced here to divide the history of the pollen flora at the western fringe of the Lower Saxon Basin. Diagram Tubbergen 6 comprises nine zones R to Z, diagram Enschede 2 only contains seven zones, R to X.

Nearly half of the total number of species, the so-called passage species, occur throughout the whole sequence. Among them there are conifers described by Couper (1958) from Mesozoic strata in Britain. Many trilete spore groups, such as *Gleicheniidites* and *Cicatricosisporites*, which have mostly been described from Cretaceous strata, occur in considerable amounts in the Jurassic already. There are 12 species which are present at the base of the sequence, but disappear before the top is reached.

Thus 53 species are described from pollen zone R, which is equivalent to ostracod zone B. At the base of pollen zone S, equivalent to ostracod zone C, seven species appear, making the *Gleicheniidites* and *Cicatricosisporites* groups complete. About half-way in the zone a peculiar spore appears for a short time, *Baldurnisporites monstruosus* (graph 55, Pl. 26 fig. 1), of which more or less similar forms have been found in Belgian "Wealden" strata (Delcourt & Sprumont 1955). In zone T the pollen flora is increased with five species, while higher in the zone 4 species disappear. As zone T partly overlaps ostracod zone E, zone U covers the remaining part of E and the major part of F, and is accompanied by the appearance of four species, to which *Cicatricosisporites mohrioides* (graph 29,Pl. 8 fig. 2–3) belongs, which was reported from the Belgian "Wealden" strata. *Vallizonosporites vallifoveatus* (graph T6–59, Pl. 21 fig. 4), reported in the mid-"Wealden" series of eastern Germany (Döring 1964), appears at the top of this zone. Pollen zone V occupies the upper part of ostracod zone F, zones "Wealden" 1 and lower "Wealden" 2. Four species appear, of which *Kraeuselisporites tubbergensis* (graph T6–86, Pl. 36 fig. 1) only occurs at the base. A more or less similar grain was reported by Couper (1958) in the Upper Jurassic of Britain. The next zone W occupies most of ostracod zone "Wealden" 2 and "Wealden" 3. The pollen flora is extended from 70 to 82 species, an increase of about 17 %. *Tricolporopollenites distinctus* appears near the top of the zone and disappears at the top of zone Y. Zone X, ranging from "Wealden" 3 to upper boundary of "Wealden" 6,contains the most extended pollen flora. Three species disappear within the zone, which means about 4 %. In contrast with the earlier development, the Valanginian zones Y and Z show a considerable decrease in the number of species. At the base of zone Y 10 species disappear, at the base of zone Z 11 species again, which means that the transition from Wealden to Valanginian would roughly be accompanied with a loss of 25 % of the species from the total pollen flora. The species which are occurring in pollen zone Z, besides the earlier discussed passage species are:

Auritulinasporites complexis n. sp.
A. deltaformis n. sp.
Cicatricosisporites crassistriatus n. sp.
C. hallei
C. mohrioides
C. sternum
C. striatus
Deltoidospora nana n. sp.

Foveotriletes subtriangularis
Gleicheniidites feronensis
G. simplex n. sp.
Matonisporites dorogensis
Osmundacidites wellmanii
Pilosisporites types
Plicatella tricornitata
Podocarpidites herbstii n. sp.
Vallizonosporites vallifoveatus
Variavesiculites delicatus n. sp.

Most of these species have already been described from younger Cretaceous strata in Belgium and Germany. There are also some forms in the Dutch pollen flora, which were up to now only described from Cretaceous strata in the U.S.A. (Brenner 1963), such as *Converrucosisporites proxigranulatus* (graph 46, Pl. 15 fig. 3), *Podocarpidites epistratus* (graph 75, Pl. 30 fig. 2), *P. potomacensis* (graph 77, Pl. 33 fig. 1–2), *P. radiatus* (graph 78, Pl. 30 fig. 2) and *Foveotriletes subtriangularis* (graph 37, Pl. 14 fig. 1).

In the Cretaceous pollen flora of the Dutch sequence nearly the whole group of *Cicatricosisporites* (24) is represented. *Plicatella tricornitata* (34), which is particularly known from the Upper Cretaceous of Germany and was reported by Couper (1958) from the English Wealden, appears already in pollen zone T. The *Gleicheniidites* group (16), which is mainly occurring with *G. senonicus* (19) and *G. circinidites* (17) in the Jurassic, is represented completely in the Valanginian. From 9 described verrucate spores 6 disappear during the "Wealden", such as *Lygodioisporites perverrucatus* (50) and *Trilites equatibossus* (51), which are reported from the English Middle Jurassic (Couper 1958); *Concavissimisporites crassatus* (43) and *C. verrucosus* (45) which were remarkably enough reported from the "Wealden" of Belgium.

The bisaccate grains are represented throughout the whole sequence except for *Rugubivesiculites reductus* (80), *Podocarpidites herbstii* (76), *Alisporites thomasii* (72) and *A. microsaccus* (73). Both *Alisporites* types disappear at the top of zone X, the upper limit of the "Wealden", while they were reported not higher than the Upper Jurassic of England (Couper 1958). *Parvisaccites radiatus* (81), which was reported from the English Wealden and the Aptian, occurs already in the Upper Malm (pollen zone R) of the Dutch Twente area. The mono- and trifossulate grains do not form important stratigraphical indicators within the interval studied. *Classopollis* is rapported in considerable amounts from the Purbeck of England, but its vertical range is too wide to be valuable for finer stratigraphical subdivisions. The only angiosperm pollen grain known in the pollen flora of the Twente area is *Tricolporopollenites distinctus* (graph 96, Pl. 37 fig. 2), which appears in the middle of the "Wealden" (pollen zone W) and occurs sporadically in zones X and Y.

When we try to establish the rate of change in the pollen flora at the transition from Jurassic to Cretaceous, we see that in pollen zone R 53 species occur, 12 of which are not represented in pollen zone Z. In zone Z 59 species are reported, of which 18 species do not occur in zone R. Consequently from 59 species in zone Z 12 species, that is about 20 %, are replaced, while 6 species, or about 10 % are newly added to the pollen flora.

3. *Secondary material*

In the palynological contents of the rock samples not only the autochthonous microflora could be found, but also elements like *Densosporites*, *Ovalipollis*, *Luecki-*

sporites, *Triquitrites*, *Reinschospora*, which most probably originated from Palaeozoic and Triassic surface rocks of the hinterland and were deposited in coastal sediments near the border of the basin after fluvial transport. This type of secondary material may easily be separated from the autochthonous sporomorph material. However, if there has been reworking within the freshly deposited strata, a natural process in near-coast or even deltaic sediments, it will mostly be impossible to distinguish the autochthonous microflora from reworked elements. In a few cases the secondary character may be suspected if a certain form disappears and returns in younger strata in a much poorer condition than the surrounding microflora. Sometimes a colour darker than usual may also point to a secondary origin.

It is not known to which extent this reworking may have influenced the vertical ranges of the sporomorphs. In the case of *Trilobosporites bernissartensis* (graph 49, Pl. 17 fig. 1) we have probably partly to do with reworking, because the grain has a much more corroded appearance than the other sporomorphs in the "Wealden" section of diagram E-2. For this reason the upper part of the vertical range belonging to the "Wealden", has been dashed.

4. *Depositional environments*

Besides the sporomorphs the rock samples contained other microfossils. They mainly belong to the following groups: *Botryococcus* (Pl. 39 fig. 8), a freshwater alga (Traverse 1955), *Hystrichosphaeridae*, *Foraminifera* and *Dinoflagellatae*. Graph 97 shows their frequencies in relation to the total of sporomorphs, while graph 98 shows their mutual frequencies in a total of 100 %. These organisms are important indicators for the sedimentary environment, because their mutual frequencies show distinct changes of the facies in the sequence. The abundance of *Botryococcus* is a confirmation for the fresh-water facies of the "Wealden" zones 2 to 5, while the brackish character of "Wealden" 6 is shown by the appearance of marine elements (*Dinoflagellatae* and *Foraminifera*). It seems that a fresh-water facies occurs again at the top of the sequence (pollen zone Z), but from what is known about the further Lower Cretaceous history of the region, this fresh-water may only have had a temporary influence.

5. *Description of pollen diagram Tubbergen* 6

The diagram, divided in a Jurassic, a "Wealden" and a Valanginian part, provided of both diagrams the most detailed information. The frequency of suitable samples and the average good preservation of the sporomorphs give the pollen picture a regular appearance and the fluctuations a rather fluent course.

One of the striking features is the abundance of *Classopollis* in the Jurassic sequence (5), which dominates the rest of the pollen flora. However, this domination has been neutralized in survey diagram 6, so that the fluctuations in both diagrams may be compared independently of each other.

Pollen zone R is represented in the section from a depth of 678.5 m to 671 m. The lithology mainly consists of marly and sandy clays, near the top of the zone overlain by a calcareous bed. The pollen flora is dominated by *Classopollis* and represented by a relative minority of conifers and trilete spores (6). The pollen grains are well represented by *Spheripollenites subgranulatus* (89), *Perinopollenites elatoides* (90), the Monocolpatae and the Praecolpates (92–95). *Peromonolites fragilis* (62), a spore which is easily destroyed, occurs also up to ca. 30 %.

Pollen zone S (671–665 m) consists of a clayey sequence and shows a considerable decrease of *Classopollis* and a sharp rise of the conifers (6), particularly the group of *Abietineaepollenites* (67) and partly the *Podocarpoids* (74). The Praecolpates group diminishes and *Peromonolites fragilis* disappears.

Pollen zone T (665–646 m) consists of sandy clays at the base and calcareous sandstones, graywackes and quartzites. About half-way limestones occur with sandy intercalations and the upper part consists of clays again. This zone shows an increase of *Classopollis* and a decrease of nearly all sporomorphs except for *Cyathidites* (11), *Gleicheniidites* (16), *Peromonolites fragilis* (62) and *Cerebropollenites mesozoicus* (65). *Spheripollenites subgranulatus* (89) is represented in the lower part of the zone with a maximum of about 50 %.

Pollen zone U (646–618 m) is split up in four parts, based on the oscillations of *Classopollis*. The Vesiculatae (6) show several fluctuations, which are mostly due to the influence of graph 83, the decayed bivesiculate grains, which could not be identified. Subzone U-1 (646–ca. 642 m), which consists of clays, is characterized by a fall of *Classopollis* and a rise of the Vesiculatae. The group of Striatriletes (24) and the Podocarpoids (74) increase, while *Cerebropollenites mesozoicus* (65) nearly disappears in the upper part. Subzone U-2 (ca. 642–ca. 632 m) is clayey at the base, changing into impure limestones, while the upper half shows a transition from sandstones into clays. The limestones return at the top. The *Classopollis* curve shows an oscillation and the Vesiculatae nearly disappear at the base of the zone, after which they gradually return in the upper half. At the top of subzone U-2 one maximum consists completely of decayed Bivesiculatae (83), while most of the other Bivesiculatae disappear. There is an increase of many trilete spores, such as *Concavisporites twentianis* (10), *Cyathidites* (11), *Gleicheniidites senonicus* (19) and *Staplinisporites caminus* (35). There is also an increase of *Peromonolites fragilis* (62). Subzone U-3 (ca. 632–ca. 628 m) consists of a clayey sequence with a marly limestone bank and is characterized by a decline of *Classopollis*. The trilete and vesiculate groups stay constant or disappear. The bulk of the pollen flora is occupied by *Peromonolites fragilis* (62) up to 80 %, while the *Abietineaepollenites* group (67), *Parvisaccites radiatus* (81) and *Vitreisporites pallidus* (82) return. Subzone U-4 (ca. 628–ca. 618 m) consists of sandstones and limestones, in the upper part changing into clays. *Classopollis* dominates the pollen picture and the rest of the pollen flora is dominated by the group of *Abietineaepollenites* (67) and by *Cerebropollenites mesozoicus* (65), while the decayed Bivesiculatae (83) also play a role. In the group of Triletes there are *Concavisporites twentianis* (10) and *Gleicheniidites senonicus* (19) as most important species.

The base of the next pollen zone V (618–608 m) is characterized by a fine lamination of clay and marl, not exceeding 1 cm in thickness. The rest of the zone is formed by sandy clays, overlain by impure limestones, at the base of which ostracod zone "Wealden" 1 starts. In these limestones laminations occur of shell banks and clays. The transition of U-4 to V is characterized by a sharp decline of *Classopollis*, while in the lower part of zone V another top of *Classopollis* occurs. The rest of the pollen flora is dominated by *Cerebropollenites mesozoicus* (65), *Abietineaepollenites minimus* (71) and the decayed Bivesiculatae (83). There is a less important increase of *Araucariacites australis* (84) and *Inaperturopollenites giganteus* (85) and of the *Eucommiidites* group (94 & 95). In the upper part of zone V (in this diagram at the base of the "Wealden") both *Classopollis* and the Vesiculatae show an important decrease, while the trilete spores, especially *Concavisporites twentianis* (10), the *Gleicheniidites* (16) and Striatrilete (24) groups are rising. *Peromonolites fragilis* (62) has completely disappeared.

Pollen zone W (608–599 m) shows a clayey and marly sequence at the base, overlain by limestones. The pollen flora is dominated by the Triletes, of which

Concavisporites twentianis (10), *Cyathidites* (11), *Deltoidospora rafaeli* (15) and the *Gleicheniidites* group (16) are the most important spores. There is a fall in the Striatrilete group (24). At the top of the zone *Peromonolites fragilis* (62) and *Abietineaepollenites minimus* (71) start to rise, while *Eucommiidites minor* (95) decreases.

Pollen zone X (599–580 m) has been subdivided on the basis of *Classopollis* and the group of Triletes in pollen diagram Enschede 2. This subdivision is not shown in pollen zone X of diagram T-6, because of the low number of pollen spectra. At the base of the zone sandy clays occur, overlain by limestones with shell beds. On top of these limestones a lamination has been developed of clay and shell beds, not exceeding 1 cm in thickness. About half-way sandstones occur, merging into limestones. The uppermost part of the zone consists of quartzitic sandstones, at the top changing into sandy clays and marls. An increase of *Classopollis* is accompanied by a fall of the trilete grains. *Peromonolites fragilis* (62) and *Abietineaepollenites minimus* (71) show oscillations, while *A. microreticulatus* (70) returns in the upper part of the zone. *Perinopollenites elatoides* (90) occurs throughout the whole zone with about 7 %.

Pollen zone Y (580–570 m) corresponds to the first Valanginian strata with a distinctly marine facies. The lower part is formed by impure clays, the middle part is alternatively clayey and calcareous. The upper part contains sandstones and near the top clay again. The pollen flora shows a small oscillation of *Classopollis*, a slow increase of the Vesiculatae, due to the return of *Parvisaccites radiatus* (81) and a peak in the trilete group, mainly at the base of the zone, which is caused by an increase of *Concavisporites twentianis* (10) and the *Gleicheniiditis* group (16).

Pollen zone Z (570–560 m) is showing an important sandstone complex, at the top overlain by clays and marls. This sandstone is about 8 m thick and might very well represent a northwestern continuation of the Bentheim Sandstone. *Classopollis* is moderately represented and the vesiculate group diminishes, caused by the decrease of the group of *Abietineaepollenites* (67) and the fall of *Parvisaccites radiatus* (81) in the upper part of the zone. The trilete group increases, mainly by a rise of the *Gleicheniidites* group (16).

6. *Description of pollen diagram Enschede* 2

The section of Enschede does not have the same time-range as the section of Tubbergen. Strata younger than the "Wealden" are not represented. Most of the Jurassic section is dominated by *Classopollis*, but the scarcity of pollen-containing samples does not allow us to separate pollen zones S, T and U properly. The lithology is mainly showing clays and limestones. The base of these limestones, possibly somewhere in pollenzone S might form the base of the Serpulite (Schott 1950). At the top of zone U (454/456 m) a low minimum of *Classopollis* is accompanied by a top of the vesiculate group. The rest of the pollen flora is mainly formed by *Peromonolites fragilis* (62) and *Perinopollenites elatoides* (90). The top of the Vesiculatae is mainly caused by the group of *Abietineaepollenites* (67) and by *Rugubivesiculites minimus* (79).

Pollen zone V (454/456–402/404 m) is mainly consisting of clays, while impure limestones occur about half-way and near the upper part. The trilete group shows a huge increase in the lower part and at the top of the zone. The first oscillation is mostly due to *Cyathidites* (11), while the second one represents more or less an increase of all components of the group, particularly of *Concavisporites twentianis* (10) and the *Gleicheniidites* group (16). *Peromonolites fragilis* (62) shows a single peak before disappearing and the *Eucommiidites* group also shows a considerable oscillation.

Zone W (402/404–354/356 m) consists mainly of clays, here and there with calcareous intercalations. The pollen picture shows a gradual decrease of *Classopollis* with an incidental peak (level 372/374 m). The base of the zone is also characterized by the definite increase of the trilete group, particularly of *Concavisporites twentianis* (10), *Gleicheniidites circinidites* (17), *G. senonicus* (19) and the Striatrilete group (24). The Vesiculatae show an increase in the graphs of *Parvisaccites radiatus* (82) and *Cerebropollenites mesozoicus* (65).

Pollen zone X (350/352–104/106 m) occupies half of the total sequence and shows a very detailed pollen picture, thanks to the relatively close distance of the spectra. Subzone X-1 (350/352–316/318 m) consists of thick limestone beds, with shell banks on top of them. The pollen flora is dominated by the trilete group, of which *Gleicheniidites* (16) shows an increase. The Vesiculatae remain more or less constant, although *Abietineaepollenites minimus* (71) shows a slight increase. Subzone X-2 (316/318–276/278 m) is mostly consisting of limestones and marls, with some intercalations of clays. The *Classopollis* curve shows an oscillation, which is accompanied by a maximum of *Peromonolites fragilis* (62), while the trilete group decreases. Subzone X-3 (276/278–194/196 m) consists of limestones, about half-way overlain by clays, in which limestone banks occur. *Classopollis* shows a considerable decrease and even disappears at the top of the subzone. The Vesiculatae show an increase, mainly in the curves of *Cerebropollenites mesozoicus* (65) and the decayed Bivesiculatae (83). *Cyathidites* (11) shows a gradual decrease, while *Deltoidospora rafaeli* (15), *Gleicheniidites circinidites* (17) and *G. senonicus* (19) show a maximum. Subzone X-4 (194/196–104/106 m) is mainly built up by clays with thin sandy or marly intercalations, while at the upper limit sandstones occur. In the upper part of the subzone there are no pollen spectra available, due to the bad preservation of the pollen flora. *Classopollis* and *Peromonolites fragilis* (62) show oscillations, while the curves of *Concavisporites twentianis* (10), *Gleicheniidites* (16) and Striatriletes (24) show an increase. The Vesiculatae rise to a maximum of 40 % in the lower part of the zone and fall to about 10 % at the upper limit. This oscillation is mainly due to the decayed Bivesiculatae (83).

7. *Comparison with the Mecklenburg "Wealden"*

Döring (1965) has investigated the "Wealden" in Mecklenburg, the eastern part of the Lower Saxon Basin, as for its palynology in order to come to a pollen-stratigraphical subdivision. Hereby the "Wealden" was divided in sporomorph zones A to G, based on the new income of species. Döring correlates these zones with the ostracod zones as follows: "Wealden" 1 comprises zones A and B, „Wealden" 2 zones C and D. The lowermost "Wealden" 3 is formed by E, while the remaining part of "Wealden" 3 and "Wealden" 4 form zone F. "Wealden" 5 and 6 are correlated with zone G.

The Mecklenburg flora involved is only comprising trilete spores, to which *Classopollis* and *Cerebropollenites mesozoicus* are added. As the Dutch trilete flora is less abundant, there are not many similar grains which might serve for correlational purposes. In the group of *Gleicheniidites*, spores much alike to *G. feronensis* or *G. circinidites* (*G. minor* Döring Pl. 5 fig. 9–11) occur in the upper half of the Mecklenburg "Wealden" in considerable amounts, which is in agreement with the Dutch curves. *Cicatricosisporites sternum* (= *C. magnus* Döring Pl. 15 fig. 1–2) occurs in zone E, but in the Dutch sequence it is reported throughout the whole "Wealden" sequence. *Plicatella tricornitata* is reported in the top of the German "Wealden", while the Dutch sequence shows the grain in pollen zones T to Z. *Cingulatisporites distaverrucosu*

(= *Uvaesporites pseudocingulatus* Döring) is reported at the top of the "Wealden", while the Dutch sequence only shows the grain at the base of pollen zone T.

In general the vertical ranges in the Dutch sequence are more extended. The frequency distributions of the species show mostly a different pattern, which may be a consequence of a limited spore dispersion of the plants, many of which may be herbs. Comparing both pollen zonations to the ostracod zonation of Wolburg, it appears that zones A, B and the lower part of C belong to the upper three-quarters of the Dutch pollen zone V, the rest of C and D belong to zone W, the zones E, F and G in zone X, while the boundary between X 1 and X 2 is located somewhere in G.

8. *Interpretation of cyclic development*

When the foregoing sections in this chapter are regarded together, it appears that there is a relation between the first and last occurrence of sporomorph species on one hand and fluctuations in the relative frequencies of the sporomorph groups on the other hand. Each major fluctuation is accompanied by the appearance or disappearance of species.

The frequency fluctuations of major sporomorph groups and of separate sporomorphs appear to take place independently, although in synchrony with the major fluctuations of *Classopollis*, so that they may be attributed to shifting vegetation belts in the region west of the Lower Saxon Basin. The fluctuations of the main sporomorph curves cannot be attributed to sedimentological processes only, because they are in part taking place independently of the type of sediment.

There are indications in diagram T–6/R to V/5 that the fluctuations are caused by movements of the sea level. It was stated in Chapter II-2 that sediments in shallow water mostly consisted of limestones, while in the deeper parts of the basin finer-grained argillaceous deposits predominate. Therefore, in the case of a regressive phase, the immediate nearness of the land would be accompanied by the deposition of limestones and possibly coarse clastic material at the location of bore-hole Tubbergen 6. During a transgressive phase the distance from this location to the coast increases, which would be accompanied by the deposition of finer-grained clays. During such a time-interval the vegetational belts would also be located at a greater distance from the location of bore-hole Tubbergen 6, so that the dominating effect of the coastal vegetation, i.e. *Classopollis* (Pocock 1962), upon the pollen rain would be reduced to more balanced amounts in the total of the pollen flora. In the pollen diagram the withdrawal of the coastal vegetation would be manifested in a decrease of the corresponding pollen flora. In fact the section of diagram T–6 mentioned above shows that a clayey sequence in the lithological column goes together with a decrease in frequency of *Classopollis*, accompanied by an increase of other sporomorph groups, such as the Triletes.

Following this argumentation, pollen zone R might picture a development of the pollen flora during a regressive phase, while pollen zone S might point to an advance of the sea. This cyclic repetition is continued more or less distinctly throughout the pollen diagrams of T–6 and E–2. Therefore it seems that during the whole time-interval represented, regular sea-level oscillations took place in the Lower Saxon Basin, affecting the vegetation and the pollen sedimentation in the Twente area.

The pre-"Wealden" sequence of diagram E–2 is represented by only eight spectra; this number is inadequate to represent the history of the pollen flora in any detail, so that a correlation with the corresponding section of diagram T–6 will be unsuccesful. In contrast with this, some parts of the "Wealden" sections of both diagrams may be compared and show an agreement in the history of the pollen flora, although the section of diagram E–2 is shown with much more details. Both diagrams show frequency fluctuations of the major sporomorph groups, comparable in importance and amplitude, the only difference being the absence of an oscillation in the group of Triletes in diagram T–6/X–3/6; here again the changes of the pollen flora are not adequately registered, as pollen zone X is represented by only two pollen spectra.

Nevertheless, it was tried to obtain a general view on the cyclic vegetational history throughout the whole investigated time-interval; for this purpose the survey diagrams 5 and 6 of both pollen diagrams are represented schematically and simplified in text-figure 7.

Thereby the pre-"Wealden" section of diagram T–6, the "Wealden" section of diagram E–2 and the Mid-Valanginian section of diagram T–6 were combined. The frequency fluctuations in the groups of Triletes and Vesiculatae within pollen zone V have been reproduced with dashes, because the pollen history in the zone was not pictured with a satisfactory agreement in both pollen diagrams.

Most probably the appearance and disappearance of part of the sporomorphs do not originate from evolutionary tendencies in the development of the vegetation, as many species, occurring only in limited sections of the pollen diagrams, yet have been reported from much older or much younger strata in other locations.

Besides the features mentioned above, the pollen flora is subject to more permanent changes, which take place in a narrow time-interval. These changes are:

(1) the decrease of *Classopollis* within pollen zones V and W,
(2) the increase of the group of Triletes in pollen zone V, mainly caused by an increase of the spores of *Cyathidites* (11), *Gleicheniidites* (16) and *Cicatricosisporites* (24).

It is also interesting to note that the first occurrence of Angiosperms (96) takes place in the upper part of pollen zone W. As far as we know distinct angiosperm pollen grains have not been reported from older strata till now.

9. *The location of the Jurassic-Cretaceous boundary*

In the foregoing chapter we have seen the results of the indirect correlations, based on ostracods, between the marine type sections in southeastern France and the equivalent section in the Lower Saxon Basin at the Jurassic-Cretaceous boundary. Taking the stratigraphy of the pollen zones into account, the most narrow range in which the boundary might be placed, lies between the base of pollen zone V and the base of pollen zone W (text-fig. 7).

In this section we shall treat this problem tentatively from a quite different point of view, taking into account the rhythmical cycles, which might possibly have more than local significance.

Similar fluctuations have been recorded in pollen diagrams from Maastrichtian and Paleocene strata of Colombia in South America (van der Hammen 1957, 1964). One of these diagrams is schematically reproduced in text-figure 7. The stratigraphical subdivision is based on the fluctuations of the *Psilamonocolpites medius* group. Regarding these fluctuations, and taking into account the cycles in the Cretaceous sedimentary succession of the Eastern Cordillera in Columbia, studied

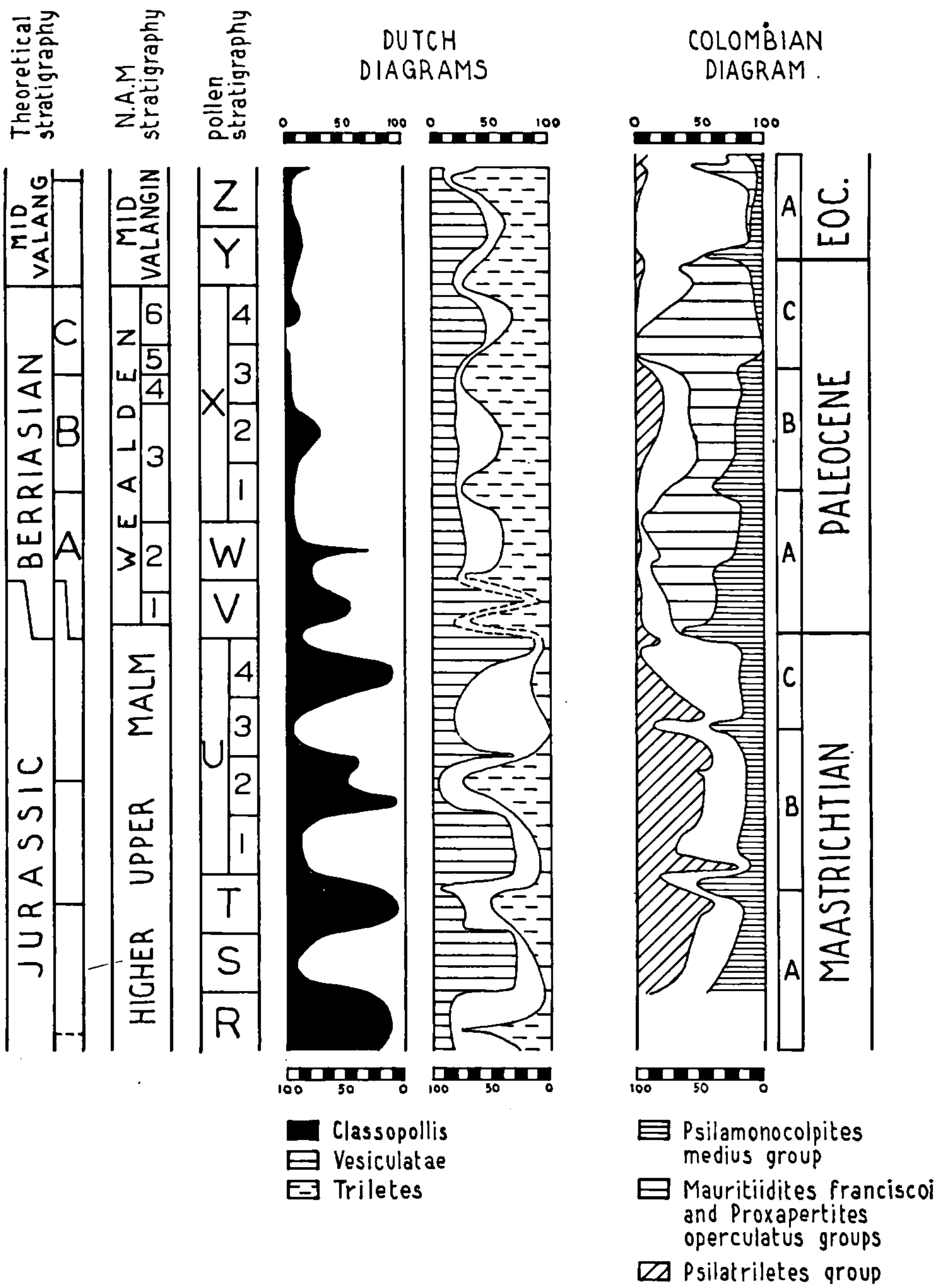

Fig. 7. Comparison between fluctuations of major sporomorph groups in the pollen floras at the Jurassic-Cretaceous boundary in Holland and the Cretaceous-Paleocene boundary in Colombia.

by Bürgl (1959), van der Hammen developed a theory, assuming that the cyclic course of the Colombian pollen diagrams, originating from oscillations of the climate, would have a world-wide occurrence. Thereby van der Hammen calculated their duration at ca. seven million years, while one cycle would comprise three minor cycles of ca. 2.3 million years. Each cycle of seven million years would correspond to one of the Cretaceous ages.

Both composite diagrams pictured in text-fig. 7 contain the beginning of one cycle of 70 million years of van der Hammen; the beginning of the Cretaceous and the beginning of the Cainozoic. When the Dutch composite diagrams are divided in cyclic intervals on the basis of the curve of the Triletes, probably one interval might correspond to a cycle of ca. 2.3 million years. The Berriasian, being one of the Cretaceous ages, would therefore occupy three intervals immediately underneath the base of the Mid-Valanginian (text-fig. 6), that is to say the intervals lying in pollen zones X and W, maybe also in pollen zone V. The base of the Berriasian, at the same time the base of the Cretaceous, would then correspond to the base of pollen zone W or the base of pollen zone V. It appears that both this boundary and the base of the Cainozoic show more permanent frequency changes of one of the sporomorph groups, viz. the group of Triletes at the base of the Cretaceous and the group of *Psilamonocolpites* at the base of the Cainozoic (text-fig. 7).

Finally, when we take into account the results of ostracod investigations mentioned above, which results would also be acquired according to the theory of van der Hammen, and the fact that both pollen zones, particularly zone W, show a considerable increase of sporomorph species, we are inclined to assume that the Jurassic-Cretaceous boundary in the Dutch-German stratigraphy might be placed at the base of pollen zone W, possibly also at the base of pollen zone V, corresponding respectively to the lower part of ostracod zone "Wealden" 2 and the uppermost part of ostracod zone "Malm" F. The Serpulite might then be placed in the Tithonian, while the "Wealden" would nearly completely belong to the Berriasian. This means that the Jurassic-Cretaceous boundary in the eastern Netherlands would be placed at or very near the base of the "Wealden".

IV. SYSTEMATICAL PART

1. *General systematics*

In this section we are dealing with the problems arising when a logical classification system of sporomorphs is designed. For the purpose of systematic classification of the sporomorph contents of our boring sections several morphographical schemes could be used. We had to choose among three major systems, i.e. a natural, a semi-natural or an artifical system. In the following lines we shall discuss each system briefly.

A natural system is a system in which all sporomorphs are placed in natural plant taxa. Dispersed fossil sporomorphs can only be placed in a natural extant plant taxon, based on morphographical identity with sporomorphs in situ. It is well known, however, that morphographical resemblance in a large number of cases does not necessarily imply an identity or even a botanical relationship. Any misinterpretation in this identification may be a source of errors, not only in palynology, but also in other fields such as palaeoclimatology and phylogeny. Moreover, the problem arises how to neutralize the effect of these errors. Pierce (1961) gives an illustrative report of the difficulty of correcting any wrong interpretation in the course of time.

In much Russian literature from last decades, recent plant names are used for Mesozoic and Tertiary dispersed spores. In this way recent plant genera are enlarged solely on the ground of pollen or spores not known before from those genera. Potonié (1956-b) states that for such an incorporation more material than only sporomorphs is needed.

A semi-natural system of classification is used by several investigators on Mesozoic and Tertiary like Cookson, Couper and Potonié. They create genera which suggest affinity with modern plant taxa, thereby adding suffixes like *-ites*, *-idites*, *-pollenites* or *-sporites*. In (Upper) Mesozoic and younger pollen floras this system is attractive, because there are many opportunities for morphological correlations with recent material. Nevertheless, in older pollen floras such a system would not be effective.

This system is fundamentally not different from a purely morphographical classification, which is based on number and structure of apertures and certain other exine features.

Pierce (1961) gives a short historical summary of the development of the systems following this method of classification. With the progress of palynology different systems of nomenclature were proposed, different morphological concepts were created and with the advancement of pollen analysis these systems were thrown together, re-interpreted or extended. The modern palynologist could not possibly disentangle this mixture and maintain one single system, without coming into conflict with the priority rules established in the International Code of Botanical Nomenclature (hereafter referred to as the ICBN).

Nowadays a classification can only be effective if:

a. It is based on a morphological nomenclature which is internationally accepted.
b. It does not offend existing valid names.

Regarding these conclusions, we have tried to design a system that is not too rigid and which can be extended if needed.

Our system is mostly based on the classification of Iversen & Troels-Smith (1950) for the pollen grains, and the classification used by Potonié (see Synopsis I–III) for the spores, with slight modifications. The binominal system is in accordance with the ICBN. We have maintained the morphological terminology of Faegri & Iversen (1964), which is fairly well-known in the whole world and which is in our opinion the most simple and logical classification of all morphological features.

Our classification in Superdivisions (Turmata of Potonié) and Divisions (Subturmata of Potonié) comes in the place of the "Classes" designed by Pierce (1961), which word can not be used in the classification of fossil dispersed spores. The classification on a lower level may be based on sculpture, and for that purpose different methods exist (Potonié, Pant 1954, van der Hammen 1954, 1956, Pierce 1961 etc.) As we use the terminology of Faegri & Iversen, the method of van der Hammen is most suitable for us. However, this method cannot be maintained in the way it was presented. But the shape-groups proposed by van der Hammen are perfectly suitable for grouping all genera of dispersed spores together in a logical and comprehensible way. For example the shape-group Psilatriletes (i.e. all trilete forms without sculpture) can combine all genera like *Cyathidites*, *Gleicheniidites*, *Deltoidospora* and so on, but it cannot replace them. Therefore, Psilatriletes and all other proposed shape-groups should not be regarded as genera (Pierce 1961), but as a kind of "Subdivisions", higher in rank than organ-genera.

Such a system is used by Potonié (1956–a, 1958, 1960–a) in the "Synopsis der Gattungen der Sporae dispersae", in which all described genera are grouped into "Infraturmata". However, while Potonié uses variably defined Infraturmata in each Turma, we prefer to apply the same "super-generic" classification of van der Hammen in every Turma or Superdivision. Doing this we create many theoretical possibilities for not (or not yet) known sporomorphs (for example Echibivesiculatae).

It is unfortunately an undeniable fact that problems arise, even using the system here explained. We cannot use the shape-groups of van der Hammen as separate units, unless we neglect the fact that systematic literature on palynology to-day is swarming with spore genera, each of them fitting in more than one shape-group or even in more than one Division.

This demonstrates the confusions existing on the subject of morphological concepts. Maintaining the system of van der Hammen would mean that a large and questionable genus has to be split up in several (newly created) genera in such a way, that each of these genera fits in one of the shape-groups. It is desirable, that somehow this task should be carried out in the future in order to obtain such a classification in genera, which are more easy to handle in the case of transference into another group or into a botanical taxon.

Regarding the present state of affairs, we have decided to follow more or less the example of Potonié and combine the different shape-groups of van der Hammen into new units which do not interfere with at least the generic conceptions used in this work. We are fully aware of the relativity of such a system, so that we have followed the advice of Dr. van der Hammen not to validate our new units in the sense of the ICBN.

We have made the following combinations:

Group a comprises all psilate forms.
Group b comprises all rugulate and striate forms.
Group c comprises all reticulate and foveolate forms.
Group d comprises all scabrate, verrucate and gemmate forms.

Group e comprises all clavate, baculate and echinate forms.
Group f comprises all sporomorphs provided with a perinous layer.

It might perhaps be easier to give these groups new names, but we consider it premature to do so at this moment.

We have used these groups, in rank lying between Divisions and genera, as taxa without any further definition, but only to come to a convenient arrangement of all organ-genera. Therefore we have not indicated a type-genus to each group.

An organ-genus is only easy to handle when the range of variety among the spores involved is very narrow. It is difficult to give strict rules in order to obtain such a narrow range. An organ-genus should at the utmost include sporomorphs belonging to one "Subdivision" only. Furthermore an organ-genus should only comprise those sporomorphs with an identical sculpture type, except for special cases. Sculpture elements however are often not distributed equally on the whole grain surface, so that we have assumed that the dominating sculpture type, decisive for the classification in organ-genera should occur on:

1. Monolete, trilete and monosaccate spores at the distal face.
2. All cingulate spores at distal face of central body.
3. Bivesiculate and polyvesiculate grains at proximal cap.
4. All alete and inaperturate grains dominating on whole surface.
5. All angiosperm and other gymnosperm pollen grains on the area beyond the marginal zone of the apertures.

The perinate sporomorphs form a separate case. It may occur that there are given different names to sporomorphs in different states of fossilization. Therefore it often appears that perinate and non-perinate spores are placed in different genera (ICBN — PB 1–1, Potonié 1956–b). In each of our Superdivisions the perinate spores represent groups, too large to be compared with organ-genera. Therefore we have ranked them (according to the system of the "Synopsis") at the "supergeneric" level. It is possible that these groups will grow out to larger units in the future, so that they will have to be ranked then in the Divisions.

There are some cases in which it is difficult to apply this system. In the case of *Trilites equatibossus* Couper 1958 (p. 250) we have regarded the spore to be verrucate. In the case of *Cerebropollenites mesozoicus* (Couper 1958) Nilsson 1958 (p. 261) we have regarded the "proximal cap" to be psilate. In the case of *Classopollis* (Pflug 1953) Pocock & Jansonius 1961 (p. 264) it was not possible to rank them in the Superdivision Monoporatae, because they would then have to be split up in different Subdivisions according to their sculpture, although morphographically they obviously belong to one genus. It may perhaps be useful to create a new Superdivision for this type of grain.

Finally, our descriptions of the species are not only based on the original descriptions, they are sometimes completed with our own observations. The reference to the Plates in the case of a new species is always meant for the holotype only. The occurrence of each species refers to the vertical distribution in the drilled sections in Holland.

2. *Descriptive systematics*

A. Superdivision TRILETES (Reinsch 1881) Potonié & Kremp 1954

A-1. Division AZONOTRILETES Luber 1935

A-1-a. Subdivision PSILATRILETES

Genus AURITULINASPORITES Nilsson 1958

Comments: the use of the genus-name *Auritulinisporites* as used by Levet-Carette (1963) is not in agreement with the rules of priority established in the ICBN.

Auritulinasporites complexis n. sp.
Plate 5, fig. 3

Holotype: Well Tubbergen 6, depth 581 m, slide T6/581–1, coordinates 44.5–109.4 micr. PO 20.

Description: Trilete, amb triangular with mostly straight sides. Trilete mark sometimes indistinct, reaching to the equator. Exine 4 μ thick, at proximal face forming walls of 4 μ thickness, like concave arcs, at the corners curving sharply around without interruption. At the corners the walls are 2–3 μ thick. At the distal face the exine shows concave foldings. Exine consisting of two layers, outer layer 1.5–2 μ thick, massive, psilate, inner layer about 2 μ thick, minutely perforated, in top view giving a reticulate impression.
Grain size 38–55 μ.

Occurrence: pollenzone W to pollenzone Z.

Comments: this grain may be related to the *Gleicheniidites* group. The queer perforations can best be observed when minute dirt particles have penetrated into them, in our case coal particles. We have to do with another kind of structure than shown in the spores of *Intrabaculisporis* Kedves & Rakosy 1964, which structure is similar to a tectate structure.

Synonym: cf. *Auritulinisporites* Levet-Carette 1963 (Pl. 17 fig. 26)

Auritulinasporites deltaformis n. sp.
Plate 5, fig. 4

Holotype: Well Tubbergen 6, depth 579.5 m, slide T6/579.5–1, coordinates 37.5–107.5 micr. PO 20.

Description: Trilete, amb triangular with straight sides. Trilete mark nearly reaching to the equator and surrounded by exine walls of 4–6 μ thick, which are curving sharply around at the corners without interruption. Distal grain face plane or slightly domed. Exine 5–6 μ thick, massive, psilate. Sometimes the inner surface shows an intragranulation.
Grain size 40–55 μ.

Occurrence: pollenzone W to pollenzone Z.

Comments: the grain differs from *A. complexis* by its more solid construction, its massive exine and the overall equal thickness of the proximal exine walls.

Genus CONCAVISPORITES (Pflug 1952) Delcourt & Sprumont 1955

Comments: many similar spores were found in the German Upper Cretaceous (Weyland & Greifeld, Weyland & Krieger 1953) and reported as cf. *Duplosporis.*

Concavisporites twentianis n. sp.
Plate 1, fig. 4

Holotype: Well Tubbergen 6, depth 579 m, slide T6/579–2, coordinates 46.4–107.1 micr. PO 20.

Description: Trilete, amb triangular with straight to concave sides. Trilete mark reaching to the equator and bordered by narrow lips. Exine 0.5–0.8 μ thick, psilate, showing a faint microgranulation. At proximal face the exine between trilete rays is stronger concave than at the equator, thus causing characteristical concave foldings.

Grain size 15–28 μ.

Occurrence: pollenzone R to pollenzone Z.

Comments: the trilete mark is not twisted at the proximal pole such as is shown at *Paraconcavisporites luzensis* Klaus 1960 from the eastern Alps. Our grains show proximal "Kyrtomes" (Potonié 1962–b) and not secondary foldings.

Synonym: possibly *Gleichenia subminor* Maliavkina 1958 (Pl. 10 figs. 5—6)

Concavisporites jurienensis Balme 1957

Plate 4, fig. 6

Type: Well Tubbergen 6, depth 605.5 m, slide T6/605.5–2, coordinates 41.6–107.2 micr. PO 20.

Description: trilete, amb triangular with concave sides and acute, sometimes faceted corners. Trilete mark raised and reaching to the equator. Exine 0.8–1.5 μ thick, psilate. Distal face showing an exine ridge 1.5 μ wide, running parallel with and close to the equator and crossing the distal face perpendicular to the radius of the grain, about half-way between the pole and the apices.

Grain size 20–27 μ.

Occurrence: pollenzone R to pollenzone Z.

Synonyms: *Auritulinasporites intrastriatus* Nilsson 1958 (Pl. 1 fig. 17)
Gleicheniidites apilobatus Brenner 1963 (Pl. 11 fig. 2)
Concavisporites (Obtusisporis) obtusangulus (Potonié 1934) Krutzsch 1959 (Pl. 15 figs. 155—158)

Genus CYATHIDITES Couper 1953

Cyathidites australis Couper 1953

Plate 5, fig. 2

Type: Well Tubbergen 6, depth 579.5 m, slide T6/579.5–2, coordinates 41.7–97.3 micr. PO 20.

Description: Trilete, amb triangular with straight or concave sides. Trilete rays reaching to the equator. Exine 1.5–2.5 μ thick, psilate.

Grain size 55–70 μ.

Occurrence: pollenzone R to pollenzone X.

Cyathidites minor Couper 1953

Plate 4, fig. 1

Type: Well Tubbergen 6, depth 579 m, slide T6/579–2, coordinates 47.0–102.0 micr. PO 20.

Description: Trilete, amb triangular with straight or concave sides. Trilete mark reaching to the equator. Exine 1–2 μ thick, psilate.

Grain size 25–55 μ.

Occurrence: pollenzone R to pollenzone Z.

Synonym: *Leiotriletes adrienniformis* Nilsson 1958 (Pl. 1 fig. 5—6)

Genus DELTOIDOSPORA (Miner 1935) Potonié 1956

Deltoidospora nana n. sp.
Plate 1, fig. 1

Holotype: Well Tubbergen 6, depth 579.5 m, slide T6/579.5–1, coordinates 29.1–101.2 micr. PO 20.

Description: Trilete, amb triangular with straight sides. Trilete mark reaching to the equator. Exine 2.5 μ thick, psilate.

Grain size 25–35 μ.

Occurrence: pollenzone U to pollenzone Z.

Deltoidospora rafaeli n. sp.
Plate 4, fig. 3

Holotype: Well Tubbergen 6, depth 605.5 m, slide T6/605.5–2, coordinates 37.5–107.6 micr. PO 20.

Description: Trilete, amb triangular with straight sides. Trilete mark reaching to the equator. Exine 0.5–1.0 μ thick, psilate, sometimes showing a faint micro-granulation.

Grain size 15–25 μ.

Occurrence: pollenzone R to pollenzone Z.

Comments: our grain differs from *Cyathidites minor* by its thinner exine and smaller size. It also differs from *Concavisporites twentianis* by the absence of proximal exine foldings.

Genus GLEICHENIIDITES (Ross 1949) Delcourt & Sprumont 1955

Gleicheniidites circinidites (Cookson 1953) Brenner 1963
Plate 3, fig. 1

Type: Well Tubbergen 6, depth 571.5 m, slide T6/571.5–1, coordinates 44.7–105.7 micr. PO 20.

Description: Trilete, amb triangular with more or less straight sides and pointed, somewhat protruding corners. Trilete mark raised, reaching to the equator. Exine about 2 μ thick at the corners, increasing to 4.5–6 μ at the sides, psilate, minutely intrareticulate. Distal face provided with more or less concave exine foldings, 3–4 μ wide, connecting the apices and forming obtuse angles near the distal pole, at the apices curving sharply around without interruption. In polar view they may easily be regarded as a margo around the trilete mark.

Grain size 33–43 μ.

Occurrence: pollenzone R to pollenzone Z.

Comments: distal exine foldings were not mentioned in Cooksons original description. Brenner mentions a tendency of the equatorial exine thickenings to continue around the corners; we think that this is caused in reality by the curving of the distal foldings (see Brenner 1963 Pl. 11 fig. 5).

Gleicheniidites feronensis (Delcourt & Sprumont 1955)
Delcourt & Sprumont 1959
Plate 4, fig. 4

Type: Well Tubbergen 6, depth T6/576.5 m, slide T6/576.5–1, coordinates 43.0–110.2 micr. PO 20.

Description: Trilete, amb irregularly triangular, corners more or less protruding. Trilete mark indistinct, reaching to the equator. Exine psilate, at the corners 2–3 μ thick, increasing to 5–8 μ at the sides. Distal face showing exine foldings, sometimes indistinct, running deeply concave, connecting the apices, at which point they are interrupted.

Grain size 25–35 μ.

Occurrence: pollenzone W to pollenzone Z.

Comments: *G. feronensis* comprises a variety of grains, as can be seen in Delcourt & Sprumont 1955. We have found many intermediate forms between this grain and *G. circinidites* and similar spores are recorded also in Australia as *G. cercinidites* (Cookson 1953) Dettman 1963 (Pl. 13 figs. 6–10). Consequently we are inclined to think that *G. feronensis* might very well be a variety (or immature form?) of *G. circinidites.*

Synonyms: *Gleicheniidites elegans* Nagy 1963 (Pl. 1 fig. 9—11)
Gleicheniidites marginatus Takahashi 1964 (Pl. 23 figs. 4—17)
Gleicheniiditis (Triremisporites) delcourti Döring 1965 (Pl. 18 fig. 9—10)
Gleicheniidites (Triremisporites) minor Döring 1965 (Pl. 5 fig. 10—11)

Gleicheniidites senonicus Ross 1949

Plate 3, fig. 5

Type: Well Tubbergen 6, depth 664 m, slide T6/664–2, coordinates 38.2–108.5 micr. PO 20.

Description: Trilete, amb triangular with straight to slightly concave sides. Trilete mark reaching to the equator. Exine psilate, at the corners 1.5–2 μ thick, increasing to 2.5–3.5 μ at the sides. Exine between trilete rays stronger concave than at the equator, causing concave foldings which are disappearing at the corners. Distal face characterized by exine ridges, deeply concave, sharply curving at the corners without interruption.

Grain size 27–35 μ.

Occurrence: pollenzone R to pollenzone Z.

Gleicheniidites simplex n. sp.

Plate 3, fig. 4

Holotype: Well Tubbergen 6, depth 572 m, slide T6/572–2 coordinates 45.4–105.3 micr. PO 20.

Description: Trilete, amb triangular with slightly concave sides. Sometimes the corners are slightly pointed. Trilete mark reaching to the equator. Exine possibly two-layered, not folded, psilate, intrareticulate, at the corners 1.5–2.5 μ thick, at the sides increasing to 2.5–3 μ.

Grain size 27–33 μ.

Occurrence: pollenzone S to pollenzone Z.

Comments: the grain differs from *G. senonicus* by the smaller degree of equatorial exine thickening and the absence of exine foldings. We have found no intermediate forms between *simplex* and *senonicus*, so that we considered it justified to erect a new species.

Genus LAROCCATRILETES n. gen.

Comments: these Coniopteris-like spores have not been described as a separate group before. As a matter of fact, they have very rarely been recorded in the palynological literature at all. They are very much resembling the spores of *Cyathidites* and *Matonisporites* Couper, but they have a thinner exine. We have not placed our spores in the genus *Leiotriletes* (Naumova 1937) Potonié & Kremp 1954, because in the description of this genus all grains can be placed that are described to-day as *Cyathidites, Deltoidospora, Triplanosporites* and so on. Such a spore group has become much too voluminous to be useful in determinative and correlative work. Potonié (1960–Synopsis III) also deals with this problem, remarking that for a good deal *Leiotriletes* can be compared with other genera. Kedves (1960 and 1961) describes triplane spores as *Leiotriletes* and Krutzsch (1962) describes identical spores as *Triplanosporites*. All these groups can be subdivided into different genera as *Cyathidites* and *Matonisporites* Couper. As this situation is unsatisfactory, we have tried to apply the same criterium as Couper (1958) used in the separation of different Dicksoniaceous spores: the thickness of the exine. In this way our grains do not fit in the most resembling genera of *Matonisporites* and *Cyathidites*, so that they can be handled as a separate group.

Diagnosis: trilete spores, amb triangular with concave sidse and more or less rounded corners. Trilete mark reaching to the equator and bordered by a narrow margo.

Exine psilate, 0.4–1.0 μ thick.

Grain size (provisionally) 35–60 μ.

Genotype: L. papyrus n. sp.

Laroccatriletes papyrus n. sp.

Plate 5, fig. 1

Holotype: Well Tubbergen 6, depth 605.5 m, slide T6/605.5–2, coordinates 39.1–108.6 micr. PO 20.

Description: Trilete, amb triangular with concave sides and rounded corners. Trilete mark reaching to the equator and bordered by a narrow margo. Exine psilate, about 0.5 μ thick.

Grain size 35–45 μ.

Occurrence: pollenzone R to pollenzone Z.

Synonym: *Cyathidites* sp. Brenner 1963 (Pl. 11 fig. 9)

Genus MATONISPORITES Couper 1958

Comments: Dettman (1963) gives an emendation of this genus, thereby excluding *Matonisporites equiexinus*, putting this grain in the genus *Dictyophyllidites*. Dettman restricts *Matonisporites* to certain spores with thickened apices (i.e. *M. phlebopteroides*). We agree with such a separation in this genus, but the emended generic diagnosis of *Dictyophyllidites* (in which *Matonisporites* sensu Couper 1958 is incorporated) would comprise such a large group of spores, that in the future it will come to the same difficulties as we are dealing with in the case of *Leiotriletes* (p. 240). Therefore we cannot agree with the emendation which Dettman proposes for *M. equiexinus*.

Matonisporites equiexinus Couper 1958

Plate 2, fig. 3

Type: Well Tubbergen 6, depth 579 m, slide T6/579–2, coordinates 32.6–102.0 micr. PO 20.

Description: Trilete, proximal face flattened, distal face hemispherical. Amb triangular with straight to concave sides and rounded corners. Trilete mark reaching to the equator and bordered by a narrow margo.

Grain size 37-50 μ.

Exine 2.5–3.5 μ thick, psilate.

Occurrence: pollenzone R to pollenzone Z.

Matonisporites dorogensis (Kedves 1960) n. comb.

Plate 2, fig. 1

Type: Well Tubbergen 6, depth 579.5 m., slide T6/579.5–1, coordinates 38.6–100.7 micr. PO 20.

Description: Trilete, proximal face flattened, distal face hemispherical to subtetrahedral. Amb triangular with straight to concave sides and more or less rounded corners. Trilete mark raised, bordered by a narrow margo and reaching to the equator. Exine 2.5–3.5 μ thick, psilate.

Grain size 50–75 μ.

Occurrence: pollenzone W to pollenzone Z.

Comments: although we have often found the grain in that queer compressed condition from which the name *Triplanosporites* has been derived, it is not the authentic shape. Spores belonging to other genera have also been found in that state. As the grain is occurring in the Mesozoic as well as in the Tertiary, we have put this grain in *Matonisporites*, its features in all respects fitting in this genus.

Synonyms: *Leiotriletes dorogensis fvar. triplan n. fvar* (Kedves 1960) Kedves 1961 (Pl. 5 figs. 9, 12, 13)
Triplanosporites sinomaxoides Krutzsch 1962 (Pl. 13 fig. 1—6)

A-1-b. Subdivision STRIATRILETES and RUGUTRILETES

Genus CICATRICOSISPORITES Potonié & Gelletich 1933

Comments: as this genus embraces a very large group of grains, occurring from the Lower Jurassic up to recent times, there is no way to make the genus valuable for stratigraphic and correlative purposes, unless a method can be developed, in which a logical division of *Cicatricosisporites* in easier surveyable groups is obtained. Such a method has been worked out by Deâk (1963) and extended by Pocock (1964); it is based on different patterns that can be shown by the striate sculpture on both faces of the spores. In a separate study on recent striatrilete spores by H. W. J. van Amerom and D. Burger (to be published) it could be proved that each species has an invariable arrangement of striae. We may therefore assume that these arrangements are also of specific value in the determination of fossil material. Taking these features into account, the investigator will be able to determine even badly distorted spores, provided that an adequate description and/or illustration exists from all types. Descriptions of striate spores should mention the striate arrangements at both grain faces, and each photograph should clearly show them.

Cicatricosisporites crassistriatus n. sp.

Plate 7, fig. 2

Holotype: Well Tubbergen 6, depth 579 m, slide T6/579–2, coordinates 41.0–110.0 micr. PO 20.

Description: Trilete, amb irregularly trilete with convex sides. Trilete mark indistinct, reaching to the equator and bordered by a narrow margo. Proximal face flattened, distal face hemispherical. Exine ornamented with striae, which are often curved, running more or less parallel to the equator, forming a pattern of concentric triangles, at the proximal face leaving a considerable contact area free and 1 or 2 in number, at the distal face 3–5, but mostly 4 in number. Here this pattern often shows deviations, particularly around the distal pole, caused by the varying width and the sinuosity of the striae. Exine between striae 1 μ thick, striae about 3 μ high, diminishing to 1 μ at the corners, 2.5–3.5 μ wide and set 2–3 μ apart. The projection of the equatorial striae often gives the grain a cingulate character.

Grain size 35–50 μ.

Occurrence: lower part of pollenzone W to pollenzone Z.

Synonym: *Corrugatisporites toratus* (pro parte) Weyland & Greifeld 1953 (Pl. 11 fig. 59)

Cicatricosisporites abacus n. sp.
Plate 7, fig. 3

Holotype: Well Tubbergen 6, depth 579 m, slide T6/579–2, coordinates 35.7–108.6 micr. PO 20.

Description: Trilete, amb triangular with more or less straight sides. Trilete mark raised, reaching to the equator and bordered by a margo of 2–3 μ wide. Exine on both faces striate, ribs running parallel to adjacent side, showing an arrangement of concentric triangles, proximally 4, distally 4–6 in number. Around the proximal pole a small contact area is left free. Striae 1 μ high, 2–3 μ wide and set apart less than 0.5 μ. Total exine thickness 5–6 μ.

Grain size 35–55 μ.

Occurrence: pollenzone R to pollenzone Z.

Cicatricosisporites cooksonii Balme 1957
Plate 8, fig. 1

Type: Well Tubbergen 6, depth 668.5 m, slide T6/668.5–1, coordinates 41.4–108.5 micr. PO 20.

Description: Trilete, amb irregularly triangular to circular. Trilete mark indistinct and reaching to the equator. Exine of proximal face either psilate or coarsely striate, in this case one broad rib connecting the corners, forming a triangle that encloses the trilete mark. Sometimes a second set of ribs, intentionally forming a second triangle, occurs at the equator, giving the grain a cingulate appearance. Distal face coarsely striate, ribs running more or less parallel to one side, 2 to 5 in number, 6–7 μ wide, 3–5 μ high and set 2–4 μ apart. Exine between striae 2.5 μ thick and showing a minutely scabrate surface.

Grain size 45–55 μ.

Occurrence: pollenzone S to pollenzone X.

Comments: Pocock (1964) makes a new combination, putting this species in *Appendicisporites* and proposing to regard his specimen (Pl. 7 figs. 9–10) as holotype. It may be left open to discussion whether the spores should be regarded as cingulate, or that equatorially arranged striae play the role of pseudo-cingulum, but Balmes description does not mention apical thickenings. Besides, Balme indicated his specimen of Plate 1 fig. 23 as holotype for the species (Balme 1957 p. 3).

Cicatricosisporites mohrioides Delcourt & Sprumont 1955

Plate 8, fig. 3

Type: Well Tubbergen 6, depth 578 m, slide T6/578–2, coordinates 43.6–105.3 micr. PO 20.

Description: Trilete, amb triangular with straight to convex sides. Trilete mark reaching to the equator and bordered by narrow lips. Proximal grain face either psilate or striate, striae running parallel to the equator and only covering the outermost part of proximal face. Distal face striate, ribs more or less concave, running parallel to adjacent side, forming 4–5 concentric triangles. Striae of outermost triangles not joining at the corners, but at the proximal face, thereby curving around the equator. This gives the apices a dentate outline. Striae 2 μ wide 1.5 μ high and set 0.5–1 μ apart. Exine between striae 1–1.5 μ thick.

Grain size 35–50 μ.

Occurrence: pollenzone U to pollenzone Z.

Synonym: *Cicatricosisporites goepperti* (Seward 1913) Groot & Penny 1960 (Plate 2 figs. 20, 22)

Cicatricosisporites myrtellii n. sp.

Plate 7, fig. 1

Holotype: Well Tubbergen 6, depth 579.5 m, slide T6/579.5–2, coordinates 33.3–95.8 micr. PO 20.

Description: Trilete, amb rounded triangular. Trilete mark sometimes indistinct, reaching to the equator and bordered by a margo of 2 μ wide. Proximal face striate, ribs running parallel to adjacent side, forming 2–3 concentric triangles and leaving a contact area of about 10–15 μ free. Distal face striate, ribs diverging from one corner, bifurcating and running more or less parallel, covering most of the distal face and blotted out by a set of 2–3 distal ribs running parallel to the opposite side. Striae 3–4 μ wide, about 1.5 μ high and set 1 μ apart. Total exine thickness 2.5–3 μ.

Grain size 35–45 μ.

Occurrence: lower part of pollenzone W to pollenzone X.

Cicatricosisporites sternum Amerom 1965

Plate 11, fig. 2

Type: Well Tubbergen 6, depth 600 m, slide T6/600-a, coordinates 38.0–110.8 micr. PO 20.

Description: Trilete, amb rounded triangular to circular. Trilete mark indistinct, nearly reaching to the equator. Exine on both grain faces striate, ribs running more or less parallel to adjacent sides, forming a pattern of concentric triangles, distally 7–9 and proximally 6–7 in number. Striae flattened, about 1 μ high, 2 μ wide and set 0.5 μ apart. The corners of the grain show a narrow, radially oriented, unsculptured area at the ends of the trilete rays. Total exine thickness 4–5 μ.

Grain size 60–70 μ.

Occurrence: pollenzone U to pollenzone Z.

Comments: this grain attracts attention by the number of triangles and the size. It differs from *C. brevilaesuratus* Couper 1958 by its distal arrangement of striae. It also differs from *C. abacus* by the size and the different apical regions. Our grain might very well be identical with the spore that Reyre (1964, Pl. 3 fig. 22) illustrates as *C. mohrioides.*

Synonym: *Cicatricosisporites magnus* Döring 1965 (Pl. 15 fig. 1—2)

Cicatricosisporites striatus Rouse 1962

Plate 6, fig. 2

Type: Well Tubbergen 6, depth 616.58 m, slide T6/616.58–1, coordinates 42.6–101.6 micr. PO 20.

Description: Trilete, amb triangular with rounded corners. Trilete mark reaching to the equator. Exine striate, proximal striae running parallel to adjacent side, forming an arrangement of 3–4 concentric triangles and leaving a small contact area free. Distal striae diverging from one corner, bifurcating and running more or less parallel across the surface. Striae 1 μ high, 2–2.5 μ wide and set 0.5 μ apart. Total exine thickness 3–5 μ, at one or two apices occasionally increasing to 5–7 μ.

Grain size 35–45 μ.

Occurrence: pollenzone V to pollenzone Z.

Comments: this grain differs from *C. myrtellii* by its thicker exine, the more slender striae and the different arrangement of distal striae.

Cicatricosisporites hallei Delcourt & Sprumont 1955

Plate 9, fig. 2

Type: Well Enschede 2, depth interval 302–304 m, slide E2/302–304-a, coordinates 43.8–104.8 micr. PO 20.

Description: Trilete, amb triangular with straight or convex sides. Trilete mark indistinct, reaching to the equator. Exine striate, proximal striae grouped in three sets, each set enclosed by 2 trilete rays and showing striae oriented parallel to one of the adjacent trilete rays and forming acute angles with the striae of the other sets. Striae crossing the equator obliquely and continuing on to the distal face, where the same striate pattern is repeated. In each of the three sets the striae are oriented parallel, leaving obliquely from the equator and cut off by the marginal striae of the adjacent set. Striae 1 μ high, 1.5–2 μ wide and set 0.5–1 μ apart. Total exine thickness 2–3 μ.

Grain size 45–55 μ.

Occurrence: pollenzone W to pollenzone Z.

Genus PLICATELLA Maliavkina 1949

Comments: Maliavkina described several striate trilete spores under the name *Plicatella*. Some of them are provided with apical thickenings. Maliavkina dit not indicate a type species, but Potonié (1960-a) indicates *P. trichacantha* as type species, thereby giving *Plicatella* the priority above the genus *Appendicisporites* Weyland & Krieger 1953 (also Weyland & Greifeld 1953) for all spores with short apical thickenings. However, the generic description of *Plicatella* (Maliavkina 1949 p. 60) does not mention such a thing as apical thickenings. This causes annoyant problems. According to art. 63 of the ICBN, the name *Plicatella* is superfluous, because the description is a duplicate of *Cicatricosisporites* (Potonié & Gelletich 1933) and consequently not legitimate. The spores provided with apical thickenings, described by Maliavkina, should be mentioned *Appendicisporites* sp. (nov. comb.). According to art. 70 of the ICBN, *Plicatella* can be divided in two easily distinguished groups, one including all spores with short apical thickenings, and one including all spores without them. In this case the name *Plicatella* can be maintained for all spores of the first group. We have arbitrarily chosen the second possibility.

The sculpture pattern in the group of *Plicatella* is until now only known as identical as the *C. abacus* type. Weyland & Krieger (1953 Pl. 3 fig. 15) illustrate a spore grain of the *C. hallei* type, calling it *Appendicisporites triceps.* However, judged by the illustration, the apical thickenings are lacking, so that we may have to do with *Cicatricosisporites.*

Plicatella problematica n. sp.
Plate 10, fig. 3

Holotype: Well Enschede 2, depth interval 298–300 m, slide E2/298–300-a, coordinates 33.0–99.6 micr. PO 20.

Description: Trilete, amb triangular with convex sides and pointed, protruding corners. Trilete mark indistinct and reaching to the equator. Exine on both faces striate, ribs running parallel to the adjacent sides, forming a pattern of concentric triangles, proximally 1–2, distally 3–5 in number. Around the proximal pole a large contact area is left free. Striae 4–5 μ high, diminishing to 2 μ at the corners, 2–3 μ wide at the base and sharply tapering to the tops, and set 1–2 μ apart. The projection of the equatorial striae, high as they are, gives the grain a zonal character. Total exine thickness 5–6 μ, apices protruding 4–5 μ.

Grain size 38–45 μ.

Occurrence: pollenzone W to pollenzone Y.

Comments: the grain differs from *Appendicisporites potomacensis* Brenner 1963 by the extreme height of the striae. It differs from *A. trichacanthus trichacanthus* (Maliavkina 1949) Pocock 1964 by its regular distal striate arrangement, its size and the absence of raised lips bordering the trilete mark. Our grain is also different from *A. irregularis* Pocock 1964 by its regular distal pattern of striae and the smaller apical thickenings.

Plicatella tricornitata (Weyland & Greifeld 1953)
Potonié 1960-a
Plate 13, fig. 1

Type: Well Tubbergen 6, depth 616.58 m, slide T6/616.58–1, coordinates 38.2–106.3 micr. PO 20.

Description: Trilete, amb triangular with straight or convex sides and blunt or tapering, protruding corners. Trilete mark sometimes indistinct, reaching to the base of the apical thickenings. Exine on both faces of grain striate. At proximal face the striae are running parallel to the adjacent sides, in an arrangement of 3–4 concentric triangles and leaving a contact area free around the proximal pole. At the distal face the striae may either be arranged parallel to the adjacent sides in a pattern of 5–7 concentric triangles, or they may diverge from one corner and cover the distal face for about 3/4, blotted out by a set of 3–5 distal ribs, running parallel to the opposite side. Between these two extreme distal striate arrangements many transition patterns exist. Near the corners the marginal striae curve outwards when they meet, enlarging their contact points, thus causing the typical thickenings. Striae 2–2.5 μ wide, set 0.5–1 μ apart. Total exine thickness 3–4 μ, at the corners 7–11 μ.

Grain size 45–60 μ (1 exceptional case 70 μ).

Occurrence: pollenzone T to pollenzone Z.

Genus STAPLINISPORITES Pocock 1962

Staplinisporites caminus (Balme 1957) Pocock 1962

Plate 12, fig. 2

Type: Well Tubbergen 6, depth 644 m, slide T6/664–2, coordinates 32.7–105.0 micr. PO 20.

Description: Trilete, amb rounded triangular. Trilete mark reaching to the equator and bordered by narrow lips. Proximal face minutely rugulate. Distal face coarsely rugulate, except for the distal pole, in which area the exine is thickened, forming a more or less circular disc, measuring 10–15 μ across and provided with small verrucae, on top of which minute spinules seem to occur. About half to two-thirds towards the equator the rugulate elements fuse and form a closed ring parallel to the equator, about 4–7 μ wide. Outside this ring the rugulae have a radial orientation. Exine thickness about 2 μ.

Grain size 36–45 μ.

Occurrence: pollenzone R to pollenzone Z.

Synonyms: *Cingulatisporites caminus* Balme 1957 (Pl. 5 figs. 62, 63)
Cingulatisporites valdensis Couper 1958 (Pl. 24 figs. 6, 7)
Spinaecoronatisporites valdensis (Couper 1958) Déak 1964 (Pl. 3 figs. 1—6)
Staplinisporites parvus Döring 1964 (Pl. 5 figs. 7—9)

Staplinisporites regularis n. sp.

Plate 13, fig. 2

Holotype: Well Tubbergen 6, depth 571 m, slide T6/571–1, coordinates 38.8–107.2 micr. PO 20.

Description: Trilete, amb rounded triangular. Trilete mark distinct, reaching to the equator and bordered by a narrow margo. Proximal exine minutely rugulate, elements measuring about 1 μ, becoming coarser with a more radial orientation near the equator. Distal exine rugulate with elements of about 3 μ, unoriented in an area enclosed by rugulae, which are more or less fused, forming a tortuous band parallel with the equator, two thirds away from the distal pole and not completely closed, here and there nearly absent. Outside this band the rugulae are more or less radially arranged. Distal pole showing a circular area of 10–15 μ across, where the exine is thicker, forming a disc provided with a scabrate-verrucate granulation, superposed by a minute reticulate(?) sculpture. Thickness of exine 3 μ, at the corners diminishing to 1 μ.

Grain size 42–49 μ.

Occurrence: pollenzone S to pollenzone Y.

Comments: this grain differs from *S. caminus* by the smaller and more densely crowded rugulae and the varying exine thickness.

A-1-c. Subdivision RETITRILETES and FOVEOTRILETES

Genus FOVEOTRILETES van der Hammen 1954 ex Potonié 1956-a

Foveotriletes subtriangularis Brenner 1963

Plate 14, fig. 1

Type: Well Tubbergen 6, depth 579 m, slide T6/579–2, coordinates 42.3–98.4 micr. PO 20.

Description: Trilete, amb triangular with straight to convex sides. Trilete mark raised and reaching to the equator. Exine on both faces foveolate, foveae 0.5–1 μ in diameter and spaced 1–4 μ apart. At the distal pole a small circular area occurs, sometimes indistinct, measuring 3–5 μ across and provided with a scabrate sculpture. Exine 3–4 μ thick, at the corners diminishing to 2 μ.

Grain size 35–55 μ.

Occurrence: pollenzone V to pollenzone Z.

Genus LYCOPODIUMSPORITES Thiergart 1938 ex Delcourt & Sprumont 1955

Lycopodiumsporites elongatus Delcourt & Sprumont 1955

Plate 14, fig. 2

Type: Well Tubbergen 6, depth 664 m, slide T6/664–2, coordinates 37.4–100.0 micr. PO 20.

Description: Trilete, amb triangular with straight sides. Trilete mark raised, not always distinct, reaching nearly to the equator and bordered by narrow lips. Exine coarsely reticulate to foveolate at distal face and psilate to microscabrate at proximal face. Sometimes the muri cross the equator and cover the outermost part of the proximal face between the corners. Muri 1.5–3 μ thick, 1–2 μ high. Lumina circular, oval or polyangular with a diameter of 2–5 μ. Total exine thickness 4 μ.

Grain size 30–45 μ.

Occurrence: pollenzone R to pollenzone Y.

Comments: this description covers nearly completely both *Ischyosporites crateris* Balme 1957 and *Klukisporites pseudoreticulatus* Couper 1958.

I. crateris may show apical thickenings, which have not been observed at *Klukisporites* (Couper 1958).

Synonym: *Ischyosporites pseudoreticulatus* (Couper 1958) Döring 1965 (Pl. 22 fig. 5—6)

Lycopodiumsporites austroclavatidites Cookson 1953

Plate 15, fig. 2

Type: Well Tubbergen 6, depth 571.5 m, slide T6/571.5–2, coordinates 35.2–99.1 micr. PO 20.

Description: Trilete, amb circular or rounded triangular. Trilete mark reaching to the equator. Proximal face flattened and faintly scabrate. Distal face hemispherical, reticulate, lumina 5–10 μ across, muri extremely thin, 3–5 μ high, also occupying the outermost part of the proximal face. Exine in the lumina also showing a faint scabrate sculpture. Total exine thickness 5–7 μ.

Grain size 40–50 μ.

Occurrence: pollenzone R to pollenzone X.

Comments: we agree with Pocock (1962) who regards this grain and *L. clavatoides* Couper 1958 as identical.

Lycopodiumsporites semireticulatus n. sp.

Plate 14, fig. 4

Holotype: Well Tubbergen 6, depth 678 m, slide T6/678–2, coordinates 38.5–104.1 micr. PO 20.

Description: Trilete, amb triangular with concave sides and rounded corners. Trilete mark raised and reaching to the equator. Exine at proximal face minutely rugulate, at distal face ornamented with muri, serpentining and sometimes bifurcating, showing a kind of imperfect reticulum. Muri are 0.8 μ wide and 1–1.5 μ high, the lumina, not closed, may show diameters of around 2 μ.

Grain size 23–28 μ.

Occurrence: pollenzone R to pollenzone Z.

Genus KLUKISPORITES Couper 1958

Klukisporites variegatus Couper 1958

Plate 15, fig. 1

Type: Well Tubbergen 6, depth 605.5 m, slide T6/605.5–2, coordinates 44.0–108.1 micr. PO 20.

Description: Trilete, amb triangular. Trilete mark reaching to the equator and bordered by narrow lips. Proximal face flattened, psilate. Distal face hemispherical, irregularly foveo-reticulate. Lumina 2–3 μ in diameter, not always closed. Muri 2–3 μ thick, 2 μ high. Total exine thickness 3 μ.

Grain size 38–46 μ.

Occurrence: pollenzone S to pollenzone X.

A-1-d. Subdivision SCABRATRILETES, VERRUTRILETES and GEMMATRILETES

Genus CONCAVISSIMISPORITES (Delcourt & Sprumont 1955) Delcourt, Dettman & Hughes 1963

Concavissimisporites crassatus (Delcourt & Sprumont 1955) Delcourt, Dettman & Hughes 1963

Plate 19, fig. 2

Type: Well Tubbergen 6, depth 577.5 m, slide T6/577.5–2, coordinates 40.9–96.3 micr. PO 20.

Description: Trilete, amb triangular, sides concave, corners rounded. Trilete rays bordered by a row of verrucae, sometimes fused and reaching to the equator. Exine on both faces verrucate, verrucae extremely flat, 2 μ in diameter and spaced about 1 μ apart. Moreover, both grain faces show a superposed minute scabrate sculpture, except for the margo bordering the trilete rays. Total exine thickness 1.5–2 μ, increasing to 2.5–3 μ midway between the corners.

Grain size 61–72 μ.

Occurrence: lower part of pollenzone W to pollenzone X.

Concavissimisporites punctatus Brenner 1963

Plate 19, fig. 3

Type: Well Tubbergen 6, depth 670.5 m, slide T6/670.5–2, coordinates 41.0–97.0 micr. PO 20.

Description: Trilete, amb triangular with concave sides and rounded corners. Trilete mark indistinct, reaching 3/4 to 1/1 to the equator. Exine verrucate, verrucae flat, 1–2 μ in diameter and set 0.5 μ apart. In the apical regions the verrucae are slightly more pronounced. Total exine thickness 2 μ.

Grain size 75–90 μ.

Occurrence: pollenzone S to lower part of pollenzone T.

Comments: Brenner illustrates this spore grain (Brenner 1963 Pl. 14 fig. 6) as *C. punctatus* (Delcourt & Sprumont 1955) Brenner 1963. This grain however is different from the original spore described by Delcourt & Sprumont 1955 as *Concavisporites punctatus* (Pl. 2 fig. 2). In Delcourt, Dettman & Hughes (1963) this grain is changed into *Cyathidites punctatus* nov. comb. (Pl. 42 figs. 1–4). As a consequence of this emendation the spore described by Brenner may be considered as a new species and not as a nov. comb. Our grain is identical with that of Brenner and we think that after the emendation of Delcourt, Dettmann & Hughes the name *Concavissimisporites punctatus* Brenner 1963 can be regarded as valid. Singh (1964) does not agree with the emendation of Delcourt, Dettman & Hughes, stating that undulose is not the same as psilate. However, Delcourt c.s. regard *Cyathidites punctatus* fundamentally as psilate; the term undulose has no sculptural significance in the nomenclature of Faegri & Iversen (1964).

Synonyms: *Concavissimisporites punctatus* (Delcourt & Sprumont 1955) Singh 1964 (Pl. 9 figs. 6—7)
Concavissimisporites punctatus (Delcourt & Sprumont 1955) Pocock 1964 (Pl. 5 fig. 7)

Concavissimisporites verrucosus (Delcourt & Sprumont 1955)
Delcourt, Dettman & Hughes 1963

Plate 20, fig. 1

Type: Well Tubbergen 6, depth 571 m, slide T6/571-2, coordinates 39.6–111.3 micr. PO 20.

Description: Trilete, amb triangular with concave sides and rounded corners. Trilete mark nearly reaching to the equator. Exine verrucate, verrucae measuring 2–3 μ across and 1 μ high. Around the trilete rays the verrucae may be fused, thus forming a wall of 2–4 μ wide. The verrucae are covering the trilete rays near their extremities.

Grain size 55–65 μ.

Occurrence: mid-pollenzone W to pollenzone Y.

Synonym: *Maculatisporites microverrucatus* Döring 1964 (Pl. 2 figs. 1—6)

Genus CONVERRUCOSISPORITES Potonié & Kremp 1954

Converrucosisporites proxigranulatus Brenner 1963

Plate 15, fig. 3

Type: Well Tubbergen 6, depth 663.5 m, slide T6/663.5–2, coordinates 36.7–105.9 micr. PO 20.

Description: Trilete, amb rounded triangular to circular. Trilete mark reaching to the equator. Proximal face flattened, sculpture scabrate. Distal face hemispherical, provided with closely spaced verrucae, 1–2 μ high, 3–4 μ across and spaced 0.5 μ apart, some of them fused. Total exine thickness 3–4 μ.

Grain size 25–35 μ.

Occurrence: pollenzone R to pollenzone Z.

Genes LEPTOLEPIDITES Couper 1958

Leptolepidites major Couper 1958
Plate 20, fig. 2

Type: Well Tubbergen 6, depth 668.5 m, slide T6/668.5–1, coordinates 40.2–102.3 micr. PO 20.

Description: Trilete, amb rounded triangular. Trilete mark raised, reaching to the equator. Exine possibly 4 μ thick, provided with verrucae, measuring 3–5 μ across, about 2 μ high and spaced 1 μ apart, sometimes fused. At the proximal face a contact area is left free.

Grain size 35–43 μ.

Occurrence: pollenzone R to pollenzone Z.

Genus LYGODIOISPORITES Potonié 1951

Lygodioisporites perverrucatus Couper 1958
Plate 16, fig. 1

Type: Well Tubbergen 6, depth 616.8 m, slide T6/616.8–1, coordinates 33,3–99.4 micr. PO 20.

Description: Trilete, amb triangular with straight or concave sides. Trilete mark indistinct, reaching to the equator and surrounded by a thickened margo, consisting of verrucae fused in one row. Exine intragranulate, verrucate, verrucae set apart 0.5–3 μ, circular or polyangular, measuring 5–10 μ in diameter, sometimes fused, in which case they are elongated. Height of verrucae 3–5 μ, at proximal face tending to reduce. Total exine thickness 7–10 μ.

Grain size 50–85 μ.

Occurrence: pollenzone T to lower part of pollenzone X.

Genus TRILITES Cookson 1947 ex Couper 1953

Trilites equatibossus Couper 1958
Plate 14, fig. 5

Type: Well Tubbergen 6, depth 663 m, slide T6/663–2, coordinates 32.8–102.2 micr. PO 20.

Description: Trilete, amb circular. Trilete mark reaching about half-way to the equator. Exine scabrate to microverrucate, except for the equatorial region, where a band of coarser verrucae with some baculae occurs. Verrucae about 2 μ high and 1.5 μ wide.

Grain size 28–38 μ.

Occurrence: pollenzone S to upper half of pollenzone X.

Genus TRILOBOSPORITES (Pant 1954) Potonié 1956

Trilobosporites apiverrucatus Couper 1958
Plate 18, fig. 1

Type: Well Enschede 2, depth interval 204–206 m, slide E2/204–206-a, coordinates 30.5–102.5 micr. PO 20.

Description: Trilete, amb triangular with concave sides and rounded corners. Trilete mark nearly reaching to the equator, bordered by a single row of verrucae, sometimes fused and forming a thickened wall. Exine verrucate, verrucae 1 μ high and 1–2 μ across, sometimes nearly absent, except for the apical regions where they are more pronounced, 2 μ high and 3–5 μ across. Total exine thickness 2–3 μ, occasionally at the apices increasing to 4–5 μ.

Grain size 60–80 μ.

Occurrence: pollenzone R to pollenzone Z.

Synonym: *Trilobosporites multituberculatus* (Bolkhovitina 1961) Pocock 1964 (Pl. 6 fig. 5)

Trilobosporites bernissartensis (Delcourt & Sprumont 1955) Potonié 1956

Plate 17, fig. 1

Type: Well Tubbergen 6, depth 675 m, slide T6/675–2, coordinates 40.0–102.2 micr. PO 20.

Description: Trilete, amb triangular with concave to straight sides and rounded or pointed corners.Trilete mark nearly reaching to the equator.Total exine thickness 4–5 μ, increasing to 8–11 μ at the corners. Sculpture complex, consisting of large flat verrucae, measuring 5–12 μ across and 1–2 μ high, irregularly distributed but close together near the corners. A second system of verrucae is superposed, smaller in size, densely crowded, 1–3 μ across and 0.5–1 μ high.

Grain size 55–80 μ.

Occurrence: pollenzone R to pollenzone U, possibly to pollenzone X.

Genus VERRUCOSISPORITES (Ibrahim 1932) Potonié & Kremp 1954

Verrucosisporites rarus n. sp.

Plate 18, fig. 3

Holotype: Well Tubbergen 6, depth 571 m, slide T6/571–2, coordinates 41.0–99.2 micr. PO 20.

Description: Trilete, outline rounded triangular. Trilete mark not always distinct, more or less straight, reaching nearly to the equator and bordered by an indistinct margo of 2–3 μ wide. Exine verrucate, verrucae flattened and oval or polyangular in cross-section, sometimes fused, measuring 2 × 2 μ to 4 × 8 μ across, set 1–2 μ apart and 0.5 μ high. Verrucae on proximal face less pronounced. Total exine thickness 2–2.5 μ.

Grain size 36–43 μ.

Occurrence: pollenzone T to pollenzone Y.

A-1-e. Subdivision CLAVATRILETES, BACUTRILETES and ECHITRILETES

Genus OSMUNDACIDITES Couper 1953

Osmundacidites wellmanii Couper 1953

Plate 20, fig. 3

Type: Well Tubbergen 6, depth 570.5 m, slide T6/570.5–2, coordinates 40.6–97.5 micr. PO 20.

Description: Trilete, amb circular. Trilete mark indistinct, nearly reaching to the equator and bordered by a narrow, thickened margin. Exine covered with baculae and some clavae, densely packed, 1.5 μ high and 0.5–1.5 μ across. Around the trilete mark this sculpture is reduced in height. Total exine thickness about 2.5 μ.

Grain size 35–44 μ.

Occurrence: pollenzone T to pollenzone Z.

Genus PILOSISPORITES Delcourt & Sprumont 1955

Plate 19, fig. 1

Comments: several badly conserved echinate spores have been encountered in our material, which we could attribute to *Pilosisporites*. However, because of their unfavourable condition we have not made a closer study of these spores.

A-1-f. Subdivision PERINOTRILETES

Genus BALDURNISPORITES Delcourt & Sprumont 1955

Baldurnisporites monstruosus n. sp.

Plate 26, fig. 1

Holotype: Well Tubbergen 6, depth 668.5 m, slide T6/668.5–2, coordinates 34.6–103.5 micr. PO 20.

Description: Trilete grain, spherical, provided with a queer perinous wrapping. Amb central body triangular with rounded corners. Trilete mark reaching to the equator. Exine two-layered, inner layer 1.5–2 μ thick, clearly scabrate. Outer layer darker coloured, enveloping the central body more or less closely, only attached around the trilete mark, showing a fluffy, stringy appearance, without clear cohesion; surface spongy, showing holes. Perine extending about 11 μ beyond the central body.

Grain size 55–70 μ.

Occurrence: upper half of pollenzone S to lower half of pollenzone T.

Comments: as far as we know this grain has not been reported before in the literature. There might be a slight resemblance with *Ricciisporites convolutus* Pocock 1962.

Genus PEROTRILITES Couper 1953

Comments: by mistake reported as *Perotriletes* (Erdtman 1945, 1947) Couper 1953 in Potonié (1956, Synopsis I p. 49).

Perotrilites pseudoreticulatus Couper 1953

Plate 24, fig. 1

Type: Well Tubbergen 6, depth 577.5 m, slide T6/577.5–2, coordinates 32.0–98.4 micr. PO 20.

Description: Trilete, amb triangular with straight to slightly convex sides. Trilete mark raised and reaching to the equator. Exine two-layered, inner layer about 1 μ thick, psilate, outer layer enveloping the spore as a narrow-fitting perine, attached near the trilete mark, psilate and about 0.5 μ thick. This perine wrinkles easily, at proximal face the foldings occur at the periphery, often radially arranged. At the equator the perine may be flattened, extending like a pseudo-cingulum. At the distal face the foldings occur unarranged, often giving the impression of a reticulum with open lumina.

Grain size 30–45 μ.

Occurrence: pollenzone X to pollenzone Y.

A-2. Division ZONOTRILETES Waltz 1935

A-2-b. Subdivision ZONOSTRIATRILETES and ZONORUGUTRILETES

Genus DENSOISPORITES Weyland & Krieger 1953

Densoisporites microrugulatus Brenner 1963

Plate 22, fig. 1

Type: Well Tubbergen 6, depth 668 m, slide T6/668–1, coordinates 33.8–102.3 micr. PO 20.

Description: Trilete, provided with an equatorially attached cingulum. Amb rounded triangular. Trilete mark raised and reaching 1/2 to 2/3 to the inner margin of the cingulum. Exine of central body thin, sculpture irregularly reticulate to microrugulate. Cingulum everywhere equal in width, reaching 5–8 μ beyond the central body and with an overlap of about 3 μ. Cingulum showing reticulate sculpture, the lumina of which are lineated parallel to the equator near the outer rim, often continued on the proximal face in an area between the trilete rays and the corners, in which case the lumina are directed radially.

Grain size 60–80 μ.

Occurrence: pollenzone R to pollenzone Z.

Comments: Brenner distinguishes this grain from *D. perinatus* Couper 1958. In our opinion Couper has also illustrated some spores which might be regarded as *D. microrugulatus*, judging by the photographs (Couper Pl. 23 fig. 6–7). In contrast with this we have illustrated a spore (see our Plate 23 fig. 2), which is clearly showing a much wider cingulum and which can be regarded as *D. perinatus*, being a replica of Plate 23 fig. 8 in Couper 1958.

A-2-c. Subdivision ZONORETITRILETES and ZONOFOVEOTRILETES

Genus VALLIZONOSPORITES Döring 1965

Comments: this genus is distinguished from *Hymenozonotriletes* Naumova 1937 by its different sculpture.

Vallizonosporites vallifoveatus Döring 1965

Plate 21, fig. 1

Type: Well Tubbergen 6, depth 560.5 m, slide T6/560.5–1, coordinates 37.6–98.6 micr. PO 20.

Description: Trilete, provided with an equatorially attached cingulum. Amb circular or rounded triangular. Trilete mark reaching to the equator of central body and bordered by a narrow margo. Exine of central body 2 μ thick, foveolate, foveae between 0.5–1 μ in diameter and spaced 2–3 μ apart. Cingulum 5–6 μ wide, extremely hyaline and thin, minutely granulate and 5–6 μ wide.

Grain size 70–85 μ.

Occurrence: upper part of pollenzone U to pollenzone Z.

A-2-d. Subdivision ZONOSCABRATRILETES, ZONOVERRUTRILETES and ZONOGEMMATRILETES

Genus CINGULATISPORITES Thomson (in Thomson & Pflug) 1953

Cingulatisporites distaverrucosus Brenner 1963

Plate 24, fig. 2

Type: Well Tubbergen 6, depth 663.5 m, slide T6/663.5–2, coordinates 32.5–100.1 micr. PO 20.

Description: Trilete, provided with an equatorially attached cingulum. Amb rounded triangular. Trilete mark raised, slightly undulating and reaching to the inner margin of the cingulum. Proximal face of central body scabrate, distal face domed, provided with a sculpture of broad worm-like elements, 2–3 μ wide, like flattened verrucae, fused and among which here and there narrow separation zones occur of 0.5–1 μ wide. Cingulum consisting of thick segments, as a continuation of the distal sculpture elements, embracing both faces of the central body with an overlap of about 2 μ. The segments are either connected by a thin membrane, or partly fused.

Grain size 30–37 μ.

Occurrence: pollenzone T except for upper part.

Synonym: *Uvaesporites pseudocingulatus* Döring 1965 (Pl. 11, fig. 5—7)

B. Superdivision MONOLETES Ibrahim 1933

B-1. Division AZONOMONOLETES Luber 1935

B-1-f. Subdivision PERINOMONOLETES

Genus CHASMATOSPORITES Nilsson 1958

Comments: although Nilsson does not mention a perinous layer in his generic description, the typical features of the grains leave no doubt that our grain belongs to the same genus. Nilsson considers the aperture as a monolete mark. We consider certain Australian spores, described by Dettman (1963) as *Coptospora*, to be closely related to Chasmatosporites. Dettman mentions a perinous layer, but she considers the aperture different from a monolete mark and placed distally. We consider the Dutch spores to be monolete, although the monolete mark is often gaping.

Chasmatosporites nilssonii n. sp.

Plate 24, fig. 3

Holotype: Well Tubbergen 6, depth 616.8 m, slide T6/616.8–2, coordinates 39.5–104.5 micr. PO 20.

Description: Monolete, provided with a rather close fitting perinous layer. Central body spherical or ellipsoidal, measuring 70 × 70 μ to 80 × 50 μ. Exine 3–4 μ thick, psilate, inner surface at proximal side showing a striation, generally orientated perpendicular to the monolete mark. At distal side the striations merge into a scabrate intragranulation. Monolete mark nearly spanning the longest grain axis, bordered by a thickened wall and often gaping. Perinous layer 1.5–2 μ thick, ornamented with a pattern of thick muri forming an imperfect reticulum. Lumina more or less equidimensional, 6–10 μ across, not always closed. Muri 1–2 μ wide and 1–1.5 μ high. Surface of lumina shows a faint scabrate sculpture.

Grain size 60–80 μ.

Occurrence: pollenzone V to nearly upper boundary of pollenzone X.

Genus PEROMONOLITES Erdtman 1947 ex Couper 1953

Peromonolites asplenioides Couper 1958
Plate 25, fig. 3

Type: Well Tubbergen 6, depth 617.8 m, slide T6/617.8–2, coordinates 37.9–97.7 micr. PO 20.

Description: Monolete, provided with a perinous layer. Central body spherical to ellipsoidal, measuring 55–75 μ. Monolete mark rarely visible. Exine 4–5 μ thick, psilate. Perinous layer psilate, 1 μ thick, loose-fitting.

Grain size 55–75 μ.

Occurrence: pollenzone R to pollenzone Y.

Peromonolites fragilis n. sp.
Plate 26, fig. 2

Holotype: Well Tubbergen 6, depth 663 m, slide T6/663–2, coordinates 40.3–106.6 micr. PO 20.

Description: Monolete, provided with a perinous layer. Central body originally spherical, measuring 25–30 μ. Exine about 1 μ thick, psilate. Monolete mark distinct and spanning the whole diameter of central body. Perinous layer thin, less than 0.5 μ, mostly minutely wrinkled with a scabrate-reticulate sculpture.

Grain size: 30–40 μ.

Occurrence: pollenzone R to pollenzone Z.

Comments: Levet-Carette 1963 (Pl. 19 fig. 10) illustrates a grain as *Peromonolosporites* (al. *Peromonolites*) *asplenioides*, which may very well be identical with our spore.

C. Superdivision VESICULATAE Iversen & Troels-Smith 1950

C-1. Division MONOSACCATAE Chitaley 1951

Comments: this classification is purely morphological, so that certain botanically related groups will be split up in two or more Divisions. It seems to us that this splitting up will cause no difficulties. But is should be avoided that, using an (artificial) morphological classification, monosaccate and polysaccate dispersed spores are provided with the same generic name.

C-1-a. Subdivision PSILAMONOVESICULATAE

Genus APPLANOPSIS (Döring 1961) Goubin, Taugourdeau & Balme 1965

Applanopsis dampieri (Balme 1957) Döring 1961
Plate 27, fig. 2

Type: Well Tubbergen 6, depth 678.5 m, slide T6/678.5–2, coordinates 29.5–101.3 micr. PO 20.

Description: Monosaccate, amb circular to oval, bladder equatorially attached. Exine of central body thin, psilate to minutely granulate, often radially folded near the equator. Sometimes a vague trilete mark can be observed. Bladder psilate with an overall equal width of about 5 μ, occasionally slightly constricted at the corners. In most cases the radial foldings continue on to the bladder, giving it a characteristical, undulating outline.

Grain size 40–55 μ.

Occurrence: pollenzone R to pollenzone Z.

Comments: both the *Applanopsis dampieri* type (Balme 1957 Pl. 8 figs. 88–90) and the *Applanopsis segmentatus* type (Balme 1957 Pl. 9 fig. 93–94) have been found in the Dutch material. Many intermediate forms were encountered as well, so that we were not able to separate the two types properly. In our main diagrams we have united all grains of both types in one graph under *Applanopsis dampieri.*

C-1-d. Subdivision SCABRAMONOVESICULATAE, VERRUMONOVESICULATAE and GEMMAMONOVESICULATAE

Genus VARIAVESICULITES n. gen.

Diagnosis: All monovesiculate grains with a scabrate central body and a wide, equatorially attached reticulate bladder.
Genotype: V. delicatus n. sp.

Variavesiculites delicatus n. sp.
Plate 28, fig. 3

Holotype: Well Tubbergen 6, depth 572 m, slide T6/572–2, coordinates 41.0–108.6 micr. PO 20.

Description: Monosaccate, bladder attached equatorially, 15–22 μ wide, reticulate. Central body spherical with a diameter of 25–30 μ. Exine thin, scabrate, possibly tectate. Foldings occur very often at the contact zone with the bladder, therefore it is difficult to determine the exine thickness.
Grain size 45–55 μ.

Occurrence: pollenzone U to pollenzone Z.

C-2. Division BISACCATAE Cookson 1947
C-2-a. Subdivision PSILABIVESICULATAE

Genus VITREISPORITES (Leschik 1955) Jansonius 1962

Comments: the emendation by Jansonius may have more than local significance, as the Dutch grains show no trilete mark whatsoever.

Vitreisporites pallidus (Reissinger 1938) Nilsson 1958
Plate 27, fig. 3

Type: Well Tubbergen 6, depth 671 m, slide T6/671–2, coordinates 41.8–106.7 micr. PO 20.

Description: small bisaccate grains, central body circular and measuring 10–15 μ, exine less than 1 μ thick, psilate to microgranulate. Air sacs attached laterally, semi-circular, about the same size as the central body, basally not constricted, height 10 μ and width 10–13 μ.
Grain size 22–29 μ (two cases of 38 μ).

Occurrence: pollenzone R to pollenzone Z.

C-2-b. Subdivision RUGUBIVESICULATAE and STRIABIVESICULATAE

Genus RUGUBIVESICULITES Pierce 1961

Rugubivesiculites minimus n. sp.
Plate 33, fig. 3

Holotype: Well Tubbergen 6, depth 570.5 m, slide T6/570.5–2, coordinates 38.5–102.3 micr. PO 20.

Description: Grain bisaccate, central body oval in direction of air sacs and measuring 36 × 27 μ to 32 × 24 μ. Proximal cap covering at least half of the central body, coarsely rugulate, total thickness 4–5 μ. Distal exine thin, psilate, between sacci about 10 μ wide, sometimes showing faint ridges (striae) parallel to the longest grain axis. Air sacs spherical, basally constricted, attached distally, showing an intrareticulum with lumina of 1–3 μ across. Height of sacci 17–20 μ, width 27–30 μ.

Grain size 30–55 μ.

Occurrence: pollenzone R to pollenzone Z.

Comments: the grain differs from *Rugubivesiculites reductus* by the smaller size and the much coarser rugulae.

Synonym: cf. "*Pinus sylvestris* type" Ross 1949 (Pl. 2 figs. 36—38)

Rugubivesiculites reductus Pierce 1961
Plate 31, fig. 2

Type: Well Tubbergen 6, depth 671 m, slide T6/671–2, coordinates 43.4–106.0 micr. PO 20.

Description: Bisaccate grain, central body circular to slightly oval, measuring 25–30 μ. Proximal cap covering about half of it, weakly rugulate, tectate and about 3 μ thick. At the margin of cap the rugulae are thickened. Distal surface psilate, and 8 μ wide between sacci. Air sacs spherical, basally constricted, about the same size as the central body, 20–33 μ high and 30–33 μ wide. Intrareticulum with lumina of 1–3 μ across. At the bases of the air sacs the muri are radially arranged.

Grain size 52–60 μ.

Occurrence: pollenzone R to pollenzone Y.

Genus PARVISACCITES Couper 1958

Parvisaccites radiatus Couper 1958
Plate 32, fig. 3

Type: Well Tubbergen 6, depth 577.5 m, slide T6/577.5–1, coordinates 30.0–106.0 micr. PO 20.

Description: Bisaccate, central body circular or oval in direction of air sacs. Proximal cap extending over more than half of the central body, 2.5–3 μ thick, tectate, minutely rugulate. Distal exine psilate, about 10 μ wide between the air sacs. Sacci attached distally, much smaller than central body, not protruding, 5–10 μ high and 40–45 μ wide. At their proximal side radially arranged thickenings occur, gradually changing into a reticulate-rugulate sculpture at the distal side.

Grain size 52–68 μ.

Occurrence: pollenzone R to pollenzone Z.

Genus ABIETINEAEPOLLENITES Potonié 1951

Abietineaepollenites brenneri n. sp.
Plate 31, fig. 3

Holotype: Well Tubbergen 6, depth 668 m, slide T6/668–1. coordinates 32.7–109.1 micr. PO 20.

Description: Bisaccate grains, central body more or less spherical, measuring 35–45 μ. Proximal cap extending over two-thirds of body, about 2 μ thick, rugulate with a superposed scabrate sculpture. Distal exine psilate to faintly scabrate, between air sacs 13 μ wide. Sacci extremely thin, originally spherical, mostly crumpled, attached distally with basal constrictions, smaller than central body with a height of 16 μ and width of 20–23 μ. An intrareticulum is hardly visible.

Grain size 40–50 μ.

Occurrence: pollenzone R to pollenzone X.

Comments: except for the size, this grain is similar to the grain which Brenner (1963 Pl. 26 fig. 2) gave the name *A. minimus* (non Couper 1958). The sculpture of the proximal cap is different from other *Abietineaepollenites* grains, so it might perhaps be useful to place this grain in another genus in the future.

C-2-c. Subdivision RETIBIVESICULATAE and FOVEOBIVESICULATAE

Abietineaepollenites dunrobinensis Couper 1958
Plate 29, fig. 1

Type: Well Tubbergen 6, depth 668 m, slide T6/668–1, coordinates 34.2–110.0 micr. PO 20.

Description: Grain bisaccate, central body oval in direction of sacci and measuring 60 × 40 μ to 75 × 50 μ. Proximal cap 2–5 μ thick, exine tectate, sculpture reticulate to microfoveolate, not showing a clear marginal ridge. Distal exine psilate, between sacci 10–15 μ wide. Air sacs spherical, smaller than central body, 30–36 μ high and 50–55 μ wide, basally constricted. Lumina of intrareticulum about 3–5 μ across and superposed by a much finer reticulum.

Grain size 60–90 μ.

Occurrence: pollenzone R to pollenzone Z.

Abietineaepollenites microreticulatus Groot & Penny 1960
Plate 30, fig. 1

Type: Well Tubbergen 6, depth 570.5 m, slide T6/570.5–1, coordinates 41.0–103.6 micr. PO 20.

Description: Bisaccate grain, central body spherical to slightly oval, measuring 45–60 μ. Proximal cap about 3 μ thick, tectate, columellae arranged into an intrarugulate or intrareticulate structure. Sculpture microreticulate. Air sacs not protruding and giving the grain a compact appearance, attached distally, slightly constricted at their bases, 22–25 μ high and 40–45 μ wide. Intrareticulum showing lumina of 1–2 μ across at the bases and 2–5 μ across at the tops of the sacci.

Grain size 50–60 μ.

Occurrence: pollenzone R to pollenzone Z.

Abietineaepollenites minimus Couper 1958

Plate 31, fig. 1

Type: Well Tubbergen 6, depth 668 m, slide T6/668–2, coordinates 31.7–98.4 micr. PO 20.

Description: Bisaccate, central body elongated in direction of sacci and measuring 40 × 25 μ to 46 × 30 μ. Exine of proximal cap about 2 μ thick, tectate, foveo-reticulate, without a distinct marginal ridge. Distal exine psilate to minutely scabrate, thin, between sacci about 8 μ wide. Air sacs slightly smaller than central body, more or less spherical, attached distally, constricted at the bases, 20–35 μ high and 30–35 μ wide. Intrareticulate meshes measuring 1–4 μ and superposed by a much finer reticulate sculpture.

Grain size 45–75 μ.

Occurrence: pollenzone R to pollenzone Z.

C-2-d. Subdivision SCABRABIVESICULATAE, VERRUBIVESICULATAE and GEMMABIVESICULATAE

Genus ALISPORITES (Daugherty 1941) Potonié & Kremp 1956

Comments: mostly the air sacs are not constricted at their bases.

Alisporites microsaccus (Couper 1958) Pocock 1962

Plate 35, fig. 1

Type: Well Tubbergen 6, depth 671 m, slide T6/671–2, coordinates 43.0–98.6 micr. PO 20.

Description: Bisaccate, central body spherical, polar regions often flattened, measuring 33–38 μ. Proximal cap 1 μ thick, scabrate, distal exine psilate, between sacci about 10 μ wide. Air sacs attached distally, small and only slightly protruding, 8–12 μ high and 30 μ wide, provided with an indistinct intrareticulum.

Grain size 33–40 μ.

Occurrence: pollenzone R to pollenzone X.

Alisporites thomasii (Couper 1958) Pocock 1962

Plate 35, fig. 2

Type: Well Tubbergen 6, depth 632.5 m, slide T6/632.5–2, coordinates 32.0–108.4 micr. PO 20.

Description: Bisaccate, central body spherical to slightly oval, measuring 37–47 μ, proximal cap scabrate to rugulate and 1–2 μ thick, distal exine psilate, between sacci 3–5 μ wide. Air sacs slightly smaller than central body, attached distally, forming two half globes, thus seemingly attached laterally, 26–30 μ high and 50–54 μ wide. Intrareticulum showing irregular shaped lumina of 2–5 μ across.

Grain size 60–75 μ.

Occurrence: pollenzone R to pollenzone X.

Genus PODOCARPIDITES Cookson 1947 ex Couper 1953

Podocarpidites epistratus Brenner 1963

Plate 27, fig. 5

Type: Well Tubbergen 6, depth 560 m, slide T6/560–2, coordinates 44.0–109.2 micr. PO 20.

Description: Bisaccate grain, central body more or less spherical, about 25 μ in diameter. Proximal surface 1–1.5 μ thick, scabrate to microrugulate, distal surface more or less psilate, between sacci 8–10 μ wide. Air sacs spherical, smaller than central body, basally constricted, 10–14 μ high and 15–18 μ wide, attached distally and showing a minute intrareticulum.

Grain size 25–38 μ.

Occurrence: pollenzone R to pollenzone Z.

Comments: the Dutch grains do not show a radial intrastructure at the bases of the air sacs.

Podocarpidites herbstii n. sp.
Plate 34, fig. 1

Holotype: Well Tubbergen 6, depth 567.5 m, slide T6/567.5–2, coordinates 37.2–108.5 micr. PO 20.

Description: Bisaccate, central body cylindrical, elongated in direction of sacci, measuring 60 × 44 μ. Proximal cap 3 μ thick, tectate, scabrate, distal exine psilate, between sacci 20–23 μ broad. Air sacs spherical, often flattened, basally constricted, 30–35 μ high and 48–53 μ wide. Attachment distally, near extremes of the central body. An intrareticulum occurs, near the bases of sacci more or less radially arranged.

Grain size 75–85 μ.

Occurrence: pollenzone S to pollenzone Z.

Synonym: *Incertae sedis* Levet-Carette 1963 (Pl. 20 fig. 12)

Podocarpidites potomacensis Brenner 1963
Plate 33, fig. 1

Type: Well Tubbergen 6, depth 571.5 m, slide T6/571.5–1, coordinates 36.1–100.7 micr. PO 20.

Description: Bisaccate, central body spherical, measuring 22–30 μ, proximal cap 2 μ thick, scabrate, tectate, distal exine psilate and 2–3 μ wide between sacci. Air sacs spherical with basal constrictions, attached distally, 16–20 μ high and 25–28 μ wide. Lumina of intrareticulum 3–4 μ across.

Grain size 35–50 μ.

Occurrence: pollenzone R to pollenzone Z.

Podocarpidites radiatus Brenner 1963
Plate 30, fig. 2

Type: Well Tubbergen 6, depth 571.5 m, slide T6/571.5–2, coordinates 34.2–98.8 micr. PO 20.

Description: Bisaccate grains, central body spherical to slightly oval, measuring 29–40 μ. Proximal cap 2–3 μ thick, tectate, scabrate, distal exine psilate, between sacci 2–3 μ wide. Sacci attached distally with basal constrictions, about the same size as the central body, incidentally bigger, spherical to flattened, 23–28 μ high and 36–50 μ wide. Intrareticulum with meshes of 2–4 μ across, merging into a clearly visible radial arrangement at the bases of sacci.

Grain size 50–70 μ.

Occurrence: pollenzone R to pollenzone Z.

C-3. Division POLYSACCATAE Cookson 1947

Comments: this group is more simple than *Trivesiculites* and *Polyvesiculites* Pierce 1961.

C-3-a. Subdivision PSILAPOLYVESICULATAE

Genus CEREBROPOLLENITES Nilsson 1958

Genotype: C. mesozoicus (Couper 1958) Nilsson 1958.

Cerebropollenites mesozoicus (Couper 1958) Nilsson 1958
Plate 28, fig. 1

Type: Well Tubbergen 6, depth 663 m, slide T6/663–2, coordinates 34.6–101.2 micr. PO 20.

Description: Grain spherical, exine two-layered, endexine thin with a smooth, undulating surface, ektexine 1–1.5 μ thick, showing an arrangement of numerous small saccate projections, irregular in cross-section, measuring 3–6 μ with a height of 4–6 μ. Inner surface of ektexine showing a granulate structure. A circular area occurs, maybe at the distal pole, with a diameter of 12–18 μ in which the ektexine is absent.

Grain size 35–55 μ.

Occurrence: pollenzone R to pollenzone Z.

Synonym: V6, cf. *Sciadopityspollen* Rouse 1959 (Pl. 2 fig. 25)

C-3-d. Subdivision SCABRAPOLYVESICULATAE, VERRUPOLYVESICULATAE and GEMMAPOLYVESICULATAE

Applanopsis trilobatus (Balme 1957) Goubin, Taugourdeau & Balme 1965
Plate 27, fig. 1

Type: Well Tubbergen 6, depth 560 m, slide T6/560–2, coordinates 39.6–110.6 micr. PO 20.

Description: Grain trisaccate, amb central body triangular with straight to convex sides and measuring 35–40 μ. Exine 2–3 μ thick, tectate, minutely scabrate, columellae scarcely scattered. No apertures are visible. At the equator three separate bladders are attached, leaving the corners of the body free, occasionally fused and constricted. Bladders 10–15 μ wide, becoming smaller towards each end, with an overlap of about half their width. Surface of bladders often radially folded, minutely scabrate.

Grain size: 45–65 μ.

Occurrence: pollenzone R to pollenzone Z.

D. Superdivision INAPERTURATAE Iversen & Troels-Smith 1950

D-1. Division AZONINAPERTURATAE, synonym with AZONALETES (Luber 1935) Potonié & Kremp 1954

D-1-a. Subdivision Psilainaperturates

Genus INAPERTUROPOLLENITES (Pflug 1952 ex Thomson & Pflug 1953) Potonié 1958

Inaperturopollenites giganteus Góczán 1964
Plate 35, fig. 4

Type: Well Tubbergen 6, depth 579.5 m, slide T6/579.5–2, coordinates 43.9–102.2 micr. PO 20.

Description: Inaperturate, amb circular, exine 1.5–2 μ thick, psilate, often showing foldings.

Grain size 50–80 μ.

Occurrence: pollenzone R to pollenzone Z.

D-1-d. Subdivision SCABRAINAPERTURATES, VERRUINAPERTURATES and GEMMAINAPERTURATES

Genus ARAUCARIACITES Cookson 1947

Synonym: *Granulonapites* Nilsson 1958

Araucariacites australis Cookson 1947

Plate 35, fig. 3

Type: Well Tubbergen 6, depth 579.5 m, slide T6/579.5–2, coordinates 42.8–102.6 micr. PO 20.

Description: Inaperturate, flattened, amb circular, exine 1–1.5 μ thick, scabrate to microverrucate. Foldings often more or less parallel to the equator.

Grain size 50–60 μ.

Occurrence: pollenzone R to pollenzone Z.

D-1-f. Subdivision PERININAPERTURATES

Genus KRAEUSELISPORITES Leschik 1955

Comments: from the generic description by Leschik follows that the sporomorphs are inapertutate (alete) and provided with a perine or exospore, and not with a cingulum, although the perine may be projected beyond the central body as a flange. Klaus (1960) is also reporting these grains as alete. However, Jansonius (1962) regards these grains as trilete and zonate. His illustrations show distinct trilete marks, while the photographs of Leschik do not show them. The Dutch grains fit perfectly in *Kraeuselisporites* sensu Leschik. Therefore we do not agree with the emendation by Jansonius.

Kraeuselisporites tubbergensis n. sp.

Plate 36, fig. 1

Holotype: Well Tubbergen 6, depth 616.8 m, slide T6/616.8–2, coordinates 36.7–107.4 micr. PO 20.

Description: Grain inaperturate, provided with a perinous layer. Central body spherical, measuring 40–45 μ, exine 2 μ thick, psilate. Perinous layer distally in close contact and often, but not always, extending equatorially 3–7 μ beyond the central body as a pseudo-cingulum. At the distal face baculae occur, 1–2 μ thick at their bases, slightly tapering, 2.5–3 μ high and set 4–5 μ apart. Near the equator the baculae are shorter, 1–2 μ high, which can best be observed when the perinous layer is extending flatly beyond the central body. The rest of the distal perinous layer is minutely scabrate. At proximal face the perine shows a reticulum with lumina measuring 1–3 μ, either equidimensional or irregular to nearly rugulate. Muri extremely thin and low.

Grain size 40–65 μ.

Occurrence: lower part of pollenzone V.

Synonym: (?) *Cingulatisporites complexus* Couper 1958 (Pl. 24 figs. 1—2)

E. Superdivision MONOPORATAE Iversen & Troels-Smith 1950
E-a. Subdivision PSILAMONOPORATES

Genus SPHERIPOLLENITES (Couper 1958) emend.

Diagnosis: Pollen grains originally spherical, provided with a sometimes indistinct equidimensional germinal aperture (pore ?), exine layers in close contact, maybe provided with structure, psilate. Grain size (provisionally) less than 50 μ.

Genotype: Spheripollenites scabratus (Couper 1958) emend.

Comments: Potonié has restricted *Inaperturopollenites* (Pflug 1952 ex Thomson & Pflug 1953) Potonié 1958 to inaperturate grains. Therefore it seems logical to restrict *Spheripollenites* to grains with an aperture in the sense of our diagnosis. The emended diagnosis of Jansonius (1962) is confusing in this respect. Besides, the exine thickness has its limit not at 1 μ, as our material has shown. Regarding this, we should like to follow Coupers diagnosis with a slight extension concerning the exine features. In our opinion only psilate grains should be incorporated in order to facilitate the classification in sculptural Subdivions.

Spheripollenites psilatus Couper 1958
Plate 36, fig. 4

Type: Well Tubbergen 6, depth 676.5 m, slide T6/676.5–2, coordinates 33.1–100.7 micr. PO 20.

Description: Spherical, exine psilate, minutely intragranulate and 0.5–1 μ thick, showing an indistinct (weakened ?) area, circular, about 10–11 μ in diameter.

Grain size 35–40 μ.

Occurrence: pollenzone R to pollenzone Z.

Comments: these grains may easily be confused with the peeled grains of some *Classopollis* species, which do not show an equatorial striation on the endexinal outer surface. *S. psilatus* can be distinguished by the granulation of the inner surface of the exine.

Spheripollenites scabratus (Couper 1958) emend.
Plate 37, fig. 3

Type: Well Tubbergen 6, depth 664 m, slide T6/664–2, coordinates 39.1–98.8 micr. PO 20.

Description: Spherical, exine two-layered, tectate, psilate and 1–1.5 μ thick. Sometimes the columellae may partly be fused, forming short walls. Columellae about 0.5 μ across, giving a scabrate appearance in top view. Endexine intragranulate. In a circular area of 6–7 μ in diameter the columellae and maybe the whole ektexine is absent.

Grain size: 24–33 μ.

Occurrence: pollenzone R to lower part of pollenzone T.

Comments: there are indications that the tectum may be built up by more than one layer, but this has to be solved by electronmicroscopic investigation.

Spheripollenites subgranulatus Couper 1958
Plate 36, fig. 3

Type: Well Tubbergen 6, depth 678 m, slide T6/678–2, coordinates 37.4–106.3 micr. PO 20.

Description: Spherical, exine two-layered, 1–1.5 μ thick, tectate, psilate, columellae measuring less than 0.25 μ across, endexine intragranulate. A circular area or pore is visible, about 7 μ in diameter without such an intragranulation, indicating that the endexine is absent in that area.

Grain size 23–30 μ.

Occurrence: pollenzone R to pollenzone Z.

E-f. Subdivision PERINOMONOPORATES

Genus PERINOPOLLENITES Couper 1958

Perinopollenites elatoides Couper 1958

Plate 37, fig. 1

Type: Well Tubbergen 6, depth 668 m, slide T6/668–2, coordinates 31.5–107.9 micr. PO 20.

Description: Monoporate, enveloped by a loose-fitting, transparant layer of 0.5 μ thick, easily folding with a scabrate sculpture. Central body spherical, 30–40 μ in diameter, provided with a pore with a diameter of about 2 μ, often invisible, surrounded by a weak annulus. Exine less than 1 μ thick, psilate to micro-scabrate.

Grain size 38–60 μ.

Occurrence: pollenzone R to pollenzone Y.

F. Superdivision AEQUATORANNULATAE (non MONOPORATAE)

Comments: we should like to make a separate group, uniting *Classopollis*, *Praecirculina*, *Classoidites* & *Circulina* grains, because they all have a (thickened) equatorial girdle and a distal aperture in common.

F-1. Division ENDOSTRIATAE, which comprises all grains with an endostriate equatorial band.

Genus CLASSOPOLLIS (Pflug 1953) Pocock & Jansonius 1961

Comments: the study of Pettitt and Chaloner (1964) on the wall of *Classopollis torosus* clearly showed that the structure is slightly more complicated than we reported (Burger 1965). The "rods of the footlayer" (Pettitt & Chaloner) are identical with our "columellae"; the tectum, however, is built up much more complicated than we previously assumed. This ultrastructure is hardly visible with an ordinary light-microscope, nevertheless we have mentioned it in our specific descriptions.

The problem of an eventual priority of the name *Corollina* Maliavkina 1949 above *Classopollis* has been treated by Pocock and Jansonius. Apart from the question whether the two species should be regarded as identical, it is in our opinion the most favourable solution to follow Pocock and Jansonius, who state that according the ICBN the name *Corollina* should not be maintained, as its generic description and illustrations are very poor.

Classopollis torosus (Reissinger 1950) Couper 1958 emend. Burger 1965
al *classoides* (Pflug 1953) Pocock & Jansonius 1961?

Plate 38, fig. 5

Holotype (refigured): Well Tubbergen 6, depth 660.5 m, slide T6/660.5–1, coordinates 34.3–117.5 micr. PO 58.

Description: Grain distally monoporate, more or less spherical, provided with a thickened equatorial band. Distal hemisphere flattened, proximal hemisphere slightly cone-shaped. Exine of both hemispheres 1.5–2 μ thick, ektexine tectate, scabrate. Tectum complex of structure, columellae irregularly circular and between 0.5–1 μ in cross-section. Equatorial band 2.5–3 μ thick, 7–8 μ wide, scabrate and provided with endostriae, running parallel around the equator and occasionally interrupted, sometimes 5–9, but mostly 6–8 in number. The endostriae may possibly be regarded as a fusion of rows of columellae. A rimula is clearly visible, formed by a thinning of the exine, caused by reduced columellae. Distal pole showing a small circular area, about 5 μ in diameter in which the endexine is absent. The ektexine with much reduced columellae is spanning the pore aperture. Proximal pole showing a triangular area in which the columellae are much reduced to absent. Endexine overall equally thick. When the ektexine loosens, the endexine seems to be smooth.

Grain size 23 × 27 μ to 26 × 29 μ.

Occurrence: pollenzone R to pollenzone Z.

Comments: the synonymy with *C. classoides* was suggested by Pocock (April 1965 pers. comm.) as the descriptions are principally not different. In that case the neotype of *C. torosus* (Burger 1965 Pl. 1 fig. 1) would become a junior synonym of *C. classoides*. However, the description by Pocock & Jansonius does not mention any sculpture, although this was clearly shown in the work of Pettitt and Chaloner 1964. This problem stays open to further investigation.

Classopollis alexi Burger 1965

Plate 38, fig. 6

Representative type: Well Tubbergen 6, depth 671 m, slide T6/671–2, coordinates 41.5–102.6 micr. PO 20.

Emended description: Grain distally monoporate with a thickened equatorial band and flattened hemispheres. Exine of hemispheres about 1.5 μ thick, ektexine tectate, psilate, tectum complex of structure, columellae densely packed, circular and not exceeding 0.5 μ in cross-section. Equatorial band 1.5–2.5 μ thick, 10–11 μ wide, psilate, showing endostriae which are running parallel around the equator, 8–10 in number, 0.5–0.6 μ wide, occasionally interrupted or bifurcating. The endostriae may possibly be formed by a fusion of columellae. A rimula is visible as a thinning of the exine, caused by reduced columellae. Distal pole showing a circular area of 9–10 μ in diameter, operculate, in which the endexine may be missing. Columellae sharply reduced to absent in the marginal area of the aperture. Proximal pole showing a circular or triangular area, measuring 7–11 μ, apparently the contact area in the tetrad. Here the ektexine is missing except for some rods or granules as remains of the columellae. Endexine overall equally thick. When the ektexine loosens, the endexine can be seen to have a minutely granulated surface on both hemispheres and very faint ridges, running parallel around the equator.

Grain size 30 × 27 μ to 40 × 35 μ.

Occurrence: pollenzone R to pollenzone Z.

Classopollis echinatus Burger 1965

Plate 38, fig. 4

Holotype (refigured): Well Tubbergen 6, depth 678 m, slide T6/678–2, coordinates 33.1–118.5 micr. PO 58.

Description: Grain distally monoporate, spherical, usually flattened at the poles, provided with a slightly thickened, equatorial band. Exine on both hemispheres 1.5–2 μ thick, ektexine tectate, echinate, tectum possibly complex of structure, echinae hair-like, irregularly scattered, hyaline with a height of 1.5–2 μ and a basal diameter of less than 1 μ. Columellae irregular to oval in cross-section, twice as long as wide, measuring approximately 1.0 × 0.5 μ. Equatorial band 4 μ wide, about 2 μ thick, covered with echinae, provided with 3–5 endostriae, which bifurcate sometimes and may possibly be regarded as fusions of equatorial columellae. Usually a rimula is vaguely visible as an exine thinning, caused by reduced columellae. At the distal pole a weakened pore area occurs, visible by its lighter colour; diameter difficult to measure, probably about 5 μ. The pore may be an endopore, regarding the fact that the echinae cover the whole distal hemisphere. Around the proximal pole the exine is thinner and shows no echinae. This may indicate that the ektexine is missing in this area. Endexine overall equally thick. When the ektexine loosens, the endexine surface appears to be smooth.

Grain size 24–26 μ.

Occurrence: pollenzone R to pollenzone Z.

Classopollis hammenii Burger 1965
Plate 38, fig. 2

Holotype (refigured): Well Tubbergen 6, depth 660.5 m, slide T6/660.5–2, coordinates 31.5–111.5 micr. PO 58.

Emended description: Grain distally monoporate, spherical, provided with an equatorial band. Exine of both hemispheres 2–2.5 μ thick, ektexine tectate, echinate. Echinae hair-like, hyaline, not higher than 1.5 μ. Tectum complex of structure. Columellae polygonal, measuring about 1 × 1 μ in cross-section and set apart about 0.5 μ. Equatorial band 2–2.5 μ thick, 2.5–3 μ wide, echinate, provided with 3–4 endostriae, running more or less parallel around the equator and sometimes bifurcating. Marginal endostriae often dissolve in separate columellae. A rimula is not visible. Ektexine absent at the distal pole in a circular pore area, 7 μ in diameter. Contact area around the proximal pole triangular and measuring about 10 μ. Here the ektexine is also absent. Endexine overall equally thick. When the ektexine loosens, the endexine surface appears to be smooth.

Grain size 23–29 μ.

Occurrence: pollenzone R to pollenzone Z.

Classopollis multistriatus Burger 1965
Plate 38, fig. 3

Holotype (refigured): Well Tubbergen 6, depth 654 m, slide T6/654–1, coordinates 35.4–109.6 micr. PO 58.

Description: Grain distally monoporate, spherical, sometimes with slightly flattened poles, provided with a thickened equatorial band. Exine of both hemispheres 1 μ thick, ektexine tectate, psilate, tectum possibly complex of structure. Columellae densely packed, circular and less than 0.5 μ in cross-section. Equatorial band 1.5 μ thick, 8–9 μ wide, provided with 10–14 endostriae running parallel around the equator, sometimes bifurcating or interrupted. Marginal endostriae often passing into a row of columellae. Rimula distinct, formed by a narrow zone without columellae. Distal pole showing a circular area of 5 μ across, in which the ektexine and the endexine are missing. Endexine is covering the proximal pole, but no statements could be made about the ektexine. Endexine equally thick everywhere. When the ektexine loosens, the endexine surface appears to be minutely granulate on both hemispheres and shows faint ribs running parallel around the equator.

Grain size 24–27 μ.

Occurrence: pollenzone R to pollenzone Z.

G. Superdivision MONOCOLPATAE Iversen & Troels-Smith 1950

G-a. Subdivision PSILAMONOCOLPATES

Genus MONOSULCITES Cookson 1947 ex Couper 1953

Monosulcites minimus Cookson 1947

Plate 39, fig. 7

Type: Well Tubbergen 6, depth 669.5 m, slide T6/669.5–2, coordinates 30.7–108.6 micr. PO 20.

Description: Monosulcate, ellipsoidal, apices often pointed. Sulcus 1–3 μ wide, spanning the longest grain axis. Exine 1 μ thick, psilate.

Grain size 22–30 μ.

Occurrence: pollenzone R to pollenzone Z.

G-d. Subdivision SCABRAMONOCOLPATES, VERRUMONOCOLPATES and GEMMAMONOCOLPATES

Monosulcites subgranulosus Couper 1958

Plate 37, fig. 4

Type: Well Tubbergen 6, depth 659 m, slide T6/659-a, coordinates 26.1–102.5 micr. PO 20.

Description: Monosulcate, ellipsoidal, apices more or less rounded. Sulcus nearly spanning the longest grain axis. Exine 1.5–2.5 μ thick, scabrate.

Grain size 35–48 μ.

Occurrence: pollenzone R to pollenzone Z.

H. Superdivision PRAECOLPATES Erdtman 1948

H-a. Subdivision PSILAPRAECOLPATES

Genus EUCOMMIIDITES (Erdtman 1948) Couper 1958

Eucommiidites troedssonii Erdtman 1948

Plate 39, fig. 1

Type: Well Tubbergen 6, depth 647 m, slide T6/647–2, coordinates 35.9–110.3 micr. PO 20.

Description: Grains mostly ellipsoidal, with rounded ends. Three furrow-like markings are visible, the best developed one being straight and reaching to the apices of the grain, the other two less developed, curving inwards near the apices, so that their ends approach each other. Exine psilate, 1–2 μ thick.

Grain size 33–42 μ.

Occurrence: pollenzone R to pollenzone Y.

Comments: in the Dutch material a closed "ring furrow" was never observed.

Eucommiidites minor Groot & Penny 1960

Plate 39, fig. 4

Type: Well Tubbergen 6, depth 670 m, slide T6/670–2, coordinates 35.5–106.7 micr. PO 20.

Description: Grains spherical to rounded ellipsoidal. Three furrow-like markings are visible, one of which is straight, spanning nearly the longest grain axis and often tapering in the center, two other minor grooves curve inwards so that their ends approach near the apices of the grain. Exine two-layered, psilate. Endexine 1 μ thick, whole exine 1.5 μ thick.

Grain size 19–25 μ.

Occurrence: pollenzone R to pollenzone Z.

J. Superdivision POLYPLICATAE Erdtman 1952

Comments: Ephedra-like grains were found regularly in the Tubbergen and Enschede material. The grains were too poor however to be sufficiently studied. Therefore in each pollen diagram they are combined in one graph (see our Plate 39 fig. 2).

K. Superdivision TRICOLPORATAE Iversen & Troels-Smith 1950

K-a. Subdivision PSILATRICOLPORATES

Genus TRICOLPOROPOLLENITES (Pflug 1952) Thomson & Pflug 1953

Tricolporopollenites distinctus Groot & Penny 1960

Plate 37, fig. 2

Type: Well Tubbergen 6, depth 572 m, slide T6/572–2, coordinates 30.4–106.3 micr. PO 20.

Description: Grain rounded ellipsoidal, tricolporate, pores indistinct. Sometimes costae equatoriales are vaguely visible. Exine two-layered, 0.8–1.0 μ thick, psilate.

Grain size 18–25 μ.

Occurrence: upper part of pollenzone W to pollenzone Y.

Comments: this grain is reported as "*Castanea*-typus" by Kuyl c.s. 1955.

LITERATURE

ALLEN, P., 1954. Geology and geography of the London-North Sea Uplands in Wealden Times. Geol. Mag. Vol. 91–6, pp. 498–508.

—— 1955. Age of the Wealden in North-Western Europe. Geol. Mag. Vol. 92 nr. 4, pp. 265–281.

AMEROM, H. W. J. VAN, 1965. Upper-Cretaceous pollen and spores assemblages from the so-called "Wealden" of the province of Léon (Northern Spain). Pollen et Spores Vol. 7–1, pp. 93–133.

ANDREWS, H. N., 1961. Studies in Paleobotany. Wiley & Sons Inc., New York.

ARNOLD, C. A., 1959. Palaeobotany and Plant classification. Sixth Sir Albert Charles Seward Memorial Lecture 22-1-1959 Publ. Birbal Sahni Inst. of Paleobot.-Lucknow (Sept. 1959).

AXELROD, D. I., 1961. How old are the angiosperms? Am. Jo. Sc. Vol. 259, pp. 447–459.

BALME, B. E., 1957. Spores and pollen grains from the Mesozoic of Western Australia. Commonw. Sc. Ind. Res. Org., Fuel. Res., pp. 1–48.

BALME, B. E., 1964. The palynological record of Australian Pre-Tertiary floras. Ancient Pac. Floras — Univ. of Hawaii Press, pp. 49–80.

BALME, B. E. & HENNELLY, J. P. F., 1955. Bisaccate sporomorphs from the Australian Permian Coals. Austral. Jo. Bot. Vol. 3, pp. 89–98.

BARTENSTEIN, H., 1959. Die Jura/Kreide Grenze in Europa. Ein Überblick des derzeitigen Forschungsstandes. Ecl. Geol. Helv. Vol. 52–1, pp. 15–18.

—— 1962. Die biostratigraphische Einordnung des NW-deutschen Wealden und Valendis in die Schweizerische Valendis-Stufe. Paläont. Z. H. Schmidt-Festband I-VIII, pp.1-7.

—— 1965. Unter-Valanginien oder Berriasien. Rev. Bulgarian Geol. Soc. Vol. 26–1, pp. 51–58.

BARTENSTEIN H. & F. BURRI, 1954. Die Jura-Kreide-Grenzschichten im schweizerischen Faltenjura und ihre Stellung im mitteleuropäischen Rahmen. Ecl. Geol. Helv. Vol. 47–2, pp. 426–443.

BENDA, L., 1962. Beiträge zur Flora des nordwestdeutschen Wealden. II Blattreste aus norddeutschen Tiefbohrungen. Geol. Jb. Vol. 79, pp. 737–782.

—— 1962. Beiträge zur Flora des nordwestdeutschen Wealden. III. Zusammenfassende Darstellung der bisher nachgewiesenen Gattungen und Arten. Geol. Jb. Vol. 80, pp. 239–246.

BERTSCH, K., 1942. Lehrbuch der Pollenanalyse. (Handbücher der praktischen Vorgeschichtsforschung Bd. 3). Verl. Ferd. Enke Stuttgart.

BISCHOFF, G. & J. WOLBURG, 1963. Zur Entwicklung des Ober-Malm im Emsland. Erdöl Z. Vol. 79-10, pp. 445-472.

BOIGK, H. c.s., 1960. Zur Geologie des Emslandes. Beih. Geol. Jb. Vol. 37, pp. 87–155.

BOLKHOVITINA, N. A., 1956. Atlas des spores et du pollen des depôts du Jurassique et du Crétacé Inférieur de la dépression du Viliouï. Trud. Geol. Inst. SSSR nr. 2, pp. 1–173.

—— 1959. Ensembles sporo-polliniques du Mésozoique de la dépression de Viljuj et leur valeur stratigraphique. (French trad). Bull. Geol. Inst. USSR nr. 24, pp. 1–208.

—— 1961. Fossil and recent spores from the family of the Schizeaceae (in Russian). Academy of sciences USSR. Reports of the Geol. Inst., Bull. 40, pp. 1–176.

—— 1962. History of Schizeaceae family in the geological past on the basis of spore studies. Acad. Sci. USSR Inst. of Geol. Reports of Soviet palynologists pp. 38–43. (for the First Int. Conf. Palyn. Tucson).

BOLTENHAGEN, E., 1965. Introduction à la palynologie stratigraphique du bassin sédimentaire de l'Afrique Equatoriale. Mém. Bur. Rech. Geol. Min. 32, pp. 305–346. (Coll. Int. de Micropaléont. Dakar 6–11 mai 1963).

BOSE, M. N., 1959. Leaf-cuticle and other plant microfossils from the Mesozoic rocks of Andøya, Norway. The Palaeobotanist Vol. 8–1/2, pp. 1–7.

BRELIE, G. VON DER, 1963. Nachweis mariner Beeinflussung mit Flagellaten, Hystrichospaerideen und Pollen. Fortschr. Geol. Rheinld. u. Westf. 10, pp. 107–120.

—— 1964. Eine unterkretazische Mikroflora aus dem nördlichen Sauerland. Fortschr. Geol. Rheinld. u. Westf. 12, pp. 117–168.

BRENNER, G. J., 1963. The spores and pollen of the Potomac Group of Maryland. Dept. Geol. Mines & Water Res. Bull. 27 pp. 1–215. Waverly Press Inc. Baltimore USA.

BRINKMANN, R., 1959. Abriss der Geologie. II: Historische Geologie. 8th ed. Ferd. Enke Verl. Stuttgart.

BROWN, C. W. & R. L. PIERCE, 1962. Palynologic correlations in Cretaceous Eagle Ford group, Northeast Texas. Bull. Am. Ass. Petr. Geol. Vol. 46–12, pp. 2133–2147.

BURGER, D., 1965. Some new species of Classopollis from the Jurassic of the Netherlands. Leidse Geol. Med. 33, pp. 63–69.

BUSNARDO, R. & J. TAUGOURDEAU, 1964. Intercalations végétales dans le Flysch Albien de los Villares (Jaen, Andalousie): introduction stratigraphique et étude palynologique. Rev. de Micropaléont. Vol. 7–3, pp. 164–179.

CAMPO-DUPLAN, M. VAN, 1950. Recherches sur la phylogénie des Abiétinées d'après leurs grains de pollen. Trav. Lab. Forest. Toulouse Vol. II: Etudes dendrologiques première section — les Gymnospermes. Généralité's Vol. IV — le pollen, art. I pp. 9–183.

—— 1961. Mécanique aperturale. Grana Palyn. Vol. 2–3, pp. 93–97.

CASEY, R., 1962. Ammonites Spilsby Sandstone and Jurassic-Cretaceous boundary. Proc. Geol. Soc. London 1598, pp. 95–100.

CHURCHILL, D. M. & W. A. S. SARJEANT, 1962. Freshwater microplancton from Flandrian (Holocene) peats of Southwestern Australia. Grana Palyn. Vol. 3–3, pp. 29–53.

COMBAZ, A., 1964. Les Palynofaciès. Rev. de Micropaléont. Vol. 7–3, pp. 205–218.

COOKSON, I. C., 1953. Difference in microspore composition of some samples from a bore at Comaum, South Australia. Austr. Jo. Bot. Vol. 1–3, pp. 462–473.

—— 1954. A palynological examination of no 1 bore, Birregurra Victoria. Proc. R. Soc. Victoria. N. S. Vol. 66, pp. 119–128.

COOKSON, I. C. & M. E. DETTMAN, 1957. Some trilete spores from Upper Mesozoic deposits in the Eastern Australian region. Proc. R. Soc. Victoria Vol. 70–2, pp. 95–128.

COPE, J. C. W. c.s., 1964. The Kimmeridgian-Portlandian boundary. Congr. Géol. Int., Colloque du Jurassique, Luxembourg 1962, pp. 933–936.

COUPER, R. A., 1953. Upper Mesozoic and Cainozoic spores and pollen grains from New Zealand. N.Z. Geol. Surv., Pal. Bull. 22, pp. 3–77.

—— 1955. Supposedly colpate pollen grains from the Jurassic. Geol. Mag. Vol. 92, nr. 6, pp. 471–475.

—— 1958. British Mesozoic microspores and pollen grains. Palaeontogr. 103-B, Lf. 4–6, pp. 75–179.

—— 1960. New Zealand Mesozoic and Cainozoic Plant microfossils. Pal. Bull. N.Z. Geol. Surv. no. 32, pp. 1–88.

—— 1964. Spore-pollen correlation of the Cretaceous rocks of the Northern and Southern hemispheres. Palynology in Oil Expl., Spec. Publ. Soc. Ec. Paleont. and Mineral. nr. 11, pp. 131–142.

COUPER, R. A. c.s., 1950. Terminology and nomenclature for fossil pollen and spores. Proc. Seventh Int. Bot. Congress, pp. 890–891. Almqvist & Wiksell-Stockholm.

Couper, R. A. & HUGHES, N. F., 1963. Jurassic and Lower Cretaceous palynology of the Netherlands and adjacent areas. Verh. Kon. Ned. Geol. Mijnb. Genootsch. geol. ser. Vol. 21–2, pp. 105–108.

COUSMINER, H. L., 1961. Palynology, paleofloras and paleoenvironment. Micropaleont. Vol. 7–3, pp. 365–368.

CRICKMAY, C. H. & S. A. J. POCOCK, 1963. Cretaceous of Vancouver, British Columbia, Canada. Bull. Am. Ass. Petr. Geol. Vol. 47 nr. 11, pp. 1928–1942.

CROSS, A. T., 1964. Plant microfossils and geology; an introduction. Palynology in Oil Expl., Spec. Publ. Soc. Ec. Paleont. and Mineral. nr. 11, pp. 3–13.

DEÂK, M. H., 1963. Quelques spores striées de l'étage Aptien. Rev. de Micropaléont. Vol. 5 nr. 4, pp. 251–256.

DEÂK, M. H. 1964. Contribution à l'étude palynologique de groupe d'argiles à Munieria de l'étage Aptien. Act. Bot. Acad. Sci. Hung. Vol. 10, fasc. 1–2, pp. 95–126.

—— 1965. Recherches palynologiques des dépôts Aptiens de la Montagne Centrale de Transdanubie. Geol. Hung. ser. Pal. fasc. 29, pp. 9–105.

DELCOURT, A., M. E. DETTMAN & N. F. HUGHES, 1963. Revision of some Lower Cretaceous microspores from Belgium. Palaeontology Vol. 6–2, pp. 282–292.

DELCOURT, A. & G. SPRUMONT, 1955. Les spores et grains de pollen du Wéaldien du Hainaut. Mém. Soc. Belg. de Géol. n.s. in 4° nr. 5, pp. 5–73.

—— 1957. Quelques microfossiles du Wéaldien de Féron-Glageon. Bull. Soc. Belg. de Géol., Pal. & Hydr. Vol. 66–1, pp. 57–70.

—— 1959-a. Curieuse association de microfossiles dans le Wéaldien de Féron-Glageon (France). Bull. Soc. Belg. de Géol. Pal. & Hydr. Vol. 68–1, pp. 122–125.

—— 1959-b. Spores, grains de pollen, Hystrichosphères et Péridiniens dans le Wéaldien de Féron-Glageon. Ann. Soc. Géol. du N. Vol. 79, pp. 29–64.

DETTMAN, M. E., 1963. Upper Mesozoic microfloras from South-Eastern Australia. Proc. R. Soc. Victoria N.S. Vol. 77–1, pp. 1–148.

DONZE, P., 1964. Les formations de la limite Jurassique-Crétacé dans le sud-est de la France. Congr. Géol. Int., Colloque du Jurassique, Luxembourg 1962, pp. 531–533.

Döring, H., 1964. Trilete sporen aus dem Oberen Jura und dem Wealden Norddeutschlands. Geologie Jg. 13 Vol. 9, pp. 1099–1129.

—— 1965. Die Sporenpaläontologische Gliederung des Wealden in Westmecklenburg (Struktur Werle). Geologie Jg. 14 Beih. 47, pp. 1–118.

DOWNIE, C., 1956. Microplankton from the Kimeridge Clay. Quart. Jo. Geol. Soc. London Vol. 92–4, pp. 413–434.

DOWNIE, C. & SARJEANT, W. A. S., 1964. Bibliography and Index of fossil Dinoflagellates and Architarchs. Geol. Soc. Am. Mem. 94, New York.

DUMAIT, P., 1962. L'action des ultrasons sur les pollens. Note préliminaire. Pollen et Spores Vol. 4 no. 1, pp. 175–180.

ENAY, R., 1964. L'étage Tithonique. Congr. Géol. Int., Colloque du Jurassique, Luxembourg 1962, pp. 355–379.

ERDTMAN, G., 1959. Some remarks on pollen and spore illustrations. Pollen et Spores Vol. I–1, pp. 15–18.

ERISTHAVI, M., 1964. Sur la limite entre le Jurassique et le Crétacé. Congr. Géol. Int., Colloque du Jurassique, Luxembourg 1962, pp. 393–401.

EVITT, W. R., 1964. Dinoflagellates and their use in petroleum geology. Palynology in Oil expl., Spec. Publ. Soc. Ec. Paleont. and Mineral. nr. 11, pp. 65–72.

FAEGRI, K. & J. EVERSEN, 1964. Textbook of Pollen analysis. 2 ed. Munksgaard-Copenhagen (Denmark).

GIGNOUX, M., 1950. Géologie Stratigraphique, 4th rev. ed. Masson Cie, Paris.

GOCHT, H., 1957. Mikroplankton aus dem nordwestdeutschen Neokom (I). Paläont. Z. Vol. 31 3–4, pp. 163–185.

—— 1959. Idem (II). Paläont. Z. Vol. 33–1, pp. 50–89.

GÓCZÁN, F., 1961. Die Palynologie der Senon-Bildungen des Süd-Bakony. Ann. Inst. Geol. Publ. Hungar. Vol. 49–3, pp. 789–799.

—— 1964. Stratigraphic palynology of the Hungarian Upper Cretaceous, Acta Geol. Acad. Sci. Hung. Vol. 8 fasc. 1–4, pp. 229–264.

GOTHAN, W. & H. WEYLAND, 1954. Lehrbuch der Paläobotanik. Vegetationsbild aus dem Oligozan-Untermiozan Mitteleuropas. Akademie-Verlag, Berlin.

GOUBIN, N., J. TAUGOURDEAU & B. E. BALME, 1965. Considérations taxonomiques sur deux espèces de pollen du Mésozoique. Rev. de Micropaléont. Vol. 7–4, pp. 225–227.

GROOT, J. J. & C. R. GROOT, 1962. Plant microfossils from Aptian, Albian and Cenomanian deposits of Portugal. Com. Serv. Geol. Portugal, Vol. 46, pp. 133–171.

GROOT, J. J. & J. S. PENNY, 1960. Plant microfossils and age of non-marine Cretaceous sediments of Maryland and Delaware. Micropaleont. Vol. 6–2, pp. 225–236.

GROOT, J. J., J. S. PENNY & C. R. GROOT, 1961. Plant microfossils and age of the Raritan, Tuscaloosa and Magothy Formations of the Eastern United States. Palaeontogr. 108-B, Lf. 3–6, pp. 121–140.

HAANSTRA, U., 1963. A review of Mesozoic geological history in the Netherlands. Verh. Kon. Ned. Geol. Mijnb. Gen. geol. ser. 21–1 (Transactions of the Jubilee Convention), pp. 35–56.

HAFSTEN, U., 1959. Bleaching+HF+acetolysis a hazardous preparation process. Pollen et Spores Vol. I-1, pp. 77–79.

HAMMEN, TH. VAN DER, 1954. Principios para la nomenclatura palinologica sistematica. Bol. Geol. Bogotá Vol. 2–2, pp. 1–21.

—— 1956. A palynological systematic nomenclature. Bol. Geol. Vol. IV nr. 2–3, pp. 63–101.

—— 1957. Climatic periodicity and evolution of South American Maestrichtian and Tertiary floras. Bol. Geol. Vol. V nr. 2, pp. 49–91.

—— 1964. Paläoklima, Stratigraphie und Evolution. Geol. Rundsch. Vol. 54, pp. 428–441.

HÖLDER, H., 1964. Handbuch der Stratigraphischen Geologie IV. Jura. Ferd. Enke Verl. Stuttgart.

HUGHES, N. F., 1958. Palaeontological evidence for the age of the English Wealden. Geol. Mag. Vol. XCV–1, pp. 41–49.

—— 1961. Further interpretation of *Eucommiidites* Erdtman 1948. Palaeontology Vol. 4–2, pp. 292–299.

International Code of Botanical Nomenclature adopted by the Ninth International Botanical Congress Montreal. August 1959. Ed. E. Lanjouw e.a. 1961.

IVERSEN, J., 1950. Identification of difficult pollen types by means of structural characters. Proc. Seventh Int. Bot. Congr., pp. 873–874. Almqvist & Wiksell-Stockholm.

JANSONIUS, J., 1962. Palynology of Permian and Triassic sediments, Peace River aiea, Western Canada. Palaeontogr. 110-B, Lf. 1–4, pp. 35–98.

JARDINÉ, S. & L. MAGLOIRE, 1965. Palynologie et stratigraphie du Crétacé des bassins du Sénégal et de Côte d'Ivoire. Mém. Bur. Rech. Géol. Min. 32, pp. 187–245. (Coll. Int. de Micropaleont. Dakar 6–11 mai 1963).

JEKHOWSKY, B. DE, 1963. Variations latérales en palynologie quantitative et passage du continental au marin; le Dogger supérieur du Sud-ouest de Madagascar. Rev. Inst. Fr. Pétr. Vol. XVIII 7–8, pp. 977–995.

JEKHOWSKY, B. DE & N. GOUBIN, 1963. Esquisse palynologique du Permien, Trias, Jurassique du bassin de Morondava à Madagascar. Ann. Géol. de Madagascar, fasc. no. XXXIII, pp. 163–165. Comptes Rendus de la Semaine Géologique 1963.

IVERSEN, J. & J. TROELS-SMITH, 1950. Pollenmorphologische Definitionen und Typen. Danm. Geol. Unders. IV. R. Vol. 3–8, pp. 1–54.

KEDVES, M., 1960. Études palynologiques dans le bassin de Dorog-I. Pollen et Spores Vol. II–1, pp. 89–118.

—— 1961. Études palynologiques dans le bassin de Dorog-II. Pollen et Spores Vol. III–1, pp. 101–153.

KEDVES, M. & J. RAKOSY, 1964. *Intrabaculisporites* n. fgen. du Pannonien Supérieur de Hongrie. Pollen et Spores Vol. 6–2, pp. 593–596.

KEDVES, M. & P. SIMONCSIS, 1964. Spores nouvelles extraites de minerai de manganèse Jurassique de la région d'Urkut (Hongrie). Pollen et Spores Vol. 6–2, pp. 605–610.

KEDVES, M. & N. SOLE DE PORTA, 1963. Comparación de las esporas del género *Cicatricosisporites* R. Pot. y Gell. 1933 de Hungría y Colombia. Algunos problemas referente a su significado estratigráfico. Bol. Geol. Univ. Ind. de Santander no. 12, pp. 51–66.

KIRKALDY, J. F., 1963. The Wealden and marine Lower Cretaceous beds of England. Proc. Geol. Assoc. Vol. 74–2, pp. 127–146.

KLAUS, W., 1960. Sporen der karnischen Stufe der ostalpinen Trias. Geol. B.A., Sonderbd. 5, pp. 107–183.

—— 1963. Sporen aus den südalpinen Perm. Jb. Geol. B.A., Vol. 106, pp. 229–263.

KREMP, G. O. W. c.s., 1957–1962. Catalog of fossil spores and pollen. Volumes 1, 2, 4, 9, 10, 14, 15, 16, 18. Pennsylvania State University (Penn.) USA.

KREMP, G. O. W., 1965. Morphologic Encyclopedia of Palynology. Univ. of Arizona Press, Tucson USA.

KRUTZSCH, W., 1959. Mikropaläontologische (sporenpaläontologische) Untersuchungen in der Braunkohle des Geiseltales. Geologie Jg. 8, Beih. 21–22, pp. 1–425.

—— 1962. Atlas der mittel- und jungtertiären dispersen Sporen- und Pollen- sowie der Mikroplanktonformen des nördlichen Mitteleuropas. Lf. I: Laevigate und toriate trilete Sporenformen. VEB Deutscher Verlag. Wissensch. Berlin.

KUYL, O. S., J. MULLER & H. TH. WATERBOLK, 1955. The application of palynology to oil geology with reference to Western Venezuela. Geol. en Mijnb. n.s. nr. 3 Vol. 17, pp. 49–76.

LANTZ, J., 1958-a. Étude palynologique de quelques échantillons mésozoiques du Dorset (Grande Bretagne). Rev. Inst. Fr. du Petr. Vol. 13–6, pp. 917–942.

—— 1958-b. Études des spores et pollens d'un échantillon Purbeckien de l'Ile d'Oléron. Rev. de Micropaléont. Vol. 1–1, pp. 33–37.

LESCHIK, G., 1955. Die Keuperflora von Neuewelt bei Basel. Die Iso- und Mikrosporen. Mém. Suisses Paléont. Vol. 72, pp. 5–70.

—— 1956. Sporen aus dem Salzton des Zechsteins von Neuhof (bei Fulda). Palaeontogr. 100-B, pp. 122–142.

LEVET-CARETTE, J., 1963. Étude de la microflore infraliasique d'un sondage effectué dans le sous-sol de Boulogne-sur-Mer (Pas-de-Calais). Ann. Soc. Géol. du N. Vol. 83–2, pp. 101–128.

LUNDBLAD, B., 1959. On *Ricciisporites tuberculatus* and its occurrence in certain strata of the "Höllviken II' boring in S.W. Scania. Grana palyn. Vol. 2–1, pp. 77–86.

MALIAVKINA, V. S., 1949. Key to spores and pollen from the Jurassic and Cretaceous (in Russian). Rep. Sci. Res. Geol. Expl. Petr. Inst. All-Union Leningrad.

—— 1958. Spores and pollen from the Lower Cretaceous in the Eastern Gobi basin (in Russian). Reports all Sci. Res. Geol. Expl. Inst. Bd. 119.

MARTIN, A. R. H., 1960. A Mesozoic microflora from South Africa. Nature Vol. 186 no. 4718, p. 95.

MCHEDLISHVILI, M. D. & S. R. SAMOILOVICH, 1962. Common elements in the Mesozoic and Cenozoic floras of Western Siberia and Australia. Abstr. First Int. Conf. Palyn. Tucson (Arizona) 23–27 IV.

MÜLLER, H., 1962. Pollen and spore investigation on Cretaceous sediments in Northern Brazil. Abstr. First Int. Conf. Palyn. Tucson (Arizona) 23–27 IV.

NAGY, E., 1963. Spores et pollens nouveaux d'une coupe de la briqueterie d'Eger (Hongrie). Pollen et Spores Vol. V–2, pp. 397–412.

NILSSON, T., 1958. Über das Vorkommen eines Mesozoischen Sapropelgesteins in Schonen. Lunds Univ. Årsskrift. N.F. Avd. 2, Bd. 54–10, pp. 3–111.

NORTON, N. J. & J. W. HALL, 1962. Pollen and spores from the Colgate Member, Fox Hills Sandstone at its type locality. Abstr. First Int. Conf. Palyn. Tucson (Arizona) 23–27 IV.

NEWMAN, K. R., 1964. Palynologic correlations of Late Cretaceous and Paleocene formations, Nortwestern Colorado. Palynology in Oil Expl., Spec. Publ. Soc. Ec. Paleont. and Mineral. nr. 11, pp. 169–180.

NORRIS, G., 1965. Triassic and Jurassic miospores and acritarchs from the Beacon and Ferrar Groups, Victoria Land, Antarctica. N.Z. Jo. Geol. and Geophys., Third Special Antartic Issue, Vol. 8–2, pp. 236–277.

PANNEKOEK, A. J. c.s., 1956. Geologische Geschiedenis van Nederland. Staatsdrukkerij en Uitg. bedrijf, 's-Gravenhage.

PANT, D. D., 1954. Suggestions for the classification and nomenclature of fossil spores and pollen grains. The Bot. Rev. Vol. 20–1, pp. 33–60.

PEABODY, D. M. & G. O. W. KREMP, 1964. Preliminary Studies of the palynology of the Chinle Formation, Petrified Forest. Geochron. Labs. Univ. of Arizona, Int. Res. Rep. 3, pp. 11–26.

PEARSON, R., 1964. Animals and plants of the Cenozoic era. Buttersw. London.

PETTITT, J. M. & W. G. CHALONER, 1964. The ultrastructure of the Mesozoic pollen *Classopollis*. Pollen et Spores Vol. VI–2, pp. 611–620.

PFLUG, H. D., 1952. Palynologie und Stratigraphie der eozänen Braunkohlen von Helmstedt. Paläont. Z. Vol. 26 1–4, pp. 112–137.
—— 1953. Zur Entstehung und Entwicklung des angiospermiden Pollens in der Erdgeschichte. Palaeontogr. 95-B Lf. 4–6, pp. 60–171.
PIERCE, R. L., 1961. Lower Upper Cretaceous Plant Microfossils from Minnesota. Bull. Minnesota Geol. Surv. no. 42.
PLA DALMÁN, J. M., 1961. Polen. Talleres Gráficos C.D.P. — Gerona.
PLAYFORD, G. & DETTMAN, M. E., 1965. Rhaeto-Liassic plant microfossils from the Leigh Creek Coal Measures, South Australia. Senck. lethaea Vol. 46 2–3, pp. 127–281.
POCOCK, S. A. J., 1961. The microspore genus *Cingulatisporites* Thomson 1953. Jo. of Paleont. Vol. 35–6, pp. 1235–1236.
—— 1962. Microfloral analysis and age determination of strata at the Jurassic-Cretaceous boundary in the Western Canada plains. Palaeontogr. 111-B, Lf. 1–3, pp. 1–95.
—— 1964-a. Pollen and spores of the Chlamydospermidae and Schizaeceae from Upper Mannville strata of the Saskatoon area of Saskatchewan. Grana Palyn. Vol. 5–2, pp. 129–209.
—— 1964-b. Palynology of the Kootenay Formation at its type section. Bull. Can. Petr. Geol. Vol. 12, pp. 500–512.
POCOCK, S. A. J. & J. JANSONIUS, 1961. The pollen genus *Classopollis* Pflug 1953. Micropaleont. Vol. 7–4, pp. 439–449.
POTONIÉ, R., 1952. Zur Morphologie und morphologischen Nomenklatur der Sporites H. Potonié 1893. Paläont. Z. Vol. 25 H. 3/4, pp. 143–154.
—— 1954. Gibt es angiospermide Eigenschaften an Paläozoischen sporen? Grana Palyn. Vol. I–1, pp. 15–23.
—— 1956-b. Die Behandlung der Sporae dispersae und der fossilen Pflanzen überhaupt nach dem Internationalen Code der Botanischen Nomenklatur. Paläont. Z. Vol. 30 H. 1/2, pp. 69–87.
—— 1956-a. Synopsis der Gattungen der Sporae dispersae. I – Sporites. Beih. Geol. Jb. Vol. 23, pp. 3–103.
1958-a. Idem II – Sporites (Nachträge), Saccites, Aletes, Praecolpates, Polyplicates, Monocolpates. Beih. Geol. Jb. Vol. 31, pp. 3–114.
1960-a. Idem III – Nachträge Sporites, Fortsetzung Pollenites. Mit Generalregister zu Teil I–III. Beih. Geol. Jb. Vol. 39, pp. 3–189.
—— 1960-b. Methoden zur Paläontologie und Stratigraphie der Sporae dispersae. Paläont. Z. Vol. 34 H. 1, pp. 17–26.
—— 1962-b. Regeln, nach denen sich die Sekundärfalten der Sporen bilden. Paläont. Z. Vol. 36–1/2, pp. 46–54.
POTONIÉ, R. & J. Gelletich, 1933. Über Pteridophyten-Sporen einer eocänen Braunkohle aus Dorog in Ungarn. S.-B. Ges. Naturf. Fr. Jg. 1932, pp. 517–528.
POTONIÉ, R. & G. KREMP, 1954. Die Gattungen der paläozoischen Sporae dispersae und ihre Stratigraphie. Geol. Jb. Vol. 69, pp. 111–194.
—— 1955. Die *Sporae dispersae* des Ruhrkarbons, ihre Morphographie und Stratigraphie mit Ausblicken auf Arten anderer Gebiete und Zeitabschnitte I. Palaeontogr. 98-B, Lf. 1–3, pp. 1–136.
PROKOVSKAJA, I. M., 1962. Upper Cretaceous and Paleogene spore and pollen assemblages in the European part of the USSR. Acad. Sci. USSR — Inst. of Geol., Reports of Soviet palynologists pp. 114–119. (for the First Int. Conf. Palyn. Tucson).

REISSINGER, A., 1950. Die "Pollenanalyse" ausgedehnt auf alle Sedimentgesteine der geologischen Vergangenheit II. Palaeontogr. 90-B, pp. 99–126.
REYRE, Y., 1964. Première contribution à l'étude des spores et pollens du Secondaire Saharien. Rev. de Micropaléont. Vol. 6 no. 4, pp. 196–210.
REYRE, Y., 1965. Description de quelques spores et pollens de séries attribuées au Jurassique Supérieur dans le Sahara Tunisien. Rev. de Micropaléont. Vol. 7–4, pp. 257–264.
RIEDEL, L., 1941. Zur Stratigraphie der tiefen Unterkreide in Nordwest-Deutschland, besonders in den Erdölgebieten. Jahrb. Reichsst. Bodenf. Bd. 60, pp. 431–483.

Ross, N. E., 1949. On a Cretaceous pollen and spore bearing clay deposit of Scania (a preliminary report). Bull. Geol. Soc. Inst. Univ. Uppsala Vol. 34, pp. 25–42.

Rouse, G. E., 1959. Plant microfossils from Kootenay coal-measures stıata of British Columbia. Micropaleont. Vol. 5–3, pp. 303–324.

—— 1962. Plant microfossils from the Burrard Formation of western British Columbia. Micropaleont. Vol. 8–2, pp. 187–218.

Saad, S. I., 1963. Pollen and spores recently discovered in the coals of Sinaï region. 1. Euone Moussa District. Palaeontogr. 113-B, Lf. 5–6, pp. 117–125.

Sarjeant, W. A. S., 1961. The Hystrichospheres, a Review and Discussion. Grana Palyn. Vol. 2–3, pp. 101–111.

—— 1962. Upper Jurassic microplankton from Dorset, England. Micropaleont. Vol. 8–2, pp. 255–268.

Schopf, J. M., 1964. Practical problems and principles in study of plant microfossils. Palynology in Oil Expl., Spec. Publ. Soc. Ec. Paleont. and Mineral. nr. 11; pp. 29–57.

Schott, W., 1951. Der Obere Weisse Jura und die tiefste Unterkreide im Deutsch-Holländischen Grenzgebiet. Geol. Jb. Vol. 65, pp. 213–270.

Schwarzbach, M., 1950. Das Klima der Vorzeit. Eine Einführung in die Paläoklimatologie. Ferd. Enke Verl. Stuttgart.

Singh, C., 1964. Microflora of the Lower Cretaceous Mannville Group, East-Central Alberta. Bull. Res. Coucil Alberta 15, pp. 1–328.

Sorgenfrei, Th., 1962. Jura und Unterkreide in Dänemark. Z. Deutsch. Geol. Ges. Bd. 114–2, pp. 446–451.

Steeves, M. W., 1962. Palynological contributions to the interpretation of the Jurassic-Lower Cretaceous boundary in Saskatchewan. Abstr. First Int. Conf. Palyn. Tucson (Arizona) 23–27 IV.

Stover, L. E., 1962. *Taurocusporites*, a new trilete spore genus from the Lower Cretaceous of Maryland. Micropaleont. Vol. 8–1, pp. 55–59.

—— 1964. Comparison of three Cretaceous spore-pollen assemblages from Maryland and England. Palynology in Oil Expl., Spec. Publ. Soc. Ec. Paleont. and Mineral. nr. 11, pp. 143–152.

Sung, G. C. L., 1955. The Wealden formation in the Netherlands. Proc. Fourth World Petr. Congr. sect I/A/3, pp. 151–160.

Sylvester-Bradley, P. C., 1964. Type sections of Bathonian, Portlandian and Purbeckian stages, and the problem of the Jurassic-Cretaceous boundary. Congr. Geol. Int., Colloque du Jurassique, Luxembourg 1962, pp. 259–263.

Takahashi, K., 1964. Spores und Pollen der oberkretazeischen Hakobuchi-Schichtengruppe, Hokkaido. Mem. Fac. Sci. Kyushu Univ. Ser. D. Geol., Vol. 14–3, pp. 159–271.

Takeoka, M. & E. Stix, 1963. On the fine structure of some Jurassic pollen grains and spores. Svensk Bot. Tidskr. Bd. 57 H. 3, pp. 396–401.

Thiergart, F., 1953. Über einige Sporen und Pollen der Perutzer Schichten (Böhmen). Palaeontogr. 95-B, Lf. 4–6, pp. 53–59.

Thomson, P. W., 1953. Zur Entstehung und Ausbreitung der Angiospermen im Mesophyticum. Paläont. Z. Vol. 27 H. 1/2, pp. 47–51.

Thomson, P. W. & H. Pflug, 1953. Pollen und Sporen des mitteleuropäischen Tertiärs Palaeontogr. 94-B Lf. 1–4, pp. 1–138.

Townrow, J. A., 1962. On some disaccate pollen grains of Permian to Middle Jurassic age. Grana Palyn. Vol. 3–2, pp. 13–44.

Traverse, A., 1955. Occurrence of the oil-forming alga Botryococcus in lignites and other Tertiary sediments. Micropaleont. Vol. 1–4, pp. 343–350.

—— 1957. The nomenclatural problem of plant microfossil species belonging to extant genera. Micropaleont. Vol. 3–3, pp. 255–258.

—— 1961. Effect of the 1959 International Botanical Congress on nomenclature of fossil spores and pollen. Micropaleont. Vol. 7–4, pp. 485–489.

Tschudy, R. H., 1964. Palynology and time-stratigraphic determinations. Palynology in Oil Expl., Spec. Publ. Soc. Ec. Paleont. and Mineral. nr. 11, pp. 18–29.

—— 1965. An Upper Cretaceous deposit in the Appalachian Mountains. U.S. Geol. Survey prof. pap. 525-B, pp. B64–B68.

VARMA, C. P., 1964. Do Dinoflagellates and Hystrichosphaerids occur in fresh water sediments? Grana Palyn. Vol. 5–1, pp. 124–128.

UPSHAW, C. F., 1959. Palynological zonation of the Uppeı Cretaceous Frontier Formation near Dubois, Wyoming. Palyn. in Oil Expl. (Div. of AAPG), pp. 153–168.

VENKATACHALA, B. S. & F. GÓCZÁN, 1964. The spore-pollen flora of the Hungarian "Kössen facies". Acta Geol. Acad. Sci. Hung. Vol. 8, fasc. 1–4, pp. 203–228.

WEIDMANN, M., 1963. Analyse palynologique sommaire du "Complexe schisteux intermédiaire" (synclinal de la Gruyère, Préalpes Médianes). Ecl. Geol. Helv. Vol. 56 no. 2, pp. 876–881.

WETZEL, O., 1953. Übersicht über die im Feuerstein erhaltenen Protisten der baltischen Kreide. Paläont. Z. Vol. 27 H. 1/2, pp. 37–46.

WEYLAND, H. & G. GREIFELD, 1953. Über Strukturbietende Blätter und pflanzliche Mikrofossilien aus den Untersenonen Tonen der Gegend von Quedlinburg. Palaeontogr. 95-B. Lf. 1–3, pp. 30–52.

WEYLAND, H. & W. KRIEGER, 1953. Die Sporen und Pollen der Aachener Kreide und ihre Bedeutung für die Charakterisierung des Mittleren Senons. Palaeontogr. 95-B. Lf. 1–3, pp. 6–29.

WODEHOUSE, R. P., 1935. Pollen grains. Ist. ed. Mc. Graw-Hill Book Cy., N.Y. U.S.A.

WOLBURG, J., 1949. Ergebnisse der Biostratigraphie nach Ostracoden im nordwestdeutschen Wealden. Erdöl. u. Tektonik Sammelbd., Amt für Bodenf. Hannover-Celle, pp. 349–360.

—— 1950. Vergleichende stratigraphische Untersuchungen der brackisch-limnischen Ablagerungen Europas an der Wende Jura-Kreide. Geol. Jb. Vol. 64, pp. 159–171.

—— 1953. Schwellen und Becken im Emsland-Tektogen mit einem paläogeographischen Abriss von Wealden und Unterkreide. Beih. Geol. Jb. Vol. 13, pp. 3–115.

WOODS, R. D., 1955. Spores and pollen- A new stratigraphic tool for the oil industry. Micropaleont. Vol. 1–4, pp. 368–375.

ZAKLINSKAYA, E. D., 1962. Importance of angiosperm pollen for the stratigraphy of Upper Cretaceous and Lower Paleogene deposits and botanical-geographical provinces at the boundary between the Cretaceous and Tertiary systems (in Russian). Acad. Sci. USSR — Inst. of Geol. Reports of Soviet palynologists, pp. 105–113. (for the First Int. Conf. Palyn. Tucson Arizona).