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## Upper Triassic spores and pollen from the Polish Carpathian Foreland

### ABSTRACT

In the foreland of the Polish Carpathians, assemblages of sporomorphs were encountered in the Lower Keuper series of dark pelites and in the variegated pelite series of the Upper Keuper. This paper contains the taxonomic description of a new genus of pollen from Keuper deposits of the borehole Trzciana near Mielec in the Carpathian Foreland. The new genus is *Diaphanisporites*, and the new combinations are *Concentricisporites insignis*, *Distalanulisporites badius*, *Diaphanisporites diaphanus*, *Cordaitina major*, *Cordaitina minor*, *Protohaploxypinus subcarpaticus*, *Alisporites perlucidus*, *Granisaccus decus*, *Granisaccus ornatus*, and *Brachysaccus fulvus*.

### INTRODUCTION

In Keuper sediments from the Polish Carpathian Foreland, rich sporomorph assemblages were found in boreholes of the State Oil Prospecting Enterprise over a distance of 60 km. from Niwiska near Mielec in the east to Radzanów near Busko in the west. The best-preserved sporomorphs were obtained from the borehole Trzciana lying centrally in this area. The geological documentation of this borehole is contained in the publication on the Niwiska structure by A. Tokarski (1962). According to this paper, the Lower Keuper sediments of the borehole Trzciana lie on Muschelkalk sediments. The boundary between Lower and Upper Keuper occurs in the borehole Trzciana at the depth of 1130 m. The Lower Keuper of Poland is equivalent to the Carnian of the Alpine region. The variegated Upper Keuper series, equivalent to the Norian, is covered by Rhaetic deposits. Sporomorphs were found only in grey shales which are intercalated in the dark pelite sediments of the upper part of the Lower Keuper series (samples from the depth interval 1132–1140 m.), and in the variegated pelite sediments of the Upper Keuper series (samples from the depth interval 1116–1123 m.). In the lower part of the Lower Keuper (below 1140 m. — Lettenkohle equivalent), no sporomorphs were found. The sporomorph assemblage from the grey shales in the dark pelites of the Lower Keuper is characterized by a great percentage of trilete spores (probably mostly fern spores) and a small percentage of Acritarcha and spores of presumably shallow-water plants (*Aratrisporites*, probably spores of *Isoëtales*, and *Calamospora*, derived from the genera of the family Calamitaceae — see sporomorph assemblages in table 1). In the assemblage from the variegated pelites of the Upper Keuper, the number of Acritarcha and shallow-water plant spores rapidly increases, and the number of trilete spores decreases. I assume that this is the result of a seacoast oscillation in the area of the borehole of Trzciana.

Due to circumstances beyond control of the author, the completion of the manuscript of the final revision of this paper was delayed severely. Because of this, many species first described here, inadvertently by now have been validly published in a later paper (Pautsch, *Acta Palaeobotanica*, 1971). Similarly, several genera were validly published through the device of the *descriptio generico-specifica*; the original diagnoses for these genera are published here.

### SYSTEMATIC DESCRIPTIONS

The slides with the figured specimens are stored in the Institute of Botany, Polish Academy of Sciences, Kraków, Poland.

TABLE 1

The spormorphs found in the Keuper deposits of the Trzciana borehole (in percent).

Species	Depth interval	1132–1140m	1119–1123m	1116–1119m
<i>Calamospora tenera</i> Leschik, emend. de Jersey	0.20	2.30	5.00	
<i>Punctatisporites crassexinis</i> Mädlar	0.20	—	—	
<i>Punctatisporites magnus</i> Pautsch	0.20	—	0.30	
<i>Punctatisporites subcarpaticus</i> Pautsch	0.50	—	0.70	
<i>Crispetectatisporites punctatus</i> Pautsch	0.15	—	—	
<i>Todisporites minor</i> Couper	13.00	5.40	5.50	
<i>Retusotrilletes mesozoicus</i> Klaus	—	0.65	0.50	
<i>Carnisporites hercynicus</i> Mädlar	0.20	0.75	0.20	
<i>Carnisporites cf. ornatus</i> Mädlar	—	—	0.20	
<i>Carnisporites cf. telephorus</i> Pautsch, emend. Mädlar	0.20	2.00	2.20	
<i>Paraconavisporites</i> sp.	0.10	0.55	0.20	
<i>Converrucosisporites conferteornatus</i> Pautsch	1.00	—	—	
<i>Converrucosisporites diverseornatus</i> Pautsch	0.20	—	0.40	
<i>Cyclogranisporites rugosetectatus</i> Pautsch	0.70	—	0.30	
<i>Baculatisporites comaumensis</i> Cookson, emend. R. Potonié	0.10	—	0.80	
<i>Conbaculatisporites mesozoicus</i> Klaus	0.10	—	0.30	
<i>Keuperisporites baculatus</i> Schulz	0.10	—	—	
<i>Distalanulisporites punctus</i> Klaus	—	—	0.30	
<i>Distalanulisporites badius</i> Pautsch, n. comb.	0.30	—	0.20	
<i>Microreticulatisporites opacus</i> Leschik, emend. Klaus	25.00	0.75	—	
<i>Lycopodiadites kuepperi</i> Klaus	0.10	—	—	
<i>Camazonosporites rudis</i> Leschik, emend. Klaus	0.20	0.75	0.30	
<i>Concentricisporites insignis</i> Pautsch, n. comb.	0.15	—	—	
<i>Stylisporites granulatus</i> Pautsch	0.20	—	—	
<i>Leschikisporis aduncus</i> Leschik, emend. R. Potonié	1.20	—	0.70	
<i>Echinitosporites illioides</i> Schulz	0.20	—	0.30	
<i>Ellipsoascus subcarpaticus</i> Pautsch	0.60	—	—	
<i>Aratrisporites saturni</i> Thiergart, emend. Mädlar	5.80	34.50	16.00	
<i>Aratrisporites virgatus</i> Leschik	3.50	7.15	2.50	
<i>Aratrisporites pilosus</i> Leschik	—	0.75	0.50	
<i>Aratrisporites rotundus</i> Mädlar	2.00	8.25	1.50	
<i>Aratrisporites cf. fischeri</i> Klaus	—	—	2.10	
<i>Aratrisporites scabratus</i> Klaus	1.00	—	0.80	
<i>Cordaitina major</i> Pautsch, n. comb.	1.50	—	4.00	
<i>Cordaitina minor</i> Pautsch, n. comb.	0.50	0.75	0.70	
<i>Institisporites crispus</i> Pautsch	0.10	—	0.70	
<i>Taeniaesporites kräuseli</i> Leschik	0.15	0.65	0.30	
<i>Ovalipollis lunzensis</i> Klaus	0.10	—	—	
<i>Striatoabieites aytugii</i> Visscher, emend. Scheuring	0.90	0.75	0.50	
<i>Protohaploxylinus limpidus</i> Balme and Hennelly	0.50	0.45	0.20	
<i>Protohaploxylinus subcarpaticus</i> Pautsch	0.20	—	—	
<i>Infirmisporites fragilis</i> Pautsch	0.30	2.30	0.30	
<i>Infernopollenites sulcatus</i> Pautsch, emend. Scheuring	1.10	0.45	—	
<i>Illinites chitonoides</i> Klaus	6.80	2.00	14.00	
<i>Angustisulcites klausii</i> Freudenthal	0.40	—	—	
<i>Vitreisporites pallidus</i> Reissinger, emend. Nilson	—	0.75	1.60	
<i>Alisporites aequalis</i> Mädlar	12.50	2.50	3.50	
<i>Alisporites perlucidus</i> Pautsch, n. comb.	0.15	—	0.80	
<i>Diaphanisporites diaphanus</i> Pautsch, n. comb.	0.80	1.50	1.10	
<i>Cuneatisporites cf. radialis</i> Leschik	0.40	1.00	1.50	
<i>Falcisporites nuthallensis</i> Clarke, emend. Balme	0.15	—	0.30	
<i>Falcisporites keuperianus</i> Pautsch	1.10	2.80	5.30	
<i>Brachysaccus cf. neomundanus</i> Leschik, emend. Mädlar	1.40	—	6.60	
<i>Brachysaccus fulvus</i> Pautsch, n. comb.	0.90	1.00	—	
<i>Protodiploxylinus gracillis</i> Scheuring	2.80	9.75	11.00	
<i>Granisaccus ornatus</i> Pautsch, n. comb.	0.15	2.00	1.50	
<i>Granisaccus decus</i> Scheuring, emend. Pautsch	0.90	1.00	0.30	
<i>Plicatisaccus badius</i> Pautsch	1.10	1.35	0.30	
<i>Platysaccus cf. papilionis</i> R. Potonié and Klaus	0.90	—	—	
<i>Platysaccus niger</i> Mädlar	1.20	0.65	0.30	
<i>Platysaccus nitidus</i> Pautsch	2.50	1.00	0.50	
<i>Platysaccus subcarpaticus</i> Pautsch	0.90	0.65	0.20	
<i>Monosulcites minimus</i> Cookson	0.20	0.45	1.20	
<i>Monosulcites perforatus</i> Mädlar	0.20	0.45	0.50	
<i>Monosulcites salebrosus</i> Pautsch	1.20	1.00	0.30	

In reporting dimensions, the first figure is the minimum, the second the mean, and the third the maximum.

Turma TRILETES Reinsch, 1881, emend. R. Potonié and Kremp, 1954

Subturma AZONOTRILETES Lubert, 1935

Infraturma LAEVIGATI Bennie and Kidston, 1886, emend. R. Potonié, 1956

Genus PUNCTATISPORITES Ibrahim, emend. R. Potonié and Kremp, 1954

***Punctatisporites magnus*** Pautsch, 1971

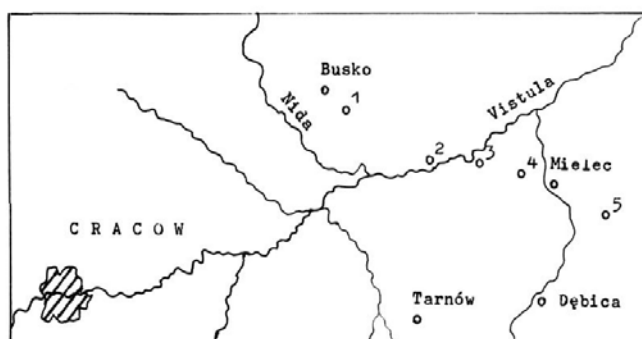
Plate 1, figure 1

**Distribution:** Lower and Upper Keuper of Trzciana, Carpathian Foreland, Poland.

**Holotype:** Plate 1, figure 1; Lower Keuper deposits of Trzciana.

**Diagnosis:** Very large, round, trilete spores without any tendency to folding. Exine dark brown, in optical section three-layered. The inner layer is lighter-coloured than the two others, its thickness equal to 1/4 of the whole wall. The middle layer is equal to 1/2 and the external layer to 1/4 of the wall thickness. Small wrinkles on the surface are perhaps of secondary origin. Rays of trilete mark longer than half but less than three quarters of the spore radius, straight, not thickened, ending obtusely or branching, the branches short and straight, without tendency to form curvatures. All specimens found are fissured.

**Dimensions:** Diameter 89/100/111  $\mu$ , length of laesurae 16/28/40  $\mu$ , wall thickness 3/4/5  $\mu$ . Four specimens were found, three of them suitable for measurement.



TEXT-FIGURE 1

Localities of the boreholes studied. 1, Radzanów; 2, Oblekoń; 3, Stupiec; 4, Trzciana; 5, Niwiska.

**Comparisons:** *Punctatisporites obesus* Loose, emend. R. Potonié, is lighter and with shorter laesurae. *P. flavus* Kosanke, emend. R. Potonié, differs in its yellow colour and convex dehiscence ridges. *P. gretensis* Balme and Hennelly has longer rays, a tendency to folding, and a rather subcircular outline.

***Punctatisporites subcarpaticus* Pautsch, 1971**

Plate 1, figure 7

**Distribution:** Lower and Upper Keuper of Trzciana, Carpathian Foreland, Poland.

**Holotype:** Plate 1, figure 7; Lower Keuper deposits of Trzciana.

**Diagnosis:** Trilete, roundish, medium-sized spores with a thick, brown exine. The wall consists of three layers. In optical section, the inner layer thickness is equal to  $\frac{1}{4}$ – $\frac{1}{3}$  of the thickness of the whole wall, the middle layer to  $\frac{1}{2}$ , and the external layer to about  $\frac{1}{4}$  of the thickness. The inner layer is slightly lighter in colour than the two others. The internal face of the exine is distinctly visible. Surface smooth, slightly punctate. The small wrinkles on it are perhaps of secondary origin. Laesurae not thickened, straight, of unequal length, often forked at the end or blunt. Laesurae branches distinctly terminated without tendency to form curvaturae. The rays extend for about  $\frac{2}{3}$  of the spore radius. Secondary folds rare.

**Dimensions:** Diameter 42/50/60  $\mu$ , length of laesurae 13/18/21  $\mu$ , thickness of wall 2/3/4  $\mu$ . Ten specimens were found, seven of which are suitable for measurement.

**Comparisons:** *Punctatisporites obliquus* Kosanke, *P. punctatus* Ibrahim and all of the *Punctatisporites* species described by Leschik from the Keuper of Basel have a thinner exine. *P. grandis* Kosanke,

emend. R. Potonié, and *P. magnus* Pautsch are much larger. *P. mundus* Kosanke is distinctly triangular in shape. *P. crassexinis* Mädlar is greyish-brown with a distinct punctation and a poorly visible internal surface of wall, which seems to be one-layered.

**Genus *Crispetectatisporites* Pautsch, 1971**

**Type species:** *Crispetectatisporites punctatus* Pautsch, 1971.

**Diagnosis:** Trilete spores with erect labra which have a crispate margin.

**Comparison:** No other miospore genus includes spores with labra having a crispate margin.

***Crispetectatisporites punctatus* Pautsch, 1971**

Plate 1, figures 3, 6

**Distribution:** Lower Keuper of Trzciana, Carpathian Foreland, Poland.

**Holotype:** Plate 1, figure 3; Lower Keuper deposits of Trzciana.

**Diagnosis:** Rounded triangular, light-coloured, trilete spores with pronounced labra that have a height of up to 6  $\mu$ . Margin of labra crispate. Laesurae  $\frac{2}{3}$  to  $\frac{3}{4}$  of the spore radius. Exine smooth, distinctly punctate near the proximal pole.

**Dimensions:** Diameter 88/93/98  $\mu$ , length of laesurae 28/35/48  $\mu$ , height of labra 5–6  $\mu$ , wall thickness 1.5  $\mu$ . Two specimens were found, both suitable for measurement.

Infraturma APICULATI Bennie and Kidston, 1886, emend. R. Potonié, 1956

Genus CONVERRUCOSISPORITES R. Potonié and Kremp, 1954

***Converrucosisporites conferteornatus* Pautsch, 1971**

Plate 1, figure 8

**Distribution:** Lower Keuper of Trzciana, Carpathian Foreland, Poland.

**Holotype:** Plate 1, figure 8; Lower Keuper deposits of Trzciana.

**Diagnosis:** Large, red-brown, triangular, trilete spores with slightly concave sides. Exine sculpture consists of polygonal warts lying close to each other. Towards the proximal pole they become gradually smaller. The basal diameter of warts on one specimen ranges from 1–3  $\mu$ . Spore corners without wall thickenings. Laesurae reach  $\frac{2}{3}$  of spore radius.

**Dimensions:** Diameter 76/101/120  $\mu$ , length of laesurae 24/33/49  $\mu$ , wart diameter 2/4/6  $\mu$ ,

wart height  $0.125/4\ \mu$ , wall thickness  $3/3, 4/4\ \mu$ . Thirteen specimens were found, all suitable for measurement.

**Comparisons:** *Converrucosisporites diverseornatus* Pautsch differs in small size, thinner wall, greyish-yellow colour, greater variability of wart diameter on one specimen and non-uniform wart distribution on the surface. *C. mosaicoides* R. Potonié and Kremp, *C. triquetrus* Ibrahim, emend. R. Potonié and Kremp, and *C. eggeri* Klaus are much smaller. *C. dejerseyi* Klaus has different sculpture and convex sides.

***Converrucosisporites diverseornatus*** Pautsch, 1971  
Plate 1, figure 10

**Distribution:** Lower and Upper Keuper of Trzciana, Carpathian Foreland, Poland.

**Holotype:** Plate 1, figure 10; Upper Keuper deposits of Trzciana.

**Diagnosis:** Large, triangular, trilete spores with slightly concave or straight sides. Sculpture is composed of warts varying in size, distributed irregularly on the surface. The wart diameter on one specimen varies within the range of  $2-6\ \mu$ . Shape of wart bases circular or polygonal. The largest warts are on the corners, and those of medium size are on the distal side. Exine near the apex punctate and without warts. Spacing between warts usually equals their diameter, but is never less than the wart radius. Exine greyish-yellow, without thickening at the corners. Laesurae straight, unthickened, extending  $2/3$  of the spore radius.

**Dimensions:** Spore diameter  $86/92/99\ \mu$ , length of laesurae  $24/33/37\ \mu$ , wart diameter  $2/4/6\ \mu$ , wart height  $0.5/2.8/6\ \mu$ , wall thickness  $1/1.75/2\ \mu$ . Four specimens were found, all suitable for measurement.

**Comparisons:** *Converrucosisporites conferteornatus* Pautsch differs in larger size, red-brown exine and smaller wart variability on one specimen; warts distributed uniformly on distal side. *C. mosaicoides* R. Potonié, *C. triquetrus* Ibrahim, emend. R. Potonié and Kremp, and *C. eggeri* Klaus differ in their much smaller size. *C. dejerseyi* Klaus differs in ornamentation and convexity of sides.

Genus CYCLOGRANISPORITES R. Potonié and Kremp, 1954

***Cyclogranisporites rugosetectatus*** Pautsch, 1971  
Plate 1, figure 4

**Distribution:** Lower and Upper Keuper of Trzciana, Carpathian Foreland, Poland.

**Holotype:** Plate 1, figure 4; Lower Keuper deposits of Trzciana.

**Diagnosis:** Trilete, round spores with two-layered exine, yellow to light brown. Inner layer  $1/4-1/3$  of the thickness of the whole wall. Exine surface covered with small, round granula up to  $1\ \mu$  in size, the distance between them  $1.5\ \mu$ . Trilete mark developed very characteristically; laesurae extending  $1/2$  of spore radius, with transverse wrinkles up to  $4\ \mu$  long and  $1\ \mu$  broad. Contact areas almost smooth, with distinct curvaturae perfectae, which are strongly convex between the laesurae. This species occurs chiefly in the Lower Keuper.

**Dimensions:** Spore diameter  $49/55/60\ \mu$ , length of laesurae  $8/13/24\ \mu$ , wall thickness  $1/2/3\ \mu$ . Twelve specimens were found, all suitable for measurement.

**Comparisons:** *Cyclogranisporites arenosus* Mädlar from the Lower Keuper of the Harz Mountains Foreland is similar in size, sculpture of the distal side, but Mädlar makes no mention of the characteristic transverse wrinkles on the tetrad scar, nor of the absence of sculpture on the contact areas.

Infraturma MURORNATI R. Potonié and Kremp, 1954  
Genus CONCENTRICISPORITES Antonescu, 1969

***Concentricisporites insignis*** (Pautsch, 1971) Pautsch, n. comb.  
Plate 1, figure 9

**Synonym:** *Spiralisporites insignis* Pautsch, 1971.

**Distribution:** Lower Keuper of Trzciana, Carpathian Foreland, Poland.

**Holotype:** Plate 1, figure 9; Lower Keuper deposits of Trzciana.

**Diagnosis:** Large, dark brown, trilete spores, covered uniformly with concentric anuli of thickened exine on the distal side and also slightly above the equator. In semiequatorial view the anuli intersect and overlap, giving the impression of spiral sculpture. This species falls within the range of variation of the genus *Concentricisporites*. The description of this genus by Antonescu (1969) reached me after the publication of my paper of 1971. In my opinion, the photograph of the genoholotype in the paper of Antonescu (1969) shows no equatorial zone.

**Dimensions:** Diameter  $124/140/155\ \mu$ , length of laesurae  $34/41/57\ \mu$ , breadth of thickened anuli  $8/9/11\ \mu$ . Two specimens were found, both suitable for measurement.



Genus *DISTALANULISPORITES* Klaus, 1960, amend. Pocock, 1970

***Distalanulisporites badius*** (Pautsch, 1971) Pautsch, n. comb.

Plate 1, figure 2

**Synonym:** *Bianulisporites badius* Pautsch, 1971.

**Distribution:** Lower and Upper Keuper of Trzciana, Carpathian Foreland, Poland.

**Holotype:** Plate 1, figure 2; Lower Keuper deposits of Trzciana.

**Diagnosis:** Triangular, trilete spores of medium size, dark brown, with slightly rounded corners and straight sides. On the equator an annulus of thickened exine and on the distal side a second one both of triangular shape. The two annuli lie next to each other. They are dark brown. The much thinner circumpolar exine is lighter-coloured. Proximal side punctate. Laesurae thin, slightly undulate, reaching equatorial annulus.

In 1970, Pocock emended the genus *Distalanulisporites* Klaus, including also triangular species. Thus, *D. badius* falls within the scope of this genus.

**Dimensions:** Diameter 37/43/53  $\mu$ , length of laesurae 11/16/24  $\mu$ , breadth of distal annulus 3/4/6  $\mu$ , breadth of equatorial annulus 3/3/4  $\mu$ . Five specimens were found, all suitable for measurement.

**Comparisons:** *Distalanulisporites punctus* Klaus and *D. schulzii* Pocock differ in the circular shape of their distal annulus. *D. incertus* Bolkhovitina, emend. Pocock, has a circular distal annulus with distinct sculpture. *D. spurius* Bolkhovitina, emend. Pocock, *D. genuinus* Bolkhovitina, emend. Pocock and *D. verrucosus* Pocock possess a verrucose distal annulus.

Turma ZONALES Bennie and Kidston, 1886, emend. R. Potonié, 1956

Subturma ZONOTRILETES Waltz, 1935

Infraturma ZONATI R. Potonié and Kremp, 1954

Genus *STYXISPORITES* Cookson and Dettmann, 1958

***Styxisporites granulatus*** Pautsch, 1971

Plate 1, figure 5; plate 2, figure 1

**Distribution:** Upper Keuper of Trzciana, Carpathian Foreland, Poland.

**Holotype:** Plate 1, figure 5; Upper Keuper deposits of Trzciana.

**Diagnosis:** Medium-sized, subtriangular, trilete spores. Labra slightly convex, extending to the equator. A 5–10  $\mu$  wide zona with a gently wavy margin surrounds the spore. Sculpture granulate or infragranu-

late. Exine light brown. The species has spinae about 3 x 1.5  $\mu$  in size on the distal part.

**Dimensions:** Diameter 60/75/99  $\mu$ , zona width 5/7/10  $\mu$ . Three specimens were found, all suitable for measurement.

**Comparisons:** *Styxisporites cooksonae* Klaus has smooth contact areas, much larger processes (8 x 5.2  $\mu$ ), and distinctly dark-coloured exine.

Turma ALETES Ibrahim, 1933

Subturma AZONALETES Lubert, emend. R. Potonié and Kremp, 1954

Genus LARICOIDITES R. Potonié, Thomson and Thiergart, 1950

***Laricoidites subcarpaticus*** Pautsch, 1971

Plate 2, figures 4, 6

**Distribution:** Lower and Upper Keuper of Trzciana, Carpathian Foreland, Poland.

**Holotype:** Plate 2, figure 6; Upper Keuper deposits of Trzciana.

**Diagnosis:** Large, probably originally circular, monolete sporomorphs, usually with a great number of secondary folds. Exine slightly infragranulate, light-brown to yellow. Some specimens show a single laesura.

**Dimensions:** Length of sporomorphs 66/107/147  $\mu$ , breadth 53/96/127  $\mu$ , wall thickness 1.5–2  $\mu$ . Nineteen specimens were found, 17 of which are suitable for measurement.

**Comparisons:** *Laricoidites magnus* R. Potonié, emend. R. Potonié, Thomson and Thiergart and *L. intra-granulosus* Bharadwaj and Singh differ in their smaller size.

Turma SACCITES Erdtman, 1947

Subturma MONOSACCITES Chitaley, 1951, emend. R. Potonié and Kremp, 1954

Infraturma TRILETESACCITI Leschik, 1955

Genus ***Ellipsosaccus*** Pautsch, 1971

**Type species:** *Ellipsosaccus subcarpaticus* Pautsch, 1971.

**Diagnosis:** Large, monosaccate pollen grains, oval in polar view. Body bearing a trilete mark and surrounded by a peripheral monosaccus. Bladder on two sides much longer, ornamented with a distinct reticulum. Both bases of the bladder are distinct and roughly circular.

**Comparisons:** *Accinctisporites* Leschik possesses no trilete mark nor bladder differentiated in length; furthermore, its whole body is covered by the bladder.

*Succinctisporites* Leschik has no trilete mark, and its whole body is inside the bladder. *Virkkisporea* Pant and Srivastava is alete. *Lebachia* Florin, *Walchianthus* Florin, *Ullmannia frumentaria* Schlotheim, emend. Goeppert, and *Florinites* Schopf, Wilson and Bentall all differ in that the whole body is surrounded by a bladder, with the exception of a sulcus on the distal side.

***Ellipsosaccus subcarpaticus* Pautsch, 1971**

Plate 2, figures 5, 7

**Distribution:** Lower Keuper of Trzciana, Carpathian Foreland, Poland.

**Holotype:** Plate 2, figure 7; Lower Keuper deposits of Trzciana.

**Diagnosis:** Large, oval, trilete monosaccate pollen grains. Bladder with infrareticulum. Body usually round and smooth. Proximally and distally a large area of body not covered by bladder, which encircles the body along its equator. Bladder much wider at the ends of the long axis of the pollen grain.

**Dimensions:** Specimen length 166/195/209  $\mu$ , breadth 101/125/132  $\mu$ ; body length 65/83/98  $\mu$ , breadth 58/77/98  $\mu$ ; smallest bladder width 11/19/24  $\mu$ , largest bladder width 47/57/65  $\mu$ ; laesurae 7–12  $\mu$ , infrareticulum lumina diameters up to 8  $\mu$ . Six specimens were found, all suitable for measurement.

Infraturma ALETESACCITI Leschik, 1955

Genus CORDAITINA Samoilovich, 1953, *sensu* Balme, 1970

***Cordaitina major* (Pautsch, 1971) Pautsch, n. comb.**

Plate 3, figures 1, 4–5

**Synonym:** *Circulisaccus major* Pautsch, 1971.

**Distribution:** Lower and Upper Keuper of Trzciana, Carpathian Foreland, Poland.

**Holotype:** Plate 3, figure 1; Lower Keuper deposits of Trzciana.

**Diagnosis:** Large, monosaccate, disklike pollen grains without trilete mark or monolete laesura. Body in polar view nearly circular and usually brown. Of the 50 specimens found, only 5 still possess a body. There remains, on the distal? side, only a single thin wall, transparent and smooth, sometimes with an indistinct reticulum, frequently with numerous irregular wrinkles. Originally, the body was probably spherical or convex lenticular, and it is much folded in the fossil state. The bladder is circular in outline and attached peripherally to the equatorial part of the

body. It is circular and bulging in its uncrumpled state, thin-walled and light yellow. Its shape reminds one of a tyre. Infrareticulum irregular, in the internal part of the bladder often radially structured. Along the distal and proximal roots thickenings frequently occur. The roots extend more or less circularly, covering each other in polar view.

The genus *Cordaitina* Samoilovich, 1953, cited by Balme (1970), comprises round forms with a thin body without a tetrad scar and with an equatorially attached inflated saccus. *C. major* Pautsch, n. comb., has those features and must be assigned to this genus.

**Dimensions:** Diameter 122/182/252  $\mu$ , body diameter 57/91/117  $\mu$ , bladder length 37/50/68  $\mu$ , reticulum lumina diameters 3–9  $\mu$ . Fifty specimens were found, of which 35 were suitable for measurement.

**Comparisons:** *Cordaitina minor* Pautsch, n. comb., differs in its much smaller dimensions and in the absence of thickenings near the bladder roots. The body in this species usually remains. *C. gunyalensis* Pant and Srivastava, 1964, emend. Balme, 1970, has a greater body diameter in relation to the total diameter ( $2/3 : 1$ ) and a little smaller mean size (142  $\mu$ ). *C. uralensis* Luber and Waltz, 1941, emend. Samoilovich, 1953, is much smaller (70  $\mu$ , *fide* Hart, 1965). The other species of the genus *Cordaitina* figured by Hart (1965) have a distinct bladder offlap.

***Cordaitina minor* (Pautsch, 1971) Pautsch, n. comb.**

Plate 3, figures 7–8

**Synonym:** *Circulisaccus minor* Pautsch, 1971.

**Distribution:** Lower and Upper Keuper of Trzciana, Carpathian Foreland, Poland.

**Holotype:** Plate 3, figure 8; Lower Keuper deposits of Trzciana.

**Diagnosis:** Monosaccate, greyish-yellow pollen grains of medium size. Outline circular to slightly trilobate; shape disklike. Body usually without secondary folds, yellow or light brown, sometimes with a fine reticulum near the bladder roots. Bladder outline smooth. Reticulum near the bladder roots often disposed radially. Bladder roots circular, covering one another. *C. minor* Pautsch, n. comb., must be included in the genus *Cordaitina* Samoilovich, 1953, *sensu* Balme, 1970, because it falls within the limits of this circumscription of the genus.

**Dimensions:** Specimen diameter 37/49/57  $\mu$ , body diameter 24/33/35  $\mu$ , bladder length 3/8/14  $\mu$ ,

reticulum lumina diameters 2–6  $\mu$ . Sixteen specimens were found, 14 of them suitable for measurement.

Genus *Institisporites* Pautsch, 1971

*Type species: Institisporites crispus* Pautsch, 1971.

*Derivation of name: instita* (Latin) = flounce. This genus shows a creased strip of inflated exoexine resembling a flounce.

*Diagnosis:* Saccate pollen grains with a creased strip of inflated exoexine which joins the bladders.

*Comparisons:* The genera *Accinctisporites* Leschik and *Succinctisporites* Leschik have a body uniformly enveloped by a bladder. *Cordaitina* Samoilovich, *sensu* Balme, 1970, and *Ellipsozaccus* Pautsch possess a circular bladder but no exoexine strip. *Rugubivesiculites* Pierce is bisaccate without a joining exine strip.

*Institisporites crispus* Pautsch, 1971

Plate 3, figures 2–3

*Distribution:* Lower and Upper Keuper of Trzciana, Carpathian Foreland, Poland.

*Holotype:* Plate 3, figure 3; Upper Keuper deposits of Trzciana.

*Diagnosis:* Bisaccate or trisaccate pollen grains in which bladders are joined by a creased strip of inflated exoexine. Body brown, granulate, with a thick wall. Body outline dentate on account of grana which partly protrude above the wall. An oval area of thinner exine visible on the distal pole. Bladders and joining strip smooth, translucent, without infrareticulum, punctate or infragranulate, both situated on the distal part of the body. The bladders are about five times longer than the width of the strip.

*Dimensions:* Specimen length 75/87/93  $\mu$ , body length 49/61/71  $\mu$ , body breadth 57/61/66  $\mu$ , bladder length 26/32/37  $\mu$ , bladder breadth 32/37/45  $\mu$ , exine strip length 9/13/19  $\mu$ . Five specimens were found, all suitable for measurement.

Subturma DISACCITES Cookson, 1947

Infraturma STRIATITI Pant, 1954

Genus STRIATOABIEITES Sedova, 1956

*Striatoabieites aytugii* Visscher, 1966, emend. Scheuring, 1970

Plate 3, figure 6

*Synonym: Striatites elongatus* Pautsch, 1971.

*Distribution:* Lower and Upper Keuper of Trzciana, Poland; Bunter of Hengelo, Netherlands; Keuper of

the B6lchentunnel southeast of Basel, Switzerland.

*Diagnosis:* Bisaccate pollen grains, diploxylonoid, light yellow, with striate body. Body oval, longer than broad, with reticulum structure on the proximal side. Taeniae and striae often run irregularly — they may terminate prematurely or join together. Distal part of body without sculpture. Bladders semicircular, distal roots usually straight. No thickenings along the proximal roots. Infrareticulum irregular, lumina polygonal. Scheuring (1970) emended the species *Striatoabieites aytugii* Visscher in such a way that the specimens from Trzciana were brought within its bounds.

*Dimensions:* Specimen length 68/90/111  $\mu$ , body length 40/61/94  $\mu$ , body breadth 35/48/62  $\mu$ , bladder length 24/36/47  $\mu$ , bladder breadth 36/54/66  $\mu$ , taeniae breadth 2–8  $\mu$ , number of striae 6–9, distance between the distal bladder roots 6/14/22  $\mu$ .

Genus PROTOHAPLOXYPINUS Samoilovich, 1953, emend. Hart, 1964

*Protohaploxypinus subcarpaticus* (Pautsch, 1971) Pautsch, n. comb.

Plate 3, figure 9

*Synonym: Faunipollenites subcarpaticus* Pautsch, 1971.

*Distribution:* Lower Keuper of Trzciana, Carpathian Foreland, Poland.

*Holotype:* Plate 3, figure 9; Lower Keuper deposits of Trzciana.

*Diagnosis:* Bisaccate, yellow pollen grains, widely oval, with arched striae. Body exine thin and infragranulate. The striae occupy only an oval area in the middle of the proximal side. There are usually four or five distinct striae. Bladders semicircular. Distal roots distinct, straight. Infrareticulum rather fine. The genus *Faunipollenites* Bharadwaj, 1962, was emended by Hart (1964) so as to be included in *Protohaploxypinus* Samoilovich, 1953, and therefore this species now is assigned to *Protohaploxypinus*.

*Dimensions:* Specimen length 86/93/98  $\mu$ , body length 50/52/53  $\mu$ , body breadth 60/65/70  $\mu$ , bladder length 29/32/35  $\mu$ , bladder breadth 58/63/70  $\mu$ , distance between distal roots 24/27/31  $\mu$ , breadth of the part with striae 32/36/42  $\mu$ , reticulum lumina diameters 1–4  $\mu$ .

*Comparisons:* *Protohaploxypinus varius* Bharadwaj, 1962, emend. Balme, 1970, is rounder in outline, *P. diagonalis* Balme is smaller in size. *P. microcorpus*

Schaarschmidt, 1963, emend. Clarke, 1965, is very large with numerous striae. Most species of *Protohaploxylinus* show more striae: *P. latissimus* (Luber and Waltz, 1941) emend. Samoilovich, 1953; *P. suchonensis* Sedova, 1956, emend. Hart, 1964; *P. perfectus* Naumova, emend. Samoilovich, 1953; *P. pennatulus* Andreyeva, 1956, emend. Hart, 1964; *P. dvinensis* Sedova, 1956, emend. Hart, 1964; *P. amplius* Balme and Hennelly, 1955, emend. Hart, 1964; *P. goraiensis* Potonié and Lele, 1961, emend. Hart, 1964; *P. kumaonensis* Lakhanpal, Sah and Dube, 1960, emend. Hart, 1964; *P. rhombaeformis* Poluchina, 1960, emend. Hart, 1964; *P. volaticus* Ischchenko, 1952, emend. Hart, 1964; *P. samoilovichii* Jansonius, 1962, emend. Hart, 1964; *P. jacobii* Jansonius, 1962, emend. Hart, 1964.

Genus *Infirmisporites* Pautsch, 1971

*Type species: Infirmisporites fragilis* Pautsch, 1971.

*Derivation of name: infirmus* (Latin) = weak. This genus has a very weak body exine.

*Diagnosis:* Bisaccate pollen grains of medium size. Body thin-walled, indistinctly taeniate. Bladders are firm and rigid, and have a smooth strip of thickened exine along the proximal bladder roots.

*Comparisons:* No other sporomorph genus with taeniae and striae shows smooth strips of thickened exine on the bladders near the proximal roots.

*Infirmisporites fragilis* Pautsch, 1971

Plate 4, figures 1–2

*Distribution:* Lower and Upper Keuper of Trzciana, Carpathian Foreland, Poland.

*Holotype:* Plate 4, figure 2; Lower Keuper deposits of Trzciana.

*Diagnosis:* Bisaccate pollen grains of medium size. Body exine very thin, translucent and smooth. In well-preserved specimens two longitudinal taeniae run slightly oblique, similar in shape to the letter X. Body usually poorly preserved, the proximal part especially often destroyed. Because of this the breadth of the body is unknown. Bladders crescent-shaped, usually well-preserved and often encountered separately. The bladders show a crescent-shaped area of thickened exine along the proximal roots. The surface of this area is smooth. Infrareticulum irregular.

*Dimensions:* Specimen length 70/73/81  $\mu$ , body length 47/50/52  $\mu$ , body breadth unknown, bladder length 19/24/26  $\mu$ , bladder breadth 42/49/60  $\mu$ , breadth of taeniae 6/7/8  $\mu$ , breadth of thickenings

near the proximal bladder roots 3/4/6  $\mu$ . Thirteen specimens were found, only 5 of which were suitable for measurement.

Genus *Infernopollenites* Scheuring, 1970

*Synonym: Umbrellisaccus* Pautsch, 1971.

*Type species: Infernopollenites sulcatus* (Pautsch, 1958) Scheuring, 1970, emend. Scheuring, 1970.

*Infernopollenites sulcatus* (Pautsch, 1958) Scheuring, 1970, emend. Scheuring, 1970  
Plate 4, figures 4–5, 7

*Synonyms: Pollenites sulcatus* Pautsch, 1958, pl. 1, fig. 8; *Umbrellisaccus sulcatus* Pautsch, 1971.

*Distribution:* Keuper of the Pomerania-Kujawy Anticlinorium; Gipskeuper of the Böhmentunnel south-east of Basel, Switzerland; Lower Keuper and lower part of the Upper Keuper of Trzciana, Carpathian Foreland, Poland.

*Description:* Large, brown, bisaccate pollen grains. Body oval, longer than broad. Taeniae reach the body margin and thus produce a notched outline of the body. The convex parts of the body outline are the ends of taeniae, whereas the notches correspond with the ends of striae. Striae 2–4 in number, narrow in uncrushed specimens. Sometimes a stria does not cross the whole body but only a part of its length. Usually, a taenia runs through the proximal pole. Body exine infragranulate, smooth, growing thinner in the direction of the distal pole. Bladders 180° or less in arc, rigid, very thick-walled, always broader than the body, umbrella-shaped in polar view and subtriangular in equatorial view. Bladders without secondary folds. Distal roots straight. Reticulum very fine, lumina diameters range from 2 to 4  $\mu$ . The genus *Pollenites* to which this species was assigned in 1958 is illegitimate.

*Dimensions:* Specimen length 88/113/173  $\mu$ , body length 49/71/101  $\mu$ , body breadth 34/58/81  $\mu$ , bladder length 32/49/78  $\mu$ , bladder breadth 58/78/107  $\mu$ , distance between distal roots 3/14/22  $\mu$ , bladder wall thickness 2/3.5/8  $\mu$ , number of striae 2–4. Twenty-one specimens were found in the material from Trzciana, 20 of them suitable for measurement.

Infraturma DISACCIATRILETI Leschik, 1955

Genus ALISPORITES Daugherty, 1941, emend. Nilson, 1958

*Alisporites perlucidus* (Pautsch, 1971) Pautsch, n. comb.

Plate 4, figures 3, 9

**Synonym:** *Complicatisaccus perlucidus* Pautsch, 1971.

**Distribution:** Lower and Upper Keuper of Trzciana, Carpathian Foreland, Poland.

**Holotype:** Plate 4, figure 3; Upper Keuper deposits of Trzciana.

**Diagnosis:** Light, medium-sized, bisaccate pollen grains, oval in shape with a tendency to form secondary folds on the body along the proximal roots of the bladders. No grooved sulcus on the distal side. Body exine infragranulate to finely reticulate, not transparent, light greyish yellow like the bladders, or slightly darker. Proximal bladder roots invisible because covered with secondary folds. Distal roots straight. Infrareticulum nearly regular. Lumina roundish, their diameter up to 3  $\mu$ . Body and bladders equally broad.

**Discussion:** No specimen was found in the equatorial position, and therefore the original uncompressed shape is not known. Neither is the reason for the folding tendency known. That is why this species is provisionally assigned to the genus *Alisporites*, although it probably occupies a position between the genera *Alisporites* and *Falcisporites*. The genus *Alisporites* Daugherty *sensu* Balme (1970) is somewhat similar, but without the tendency to form secondary folds on the body near the proximal roots. The genus *Falcisporites* Leschik, emend. Klaus, in some cases exhibits similar folds but constantly also a distinct, grooved sulcus on the distal side, which is absent in *A. perlucidus*.

**Dimensions:** Specimen length 57/64/75  $\mu$ , body length 32/36/44  $\mu$ , body breadth 36/45/53  $\mu$ , bladder length 17/23/29  $\mu$ , bladder breadth 36/45/50  $\mu$ . Seven specimens were found, all suitable for measurement.

Genus ***Diaphanisporites*** Pautsch, n. gen.

**Type species:** *Diaphanisporites diaphanus* (Pautsch, 1958) Pautsch, n. comb.

**Diagnosis:** Bisaccate alete pollen grains, small to medium-sized, with transparent body. Bladders light yellow, darker than the body, usually with clearly visible thickened strips along the proximal roots.

**Discussion:** This genus is here established to include pollen similar to *Caytonanthus* pollen grains, but of larger size. It does not seem suitable to assign such pollen to the genus *Alisporites* Daugherty, emend. Nilson, because the type species, *A. opii* Daugherty, is very much larger (mean 132  $\mu$ , cf. Balme, 1970)

with a regularly reticulate body and a relatively smaller distance between the distal bladder roots (maximum  $\frac{1}{3}$  of the body length). In the species *Diaphanisporites diaphanus* (Pautsch) Pautsch, n. comb., this distance amounts to more than  $\frac{1}{2}$  of the body length. The assignment of the species *D. diaphanus* to the genus *Vitreisporites* Leschik also is not suitable, because it is considered that the type species of the latter genus is pollen from *Caytonanthus arberi* Thomas, emend. Harris. Therefore, the genus *Vitreisporites* Leschik should be restricted to pollen of presumed *Caytonanthus* origin.

***Diaphanisporites diaphanus*** (Pautsch, 1958) Pautsch, n. comb.  
Plate 4, figure 6

**Synonym:** *Caytoniales-Pollenites diaphanus* Pautsch, 1958.

**Distribution:** Keuper of the Pomerania-Kujawy Anticlinorium, Lower and Upper Keuper of Trzciana, Carpathian Foreland, Poland.

**Holotype:** Micropaleontology, vol. 4, no. 3, pl. 1, fig. 11, 1958.

**Description:** Small to medium-sized bisaccate pollen grains, oval in outline. Body transparent, bladders yellow. Body oval, much broader than long, smooth, rarely with separate muri or indistinct reticulum, slightly broader than the bladders. Distal roots usually arcuate. In proximal view, the proximal and distal roots lie close to each other or overlap. The greatest breadth of the bladders is at their roots. Usually thickened strips of exine at the proximal roots. Specimens from the Carpathian Foreland differ from those of the Pomerania-Kujawy Anticlinorium (Swierczyna borehole, 1958) in slightly larger size. The specimen length in the anticlinorium ranges from 35 to 46  $\mu$  and in the Carpathian Foreland from 37 to 62  $\mu$ . The genus *Pollenites*, used to include this species in 1958, is not legitimate, and therefore a new genus must be constituted.

**Dimensions:** Specimen length 37/50/62  $\mu$ , body length 14/27/32  $\mu$ , body breadth 31/39/45  $\mu$ , bladder length 13/17/24  $\mu$ , breadth of bladders 24/37/45  $\mu$ , reticulum lumina diameters 3–4  $\mu$ . Twenty-four specimens were found, but only 14 are suitable for measurement.

Genus **FALCISPORITES** Leschik, 1956, emend. Klaus, 1960

***Falcisporites keuperianus*** Pautsch, 1971  
Plate 4, figures 8, 10–11



**Distribution:** Lower and Upper Keuper of Trzciana, Carpathian Foreland, Poland.

**Holotype:** Plate 4, figure 8; Lower Keuper deposits of Trzciana.

**Diagnosis:** Light-coloured, bisaccate pollen grains of elongate shape, haploxytonoid. Size large. Body length usually greater than body breadth. Along the proximal roots, crescent-shaped, dark thickenings, which are not secondary folds. The proximal part of body without exine thickening, and different sculpture on the polar area. Distal bladder roots indistinct. Distally, a sulcus present. Bladder reticulum often reaches the sulcus. The greatest bladder breadth occurs at the distal roots.

**Dimensions:** Specimen length 81/99/122  $\mu$ , body length 40/60/73  $\mu$ , body breadth 49/53/78  $\mu$ , bladder length 24/32/42  $\mu$ , bladder breadth 44/59/78  $\mu$ , sulcus length 4/16/19  $\mu$ , reticulum lumina diameters 2/4/8  $\mu$ . Sixty-one specimens were found, but only 44 were suitable for measurement.

**Comparisons:** *Falcisporites zapfei* R. Potonié and Klaus differs in smaller size and in the sculpture of the proximal part of the body. At the proximal roots there are often secondary folds, considered by Leschik to be a diagnostic feature. *F. granulatus* Leschik has a distinct granulate body and secondary folds near the proximal roots. *F. snopkova* Visscher possesses a body broader than long, and narrower bladders. *F. stabilis* Balme is somewhat smaller and partly diploxytonoid. *F. nuthallensis* Clarke, emend. Balme, is distinctly smaller.

***Falcisporites nuthallensis*** Clarke, 1965, emend. Balme, 1970  
Plate 5, figure 4

**Synonym:** *Diaphanisporites major* Pautsch, 1971.

**Distribution:** British Permian; Pakistan Permian; Lower and Upper Keuper of Trzciana, Carpathian Foreland, Poland.

**Description:** Medium-sized bisaccate pollen grains, subangular to oval in outline. Body translucent, much broader than long, infragranulate, with a more or less distinct sulcus on the distal side. Bladders and body of the same breadth. Thickenings along the proximal roots. Distal roots arcuate. The greatest breadth of bladders situated at some distance from their roots. Bladders greyish-yellow. Pollen grain outline subrectangular.

**Dimensions:** Specimen length 63/66/70  $\mu$ , body

length 25/28/44  $\mu$ , body breadth 39/42/44  $\mu$ , bladder length 18/23/26  $\mu$ , bladder breadth 40/42/45  $\mu$ . Four specimens were found, all suitable for measurement.

Genus **PROTODIPLOXYPINUS** Samoilovich, 1953, emend. Scheuring, 1970

***Protodiploxypinus gracilis*** Scheuring, 1970  
Plate 2, figures 8–9

**Synonym:** *Minutisaccus subcarpaticus* Pautsch, 1971.

**Distribution:** Swiss Keuper; Lower and Upper Keuper of Trzciana, Carpathian Foreland, Poland.

**Description:** Bisaccate, small, light-coloured pollen grains. Body oval, elongate, infragranulate to granulate on proximal part. Outline slightly notched. Exine of the distal part of the body smooth. The border of the sculptured proximal part is not always clearly visible. It is bent archwise in equatorial view. The thinner distal exine is often invaginated, and in such cases the body exine is arched and the bladders are lying distally. In this aspect the specimens, except for the presence of bladders, resemble cycadophyte pollen. Straightened specimens distinctly longer than broad. Bladders very small, short and broad, appearing almost as semicircular warts. Reticulum distinct.

**Dimensions:** Body length 32/40/49  $\mu$ , body breadth 27/30/34  $\mu$ , body height 21/27/35  $\mu$ , bladder length 6/8/11  $\mu$ , bladder breadth 11/13/17  $\mu$ , bladder height 11/12/13  $\mu$ .

Genus **GRANISACCUS** Mädlar, 1964, emend. Pautsch

**Type species:** *Granisaccus sulcatus* Mädlar, 1964.

**Diagnosis:** Bisaccate pollen grains, in which the body is covered with grana, verrucae, gemmae, rugulae or cristae. This emendation is necessary in regard to the usually great variability of the sculpture. Scheuring (1970) included the genus *Granisaccus* Mädlar, 1964, in the genus *Protodiploxypinus* Samoilovich, 1953. The latter genus was established by Samoilovich for bisaccate diploxytonoid pollen with laevigate or striate body. Pollen grains of the genus *Granisaccus* (Mädlar, 1964a) show a completely different sculpture, are very characteristic and easy to distinguish even in distorted state. Therefore, it seems to be useful and suitable to retain *Granisaccus* Mädlar as a separate genus.

**Granisaccus decus** (Scheuring, 1970) Pautsch, n. comb.  
Plate 5, figures 3, 6

**Synonyms:** *Protodiploxypinus decus* Scheuring, 1970;  
*Granisaccus elongatus* Pautsch, 1971.

**Distribution:** Swiss Keuper, Lower and Upper Keuper of Trzciana, Carpathian Foreland, Poland.

**Description:** Bisaccate pollen grains with dark body and yellow bladders. Body oval in polar view, steeply vaulted in equatorial view. Proximal side with irregular verrucae lying near each other. Border of the sculptured proximal part distinct. Bladders thin and light-coloured. Distal roots arcuate and slightly narrower than the body breadth. In polar view, the bladders protrude beyond the body outline. Reticulum very fine.

**Dimensions:** Specimen length 63/76/89  $\mu$ , body length 55/66/80  $\mu$ , body breadth 45/56/78  $\mu$ , body height 40/51/60  $\mu$ , bladder length 24/31/65  $\mu$ , bladder breadth 40/53/65  $\mu$ , reticulum lumina diameters 1–3  $\mu$ .

**Granisaccus ornatus** (Pautsch, 1971) Pautsch, n. comb.  
Plate 2, figures 2–3

**Synonym:** *Minutisaccus ornatus* Pautsch, 1971.

**Distribution:** Lower and Upper Keuper of Trzciana, Carpathian Foreland, Poland.

**Holotype:** Plate 2, figure 2; Upper Keuper deposits of Trzciana.

**Diagnosis:** Bisaccate, small pollen grains with distinct body sculpture. Body oval, longer than broad. The thick, brown exine of the proximal part has two visible layers. The sculpture consists of half-raised grana. This is because the outline is distinctly notched. The exine of the distal part seems single-layered and is much lighter. The border of the ornamented cappa is distinct and bent archlike in equatorial view. Bladders small and yellow. After emendation of *Granisaccus* Mädlar, this species falls within the bounds of this genus.

**Comparisons:** *Granisaccus decus* (Scheuring) Pautsch, n. comb., and *G. sulcatus* Mädlar show greater sculpture elements and greater dimensions.

**Dimensions:** Body length 22/29/34  $\mu$ , body breadth 19/23/29  $\mu$ , bladder length 5/8/12  $\mu$ , bladder breadth 8/11/14  $\mu$ , bladder height 9/11/14  $\mu$ . Sixteen specimens were found, all suitable for measurement.

Genus **Plicatisaccus** Pautsch, 1971

**Type species:** *Plicatisaccus badius* Pautsch, 1971.

**Diagnosis:** Bisaccate pollen grains, consistently with radial foldings of bladder exine, especially on the distal side. Body thick-walled. The type species has a very similar appearance to some species of *Dacrydium* (*Dacrydium cupressinum* Soland, *D. elatum*, *D. falciforme*, *D. taxoides* – the last three species in Erdtman, 1957).

**Comparisons:** *Parvisaccites* Couper has much shorter bladders with radial thickenings of exoexine in their proximal part. *Cedripites priscus* Balme has a thick bladder exine without radial foldings.

**Plicatisaccus badius** Pautsch, 1971  
Plate 5, figures 7–8

**Distribution:** Lower and Upper Keuper of Trzciana, Carpathian Foreland, Poland.

**Holotype:** Plate 5, figure 7; Lower Keuper deposits of Trzciana.

**Derivation of name:** *badius* (Latin)—dark brown.

**Diagnosis:** Bisaccate pollen grains with thick, brown exine. Body oval, much longer than broad, opaque; structure indistinct, probably infragranulate. In specimens flatly compressed in polar position, the body exine bends and overlaps, giving the impression of a ruff around the body. The breadth of the overlap extends up to 8  $\mu$ . In equatorial view, body nearly triangular. Bladders brown, with radially disposed rows of reticulum lumina and radial foldings of the bladder wall, especially on the distal side. Distal roots not clearly visible, usually crescent-shaped. Often bladders secondarily and centripetally brought together, so that a narrow parallel-sided space is formed distally between them. This space has undulate margins on account of the ridges of radial exine foldings.

**Dimensions:** Specimen length 53/64/73  $\mu$ , body length 38/50/60  $\mu$ , body breadth 34/41/49  $\mu$ , bladder length 21/31/40  $\mu$ , bladder breadth 32/41/49  $\mu$ . Twenty-six specimens were found, 20 of which were suitable for measurement.

Genus BRACHYSACCUS Mädlar, 1964

**Brachysaccus fulvus** (Pautsch, 1971) Pautsch, n. comb.  
Plate 5, figures 2, 5

**Synonym:** *Radiatisaccus fulvus* Pautsch, 1971.

**Distribution:** Lower Keuper and lower part of the Upper Keuper of Trzciana, Carpathian Foreland, Poland.

*Holotype*: Plate 5, figure 5; Lower Keuper deposits of Trzciana.

*Diagnosis*: Bisaccate, oval, rufous pollen grains. Body broader than long. Body exine about 2  $\mu$  thick, indistinctly reticulate, or infrareticulate, with almost smooth outline. Bladders relatively large. On the proximal face of the bladders are radially disposed rows of reticulum lumina. Distally, infrareticulum irregular. Distal bladder roots straight, shorter than body breadth. Because of its over-all shape, this species is here transferred to the genus *Brachysaccus*.

*Dimensions*: Specimen length 71/84/98  $\mu$ , body length 52/63/73  $\mu$ , body breadth 53/69/91  $\mu$ , bladder length 31/38/52  $\mu$ , bladder breadth 49/66/91  $\mu$ , distance between distal roots 2/8/14  $\mu$ , reticulum lumina diameters 3/4/8  $\mu$ .

*Comparisons*: All of the other *Brachysaccus* species lack radial rows of reticulum lumina near the proximal bladder roots.

Genus PLATYSACCUS Naumova, emend. R. Potonié and Klaus, 1954

*Platysaccus nitidus* Pautsch, 1971  
Plate 5, figures 9–10

*Distribution*: Lower and Upper Keuper of Trzciana, Carpathian Foreland, Poland.

*Holotype*: Plate 5, figure 10; Lower Keuper deposits of Trzciana.

*Diagnosis*: Bisaccate, medium-sized, light-coloured pollen grains. Body oval or round, thin-walled, indistinctly infragranulate or reticulate. In specimens flatly compressed in polar position, the body exine

bends, forming a circular secondary fold around the body. Bladders semicircular or larger, always much broader than the body. In polar view the proximal roots are covered by the secondary fold running around the body. Distal roots straight. Originally, the exine must have been very soft, as indicated by the often bent and wavy outline of many specimens. Body and bladders of the same colour.

*Dimensions*: Specimen length 62/78/94  $\mu$ , body length 40/50/71  $\mu$ , body breadth 35/48/66  $\mu$ , bladder length 24/34/49  $\mu$ , bladder breadth 35/55/78  $\mu$ , distance between distal roots 4/10/21  $\mu$ . Fifty specimens were found, but only 24 were suitable for measurement.

*Comparisons*: All of the other species of the genus *Platysaccus* Naumova, emend. R. Potonié and Klaus, are larger, the body being usually darker than the bladders.

*Platysaccus subcarpaticus* Pautsch, 1971  
Plate 5, figure 1

*Distribution*: Lower and Upper Keuper of Trzciana, Carpathian Foreland, Poland.

*Holotype*: Plate 5, figure 1; Lower Keuper of Trzciana.

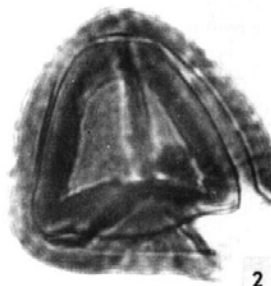
*Diagnosis*: Bisaccate pollen grains of large size. Body oval, longer than broad with indistinct outline marked only by a darker strip of exine. Body and bladders yellow. Bladders larger than the body, more than semicircular, sometimes wrinkled at the distal roots. Distal roots straight, the space between the roots small.

# PLATE 1

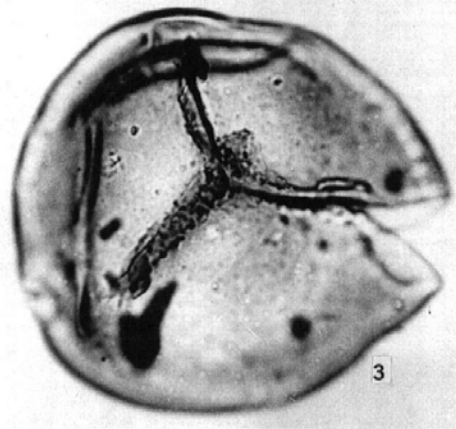
- 1 *Punctatisporites magnus* Pautsch  
Holotype, single sporomorph slide no. 4; 111  $\mu$ .
- 2 *Distalanulisporites badius* (Pautsch) Pautsch, n. comb.  
Holotype, single sporomorph slide no. 63; 42  $\mu$ .
- 3 *Crispetectatisporites punctatus* Pautsch  
Holotype, single sporomorph slide no. 17; 88  $\mu$ .
- 4 *Cyclogranisporites rugosetectatus* Pautsch  
Holotype, single sporomorph slide no. 32; 58  $\mu$ .
- 5 *Styxisporites granulatus* Pautsch  
Holotype, single sporomorph slide no. 66; 65  $\mu$ .
- 6 *Crispetectatisporites punctatus* Pautsch  
Single sporomorph slide no. 16; 98  $\mu$ .
- 7 *Punctatisporites subcarpaticus* Pautsch  
Holotype, single sporomorph slide no. 6; 60  $\mu$ .
- 8 *Converrucosisporites conferteornatus* Pautsch  
Holotype, single sporomorph slide no. 28; 76  $\mu$ .
- 9 *Concentricisporites insignis* (Pautsch) Pautsch, n. comb.  
Holotype, T 5, slide no. 4, 59.9/117 Leitz 536510; 124  $\mu$ .
- 10 *Converrucosisporites diverseornatus* Pautsch  
Holotype, single sporomorph slide no. 30; 89  $\mu$ .



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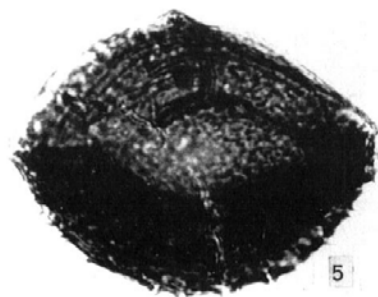
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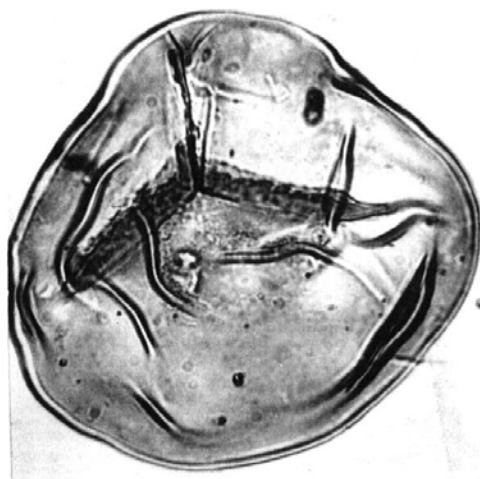
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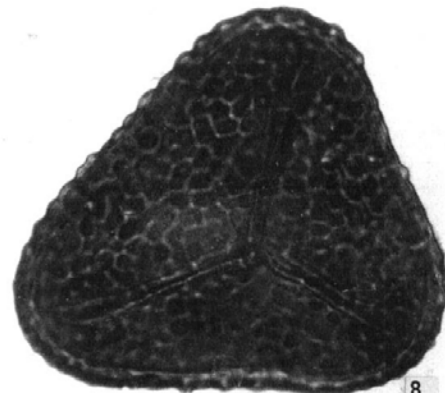
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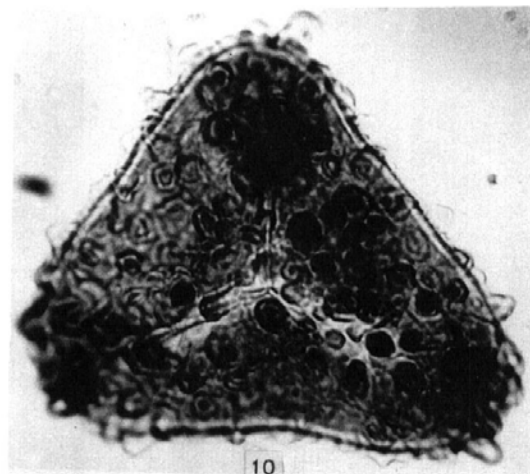
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**Dimensions:** Specimen length 119/152/185  $\mu$ , body length 52/74/98  $\mu$ , body breadth 52/67/89  $\mu$ , bladder length 55/75/94  $\mu$ , bladder breadth 71/92/114  $\mu$ , reticulum lumina diameters 3–9  $\mu$ . Eighteen specimens were found, 16 being suitable for measurement.

**Comparisons:** *Platysaccus umbrosus* Leschik is much smaller and dark, its bladders showing a tendency to join. *P. leschikii* Hart is slightly smaller (106–133  $\mu$ ) with a small body (31–41  $\mu$ ), broader than long. *P. triassicus* Mädlar and *P. nitidus* Pautsch are smaller with widely separated distal roots. *P. niger* Mädlar, *P. papilionis* R. Potonié and Klaus, and *P. reticulatus* Mädlar also are smaller and have dark bodies.

Turma PLICATES Naumova, 1959, emend. R. Potonié, 1960  
Subturma MONOCOLPATES Iversen and Troels-Smith, 1950  
Genus MONOSULCITES Cookson, 1947, emend. Couper, 1958

***Monosulcites salebrosus* Pautsch, 1971**

Plate 5, figure 11

**Distribution:** Lower and Upper Keuper of Trzciana, Carpathian Foreland, Poland.

**Holotype:** Plate 5, figure 11; Lower Keuper deposits of Trzciana.

**Diagnosis:** Roundish-oval, medium-sized, monosulcate pollen with a rugged outline. The rugged outline is the result of the uneven height of the sculpture granules. The granule diameters are less than 1  $\mu$ . Granules arranged close to each other. Colour of the pollen greyish yellow. The sulcus, not extending the whole length of the grain, usually bordered by folds. Sulcus surface smooth; exine of this part thin.

**Dimensions:** Specimen length 31/35/40  $\mu$ , specimen breadth 24/29/34  $\mu$ , sulcus breadth 1–5  $\mu$ , exine thickness ca. 1  $\mu$ . Twenty-five specimens were found, of which 17 are suitable for measurement.

**Comparisons:** The specimens of this species are similar to pollen grains of *Androstrobus manis* Harris and *A. wonnacottii* Harris, the photographs of which are presented by Couper (1958, pl. 26, figs. 15–16; pl. 26, figs. 17–18). These two species have a less distinct sculpture and a little longer sulcus. *Monosulcites* sp. Jansonius (1962), according to the photograph, is of more elongate shape, smoother outline, and more marked folds near the sulcus.

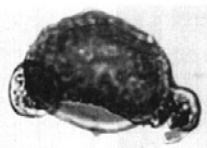
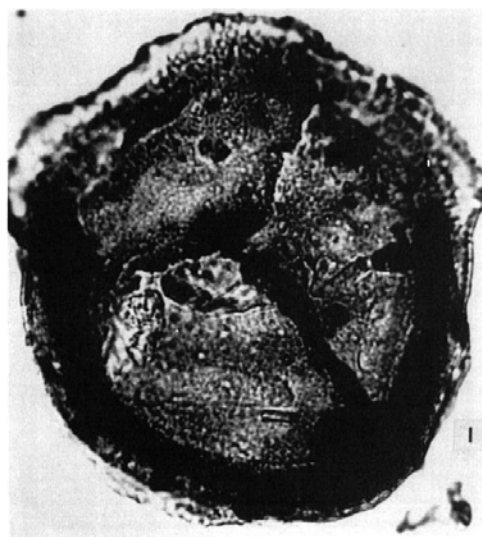
**ACKNOWLEDGEMENTS**

The morphological analysis of the described sporomorphs was mainly made at the Palaeobotanical Department of the Botanical Institute of the Polish

**PLATE 2**

- 1 *Styxisporites granulatus* Pautsch  
Single sporomorph slide no. 65; 99  $\mu$ .
- 2 *Granisaccus ornatus* (Pautsch) Pautsch, n. comb.  
Holotype, single sporomorph slide no. 235; 29  $\mu$ .
- 3 *Granisaccus ornatus* (Pautsch) Pautsch, n. comb.  
Single sporomorph slide no. 236; 32  $\mu$ .
- 4 *Laricoidites subcarpaticus* Pautsch  
Single sporomorph slide no. 76; 106  $\mu$ .
- 5 *Ellipsosaccus subcarpaticus* Pautsch  
Single sporomorph slide no. 98; 167  $\mu$ .
- 6 *Laricoidites subcarpaticus* Pautsch  
Holotype, single sporomorph slide no. 75; 142  $\mu$ .
- 7 *Ellipsosaccus subcarpaticus* Pautsch  
Holotype, single sporomorph slide no. 99; 199  $\mu$ .
- 8 *Protodiploxypinus gracilis* Scheuring  
Single sporomorph slide no. 213; 44  $\mu$ .
- 9 *Protodiploxypinus gracilis* Scheuring  
Single sporomorph slide no. 211; 52  $\mu$ .

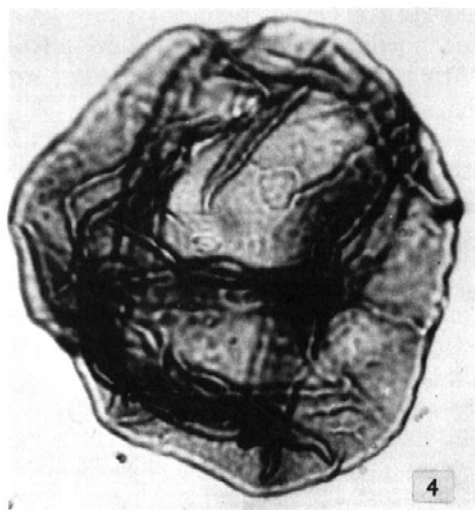




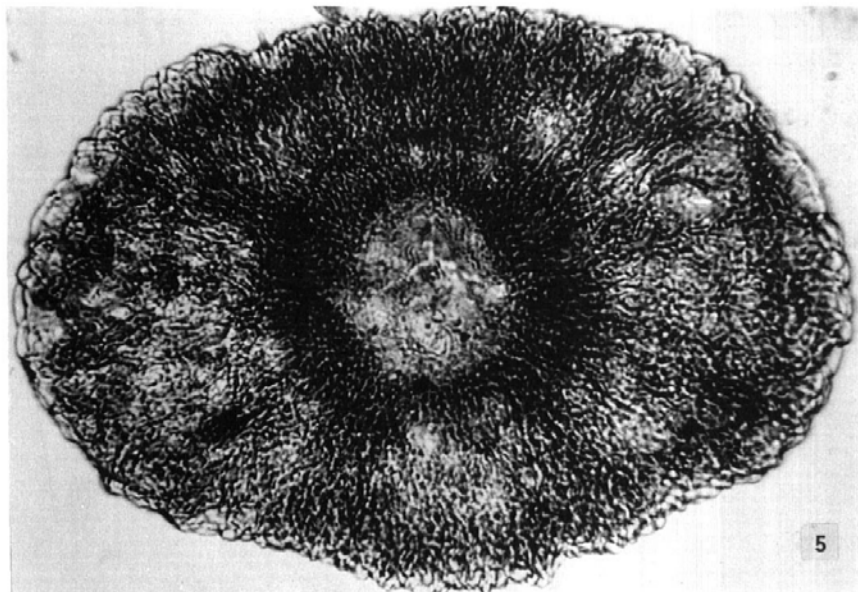
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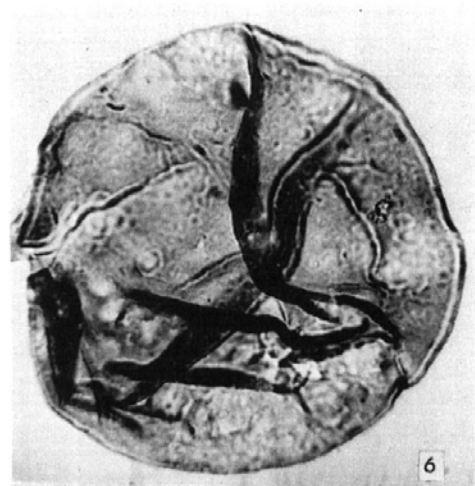
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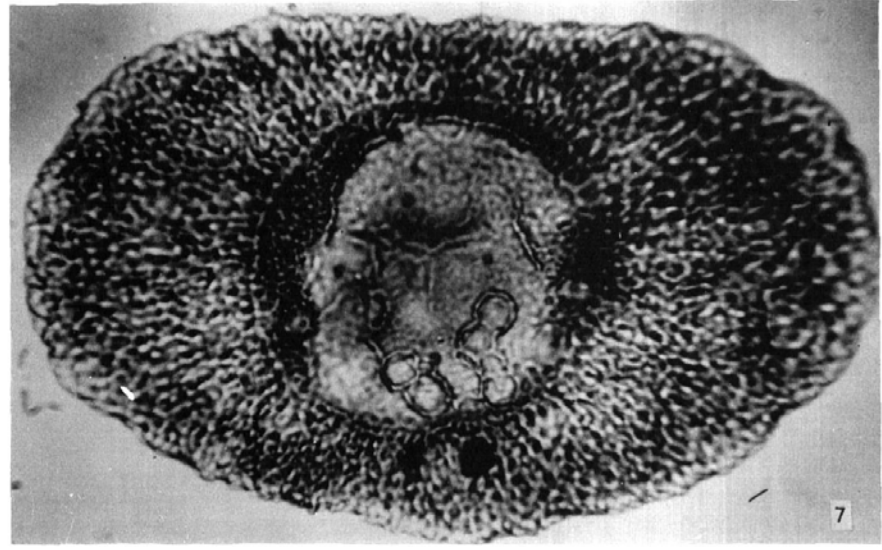
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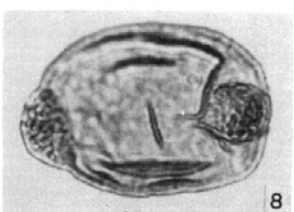
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Academy of Sciences in Kraków. Here I wish to acknowledge the encouraging attitude of Prof. W. Szafer towards the undertaking of palynological investigation of the Triassic. I must also thank Prof. J. Dyakowska and Prof. A. Środon for their advice during the morphological analysis of the described sporomorphs.

I obtained the core samples of the borehole Trzciana when I was working in the Micropalaeontological Laboratory of the State Oil Prospecting Enterprise in Kraków in order to carry out the stratigraphic dating on a palynological basis. I thank the head of the Micropalaeontological Laboratory, Dr. Z. Kirchner, for encouraging me to examine the morphology of the Keuper sporomorphs. I wish also to thank Dr. J. Kruczek, the chief geologist of the enterprise, for permission to work up and publish this material.

I am indebted to Prof. W. Klaus of the Geologische Bundesanstalt in Vienna for offering me comparative material from the Permian and Carnian of the Alps, and for putting at my disposal several necessary reprints.

I also wish to express my gratitude to Dr. J. Jansonius of Imperial Oil Limited, Calgary, for his kindness in offering his help, and for reading and discussing my manuscript.

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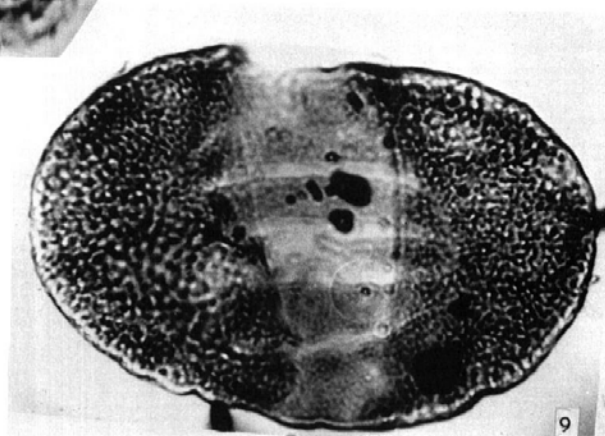
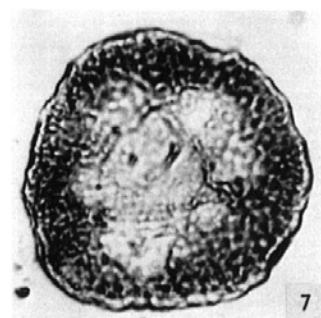
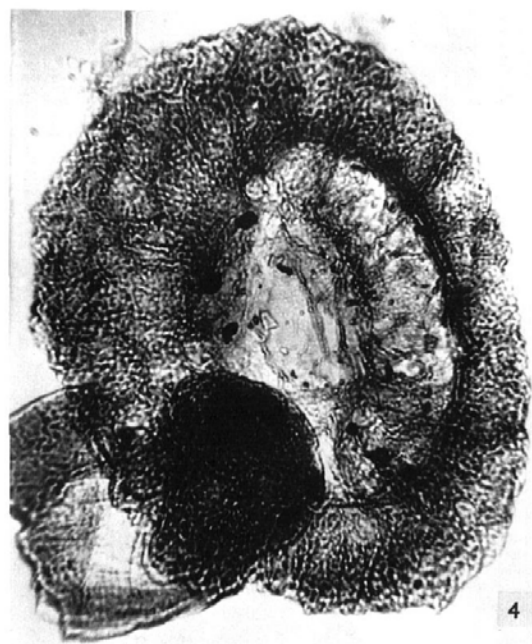
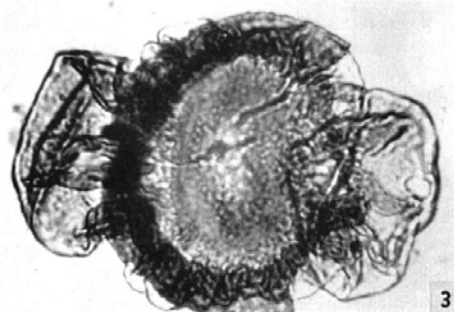
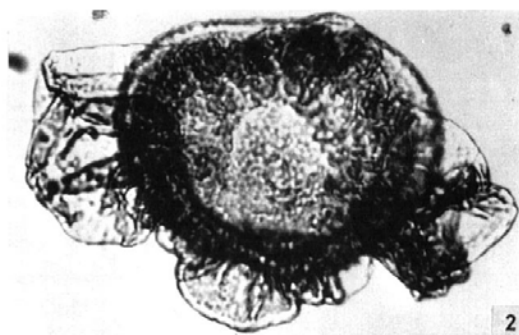
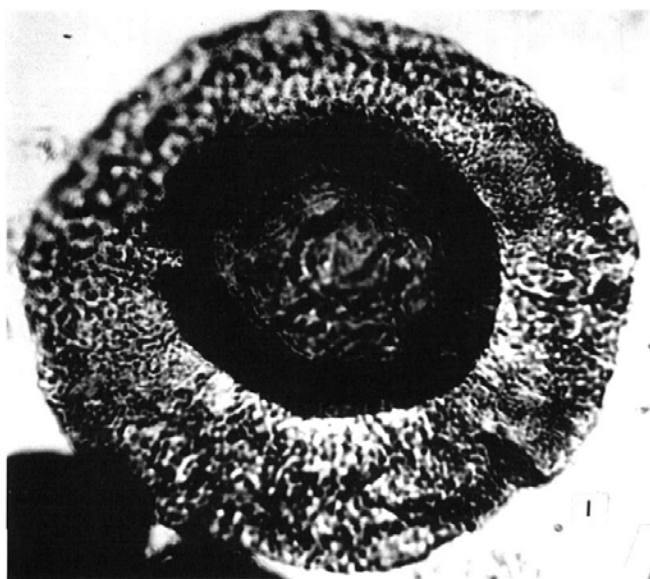
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# PLATE 3

- 1 *Cordaitina major* (Pautsch) Pautsch, n. comb. Holotype, T 5, slide no. 1, 30/116 Leitz 536510; 147  $\mu$ .
- 2 *Institisporites crispus* Pautsch Single sporomorph slide no. 119; 89  $\mu$ .
- 3 *Institisporites crispus* Pautsch Holotype, single sporomorph slide no. 120; 75  $\mu$ .
- 4 *Cordaitina major* (Pautsch) Pautsch, n. comb. Single sporomorph slide no. 104; 175  $\mu$ .
- 5 *Cordaitina major* (Pautsch) Pautsch, n. comb. Single sporomorph slide no. 107; 223  $\mu$ .
- 6 *Striatoabieites aytugii* Visscher, emend. Scheuring Single sporomorph slide no. 127; 105  $\mu$ .
- 7 *Cordaitina minor* (Pautsch) Pautsch, n. comb. Single sporomorph slide no. 117; 53  $\mu$ .
- 8 *Cordaitina minor* (Pautsch) Pautsch, n. comb. Holotype, single sporomorph slide no. 115; 57  $\mu$ .
- 9 *Protohaploxypinus subcarpaticus* (Pautsch) Pautsch, n. comb. Holotype, single sporomorph slide no. 132; 94  $\mu$ .



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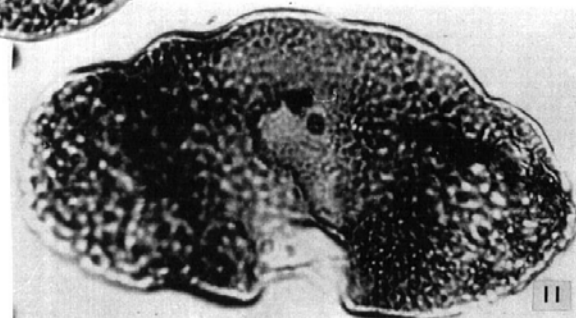
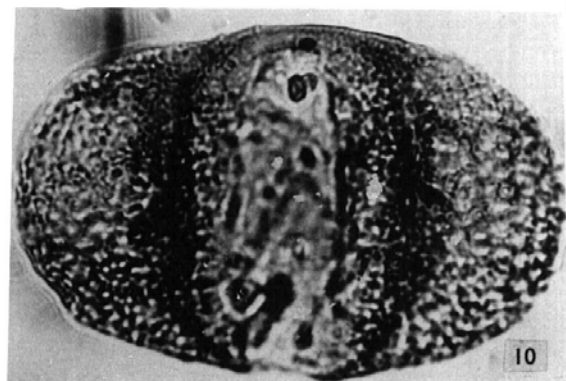
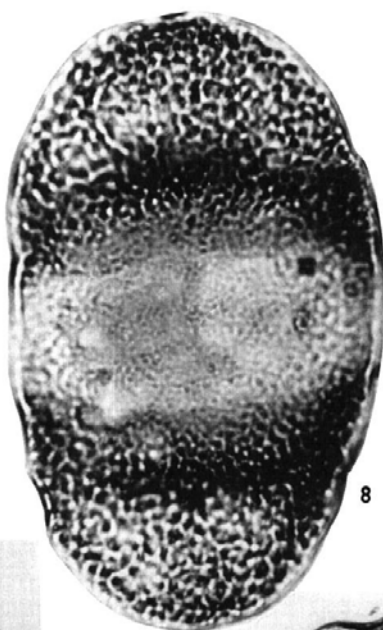
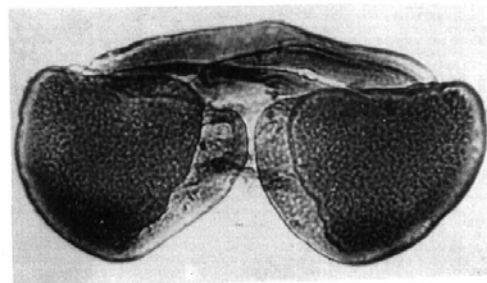
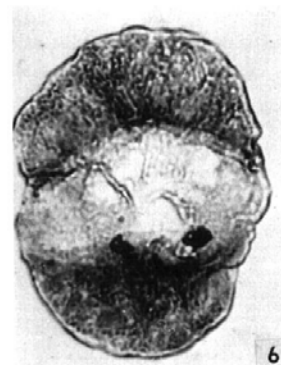
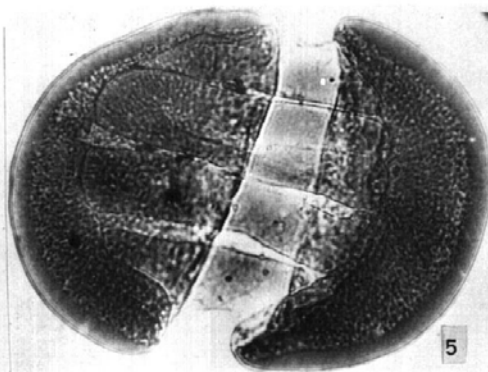
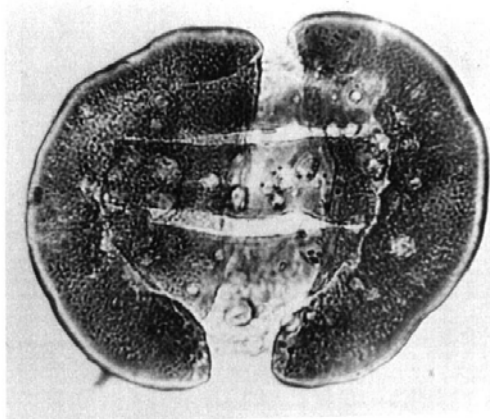
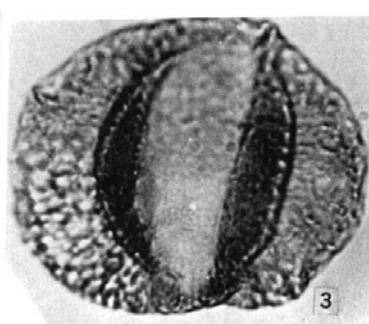
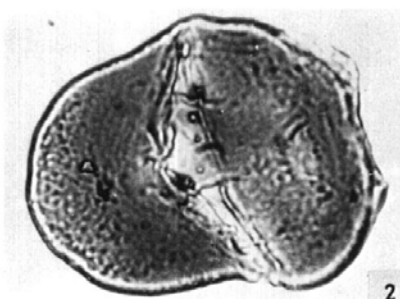
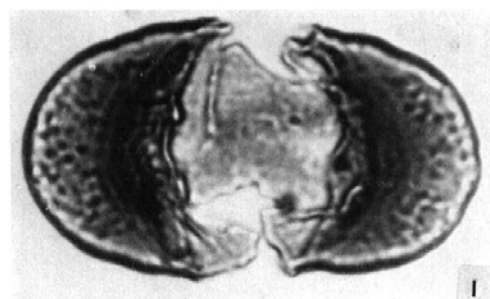
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## PLATE 4

- 1 *Infirmissporites fragilis* Pautsch  
Single sporomorph slide no. 134; 81  $\mu$ .
- 2 *Infirmissporites fragilis* Pautsch  
Holotype, single sporomorph slide no. 136.
- 3 *Alisporites perlucidus* (Pautsch) Pautsch n. comb.  
Holotype, single sporomorph slide no. 171; 62  $\mu$ .
- 4 *Infernopollenites sulcatus* Pautsch, emend. Scheuring  
Single sporomorph slide no. 138; 101  $\mu$ .
- 5 *Infernopollenites sulcatus* Pautsch, emend. Scheuring  
Single sporomorph slide no. 140; 113  $\mu$ .
- 6 *Diaphanisporites diaphanus* (Pautsch) Pautsch, n. comb.  
Single sporomorph slide no. 173; 60  $\mu$ .
- 7 *Infernopollenites sulcatus* Pautsch, emend. Scheuring  
Single sporomorph slide no. 141; 104  $\mu$ .
- 8 *Falcisporites keuperianus* Pautsch  
Holotype, single sporomorph slide no. 178; 112  $\mu$ .
- 9 *Alisporites perlucidus* (Pautsch) Pautsch, n. comb.  
Single sporomorph slide no. 172; 62  $\mu$ .
- 10 *Falcisporites keuperianus* Pautsch  
Single sporomorph slide no. 179; 97  $\mu$ .
- 11 *Falcisporites keuperianus* Pautsch  
Single sporomorph slide no. 184; 101  $\mu$ .







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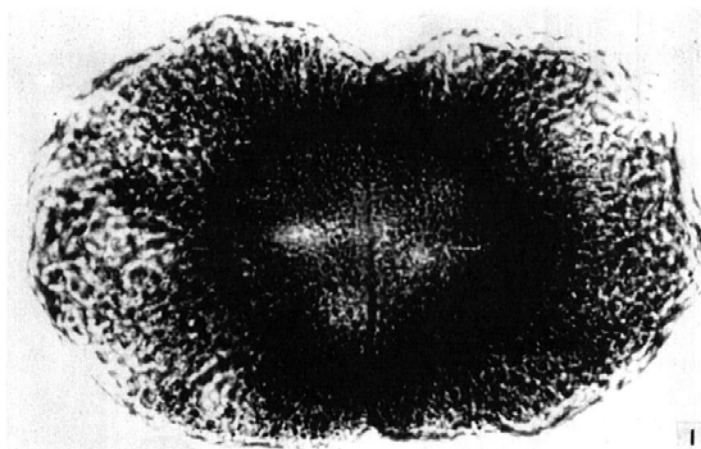
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First revised manuscript received August 24, 1970.

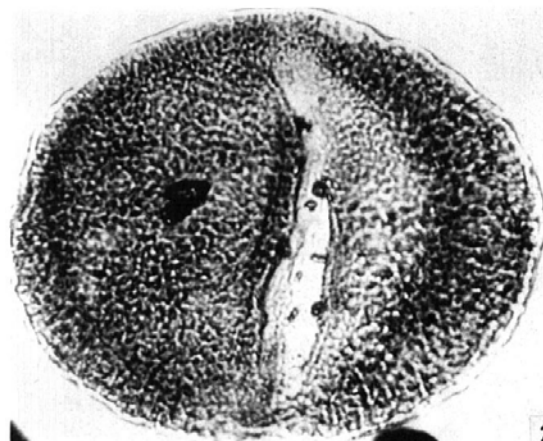
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## PLATE 5

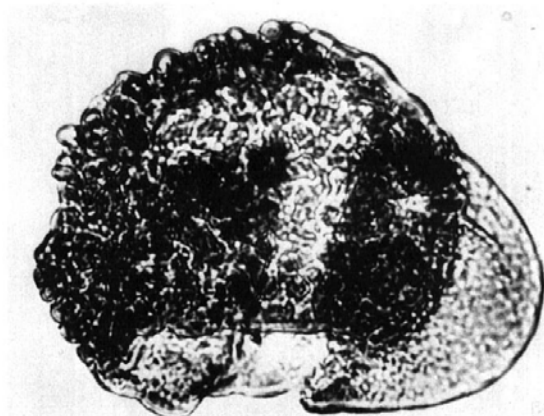
- 1 *Platysaccus subcarpaticus* Pautsch  
Holotype, single sporomorph slide no. 271; 132  $\mu$ .
- 2 *Brachysaccus fulvus* (Pautsch) Pautsch, n. comb.  
Single sporomorph slide no. 250; 98  $\mu$ .
- 3 *Granisaccus decus* (Scheuring) Pautsch, n. comb.  
Single sporomorph slide no. 238; 89  $\mu$ .
- 4 *Falcisporites nuthallensis* Clarke, emend. Balme  
Single sporomorph slide no. 177; 63  $\mu$ .
- 5 *Brachysaccus fulvus* (Pautsch) Pautsch, n. comb.  
Holotype, single sporomorph slide no. 249; 98  $\mu$ .
- 6 *Granisaccus decus* Scheuring, emend. Pautsch, n. comb.  
Single sporomorph slide no. 239; 88  $\mu$ .
- 7 *Plicatisaccus badius* Pautsch  
Single sporomorph slide no. 246; 68  $\mu$ .
- 8 *Plicatisaccus badius* Pautsch  
Holotype, single sporomorph slide no. 245; 60  $\mu$ ; outline retouched.
- 9 *Platysaccus nitidus* Pautsch  
Single sporomorph slide no. 266; 89  $\mu$ .
- 10 *Platysaccus nitidus* Pautsch  
Holotype, single sporomorph slide no. 264; 84  $\mu$ .
- 11 *Monosulcites salebrosus* Pautsch  
Holotype, single sporomorph slide no. 298; 40  $\mu$ .



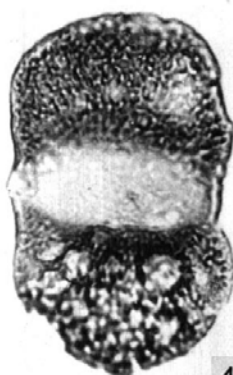
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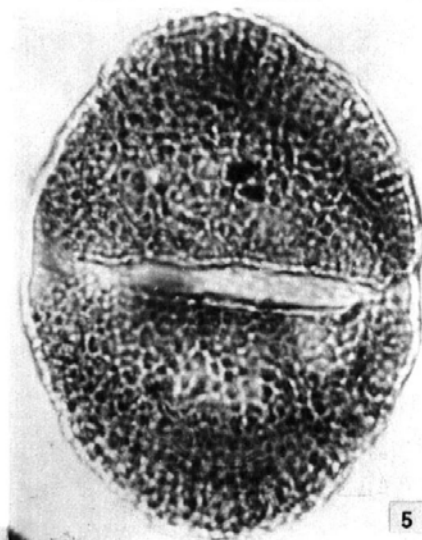
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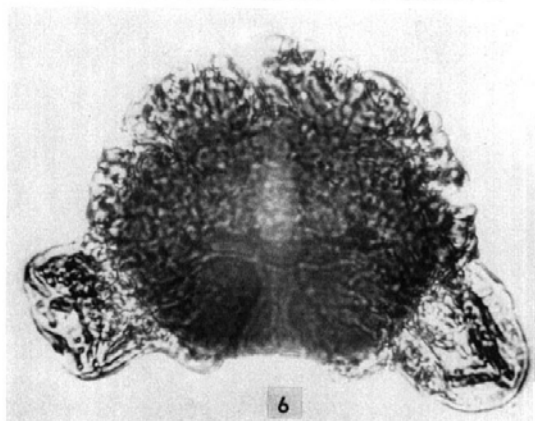
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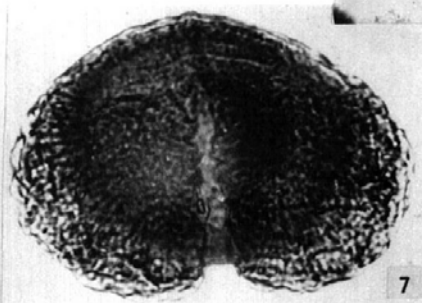
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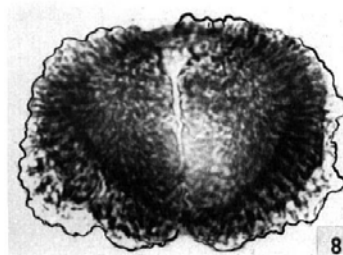
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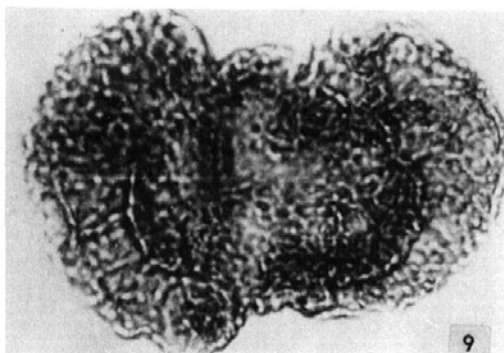
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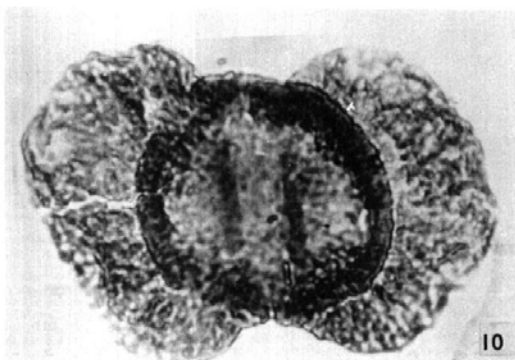
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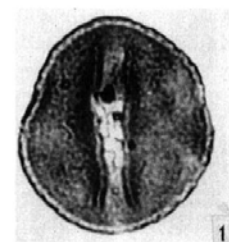
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9



10



11

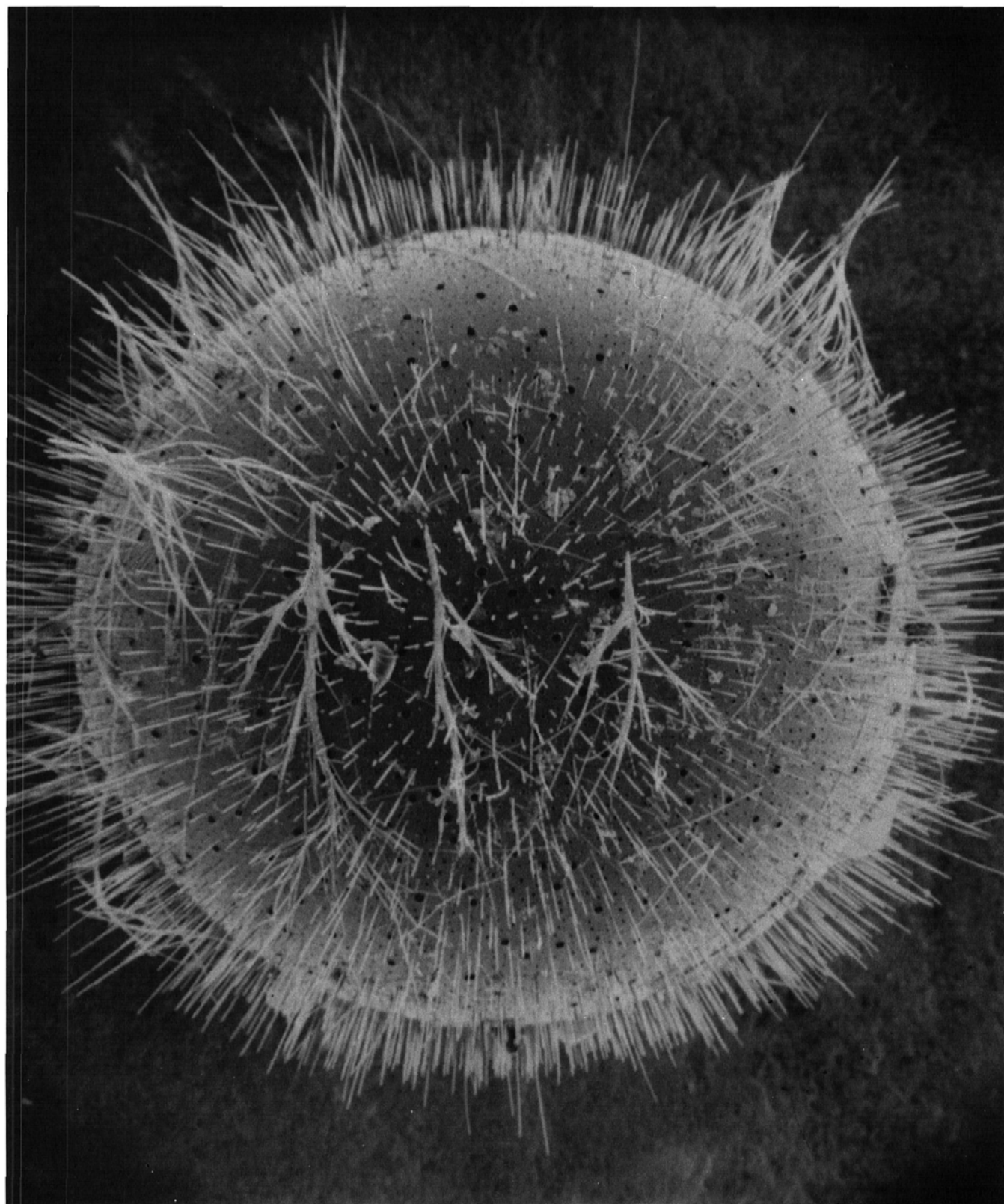


PLATE 1

*Orbulina universa* d'Orbigny from surface waters of the Indian Ocean, lat. 3°27'N, long. 86°21'E, x 210.