AN UPPER TRIASSIC MIOSPORE ASSEMBLAGE FROM THE COALS OF LUNZ, AUSTRIA

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ABSTRACT

A miospore assemblage recovered out of Upper Triassic (*Lunzer Schichten*) coal from Lunz (Austria) has been described. *Lunzisporites* gen. nov., and *Peroaletes* gen. nov., are the new genera described and the generic diagnoses of *Leschikisporis* Pot. and *Aratrisporites* Lesch. have been emended. A few genera viz., *Dictyophyllidites* Coup., *Laricoidites* Pot., Thoms. & Thierg., *Cycadopites* Wodehouse and *Decussatisporites* Lesch., have been critically discussed and their comparative diagnoses elaborated.

The assemblage has been compared with all the known, contemporary spore assemblages.

INTRODUCTION

THE present paper deals with the sporological investigation of 2 coal seams of Upper Triassic (Keuper) age from near Lunz in Austria. Coal seam I was sampled from Pözzenreith and coal seam II from Gaming Colliery.

The sample out of coal seam I yielded a nicely preserved and fairly well diversified spore assemblage but coal seam II proved barren. The miospores, recovered out of coal seam I, have been described here and referred to 20 genera and 40 species, out of which two genera, *Lunzisporites* gen. nov., and *Peroaletes* gen. nov., and 19 species are new. 2 miospore genera i.e. *Leschikisporis* Pot., and *Aratrisporites* Lesch., have been redefined and the generic diagnoses emended. 3 new combinations i.e. *Leiotriletes tenuis* (Lesch.) comb. nov., *Cycadopites subgranulosus* (Coup.) comb. nov., and *C. accerimus* (Lesch.) comb. nov., have been proposed. A few genera such as *Dictyophyllidites* Coup., *Laricoidites* Pot., Thoms. & Thierg., *Cycadopites* Wodehouse and *Decussatisporites* Lesch., have been critically examined and their comparative diagnoses elaborated. The spore assemblage described here is compared with the known spore floras of the comparable strata.

EARLIER WORK ON TRIASSIC SPORAE DISPERSAE

Thiergart (1949) has sporologically investigated the sediments out of Lower and Middle Keuper of Thüringen and Holstein in Europe, respectively. The former miospore-flora is poorer in composition and distinct by having different spore forms as compared to those in the latter.

de Jersey (1949) has described principal miospore types of the Ipswich coals from south-eastern Queensland, Australia. The miospore assemblage is richly represented by trilete, monolete, monosaccate and disaccate grains. From this study, de Jersey (*loc. cit.*) has suggested that Ipswich Series may be older than Middle Triassic. This age has already been suggested by the study of megaflora as well (JONES & DE JERSEY 1947, p. 82).

Leschik (1955) has described a rich and much diversified spore flora from Keuper of Neuewelt near Basel in Europe. This assemblage in addition to the trilete, monolete and monosaccate spores and pollen-grains also contains good many disaccate genera.

Recently Pautsch (1958) has contributed to our knowledge of Triassic *Sporae dispersae* from Swierczyna, Poland. The assemblage comprises chiefly the disaccate genera.

Klaus (1960) has sporologically investigated the Upper Triassic clays and shales belonging to the Karn of the alpine Triassic (= Zone of *Halobia rugosa* and *Cardita gümbeli* = Lower Middle Keuper). In this work he has indicated that the finer zonation within the Triassic period is feasible as a number of spores seem to be stratigraphically important.

MATERIAL AND METHODS

The coal samples from Pözzenreith and Gaming near Lunz in Austria were collected by one of us (BHARADWAJ) accompanied by Dr. A. Ruttner of Austrian Geological Survey, in October, 1954. The samples from these coal seams were taken and packed in thick brown paper envelopes. While sampling, the customary precautions to avoid surface contamination were taken.

These coals are shining black and soft, the coal lumps breaking into small pieces with slight pressure.

The customary maceration technique was followed with a little modification. For the oxidation of these coals, Nitric acid (Commercial) proved too strong causing ejection of the coal pieces from the maceration jars, due to vigorous effervescence immediately after the addition of the acid. To avoid this, coal samples were treated with dilute Nitric acid (35 per cent) for 24-36 hours and the acid free residue after repeated washings was covered with hot, 5 per cent KOH solution for one hour. One set each of 20 slides was prepared in Canada balsam and glycerine jelly.

DESCRIPTION OF SPORAE DISPERSAE

Anteturma — Sporites H. Pot. 1893
Turma — Triletes (R.) Pot. & Kr. 1954
Subturma — Azonotriletes Luber 1935
Infraturma — Laevigati (B. & K.) Pot. 1956
Genus — *Leiotriletes* (Naum.) Pot. & Kr. 1954

Leiotriletes tenuis (Lesch.) comb. nov.

Pl. 1, Figs. 1-4

Syn.— *Laevigatisporites tenuis* Lesch. 1955
Holotype — Leschik 1955, Pl. 1, Fig. 8.
Diagnosis (emend.) — Known size 33-42 μ, miospores triangular, sides slightly concave, trilete, Y-rays 2/3 of the radius, exine laevigate.

Description of our Specimens — Miospores triangular with slightly concave sides and broadly rounded angles. Trilete, Y-rays 2/3 of the radius long, ± straight, unequal. Exine about 1 μ thick, smooth.

Remarks — Potonié (1956, p. 23, 1958, p. 14) remarks that *Laevigatisporites* in an organ genus for the megaspores of Sigillariaceae and not a form genus as has been understood by Leschik (1955). Therefore, species of miospores assigned to *Laevigatisporites* by Leschik (*loc. cit.*) require a careful revision. Keeping the above fact in view, a new combination has been proposed to transfer *Laevigatisporites tenuis* to *Leiotriletes*. Exine of the holotype, appears to be more hyaline than is the case in our specimens. The presence of folds in the holotype of *L. tenuis* is coincidental and not a regular feature of specific value as has been surmised by Leschik (*loc. cit.*). In the diagnosis given by Leschik (*loc. cit.*) the trilete rays are said to be reaching almost to the equator which is not corroborated either by his figure of the holotype or by our specimens.

Leiotriletes adnatoides Pot. & Kr. 1955

Pl. 1, Figs. 5-6

Description of Our Specimens — Known size 36-44 μ, miospores triangular with broadly rounded corners and slightly concave sides. Y-rays more than 3/4 of the radius sometimes reaching the equator. *Extrema lineamenta* smooth, exine densely intrapunctate, exine along the rays in the inter-ray area darker in colour and thicker.

Genus — *Dictyophyllidites* Coup. 1958

Remarks — Couper (1958) has given description for the *in situ* spores of 3 species of *Dictyophyllum* L. & H., i.e. *D. rugosum* L. & H., *D. nilssoni* (Brongn.) Goepp., and *D. muensteri* (Goepp.) Nathorst and has instituted a new spore genus *Dictyophyllidites* to include dispersed triangular, laevigate spores with Y-rays bordered by thickening as is the case in the *in situ* spores of *Dictyophyllum*. However, a study of the dispersed spores recovered from Upper Triassic of Lunz and referred here to the genus *Dictyophyllidites* shows that the inter-ray thickening of the spore exine is not actually along the trilete rays but a little away from it, a fact also quite apparent in the spore figures of *Dictyophyllum rugosum* (Coup. 1958, Pl. 21, Fig. 4) and *Dictyophyllidites harrisii* Coup. (Coup. 1958, Pl. 21, Fig. 26). In addition to this the spores of *Dictyophyllidites* show characteristic bends in the rays towards right or left near the apex of the Y-mark, a feature mentioned by Klaus (1960) as characteristic for *Paraconcavisporites*. Between these two genera, in *Dictyophyllidites* the inter-ray thickenings are not always well defined being prominent to incipient whereas in *Paraconcavisporites* (cf. genotype) the thickenings have a sharply defined apex ± continuing around the ray-ends at the same optical level as the Y-mark. In view of the latter-feature, *Paraconcavisporites* approaches *Gleicheniidites* (Ross) Delc. & Sprum. very closely. The bending of the rays near the apex, seems to arise on

flattening of elevated apex. Organizationally the specimens of *Dictyophyllidites* are also comparable to those of *Matonisporites* Coup.

Dictyophyllidites harrisii Coup. 1958

Pl. 1, Figs. 7-10

Description of our Specimens — Miospores 34-52 μ, triangular, sides usually convex, with rounded corners. Trilete rays almost reaching the equator, labra thick, raised, flexuose, interradial exine arcuately thickened. Exine about 1 μ thick in optical section, smooth allover but occasionally puncta observed here and there.

Dictyophyllidites surangei sp. nov.

Pl. 1, Figs. 11-16

Holotype — Pl. 1, Fig. 11; Sl. No. 1851.

Diagnosis — Known size 50-60 μ, triangular miospores, sides straight to convex, Y-rays reaching almost to the periphery, inter-ray zone differentially thickened, exine thick, usually laevigate.

Description Holotype 52 μ, triangular miospores in equatorial contour having straight to convex sides with rounded angles. Trilete mark prominent, Y-rays extending to or ending slightly before the equator, ray-vertex elevated; interradial exine thin, flanked by arcuate thickenings. Exine normally 2·5 μ thick but increasing to 4 μ at the angles in optical section, proximally as well as distally laevigate, (some specimens showing irregularly distributed faint punctation or microfoveolation).

Comparison — Spores of *D. harrisii* have got thinner exine. *D. major* differs by having incipient, arcuate, inter-ray thickening near the vicinity of Y-mark.

Remarks — Most of the specimens referable to *D. surangei* observed by us, are perfectly laevigate. But in a few specimens the exine is faintly punctate. The puncta are not distributed regularly allover the distal surface. Very rarely microfoveolate (PL. 1, FIG. 14) ornamentation restricted on a small portion of the exine has been seen. These irregular features do not appear to be primary.

Dictyophyllidites major sp. nov.

Pl. 1, Figs. 17-20

Holotype — Pl. 1, Fig. 17; Sl. No. 1848.

Diagnosis — Known size 38-50 μ, subtriangular miospores, sides slightly convex, trilete, Y-rays 3/4 the radius, undulating, inter-ray thickenings incipient, exine laevigate.

Description — Holotype 42 μ, subtriangular with sides convex and angles rounded. Trilete mark prominent, Y-rays 3/4 the radius, undulating usually broadening near the apex or middle of the ray, vertex raised, exine laevigate or apparently finely structured in deep focus. Sometimes folds present near the ray-ends. *Extrema lineamenta* smooth.

Comparison — Similarity of *D. major* to the spores of *D. harrisii* and *D. surangei*, is very striking but the latter have more prominent inter-ray thickenings.

Dictyophyllidites sp.

Pl. 1, Fig. 21

Description — Size 46 × 32 μ, miospore triangular in polar view, sides convex, corners round. Trilete mark prominent, Y-rays almost reaching the equator, labra thick, raised, apex and vertex slightly elevated, interradial exine having a conspicuous, arcuate thickening forming pseudo-auriculae at the corners. Exine ± 1·0 μ thick, laevigate. *Extrema lineamenta* smooth.

Comparison — So far no specimen of *Dictyophyllidites* with auriculate folds at the angles has been described elsewhere. As only one specimen has been observed so far, it has been not given a specific status. As compared to *D. harrisii* the inter-ray thickenings are broader and more prominent in *D.* sp.

Genus — *Todisporites* Coup. 1958

Todisporites major Coup. 1958

Pl. 1, Figs. 22-27

Description of our Specimens — Size 50-70 μ in diameter, circular miospores, exine frequently folded. Trilete mark distinct, Y-rays slightly more or less than 3/4 of the spore radius long depending upon the overall size of the spore, generally 22-26 μ long, labra thin. Exine about 1 μ thick in optical section, laevigate.

Todisporites minor Coup. 1958

Pl. 1, Fig. 28; Pl. 2, Fig. 29

Description of our Specimens — Size 39-45 μ in diameter, circular miospores, exine

frequently folded. Y-rays slightly more or less than 3/4 of the spore radius. Exine about 1 μ thick in optical section, laevigate.

Remarks — Morphographically *Todisporites minor*, is indistinguishable from *T. major* but for its smaller size.

Todisporites fissus sp. nov.

Pl. 2, Figs. 30-32

Holotype — Pl. 2, Fig. 30; Sl. No. 1853.

Diagnosis — Known size 52-66 μ, circular miospores, frequently folded, trilete mark 3/4 or more of the radius, exine punctate, puncta less than 1 μ in diameter.

Description — Holotype 60 μ, miospores usually circular in equatorial contour but assume variable shapes due to secondary folding of the exine. Y-rays thin, long, extending over 3/4 of spore radius. Exine up to 1·8 μ thick, punctate, puncta closely spaced, very small, usually 0·5 μ in diameter.

Comparison — *Todisporites major* is different by having laevigate exine. Sculptural elements in *Todites szeiana* (P'an Brick) Bolchowitina (1956) project beyond the *Extrema lineamenta* and hence are not comparable.

Todisporites marginalis sp. nov.

Pl. 2, Figs. 33-35

Holotype — Pl. 2, Figs. 34-35; Sl. No. 1859.

Diagnosis — Known size 50-80 μ, circular miospores, trilete, Y-arms long, exine about 2 μ thick, intragranulose, rarely folded, in flattened condition exine tends to crack irregularly along the margin.

Description — Holotype 80 μ, spores spherical in equatorial contour. Trilete apparatus prominent, Y-arms long, labra thin. Exine about 2 μ thick, translucent, finely intragranulose, laevigate, along the margin all specimens showing irregularly radially directed cracks out of which some matter protruding out like stubs. Number of cracks variable.

Comparison — Both the species *T. major* and *T. minor* are different by having laevigate unstructured exine. The cracks along the margin though variable in number are always present and thus are very characteristic of *T. marginalis*. The morphology of stubs is not clear so far.

Genus — *Calamospora* S.W. & B. 1944

Remarks — *Calamospora* is a Palaeozoic genus which includes spores mostly of calamarian affinity. Spores morphographically similar to *Calamospora* are known in dispersed as well as *in situ* condition from the Mesozoic also. Halle (1908) has described *Equisetites* (*Equisetostachys*) *nathorstii* and *E.* (*Equisetostachys*) *suecicus* from Rhaetic-Liassic of Sweden containing spores similar to those included in *Calamospora*. Leschik (1955) has referred a few species to *Calamospora* from Upper Triassic of Neuewelt near Basel. Subsequently Couper (1958) has also described *C. mesozoica* from the Jurassic of Yorkshire and remarks that the equisetalean fossils (*Neocalamites nathorstii* Erdtm.) are known from the Deltaic Series of Yorkshire (HARRIS 1946, pp. 649-654). In view of these facts, *Calamospora*, which is a form genus, should accommodate morphographically similar, dispersed spores from the Mesozoic strata as well. Klaus (1960) reports the occurrence of *Calamospora* in the Triassic of Eastern Alps. However, he refers it as *C. nathorstii* (Halle) comb. nov., substituting the generic name *Calamospora* for *Equisetites* (*Equisetostachys*). Thus, Klaus (*loc. cit.*) has combined the specific name of a fructification with the form genus of dispersed spores. Such a taxonomic rearrangement is untenable in our opinion.

Calamospora lunzensis sp. nov.

Pl. 2, Figs. 36-38

Holotype — Pl. 2, Fig. 38; Sl. No. 1838.

Diagnosis — Known size 48-70 μ, circular miospores, Y-rays 1/3-1/2 of the spore radius, *area contagionis* not clearly demarcated, exine thin and laevigate.

Description — Holotype 60 μ in diameter, miospores yellowish brown, originally circular but assume different forms due to frequent folding of the exine. Trilete mark prominent, Y-rays thin, equal, ± 12 μ long, ray-vertex level, *area contagionis* may or may not be discernible. Exine thin, hyaline, transparent, laevigate. *Extrema, lineamenta* smooth.

Comparison — *Calamospora mesozoica* Coup., is smaller in size. *C. aequatilis* Lesch., is different by having intrapunctate exine and smaller Y-rays. *C. niger* Lesch., and *C. astigmosus* Lesch., have thicker exine and do not compare. *C. sinuosus* Lesch.,

distinguishes itself in having smaller triradiate mark.

Calamospora klausii sp. nov.

Pl. 2, Figs. 39-40

Holotype — Pl. 2, Fig. 39; Sl. No. 1830.

Diagnosis— Known size 50-60 μ, circular miospores, trilete mark prominent, Y-rays 2/3 of the spore radius, labra thick flexuose, exine mediumly thick, laevigate — intragranulose.

Description — Holotype size 50 μ, miospores originally circular, assuming variable shapes in flattened condition due to folding of the exine. Trilete mark prominent, appearing darker, Y-rays 2/3 of the spore radius long, ray-ends tapering, labra thick, dark brown in colour, flexuous and elevated. Exine mediumly thick, laevigate — finely intragranulose.

Comparison — *Calamospora mesozoica, C. aequatilis, C. niger, C. astigmosus, C. sinuosus* and *C. lunzensis* do not have flexuous labra and hence are not comparable.

Infraturma — Apiculati (B. & K.) Pot. 1956

Genus — *Lunzisporites* gen. nov.

Genotype — *Lunzisporites lunzensis* gen. et sp. nov.

Diagnosis — Triangular miospores with straight to slightly convex sides. Tetrad mark conspicuous, raised at the apex, rays 3/4 or whole radius long, inter-ray thickening present. Exine ornamentation composed of verrucae, bacula and coni in varying proportions.

Comparison — The closely comparable genus is *Converrucosisporites* which is triangular with the exine typically verrucose as described and figured by Potonié and Kremp (1955) from the Palaeozoic strata. As compared to the species of the genus *Converrucosisporites*, the specimens of *Lunzisporites* possess different ornamentation. Exine in them exhibits mixed sculptural elements such as verrucae with bacula-like verrucae and bacula appearing truncate to rounded at the tip in optical section. Besides ornamentation, the inter-ray thickening, as evident in all the forms studied here, suggests that the species referred to *Lunzisporites* from the Triassic of Lunz and elsewhere, constitute a different morphographical combination as compared to the Palaeozoic genus *Converrucosisporites*. *Conbaculatisporites* Kl., is reported to possess only baculate ornamentation on the exine and it also differs from *Lunzisporites* by having shorter Y-rays and lacking inter-ray thickening. *Baculatisporites* Thoms., & Pflug is circular in shape and hence it is not comparable. *Anapiculatisporites* Pot. & Kr. is different by having coni for the ornamentation of the exine and these too present only on the distal surface.

Lunzisporites lunzensis

Pl. 2, Figs. 41-42

Holotype — Pl. 2, Fig. 41; Sl. No. 1831.

Diagnosis — Known size 50-60 μ, triangular miospore, Y-mark more than 3/4 of the radius, exine thick, densely verrucose with a few interspersed bacula, verrucae low, inter-ray exine arcuately thickened.

Description — Holotype 60 μ, triangular spores, dark brown with straight to slightly convex sides and roundly demarcated corners. Trilete mark conspicuous, Y-rays extending over 3/4 of the spore radius, labra thick, and folded, exine thickened in an arc between the adjacent rays. Exine generally thick. densely verrucose, verrucae about 2 μ wide at the base but about 1 μ high, bases of verrucae apparently confluent ± building peaked muri, sparsely interspersed between the verrucae. *Extrema lineamenta* and surface of the spore exine rough.

Remarks — Leschik (*loc. cit.*) does not describe any specimen of *Lunzisporites*. Some of the specimens illustrated and referred by him to *Verrucosisporites*, though apparently roundly triangular, are not comparable to the spores illustrated here, either in ornamentation or shape and other characters.

Lunzisporites pallidus sp. nov.

Pl. 2, Figs. 43-44

Holotype — Pl. 2, Fig. 43; Sl. No. 1849.

Diagnosis — Known size 42-50 μ, triangular to subtriangular miospores, Y-mark elevated ± reaching the equator, exine mediumly thick, verruco-baculate ornamented, bacula mostly with truncate apex, ornamentation dense but elements separated from adjacent ones, inter-ray exine thickened.

Description — Holotype 42 μ, yellowish brown, ± triangular miospores in equatorial contour, sides ± convex. Trilete mark prominent, Y-rays 3/4 or whole radius long, labra thick, broad, folded, inter-ray exine slightly thickened and appearing dark, exine mediumly thick, verruco-baculate, elements not confluent at the base, usually truncate at the tip, occasionally bluntly pointed. Surface and *Extrema lineamenta* rough.

Comparison — *L. lunzensis* is different by having thicker exine and very closely spaced basally confluent verrucae or bacula. The shape and size of the bacula is also different in the two species. However, these species though distinct from each other are organizationally quite near.

Remarks — In the holotype, the rays at the apex are bent in the same manner as held by Klaus (1960) to be characteristic for *Paraconcavisporites*. However, in the paratype of *L. pallidus* (Pl. 2, Fig. 44) such a bend is absent. In view of the fact that similar bending of the rays at the apex also occurs in *Dictyophyllidites*, it does not appear to be a feature of great significance.

Lunzisporites sparsus sp. nov.

Pl. 2, Fig. 45

Holotype — Pl. 2, Fig. 45; Sl. No. 1852.

Diagnosis — Known size 48-54 μ, triangular miospores, sides ± straight, Y-mark 3/4 the radius, exine sparsely verruco-baculate, elements 0·5 μ high, about 1 μ broad.

Description — Holotype 50 μ, triangular miospores, sides straight to concave, trilete, Y-rays 3/4 of the radius, tapering at the ends, not bifurcated, exine between the rays apparently thickened. Exine mediumly thick, beset with bacula and verrucae, irregularly sparse and of varying sizes, elsewhere exine very finely ornamented consisting of very low, basally confluent verrucae. *Extrema lineamenta* rough.

Comparison — *L. lunzensis* and *L. pallidus* have got much denser ornamentation on the exine and possess comparatively thicker, arcuate, inter-ray thickening as compared to *L. sparsus* which has got fewer and scattered bacula and verrucae on the surface.

Remarks — *Sporites trichopunctatus* Thiergart (1949, Pl. 3, Figs. 1-2) described from Dowger horizon has the exine covered with small, spinose hair and thus is not comparable.

Genus — *Conbaculatisporites* Klaus 1960

Conbaculatisporites triassicus sp. nov.

Pl. 2, Figs. 46-47

Holotype — Pl. 2, Fig. 46; Sl. No. 1849.

Diagnosis — Known size 50-55 μ, triangular miospores, sides ± straight, angles round, trilete, Y-rays 3/4 of the radius long, labra thick, high, exine thick, densely packed with small but longish bacula having confluent bases.

Description — Holotype 50 μ, miospores triangular in polar view, sides ± straight, corners round. Y-mark extending more than 3/4 of the radius, labra thick elevated appearing sinuous in flattened condition. Exine dirty brown, thick covered with closely packed, basally confluent, small bacula appearing longish at the *Extrema lineamenta*.

Comparison — *Conbaculatisporites mesozoicus* Klaus has got bigger and sparser sculptural elements of the exine which tend to aggregate at the angles whereas in *C. triassicus* small bacula are very densely packed allover the exine and hence these two species are distinct from each other.

Conbaculatisporites baculatus sp. nov.

Pl. 2, Fig. 48

Holotype — Pl. 2, Fig. 48; Sl. No. 1860.

Diagnosis — Known size 42-68 μ, triangular miospores, sides ± straight, Y-arms 3/4 of the radius, exine thick, baculate all over, bacula up to 4 μ high and 2-4 μ broad. *Extrema lineamenta* rough.

Description — Holotype 62 × 68 μ, triangular miospores with round corners, Y-mark 3/4 of the radius. Exine thick, dark brown, ornamented with bacula with rounded or truncate head, upto 4 μ high and 2-4 μ broad at the base, distributed all over the surface partly covering the Y-mark as well. Surface and *Extrema lineamenta* rough due to thick ornamentation.

Comparison — Both *C. triassicus* and *C. mesozoicus* have considerably smaller sculptural elements of the exine and thus they are not comparable to *C. baculatus*.

Genus — *Converrucosisporites* Pot. & Kr. 1954

Converrucosisporites lunzensis sp. nov.

Pl. 2, Figs. 49-50

Holotype — Pl. 2, Fig. 49; Sl. No. 1844.

Diagnosis — Size 54-58 μ, subtriangular miospores. Y-mark 2/3 radius long or

slightly more. Exine proximally as well as distally verrucose, verrucae 2-4 μ broad, ± 1·5 μ high, closely spaced, 40-45 in number along the perimeter.

Description — Holotype ± 58 μ, subtriangular in equatorial contour. Y-rays extending slightly more than 2/3 of the radius. Exine ± 2 μ thick in optical section, verrucose on both the faces, verrucae variable in shape, building negative reticulum in deep focus. *Extrema lineamenta* rough.

Comparison — So far as we are aware from the published record, there is no species of *Converrucosisporites* reported from the Triassic strata. However, Leschik (1955) has described some roundly triangular spores as species of *Verrucosisporites*. Two out of these viz., *V. tumulosus* Lesch., and *V. opacus* Lesch., though comparable to *C. lunzensis* are distinctly smaller in size.

Converrucosisporites triassicus sp. nov.

Pl. 2, Figs. 51-52

Holotype — Pl. 2, Fig. 51; Sl. No. 1822.

Diagnosis — Size 36-44 μ, triangular — subtriangular miospores. Y-rays 2/3-3/4 radius long. Exine ornamentation verrucose on both the surfaces, verrucae ± 2 μ broad and ± 1 μ high, 50-55 along the perimeter.

Description — Holotype 44 × 38 μ, subtriangular in equatorial contour. Y-rays extending up to 2/3 of the radius, open. Exine verrucose, beset with small, closely spaced verrucae simulating negative reticulum in the deep focus. *Extrema lineamenta* rough.

Comparison — *C. lunzensis* differs from *C. triassicus* by having bigger spore size, coarser ornamentation and less number of verrucae along the circumference.

Genus — *Trilites* (Coup.) Pot. 1956

Trilites subtriangularis sp. nov.

Pl. 3, Figs. 53-55

Holotype — Pl. 3, Fig. 53; Sl. No. 1857.

Diagnosis — Known size 46-60 μ, subcircular — subtriangular miospores, Y-rays 2/3-3/4 of the radius, exine ornamentation dense on both the faces, consisting of bacula and papillae, 3-6 μ broad, ± 2 μ high, 32-40 in number along the equator.

Description — Holotype 56 μ, subcircular-subtriangular miospores in equatorial contour. Trilete rays distinct, straight, labra thin, ray-ends tapering. Exine thick, densely baculo-papillate proximally as well as distally, ornamentational elements 3-6 μ broad and ± 2 μ high. *Extrema lineamenta* rough due to ornamentation of the exine.

Comparison — *T. subtriangularis* differs from *T. tuberculiformis* Cooks., in having closely spaced verrucae. *T. bossus* Coup., is smaller in size and has got shorter length of the Y-rays. *T. equatibossus* Coup., is also smaller in size and appears to have coarser ornamentation of the exine.

Trilites klausii sp. nov.

Pl. 3, Figs. 56-58

Holotype — Pl. 3, Fig. 56; Sl. No. 1839.

Diagnosis— Known size 45-60 μ, subtriangular miospores, Y-rays reaching 3/4 the spore radius, exine thick, densely verrucose, verrucae 4-6 μ broad and up to 2 μ high, ± 25 in number along the perimeter.

Description — Holotype 48 μ in diameter, miospores roundly triangular in polar view. Y-rays thin, extending 3/4 of the spore radius, apex and vertex level, ray-ends tapering. Exine thick, dark brown, bearing 4-6 μ broad and usually 2 μ high verrucae, roundish truncate or sharply tipped, much variable in surface view, sparsely spaced on both the surfaces of the spore. *Extrema lineamenta* rough.

Comparison — The coarse exine ornamentation, the spore size and other features in *T. klausii* are very closely comparable to *T. tuberculiformis* Cookson. However, these two species are stratigraphically and geographically so widely separated that they are considered as distinct from each other. Specimen referred by Klaus to *T. tuberculiformis* belongs here.

Genus—*Verrucosisporites* (Ibr.) Pot. & Kr. 1954

Verrucosisporites morulae Kl. 1960

Pl. 3, Figs. 59-63

Description of our Specimens — Circular miospores, 50-70 μ. Y-rays faint but clearly perceptible, reaching up to 3/4 length of the spore radius. Exine dark brown, verrucose, verrucae irregularly shaped in surface view, roundish to truncate in meridional view, 3-6 μ broad, ± 1·5 μ high, present on both the faces. Exact thickness of the exine not

assessible due to thick ornamentation. *Extrema lineamenta* rough.

Remarks — In the diagnosis of *V. morulae*, Klaus (1960) has mentioned that the Y-rays are nearly 2/3 of the radius but in the specimens figured here Y-rays are slightly longer.

Verrucosisporites sp. A

Pl. 3, Fig. 64

Description — ± circular miospore, 54 μ in diameter. Y-mark ± 3/4 radius long. Exine thick, dark brown, verrucose proximally as well as distally, verrucae 2-6 μ broad, ± 1·5 μ high, variable in shape, not colsely spaced, ± 28 in number along the perimeter. *Extrema lineamenta* rough.

Comparison — Though *V. morulae* is closely comparable to the specimen described here as *Verrucosisporites* sp. A, it differs from the latter by having more densely and closely spaced ornamentation of the exine.

Verrucosisporites sp. B

Pl. 3, Fig. 65

Description — ± subcircular miospore, 48 μ in diameter. Y-rays slightly more than 2/3 radius long. Exine dark brown, thick, densely verrucose on both the faces, verrucae usually sharply-tipped, variable in shape in surface view, 2-5 μ broad, ± 1·5 μ high, ± 50 in number along the circumference. *Extrema lineamenta* rough.

Comparison — *V.* sp. B falls with in the size range of *V. morulae* but it differs from the latter by having ± subcircular shape and sharply tipped verrucae on the exine. *V.* sp. A differs from *V.* sp. B in having larger, sparsely spaced verrucae which are also less in number along the perimeter of the spore.

Verrucosisporites sp. C

Pl. 3, Fig. 66

Description — ± subcircular miospore, 40 μ in diameter. Y-rays extending up to 3/4 of the radius, labra thin. Exine verrucose, proximally as well as distally, verrucae small, 1-2 μ broad, ± 1 μ high, 50 in number along the perimeter.

Comparison — *V.* sp. C differs from *V. morulae*, *V.* sp. A and *V.* sp. B in having smaller spore size and finer ornamentation of the exine.

Turma — Monoletes Ibr. 1933
Subturma — Azonomonoletes Luber 1935
Infraturma— Sculptatomonoleti Dyb. & Jach. 1957

Genus — *Leschikisporis* (Pot.) emend.

Remarks — Spores referred by Leschik (1955) to *Punctatosporites aduncus* Lesch., are bilateral, oval, having an asymmetric trilete mark, one trilete ray being shorter than the other two. On the basis of this asymmetric trilete mark, Potonié (1958, p. 18) has instituted a new genus *Leschikisporis*, designating *L. aduncus* (= *P. aduncus* Lesch.) as its genotype. He has placed *Leschikisporis* under the infraturma LAEVIGATI of the turma TRILETES. Leschik (*loc. cit.*) has described another species *Punctatosporites rimosus* Lesch., which Potonié (1958) has transferred to the genus *Monolites* (Erdtm.) Pot., and includes bilateral, oval spores with a monolete slit slightly bent in the centre. From the study of the photographs of these two species and also of the specimens referred to *L. aduncus* by us from the coal of Lunz, we opine that all these are referable to one and the same species. The third arm constituting the asymmetric trilete mark is only a medianly placed crack in the centre of a monolete mark as already observed by Bhardwaj & Singh (1956) in the *in situ* spores of *Asterotheca meriani* (Brongn.) Stur, a member of fossil Marattiaceae from the Upper Triassic of Lunz. This study by Bhardwaj and Singh (*loc. cit.*) shows that all the variations from circular to elliptical spore shape and monolete to an asymmetric trilete mark are present in the specimens recovered from one and the same sporangium. In view of these facts, asymmetric trilete mark cannot be considered as a constant feature and much less a diagnostic character of this genus. In our opinion, *Leschikisporis* is really a monolete genus, not a trilete one, and thus it has been transferred to the infraturma — SCULPTATOMONOLETI Dyb. & Jach. 1957.

Couper (1958) has observed the presence of a vague trilete mark in the spores assigned to *Marattisporites* Coup. W. F. Harris (1955) has also recorded the same feature in the living species of *Marattia salicina*. Brown and Brown (1931) have observed an obscure three parted ridge in the spores of *M. stokesii* and *M. fraxinea* (= *M. salicina*). Couper's (1958) *Marattisporites* Coup., a new genus

for the reception of spores which are organizationally very similar to the spores of *Marattia* is nothing else but a synonym of *Leschikisporis*. The diagnosis of *Leschikisporis* is emended accordingly as follows:

Generic Diagnosis (emend.) — Miospores rounded to oval, bearing a monolete or an asymmetric trilete mark, exine ± finely granulose.

Leschikisporis aduncus (Lesch.) Pot. emend.

Pl. 3, Figs. 67-69

Syn.— *Punctatosporites aduncus* Lesch. 1955.

Holotype — Leschik 1955, Pl. 3, Fig. 17.

Diagnosis (emend.) — Known size 33-48 μ, rounded-oval miospores, bearing a monolete mark often slightly bent in the middle or an asymmetric trilete mark, exine finely granulose to matt. Distal spore surface convex in lateral view.

Description of our Specimens — Holotype 43 μ, miospores circular in polar view, oval in lateral view. Medianly dented monolete mark or an asymmeteric trilete mark present with one Y-ray shorter than the other two. Exine finely granulose, simulating negative reticulum or powdery rough. Distal surface of the spores deeply convex in lateral view but proximal surface only slightly convex.

Remarks — Leschik (1955) suspects polypodiaceous affinity for his *P. aduncus* (= *L. aduncus*) but its general similarity with the *in situ* spores of *Asterotheca meriani* (Brongn.) Stur and the spores of living species of *Marattia*, suggests marattiaceous affinity for it although other plants, if producing similar kind of spores, cannot be excluded.

Anteturma— Pollenites R. Pot. 1931
Turma — Saccites Erdtm. 1947
Subturma — Monosaccites (Chit.) Pot. & Kr. 1954
Infraturma— Aletesacciti Lesch. 1955

Genus — *Patinasporites* (Lesch.) Klaus 1960

Patinasporites sp.

Pl. 3, Fig. 70

Description — Pollengrains circular in equatorial contour, central body circular, 30 μ in diameter, dark brown in colour, sharply demarcated from the bladder. Body exine consisting of closely packed elements, simulating network in surface view. Bladder about 8 μ broad, dirty yellow in colour, translucent. *Extrema lineamenta* very rough.

Comparison — As compared to the known species of *Patinasporites* i.e. *P. densus* Lesch., *P. pluritectus* Lesch., *P. funiculus* Lesch., and *P. toralis* Lesch., our specimen is different by having a dark brown central body. *Patinasporites iustus* Kl., is very closely comparable to *P.* sp. but it differs from the latter in having less dense central body.

Genus — *Aratrisporites* (Lesch.) emend.

Remarks — Leschik (1955) groups *Aratrisporites* under ZONALETES Luber. This treatment is subsequently followed by Potonié (1958, p. 83) after emending the subturma ZONALETES. Potonié (*loc. cit.*) however, doubts if the zona (cingulum) in *Aratrisporites* may not be really a monosaccus. From a study of a large number of specimens from the coal of Lunz, closely comparable to the genotype of *Aratrisporites* by us, we conclude that *Aratrisporites* is a monosaccate genus as is apparent from the presence of folds extending beyond the central body (PL. 3, FIGS. 71, 72), half-way into the outer zone. This could not be possible unless the outer zone was built by a sac-like exinous layer, loose from the central body. The statement by Leschik (*loc. cit.* p. 34) while describing the genotype that *"Zone ungleichmässig breit"*, is an incorrect interpretation. The unequal width of the outer zone and the displacement of the central body from the centre is due to oblique pressure on a saccate miospore while flattening. In view of these facts, *Aratrisporites* has been placed under the infraturma ALETESACCITI Lesch. in the present work.

Besides recognizing *Aratrisporites* Klaus (1960) has created *Saturnisporites* which, as apparent to us, differs from *Aratrisporites* only in the height of the spines, the two being organizationally similar.

Genotype — Aratrisporites parvispinosus Lesch. 1955.

Generic Diagnosis (emend.) — Pollengrains subcircular — subtriangular or elliptical in flattened condition, secondary folds frequntly present in the bladder running in various directions, extending over the central body as well. Central body granulose to coarsely ornamented. Bladder ± granulose allover, with few to many spiny projections, up to ± 4 μ high in optical section along the equator.

Aratrisporites scabratus (KLAUS 1960) emend.

Pl. 3, Figs. 71-75; Pl. 4, Figs. 76-86

Holotype — Klaus 1960, Pl. 5, Figs. 37, 38.

Diagnosis (emend.) — Known size 50-80 μ, circular to elliptical monosaccate pollen-grains, central body ± circular, granulose with occasional longish elements, bladder 10-16 μ wide, granulose to microspinose.

Description — Grains monosaccate, circular, frequently folded, central body ± circular, 40-50 μ in diameter, dark brown, dense, coarsely granulose, exine apparently wrinkled, folds usually present. Bladder 10-16 μ wide, granulose, having few sparsely distributed, ± 1·5 μ high, small spine-like projections. *Extrema lineamenta* rough.

Comparison — *A. parvispinosus* and *A. paraspinosus* Kl., are distinctly spinose. *A. coryliseminis* Kl., has granulose exine.

Subturma — Disaccites Cookson 1947
Infraturma— Striatiti Pant 1954

Genus—*Lueckisporites* (Pot. & Kl.) Pot. 1958

Lueckisporites ruttneri sp. nov.

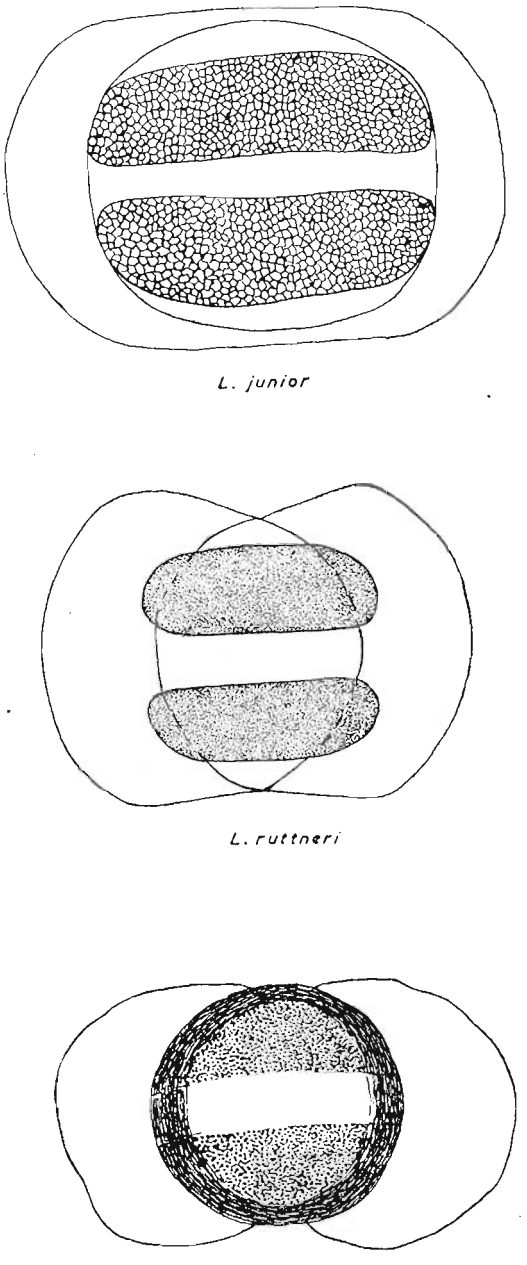
Pl. 4, Figs. 87-88

Holotype — Pl. 4, Fig. 87; Sl. No. 1858.

Diagnosis — Known size 72-84 μ long, central body vertically oval partly covered by 2, thick, exinous shields separated by a uniformly wide, horizontal channel on proximal face. Shield-ends extended beyond the central body. Distally bladders separated by a narrow, vertically biconvex sulcus. Laterally bladders closely approaching each other, not connected by a ledge.

Description — Holotype 78 μ, central body ± oval, exine appearing finely intramicroreticulate, bearing two horizontally extended, kidney-like shields of thickened exine separated by a channel with thin exine on the proximal face, shield-ends apparently project beyond the body wall. Bladders laterally closely placed and distally leaving a biconvex, thin-walled bladder-free channel. Bladders finely intrareticulate, distally inclined laterally approximated, bigger in height than the height of the central body.

Comparison — *L. junior* Kl., differs from *L. ruttneri* by having coarser ornamentation on the shields, horizontally oval shape of the body and laterally connected haploxylonoid bladders. *L. virkkiae* Pot. & Kl. differs in the shape of the central body, non-extension of the shield-ends beyond the body and laterally wide separation of the bladders. Text-fig. 1 illustrates the differences among the three species.



TEXT-FIG. 1 — Illustrates the specific differences among *L. junior*, *L. ruttneri*, and *L. virkkiae*.

Genus — *Lunatisporites* (Lesch.) Bharad. 1960

Remarks — Leschik (1955) has given an inadequate generic description of the spore genus *Lunatisporites* Lesch., its genotype, i.e. *L. acutus* Lesch. (= *L. detractus* Lesch.) as well as the other species *L. impervius* Lesch., have also been scantily described and rather misunderstood by him. Recently Bharadwaj (1960) has given a revised diagnosis of the genus after a restudy of the genotype, *L. acutus* (= *L. detractus*), and *L. impervius*. The specimens recovered out of coal from Lunz are assigned to the emended genus *Lunatisporites*.

Lunatisporites acutus Lesch. 1955

Pl. 4, Figs. 89-91

Syn.— *Lunatisporites impervius* Lesch. 1955.

Holotype — Leschik 1955, Pl. 7, Fig. 24.

Diagnosis — Known size 58-62 μ long, central body oval to subcircular, exine matt to imperceptibly microreticulate, bearing about 5 horizontal striations on the proximal face. The zone of bladder attachment darker enclosing a distal, biconvex bladder-free area.

Description — Pollengrains ± diploxylonoid, central body ± vertically oval, 25-48 μ high. Exine thick, dark brown, matt-imperceptibly microreticulate on both the faces, bearing usually 5 horizontal striations only on the proximal face. Bladders laterally closely placed, the zone of bladder attachment conspicuously dense, leaving a distal, biconvex, thinner, bladder-free channel. Bladders finely intrareticulate, slightly distally inclined.

Remarks — The holotypes of *L. acutus* and *L.* impervius are hardly distinguishable from each other but for the small difference in size.

Genus — *Striatopodocarpites* (Soritsch. & Sedowa) Bharad. 1960

Striatopodocarpites sp.

Pl. 4, Figs. 92-93

Description — Known size 60 × 40 μ, pollengrains disaccate, bilateral, diploxylonoid, central body vertically oval to subcircular 34 × 32 μ, bearing 6-8 horizontal striations with intramicroreticulate exine proximally. Bladders large, more than semicircular, intrareticulate.

Turma — Aletes Ibr. 1933
Subturma — Azonoaletes (Lub.) Pot. & Kr. 1954
Infraturma— Psilonapiti Erdtm. 1947

Genus — *Laricoidites* Pot., Thoms. & Thierg. 1950

Remarks — *Laricoidites*, *Inaperturopollenites* (Pflug) Pot., and *Psophosphaera* (Naum.) Pot., agree in having circular shape and laevigate but intrapunctate, much folded exine and are said to distinguish from each other only on the basis of variation in the overall size as well as the thickness of the exine. But both these characteristics are quantitative and hence the recognition of three genera for miospores not evidencing any qualitative or organizational differences between them does not appear sound.

Laricoidites intragranulosus sp. nov.

Pl. 5, Figs. 94-96

Holotype — Pl. 5, Fig. 94; Sl. No. 1850.

Diagnosis — Known size 63-83 μ. Pollengrains circular, exine about 1·5 μ thick, intragranulose, *Extrema lineamenta* smooth.

Description — Holotype 80 μ, pollen grains circular, no germinal mark present. Exine about 1·5 μ thick, laevigate, finely intragranulose, secondary folds frequent. *Extrema lineamenta* smooth.

Comparison — *Laricoidites intragranulosus* is proposed as a new species on account of its wide geological as well as geographical separation from *L. magnus* (Pot.) Pot., Thoms. and Thierg., which is reported from the younger strata.

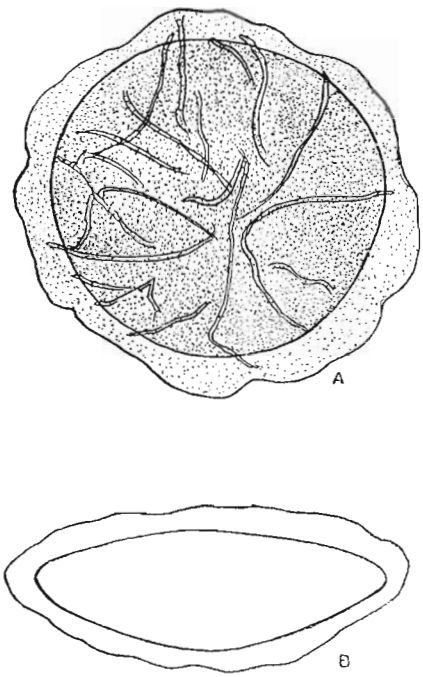
Peroaletes gen. nov.

Genotype — *Peroaletes convolutus* gen. et sp. nov.

Generic Diagnosis — Alete miospores, ± circular, sometimes outline irregular due to deep infolding of the spore exine, enveloped by a distinct layer of perispore, with many irregular folds exine as well as the perispore laevigate.

Reconstruction — The organization of the genus as stipulated in various planes is given in Text-fig. 2.

Comparison — *Peroaletes* may be compared with *Peromonolites* Couper (1953, p. 32), who mentions in the generic diagnosis of *Peromonolites* that spores are monolete or occasionally alete, the latter condition



TEXT-FIG. 2 — Organization of *Peroaletes* gen. nov., A, polar view, B, meridional section.

being met with only in a problematical species of the genus. Thus, it seems that *Peromonolites* is normally a monolete genus of bilateral miospores enveloped by a perinous layer and thus, distinct from the invariably alete and spherical spores with a perisporial envelope recovered in large numbers from the coal of Lunz. These are circumscribed here as a new genus, *Peroaletes*, restricted only to those forms which do not possess any germinal mark and are spherical.

Peroaletes convolutus sp. nov.

Pl. 5, Figs. 97-103

Holotype — Pl. 5, Fig. 99; Sl. No. 1852.

Diagnosis — Known size 60-80 μ, circular miospores, alete, covered with a loose layer of perispore, exine laevigate, perispore thin, rugose, hyaline.

Description — Holotype 70 μ, miospores originally spherical, assume variable shapes due to the folding of the spore exine enveloped in a loose cover of perispore. Exine mediumly thick, transparent to translucent, laevigate, without any type of germinal mark. Perisporial layer covers the spores all over forming numerous, delicate, anastomosing folds on the surface, thin, transparent and loose or sometimes tight in a few specimens.

Turma — Monocolpates Iverson & Troels-Smith 1950
Subturma — Intortes (Naum.) Pot. 1958

Genus — *Cycadopites* Wodehouse ex Wils. & Webs. 1946

Remarks — In *Cycadopites* the specimens are twice as long as broad, with a sulcus running from one end to the other, wider at the ends and narrower in the middle. A genus often confused with *Cycadopites* is *Monosulcites* where the grains are boat shaped to circular in polar view having a sulcus broader in the middle than at the ends. Couper (1958) has referred his specimens to *Monosulcites carpentieri* instituted by Delcourt and Sprumont (1955) although a comparison of the illustrations by Delcourt and Sprumont (*loc. cit.*) with those of Couper (*loc. cit.*) reveal wide differences between them, the latter being referable to the genus *Cycadopites* rather than *Monosulcites*.

Cycadopites follicularis Wils. & Webs. 1946

Pl. 5, Fig. 104

Remarks — *C. follicularis* has a size range of 39-42 μ but we have examined specimens extending up to 60 μ.

Cycadopites potoniei sp. nov.

Pl. 5, Figs. 105-106

Syn. — Couper 1958, Pl. 26, Figs. 26-27 referred as *Monosulcites carpentieri*.

Holotype — Pl. 5, Fig. 105; Sl. No. 1856.

Diagnosis — Known size 86-102 μ, pollengrains twice longer than broad, ends pointed, monosulcate, sulcus running from pole to pole, narrower in the middle than on the ends, exine thin, laevigate, intrapunctate.

Description — Holotype 102 μ in the longer dimension. Pollengrains broadly spindleform, narrowed on both the ends. Median sulcus running from one polar end to the other, broader at the ends and narrower in the middle. Exine about 1 μ thick.

Comparison — Both *C. follicularis* and *C. subgranulosus* (Coup.) comb. nov., are distinctly smaller in size as compared to *C. potoniei*.

Cycadopites subgranulosus (Coup.) comb. nov.

Pl. 5, Fig. 107

Syn.— *Monosulcites subgranulosus* Couper 1958

Diagnosis (emend.) — Known size 45-80 μ, pollengrains twice longer than broad, monosulcate, sulcus running from pole to pole, narrower in the middle than at the ends, exine ± 2 μ thick, granulose.

Remarks — Pollengrains as long as 80 μ have been noticed by us whereas the reported size range of the length in this species is 45-68 μ.

Cycadopites accerimus (Lesch.) comb. nov.

Pl. 5, Figs. 108-110

Syn.— *Monocolpopollenites accerimus* Lesch. 1955

Diagnosis (emend.) — Grains longish-oval with tapering ends. Monosulcate, median sulcus long and reaching the poles, broader and rounded at the ends. Exine structured.

Remarks — From the description of *M. accerimus* and the study of the photograph of its holotype (Leschik *loc. cit.*, Pl. 5, Fig. 15) it is apparent that the pollengrains are longish oval, sulcus has rounded ends and extends from pole to pole. This description answers to the circumscription of *Cycadopites*. So *M. accerimus* has been transferred to *Cycadopites*.

Cycadopites sp.

Pl. 5, Fig. 111

Description — Known size 20-25 μ long, broadly oval, ends broadly rounded, exine faintly structured.

Remarks — Pollengrain identified by Leschik (1955, Pl. 5, Fig. 17) as *Monocolpopollenites zievelensis* Pflug does not at all appear to resemble the type figures of that species by Pflug (Thomson & Pflug, 1953, Pl. 4, Figs. 18-23) instead it resembles the specimens described here as *Cycadopites* sp.

Subturma — Retectines (Malaw.) Pot. 1958

Genus — *Monosulcites* (Erdtm.) Coup. 1953

Monosulcites sp.

Pl. 5, Fig. 112

Description — Size 32 × 31 μ, broadly oval with broadly pointed ends, sulcus wider in the middle, ends not extending to the equator. Exine dense, finely unevenly sculptured.

Subturma — Monoptyches (Naum.) Pot. 1958

Infraturma — Lagenella (Malaw.) Klaus 1960

Genus — *Decussatisporites* Lesch. 1955

Remarks — The striated exine is a very important feature of this genus. For this reason, Potonié (1958, p. 96) objects to the assignment of similarly striated forms to *Entylissa* (Naum.) Pot. & Kr., e.g. *Entylissa martini* Leschik (1955, pp. 42-43) is nothing else but a synonym of *Decussatisporites delineatus*. In this species the widening of the furrow-ends in one of the specimens (Leschik, 1955, Pl. 5, Fig. 22) might have arisen by slight compression at the two lateral ends. On the other hand *Entylissa* is supposed to accommodate only non-striated pollengrains perhaps of cycadean and bennettitalean affinity. One specimen illustrated here (Pl. 5, Fig. 114) seems to suggest that the striations are borne by a membraneous layer external to spore exine and comparable to perisporial covering in perisporate genera.

Klaus (1960) recognises *Decussatisporites* as a synonym of Lagenella Malawkina (1949) as emended by him within the extensive application of the original diagnosis by Malawkina (*loc. cit.*). According to Potonié (1958, p. 99) Lagenella is not a spore genus. It appears from Malawkina's publication in 1953 to be a suprageneric category. Even the emended diagnosis by Klaus (*loc. cit.*) retains the suprageneric nature because it purports to include laevigate as well as variously ornamented forms within it thus including such genera as *Entylissa*, *Ginkgocycadophytus* and *Decussatisporites* together. Such a treatment, in our opinion is contrary to the rational practice of narrower circumscription of spore genera to bring out their stratigraphical range more clearly. However, it would have been a different matter if the variedly ornamented spores proposed to be included under Lagenella were proved to have belonged to one genus or a group of closely related genera of plants. For this reason we have recognised *Decussatisporites* as a valid genus and Lagenella as an Infraturma.

Decussatisporites delineatus Lesch. 1955

Pl. 5, Figs. 113-118

Syn. — *Entylissa martini* Leschik 1955.

Description of our Specimens — 38-46 μ in the longest axis, broadly oval to nearly subcircular in equatorial contour. Furrow 8-10 μ wide running from pole to pole, not tapering at the ends. Exine about 1·5 μ thick, covered with many vertical as well as horizontal striations, the former running parallel to the furrow axis and the latter across it, oriented in an ovaloid pattern, converging at the opposite ends.

DISCUSSION

Morphographical

A critical examination of miospore assemblage from the coals of *Lunzer Schichten* has revealed certain interesting spore characters and organizations.

Lunzisporites exhibits mixed sculptural elements such as verrucae mixed with bacula-like verrucae or bacula which appear truncate to rounded at the tip in optical section.

Leschikisporis (Pot.) emend., has been reinterpreted to comprise spores bearing a monolete mark with frequently a crack or a split arising medianly suggesting a vague trilete mark. So *Leschikisporis* with emended diagnosis is grouped in Monoletes.

Aratrisporites (Lesch.) emend., includes monosaccate pollengrains which are invariably alete. In this paper *Aratrisporites* has been removed from ZONALETES and placed under ALETESACCITI.

Laricoidites, *Inaperturopollenites* and *Psophosphaera* are circular in shape, laevigate but intrapunctate with much folded exine. They distinguish from each other only on the basis of variation in overall size as well as the thickness of the exine. Both these characteristics are quantitative and hence the recognition of three genera for pollengrains not exhibiting any qualitative or organizational divergences between them has not been considered sound.

Peroaletes gen. nov., is a newly created genus comprising miospores, ± circular in shape, alete and enveloped by a distinct layer of rugose perispore, exine being laevigate. It is restricted only to those forms which are spherical in shape and do not possess any germinal mark.

Leschik (*loc. cit.*) grouped pollengrains bearing striated exine with *Entylissa* (*E. martini*) when *Entylissa* is supposed to accommodate only non-striated pollengrains. Thus, *E. martini* has been suggested to be nothing else but *Decussatisporites delineatus* by Klaus (1960). In *Decussatisporites* the striations are interpreted to be borne on a membraneous layer covering the exine.

Stratigraphical

The spore flora from *Lunz* in Austria, which is believed to be of Upper Triassic (Keuper) age, has revealed a fairly varied assemblage. It is represented by 20 genera as listed below:

Leiotriletes
Dictyophyllidites
Todisporites
Calamospora
Lunzisporites
Conbaculatisporites
Converrucosisporites
Trilites
Verrucosisporites
Leschikisporis
Patinasporites
Aratrisporites
Lueckisporites
Lunatisporites
Striatopodocarpites
Laricoidites
Peroaletes
Cycadopites
Monosulcites
Decussatisporites

The assemblage is rich in trilete and monosaccate forms. Disaccate pollengrains are very poorly represented. Monocolpate pollengrins are fairly characteristic.

Thiergart (1949) has described the spore flora of Lower Keuper near Thüringen and Middle Keuper (?) near Holstein, in Europe. All the spore forms figured from the former are distinctly different from the Lunz-miospore flora and thus do not compare. However, this florule is rich in triletes. No saccate pollengrains are found. The spore assemblage of Middle Keuper of Holstein consists predominantly of saccate and non-saccate pollengrains unlike the spore flora of Lunz coals. It has a few genera common with the Lunz-spore flora i.e., *Pollenites magnus* R. Pot. *peissensis* Thierg. (= *Laricoidites*), *Pollenites saturni* Thierg. (= *Aratri-*

sporites) and *Sporites adriennis mesozoicus* Thierg. (= *Dictyophyllidites*).

Pautsch (1958) has described Keuper spores and pollengrains from Swierczyna, Poland. The spore assemblage is dominated both qualitatively and quantitatively by saccate pollengrains, out of which disaccate pollengrains outnumber the rest. Two spore types figured by Pautsch (*loc. cit.*) *Sporites telephorus* Pautsch and cf. *Cycas* sp. are the only non-saccate forms, the former bearing a trilete mark with ornamented exine and the latter bearing a distal sulcus. Some of the disaccate genera figured by Pautsch (*loc. cit.*) are comparable with those known from the Keuper spore flora of Neuewelt near Basel described by Leschik (*loc. cit.*). These are *Picea-Pollenites fuscus* Pautsch [= *Sulcatisporites* (Lesch.) Bharad.], *Picea* ?-*Pollenites aurentius* Pautsch [= *Sulcatisporites* (Lesch.) Bharad.], *Pollenites sulcatus* [= *Lueckisporites* (Pot. & Kl.) Pot], cf. *Walchia* sp. (PAUTSCH, PL. 1, FIG. 7) and *Picea* ?-*Pollenites ferrugineus* Pautsch (PAUTSCH, PL. 1, FIG. 10) are perhaps comparable with the genus *Abietineaepollenites* Pot. As compared to the Lunz spore flora, the Polish assemblage has only two common genera i.e. *Lueckisporites* and *Monosulcites*. A large number of spore genera present in the assemblage of Lunz are absent in the Polish spore complex.

Leschik (1955) has described a miospore flora from coal seams of Neuewelt near Basel, considered to be Middle Keuper in age.

Leschik (*loc. cit.*) has instituted a large number of new genera and species, some of which, on critical study appear superfluous. Besides this Leschik (*loc. cit.*) has also wrongly assigned some miospores to the following megaspores genera i.e. *Laevigatisporites*, *Tuberculatisporites* and *Triangulatisporites* even emending the generic diagnosis of *Triangulatisporites*, designating a new genotype for it., i.e. *T. undulosus* Lesch., which according to the International Code of Botanical Nomenclature is untenable. Another genus *Reticulatasporites* (Ibr.) Pot. & Kr., already exists, so the proposal for a new genus having the same name as *Reticulatasporites* by Leschik (*loc. cit.*) is superfluous. The recognition of *Reticulatasporites* Lesch., by Potonié (1958, p. 83) seems to be due to oversight.

The spore flora from Neuewelt consists of some miospore genera and species which do not show any qualitative characters that may distinguish them from the already known miospore genera. These taxa are superfluous. Thus, a revised list of spore genera occurring in the assemblage of Neuewelt as recognized by us is given below:

Leiotriletes (= *Laevigatisporites tenuis* Lesch.)
Aulisporites
Undulatisporites
Stereosporites
Todisporites (= *Punctatisporites parvigranulosus* Lesch.)
Punctatisporites
Calamospora (= *Laevigatisporites* Lesch. *loc. cit.*, PL. 1, FIGS. 20-22)
Cyclogranisporites
Apiculatisporis
Verrucosisporites
Rugulatisporites
cf. *Pustulatisporites* (= *Triangulatisporites undulosus* Lesch.)
cf. *Cirratriradites* (= *T. maximus* Lesch.)
Anguisporites
cf. *Reinchospora* (= *Triangulatisporites corneolus* Lesch.)
Leschikisporis (Pot.) emend. (Lesch. 1955, Pl. 3, Figs. 14-17 = *Punctatosporites*)
Partitisporites
Duplicisporites Lesch. (= *Advisisporites* Lesch.)
Circulina (Malaw.) Klaus (= *Discisporites* Lesch.)
Simplicesporites Lesch.
Kraeuselisporites (incl. *Striatisporites* Lesch. and *Thomsonisporites* Lesch.)
Aratrisporites (Lesch.) emend.
Vallasporites (= *Enzonalasporites* Lesch.)
Zonalasporites
Patinasporites
Accinctisporites (= *Succinctisporites* Lesch.)
Cuneatisporites
Ovalipollis (= *Unatextisporites* Lesch.)
Sulcatisporites (Lesch.) Bharad. 1960
Vitreisporites
Lueckisporites (Pot. & Kl.) Pot.
Lunatisporites (Lesch.) Bharad. 1960
Scopulisporites
Exiguisporites
Saeptasporites (= *Rimaesporites* Lesch. and *Lorisporites* Lesch.)
Punctatasporites
Granulatasporites
Apiculatasporites
Camerosporites
Cycadopites (= *Monocolpopollenites accerimus* Lesch. & *M. zievelensis* Pflug)
Decussatisporites

The spore flora from Lunz coals as compared to the Neuewelt assemblage of Leschik (1955) as revised here, is less varied in spore forms but agrees with it in having some genera and species common to both. The common genera between them are — *Leiotriletes, Todisporites, Calamospora, Verrucosisporites, Leschikisporis* (Pot.) emend., *Patinasporites, Aratrisporites* (Lesch.) emend., *Lueckisporites* (Pot. & Kl.) Pot., and *Decussatisporites*. Besides these common genera between the two spore assemblages, the spore flora of Neuewelt comprises many genera of trilete, monolete, saccate and non-saccate miospores. The disaccate pollengrains are fairly well represented in the Neuewelt spore flora but in the spore assemblage of Lunz these are limited to only three genera i.e. *Lueckisporites, Lunatisporites* and *Striatopodocarpites* each represented by only a few specimens. The spore assemblage of the coals from Lunz differs from that of Neuewelt by the presence of *Dictyophyllidites, Lunzisporites, Conbaculatisporites, Trilites, Striatopodocarpites, Laricoidites* and *Peroaletes* gen. nov.

Klaus (1960) has published an account of the spores from shales and clays in Karn Stage of East Alpine Triassic represented by *Cardita* Layer, Halobien shale and Lunz Layer. He has described 49 spore species distributed in 35 spore genera. Out of these, 18 species belonging to the genera — *Calamospora, Aulisporites, Retusotriletes, Paraconcavisporites, Trilites, Microreticulatisporites, Ovalipollis, Lueckisporites, Duplicisporites, Praecirculina, Enzonalasporites*, and *Ellipsovelatisporites*. *Pityosporites* and *Lagenella* (= *Decussatisporites*) are reported from the sphaerosiderite of Lunz Layer. As compared to this association, the spore assemblage from the coals of Lunz is rather different but for the characteristic presence of *Trilites, Lueckisporites* and *Decussatisporites* in both. As compared to *Cardita* layer and Halobien shale, the assemblage of Lunz coals has *Conbaculatisporites, Trilites, Verrucosisporites, Patinasporites, Aratrisporites* and *Lueckisporites* as the common spore genera.

CONCLUSION

A comparison of the spore assemblage from Lunz coals with comparably contemporaneous spore assemblages indicates general closeness with the Middle Keuper assemblage from Neuewelt and the Karn horizon (Lower Middle Keuper) of the alpine Triassic. The most important, common components among these are *Aratrisporites, Lueckisporites* and *Decussatisporites*. Strikingly enough, the sphaerosiderite assemblage from Lunz is different from the coal assemblage of Lunz although both belong to *Lunzer Schichten*. On the other hand the mioflora of Lunz coals shows greater agreement with the assemblages of *Cardita* and Halobien layers within the Karn horizon. Considering an overall miofloristic picture of Upper Triassic (Keuper) it is apparent that the spore assemblages of this age are equally represented by triletes and saccate pollengrains with the monosaccates more in number than the disaccates. The monocolpates are fairly characteristic. Among the disaccates, those with striated or non-striated central body are equally represented. This miofloristic composition of Upper Triassic assemblages stands as the transitional stage between the striated-disaccates-dominated Lower Triassic assemblages and the miospore floras of Liassic and younger Mesozoic ages characterized by non-striated-disaccates.

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EXPLANATION OF PLATES

(*All photomicrographs unless otherwise stated are* × 500)

PLATE 1

1-4. *Leiotriletes tenuis* (Lesch.) comb. nov. Ph. Nos. 167/6, 166/19a, 167/7, 148/9.
5-6. *L. adnatoides* Pot. & Kr. Ph. Nos. 167/5, 167/9.
7-10. *Dictyophyllidites harrisii* Coup. Ph. Nos. 165/17, 34/13, 164/9, 34/5.
11-16. *D. surangei* sp. nov. Ph. Nos. 166/12, 165/7, 165/2, 165/5, 167/12, 167/13.
17-20. *D. major* sp. nov. Ph. Nos. 166/35, 164/12, 166/27, 165/15.
21. *D.* sp. Ph. No. 164/3.
22-27. *Todisporites major* Coup. Ph. Nos. 145/20, 148/24, 17/10, 145/18, 145/8, 17/13.
28. *T. minor* Coup. Ph. No. 167/16.

PLATE 2

29. *T. minor* Coup. Ph. No. 167/15.
30-32. *T. fissus* sp. nov. Ph. Nos. 166/4, 166/26, 166/16.
33-35. *T. marginalis* sp. nov. Ph. Nos. 165/33, 164/15, 164/16.
36-38. *Calamospora lunzensis* sp. nov. Ph. Nos. 145/26, 144/21, 148/17.
39-40. *C. klausii* sp. nov. Ph. Nos. 145/24, 144/34.
41-42. *Lunzisporites lunzensis* gen. et sp. nov. Ph. Nos. 16/15, 17/24.
43-44. *L. pallidus* sp. nov. Ph. Nos. 166/23, 148/22.
45. *Lunzisporites sparsus* sp. nov. Ph. No. 165/32.
46-47. *Conbaculatisporites triassicus* sp. nov. Ph. Nos. 166/24, 164/5.
48. *C. baculatus* sp. nov. Ph. No. 164/8.
49-50. *Converrucosisporites lunzensis* sp. nov. Ph. Nos. 148/29, 166/19.
51-52. *C. triassicus* sp. nov. Ph. Nos. 144/20, 164/17.

PLATE 3

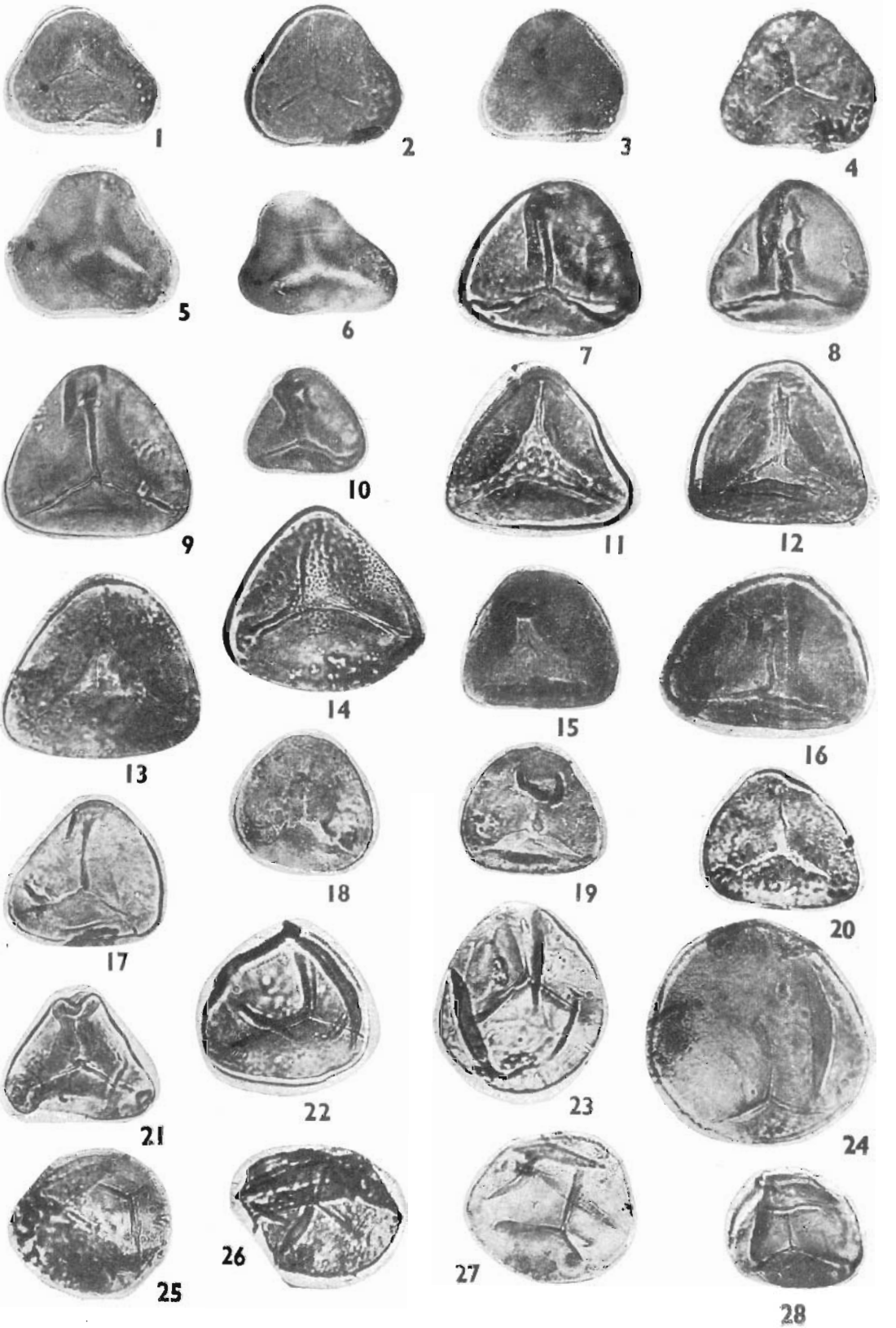
53-55. *Trilites subtriangularis* sp. nov. Ph. Nos. 164/22, 165/21, 166/22.
56-58. *T. klausii* sp. nov. Ph. Nos. 34/2, 34/3, 144/32.
59-63. *Verrucosisporites morulae* Kl. Ph. Nos. 164/1, 164/2, 165/1, 165/22, 166/28.
64. *V.* sp. A. Ph. No. 164/21.
65. *Verrucosisporites* sp. B. Ph. No. 167/21.
66. *V.* sp. C. Ph. No. 166/34.
67-69. *Leschikisporis aduncus* (Lesch.) Pot.emend. Ph. Nos. 16/18, 34/11, 34/4.
70. *Patinasporites* sp. Ph. No. 165/31.
71-75. *Aratrisporites scabratus* (Kl.) emend. Ph. Nos. 165/34, 165/35, 165/13, 165/14, 165/12.

PLATE 4

76-86. *Aratrisporites scabratus* (Kl.) emend. Ph. Nos. 164/10, 165/26, 144/3, 17/4, 167/17, 167/20, 165/10, 166/36, 166/30, 164/11, 164/23.
87-88. *Lueckisporites ruttneri* sp. nov. Ph. Nos. 164/18, 166/13.
89-91. *Lunatisporites acutus* Lesch. Ph. Nos. 165/16, 144/27, 145/11.
92-93. *Striatopodocarpites* sp. Ph. Nos. 165/19, 166/14.

PLATE 5

94-96. *Laricoidites intragranulosus* sp. nov. Ph. Nos. 166/8, 145/36, 145/37.
97-103. *Peroaletes convolutus* gen. et sp. nov. Ph. Nos. 165/30, 165/29, 166/1, 165/9, 166/3, 164/7, 164/27.
104. *Cycadopites follicularis* Wils. & Webs. Ph. No. 165/28.
105-106. *C. potoniei* sp. nov. Ph. Nos. 165/11, 165/4.
107. *C. subgranulosus* (Coup.) comb. nov. Ph. No. 165/27.
108-110. *C. accerimus* (Lesch.) comb. nov. Ph. Nos. 164/14, 165/20, 165/8.
111. *C.* sp. Ph. No. 144/28.
112. *Monosulicites* sp. Ph. No. 148/16.
113-118. *Decussatisporites delineatus* Lesch. Ph. Nos. 166/9, 166/10, 166/11, 145/17, 145/21, 166/20.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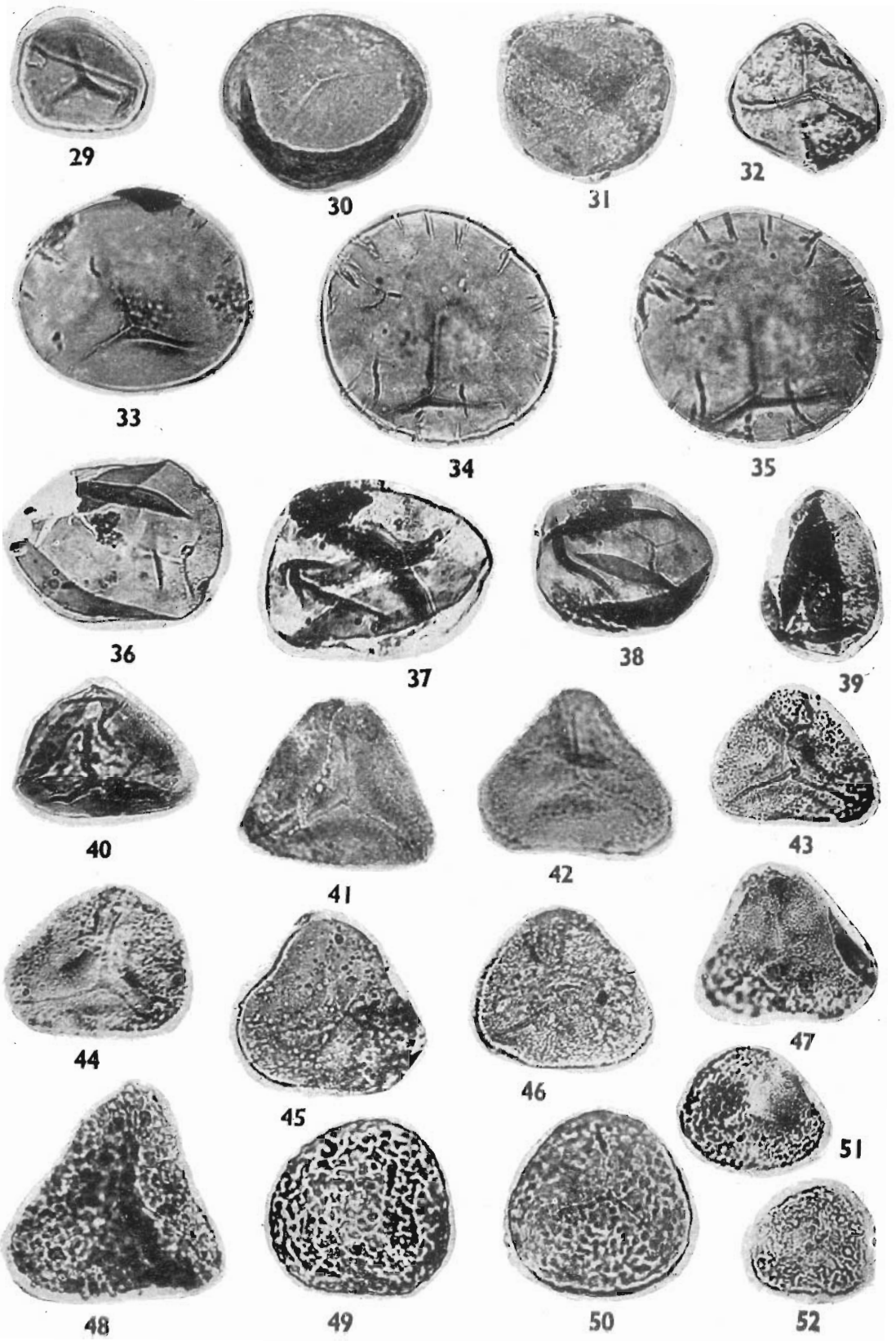
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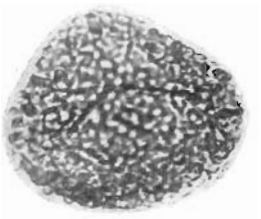
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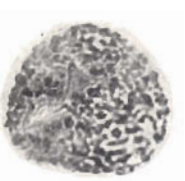
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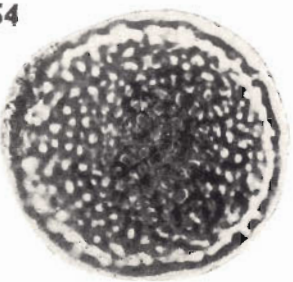
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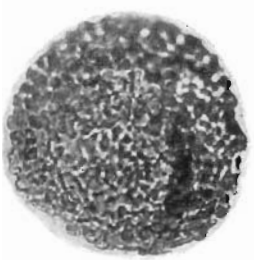
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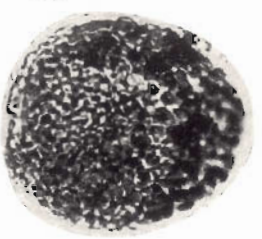
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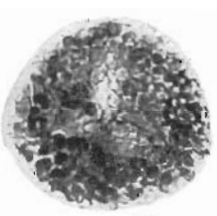
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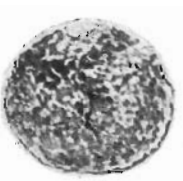
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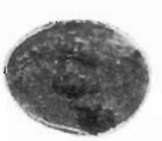
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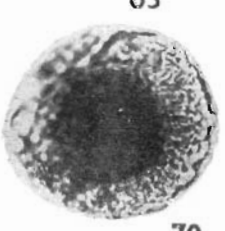
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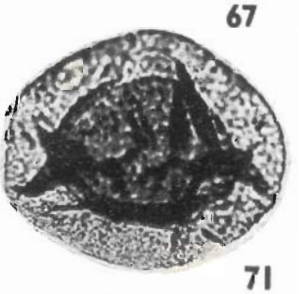
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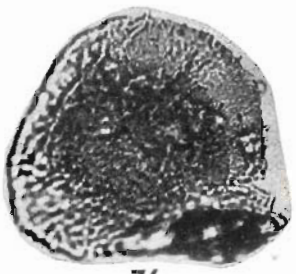
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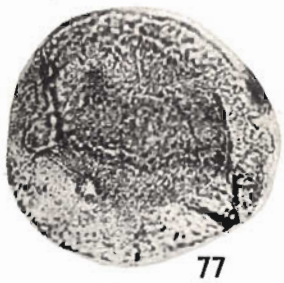
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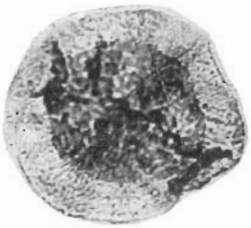
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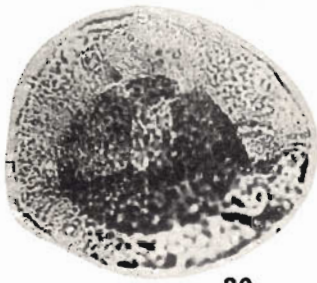
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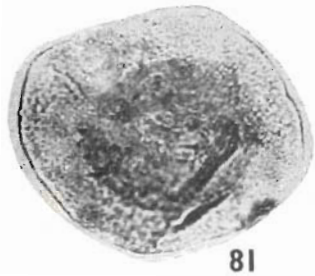
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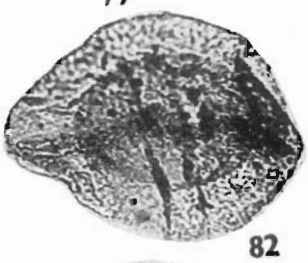
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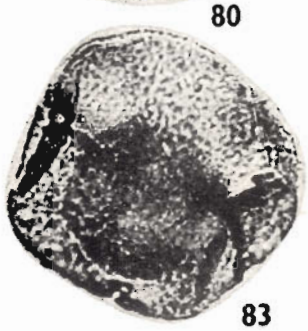
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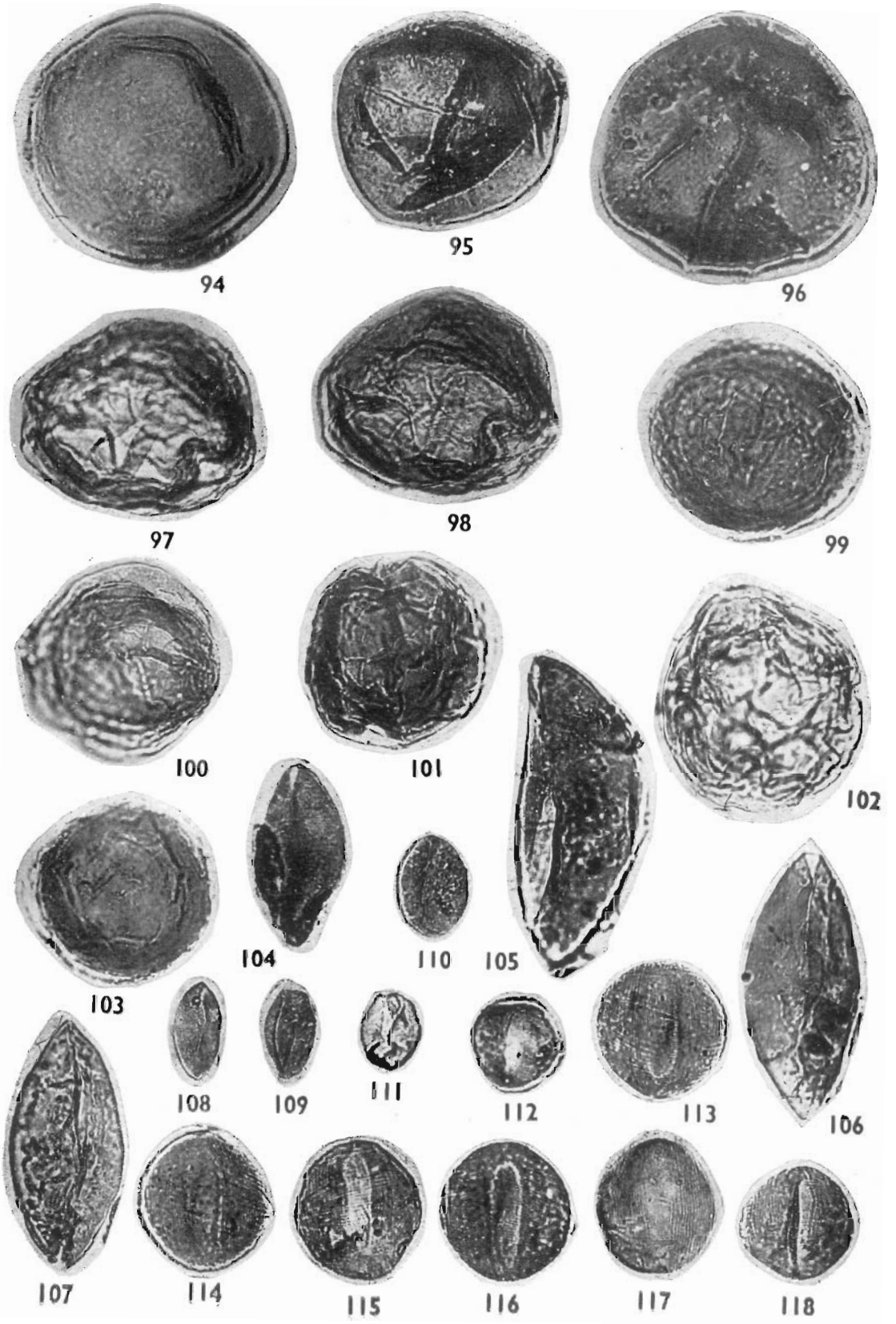
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