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PALAEOBOTANY OF THE MESOPHYTIC III

PLANT MICROFOSSILS FROM THE UPPER BUNTER OF HENGELO, THE NETHERLANDS

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ABSTRACT

The Upper Bunter palynological assemblage described includes 54 species, assigned to 29 genera. Seven genera (*Scabratisporites, Guttatisporites, Lapposisporites, Pseudogravisporites, Paralundbladispora, Taeniaepollenites* and *Tubantiapollenites*) and 39 species are new; three generic descriptions are emended (*Apiculatasporites, Colpectopollis* and *Angustisulcites*) and three new combinations are proposed. Bisaccate pollen grains average 84 %; within this group no Upper Permian elements could be demonstrated. The assemblage is compared with other European Lower and Middle Triassic assemblages; there are no close similarities to assemblages outside Europe.

1. INTRODUCTION

As a result of the accelerated development of Lower Mesophytic palynology during the last few years, even the conclusions of recent investigations may soon become obsolete.

By starting our studies in Triassic palynology we suspected the existence of important floristic differences between the European Upper Permian and Lower Triassic series. In order to prove this suspicion we had to continue and to revise the investigations carried out by FREUDENTHAL (1964). Under the direction of Dr. W. Klaus, Vienna, we trained in recognizing Upper Permian sporae dispersae in order to be able to make comparisons with Lower Triassic assemblages. These were investigated from Upper Bunter evaporites and pelites.

The samples studied originate from the core of a drill hole situated in the exploited part of the Hengelo salt-deposits, south of the city of Hengelo in the province of Overijssel (situation: Cox 1963, Fig. 2). The boring was carried out in 1953 by the Koninklijke Nederlandsche Zoutindustrie (Royal Dutch Salt Industry) in behalf of the construction of well 31 (situation: Cox 1963, Figs. 4, 5). In this paper it will be indicated as "Boring 31, K.N.Z., Hengelo". The investigations were performed in the Palaebotanical laboratories of the Botanical Museum and Herbarium of the State University, Utrecht, under the direction of Dr. F. P. Jonker, professor of Special Botany.

2. CONCLUSIONS

In a large part of Europe the Upper Permian sediments contain similar palynological assemblages. Apart from local differences the microfloras are identical both in the German Basin and in the Alpine regions.

This phenomenon can also be observed in the Upper Bunter. However, the microflora has changed into a totally new composition. Important Upper Permian elements like *Nuskoisporites dulhuntyi*, *Lueckisporites virkkiae*, *Falcisporites zapfei*, *Limitisporites rectus*, *Klausipollenites schaubergeri*, etc. have given way to *Triadispora* spec. div., *Voltziaceaesporites heteromorpha*, *Angustisulcites klausii*, *Alisporites grauvogeli*, etc. The regional similarities in the European (micro)flora during the Permian and Triassic periods indicate the existence of an important palaeo-phytogeographic unit. This may be of great interest for the knowledge about the Post-Carboniferous evolution of European palaeogeography. Up till now the available palynological data from Bunter sediments have been insufficient to introduce conceptions about the regional stratigraphical problems in this series.

The author was also unable to solve the local stratigraphical problem of the boundary between the Bunter and Muschelkalk; however, it is hoped that this investigation will contribute to the knowledge of the European Lower Triassic, which, until recently, remained undiscovered by palynology.

3. GEOLOGY

3.1. *General*

For a summary of the geological history and the tectonical relations in the eastern Netherlands we refer to PANNEKOEK *et al.* (1956), FABER (1960) and HAANSTRA (1963). Local geological data concerning the Hengelo region were published by COX (1963). He also summarized the historical, technical and economical aspects of salt production in the Netherlands.

The Hengelo salt-deposits are situated in the eastern part of the East Netherlands Triassic Swell, a tectonical unit extending in NW-SE direction from Eastern Flevoland in the former Zuiderzee to the Dutch-German border (PANNEKOEK *et al.* 1956, Fig. 2; HAANSTRA, 1963, Fig. 13). This unit consists mainly of Bunter (Buntsandstein) sediments with locally some remains of Muschelkalk and Liassic. These sediments are unconformably covered by Tertiary and Quaternary sands, sandy clays, gravels and peats. The eastern part of the unit is bounded by a zone of Lower Cretaceous, east of which we find the Münster Basin (PANNEKOEK *et al.* 1956, Fig. 17; FABER 1960, Fig. 175).

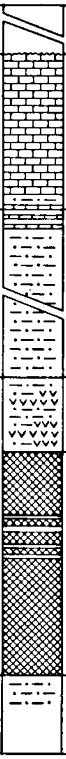
3.2. *The Bunter*

The Bunter is considered to be a lithostratigraphical series.

Besides the general geological publications by PANNEKOEK *et al.* (1956), FABER (1960) and HAANSTRA (1963) one has to take resource to the more detailed research in the German area. BOIGK (1959) and TRUSHEIM (1963) have tried to build up a lithostratigraphical classification of the Bunter. Also the eastern Netherlands have been covered by their studies. The same applies to the sedimentological approach by SINDOWSKI (1957).

TABLE 1

Boring 31, K.N.Z., Hengelo; stratigraphy



TERT. AND QUART.			Surface-129.75 m Holocene and Pleistocene (approx. 10 m) and Tertiary (120 m) (green) sands, sandy clays, gravels and peat
MUSCHELKALK			129.75-173.30 m Mainly greenish-grey limestone Lower part: calcareous shales and limestone
UPPER BUNTER	RÖT GROUP	RÖT PELITES	173.30-368.60 m Mainly reddish sandy shales Upper part: calcareous shales and limestone (transition to Muschelkalk)
			368.60-385.60 m Red and grey shales alternated with anhydrite layers
		RÖT SALINAR	385.60-402.65 m 1st saltlayer 402.65-402.87 m anhydrite 402.87-450.50 m 2nd saltlayer 450.50-406.80 m gray shales 406.80-410.20 m 3rd saltlayer 410.20-410.70 m anhydrite 410.70-411.90 m 4th saltlayer 411.90-412.60 m anhydrite 412.60-444.28 m 5th saltlayer
	SOLLING GROUP		444.28-446.83 m red sandy shales (446.83 m end of the boring)

In a great part of the Netherlands the Bunter appeared to exist in the subsoil. However, important variations in thickness have been proved (FABER 1960, fig. 91). The coarse of the isopaches in Western Germany has been shown by TRUSHEIM (1963, fig. 1). In the area of the East Netherlands Triassic Swell the thickness of the Bunter increases in SE direction. Near Hengelo the sediments amount to 900 m.

The Bunter is subdivided into the Lower-, Middle- and Upper Bunter. There is no unanimity about the limits of these subdivisions (TRUSHEIM 1963). As the samples investigated have been taken from the Upper Bunter and the Lower Muschelkalk it seems useful to treat briefly the problems about the boundaries between Middle Bunter and Upper Bunter and between Upper Bunter and Muschelkalk. In the Netherlands one usually starts the Upper Bunter with the Röt salt deposits. Also BOIGK (1959) takes this view with regard to his subdivision of the German Bunter. The Röt is considered identical with the Upper Bunter and can be divided into the Röt salinar and the younger Röt pelites. The underlying Solling Group belongs to the Middle Bunter. Another boundary has been proposed by TRUSHEIM (1963). Both the Solling and the Röt belong to the Upper Bunter; so the latter cannot be considered identical with the Röt. The boundary between the upper part of the Middle Bunter, the Hardegsen Group, and the Solling Group is marked by an uncomformity ("H-Diskordanz") whose occurrence has been demonstrated from the Dutch-German border up to Thüringen and which can be correlated with the well-known fossil land surface in southern Germany. It may be regarded as the most important hiatus within the Bunter, if not within the whole German Triassic (TRUSHEIM 1963, figs. 2, 8). Because of the comparatively small regional extension of the Röt salinar we prefer the "H-Diskordanz" as a criterion for the boundary between the Middle Bunter and the Upper Bunter. Unlike the interpretation by the K.N.Z. we consider the red sandy shales underlying the salt deposits to be the Upper Bunter (Solling Group; compare Table 1).

Though the upper part of the Röt pelites may already be calcareous and dolomitic, the base of the German Muschelkalk is characterized by a yellowish crystalline limestone layer, often developed as a conglomerate. This layer starts the so-called Wellenkalk facies (Boigk 1959). In the eastern Netherlands, however, the boundary between the Bunter- and the Muschelkalk series cannot be drawn with the same accuracy. Usually the differences in colour of the calcareous shales will settle the matter; the Röt is brownish, the Muschelkalk greyish (Faber 1960).

In the stratigraphical section (Table 1) the boundary between the Upper Bunter and Muschelkalk has been copied from the interpretation by the K.N.Z., though outstanding lithological differences could not be demonstrated.

4. PREPARATION AND STUDY TECHNIQUE

Apart from some experiments with other techniques the sample-digestion technique employed in preparing the samples has been as follows:

The samples were pulverized. Depending on the presence of NaCl or $CaCO_3$ the powder was boiled in water or treated with diluted HCl respectively. The residue was placed in a 45 % HF solution for 24–48 hours. In some cases treatments with HCl were added to stimulate the solubility of the SiO_2. The effect of the HF was hampered by a film of fluor silicates around the SiO_2 particles. HCl dissolved the fluor silicates. Also, after the HF treatment a wash with HCl i. to follow. Since many samples appeared to contain a great deal of anhydrite or gypsum it was necessary to practice gravity separations For this separation a solution of ZnBr in 10 % HCl was used.

For counting microscopic slides were made from the concentrated fossil preparations, using glycerine. In order to study and describe the various species we used single grain slides made according to the preparation method of Punt (1962) which are numbered 31-HV-01, 31-HV-02, etc. They are stored in the Palaeobotanical laboratories of the Botanical Museum and Herbarium of the State University, Utrecht, the Netherlands.

5. QUANTITATIVE PALYNOLOGY

5.1. *Presence of sporae dispersae*

We have investigated 43 core-samples from the boring 31, K.N.Z., Hengelo; they originate both from the Upper Bunter and the Lower Muschelkalk sediments (Table 2). In the latter no pollen and spores could be indicated (samples 1–6). Neither did the reddish Fe^{3+}-containing layers yield any microflora. The calcareous shale of sample 8 and the greyish sandy shales of samples 17, 20 and 26 contained some badly conserved pollen grains and spores. This also applies to the greyish shales of the upper part of the Röt salinar (samples 31 and 33). Five salt layers more or less mixed with clay and anhydrite can be distinguished (Table 1). They contain sporae dispersae in

TABLE 2

Stratigraphical position of the samples and occurrence of sporae dispersae (+)

sample number	depth below surface (m)	stratigraphical position	sporae disp.
1	152.32	Muschelkalk	
2	161.76	Muschelkalk	
3	166.69	Muschelkalk	
4	167.73	Muschelkalk	
5	170.05	Muschelkalk	
6	172.36	Muschelkalk	
7	175.85	Röt pelites (calcareous)	
8	177.76	Röt pelites (calcareous)	+
9	184.50	Röt pelites (calcareous)	
10	197.46	Röt pelites (red shales)	
11	212.45	Röt pelites (red shales)	
12	230.15	Röt pelites (red shales)	
13	242.19	Röt pelites (red shales)	
14	251.63	Röt pelites (red shales)	
15	261.52	Röt pelites (red shales)	
16	266.35	Röt pelites (red shales)	
17	271.33	Röt pelites (grey shales)	+
18	286.07	Röt pelites (red shales)	
19	301.90	Röt pelites (red shales)	
20	307.21	Röt pelites (grey shales)	+
21	312.52	Röt pelites (red shales)	
22	322.25	Röt pelites (red shales)	
23	330.41	Röt pelites (red shales)	
24	335.93	Röt pelites (red shales)	
25	339.90	Röt pelites (red shales)	
26	347.52	Röt pelites (grey shales)	+
27	353.89	Röt pelites (red shales)	
28	359.95	Röt pelites (red shales)	
29	364.85	Röt pelites (red shales)	
30	366.93	Röt pelites (red shales)	
31	372.83	Upper Röt salinar	+
32	276.78	Upper Röt salinar	
33	382.85	Upper Röt salinar	+
34	392.00	1st salt layer	+
35	399.40	1st salt layer	+
36	404.00	2nd salt layer	+
37	405.50	2nd salt layer/shales	+
38	406.80	shales/3rd salt layer	+
39	411.50	4th salt layer	+
40	431.85	5th salt layer	+
41	439.47	5th salt layer	+
42	444.28	5th salt layer/Solling Gr.	
43	446.78	Solling Group	

widely varying numbers. The shales between 405.50 and 406.80 m yielded the richest preparations. The red Solling sediments are sterile.

In general the Röt pollen is badly preserved. A sufficient number of rather well-preserved pollen grains, necessary for studying and describing the species, has been found only in the relatively rich preparations. Unlike the pollen, the spores are usually well preserved. They always occur in very low percentages.

5.2. *The Hengelo palynological assemblage*

The quantitative analysis has been based on the 54 formspecies described in this paper.

The qualitative distribution of these species within the various pollen and spores bearing samples is shown in Table 3a.

Very few samples appeared to contain well preserved specimens, which is essential to detailed counting. Sample 37 turned out to contain a relatively rich microflora. Table 3b reproduces a counting based on this sample. In order to obtain the many low percentages it has been necessary to choose a high pollen sum (≡ 1000 determinable pollen grains and spores). On account of our observations we believe the percentages of this sample to be representative for the entire Röt salinar. The many gaps in Table 3a are due to the relatively smaller number of determinable pollen grains and spores.

It has been impossible to establish whether the percentages of Table 3b also apply to the samples 17, 20 and 26, which were taken from the Röt pelites. However, the percentages of sample 37 do certainly not apply to the microflora from the calcareous shale of sample 8 (upper part of the Röt pelites, transition to the Lower Muschelkalk). Here too we are dealing with a very poor and badly preserved microflora; however, a counting is reproduced in order to get an impression of the changed percentages (Table 3c).

6. COMPARATIVE PALYNOLOGY

6.1. *Comparisons within the section investigated*

As no important microfloristic changes were demonstrated within the Röt salinar it is sufficient to discuss the differences between Röt salinar and Röt pelites. A comparison of the percentages of sample 8 (calcareous shale in the upper Röt pelites) with the percentages of sample 37 (representative for the Röt salinar) reveal some striking differences (Table 3b, c):

increased percentages of
- *Paralundbladispora quadriiuga*
- *Paralundbladispora vieta*
- *Saturnisporites praevius*
- *Alisporites grauvogeli*
- *Colpectopollis ellipsoideus*
- *Microcachryidites doubingeri*
- *Angustisulcites klausii*

decreased percentages of
- *Voltziaceaesporites heteromorpha*
- *Triadispora crassa*

The different character of sample 8 is specially owing to the increased percentage of *Angustisulcites klausii* at the cost of *Voltziaceaesporites heteromorpha* and *Triadispora crassa*.

In view of the very poor data obtained from the samples 17, 20

TABLE 3

Qualitative distribution of sporae dispersae in the various samples and quantitative analysis of samples 37 (Röt salinar) and 8 (Upper Röt pelites; transition to Muschelkalk)

Species	a Qualitative Distribution														b mean %	c mean %
	8	17	20	26	31	33	34	35	36	37	38	39	40	41	37	8
Calamaspora sp.							+								—	
Psilatriletes triassicus										+	+				0.4	
Apiculatasporites plicatus	+	+	+	+	+	+	+	+	+	+	+	+	+	+	1.2	3
Scabratisporites scabratus							+		+	+	+	+		+	0.2	
Verrucosisporites jenensis							+	+	+	+	+			+	0.4	
Verrucosisporites reinhardtii							+	+	+	+	+	+		+	0.3	
Verrucosisporites pseudomorulae						+	+			+	+	+			0.4	
Guttatisporites guttatus						+	+		+	+	+				0.4	
Guttatisporites elegans										+	+				0.2	
Guttatisporites microechinatus							+			+	+			+	0.4	
Lapposisporites lapposus							+		+	+				+	0.2	
Lapposisporites villosus							+			+					0.2	
Lapposisporites armatus										+					0.2	
Lapposisporites loricatus							+			+					0.2	
Densoisporites caretteae							+			+	+	+	+		0.4	
Pseudogravisporites reticulatus										+	+				0.3	
Anguisporites tenuis					+		+		+	+				+	0.5	
Paralundbladispora quadriiuga	+		+				+			+	+			+	0.3	4
Paralundbladispora vieta	+		+				+			+	+				0.2	4
Kraeuselisporites hystrix						+	+	+	+	+	+	+			0.4	
Kraeuselisporites hoofddijkensis	+	+	+	+	+	+	+	+	+	+	+	+	+	+	0.8	2
Saturnisporites praevius	+		+				+		+	+	+				0.2	5
Nuskoisporites inopinatus										+	+				0.4	
Voltziaceaesporites heteromorpha	+	+	+	+	+	+	+	+	+	+	+	+	+	+	21.0	11
Alisporites microreticulatus						+	+	+	+	+	+	+		+	0.7	
Alisporites grauvogeli	+	+	+	+	+	+	+	+	+	+	+	+	+	+	6.7	10
Colpectopollis ellipsoideus	+	+	+	+	+	+	+	+	+	+	+	+	+	+	1.8	6
Chordasporites voltziaformis	+						+		+	+	+	+			0.5	1
Falcisporites snopkovae							+		+	+	+	+		+	1.2	
Paravesicaspora planderovae							+		+	+	+	+	+	+	2.0	
Microcachryidites doubingeri	+						+		+	+	+				0.4	7
Triadispora crassa	+	+	+	+	+	+	+	+	+	+	+	+	+	+	18.4	7
Triadispora staplini					+	+	+	+	+	+	+	+	+	+	0.9	
Triadispora falcata							+			+	+				0.2	
Triadispora muelleri	+						+		+	+	+				0.3	1
Triadispora plicata							+	+	+	+	+	+	+		0.5	
Triadispora epigona	+	+	+	+	+	+	+	+	+	+	+	+	+	+	1.8	3
Illinites trivisus										+	+				1.4	
Angustisulcites klausii	+	+	+	+	+	+	+	+	+	+	+	+	+	+	6.3	29
Angustisulcites grandis							+		+	+	+	+	+	+	2.1	
Angustisulcites gorpii							+	+	+	+	+	+	+	+	3.5	
Lunatisporites puntii							+		+	+				+	1.0	
Striatoabietites aytugii	+				+		+		+	+	+	+		+	2.1	2
Taeniaepollenites jonkeri							+	+	+	+	+	+	+	+	1.8	
Taeniaepollenites multiplex	+			+	+	+	+	+	+	+	+	+	+	+	4.1	4
Taeniaepollenites discrepans							+		+	+	+	+			1.4	
Taeniaepollenites hengeloensis							+		+	+	+	+			0.7	
Tubantiapollenites striatitoides						+	+		+	+	+				0.7	
Tubantiapollenites balmei	+						+	+	+	+	+	+	+	+	1.3	1
Tubantiapollenites schulzii							+	+	+	+	+	+	+	+	1.4	
Cycadopites coxii				+	+		+	+	+	+	+	+	+	+	3.0	
Cycadopites sufflavus					+	+	+	+	+	+	+	+	+	+	2.5	
Cycadopites trusheimii							+			+	+	+			0.7	
Cycadopites crenulatus							+	+	+	+	+	+		+	1.4	

and 22 it has been impossible to check whether this change is sudden or gradual.

6.2. *Comparisons with Boring 69, K.N.Z., Hengelo*

The palynological investigations in the Dutch Röt salinar were started by FREUDENTHAL (1964). He studied samples from another K.N.Z. drill hole (69). The average quantitative distribution of sporae dispersae in the Röt, as given by Freudenthal, is reproduced in Table 4.

By far the greatest part of the Röt microflora was supposed to consist of components that play already a more or less important part in the European Upper Permian (group 1). We have to refute this concept with emphasis; the presence of Upper Permian saccate pollen could be demonstrated neither in Freudenthal's slides nor in our own preparations.

TABLE 4

Quantitative distribution of pollen species and spores in the assemblage from Boring 69, K.N.Z., Hengelo (modified after FREUDENTHAL 1964, t. 1)

species	mean (%)
Group 1. Species based on a holotype from the European Upper Permian	
Eridospollenites bentzi	0.2
Eridospollenites parvus	4.1
Jugasporites delasaucei	2.6
Jugasporites moersensis	0.5
Klausipollenites schaubergeri	7.4
Falcisporites zapfei	27.0
Platysaccus papillionis	2.0
Labiisporites granulatus	28.3
Favisporites tenuis	7.4
Taeniaesporites noviaulensis	5.0
Taeniaesporites nubilis	?
Striatites richteri	0.5
Group 2. Species based on a holotype from the Canadian Lower Triassic	
Falcisporites staplini	3.0
Group 3. Species based on a holotype from the European Upper Triassic	
Pityosporites devolvens	7.7
Group 4. Species based on a holotype from the assemblage investigated	
Falcisporites triangularis	0.3
Falcisporites ? grandis	0.3
Platysaccus hengeloensis	0.6
Angustisulcites klausii	0.5
Protosacculina jansonii	1.3
Group 5. *Sporites*	1.0

Also the presence of group 2 and group 3 in the Röt salinar is rather unlikely (*Falcisporites staplini* unequals *Triadispora staplini*).

Considering the species described by Freudenthal (group 4) only *Falcisporites*? *grandis* (≡ *Angustisulcites grandis*) and *Angustisulcites klausii* could be maintained. Our concepts with regard to the systematical positions of Freudenthal's species will be discussed in the systematical part of this paper.

Even after a "systematical revision" it has not been possible to compare Freudenthal's data with the results of our investigations. However, we are of opinion that there are no appreciable differences between the spectra of the two borings.

The ratio between striate pollen and non-striate pollen in the counting of sample 37 (approx. 1 : 2) differs from the ratio mentioned by Freudenthal (8 : 91). Besides considering *Illinites* and *Angustisulcites* as striate pollen, this difference is attributable to the higher pollen sum. This may also explain the more prominent percentages of *Sporites*.

6.3. *Comparisons with other European Bunter and Muschelkalk assemblages*

Similarities to Lower Triassic palynological assemblages outside Europe, for example Canada (Jansonius 1962) and Australia (Balme 1963), can only be found at a generic level. So comparisons can be restricted to some European assemblages.

Klaus (1964) investigated the characteristic microflora of German and French Upper Bunter sediments and also that of the Alpine Upper "Werfener Schichten", which can be correlated with the Upper Bunter. He also studied samples from German, French and Italian Middle Muschelkalk.

Finding characteristic assemblages in Upper Permian, Upper Bunter, Middle Muschelkalk and Keuper, Klaus states that sediments of these series can be distinguished palynologically.

Table 5 shows a comparison with the Bunter and Muschelkalk assemblages described by Klaus (1964). Three groups of species can be distinguished:

1. Species occurring both in the Upper Bunter (possibly also in the Middle Muschelkalk) studied by Klaus and in the Hengelo Röt group. The regional distribution of these species appears to include the eastern Netherlands.
2. Species occurring in the Middle Muschelkalk studied by Klaus but also in the Upper Bunter of Hengelo. In this group only *Microcachryidites doubingeri* shows an increased percentage in the upper part of the Röt pelites (sample 8), which may be interpreted as a Muschelkalk "influence".
3. Species recognized in Upper Bunter and/or Middle Muschelkalk samples from Germany, Austria, France and Italy but unknown from the Hengelo Röt sediments.

Klaus states that *Voltziaceaesporites heteromorpha* decreases in the Muschelkalk series. This view is supported by the diminished per-

TABLE 5
Qualitative comparison with the assemblages investgated by KLAUS (1964)

species	Klaus 1964		boring 31	
	Bunter	Musch.	37	8
Group 1.				
Triadispora staplini	+		+	
Triadispora falcata	+		+	
Triadispora crassa	+		+	+
Illinites melanocorpus [1])	+	+	+	+
Voltziaceaesporites heteromorpha	+	+	+	+
Alisporites grauvogeli	+		+	+
Group 2.				
Triadispora plicata		+	+	
Triadispora epigona		+	+	+
Striatoabietites balmei [2])		+	+	+
Microcachryidites doubingeri		+	+	+
Group 3.				
Jugasporites renalis		+		
Jugasporites commilvinus	+			
Illinites kosankei	+			
Illinites chitinoides		+		
Taeniaesporites novimundi		+		
Taeniaesporites austriacus	+			
Voltziaceaesporites nephrosaccus	+	+		
Sulcosaccospora minuta		+		
Alisporites progrediens		+		
Chordasporites magnus	+			
Chordasporites cf. *singulichorda*		+		
Microcachryidites fastidioides	+			
Microcachryidites sittleri	+			
Tsugaepollenites oriens		+		

[1]) probably identical with *Angustsulcites klausii.*
[2]) identical with *Tubantiapollenites balmei.*

centage of this species in the upper part of the Röt pelites (sample 8). It is of great interest to compare the quantitative distribution of the species of *Triadispora* (Table 6):

TABLE 6
Quantitative distribution of species of Triadispora within the assemblages investigated by KLAUS (1964) and the Hengelo Röt salinar

species	Klaus 1964		Hengelo Röt sal.
	Bunter	Musch.	
Triadispora crassa	+ +		+ + +
Triadispora staplini	+ + +		+
Triadispora falcata	?		+
Triadispora epigona		+ +	+
Triadispora plicata		+ +	+

percentages: + + + high; + + moderate; + low.

Triadispora crassa exists both in the Bunter studied by Klaus and in our preparations. It is a rather dominant species.

Triadispora staplini is even more frequent in Klaus' samples. In the Hengelo Röt, however, it is fairly uncommon.

Klaus does not mention the avarage of *Triadispora falcata*, known from the Upper Bunter. In the Hengelo assemblage this species is very rare.

Triadispora epigona and *Triadispora plicata* are important elements of the Middle Muschelkalk assemblages from Kochendorf (Germany), Sarralbe (France) and Recoaro (Italy). However, they also exist in low percentages in the Hengelo Röt Group.

Considering the existence of progressive transitions in the *Triadispora*-group – at least in the Hengelo assemblage – these species may originate from the same conifer species. But in this case the differences in quantitative distribution are still more striking, and besides biostratigraphical and palaeo-phytogeographical aspects one has to reckon with phylogenetic considerations (compare p. 350).

REINHARDT (1964a, b) described some species from the Lower Röt of Thüringen. The following elements of this incomplete assemblage can also be found in the Hengelo Röt:

Verrucosisporites jenensis
Alisporites microreticulatus
Nuskoisporites muelleri (≡ *Triadispora muelleri*)

There are no resemblances to the Middle Bunter microflora described by SCHULZ (1964). In future palynology may provide the possibilities to demonstrate the important "H-Discordanz" (p. 318) between Middle and Upper Bunter biostratigraphically.

7. DESCRIPTIVE PALYNOLOGY

ANTETURMA *Sporites* H. Potonié 1893
TURMA *Triletes* (Reinsch 1881) Potonié & Kremp 1954
SUBTURMA *Azonotriletes* Luber 1935
INFRATURMA *Laevigati* (Bennie & Kidston 1886) Potonié 1956

Calamaspora Schopf, Wilson & Bentall 1944

Type species: *Calamaspora hartungiana* Schopf 1944 in SCHOPF, WILSON and BENTALL 1944, p. 51, f. 1.

Calamaspora sp.

Fig. 1; Plate VI, Fig. 2.

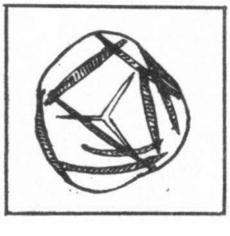


Fig. 1. *Calamaspora* sp.

Remarks and comparisons: Some spores considered as *Calamaspora* have been found in sample 34. Because of the few specimens found and the bad preservation it has been impossible to compare our forms with the numerous species of *Calamaspora* mentioned in the palynological literature. *Calamaspora* sp. possesses an irrigular, but fundamentally circular outline; diameter approx. 60 μ. Exine smooth with fine infrastructure; thickness approx. 1 μ. Length of the Y-mark rays approx. 4/5 of the spore radius; usually the sutures are widely opened. Strongly folded. *Calamaspora* sp. differs from *Calamaspora nathorstii* (Halle 1906) Klaus 1960, which is important to Upper Triassic and Lower Jurassic stratigraphy, by its bigger size and its thicker exine.

Psilatriletes (van der Hammen 1954) ex Potonié 1956

Type species: *Psilatriletes* (al. *Punctatisporites*) *detortus* (Weyland & Krieger 1953) Potonié 1965; WEYLAND and KRIEGER 1953, t. 14, f. 24.

Psilatriletes triassicus n. sp.
Fig. 2; Plate VI, Fig. 5.

Holotype: *Psilatriletes triassicus* n. sp.
Single grain side 31-HV-276: plate VI, Fig. 5.

Fig. 2. *Psilatriletes triassicus*

Diagnosis: Spores trilete, azonal, with convex-triangular equator; diameter holotype 46 μ. Smooth exine with fine infrastructure; thickness approx. 1.5 μ. Faintly wavy trilete rays extend to equator. Strongly folded, due to compression.

Remarks and comparisons: On account of the strongly convex-triangular outline we consider our forms as *Psilatriletes* (van der Hammen 1954) ex Potonié 1956 (*Psilatriletes* van der Hammen 1956b seems to be unvalid; compare POTONIÉ 1960, p. 20). Unlike species of the genera *Leiotriletes* Naumova 1937 emend. Potonié & Kremp 1954 and *Deltoidospora* Miner 1935 emend. Potonié 1956 (syn. *Deltoidisporites* Danzé-Corsin & Laveine 1963), *Psilatriletes triassicus* does not include forms with straight or concave-triangular sides.

Locus typicus: Boring 31, K.N.Z., Hengelo; depth 405.50 m (Röt salinar)
Occurrence: Only recognized in the shales between 405.50 and 406.80 m; rare.

INFRATURMA *Apiculati* (Bennie & Kidston 1886) Potonié 1956
SUBINFRATURMA *Nodati* Dybová & Jachowicz 1957

Apiculatasporites Ibrahim 1933 emend.

Type species: *Apiculatasporites* (al. *Sporonites*) *spinulistratus* (Loose 1932) Ibrahim 1933; POTONIÉ, IBRAHIM and LOOSE 1932, t. 18, f. 47; photo after type in POTONIÉ and KREMP 1955, t. 14, f. 214.

Diagnosis: Spores trilete, azonal, with approx. circular equator. Exine ornamentated with more or less regularly placed tapering or rather blunt echinae; height 0.5–1.5 μ. The trilete rays are often indistinct and invisible by folding; they do not extend to the equator.

Remarks and comparisons: By describing *Apiculatasporites* IBRAHIM (1933) has chosen a trilete type species. Consequently afterwards this type species has been placed in trilete genera, viz. *Apiculatisporites* (by LOOSE 1934), *Punctatisporites* (by SCHOPF, WILSON and BENTALL 1944), *Spinososporites* (by KNOX 1950) and *Planisporites* (by POTONIÉ and KREMP 1955). However *Apiculatisporites* includes megaspores (compare POTONIÉ 1956, p. 30); the usage of American authors considering apiculate forms to *Punctatisporites* is objectionable; the position of *Spinososporites* is discussed by POTONIÉ (1958, p. 21); the latter author also dealt with the relation *Apiculatasporites–Planisporites* (POTONIÉ 1960, p. 21). Yet LESCHIK (1956a) considers *Apiculatasporites* alete; because of the trilete type species this is not permissible. *Apiculatasporites* can be distinguished from *Scrabratisporites* n. gen. by its higher exinal elements (>0,5 μ).

Apiculatasporites plicatus n. sp.

Fig. 3; Plate III, Fig. 3.

Holotype: *Apiculatasporites plicatus* n.sp. Single grain slide 31-HV-109; Plate III Fig. 3.

Fig. 3. *Apiculatasporites plicatus*

Diagnosis: Spores trilete, azonal, with approx. circular equator; diameter 55–65 μ (holotype 61 μ). Exine, 1.5–2 μ thick, with a rather regular but not very dense ornamentation of small echinae (basis diameter 1–2 μ, height max. 1 μ). Trilete rays approx. 2/3 of spore radius, accompanied by indistinct labra (2.5–3 μ). Usually many compression folds.

Remarks and comparisons: Because of the strong folding the Y-mark is only occasionally recognizable. The holotype of *A. plicatus*, however, shows a rather distinct Y-mark. *Apiculatasporites spinulistratus* (Loose 1932) Ibrahim 1933 differs by the more densely placed echinae of which the height exceeds the diameter.

Scabratisporites scabratus n. sp. possesses elements 0.5 μ.

Locus typicus: Boring 31, K.N.Z., Hengelo; depth 392 m (Röt salinar).

Occurrence: Most dominant spore in the Röt Group of Hengelo; yet not occurring in high percentages.

Scabratisporites n. gen.

Type species: *Scabratisporites scabratus* n.sp., Plate V, Fig. 4.

Diagnosis: Spores trilete, azonal, with approx. circular equator. Exine ornamentated with more or less regularly distributed scabrae. Trilete rays not extending to equator. Usually folded.

Remarks and comparisons: Following STRAKA (1964, Fig. 16), we define scabrae as exinal elements with a height < 0.5 μ. VAN DER HAMMEN (1954, 1956a) proposed the genus *Scabratriletes* to include scabrate, trilete microspores. POTONIÉ (1956) legitimated this name but at present *Scabratriletes* (van der Hammen 1954) ex Potonié 1956 includes megaspores with elements up to 50 μ. *Apiculatasporites* Ibrahim 1933 emend. possesses elements > 0.5 μ. The same applies to to *Planisporites* Knox 1950 emend. Potonié 1960. Moreover the latter genus possesses a subtriangular equator. At first sight *Scabratisporites* seems to have a rather smooth exine but with high magnification the scabra are visible. By these minute elements *Scabratisporites* can be distinguished from laevigate genera like *Punctatisporites* Ibrahim 1933 emend. Potonié & Kremp 1954, *Orbella* Malavkina 1949, *Phyllothecotriletes* Luber 1955 and *Cyclinasporites* Nilsson 1958. *Mariattisporites scabratus* Couper 1958 is monolete.

Scabratisporites scabratus n. sp.

Fig. 4; Plate V, Fig. 4.

Holotype: *Scabratisporites scabratus* n. sp. Single grain slide 31-HV-56; Plate V, Fig. 4.

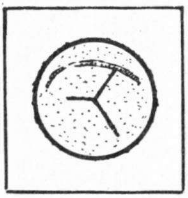


Fig. 4. *Scabratisporites scabratus*

Diagnosis: Spores trilete, azonal, with approx. circular equator; diameter 44–50 μ (holotype 48 μ). Exine 1.5–2 μ in thickness, rather regularly ornamentated with scabrae which have the shape of coni. Trilete rays of unequal length, the longest ray never exceeds 3/4 of the spores radius.

Remarks and comparisons: The spores are mostly folded. *S. scabratus* differs from *Apiculatasporites plicatus* n. sp. by its smaller exinal elements.

Locus typicus: Boring 31, K.N.Z., Hengelo; depth 405.50 m (Röt salinar).

Occurrence: Röt salinar of Hengelo; rare.

INFRATURMA *Verrucati* Dybová & Jachowicz 1957

Remarks: A boundary between the subinfraturma *Verrucati* and the infraturma *Murornati* Potonié & Kremp 1954 cannot be drawn with accuracy. For example, the bigger verruca-like elements of *Guttatisporites* n. gen. seem to have developed by the growing together of some small elements. The general impression, however, remains verrucate. So we will give up the idea of considering such forms as *Murornati*, because within this infraturma the phenomenon of elements grown together is much more striking.

Verrucosisporites Ibrahim 1933 emend. Smith et al. 1964

Type species: *Verrucosisporites* (al. *Sporites*) *verrucosus* (Ibrahim 1932) Ibrahim 1933; Potonié, Ibrahim and Loose 1932, t. 15, f. 17; photo after the type in Potonié and Kremp 1955, t. 13, f. 196 and in Smith, Butterworth, Knox and Love 1964, t. 3, f. 7.

Verrucosisporites jenensis Reinhardt & Schmitz in Reinhardt 1964. Fig. 5b; Plate I, Figs. 1, 2.

Holotype: *Verrucosisporites jenensis* Reinhardt & Schmitz in Reinhardt 1964, t. 1, f. 7.

Remarks and comparisons: Our specimens well correspond to the specific description by Reinhardt (1964b). An average of 50 verrucae can be counted on the spore outline; diametrically an average of 20. *V. jenensis* differs from *Verrucosisporites reinhardtii* n. sp. by possessing a thinner exine (respectively 3–4 μ and 6–7 μ).

Occurrence: Röt salinar of Hengelo; rare. Reinhardt mentions the species from the Lower Röt of Thüringen (Germany).

Verrucosisporites reinhardtii n. sp.
Fig. 5a; Plate I, Fig. 3.

Holotype: *Verrucosisporites reinhardtii* n. sp. Single grain slide 31-HV-150; plate I, Fig. 3.

Derivatio nominis: P. Reinhardt, Geologisches Institut der Bergakademie Freiberg, Germany.

Diagnosis: Spores trilete, azonal, with covex-subtriangular equator. Very thick exine (6–7 μ), with a dense ornamentation of polygonal verrucae (diameter 2.5–5 μ, height 1.5–2.5 μ; the bigger elements only at the distal surface). An average of 37 verrucae can be counted on the spore outline, diametrically about 15–20. Between the verrucae a polygonal negative reticulum is visible. Trilete rays of the distinct Y-mark extend to 2/3–3/4 of the spore radius. Known size range 65–72 μ (holotype 67 μ).

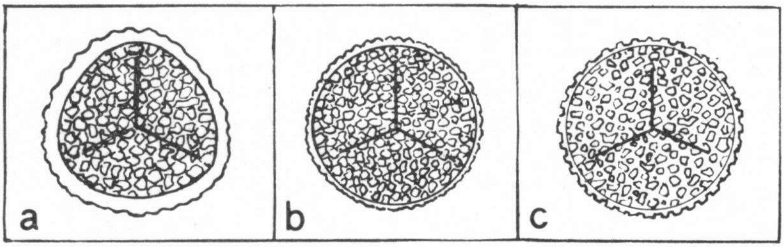


Fig. 5. *Verrucosisporites*. a. *V. reinhardtii*; b. *V. jenensis*; c. *V. psedomorulae*

Remarks and comparisons: The thick exine is very striking. By this phenomenon *V. reinhardtii* can be distinguished from *Verrucosisporites jenensis* Reinhardt & Schmitz in Reinhardt 1954b and *Verrucosisporites pseudomorulae* n. sp.

Locus typicus: Boring 31, K.N.Z., Hengelo; depth 392 m (Röt salinar).
Occurrence: Röt salinar of Hengelo; rare.

Verrucosisporites pseudomorulae n. sp.

Fig. 5c; Plate I, Figs. 4, 5.

Holotype: *Verrucosisporites pseudomorulae* n. sp. Single grain slide 31-HV-92; Plate I, Fig. 4.

Derivatio nominis: The new species reminds one of *Verrucosisporites morulae* Klaus 1960.

Diagnosis: Spores trilete, azonal, with approx. circular equator. Exine, 1.5–2 μ thick, distally covered by a dense irrigular ornamentation of polygonal verrucae (basis 1.5–3.5 μ, height 1.5–2 μ); proximally smaller (1.5–2 μ), regularly distributed verrucae are dominating; here a polygonal negative reticulum appears. Usually the verrucae are flattened, occasionally they are slightly gemmate. Equatorially 40–50 elements can be counted, diametrically 15–20. Distinct Y-mark with rays extending to 3/4–2/3 of the spore radius. Known size range 65–70 μ (holotype 68 μ).

Remarks and comparisons: A progressive transition between the irregularly distributed distal verrucae and the regularly placed proximal verrucae has been demonstrated. The species reminds one of *Verrucosisporites morulae* Klaus 1960 which, however, possesses rounded regularly placed verrucae. The same applies to *Verrucosisporites jenensis* Reinhardt and Schmitz in REINHARDT 1964 and *Verrucosisporites reinhardtii* n. sp.

Locus typicus: Boring 31, K.N.Z., Hengelo; depth 392 m (Röt salinar).

Occurrence: Röt salinar of Hengelo; rare.

Guttatisporites n. gen.

Type species: *Guttatisporites guttatus* n. sp., Plate II, Eigs. 1 A, B.

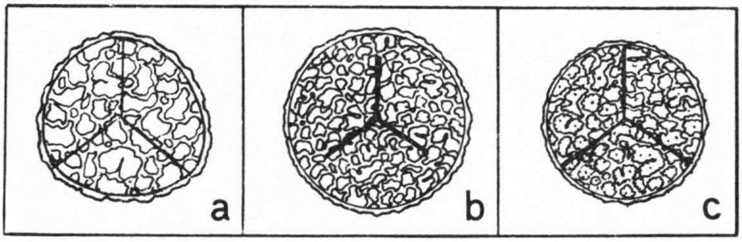


Fig. 6. *Guttatisporites*. a. *G. elegans*; b. *G. guttatus*; c. *G. microechinatus*

Diagnosis: Spores trilete, azonal, with approx. circular to convex-subtriangular equator. Exine densely covered by very irregularly shaped verruca-like elements. These elements show polygonal to crenulate outlines; they vary in size and shape. Bigger elements seem to have developed by the growing together of some small elements; they are mainly restricted to the distal spore surface. Between the elements a negative reticulum appears.

Remarks and comparisons: In spite of the bigger, complex elements *Guttatisporites* presents itself as a verrucate genus. It differs from *Verrucosisporites* Ibrahim 1933 emend. Smith *et al.* 1964 in that it possesses the characteristic exinal elements described.

Guttatisporites guttatus n. sp.

Fig. 6b; Plate 2, Figs. 1A, B.

Holotype: *Guttatisporites guttatus* n. sp. Single grain slide 31-HV-190; Plate II, Figs. 1A, B.

Diagnosis: Spores trilete, azonal, with circular equator. Diameter of holotype 95 μ. Exine, approx. 3.5 μ thick, densely covered by very irregularly shaped, low (approx. 1.5 μ) verruca-like elements; these show polygonal to slightly crenulate outlines; they vary in size and shape (basis 3–4 μ). Bigger elements, both proximally and distally existing, seem to have developed by the growing together of some smaller elements. The elements are unflattened, they possess a faint irregular relief. The narrow pits (approx. 0.5 μ) between the elements form a negative reticulum. Rather distinct Y-mark with trilete rays extending to 3/4–2/3 of the spore radius.

Remarks and comparisons: G. guttatus strikes by its truly circular equator; also specimens which are not proximo-distally flattened show a circular outline, this suggest a sphaerical shape of the spores. *Guttatisporites microechinatus* n. sp. differs by its small echinae superposed on the verrucae. *Guttatisporites elegans* n. sp. shows a subtriangular equator, longer trilete rays and bigger elements.

Locus typicus: Boring 31, K.N.Z., Hengelo; depth 405.50 m (Röt salinar).
Occurrence: Röt salinar of Hengelo; rare.

Guttatisporites elegans n. sp.

Fig. 6a; Plate II, Figs. 4A, B.

Holotype: *Guttatisporites elegans* n. sp. Single grain slide 31-HV-228; Plate II, Figs. 4A, B.

Diagnosis: Spores trilete, azonal, with convex-subtriangular equator. Diameter of holotype 72 μ. Exine densely covered by very irregularly shaped verruca-like elements; these show polygonal to crenulate outlines; they vary in size and shape (basis 2–8 μ, height 1,5–2 μ); proximally only smaller elements can be found, distally the bigger elements predominate. The latter seem to have developed by the growing together of some small elements. The elements are unflattened, they possess a faint irregular relief. The trilete rays of the distinct Y-mark extend to the equator.

Remarks and comparisons: The shape of *G. elegans* seems related to an undescribed species illustrated by COUPER and HUGHES (1963, t. 1, f. 3) from the Dutch Lower Liassic; this species differs by the still more remarkably grown together elements. *Guttatisporites guttatus* n. sp. differs by its circular equator, by the shorter trilete rays and by the smaller average size of the verrucae. *Guttatisporites microechinatus* n. sp. possesses small echinae superposed on the verruca-like elements.

Locus typicus: Boring 31, K.N.Z., Hengelo; depth 405.50 m (Röt salinar).
Occurrence: Only recognized in the shales between 405.50 and 406.80 m; very rare.

Guttatisporites microechinatus n. sp.

Fig. 6c; Plate II, Figs. 2, 3A, B.

Holotype: *Guttatisporites microechinatus* n. sp. Single grain slide 31-HV-275; Plate II, Fig. 2.

Diagnosis: Spores trilete, azonal, with approx. circular equator. Diameter of the holotype 89 μ. Exine, approx. 4.5 μ thick, densely covered by very irregularly shaped, low (approx. 1 μ) verruca-like elements; these show polygonal to strongly crenulate outlines; they differ strongly in size and shape. Bigger elements, existing both proximally and distally, seem to have developed by the growing together of some smaller elements. The elements are unflattened, they possess an irregular relief. Sometimes echina-like differentiations are superposed on the verrucae; usually one element bears one echina, but bigger elements may also possess two or more echinae. The narrow pits (approx. 0.5 μ) between the verrucae form a negative reticulum. The trilete rays extend to the equator.

Remarks and comparisons: The superposed echinae are only visible with high magnification. *G. microechinatus* differs from *Guttatisporites guttatus* n. sp. and *Guttatisporites elegans* n. sp. by its characteristic echina-bearing verrucae.

Locus typicus: Boring 31, K.N.Z., Hengelo; depth 405.50 m (Röt salinar).

Occurrence: Röt salinar of Hengelo; rare.

SUBINFRATURMA *Tetradoapiculati* nov. subinfraturma

Diagnosis: Spores trilete, azonal, apiculate, still connected in tetrahedral tetrads.

Lapposisporites n. gen.

Type species: *Lapposisporites lapposus* n. sp., Plate III, Figs. 1A, B.

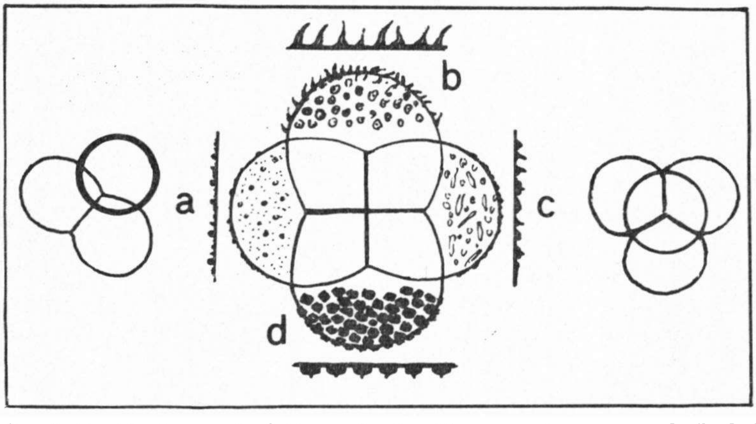


Fig. 7. *Lapposisporites*. a. *L. lapposus*; b. *L. villosus*; c. *L. armatus*; d. *L. loricatus*

Diagnosis: Spores trilete, azonal, apiculate, still connected in tetrahedral tetrads. Exine ornamentated with scabrae, grana, gemmae, verrucae, echinae, etc. in different combinations and/or ratios, depending on the species. Distal side semi-sphaerical, proximal side pyramidal; equator approx. circular.

Remarks and comparisons: Although the still connected spores do not show a tetrad mark the trilete character of *Lapposisporites* is indicated by the tetrahedral tetrads. The tetrads can be fossilized in three fundamental positions (Fig. 7). Superficially the genus reminds one of *Quadrisporites* Hennelly 1958 emend. Potonié & Lele 1961; this genus, however, differs by its tetragonal (square) or rhombic tetrads which suggest a monolete character. Moreover, investigations by Erdtman (1945) on the occurrence of tetrads of recent pollen show the exceptional appearance of both tetrahedral tetrads and tetragonal or rhombic tetrads within one plant species. *Ricciisporites* Lundblad 1954 emend. Lundblad 1959 differs by the presence of a distal sulcus and the absence of a pyramidal proximal side.

Lapposisporites lapposus n. sp.

Fig. 7a; Plate III, Figs. 1A, B, 2.

Holotype: *Lapposisporites lapposus* n. sp. Single grain slide 31-HV-108; Plate III, Figs. 1A, B.

Diagnosis: Spores trilete, azonal, apiculate, still connected in tetrahedral tetrads. Exine densely ornamentated by scabrae alternating with regularly placed grana and gemmae (max. height 1.5 μ). Biggest dimension of holotype 98 μ.

Comparisons: L. lapposus differs from *Lapposisporites villosus* n. sp., *Lapposisporites loricatus* n. sp. and *Lapposisporites armatus* n. sp. by its ornamentation of scabrae, grana and gemmae.

Locus typicus: Boring 31, K.N.Z., Hengelo; depth 392 m (Röt salinar).
Occurrence: Röt salinar of Hengelo; rare.

Lapposisporites villosus n. sp.

Fig. 7b; Plate V, Fig. 1.

Holotype: *Lapposisporites villosus* n. sp. Single grain slide 31-HV-98; Plate V, Fig. 1.

Diagnosis: Spores trilete, azonal, apiculate, still connected in tetrahedral tetrads. Exine densely ornamentated by long echinae (6–7 μ). Biggest dimension of holotype 120 μ.

Comparisons: L. villosus differs from *Lapposisporites lapposus* n. sp., *Lapposisporites loricatus* n. sp. and *Lapposisporites armatus* n. sp. by its striking echinate exine.

Locus typicus: Boring 31, K.N.Z., Hengelo; depth 392 m (Röt salinar).
Occurrence: Only recognized in the samples 34 (392 m) and 37 (405.50 m); very rare.

Lapposisporites armatus n. sp.

Fig. 7c; Plate IV, Fig. 1.

Holotype: *Lapposisporites armatus* n. sp. Single grain slide 31-HV-55; Plate IV, Fig. 1.

Diagnosis: Spores trilete, azonal, apiculate, still connected in tetrahedral tetrads. Exine ornamentated with spread echinae and verrucae with superposed echina-like differentiations (height 2–2.5 μ). Occasionally elements are grown together; in this case short narrow ridges can be formed. Biggest dimension of holotype 90 μ.

Remarks and comparisons: The verrucae with superposed echinae are very striking; there are progressive transitions between these elements and the normal echinae. This can be considered to be the principal difference with *Lapposisporites loricatus* n. sp. which is ornamentated by echina-bearing verrucae only. *Lapposisporites lapposus* n. sp. and *Lapposisporites villosus* n. sp. have a different exinal structure.

Locus typicus: Boring 31, K.N.Z., Hengelo; depth 405.50 m (Röt salinar).
Occurrence: Only recognized in sample 37 (405.50 m); very rare.

Lapposisporites loricatus n. sp.

Fig. 7d; Plate IV, Fig. 2.

Holotype: *Lapposisporites loricatus* n. sp. Single grain slide 31-HV-151; Plate IV, Fig. 2.

Diagnosis: Spores trilete, azonal, apiculate, still connected in tetrahedral tetrads. Exine densely covered by approx. polygonal verrucae with superposed echina-like differentiations (basis elements 2.5–3 μ, distally 5 μ; height 3 μ). The pits between the elements form a negative reticulum. Biggest dimension of holotype 101 μ.

Remarks and comparisons: The dense ornamentation by verrucae with superposed echinae is very striking. No transitions to normal echinae can be seen as in *Lapposisporites armatus* n. sp. *Lapposisporites lapposus* n. sp. and *Lapposisporites villosus* n. sp. differ by their different exinal structure.

Locus typicus: Boring 31, K.N.Z., Hengelo; depth 392 m (Röt salinar).
Occurrence: Only recognized in the samples 34 (392 m) and 37 (405.50 m); very rare.

TURMA *Zonales* (Bennie & Kidston 1886) Potonié 1956
SUBTURMA *Zonotriletes* Waltz 1935
INFRATURMA *Cingulati* Potonié & Klaus 1954

Densoisporites Weyland & Krieger 1953

Type species: *Densoisporites velatus* Weyland & Krieger 1953, t. 4, f. 13, 14.

Densoisporites caretteae n. sp.

Fig. 8; Plate V, Fig. 2.

Holotype: *Densoisporites caretteae* n. sp. Single grain slide 31-HV-82; Plate V, Fig. 2.

Derivatio nominis: Mrs J. Levet-Carette, Laboratoire de Paléobotanique, Lille, France.

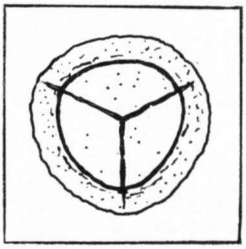


Fig. 8. *Densoisporites caretteae*

Diagnosis: Spores trilete, zonal. Equator of spore body and outline of cingulum subtriangular; diameter of holotype (cingulum included) 55 μ. Exine of spore body approx. 1 μ thick; finely infrastructured.

Cingulum scabrate with small circumequatorially situated folds; cingulum 5–7 μ wide. Trilete rays of the Y-mark extend into the cingulum; narrow labra.

Comparisons: D. caretteae reminds one of *Densoisporites perinatus* Couper 1958 (Jurassic – Lower Cretaceous); the latter species differs by its wider labra. Combined with a wider cingulum this also applies to *Densoisporites fissus* Reinhardt 1964, which also possesses, like *Densoisporites regularis* Danzé-Corsin & Laveine 1963, trilete rays extending to the outer margin of the cingulum.

Locus typicus: Boring 31, K.N.Z., Hengelo; depth 411.50 m (Röt salinar).
Occurrence: Röt salinar of Hengelo; very rare.

Pseudogravisporites n. gen.

Type species: *Pseudogravisporites reticulatus* n. sp., Plate V, Figs. 5A, B.
Derivatio nominis: The new genus reminds one of *Gravisporites* Bharadwaj 1954.

Diagnosis: Spores trilete, zonal. Equator of spore body and outline of cingulum approx. circular to subtriangular. Exine laevigate to scabrate. Very narrow trilete sutures situated between strongly developed labra which form rather wide ridges with crenulate margins; they terminate abruptly just before the equator of the spore body.

Remarks and comparisons: The genus reminds one of *Gravisporites* (al. *Cadiospora*) *sphaerus* (Butterworth & Williams 1954) Bharadwaj 1954, the type species of *Gravisporites* Bharadwaj 1954. This species, however, is characterized by a thickening of the equator of the spore (crassitudo). *Pseudogravisporites* does not show this equatorial thickening: the cingulum is lighter coloured than the exine of the spore body. Also *Cadiospora* Kosanke 1950 emend. Venkatachala & Bharadwaj 1964 is characterized by a thickened equatorial exine. *Lycospora* Schopf, Williams & Bentall 1944 emend. Potonié & Kremp 1954 includes smaller species with longer and narrower labra. *Polimorphisporites* Alpern 1958, at least the type species *Polymorphisporites laevigatus* Alpern 1958 differs by its trilete rays of unequal length and its less pronounced labra.

Pseudogravisporites reticulatus n. sp.

Fig. 9; Plate V, Figs. 5 A, B.

Holotype: *Pseudogravispoirtes reticulatus* n. sp. Single grain slide 31-HV-160; Plate V, Figs. 5A, B.

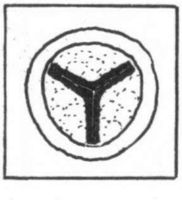


Fig. 9. *Pseudogravisporites reticulatus*

Diagnosis: Spores trilete, zonal; equator of spore body and outline of cingulum subtriangular; diameter (cingulum included) 58–62 μ (holotype 61 μ). Exine laevigate to scabrate; distally low muri make a very vague reticulate structure. Very narrow trilete sutures situated between wide ridge-like labra (approx. 5 μ wide); the margins of the labra are slightly crenulate; they terminate abruptly just before the equator of the spore body.

Remark: The vague reticulate structure is only visible with phase-contrast microscopes.

Locus typicus: Boring 31, K.N.Z., Hengelo; depth 405.50 m (Röt salinar).
Occurrence: Only recognized in the shales between 405.50 and 406.80 m; rare.

Anguisporites Potonié & Klaus 1954

Type species: *Anguisporites anguinus* Potonié & Klaus 1954, t. 10, f. 4.

Anguisporites tenuis n. sp.

Fig. 10; Plate V, Fig. 3.

Holotype: *Anguisporites tenuis* n. sp. Single grain slide 31-HV-09; Plate V, Fig. 3

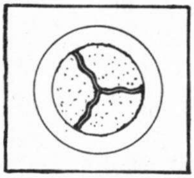


Fig. 10. *Anguisporites tenuis*

Diagnosis: Spores trilete, zonal; equator of spore body and outline of cingulum approx. circular; relatively small diameter (30–35 μ; holotype 32 μ). Exine probably finely scabrate. Trilete rays extend to the equator of the spore body; the sutures are situated between more or less wavy ridge-like labra.

Remarks and comparisons: The characteristics of *A. tenuis* are badly pronounced; the wavy trilete rays do not appear as clear dark differentiations like the Y-mark of the Permian *Anguisporites anguinus* Potonié & Klaus 1954, *Anguisporites intonsus* Wilson 1962 and *Anguisporites contortus* Wilson 1962; moreover these species are bigger. Cf. *Anguisporites anguinus* Grebe 1957 seems more related to *A. tenuis.*

Locus typicus: Boring 31, K.N.Z., Hengelo; depth 405.50 m (Röt salinar).
Occurrence: Röt salinar of Hengelo; rare.

Paralundbladispora n. gen.

Type species: *Paralundbladispora quadriiuga* n. sp., Plate IV, Fig. 4.
Derivatio nominis: The new genus seems related to *Lundbladispora* Balme 1963.

Diagnosis: Spores trilete, zonal, usually still connected in tetrahedral tetrads. Equator of spore body approx. circular to subtriangular. Exine finely structured or infrastructured. Narrow cingulum, situated proximal of the equator. Proximal side with subpyramidal shape. The rare single specimens show a tetrad mark with thickened labra.

Remarks and comparisons: We consider the occurrence in still connected tetrahedral tetrads a generic characteristic; single spores are very rare. Superficially the tetrads remind one of tetrads of *Circulina*

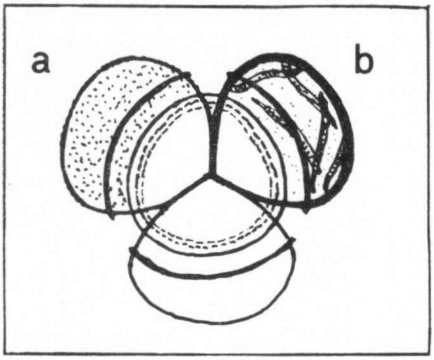


Fig. 11.
Paralundbladispora.
a. *P. quadriiuga*;
b. *P. vieta*

(Malavkina 1949) ex Klaus 1960 which is characterized, however, by a circumequatorial thinning of the exine. The cingulum of Paralundbladispora is clearly projecting. Moreover, the proximal side of *Circulina* is more rounded, it shows a very small Y-mark. *Lundbladispora* Balme 1963, sometimes also occurring in tetrads, seems very related but differs by the truly equatorial cingulum and the eccentrically placed papillate intexine.

Paralundbladispora quadriiuga n. sp.

Fig. 11a; Plate IV, Figs. 4, 5.

Holotype: *Paralundbladispora quadriiuga* n. sp. Single grain slide 31-HV-268; Plate IV, Fig. 4.

Diagnosis: Spores trilete, zonal, usually still connected in tetrahedral tetrads. Equator of spore body approx. circular to subtriangular. Exine scabrate to finely granulate; exine approx. 1 μ thick. Narrow cingulum, situated proximal of the equator. Proximal side subpyramidal. Single specimens show the tetrad mark with the thickened irregularly wavy labra which approximately extend to the equator (Plate IV, Fig. 5). Biggest dimension of the holotype 57 μ.

Remarks and comparisons: Because of the proximal position of the cingulum polar flattened specimens, both single spores and spores forming part of a tetrad do not show the narrow cingulum clearly. It appears as proximal folds parallel to the equator. Equatorially flattened specimens of the tetrads, however, demonstrate the cingulum very clearly. *P. quadriiuga* reminds one of *Lundbladispora nejburgii* Schulz 1964 which may be compared with the microspores of *Pleuromeia rossica* Nejburg 1960; it differs by occurring in tetrads and by slightly narrower labra. *Paralundlbadispora vieta* n. sp. differs by a thick infrastructured exine.

Locus typicus: Boring 31, K.N.Z., Hengelo; depth 405.50 m (Röt salinar).

Occurrence: Röt salinar of Hengelo; rare. In the upper part of the overlying Röt pelites (transition to Muschelkalk) the species is more frequent.

Paralundbladispora vieta n. sp.

Fig. 11b; Plate IV, Figs. 3A, B.

Holotype: *Paralundbladispora vieta* n. sp. Single grain slide 31-HV-230; Plate IV, Figs. 3A, B.

Diagnosis: Spores trilete, zonal, only recognized in still connecting tetrahedral tetrads. Equator of spore body approx. circular to subtriangular. Exine 2.5–3 μ thick, smooth with fine infrastructure. Narrow cingulum, situated proximal of the equator. Proximal side of a single spore subpyramidal. The spores are strongly folded. Biggest dimension of holotype 66 μ.

Remarks and comparisons: As for the visibility of the proximal cingulum, compare *Paralundbladispora quadriiuga* (remarks, p. 338). The latter species differs from *P. vieta* by its thinner scabrate-granulate exine.

Locus typicus: Boring 31, K.N.Z., Hengelo; depth 405.50 m (Röt salinar).

Occurrence: Röt salinar of Hengelo; very rare. In the upper part of the overlying Röt pelites (transition to Muschekallk) the species is more frequent.

INFRATURMA *Zonati* Potonié & Kremp 1954

Kraeuselisporites Leschik 1956a emend. Jansonius 1962

Type species: *Kraeuselisporites dentatus* Leschik 1956a, t. 4, f. 21.

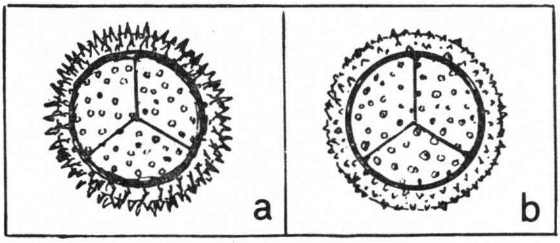


Fig. 12. *Kraeuselisporites*. a. *K. hystrix*; b. *K. hoofddijkensis*

Remarks and comparisons: We want to restrict *Kraeuselisporites* to forms with a distal echinate spore-exine and an echinate zona. *Styxisporites* Cookson and Dettmann 1958 differs by possessing a laevigate zona.

Kraeuselisporites hystrix n. sp.

Fig. 12a; Plate VI, Fig. 1.

Holotype: *Kraeuselisporites hystrix* n. sp. Single grain slide 31-HV-301; Plate VI, Fig. 1.

Diagnosis: Spores trilete, zonal; equator of spore body and outline of zona approx. circular to subtriangular. Diameter (zona included) 70–80 μ (holotype 75 μ). Exine of spore body 1.5–3 μ thick, proximally smooth, distally ornamentated by long echinae (basis 2–3 μ, length 6–7 μ). Zona 3–5 μ wide, also covered by long echinae. Trilete rays extend to the equator of the spore body; they are accompanied by narrow, slightly thickened labra.

Remarks and comparisons: The long echinae may break easily during fossilisation. *K. hystrix* differs from *Kraeuselisporites hoofddijkensis* n. sp. by its longer echinae.

Locus typicus: Boring 31, K.N.Z., Hengelo; depth 405.50 m (Röt salinar).

Occurrence: Röt salinar of Hengelo; rare.

Kraeuselisporites hoofddijkensis n. sp.
Fig. 12b; Plate VI, Figs. 3, 4.

Holotype: *Kraeuselisporites hoofddijkensis* n. sp. Single grain slide 31-HV-302; Plate VI, Fig. 4.

Derivatio nominis: Fort Hoofddijk, Utrecht, the Netherlands; former fort, at present Palaeobotanical and Pollenmorphologicol laboratories.

Diagnosis: Spores trilete, zonal; equator of spore body and outline of zona approx. circular to subtriangular. Diameter (zona included) 55–70 μ (holotype 59 μ). Exine of spore body 2–4 μ thick, proximally smooth with fine infrastructure, distally ornamentated by echinae. The echinae show a diverging variability in shape; elements with a wide basis (max. 4 μ) show a polygonal outline, smaller elements (from 1 μ) are more or less circular; length of echinae 2–3.5 μ. Zona 2–2.5 μ wide, also covered by echinae. Trilete rays extend to the equator of the spore body; they are accompanied by narrow slightly thickened labra which are fan-shaped at the ends.

Remarks and comparisons: The species shows an important variation in size and shape of the echinae; however, there is always progressive transition, so a specific separation does not seem desirable. *K. hoofddijkensis* differs from *Kraeuselisporites hystrix* n. sp. by its shorter echinae. Frequently there are tendencies to a release of the zona.

Locus typicus: Boring 31, K.N.Z., Hengelo; depth 405.50 m (Röt salinar).
Occurrence: Most frequent zonal spore in the Hengelo Röt salinar; never high percentages. Also recognized in the overlying Röt pelites.

TURMA *Monoletes* Ibrahim 1933

Saturnisporites Klaus 1960

Type species: *Saturnisporites fimbriatus* Klaus 1960, t. 32, f. 32, 33.

Remarks and comparisons: Klaus (1960) dealt with the relation *Aratrisporites* Leschik 1956a – *Saturnisporites* Klaus 1960; he separates the genera strictly. Recently this subject was discussed again by BHARADWAJ and SINGH (1964); they do not find any important differences. Because of differences existing in equatorial flattened specimens, however, we want to follow Klaus. In equatorial view *Aratrisporites* shows a slightly concave proximal outline (KLAUS 1960, t. 44, f. 41); *Saturnisporites* differs by a straight to slightly convex outline (Plate XIII, fig. 4). These differences suggest a different shape of the spores and justify a separation. We are not convinced of the zonal character of the genus.

Up till now both *Saturnisporites* and *Aratrisporites* have only been found in Upper Triassic assemblages; our findings indicate a still earlier appearance of these interesting monolete spores.

Saturnisporites praevius n. sp.
Fig. 13; Plate XIII, Figs. 3, 4.

Holotype: *Saturnisporites praevius* n. sp. Single grain slide 31-HV-126; Plate XIII, Fig. 3.

Diagnosis: Spores monolete, zonal (?), with elliptical equator. Proximal exine with fine infrastructure; the distal exine seems strongly

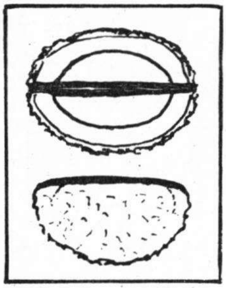


Fig. 13. *Saturnisporites praevius*

fibrous, it can easily be deformed, causing an irregular outline with projecting "fibres". Very narrow monolete suture accompanied by pronounced dark labra which extend into the "zona". "Zona" 6–9 μ wide. In equatorial view the proximal outline appears straight to slightly convex. Known size range 54–62 μ (holotype 59 μ).

Remarks and comparisons: Specimens of *S. praevius* are always badly preserved; we are not convinced of the zonal character. *Saturnisporites fimbriatus* Klaus 1960, *Saturnisporites palettae* Klaus 1960 and *Saturnisporites fischeri* Klaus 1960 differ by possessing regularly shaped hairs which cannot be confused with the fibre-like projections of *S. praevius*.

Locus typicus: Boring 31, K.N.Z., Hengelo; depth 392 m (Röt salinar).

Occurrence: Röt salinar of Hengelo; rare. Also recognized in the upper part of the Röt pelites (transition to Muschelkalk); more frequent.

ANTETURMA *Pollenites* Potonié 1931
TURMA *Saccites* Erdtman 1947
SUBTURMA *Monosaccites* (Chitaley 1951) Potonié & Kremp 1954
INFRATURMA *Triletesacciti* Leschik 1956a

Nuskoisporites Potonié & Klaus 1954 emend. Klaus 1963a

Type species: *Nuskoisporites dulhuntyi* Potonié and Klaus 1954, t. 10, f. 5.

Nuskoisporites inopinatus n. sp.

Fig. 14; Plate VII, Figs. 1A, B.

Holotype: *Nuskoisporites inopinatus* n. sp. Single grain slide 31-HV-179; Plate VII, Figs. 1A, B.

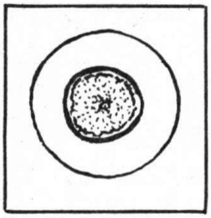


Fig. 14. *Nuskoisporites inopinatus*

Diagnosis: Pollen radial, monosaccate, trilete. Equator of central body approx. circular to subtriangular. Proximal exoexine infragranulate; small short-rayed trilete Y-mark in proximal intexine, only visible with high magnification. Saccus imperfectly and finely infrareticulate. Because of the thin exine a distinct saccus-margin ("limbus") is absent. Narrow distal saccus-overlap with irregularly shaped contact edge. Diameter of holotype 85 μ.

Remarks and comparisons: The Y-mark does not appear in the proximal exoexine. Usually the recognized specimens of *N. inopinatus* are badly preserved. However, the holotype shows sufficient details to compare it with the Permian representatives of *Nuskoisporites*. In some aspects *N. inopinatus* reminds one of the American *Nuskoisporites crenulatus* Wilson 1962 which, however, possesses a deeply crenulate contact edge. *Nuskoisporites triangularis* (Metha 1944) Potonié & Lele 1961 (≡ *Nuskoisporites gondwanensis* Balme & Hennelly 1956) and *Nuskoisporites rotatus* Balme & Hennelly 1956 from the Gondwana region do not show distinct saccus-margins, but differ by the presence of a clearly visible Y-mark. The European species *Nuskoisporites dulhuntyi* Potonié & Klaus 1954 and *Nuskoisporites klausii* Grebe 1947 are characterized both by a distinct margin and a distinct Y-mark.

Locus typicus: Boring 31, K.N.Z., Hengelo; depth 405.50 m (Röt salinar).

Occurrence: Only recognized in the shales between 405.50 and 406.80 m; rare.

SUBTURMA *Disaccites* Cookson 1947

INFRATURMA *Disacciatriletes* (Leschik 1956a) Potonié 1958

Voltziaceaesporites Klaus 1964

Type species: *Voltziaceaesporites heteromorpha* Klaus 1964, t. 2, f. 19.

Voltziaceaesporites heteromorpha Klaus 1964

Fig. 15; Plate VIII, Figs. 3, 4, 5.

Holotype: *Voltziaceaesporites heteromorpha* Klaus 1964, t. 2, f. 19.

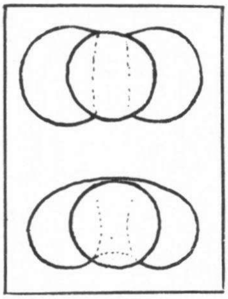


Fig. 15. *Voltziaceaesporites heteromorpha*

Remarks: Our forms correspond to the specific description by KLAUS (1964). Within the variation of *V. heteromorpha* monosaccate, trisaccate and platysaccoid forms are rather common. There are also divergences in the thickness of the proximal exine of the central body. Observed size range 70–135 μ.

Occurrence: V. heteromorpha is the most common species in the Hengelo Röt salinar; less frequent in the Röt pelites. Also known from French, German and Alpine Upper Bunter or equivalents (KLAUS 1964). In Muschelkalk and Keuper assemblages the species may still be present in decreased percentages.

Alisporites Daugherty 1941

Type species: *Alisporites opii* Daugherty 1941, t. 34, f. 2.

Alisporites microreticulatus Reinhardt 1964a

Fig. 16a; Plate XIII, Figs. 1, 2A, B.

Holotype: *Alisporites microreticulatus* Reinhardt 1964a, t. 2, f. 5, 6.

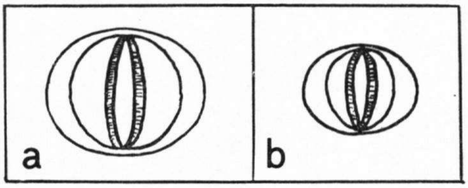


Fig. 16. *Alisporites*. a. *A. microreticulatus*; b. *A. grauvogeli*

Remarks and comparisons: Our forms correspond to the specific description by REINHARDT (1964a). The very finely infrareticulate sacci are exceedingly striking; they are radially structured. Compared with the other bisaccate species from the assemblage described *A. microreticulatus* is remarkably dark-brown coloured. The fundamentally fusiform germinal area may show diverging shapes, due to fossilisation. In a few cases specimens with a clear reduced trilete mark in the proximal exoexine were recognized (Plate XIII, Figs. 2A, B), there are no other differences with the dominant alete forms. This feature may suggest a trilete tendency within the variation of *A. microreticulatus*. Observed size range 68–128 μ.

The species differs from *Alisporites grauvogeli* Klaus 1964 by its characteristic infrareticulum and by a bigger average size.

Occurrence: Regularly recognized in the Hengelo Röt salinar; never in high percentages. REINHARDT (1964a) reports the species from the Lower Röt of Thüringen (Germany).

Alisporites grauvogeli Klaus 1964

Fig. 16b; Plate XIV, Figs. 5, 6.

Holotype: *Alisporites grauvogeli* Klaus 1964, t. 4, f. 38.

Remarks and comparisons: Our forms correspond to the specific description by KLAUS (1964); we observed a wider size range (40–80 μ, Klaus: 60–80 μ). The fundamentally fusiform germinal area may show diverging shapes due to fossilisation. Compared with *Alisporites microreticulatus* Reinhardt 1964a, *A. grauvogeli* possesses a considerably coarser infrareticulum.

Occurrence: Regularly recognized both in the Röt salinar and in the Röt pelites of Hengelo. KLAUS (1964) mentions *A. grauvogeli* from German, French and Alpine Upper Bunter or equivalents.

Colpectopollis Pflug 1953 emend.

Type species: *Colpectopollis occupatus* Pflug 1953, t. 17, f. 7, 8, 9.

Diagnosis: Pollen bisaccate, alete. Elliptical outline both in polar view and in equatorial view; this is due to the original ellipsoid shape of the pollen grains. Central body with thickened proximal exoexine.

Sacci haploxylonoid, equatorially interconnected. Very indistinct distal germinal area which is fundamentally fusiform. Both the thickened proximal exine of the central body and the unthickened distal exine can be longitudinally folded. This happens very frequently in a very characteristic way (see remarks).

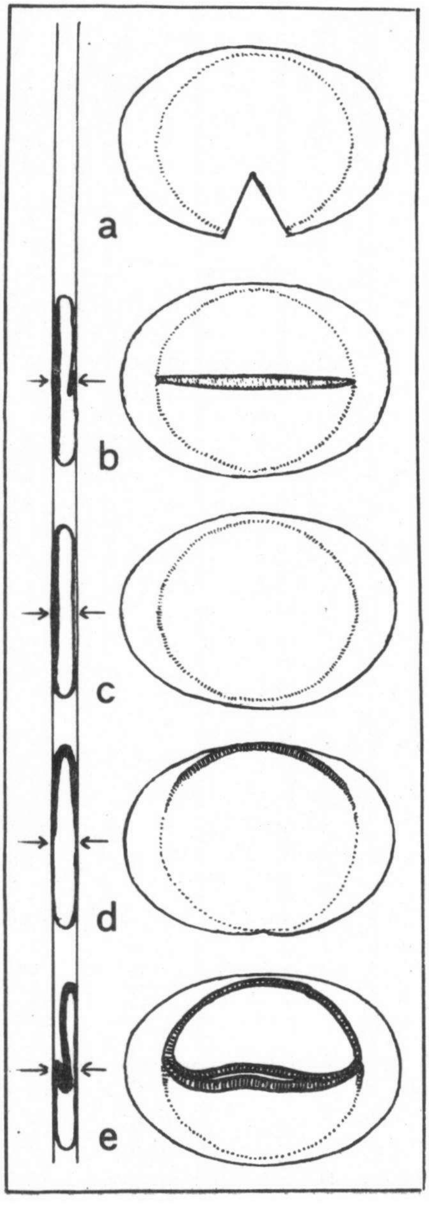


Fig. 17.
Colpectopollis ellipsoideus.
a. torn specimen
b. distal folding
c. polar view
d. equatorial view
e. proximal folding

Remarks and comparisons: PFLUG (1953) described his genus *Colpectopollis* as follows: "Mit Resten von Luftsäcken. Germinalapparat besteht nur aus der Kammgerminal. Porus rückgebildet". Within the assemblage described we found specimens which are well comparable with Pflug's illustrations of *Colpectopollis* and of his "Siegelsum M-Typus". However the author considers the "Kammgerminal" nothing but a longitudinal fold in the thickened proximal exine. Differences in the projection of the infrabaculate proximal exine cause a seeming ridge, split by a seeming crack (Fig. 17e). Also the unthickened distal exine is sensitive to folding (Fig. 17b). Specimens in polar view without any folding are very rare (Fig. 17c). Specimens in equatorial view show clearly the thickened proximal exine and the elliptical outline (Fig. 17d). Because of the original ellipsoid shape the pollen grains do not show any preference for their position during sedimentation; consequently they can be fossilized in diverging positions.

On account of our reconstructions (Fig. 17) we have to disagree with Pflug's concept of a germinal function of the longitudinal ridges; we also deny the existence of a "rückgebildete Porus".

Although the presence of the characteristic folds is due to fossilisation the genus *Colpectopollis* can be maintained; the folds, combined with the ellipsoid shape are useful generic characteristics.

It seems likely that *Unatextisporites* Leschik 1956a also possesses a seeming crack (compare LESCHIK 1956a, t. 8, f. 7 with PFLUG 1953, t. 17, f. 15, 16 and our Plate IX, Fig. 3).

Also torn specimens (Fig. 17a) are frequent; they can be compared with *Schismatosporites* Nilsson 1958. The polar view, without folds, reminds one of *Sulcatisporites* Leschik 1956a emend. Bharadwaj 1962 which, however, possesses distally inclined sacci. The general shape of *Ovalipollis* Krutzsch 1955 emend. Klaus 1960 may be related, but according to Klaus (1960) this genus possesses a true exinal crack. *Chordasporites* Klaus 1960 differs by its saccus interconnecting exoexinal strand and the absence of an ellipsoid shape.

Colpectopollis ellipsoideus n. sp.

Fig. 17; Plate IX, Figs. 1, 2, 3, 4, 5.

Holotype: *Colpectopollis ellipsoideus* n. sp. Single grain slide 31-HV-218; Plate IX, Fig. 3.

Diagnosis: Pollen bisaccate, alete. Elliptical outline both in polar view and in equatorial view; this is due to the original ellipsoid shape of the pollen grain. Equator of the central body approx. circular to longitudinally elliptical. Central body with proximally thickened exine (3–3.5 μ). Sacci haploxylonid, equatorially interconnected. Very indistinct distal germinal area which is fundamentally fusiform. Both the thickened proximal exine of the central body and the unthickened distal exine can be longitudinally folded. This happens very frequently and in a very characteristic way (compare emended generic description, remarks.) Known size range 70–100 μ (holotype 77 μ).

Remarks and comparisons: Reconstructing the original shape of the pollen grain it has been demonstrated that the equatorial exine is not thickened (Fig. 17d); so in polar view the outline of the central body shows very indistinctly. This in contrast with *Colpectopollis occupatus* Pflug 1953.

Locus typicus: Boring 31, K.N.Z., Hengelo; depth 405.50 m (Röt salinar).

Occurrence: Röt salinar of Hengelo; regularly recognized but never in high percentages. Also present in the upper part of the overlying Röt pelites; more frequent.

Chordasporites Klaus 1960

Type species: *Chordasporites singulichorda* Klaus 1960, t. 33, f. 45.

Remarks: Bisaccate pollen grains showing the striking exinal strand interconnecting the sacci may be considered monstrousities. In all probability the phenomenon of a chorda appears within several form-genera. Because of the important stratigraphical value of *Chordasporites* (KLAUS 1960, 1964), however, accidental deformations are out of the question. The occurrence of the genus is mainly restricted to Triassic assemblages (KLAUS 1960, 1964; DE JERSEY 1962) but also in Upper Permian rare representatives of *Chordasporites* are to be expected (KLAUS 1963b).

Chordasporites voltziaformis n. sp.

Fig. 18; Plate VII, Figs. 4A, B.

Holotype: *Chordasporites voltziaformis* n. sp. Single grain slide 31-HV-19; Plate VII, Figs. 4A, B.

Derivatio nominis: The new species may be derived from *Voltziaceaesporires heteromorpha* Klaus 1964.

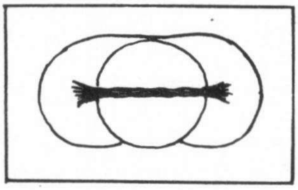


Fig. 18. *Chordasporites voltziaformis*

Diagnosis: Pollen bisaccate, alete; shaped essentially like *Voltziaceaesporites heteromorpha* Klaus 1964 but provided with a longitudinal saccus-interconnecting chorda. Chorda approx. 4 μ wide, fan-wise shading off into the saccus infrareticulum, which is radially structured. Known size range 70–80 μ (holotype 79 μ).

Remarks and comparisons: Specimens of *C. voltziaformis* are usually badly preserved. Apart from the chorda there are great similarities to *Voltziaceaesporites heteromorpha*, from which our species may be derived. *Chordasporites magnus* Klaus 1964 seems highly related, but differs by its bigger size. *Chordasporites singulichorda* Klaus 1960 and *Chordasporites australiensis* De Jersey 1962 do not show any relation to *V. heteromorpha.*

Locus typicus: Boring 31, K.N.Z., Hengelo; depth 404 m (Röt salinar).

Occurrence: Röt Group of Hengelo; rare.

Falcisporites Leschik 1956b emend. Klaus 1963a

Type species: *Falcisporites* (al. *Pityosporites*) *zapfei* (Potonié & Klaus 1954) Leschik 1956b; POTONIÉ and KLAUS 1954, t. 10, f. 9.

Falcisporites snopkovae n. sp.

Fig. 19; Plate VII, Figs. 3A, B.

Holotype: *Falcisporites snopkovae* n. sp. Single grain slide 31-HV-194; Plate VII, Figs. 3A, B.

Derivatio nominis: Mrs P. Snopková, Geologický ústav D. Štúra, Bratislava, Czecho-Slovakia.

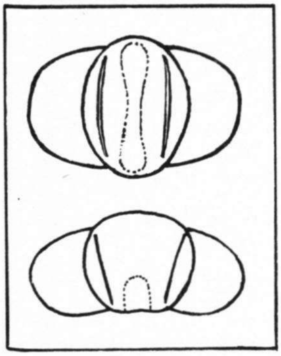


Fig. 19. *Falcisporites snopkovae*

Diagnosis: Pollen bisaccate, alete. Equator of central body usually transversely elliptical but occasionally tendencies to circular and even longitudinally elliptical outlines. Proximal exoexine finely infrareticulate to finely granulate at the proximal pole. Sacci haploxylonoid, hardly or not distally inclined, laterally not interconnected; meshes of the regularly shaped infrareticulum 2–3 μ wide. Distal germinal area more or less distinctly limited, lemniscatoid shape, usually accompanied by narrow transversal folds. Known size range 80–92 μ (holotype 84 μ).

Remarks and comparisons: Compared with most of the other bisaccate species in the assemblage described, the sacci of *F. snopkovae* are rather coarsely infrareticulate. *Falcisporites zapfei* (Potonié & Klaus 1954) Leschik 1956b is very related, but this Upper Permian species differs by a still coarser infrareticulum which is irregularly and imperfectly shaped. Specimens with a transversely elliptical equator do not exist within the variation of *F. zapfei*.

FREUDENTHAL (1964) illustrates three specimens of "*F. zapfei*"; one of them, however, must be considered to be *F. snopkovae* (t. 2, f. 2); the other two specimens belong to *Paravesicaspora planderovae* n. sp. (t. 2, f. 1, 3).

F. snopkovae differs from *Triadispora falcata* Klaus 1964 by the absence of a tetrad mark and by its relatively coarse infrareticulum.

Locus typicus: Boring 31, K.N.Z., Hengelo; depth 405.50 m (Röt salinar).
Occurrence: Röt salinar of Hengelo; rare.

Paravesicaspora Klaus 1963a

Type species: *Paravesicaspora* (al. *Sulcatisporites*) *splendens* (Leschik 1956b) Klaus 1963a; Leschik 1956b, t. 22, f. 10.

Paravesicaspora planderovae n. sp.

Fig. 20; Plate VIII, Figs. 1A, B, 2.

Holotype: *Paravesicaspora planderovae* n. sp. Single grain slide 31-HV-54; Plate VIII, Figs. 1A, B.

Derivatio nominis: Mrs E. Planderová, Geologický ústav D. Štúra, Bratislava, Czecho-Slovakia.

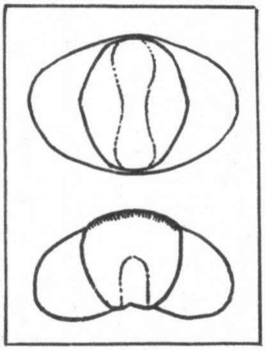


Fig. 20. *Paravesicaspora planderovae*

Diagnosis: Pollen bisaccate, alete. Equator of central body transversely elliptical to subangular (rhombic). Proximal exoexine finely infrareticulate to infragranulate. Sacci haploxylonoid, distally inclined, finely infrareticulate. In polar view a narrow lateral saccus-interconnection is visible. Smooth distal germinal area, more or less distinctly limited, usually clearly lemniscatoid. Known size range 70–94 μ (holotype 90 μ).

Remarks and comparisons: Because of fossilisation sometimes the lateral exoexinal saccus-interconnections are ruptured; in this case specimens with a more or less *Falcisporites*-like habitus can be formed (Freudenthal 1964, t. 2, f. 3: "*Falcisporites zapfei*"). These forms differ from *Falcisporites zapfei* (Potnié & Klaus 1954) Leschik 1956b and *Falcisporites snopkovae* n. sp. by a much finer saccus infrareticulum. *P. planderovae* also differs from *Paravesicaspora splendens* (Leschik 1956b) Klaus 1963a by a finer infrastructure of the bladders.

Locus typicus: Boring 31, K.N.Z., Hengelo; depth 405.50 m (Röt salinar).
Occurrence: Röt salinar of Hengelo; rare.

Microcachryidites (Cookson 1947) ex Couper 1953

Type species: *Microcachryidites antarcticus* Cookson 1947, t. 14, f. 19.

Microcachryidites doubingeri Klaus 1964

Fig. 21; Plate VII, Figs. 2A, B.

Holotype: *Microcachryidites doubingeri* Klaus 1964, t. 3, f. 27.

Remarks: Our specimens correspond to the specific description by Klaus (1964). The thick exine is very striking.

Occurrence: Klaus (1964) reported *M. doubingeri* from French and Italian Muschelkalk assemblages. We recognized the species in very low percentages in the Hengelo

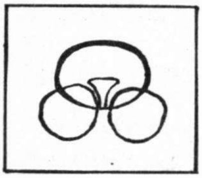


Fig. 21. *Microcachryidites doubingeri*

Röt salinar; the percentages increase, however, in the upper part of the Röt pelites (transition to Muschelkalk).

INFRATURMA *Disaccitriletes* Leschik 1956a.

Triadispora Klaus 1964

Type species: *Triadispora plicata* Klaus 1964, t. 2, f. 15.

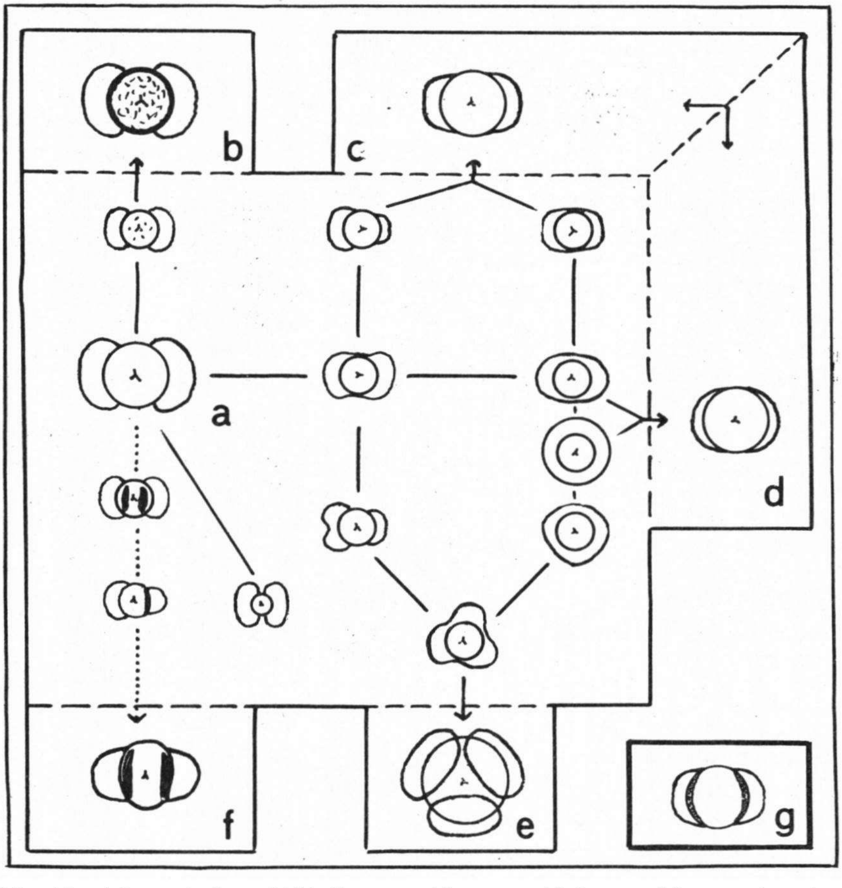


Fig. 22. The variation of *Triadispora*. a. *T. crassa* with its transitions to the other species; b. *T. plicata*; c. *T. staplini*; d. *T. epigona*; e. *T. muelleri*; f. *T. falcata*; g. *Klausipollenites staplini*

Remarks and comparisons: In 1958 KLAUS already reported the existence of bisaccate trilete pollen which should be characteristic for European Lower Triassic assemblages. In 1964 he described the genus *Triadispora*. Apart from abnormal forms ("Forma Y") KLAUS (1964) distinguished five different species: *T. staplini* (we do not consider *T. staplini* identical with *Klausipollenites staplini* Jansonius 1962), *T. crassa, T. falcata, T. epigona* and *T. plicata*. Moreover, a sixth species can be distinguished: *T. muelleri* (≡ *Nuskoisporites muelleri* Reinhardt and Schmitz in REINHARDT 1964b).

In the assemblage described, more than 80 % of the *Triadispora*-forms belong to *Triadispora crassa*. The variation of this species turns out to be very diverging and includes amongst others progressive transitions to the other *Triadispora*-species (Fig. 22). This may be an argument for placing these species within the variation of *T. crassa*, in order to avoid a subjective specific subdivision. For stratigraphical reasons, however, a separation remains desirable (compare p. 326). The variation of the genus *Triadispora* reminds one of the analogue divergences in the pollen in situ of *Ullmannia frumentaria*, investigated by GREBE and SCHWEITZER (1962). A wide variation combined with the occurrence of abnormal forms is also demonstrated within the striate pollen studied by BHARADWAJ (1962). Frequently a wide variation of recent coniferal saccate pollen is due to interspecific hybridizing. For example the hybrid *Pinus uncinata* × *Pinus silvestris* produces pollen grains possessing both abnormal shapes and varying dimensions compared with the parents (AYTUG 1962).

In the symposium "Evolution" (Amsterdam 1959) Sirks mentioned the widespread opinion according to which interspecific hybridizing might be an important factor in plant evolution. The creation of botanical interspecific hybrids may lead to an explosion of new phenotypes (SIRKS 1960).

An evolutionary trend within the genus *Triadispora* might explain the differences in relative quantitative distribution of its species in other localities (compare p. 325). However, to prove this preliminary impression we need more data about the horizontal and vertical occurrence of this interesting genus.

FREUDENTHAL's (1964) illustrations of his genus *Eridospollenites* are concerned with *Triadispora. Limitisporites* Leschik 1956b emend. Potonié 1958 differs from *Triadispora* by the presence of a structureless exoexinal area around the Y-mark (for the taxonomical problem with regard to *Limitisporites, Jugasporites, Illinites* and *Eridospollenites* we refer to the description of *Illinites*, p. 353).

Triadispora crassa Klaus 1964

Fig. 22a; Plate X, Figs. 1–6; Plate XI, Figs. 1–12; Plate XII, Fig. 7.

Holotype: *Triadispora crassa* Klaus 1964, t. 1, f. 2.

Remarks and comparisons: In spite of distinguishing five more species of *Triadispora* the variation of *T. crassa* still remains very diverging (Fig. 22a). This is mainly due to the multitude in transitional forms between this species and *T. staplini, T. plicata, T. epigona, T. falcata*

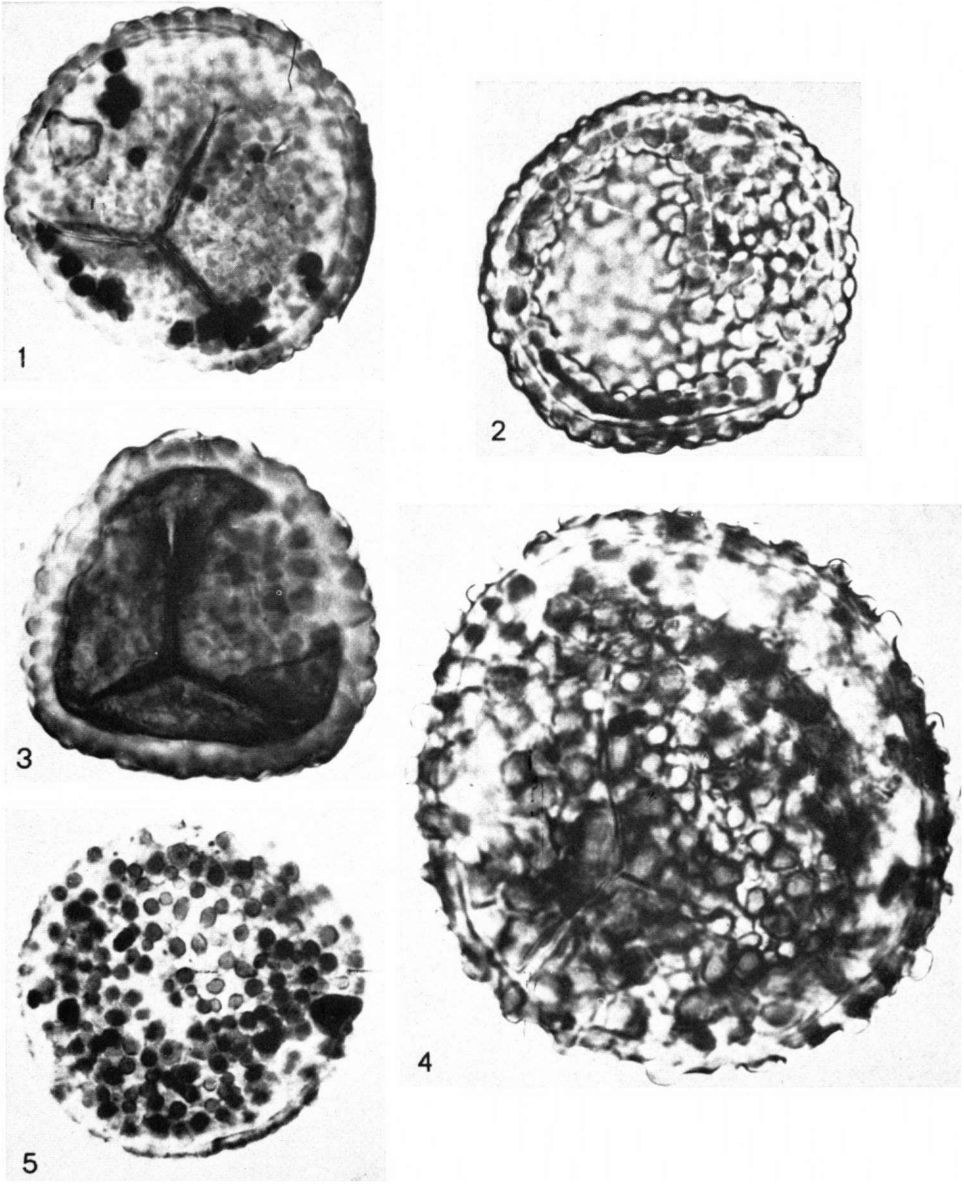


Plate I. 1. *Verrucosisporites jenensis* (675 ×); 2. id. (675 ×); 3. *Verrucosisporites reinhardtii*, holotype (675 ×); 4. *Verrucosisporites pseudomorulae*, holotype (1100 ×); 5. id. (675 ×).

PLATE I

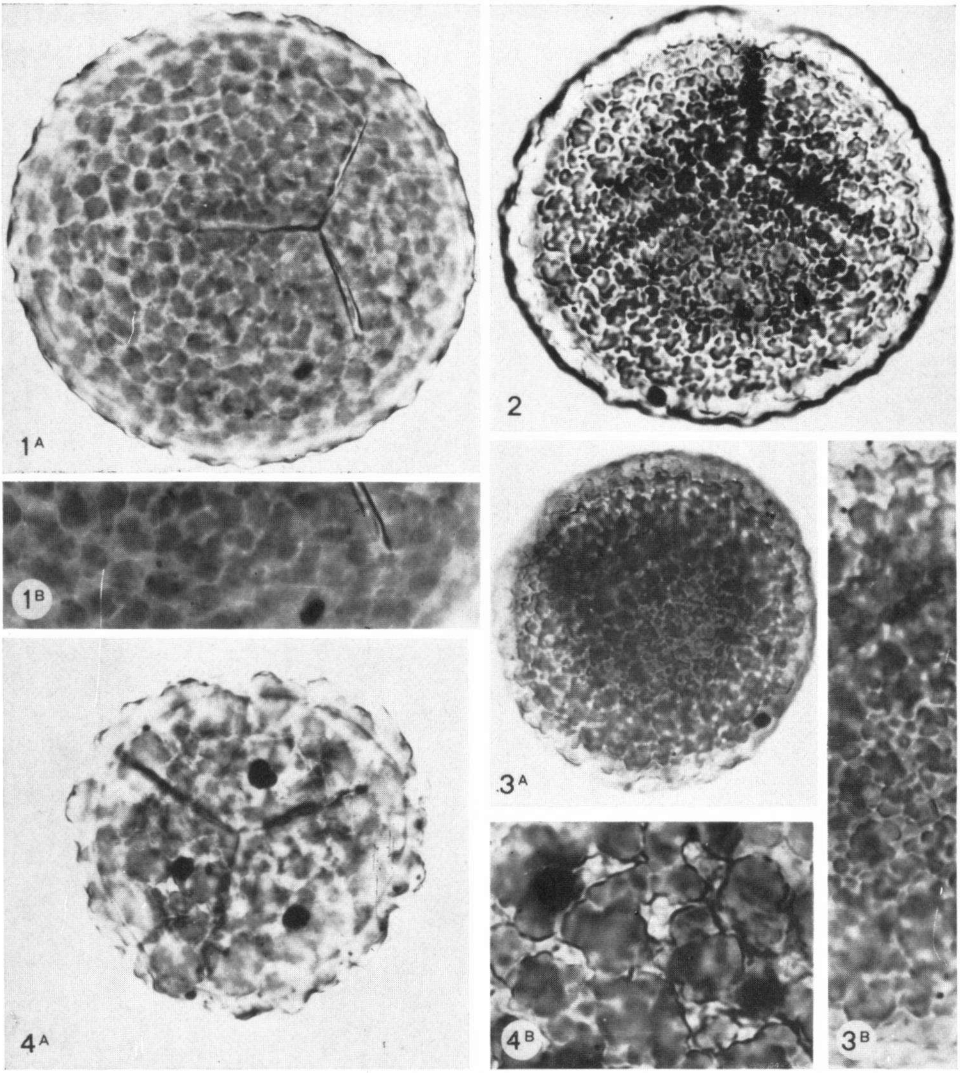


Plate II. 1A. *Guttatisporites guttatus*, holotype (650 ×); 1B. detail, showing structure; 2. *Guttatisporites microechinatus*, holotype (675 ×); 3A. id. (500 ×); 3B. detail, showing structure; 4A. *Guttatisporites elegans*, holotype (675 ×); 4B. detail, showing structure.

PLATE II

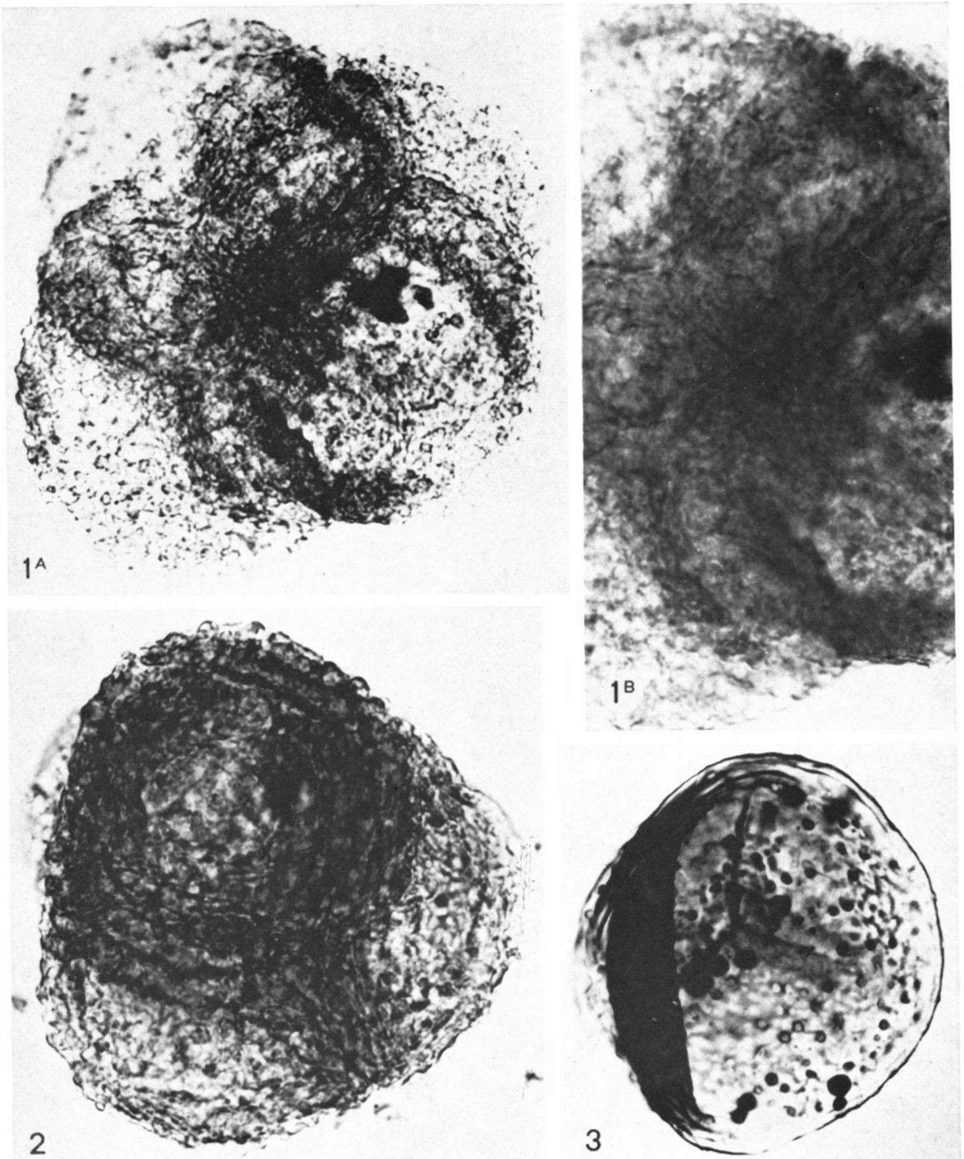


Plate III. 1A. *Lapposisporites lapposus*, holotype (800 ×); 1B. detail, showing structure; 2. id. (800 ×); 3. *Apiculatasporites plicatus*, holotype (850 ×).

PLATE III

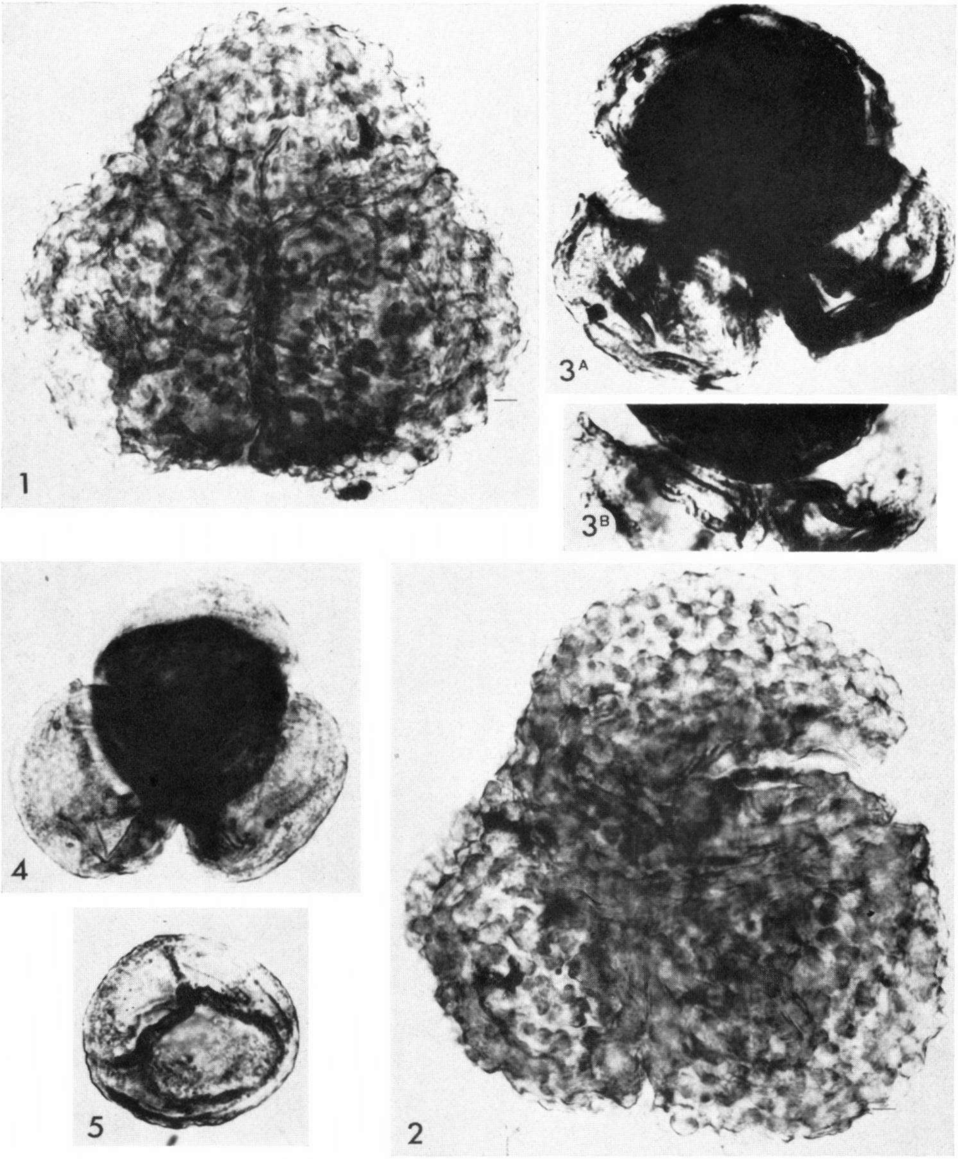


Plate IV. 1. *Lapposisporites armatus*, holotype (750 ×); 2. *Lapposisporites loricatus*, holotype (750 ×); 3A. *Paralundbladispora vieta*, holotype (800 ×); 3B. detail, showing narrow cingulum in equatorial view; 4. *Paralundbladispora quadriiuga*, holotype (800 ×); 5. id., single specimen (800 ×).

PLATE IV

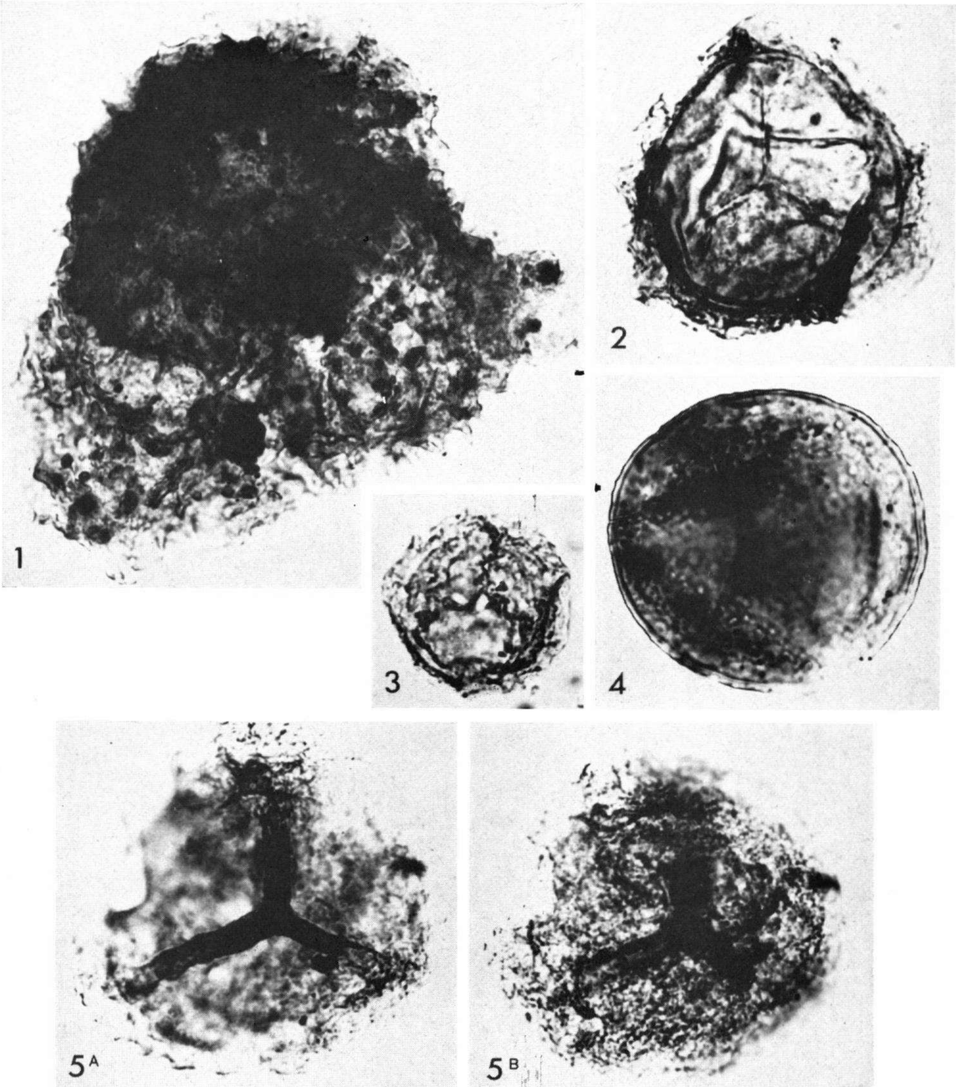


Plate V. 1. *Lapposisporites villosus*, holotype (675 ×); 2. *Densoisporites caretteae*, holotype (800 ×); 3. *Anguisporites tenuis*, holotype (800 ×); 4. *Scabratisporites scabratus*, holotype (875 ×); 5A, 5B. *Pseudogravisporites reticulatus*, holotype (800 ×).

PLATE V

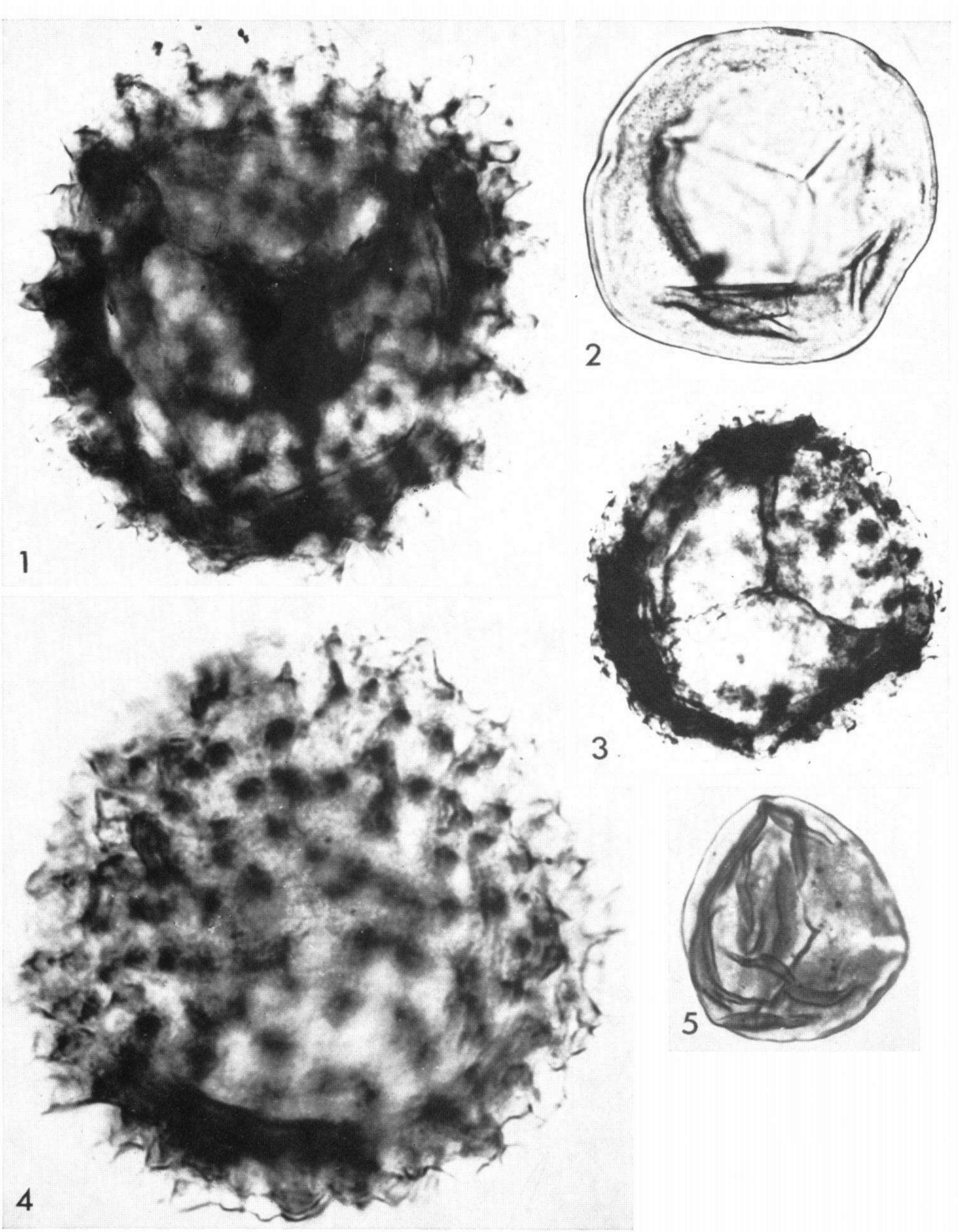


Plate VI. 1. *Kraeuselisporites hystrix*, holotype (1000 ×); 2. *Calamaspora* sp. (800 ×); 3. *Kraeuselisporites hoofddijkensis* (800 ×); 4. id., holotype (1400 ×); 5. *Psilatriletes triassicus*, holotype (750 ×).

PLATE VI

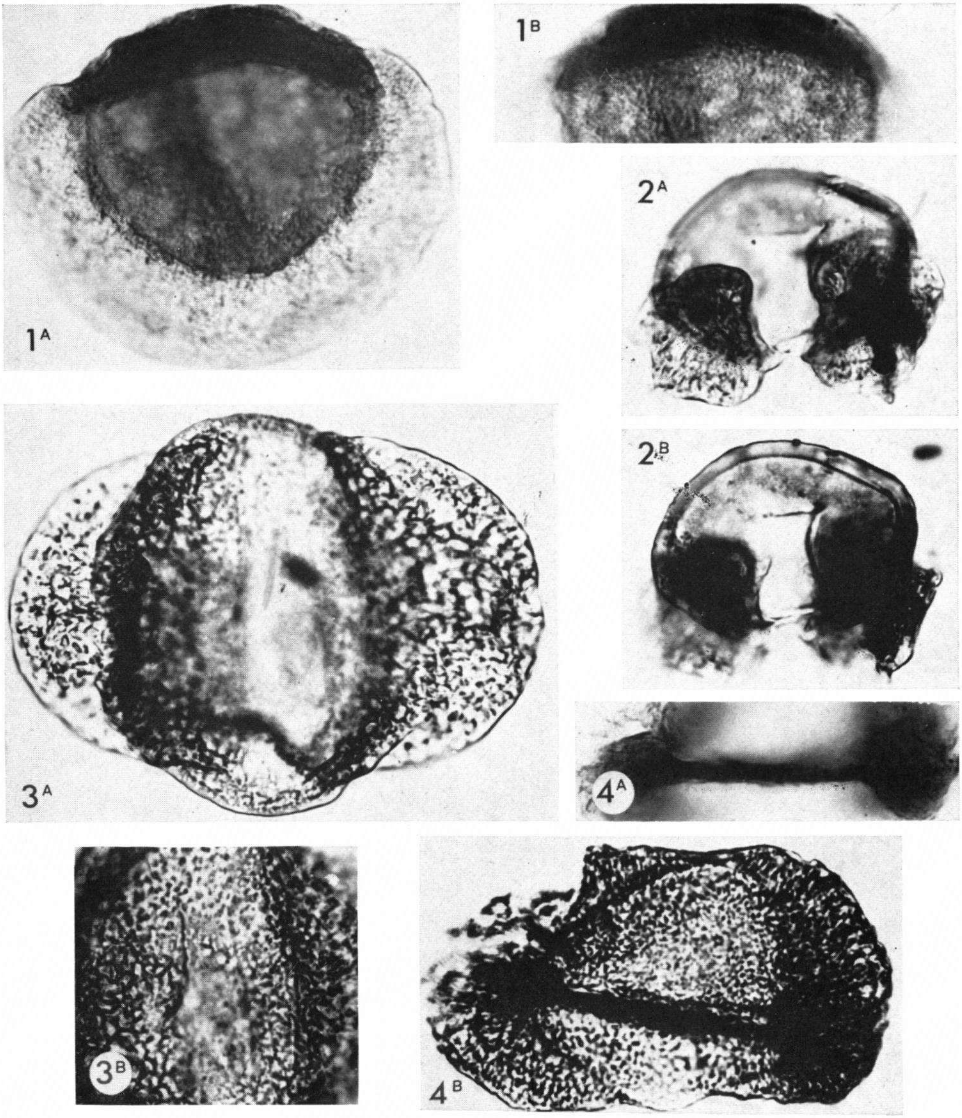


Plate VII. 1A, 1B. *Nuskoisporites inopinatus*, holotype (700 ×); 2A, 2B. *Microcachryidites doubingeri* (1000 ×); 3A, 3B. *Falcisporites snopkovae*, holotype (850 ×); 4A. *Chordasporites voltziaformis*, detail, showing chorda; 4B. id., holotype (800 ×).

PLATE VII

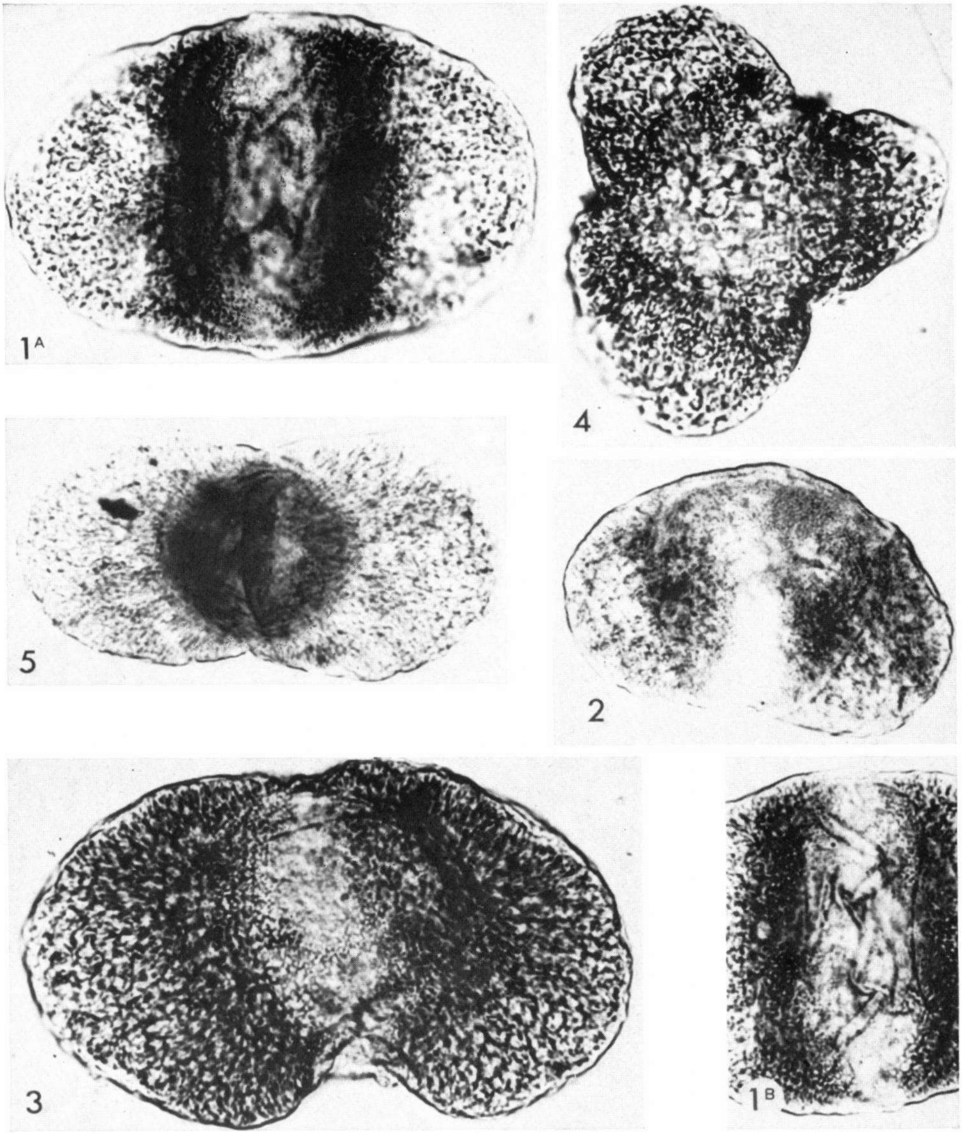


Plate VIII. 1A, 1B. *Paravesicaspora planderovae*, holotype (800 ×); 2. id., equatorial view (750 ×); 3. *Voltziaceaesporites heteromorpha* (800 ×); 4. id., trisaccate specimen (750 ×); 5. id., id., platysaccoid specimen (750 ×).

PLATE VIII

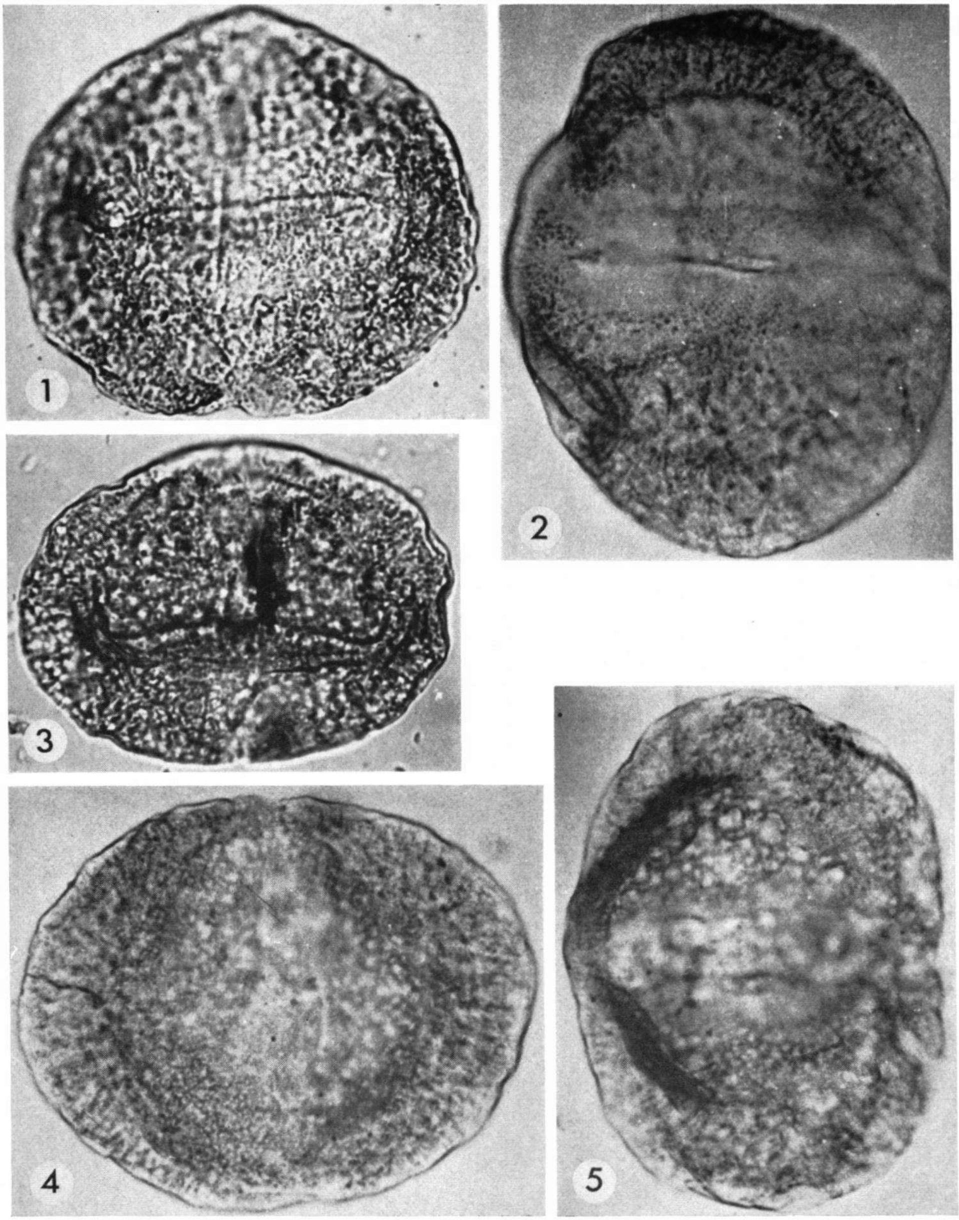
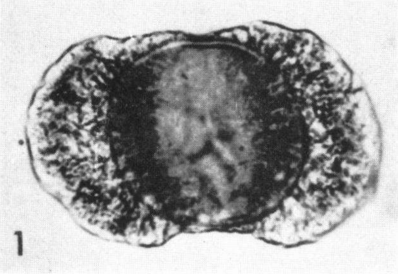


Plate IX. 1. *Colpectopollis ellipsoideus*, with distal folding; 2. id., equatorial view; 3. id., holotype, with proximal folding; 4. id., polar view without folding; 5. id., subequatorial view. (all specimens 750 ×).

PLATE IX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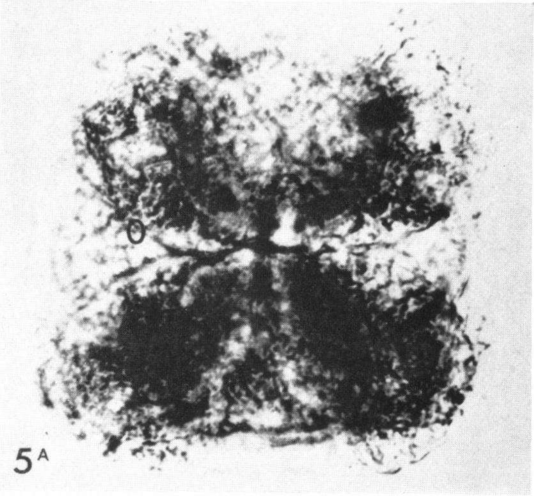
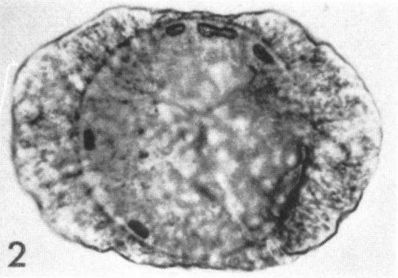
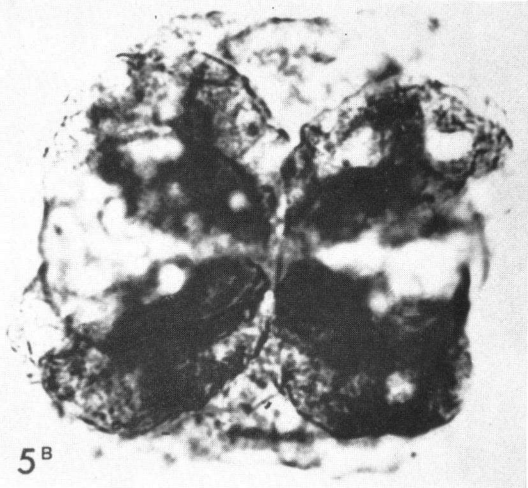
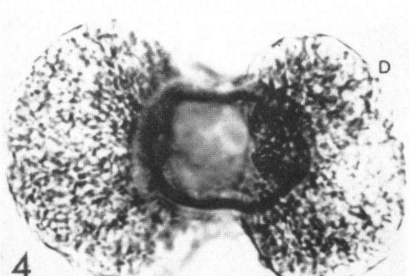


5A


2


5B


3



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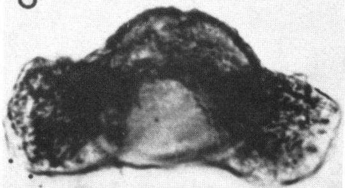

Plate X. 1. *Triadispora crassa*; 2. id.; 3. id.; 4. id., platysaccoid; 5A, 5B. id., tetrad; 6. id., equatorial view. (all specimens 750 ×).

PLATE X

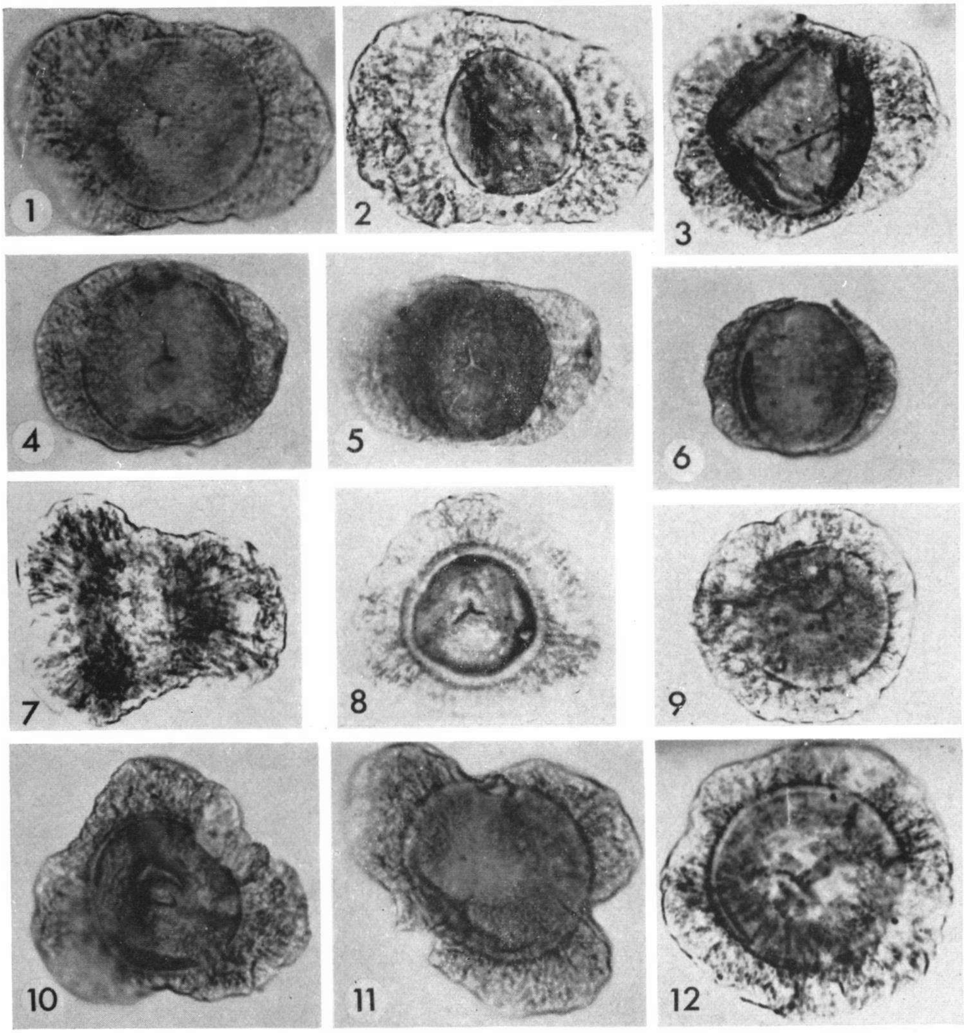

Plate XI. 1–12. *Triadispora crassa*, different shapes. (all specimens 650 ×).

PLATE XI

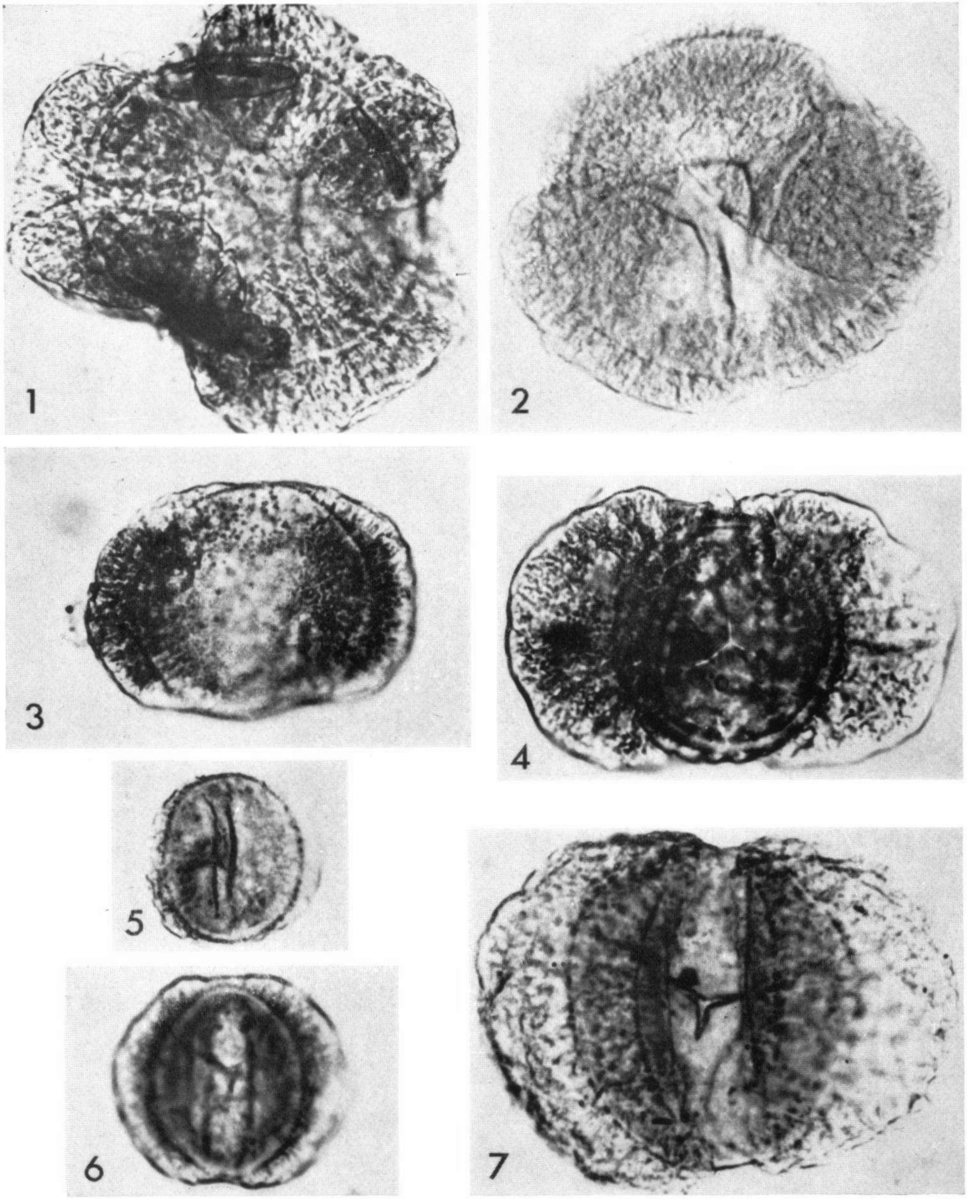

Plate XII. 1. *Triadispora muelleri*; 2. id.; 3. *Triadispora staplini*; 4. *Triadispora plicata*; 5. *Triadispora epigona*; 6. id.; 7. *Triadispora crassa*. (all specimens 750 ×).

PLATE XII

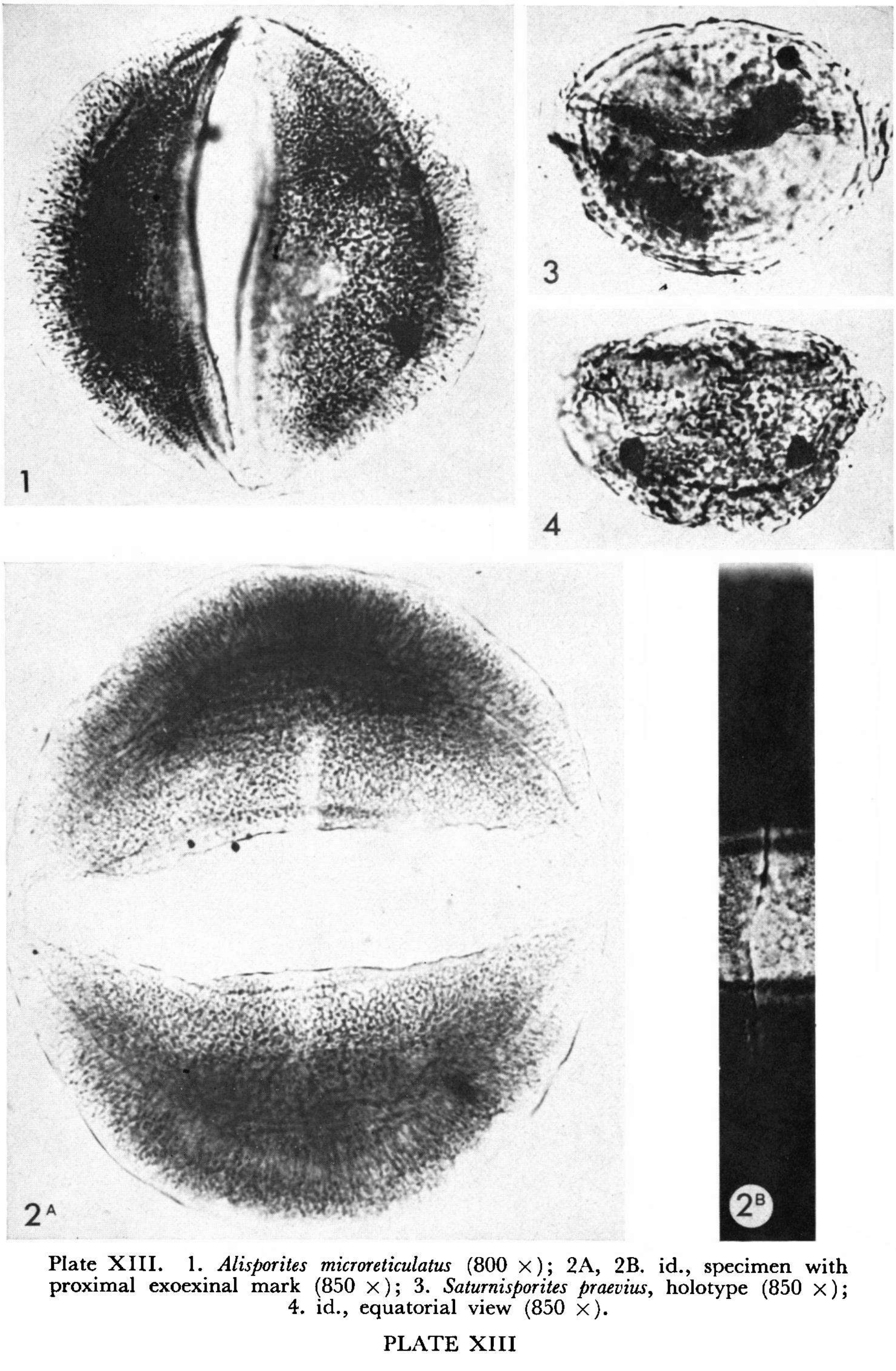

Plate XIII. 1. *Alisporites microreticulatus* (800 ×); 2A, 2B. id., specimen with proximal exoexinal mark (850 ×); 3. *Saturnisporites praevius*, holotype (850 ×); 4. id., equatorial view (850 ×).

PLATE XIII

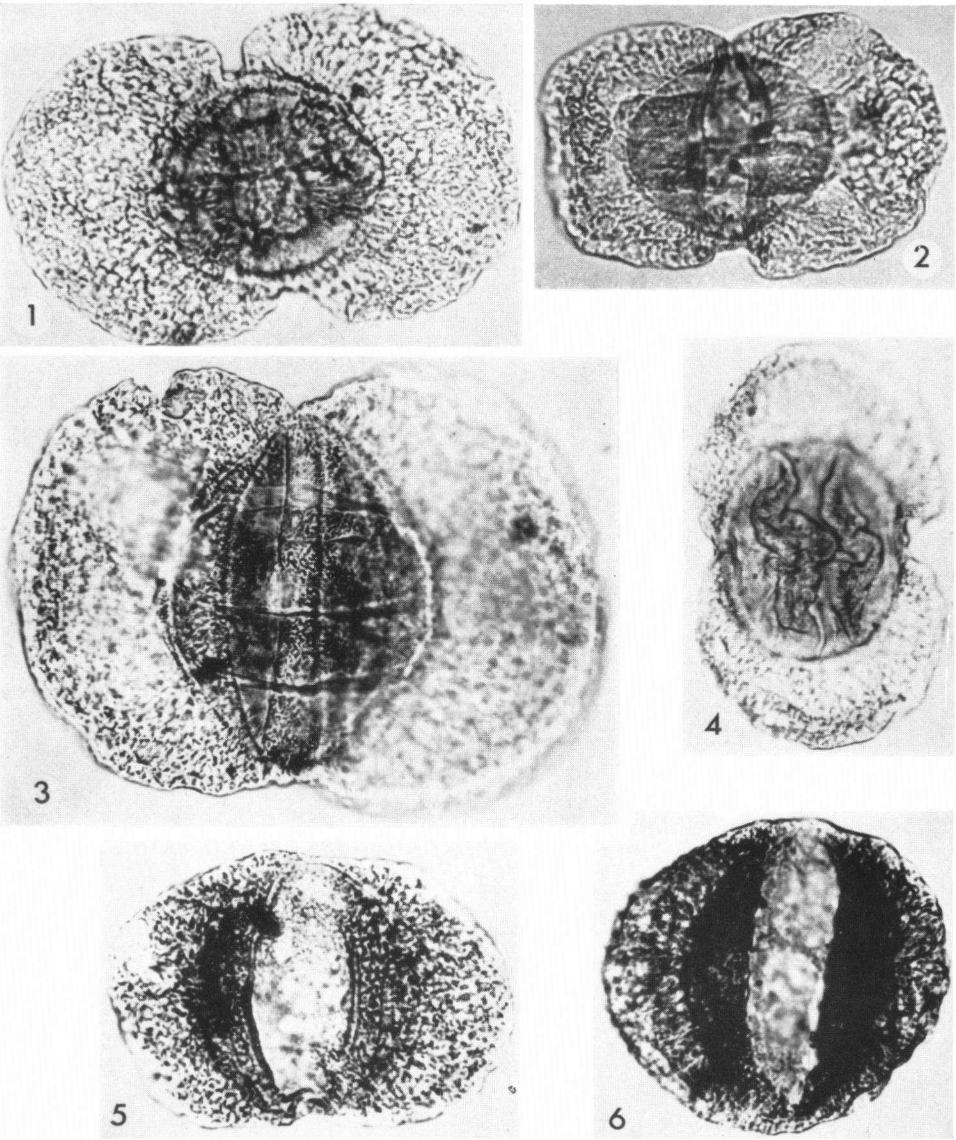

Plate XIV. 1. *Lunatisporites puntii*, platysaccoid specimen (675 ×); 2. id. (675 ×); 3. id., holotype (700 ×); 4. id., specimen with deformed taeniae (675 ×); 5. *Alisporites grauvogeli* (700 ×); 6. id. (700 ×).

PLATE XIV

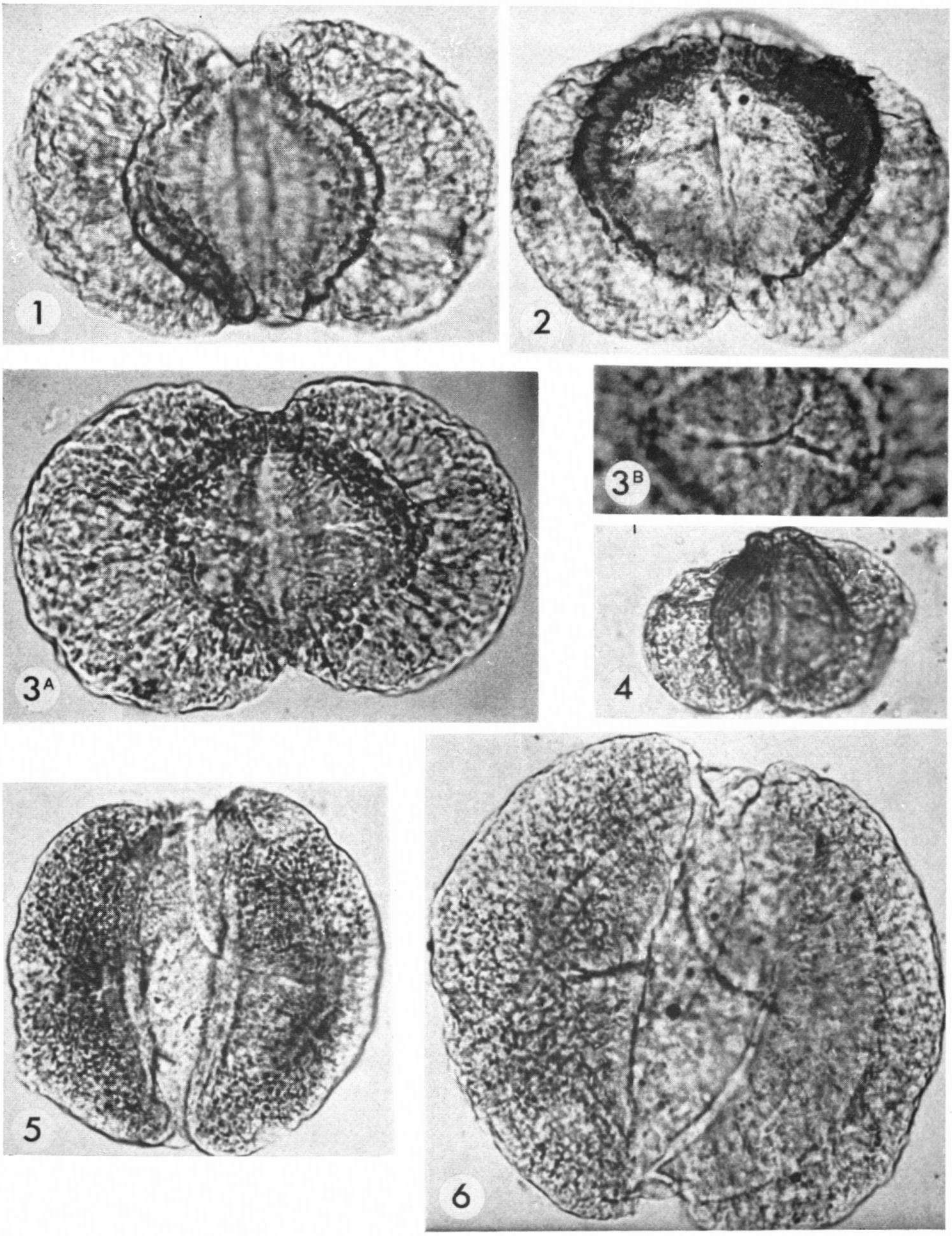

Plate XV. 1. *Angustisulcites klausii* (850 ×); 2. id., equatorial view (850 ×); 3A, 3B. id. (850 ×); 4. id., holotype described by Freudenthal 1964 (500 ×); 5. *Angustisulcites gorpii* (650 ×); 6. id., holotype (900 ×).

PLATE XV

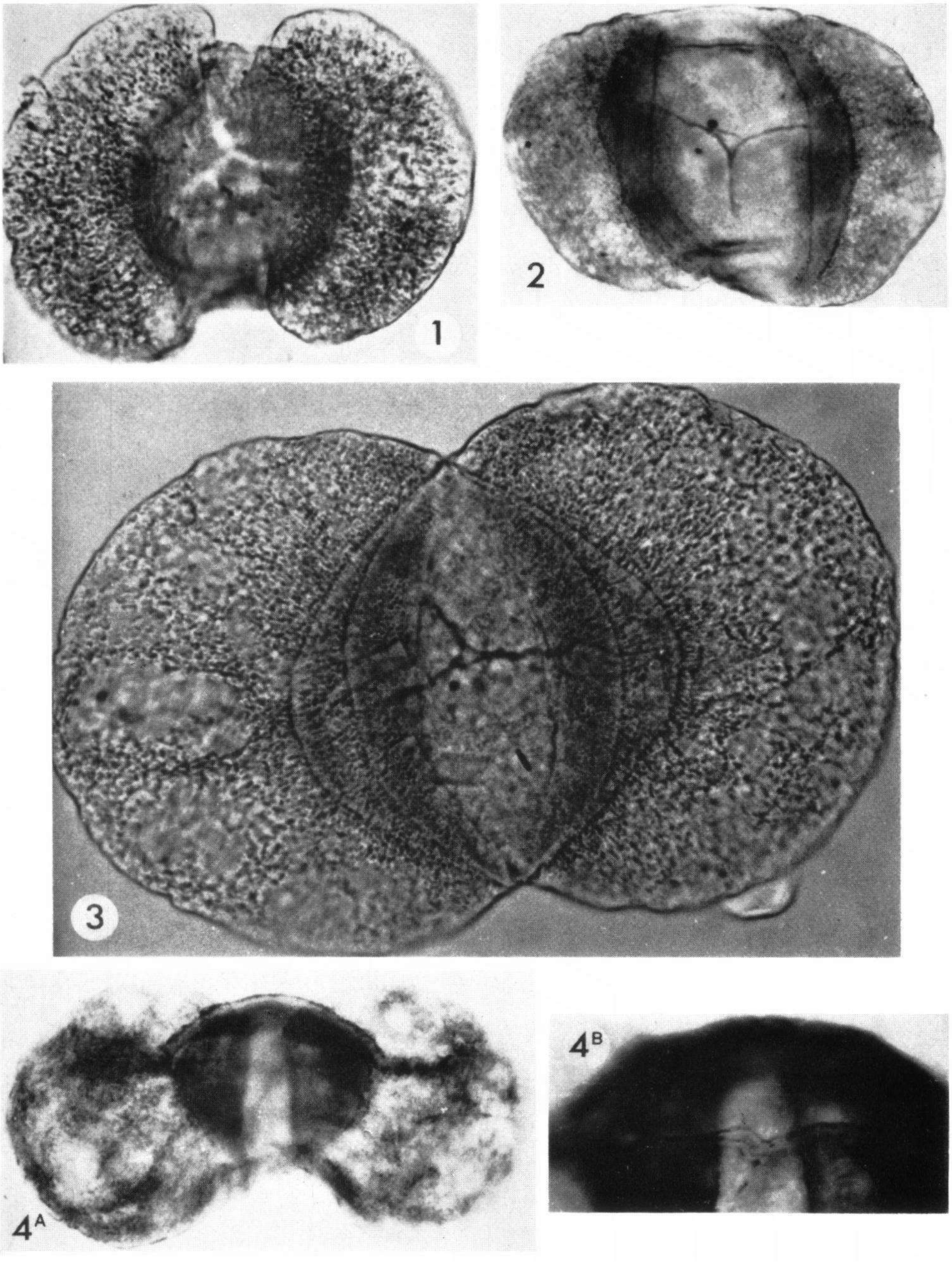

Plate XVI. 1. *Angustisulcites gorpii* (750 ×); 2. *Illinites trivisus*, holotype (750 ×); 3. *Angustisulcites grandis* (750 ×); 4A. id., equatorial view (350 ×); 4B. detail, showing equatorial suture.

PLATE XVI

and *T. muelleri*. As stratigraphical counter-arguments are lacking also monosaccate and platysaccoid forms are placed within *T. crassa*.

The presence of transveral folding has to be considered a secondary feature; both forms with one and with two folds can be found, but also folds in other directions appear frequently. However, the haploxylonoid *T. falcata* and its transitions may be more sensitive to compression folding.

Apart from the shape of the sacci there are also variations in size, Y-mark development (trilete, reduced trilete, rarely monolete), distal bladder base (distinct or indistinct) and proximal exoexinal structure of cental body (tendency to plicate structure which results in *T. plicata*).

KLAUS (1964) mentioned already the occurrence of tetrads; Plate X, Figs. 5A, B shows a well preserved example of *T. crassa* quadruplets.

TABLE 7

The variation within the genus *Triadispora* (mean percentages of some important forms)

shape	species	mean (%)
haploxylonoid	*T. staplini*	4
diploxylonoid	*T. crassa*	66
submonosaccate/monosaccate	*T. crassa*	12
transversal folds	mainly *T. crassa*	2
subtrisaccate/trisaccate	*T. crassa/T. muelleri*	4
reduced sacci	*T. epigona*	7
plicate	mainly *T. plicata*	2
"*Falcisporites*-like"	*T. falcata*	1

Table 7 shows the averages of the most prominent forms of *Triadispora* in the Hengelo assemblage. The remainder mainly consists of badly preserved indeterminable specimens, which mostly show lost sacci or a dissolved intexine. Also KLAUS (1964) reported the frequency of the latter phenomenon.

Occurrence: *T. crassa* is common in the Hengelo Röt salinar. In the upper part of the Röt pelites the species is less frequent. KLAUS (1964) reported *T. crassa* from the Vosges and from Thüringen.

Triadispora staplini Klaus 1964

Fig. 22c; Plate XII, Fig. 3.

Holotype: *Triadispora staplini* Klaus 1964, t. 1, f. 5 (non *Klausipollenites staplini* Jansonius 1962, t. 12, f. 21).

Remarks and comparisons: KLAUS (1964) stated that the haploxylonoid forms of *Triadispora* should be identical with *Klausipollenites staplini* Jansonius 1962. Some of Jansonius' Canadian preparations, rich in *K. staplini*, are stored in Utrecht and the author restudied this species. He disagrees with Klaus' conception about its fundamental trilete character. In some rare cases faint lines may suggest an Y-mark, but probably these are secondary phenomena. Furthermore the species possesses the characteristic thickened bladder base, already reported by JANSONIUS (1962). Because of the alete character the Canadian species cannot be placed within the genus *Triadispora*. So with regard to the European haploxylonoid *Triadispora*-forms the epithet *staplini* and Klaus' specific diagnosis remain useful. A new holotype has been chosen from Klaus' illustrations (KLAUS 1964, t. 1, f. 5).

The position of *Falcisporites staplini* (Jansonius 1962) Freudenthal 1964 is not clear. Freudenthal does not illustrate this species and single grain slides are unavailable.

Only truly haploxylonoid forms without equatorial bladder interconnections are considered as *T. staplini*; for practical reasons transitions to *T. crassa* are considered as the latter species. Specimens with very small haploxylonoid sacci belong to *T. epigona*; in this case the transitions are considered as *T. staplini*. Transitions to *T. plicata* have not been recognized.

Occurrence: Very low percentages in the Hengelo Röt salinar; very frequent in the German, French, Italian and Austrian Upper Bunter assemblages investigated by KLAUS (1964).

Triadispora falcata Klaus 1964

Fig. 22f.

Holotype: *Triadispora falcata* Klaus 1964, t. 1, f. 6.

Remarks and comparisons: Triadispora-forms conforming to the description of *T. falcata* have been demonstrated very seldom in the Hengelo assemblage. Well preserved specimens for using in single grain slides have not been found.

The presence of transversal folds is considered a secondary phenomenon (p. 351). However, the haploxylonoid *Falcisporites*-like sacci are sufficiently characteristic to maintain *T. falcata*. Transitions to *T. crassa* occur less seldom; they are considered as the latter species (FREUDENTHAL 1964, t. 1, f. 1: "*Eridospollenites bentzi*").

Occurrence: Very rare in the Hengelo Röt salinar. KLAUS (1964) also recognized the species in Upper Bunter assemblages.

Triadispora muelleri (Reinhardt and Schmitz in REINHARDT 1964b) nov. comb.

Fig. 22e; Plate XII, Figs. 1, 2.

Holotype: *Triadispora* (al. *Nuskoisporites*) *muelleri* (Reinhardt and Schmitz in REINHARDT 1964b) nov. comb.; REINHARDT 1964b, t. 1, f. 5.

Remarks and comparisons: Unlike REINHARDT (1964b) we consider *T. muelleri* a fundamentally trisaccate species. Via transitions it can be derived from *T. crassa* (Fig. 22). *T. muelleri* differs from these transitional forms by its relatively bigger central body, by the less projecting oval sacci (in polar view), by the rather distinct bladder bases and by the very characteristic distal bladder interconnections. Although trisaccate the species has been placed within a bisaccate genus. By creating a new trisaccate genus the relation with *T. crassa* would not be clear. *Nuskoisporites* is limited to monosaccate species; consequently the characteristic shape of the germinal of *T. muelleri* is absent.

Occurrence: Hengelo Röt salinar and upper Röt pelites; rare. REINHARDT (1964b) mentioned the species from the Lower Röt of Thüringen.

Triadispora plicata Klaus 1964

Fig. 22b; Plate XII, Fig. 4.

Holotype: *Triadispora plicata* Klaus 1964, t. 2, f. 15.

Remarks and comparisons: Although connected with *T. crassa* by transitions, we consider forms with a clearly plicate central body and thickened proximal exoexine as *T. plicata.* Transitions to haploxylonoid forms (*T. staplini*) and to forms with reduced sacci (*T. epigona*) have not been demonstrated.

Occurrence: Hengelo Röt salinar; rare. KLAUS (1964) reports the species from Italian and French Muschelkalk assemblages; here it is more frequent.

Triadispora epigona Klaus 1964

Fig. 22d; Plate XII, Figs. 5, 6.

Holotype: *Triadispora epigona* Klaus 1964, t. 2, f. 13.

Remarks and comparisons: Although connected with *T. crassa* and *T. staplini* by transitions, we maintain *T. epigona* for stratigraphical reasons (p. 326). It differs from the former species by its small reduced sacci. These can be haploxylonoid or faintly diploxylonoid with a semi-lunar shape. But also forms with a small monosaccus are rather frequent. Depending on the saccus shape, the transitions are placed within *T. crassa* or *T. staplini.*

Occurrence: Regularly recognized in the Hengelo Röt Group; never in high percentages. KLAUS (1964) mentions the species from French and Italian Muschelkalk assemblages; sometimes rather dominant.

INFRATURMA *Striatiti* Pant 1954

SUBINFRATURMA *Aletestriatiti* nov. subinfraturma

Diagnosis: Pollen bisaccate, striate. Intexine of the central body without proximal tetrad mark.

Remarks: The author considers the presence or absence of an intexinal tetrad mark within the *Striatiti* a very important feature. It seems a good argument for subdividing the *Striatiti* into the *Aletestriatiti* nov. subinfraturma and the *Triletestriatiti* nov. subinfraturma (p. 360).

Illinites Kosanke 1950 emend. Klaus 1964

Type species: *Illinites unicus* Kosanke 1950, t. 1, f. 3.

Remarks and comparisons: By restudying the type specimen both JANSONIUS and STAPLIN (1962) and KLAUS (1964) have given valuable contributions to a better knowledge of the genus *Illinites* (synonym: *Complexisporites* Jizba 1962). By the proximal exoexinal differentiations (reduced trilete mark accompanied by two laterally placed longitudinal sutures) *Illinites* can be distinguished from the "*Illinites*"-species from the European Upper Permian (≡ *Eridospollenites* Freudenthal 1964, which has to be considered, together with *Jugasporites* Leschik 1956b, as *Limitisporites* Leschik 1956b emend. Potonié 1958 (the genus *Jugasporites* Leschik 1956b emend. Klaus 1963a might be preferable, but according to Art. 57 of the International Code of Botanical Nomenclature Potonié's "choice must be followed"). An intexinal (reduced) trilete or monolete is absent.

Illinites differs from *Angustisulcites* Freudenthal 1964 emend. by possessing approx. haploxylonoid sacci and by the still proximal, not equatorially placed longitudinal sutures. Both genera are related more to the *Striatiti* Pant 1954 than to the *Disaccitriletes* Leschik 1956. So we place both genera in the former infraturma.

Illinites trivisus n. sp.

Fig. 23; Plate XVI, Fig. 2.

Holotype: *Illinites trivisus* n. sp. Single grain slide 31-HV-271; Plate XVI, Fig. 2.

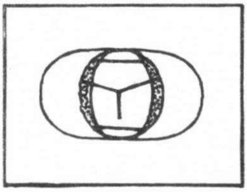

Fig. 23. *Illinites trivisus*

Diagnosis: Pollen bisaccate, striate. Equator of central body approx. circular to transversely elliptical. Exine with fine infrastructure. Trilete mark in proximal exoexine well developed: two rays extend to the equator, the third – transversal – ray is hardly reduced. This Y-mark is accompanied by two still proximally situated longitudinal sutures. Proximal intexine without (reduced) trilete or monolete mark. Sacci finely infrareticulate, approx. haploxylonoid with narrow equatorial interconnections. Bladder bases usually accompanied by folds. Known size range 70–80 μ (holotype 78 μ).

Comparison: Illinites kosankei Klaus 1964, also from Upper Bunter assemblages, differs by possessing a strongly reduced Y-mark and by its bigger size.

Locus typicus: Boring 31, K.N.Z., Hengelo; depth 405.50 m (Röt salinar).

Occurrence: Only recognized in the shales between 405.50 and 406.80 m; rare.

Angustisulcites Freudenthal 1964 emend.

Type species: *Angustisulcites klausii* Freudenthal 1964, t. 2, f. 6a, 6b; Plate XV, fig. 4.

Diagnosis: Pollen bisaccate, striate. Equator of central body approx. circular to transversely elliptical or, very often, subangular (rhombic). Proximally thickened exoexine with Y-mark; two rays extend to the equator, the third may be strongly reduced and assymmetrically placed. Apart from the Y-mark there are two equatorially situated longitudinal exoexinal sutures. Consequently these are only visible in equatorial view (lateral view). Proximal intexine without (reduced) trilete or monolete mark. Sacci faintly diploxylonoid to strongly libelloid. In principle the distal germinal area is biconvex; it is often accompanied by transversal compression folds.

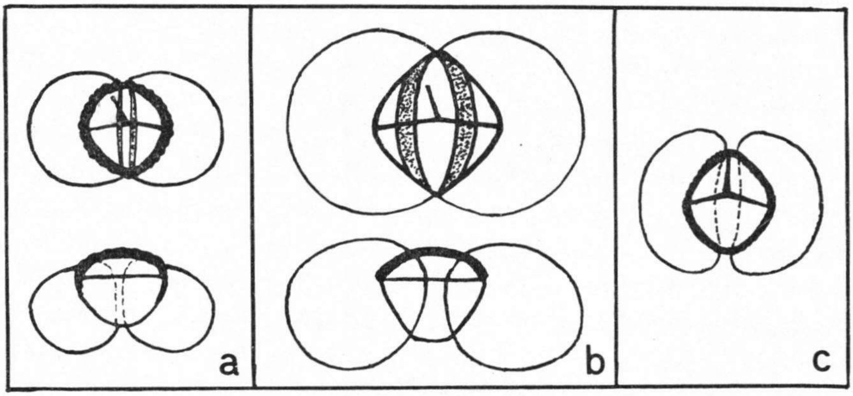

Fig. 24. *Angustisulcites*. a. *A. klausii*; b. *A. grandis*; c. *A. gorpii*

Remarks and comparisons: FREUDENTHAL (1964) based his generic diagnosis on a badly preserved type specimen which does not show a distinct Y-mark in the proximal exoexine. We reprepared the genotype and have been able to demonstrate the Y-mark. Specimens without a distinct open mark have also been found in our preparations, but usually it becomes visible with high magnification. In order to include more species we changed Freudenthal's generic description in a more extensive sense; not even to *Angustisulcites klausii* Freudenthal 1964 can the "narrow deep sulcus" be considered characteristic. *Angustisulcites* is highly related to *Illinites* Kosanke emend. Klaus 1964; it differs by the diploxylonoid shape, but especially by the equatorial position of the lateral sutures, which are invisible in polar view (proximo-distal view).

Angustisulcites differs from *Lueckisporites* Potonié and Klaus 1954 emend. Klaus 1963a by the trilete shape of the proximal exoexinal mark and by the absence of a monolete or (reduced) trilete mark in the proximal intexine. The latter fact has been the argument for placing *Angustisulcites*, together with *Illinites*, within the *Aletestriatiti* nov. subinfraturma.

Angustisulcites klausii Freudenthal 1964

Fig. 24a; Plate XV, Figs. 1, 2, 3A, B, 4.

Holotype: *Angustisulcites klausii* Freudenthal 1964, t. 2, f. 6a, 6b; Plate XV, Fig. 4.

Diagnosis: Pollen bisaccate, striate. Equator of central body circular, transversely elliptical or subangular (rhombic). Strongly thickened proximal exoexine (3–4.5 μ) with fine infrastructure and trile mark; two rays extend to the equator, the third ray can be strongly reduced and is placed asymmetrically. Equatorially two longitudinal singular exoexinal sutures, only visible in equatorial view. Intexine without (reduced) trilete or monolete mark. Sacci faintly diploxylonoid, distally inclined, laterally close to each other or equatorially interconnected by a narrow exoexinal strip. Distal germinal area fundamentally biconvex; usually accompanied by transversal folds. Observed size range 57–85 μ.

Remarks and comparisons: By restudying the holotype we have been able to demonstrate the exoexinal Y-mark (p. 355). Although narrow germinal areas appear very frequently, a "narrow deep sulcus" (FREUDENTHAL 1964) cannot be considered characteristic; a variation from 1–7 μ was recognized.

A. klausii is very close to *Illinites melanocorpus* Klaus 1964; it only differs by its smaller average size (respectively 57–85 μ and 90–120 μ). Further investigations have to show whether *I. melanocorpus* can be maintained for stratigraphical reasons.

Angustisulcites gorpii n. sp. distinguishes by its libelloid shape, its unreduced transversal trilete ray and by possessing a very characteristic saccus infrareticulum. *Angustisulcites grandis* (Freudenthal 1964) nov. comb. differs by its striking size.

Occurrence: Regularly recognized in the Röt salinar of Hengelo; low percentages. In the upper part of the overlying Röt pelites, however, *A. klausii* is the most dominating species.

Angustisulcites grandis (Freudenthal) 1964 nov. comb.

Fig. 24b; Plate XVI, Figs. 3, 4A, B; Plate XVII, Figs. 1, 2.

Holotype: *Angustisulcites* (al. *Falcisporites*) *grandis* (Freudenthal 1964) nov. comb.; FREUDENTHAL 1964, t. 5, f. 1.

Diagnosis: Pollen bisaccate, striate. Striking but variable size (known size range 110–210 μ). Equator of central body approx. circular to strongly subangular (rhombic). Thickened proximal exoexine with reduced trilete mark; two rays extend to the equator, the third – approx. transversal – is reduced and situated asymmetrically. Equatorially two longitudinal singular exoexinal sutures, only visible in equatorial view. These sutures also limit the thickened proximal exoexine, Proximal intexine without (reduced) trilete or monolete mark. Sacci faintly to strongly diploxylonoid, both proximally and distally inclined, laterally close to each other or equatorially interconnected. Fine, more or less imperfect, saccus-infrareticulum. Distal germinal area fundamentally biconvex, usually accompanied by folds.

Remarks and comparisons: Especially the bigger specimens are usually badly preserved. This also applies to Freudenthal's holotype. Even with high magnification a trilete mark can be suspected only. On account of the general shape and of analogue finds within the variation of a trilete species Freudenthal's specimen has to be maintained as the holotype of *Angustisulcites grandis* (Freudenthal 1964) nov. comb. Our better preserved specimens explain the upbuilding of *A. grandis* which differs from *Angustisulcites klausii* Freudenthal 1964 and *Angustisulcites gorpii* n. sp. by its striking size.

Occurrence: Regularly recognized in the Hengelo Röt salinar; never in high percentages.

Angustisulcites gorpii n. sp.

Fig. 24c; Plate XV, Figs. 5, 6; Plate XVI, Fig. 1.

Holotype: *Angustisulcites gorpii* n. sp. Single grain slide 31-HV-226; Plate XV, Fig. 6.

Derivatio nominis: J. J. M. van Gorp, chemist in Tilburg, the Netherlands, who gave valuable chemical advices during our investigations.

Diagnosis: Pollen bisaccate, striate. Equator of central body transversely elliptical to subangular (rhombic). Strongly thickened exoexine with trilete mark; two rays always extend to the equator, the third – approx. transversal – ray can also reach the equator or can be slightly reduced; this ray is approx. symmetrically situated. Equatorially two longitudinal singular exoexinal sutures, only visible in equatorial view. The suture situated at the side, to which the transversal trilete ray extends has developed only rudimentalary. Proximal intexine without (reduced) trilete or monolete mark. Sacci libelloid, distally inclined, laterally close to each other. Striking infrareticulum with narrow elongated meshes. Distal germinal area fundamentally biconvex. Known size range 65–95 μ (holotype 78 μ).

Remarks and comparisons: Because of the strongly libelloid shape equatorially flattened specimens are very rare; it has been impossible to find a well-preserved specimen that lent itself to illustrate the equatorial sutures. They can often be vaguely observed in approximately polar view.

A. gorpii differs from *Angustisulcites klausii* Freudenthal 1964 and *Angustisulcites grandis* (Freudenthal 1964) nov. comb. by its well-developed transversal trilete ray, the libelloid shape and the characteristic saccus infrareticulum.

Locus typicus: Boring 31, K.N.Z., Hengelo; depth 405.50 m (Röt salinar).

Occurrence: Regularly recognized in the Röt salinar of Hengelo; never in high percentages.

Lunatisporites Leschik 1956a emend. Bharadwaj 1962

Type species: *Lunatisporites acutus* Leschik 1956a, t. 7, f. 24.

Remarks and comparisons: By many authors (Grebe 1957; Klaus 1960; Bharadwaj 1962; Jansonius 1962; Hart 1964; Freudenthal 1964) the type species of *Lunatisporites* Leschik 1956a and *Taeniaesporites* Leschik 1956a (respectively *Lunatisporites acutus* Leschik 1956a and *Taeniaesporites kraeuseli* Leschik 1956a) are considered identical; in this case both genera have to be united. We agree with this conception. However, in the literature there is no unanimity about the question of taxonomical priority, which is given to *Lunatisporites* as well to *Taeniaesporites*.

Leschik (1956a) described both genera in the same paper; *Lunatisporites* at p. 56, *Taeniaesporites* at p. 58. The descriptions are poor and insufficient.

Grebe (1957) restudied the type species and did not notice any important differences. However, she united both genera with *Lueckisporites* Potonié & Klaus 1954.

Leschik (1959) disagrees with Grebe's concept about the nature of the semi-lunar dark area on the central body of *Lunatisporites*; this should be a morphological feature instead of an optical effect.

Klaus (1960) followed Grebe (1957).

Bharadwaj (Febr. 1962) states that there are no differences between the two genera. On account of "page priority" he considers *Taeniae-*

sporites a synonym of *Lunatisporites* Leschik 1956a emend. Bharadwaj 1962. Independently, JANSONIUS (April 1962) stated the same concept. But because of the better preserved holotype he gives priority to *Taeniaesporites* Leschik 1956a emend. Jansonius 1962.

KLAUS (1963a) disagrees, since according to the "page priority" *Lunatisporites* should have been chosen. He appeals to LESCHIK (1959) in order to maintain a separation between *Lunatisporites* and *Taeniaesporites* Leschik 1956a emend. Klaus 1963a.

HART (1964) also considers the type species identical, but next he argues inconsistently by maintaining *Taeniaesporites* without mentioning *Lunatisporites* as a synonym. The latter genus can be found in the list of synonyms of the genus *Protohaploxypinus* Samoilovich 1953 emend. Hart 1964.

FREUDENTHAL (1964) follows JANSONIUS (1962).

Jansonius has been perfectly correct and logical in choosing *Taeniaesporites*. Bharadwaj was guided by the "page priority" when he chose *Lunatisporites*. On the other hand, this "page priority" has been the very motive of KLAUS (1963a) to separate the genera. However, the idea of "page priority" is not provided by the International Code of Botanical Nomenclature. Art. 51 is very plain when it states:

" . . . The author who first unites taxa bearing names or epithets of the same date *has the right to choose one of them*, and his choice must be followed".

Bharadwaj did not make use of "the right to choose one of them", but yet "his choice must be followed".

Lunatisporites is restricted to forms without a monolete or reduced trilete mark in the proximal intexine of the central body. As for the existence of these characteristics we refer to the description of *Taeniaepollenites* n. gen. (remarks, p. 360). *Lunatisporites* differs from *Protohaploxypinus* Samoilovich 1953 emend. Hart 1964 and *Striatopodocarpites* Sedova 1956 emend. Bharadwaj 1962 by the presence of a biconvex germinal area and narrow equatorial bladder connections.

Lunatisporites puntii n. sp.

Fig. 25; Plate XIV, Figs. 1, 2, 3, 4.

Holotype: *Lunatisporites puntii* n. sp. Single grain slide 31-HV-239; Plate XIV, Fig. 3.

Derivatio nominis: Dr W. Punt, Pollenmorphological Laboratories of the Botanical Museum and Herbarium of the State University, Utrecht, the Netherlands.

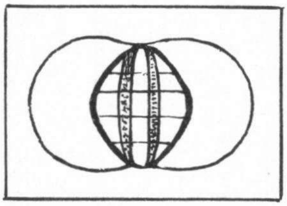

Fig. 25. *Lunatisporites puntii*

Diagnosis: Pollen bisaccate, striate. Equator of central body approx. circular to transversely elliptical or subangular (rhombic). Thickened proximal exoexine with 4–6 taeniae in polar view, frequently of unequal width, usually separated by very narrow sutures. Taeniae with fine infrastructure. Proximal intexine without tetrad mark. Sacci more or less diploxylonoid to platysaccoid, distally inclined, laterally very close to each other or even equatorially interconnected. Sacci very finely infrareticulate. Distal germinal area in principle biconvex, frequently accompanied by transversal compression folds. Known size range 79–119 μ (holotype 115 μ).

Remarks and comparisons: Within the variation of the species the shape of the sacci is liable to rather important divergences. Specimens with sutures between the taeniae – a characteristic of *Taeniaepollenites* n. gen. – are uncommon. A few specimens with remarkably deformed taeniae have been found (Plate XIV, Fig. 4). *L. puntii* differs from *Lunatisporites acutus* Leschik 1956a especially by its bigger size.

Locus typicus: Boring 31, K.N.Z., Hengelo; depth 405.50 m (Röt salinar).
Occurrence: Röt salinar of Hengelo; rare.

Striatoabietites Sedova 1956 emend. Hart 1964

Type species: *Striatoabietites bricki* Sedova 1964, t. 41, f. 5.

Comparison: Striatoabietites differs from *Tubantiapollenites* n. gen. by the absence of a reduced trilete (roof-shaped) or monolete (straight) mark in the proximal intexine.

Striatoabietites aytugii n. sp.
Fig. 26; Plate XVII, Figs. 3, 4, 5, 6.

Holotype: *Striatoabietites aytugii* n. sp. Single grain slide 31-HV-114; Plate XVII, Fig. 3.
Derivatio nominis: B. Aytug, Faculty of Forestry, University of Istanbul, Turkey.

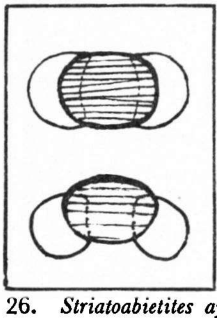

Fig. 26. *Striatoabietites aytugii*

Diagnosis: Pollen bisaccate, multistriate. Equator of central body strongly longitudinally elliptical. Thickened proximal exoexine with 10–14 taeniae in polar view; taeniae finely infragranulate, separated by very narrow sutures. Proximal intexine without (reduced) trilete or monolete mark. Sacci more or less diploxylonoid, distally inclined, finely infrareticulate. Very wide distal germinal area. Known size range 60–80 μ (holotype 75 μ).

Remarks and comparisons: Usually the shape is faintly diploxylonoid but occasionally it may become more pronounced. *S. aytugii* differs from *Tubantiapollenites balmei* (Klaus 1964) nov. comb. by the absence of a (reduced) trilete or monolete mark in the proximal intexine.

Locus typicus: Boring 31, K.N.Z., Hengelo; depth 392 m (Röt salinar).

Occurrence: Regularly recognized in the Hengelo Röt salinar; never in high percentages.

SUBINFRATURMA *Triletestriatiti* nov. subinfraturma.

Diagnosis: Pollen bisaccate, striate. Intexine of the central body with a proximal trilete, reduced trilete (roof-shaped) or monolete mark.

Remarks: See *Aletestriatiti* nov. subinfraturma (remarks, p. 353).

Taeniaepollenites n. gen.

Type species: *Taeniaepollenites jonkeri* n. sp., Plate XVIII, Figs. 1A, B, C.

Diagnosis: See diagnosis of *Taeniaesporites* Leschik 1956a emend. KLAUS 1963a (KLAUS 1963a, pp. 306–307). This excellent diagnosis can serve without restrictions as a description of a new striate genus, which includes among others all the forms recognized by KLAUS (1963a).

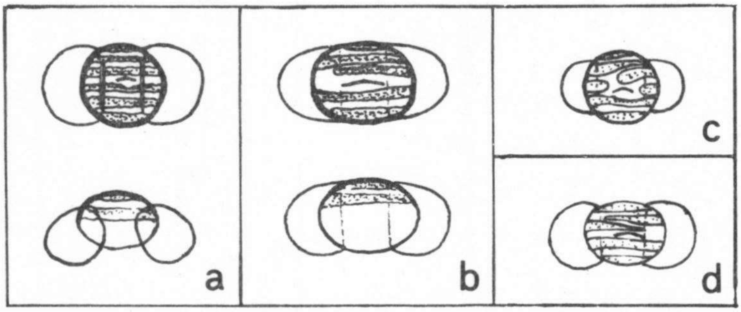

Fig. 27. *Taeniaepollenites.* a. *T. multiplex;* b. *T. jonkeri;* c. *T. hengeloensis;* d. *T. discrepans*

Remarks and comparisons: We consider the presence or absence of a (reduced) trilete or monorete mark in the proximal intexine of striate pollen a very important feature. With the exception of KLAUS (1963a) little attention has been paid to this characteristic.

Since species of *Taeniaepollenites* n. gen. were mostly placed within the genus *Taeniaesporites* Leschik 1956a and since the latter genus has to be considered a synonym of *Lunatisporites* Leschik 1956a emend Bharadwaj 1962 (compare p. 357), it seems useful to check the concepts about the intexinal Y-mark within these genera.

LESCHIK (1956a) creates both *Lunatisporites* and *Taeniaesporites,* not mentioning the existence of an Y-mark. Also the illustrations do not show a tetrad mark. However, the genera are placed within the *Disacciatriletes.*

LESCHIK (1956b) also describes *Taeniaesporites noviaulensis* from the German Zechstein deposits. A monolete mark is clearly visible and is mentioned in the description.

GREBE (1957) considers both *Lunatisporites* and *Taeniaesporites* synonyms of *Lueckisporites* Potonié & Klaus 1954 (*Lueckisporites* was considered to include "bisaccate spores without Y-mark", even after the emendation by POTONIÉ 1958; JANSONIUS 1962 states that "a monolete mark may be present"; only KLAUS 1963a recognizes the fundamentally trilete character). *T. noviaulensis* should be identical with *Lueckisporites virkkiae* Potonié & Klaus 1954.

In principle POTONIÉ (1958) follows GREBE (1957); however, he maintains the species "*Lueckisporites*" *noviaulensis*; nothing is to be said about the monolete mark. *Lunatisporites* remains separate; like Grebe, Potonié has restudied the type species but an Y-mark was not demonstrated. Various authors (e.g. LAKHANPAL, SAH and DUBE 1960; POTONIÉ and LELE 1961) continued to interpret *Lunatisporites* in this way.

LESCHIK (1959) points out the differences between his alete Triassic species and his Permian *T. noviaulensis*. KLAUS (1960) follows GREBE (1957); he finds "*Lueckisporites kraeuseli*" in Keuper sediments; pollen without Y-mark.

BHARADWAJ (1962) considers *Taeniaesporites* a synonym of *Lunatisporites* Leschik 1956a emend. Bharadwaj 1962, which does not possess a tetrad mark. In India this concept is commonly followed. We agree with it too (compare p. 357).

JANSONIUS (1962) emends the generic diagnosis of *Taeniaesporites* and also describes some new species. Nothing is stated about a possible tetrad mark. There is a strong resemblance with European monolete species. Particularly *Taeniaesporites novimundi* Jansonius 1962 reminds us of *T. noviaulensis*. However, studying some of Jansonius' slides we have not been able to recognize a convincing tetrad mark within the Canadian species. Yet they differ from *Lunatisporites* Leschik 1956a emend. Bharadwaj 1962.

ORŁOWSKA ZWOLIŃSKA (1962) determines *T. noviaulensis* from the Polish Upper Permian deposits; she mentions the monolete mark.

GREBE and SCHWEITZER (1962) do not pay attention to the monolete mark of *Lueckisporites noviaulensis* (Leschik 1956a) Potonié 1958.

BALME (1963) follows JANSONIUS (1962) but he mentions the monolete marks both of cf. *T. noviaulensis* and *Taeniaesporites obex* Balme 1963. In his illustrations the marks are well visible.

SCHAARSCHMIDT (1963a) considers *Taeniaesporites* a synonym of *Striatites* Pant 1955. Some species, like *Striatites noviaulensis* (Leschik 1956a) Schaarschmidt 1693, may possess a proximal monolete mark.

By emending *Taeniaesporites*, KLAUS (1963a) gives an excellent diagnosis for the monolete forms. In fact all his new species are monolete. So they must be compared with *T. noviaulensis* instead of with *T. kraeuseli*, the type species of the genus.

A clear intexine-mark is also visible in the illustrations of *T. noviaulensis* from the Zechstein of Thüringen (ULLRICH 1964).

In his generic descriptions of striate pollen HART (1964) does not reckon with possible tetrad marks. With regard to *Taeniaesporites* he follows Jansonius' emendation. He considers the mark of *T. obex* a species-characteristic, suppressing it, however, when describing *T. noviaulensis* (syn: *T. novimundi*).

BHARADWAJ and SINGH (1964) also recognize *Lunatisporites acutus* Leschik 1956a in the Austrian Upper Triassic. They do not mention the presence of a tetrad mark. Within European Bunter and Muschelkalk sediments KLAUS (1964) recognizes *T. novimundi*. Not mentioning the tetrad mark, he classes this species together with the monolete *Taeniaesporites austriacus* Klaus 1964, under the *Disaccimonoletes* Klaus 1963a. This infraturma is considered to contain bisaccate monolete pollen but, however, it excludes striate pollen.

In FREUDENTHAL'S (1964) opinion the specimens from the Dutch Bunter belong to *T. noviaulensis* (syn: *T. novimundi*). The tetrad mark is visible in his illustrations but it is not drawn into the discussion. Also SCHULZ (1964) compares his specimen from the Middle Bunter with *noviaulensis*; nothing is stated about a possible monolete mark.

According to this enumeration it is clear that there is no unanimity about the importance of the presence or absence of a monolete tetrad mark. This should be regarded a grave hiatus, particularly because within the Hengelo assemblage we recognize both forms habitu *Lunatisporites* Leschik 1956a emend Bharadwaj 1962, without a tetrad mark, and forms habitu *Taeniaesporites* Leschik 1956a emend. Klaus 1963a with well-developed monolete or reduced trilete marks. So we want to separate them strictly.

The genus *Taeniaesporites* cannot be maintained because it is a synonym of *Lunatisporites* (compare p. 358; also in the case of separating these genera one has to realize that the type species of *Taeniaesporites* does not possess a tetrad mark). So the genus *Taeniaepollenites* n. gen. is proposed, including species with monolete or reduced trilete marks. Choosing this related name may cause confusion, but we want to keep the prefix *Taeniae-*.

Taeniaepollenites n. gen. can be distinguished from *Lueckisporites* Potonié & Klaus 1954 emend. Klaus 1963a by possessing more taeniae. The taeniae of *Strotersporites* Wilson 1962 emend. Klaus 1963a are not differentiated into polar and equatorial taeniae. *Lunatisporites* Leschik 1956a emend. Bharadwaj 1962 is alete and has a narrow biconvex germinal area; furthermore its saccus infrareticulum is very fine, the sacci are very close to each other or even equatorially interconnected and the equator of the central body is usually transversely elliptical.

Taeniaepollenites jonkeri n. sp.

Fig. 27b; Plate XVIII, Figs. 1A, B, C, 2; Plate XIX, Fig. 1.

Holotype: *Taeniaepollenites jonkeri* n. sp. Single grain slide 31-HV-209; Plate XVIII, Figs. 1A, B, C.

Derivatio nominis: Prof. Dr. F. P. Jonker, Botanical Museum and Herbarium of the State University, Utrecht, the Netherlands.

Diagnosis: Pollen bisaccate, striate. Equator of the central body longitudinally elliptical. Thickened proximal exoexine differentiated into 2 equatorial taeniae and 2–4 polar taeniae. The taeniae are separated by rather wide sutures; they are pronounced infragranulate, frequently the margins are more or less crenulate. Proximal intexine with reduced trilete to monolete mark. Sacci haploxylonoid, hardly distally inclined; meshes of saccus-infrareticulum 1–2.5 μ wide. Wide distal germinal area with approx. structureless exine. Known size range 75–110 μ (holotype 95 μ).

Remarks and comparisons: In principle there are 2 polar taeniae but these can be divided. Specimens with 3 or 4 polar taeniae are very frequent and even specimens with 2½ or 3½ taeniae are common. *T. jonkeri* differs from *Taeniaepollenites multiplex* n. sp. and *Taeniaepollenites discrepans* n. sp. by its haploxylonoid shape. *Taeniaepollenites hengeloensis* n. sp. possesses reduced sacci. These newly described species differ from the *Taeniaepollenites*-species from European Upper Permian assemblages (≡ "*Taeniaesporites*" *with* proximal intexine-mark; compare p. 360) by their relatively finer saccus-infrareticulum.

Locus typicus: Boring 31, K.N.Z., Hengelo; depth 405.50 m (Röt salinar).

Occurrence: Regularly recognized in the Hengelo Röt salinar; never in high percentages.

Taeniaepollenites multiplex n. sp.

Fig 27a; Plate XIX, Figs. 6, 7.

Holotype: *Taeniaepollenites multiplex* n. sp. Single grain slide 31-HV-39; Plates XIX, Fig. 6.

Diagnosis: Pollen bisaccate, striate. Equator of the central body approx. circular to longitudinally elliptical. Thickened proximal exoexine, differentiated into 2 equatorial taeniae and 2–4 polar taeniae. The taeniae are separated by rather wide sutures; they are pronounced infragranulate, frequently the margins are more or less crenulate. Proximal intexine with reduced trilete to monolete mark. Sacci faintly to strongly diploxylonoid, strongly distally inclined; meshes of saccus-infrareticulum 1–3 μ wide. Wide distal germinal area with approx. structureless exine. Known size range 80–105 μ (holotype 84 μ).

Remarks and comparisons: Specimens with 2, 2½, 3, 3½, and 4 polar taeniae were recognized (compare *T. jonkeri*, remarks above). The appearance of an elliptical equator is mostly attended with a more pronounced diploxylonoid shape. There are, however, progressive transitions to faintly diploxylonoid forms with a circular equator. So a separation seems undesirable.

T. multiplex differs from *Taeniaepollenites discrepans* n. sp. by its thickened proximal exoexine with pronounced infragranulate taeniae. The species differs from *Taeniaepollenites jonkeri* n. sp. and *Taeniaepollenites hengeloensis* n. sp. by its diploxylonoid shape.

Locus typicus: Boring 31, K.N.Z., Hengelo; depth 405.50 m (Röt salinar).

Occurrence: Most common striate species in the Hengelo Röt salinar but never reaching high percentages. Also recognized in the overlying Röt pelites.

Taeniaepollenites discrepans n. sp.

Fig. 27d; Plate XVIII, Fig. 3.

Holotype: *Taeniaepollenites discrepans* n. sp. Single grain slide 31-HV-125; Plate XVIII, Fig. 3.

Diagnosis: Pollen bisaccate, striate. Equator of the central body approx. circular to longitudinally elliptical. Hardly thickened proximal exoexine differentiated into 2 equatorial taeniae and 2–5 polar taeniae. The taeniae are separated by rather wide sutures; they are faintly infrastructured. Proximal intexine with reduced trilete to monolete mark. Sacci diploxylonoid, distally inclined; meshes of saccus-infrareticulum 1–2 μ wide. Wide distal germinal area with approx. structureless exine. Known size range 90–100 μ (holotype 98 μ).

Remarks and comparisons: In principle there are 2 polar taeniae; they can be split up into more exoexinal strips, which are sometimes incompletely developed (compare *T. jonkeri*, remarks p. 363). *T. discrepans* differs from *Taeniaepollenites multiplex* n. sp. by its hardly thickened proximal exoexine without pronounced infragranulate structure. *Taeniaepollenites jonkeri* n. sp. and *Taeniaepollenites hengeloensis* n. sp. are haploxylonoid and possess also a thickened proximal exoexine.

Locus typicus: Boring 31, K.N.Z., Hengelo; depth 392 m (Röt salinar).
Occurrence: Röt salinar of Hengelo; rare.

Taeniaepollenites hengeloensis n.sp.

Fig. 27c; Plate XIX, Fig. 2.

Holotype: *Taeniaepollenites hengeloensis* n. sp. Single grain slide 31-HV-16; Plate XIX, Fig. 2.

Derivatio nominis: named for the city of Hengelo, the Netherlands.

Diagnosis: Pollen bisaccate, striate. Equator of the central body approx. circular. Thickened proximal exoexine differentiated into 2 equatorial taeniae and 2–4 polar taeniae. The taeniae are separated by rather wide sutures; they are pronounced infragranulate, frequently the margins are more or less crenulate. Proximal intexine with reduced trilete to monolete mark. Sacci haploxylonoid, strongly reduced; meshes of saccusinfrareticulum 1–2.5 μ wide. Wide distal germinal area with approx. structureless exine. Known size range 80–90 μ (holotype 84 μ).

Remarks and comparisons: In principle there are 2 polar taeniae; they can be split up into more exoexinal strips which are sometimes incompletely developed (compare *T. jonkeri*, remarks, p. 363). *T. hengeloensis* differs from *Taeniaepollenites jonkeri* n. sp. by its reduced sacci and the circular equator. *Taeniaepollenites multiplex* n. sp. and *Taeniaepollenites discrepans* n. sp. are diploxylonoid.

Locus typicus: Boring 31, K.N.Z., Hengelo; depth 404 m (Röt salinar).
Occurrence: Röt salinar of Hengelo; very rare.

Tubantiapollenites n. gen.

Type species: *Tubantiapollenites striatitoides* n. sp., Plate XIX, Fig. 3.

Derivatio nominis: Tubantia, Latin name for Twente, the region from which our samples originate.

Diagnosis: Pollen bisaccate, multistriate. Slightly thickened proximal exoexine differentiated into a great number of taeniae; these are separated by very narrow sutures. Proximal intexine with reduced trilete (roof-shaped) to monolete (straight) mark. Sacci haploxylonoid or faintly diploxylonoid. Wide distal germinal area.

Remarks and comparisons: Except *Striatoabietites balmei* Klaus 1964

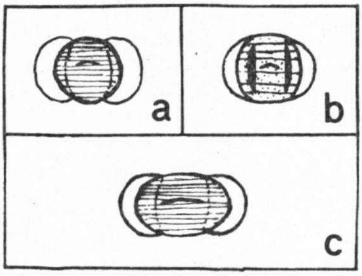

Fig. 28. *Tubantiapollenites*. a. *T. schulzii*; b. *T. striatitoides*; c. *T. balmei*

we did not find in the palynological literature multistriate species built up according to the description of *Tubantiapollenites* n. gen. We consider the presence or absence of an intexinal tetrad mark a very important feature and we want to separate the monolete or trilete species strictly from genera like *Striatites* Pant 1955 emend. Klaus 1963a, *Striatoabietites* Sedova 1956 emend. Hart 1964, etc. The Y-mark is not always clearly visible; before claiming multistriate species alete it is advisible to study sufficient specimens. *Strotersporites* Wilson 1962 emend. Klaus 1963a differs by possessing a wide rupture between the medial taeniae. *Taeniaepollenites* n. gen. is distinguished by a differentiation into polar and equatorial taeniae.

Tubantiapollenites striatitoides n. sp.

Fig. 28b; Plate XIX, Fig. 3.

Holotype: *Tubantiapollenites striatitoides* n. sp. Single grain slide 31-HV-40; Plate XIX, Fig. 3.

Derivatio nominis: Apart from the tetrad mark, the new species reminds one of *Striatites* Pant 1955 emend. Klaus 1963a.

Diagnosis: Pollen bisaccate, multistriate. Equator of the central body approx. circular to subangular. Slightly thickened proximal exoexine differentiated into taeniae (7–10 visible in polar view); taeniae finely infragranulate, separated by very narrow sutures. Proximal intexine with reduced trilete to monolete mark. Small sacci, haploxylonoid, semi-lunar, finely infrareticulate. Wide distal germinal area, usually limited by compression folds. Known size range 60–65 μ (holotype 64 μ).

Remarks and comparisons: Often specimens of *T. striatitoides* tend to release the sacci. The species differs from *Tubantiapollenites schulzii* n. sp. by the small haploxylonoid sacci. *Tubantiapollenites balmei* (Klaus 1964) nov. comb. possesses a longitudinally elliptical equator. Furthermore, compared with the two other species, *T. striatitoides* possesses a smaller number of taeniae.

Locus typicus: Boring 31, K.N.Z., Hengelo; depth 405.50 m (Röt salinar).
Occurrence: Röt salinar of Hengelo; rare.

Tubantiapollenites balmei (Klaus 1964) nov. comb.

Fig. 28c; Plate XIX, Fig. 5.

Holotype: *Tubantiapollenites* (al. *Striatoabietites*) *balmei* (Klaus 1964) nov. comb.; KLAUS 1964, t. 2, f. 17.

Remarks and comparisons: On account of the presence of a proximal intexine-mark Klaus' species is considered as *Tubantiapollenites* n. gen. The length of the roof-shaped or straight mark is rather variable; forms with elongated marks predominate, but there is no reason to propose a separation.

In polar view 13–20 taeniae are visible. Observed size range 40–70 μ. The longitudinally elliptical equator of the central body is characteristic; by this feature *T. balmei* can be distinguished from *Tubantiapollenites schulzii* n. sp. and *Tubantiapollenites striatitoides* n. sp.; Moreover, the latter species is haploxylonoid.

Occurrence: Röt salinar of Hengelo; rare. KLAUS (1964) mentions *T. balmei* from German, French and Italian Muschelkalk assemblages.

Tubantiapollenites schulzii n. sp.

Fig 28a; Plate XIX, Fig 4.

Holotype: *Tubantiapollenites schulzii* n. sp. Single grain slide 31-HV-113; Plate XIX, Fig. 4.

Derivatio nominis: Dr E. Schulz, Zentrales Geologisches Institut, Berlin, Germany.

Diagnosis: Pollen bisaccate, multistriate. Equator of central body approx. circular. Slightly thickened proximal exoexine differentiated into taeniae (10–15 μ visible in polar view); taeniae finely infragranulate, separated by very narrow sutures. Proximal intexine with reduced trilete or monolete mark. Sacci diploxylonoid, finely infrareticulate. Wide distal germinal area. Known size range 46–56 μ (holotype 51 μ).

Remarks and comparisons: Often the intexinal mark of *T. schulzii* is hardly visible. *Protosacculina jansonii* Freudenthal 1964 may be considered conspecific with this species; we restudied the holotype but could not demonstrate the intexinal mark with certainty. To propose a new combination seems incorrect, because in that case "*Tubantiapollenites jansonii*" should be based on a holotype without the characteristic tetrad mark. *T. schulzii* differs from *Tubantiapollenites balmei* (Klaus 1964) nov. comb. by its circular equator. *Tubantiapollenites striatitoides* n. sp. possesses small haploxylonoid sacci and a smaller number of taeniae.

Locus typicus: Boring 31, K.N.Z., Hengelo; depth 392 (Röt salinar).

Occurrence: Röt salinar of Hengelo; rare.

TURMA *Monocolpates* (Wodehouse 1935) Iversen and Troels-Smith 1950
SUBTURMA *Intorti* (Naumova 1937) Potonié 1958

Cycadopites (Wodehouse 1933) ex Wilson & Webster 1946

Type species: *Cycadopites fellicularis* Wilson & Webster 1946, p. 274, f. 7.

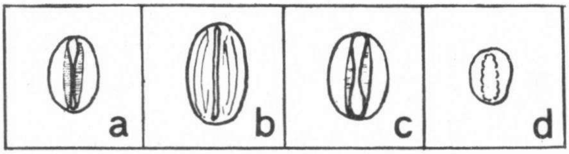

Fig. 29. *Cycadopites*. a. *C. coxii*; b. *C. trusheimii*; c. *C. sufflavus*; d. *C. crenulatus*

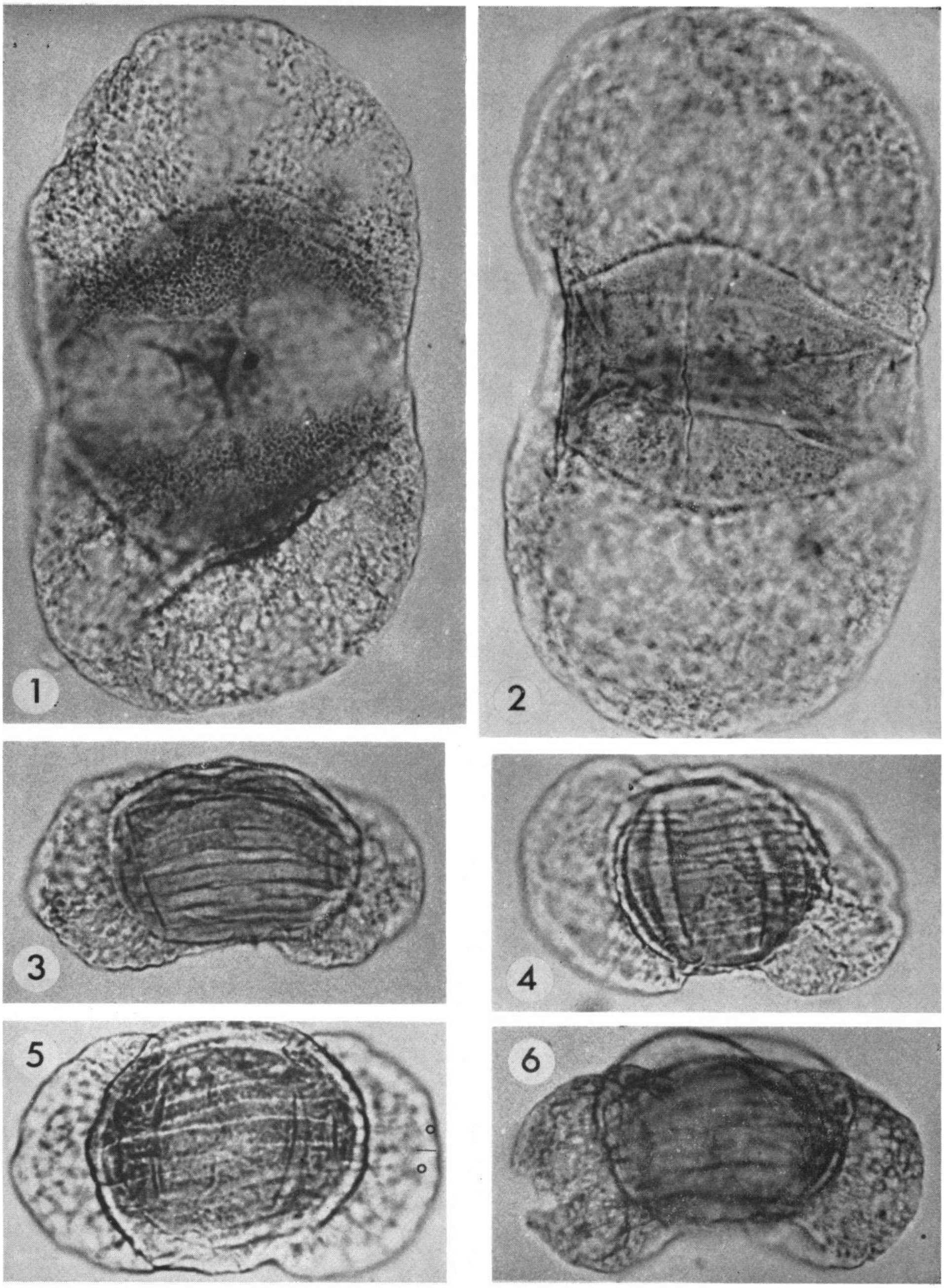

Plate XVII. 1. *Angustisulcites grandis*; 2. id.; 3. *Striatoabietites aytugii*, holotype; 4. id.; 5. id.; 6. id., equatorial view. (all specimens 750 ×).

PLATE XVII

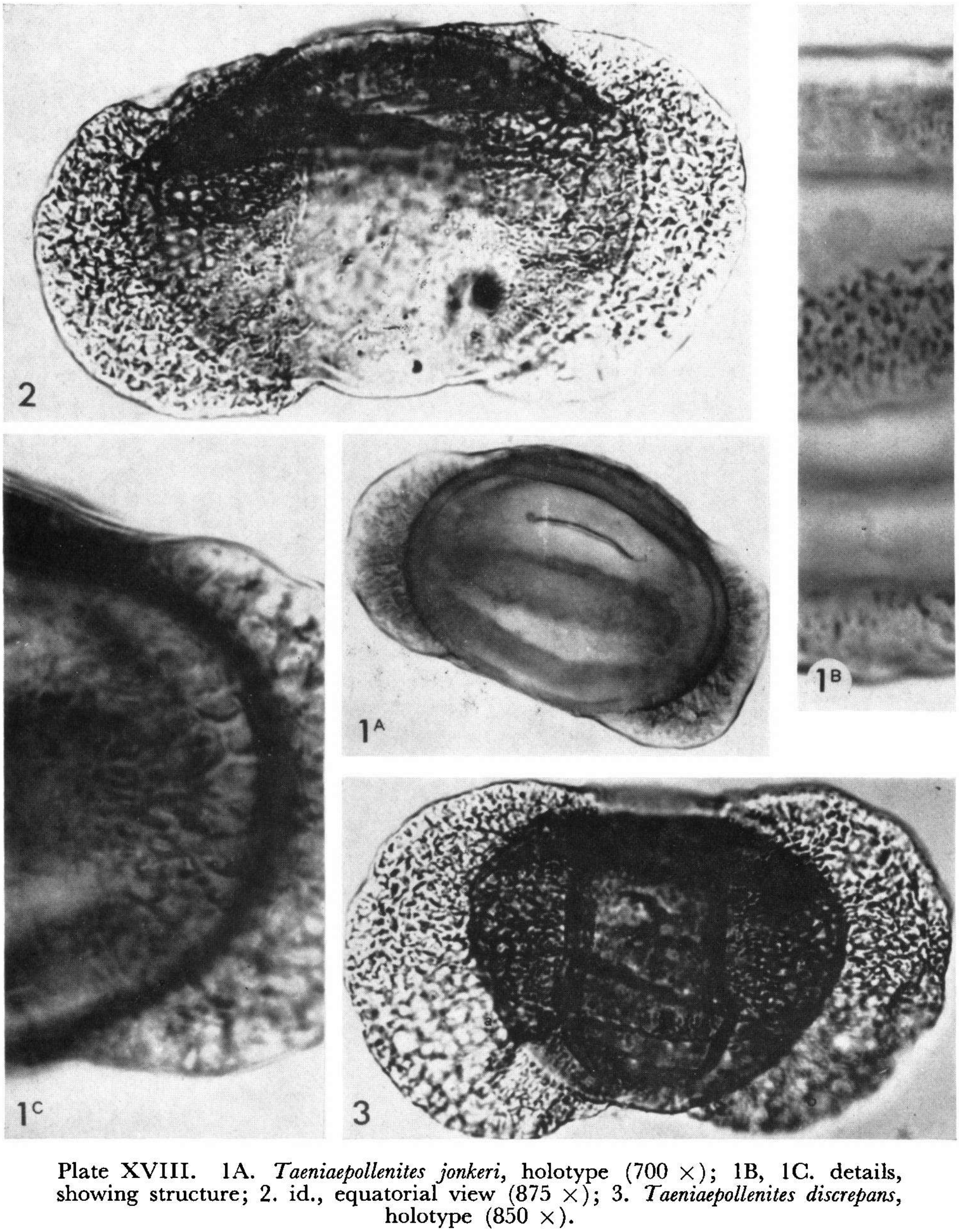

Plate XVIII. 1A. *Taeniaepollenites jonkeri,* holotype (700 ×); 1B, 1C. details, showing structure; 2. id., equatorial view (875 ×); 3. *Taeniaepollenites discrepans,* holotype (850 ×).

PLATE XVIII

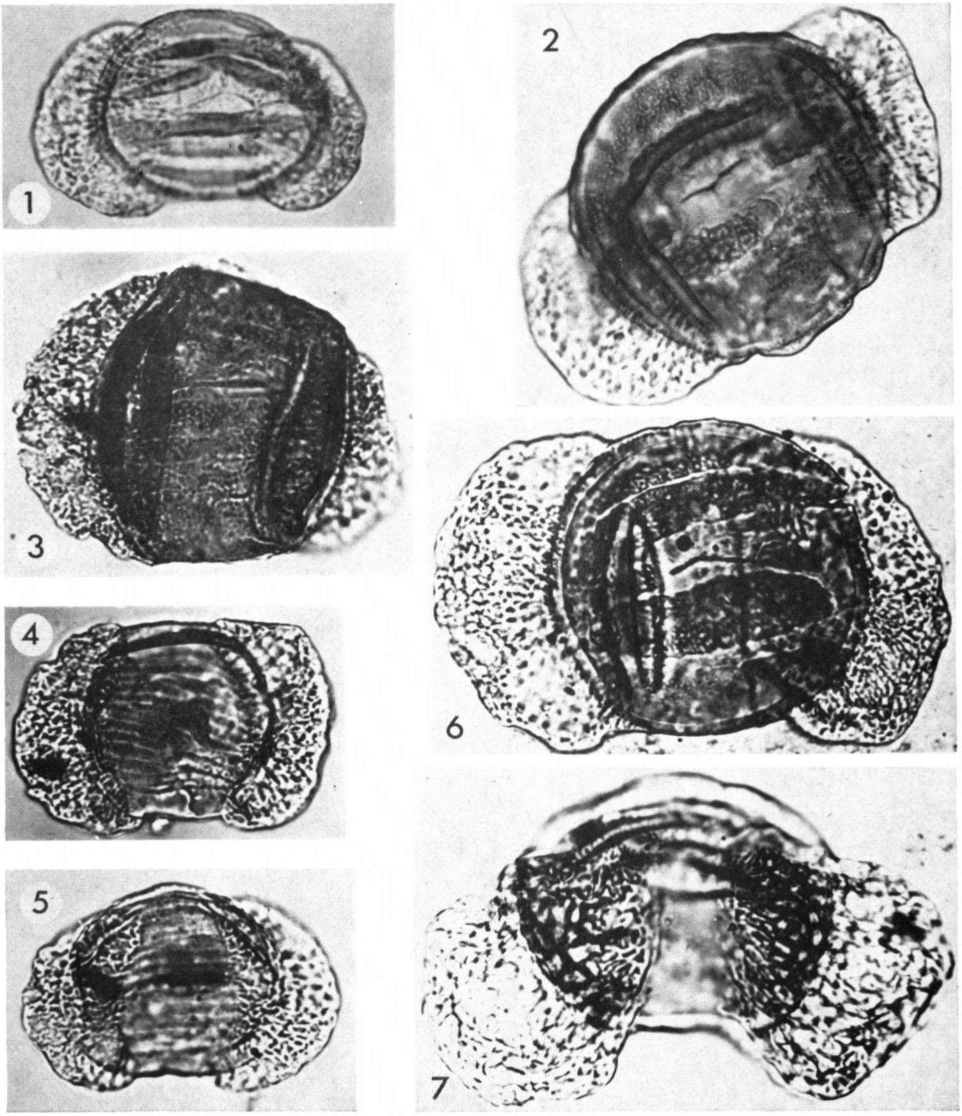

Plate XIX. 1. *Taeniaepollenites jonkeri* (500 ×); 2. *Taeniaepollenites hengeloensis*, holotype (700 ×); 3. *Tubantiapollenites striatitoides*, holotype (850 ×); 4. *Tubantiapollenites schulzii*, holotype (850 ×); 5. *Tubantiapollenites balmei* (850 ×); 6. *Taeniaepollenites multiplex*, holotype (700 ×); 7. id., equatorial view (700 ×).

PLATE XIX

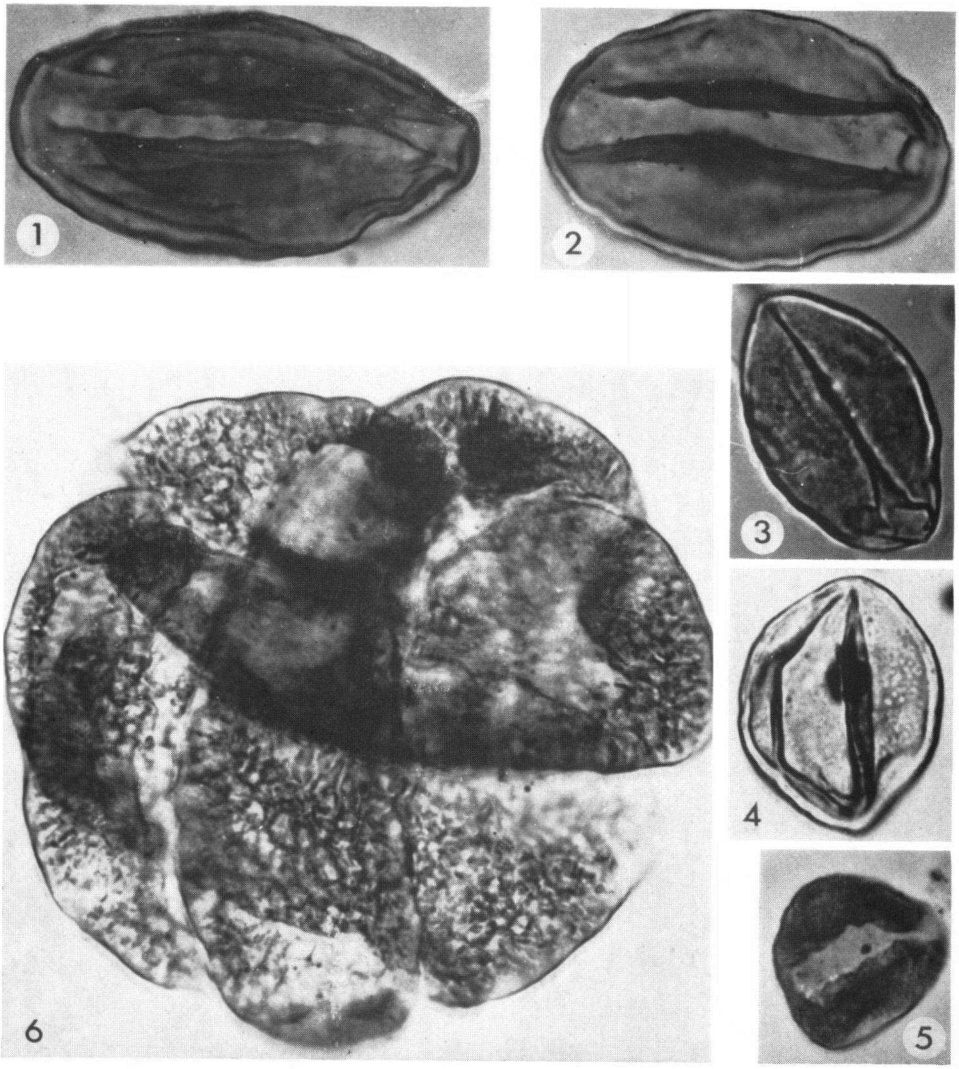

Plate XX. 1. *Cycadopites trusheimii*, holotype; 2. *Cycadopites sufflavus*, holotype; 3. *Cycadopites coxii*, holotype; 4. id.; 5. *Cycadopites crenulatus*, holotype; 6. Incert. sed. (all specimens 1200 ×).

PLATE XX

Remarks and comparisons: A generic differentiation of monocolpate pollen grains is hampered by the few characteristics which can be used in describing the species; this is due to the relatively simple shape. So provisionally it seems more reasonable to use the genus *Cycadopites* in a very broad sense (compare e.g. JANSONIUS 1962). Even the relation with *Monosulcites* (Cookson 1947) ex Couper 1953 is not clear; within the variation of a species both *Cycadopites*-like specimens and forms corresponding to the description of *Monosulcites* are found.

Cycadopites coxii n. sp.

Fig 29a; Plate XX, Figs 3, 4

Holotype: *Cycadopites coxii* n. sp. Single grain slide 31-HV-259; Plate XX, Fig. 3.

Derivatio nominis: R. Cox, Koninklijke Nederlandsche Zoutindustrie, Hengelo, the Netherlands.

Diagnosis: Pollen monocolpate with approx. elliptical outline. Thin exine with fine infrastructure. Sulcus lemniscatoid to irregularly elliptical depending on the fossilisation. Size very constant (28–31 μ).

Remarks and comparisons: Many specimens show a wide sulcus, which is not lemniscatoid; these forms should have been considered as *Monosulcites* Cookson 1947 ex Couper 1953. However, they can be derived from true lemniscatoid *Cycadopites* forms by progressive transitions.

C. coxii differs from *Cycadopites sufflavus* n. sp. by its smaller size; the size range of the latter species is also very constant (42–45 μ); transitions were not recognized, so a separation of the species seems justified.

Locus typicus: Boring 31, K.N.Z., Hengelo; depth 405.50 m (Röt salinar).

Occurrence: Regularly recognized in the Röt salinar of Hengelo; low percentages.

Cycadopites sufflavus n. sp.

Fig 29c; Plate XX, Fig. 2.

Holotype: *Cycadopites sufflavus* n. sp. Single grain slide 31-HV-90; Plate XX, Fig. 2.

Diagnosis: Pollen monocolpate with approx. elliptical outline. Thin exine with fine infrastructure. In principle the sulcus possesses a lemniscatoid shape, but elongated elliptical outlines appear frequently. Size very constant (42–45 μ).

Remarks and comparisons: Within the variation of *C. sufflavus* occur *Monosulcites*-like forms (compare *C. coxii*; remarks p. 367). *C. sufflavus* is very related to *Cycadopites coxii* n. sp., but the absence of transitional sizes justifies a separation. *Cycadopites trusheimii* n. sp. differs by its bigger size and its characteristic folding.

Locus typicus: Boring 31, K.N.Z., Hengelo; depth 392 m (Röt salinar).

Occurrence: Regularly recognized in the Röt salinar of Hengelo; low percentages.

Cycadopites trusheimii n. sp.

Fig 29b; Plate XX, Fig. 1.

Holotype: *Cycadopites trusheimii* n. sp. Single grain slide 31-HV-260; Plate XX, Fig. 1.

Derivatio nominis: Dr. F. Trusheim, Gewerkschaft Brigitta, Hannover, Germany.

Diagnosis: Pollen monocolpate with approx. elliptical outline. Thin exine with fine infrastructure. Sulcus usually lemniscatoid to elongated elliptical. Parallel to sulcus a varying number of narrow folds. Size very constant (54–58 μ).

Remarks and comparisons: We consider the presence of the narrow folds an important characteristic; within the variation of *Cycadopites coxii* n. sp. and *Cycadopites sufflavus* n. sp. this type of folding never appears.

Locus typicus: Boring 31, K.N.Z., Hengelo; depth 405.50 m (Röt salinar).
Occurrence: Röt salinar of Hengelo; rare.

Cycadopites crenulatus n. sp.

Fig. 29d; Plate XX, Fig. 5.

Holotype: *Cycadopites crenulatus* n. sp. Single grain slide 31-HV-79; Plate XX, Fig. 5.

Diagnosis: Pollen monocolpate with irregular elliptical outline. Thin exine with rather pronounced infragranulate structure. Wide sulcus with crenulate margin. Small sizes, very constant (18–21 μ).

Remarks and comparisons: A lemniscatoid sulcus has never been recognized; so the species might belong to *Monosulcites* Cookson 1947 ex Couper 1953. However, the relations between *Cycadopites* and *Monosulcites* are not very clear to us (p. 367). It seems therefore preferable to consider the species as *Cycadopites.* It differs from *Cycadopites coxii* n. sp., *Cycadopites sufflavus* n. sp. and *Cycadopites trusheimii* n. sp. by its very small size, its crenulate sulcus margin and a more pronounced infrastructure.

Locus typicus: Boring 31, K.N.Z., Hengelo; depth 411.50 m (Röt salinar).
Occurrence: Regularly recognized in the Röt salinar of Hengelo; low percentages.

Incertae sedis

A few specimens of rather particular plant microfossils were found in the palynological assemblage of Hengelo (Plate XX, Fig. 6). These bodies consist of some twisted strips of a material remarkably resembling the infrareticulate saccus exine of saccate pollen. Size approx. 80 μ.

ACKNOWLEDGEMENTS

The author wishes to express his sincere appreciation to Professor Dr. F. P. Jonker for proposing and stimulating this investigation and to Dr. W. Punt for his guidance in the delicate fields of pollenmorphology and botanical nomenclature and taxonomy.

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Thanks are especially due to the Koninklijke Nederlandsche Zoutindustrie for supplying the requisite rock samples.

APPENDIX

Some important papers on Permian and Triassic palynology became available to us after finishing the present investigation ¹).

We regret the fact of being unable to make use of the information derived from them. Apart from some inevitable synonyms these papers give further information about the horizontal and vertical distribution of Lower Mesophytic pollen and spores in Europe.

MÄDLER (1964) has described palynological assemblages from the Röt, Lower Muschelkalk and Keuper of Germany. Other data from the Röt is given by SCHULZ (1965) and by REINHARDT and SCHMITZ (1965). An important stratigraphic diagram is published by KLAUS (1965). Finally, I ought to mention two papers by CLARKE (1965a, b) on Keuper and Permian palynology, respectively.

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¹) CLARKE, R. F. A. 1965a. Keuper miospores from Worcestershire, England. Palaeontology **8**: 294–321.
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REINHARDT, P. and W. SCHMITZ. 1965. Zur Kenntnis der Sporae dispersae des mitteldeutschen Oberen Buntsandsteins. Freiberger Forschungshefte **C 182**: 19–36.
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———— and ————. 1956. Monolete, monocolpate and alete sporomorphs from Australian Permian sediments. Austr. J. Bot. **4**: 54–67.

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