SACCATE POLLEN GRAINS FROM THE LOWER TRIASSIC OF HALLSTATT, AUSTRIA

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ABSTRACT

A dispersed miospore assemblage consisting of 8 miospore genera and 19 species is described from a shale of Werfen, Hallstatt, Austria. 6 species are new. Saccate pollen grains, the only constituents of this mioflora are abundantly represented. The predominant occurrence of *Lueckisporites* (Pot. & Kl.) Potonié and *Gigantosporites* Klaus appears to be very characteristic for this assemblage. A brief comparison of the present mioflora with comparable ones has been given.

INTRODUCTION

THE present paper describes and illustrates the saccate pollen grains dispersed in the rocks of Lowermost Triassic of Austria. The miospore assemblage is characteristically represented by saccate pollen grains only, the frequency of bisaccate types being enormous. The preservation of the organic matter is not satisfactory as many of the pollen grains appear to be dark brown and are almost opaque. Despite this, I have been fortunate in getting some better preserved specimens which, in fact, have laid the basis for the taxonomic work of the present mioflora. Klaus (1953a) has recognized 5 miospore genera in the *Werfener Sichichten* of Hallstatt but in the present treatment 8 miospore genera and 19 species have been recognized, of which 6 species are new. A brief comparison of the present mioflora with comparable assemblages has been given. The abundant occurrence of *Lueckisporites* (Pot. & Kl.) Potonié and *Gingantosporites* Klaus appears to be very characteristic for the *Werfener schiefer* mioflora as has been held by Klaus (1953a).

The Upper Permian (Zechstein) strata of the European formations have been sporologically investigated by Potonié and Klaus (1954), Klaus (1955), Leschik (1956), Grebe (1957), Grebe and Schweitzer (1962) and Klaus (1963). Some forms out of these miofloras continue to be represented in the assemblage of *Werfener schiefer*.

Klaus (1953b) has made valuable contribution towards stratigraphical knowledge of the east alpine hills in Austria on the basis of relative abundance of dispersed spores. Hennelly (1958) has given an account of spores and pollen grains from a Permian — Triassic transition in N.S.W. Australia. The zone above the Bulli seam characterized by a dominant species of *Apiculatisporis* and cristate tetrads in association with other spore types has been shown to be representing Triassic age. Jansonius (1962) has palynologically investigated the Permian to Lower Triassic rocks of Western Canada stating that the occurrence of trilete miospores in comparison to saccate ones is not an important feature in the strata investigated. Balme (1963) has described an early Triassic miospore assemblage from the Kockatea shale occurring in the Perth Basin, Western Australia and has also summed up its phytogeographical significance.

The present spore assemblage has been arranged according to the artificial system of classification proposed by Potonié and Kremp (1954) and subsequently modified by Potonié (1956, 1958 and 1960).

MATERIAL AND METHODS

The material consisting of a grey shale was collected by Dr. D. C. Bharadwaj out of *Werfener schiefer*, Salzberg — Hallstatt (Nördlisch Einlagerung untereste Trias) Austria in 1954. The shale sample was treated with cold hydrofluoric acid for 48 hours and then the residue was repeatedly washed with water by decantation. The acid free macerate was further treated with cold commercial nitric acid for 72 hours. The washed acid-free sporiferous matter (dark brown in colour) was digested with warm 10 per cent KOH solution for 10 minutes. Then the macerate was centrifuged and washed till it was free from alkali. The slides for miospore analysis

have been made in Canada balsam. They are deposited in the museum of the Birbal Sahni Institute of Palaeobotany, Lucknow.

DESCRIPTION OF DISPERSED SPORES

Anteturma ***Pollenites*** **Potonié 1931**
Turma ***Saccites*** **Erdtman 1947**
Subturma ***Monosaccites*** **(Chitaley) Potonié & Kremp 1954**
Infraturma ***Striasacciti*** **Bharadwaj 1962**
Syn ***Striatornati*** **Jansonius 1962**

Genus — *Crustaesporites* (Lesch.) Jansonius 1962

Crustaesporites cf. *globosus* Leschik 1956
Pl. 1, Fig 1

Remarks — A solitary specimen of *C. globosus* has been recorded from the present assemblage. It is monosaccate and has a dark brown saccus as compared to the lighter and thinner central body bearing more or less 7 proximal stripes. Jansonius (1962) seems to be quite correct in envisaging a fundamentally monosaccate organization for the pollen grains of *Crustaesporites*.

Infraturma ***Triletesacciti*** **Leschik 1955**

Genus — *Culleisporites* Leschik 1956

Culleisporites cf. *densus* Leschik 1956
Pl. 1, Fig. 2

Remarks — The occurrence of *C.* cf. *densus* is extremely rare in the present mioflora. Only two specimens exhibiting closer similarity with *C. densus* have been examined but they are distinguishable from the latter in possessing a darker and heavier saccus. The ornamentation of the saccus and the central body is also not clear.

Subturma ***Disaccites*** **Cookson 1947**
Infraturma ***Striatiti*** **Pant 1954**

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

Remarks — A study of the photographs of the type species and cotype of *Lueckisporites* i.e. *L. virkkiae* Pot. & Kl. as well as a large number of the pollen grains closely comparable to this species from the present assemblage reveals that the central body characteristically possesses two proximal intramicroreticulate structured stripes enclosing a horizontal split. Similar specimens exhibiting these characters have been figured by Leschik (1956, Pl. 21, Fig. 17), Grebe (1957, Pl. 5, Fig. 11), Grebe and Schwietzer (1962, Pl. 5, Figs. 3-5) and Klaus (1963, Pl. 11, Figs. 50, 51; Pl. 12, Fig. 52). However, in the diagnosis of *L. virkkiae* given by Potonié & Klaus (1954, p. 534) occasional occurrence of additional faint splits (*Laesurae*) parallel to the middle one has been stated. These are neither seen in the type specimens nor in the specimens figured by subsequent workers. Jansonius (1962) and Klaus (1963) have based an emendation of *Lueckisporites* on a quantitative character that the genus should be restricted to include only those species in which the central body is divided into two proximal stripes enclosing a single horizontal split. This circumscription of *Lueckisporites* is contrary to the view held by Potonié (1958) that *Lueckisporites* can include even those specimens where the number of proximal stripes is sometimes more than two. I concur with Potonié's interpretation and believe that the limits of *Lueckisporites* should be further enlarged to accommodate such forms which are organizationally in agreement with the type species even if they have two or more than two proximal stripes on the central body. Thus the forms referred to *Taeniaesporites*, i.e. *T. alatus* Kl., *T. ortisei* Kl., *T. labdacus* Kl., *T. samoilovichii pantii* (Jans.) Kl., *T. albertae* Jans., *T. gracilis* Jans., *T. novimundus* Jans., *T. hexagonalis* Jans., *T. interruptus* Jans., *T. transversundatus* Jans., *T. noviaulensis* Lesch. and *T. obex* Balme, belong here.

Lueckisporites cf. *virkkiae* Potonié & Klaus 1954
Pl. 1, Fig. 3

Remarks — The specimen illustrated here is closely comparable to *L. virkkiae* but it lacks the distinct equatorial thickening as is apparent in the holotype figure. *L.* cf. *virkkiae* is predominantly represented in the present assemblage. Occasionally some abnormal triasaccate pollen grains of the same species have been found. Similar tendency has also been noticed and figured by Grebe (1957, Pl. 5, Fig. 15).

Lueckisporites tattooensis Jansonius 1962
Pl. 1, Figs. 4, 5

Description — Bisaccate, bilateral, more or less diploxylonoid pollen grains. Central body light brown, oval along the elongated

axis, mediumly thick bearing two proximal finely intramicroreticulate stripes, usually extending beyond the body wall deep into the sacci, translucent (in comparison to the heavier and opaque sacci) enclosing a narrow parallel split. Sacci dark brown, almost crescent shaped, laterally wide apart and distally slightly inclined, ornamentation obscure.

Comparison — The pollen grains of *L. virkkiae* and *L. ruttneri* Bharad. and Singh have a thicker body wall, coarser ornamentation on the proximal face, broader split and lighter sacci in comparison to *L. tattooensis*. *L. junior* Kl. is distinguishable from *L. tattooensis* by having coarsely ornamented proximal stripes and distinctly intrareticulate sacci.

Remarks — The specimens referable to *L. tattooensis* from the present assemblage measure more or less 80 μ whereas the known size range of the same species is 55-70 μ.

Lueckisporites hallstattensis sp. nov.
Pl. 1, Figs. 6, 7

Holotype — Pl. 1, Fig. 6.

Diagnosis — Known size 65-100 μ × 50-60 μ, bisaccate pollen grains. Central body oval to subcircular bearing two proximal, kidney shaped, intramicroreticulate stripes, enclosing a wide split, sacci crescent shaped, intrareticulate, meshes mediumly coarse.

Description — Holotype 93 × 60 μ, slightly diploxylonoid. Central body dark brown about 60 μ in diameter mediumly thick walled, proximal cap split into two equal, kidney shaped, intramicroreticulate, translucent stripes, not bulging beyond the body wall. Sacci less than half circular, equal to or slightly bigger than the body height, the zones of bladder attachment slightly denser, distally separated by a wide saccus free area, laterally usually widely separated sometimes approaching near each other, intrareticulate, meshes mediumly coarse.

Comparison — *L. tattooensis* Jans. is different from *L. hallstattensis* by having bulging type of stripes, narrower split, lighter central body and darker sacci. *L. virkkiae* Pot. & Kl. has thicker body wall and finer ornamentation of the sacci. *L. junior* Kl. is distinctly distinguishable from *L. hallstattensis* by having coarser reticulation of the proximal stripes and monosaccoid appearance. *L. ruttneri* Bharad. and Singh differs from *L. hallstattensis* by having proximal stripes extending beyond the central body and a distal biconvex sulcus. *L. microgranulatus* Kl. is smaller in size and has finer ornamentation of the central body than that of *L. hallstattensis*. *L. parvus* Kl. and *L. globosus* Kl. do not compare with *L. hallstattensis*.

Lueckisporites klausii sp. nov.
Pl. 1, Figs. 8, 9

Holotype — Pl. 1, Fig. 8.

Diagnosis — Known size range 60-80 μ, bilateral bisaccate pollen grains. Central body oval along the elongated axis bearing two proximal, matt to faintly structured, intramicroreticulate stripes enclosing a narrow to wide split (parallel to the stripes). Sacci equal to half or more than half circular, lighter in colour, finely to mediumly coarse.

Description — Holotype 74 × 46 μ, more or less haploxylonoid. Central body dark brown translucent, thick walled, oval along the longest axis of the pollen grains, proximally ornamented with two, almost kidney shaped, matt to faintly intramicroreticulate stripes enclosing a narrow to wide split. Sacci about half circular or more, finely to mediumly coarse, intrareticulate, slightly distally inclined.

Comparison — *L. tattooensis* Jans. has lighter stripes, almost opaque and less than half circular sacci. *L. hallstattensis* distinguishes itself by having subcircular central body with distinctly intramicroreticulate stripes and less than half circular sacci. *L. ruttneri* Bharad. and Singh has got an oval central body (perpendicular to the longest axis) with coarser ornamentation. *L. parvus* Kl. is smaller in size and has got thinner central body. *L. globosus* Kl. and *L. microgranulatus* Kl. do not compare.

Lueckisporites monosaccoides sp. nov.
Pl. 1, Figs. 10, 11

Holotype — Pl. 1, Fig. 11.

Diagnosis — Known size range 60-75 μ, tending to be monosaccate, bilateral, bisaccate pollen grains. Central body circular to subcircular thick-walled bearing two proximal matt to indeterminably sculptured stripes enclosing a wide horizontal split (with respect to the longest axis). Sacci continuous by a broad lateral ledge, may be notched.

Description — Holotype 70×52 μ, slightly diploxylonoid condition apparent. Central body dark brown, thick walled (3 μ) bearing two proximal stripes, not bulging beyond the body wall and enclosing a single uniformly broad about 7 μ wide split. Sacci mediumly coarse.

Comparison — *L. virkkiae* Pot. & Kl. affords a closer comparison with *L. monosaccoides* but it differs from the latter by virtue of its distinctly ornamented stripes of the central body and bisaccate nature of the pollen grains. *L. klausii* sp. nov. is different from *L. monosaccoides* by having an oval central body, narrower horizontal split and lighter sacci.

Lueckisporites interruptus (Jans.) comb. nov.

Pl. 1, Figs. 12-14

Remarks — The size range of *T. interruptus* as given by Jansonius is 55 to 65 μ whereas specimens measuring as large as 80 μ have been noticed in the present assemblage. The proximal stripes on the central body vary from 3 to 8 in number, the middle ones being usually interrupted. The ornamentation on the proximal face appears to be matt.

Lueckisporites jansonii sp. nov.

Pl. 1, Figs. 15-16

Holotype — Pl. 1, Fig. 15.

Diagnosis — Known size 80-100 μ, bilateral, bisaccate pollen grains. Central body oval along the elongated axis of the pollen grains in polar view, light to medium brown, proximal face bearing 3-4 in number prominent, broad, intramicroreticulate stripes separated by thinner intexine. Sacci crescent shaped, haploxylonoid sometimes coming close laterally, intrareticulate, meshes rough and dark known.

Description — Holotype 80×50 μ. Central body oval, 50×54 μ bearing 3 to 4 in number, 8 to 12 μ broad, intramicroreticulate proximal stripes separated by narrow to wide almost hyaline intexine. Stripes not bulging beyond the body wall, usually tending to be bisaccate. Sacci crescentic and darker than the central body.

Comparison — *L. novimundi* (Jans.) comb. nov. is the only closely comparable species with *L. jansonii* but it differs from the latter in having thicker central body wall with copious folds and lighter sacci. The previous species referred to *Lueckisporites* in this paper have only two proximal stripes on the central body.

Lueckisporites pallidus sp. nov.

Pl. 1, Figs. 17-18

Holotype — Pl. 1, Fig. 18.

Diagnosis — Known size 80-90 μ, bilateral, bisaccate pollen grains. Central body oval to subcircular in polar view, proximal face bearing 3 to 4 in number prominent, broad, almost matt stripes separated by thinner and broader intexine, sacci half circular to crescent shaped, widely separated laterally, lighter as compared to the central body and meshes mediumly coarse.

Description — Holotype 90×58 μ, slightly diploxylonoid. Central body 54×50 μ, medium to dark brown, thick walled, proximal face ornamented with 3 to 4 in number about 6 μ wide, matt to indeterminably sculptured (opaque) stripes not bulging beyond the limits of the central body. Sacci widely apart laterally, half circular to crescentic, the zones of saccus attachment clearly defined and darker, delimiting an appreciably wide (straight) saccus-free-area.

Comparison — *L. jansonii* possesses an oval central body (elongated along the longest axis) bearing distinctly sculptured proximal stripes and darker sacci. This species distinguishes itself from the rest by having almost matt and opaque proximal stripes of the central body.

Genus — *Lunatisporites* (Lesch.) Bharadwaj 1962

Lunatisporites sp.

Pl. 2, Fig. 19

Description — Size 75×50 μ, bilateral, bisaccate pollen grain. Central body dark brown, more or less subcircular, 46 μ across, thick walled, matt to indeterminally structured, proximal face bearing about 7 stripes. Sacci crescentic, more or less haploxylonoid, lighter as compared to the central body, the zones of saccus attachment area prominently thickened and darker.

Infraturma *Disaccitrileti* Leschik 1955

Genus — *Illinites* Kosanke 1950

Remarks — The type species of *Illinites* as well as the other species referable to it mostly possess a trilete mark on the central body. This feature differentiates it from *Pitysoporites* (Sew.) Manum.

Illinites delasaucei (Pot. & Kl.) Grebe & Schweitzer 1962

Pl. 2, Fig. 20

Syn.— See Grebe and Schweitzer 1962.

Description — Bisaccate, bilateral pollen grains. Central body dark brown, vertically oval with truncate ends, characteristically having two longitudinal folds, trilete mark distinctly present, Y-rays small, one ray smaller than the other two.

Infraturma *Disacciatrileti* (Lesch.) Potonié 1958

Genus — *Klausipollenites* Jansonius 1962

Klausipollenites schaubergeri (Pot. & Kl.) Jansonius 1962

Pl. 2, Figs. 21-24

Remarks — The specimens of *K. schaubergeri* illustrated here are darker in colour as compared to the holotype photograph. This difference is quite understandable on account of the ill-preserved organic matter in the present case. All the specimens examined here are bilateral in which the sacci are usually latterally joined by a broad to narrow ledge giving a monosaccate appearance to the pollen grains.

Klausipollenites cf. *vestitus* Jansonius 1962

Pl. 2, Figs. 25, 26

Remarks — The specimens of *K.* cf. *vestitus* examined here measure up to 70 μ whereas the known size range of *K. vestitus* is 42-55 μ. Specimens of the former type, though rare in the present assemblage, are haploxylonoid, the sacci being almost equal to the height of the central body in contrast to the holotype of *K. vestitus* where the sacci are shorter than the height of the central body. A straight, thinwalled distal area perpendicular to the longest axis of the specimen is prominently discernible. This feature has been reported to be quite characteristic for *K. vestitus* by Jansonius.

Klausipollenites sp.

Pl. 2, Fig. 27

Remarks — This specimen is the only record from the present assemblage and is absolutely indistinguishable from *Pityosporites zapfei* Pot. & Kl. illustrated by Grebe (1957, Pl. 6, Fig. 37). Holotype figure of *P. zapfei* seems to be different from *K.* sp. in having a vertically oval central body and darker zones of the saccus attachment.

Infraturma *Pinosacciti* (Erdtm.) Potonié 1958

Genus — *Gigantosporites* Klaus 1963

Remarks — Klaus (1953) records *Pityosporites hallstattensis* (= *Disaccites hallstattensis*) from the *Werfener schiefer*, Austria, stating that the pollen grains are bisaccate and measure almost 180 μ in the longest axis. Subsequently in 1963, he has instituted a new genus *Gigantosporites* Klaus for the same species from the Permian strata of southern Alps. From the present assemblage specimens of *G. hallstattensis* Kl. and *G. grebei* sp. nov. (described below) exhibit para condition of the sacci, an indistinct central body (mostly without any proximal germinal mark) which lies vertically oval (i.e. perpendicular to the longest axis) and is usually equal to the height of the sacci. The exine of the central body is differentially thickened and structured. The zones of saccus attachment are usually straight enclosing a distal, thinner and wide saccus-free area. The sacci possess a double set of meshes, the outer and bigger ones enclosing the inner and finer meshes. *Gigantosporites* appears to be different from *Alisporites* by having a differentially thickened exine of the central body and a double set of saccus-reticulum. Majority of the specimens of *Gigantosporites* examined here are alete; rarely a monolete mark or a vaguely trilete mark has been observed which does not appear to be a primary character. Klaus (1963, p. 293) per mistake has mentioned *Gigantosaccites aletoides* Kl. as the holotype instead of *Gigantosporites aletoides*.

Gigantosporites hallstattensis Klaus 1963

Pl. 2, Figs. 28, 29

Description — Specimens usually measuring more or less 140 μ in the longest axis,

may be as big as 185 μ, bilateral, haploxylonoid. Central body vertically oval 100× 70 μ, thin walled, appearing intramicroreticulate on both the faces, without striations. The zones of saccus attachment thick and dark brown forming a crest disappearing into the sacci gradually. Sacci dark brown, heavy, having very coarse intrareticulate meshes, may be measuring as wide as 8 μ and enclosing another set of fine meshes.

Gigantosporites grebei sp. nov.
Pl. 2, Figs. 30, 31

Holotype — Pl. 2, Fig. 30.

Diagnosis — Known size 55-70 μ, 80-102 μ, bisaccate, haploxylonoid pollen grains. Central body vertically oval, exine intramicroreticulate on both the faces, without striations. Sacci coming close laterally, distal saccus-free-area thin and wide, the zones of saccus attachment thickened, meshes coarse.

Description — Holotype 102×62 μ. Central body oval (perpendicular to the longest axis), intramicroreticulate on both the faces without any striations or germinal mark. The zones of saccus attachment thick, dark brown, forming about 5 μ wide crest, gradually disappearing into the sacci. Laterally sacci free, sometimes approaching closely, meshes intrareticulate, coarse.

Comparison — *G. grebei* distinguishes itself from *G. hallstattensis* by virtue of its smaller size and less coarse meshes of the sacci. *G. aletoides* Kl. is closely comparably to *G. grebei* but differs from it in having a markedly thickened (differential) exine of the central body.

Infraturma *Podocarpiditi* Potonié, Thomson & Theirgart 1950

Genus — *Platysaccus* (Naum.) Potonié & Klaus 1954

Platysaccus cf. *papilionis* Potonie & Klaus 1954
Pl. 2, Fig. 32

Remarks — The specimen illustrated here though comparable to *P. papilionis* differs from it in having coarser and larger meshes of the sacci.

Platysaccus sp.
Pl. 2, Figs. 33-35

Description — Known size about 70×42 μ, pollen grains bisaccate, bilateral, diploxylonoid. Central body dark brown, thick walled, circular, usually 42 μ in diameter, exine almost matt on both the faces. Sacci free laterally, leaving about 14 μ wide saccus-free, straight edged channel, distally, intrareticulate, meshes small.

Comparison — The pollen grains of *Platysaccus papilionis* have smaller central body, relatively larger sacci with coarser and larger meshes as compared to *P.* sp.

DISCUSSION

The miospore assemblage studied out of a grey shale from *Werfener schiefer*, Salzberg-Hallstatt, Austria is believed to be of lowermost Triassic age. It consists of 8 saccate miospore genera and 19 species; trilete, monolete, and nonsaccate pollen grains being not represented in the sample investigated. The assemblage as exhibited by miospore genera comprises *Lueckisporites, Lunatisporites, Illinites, Klausipollenites, Gigantosporites, Platysaccus, Crustaesporites* and *Culleisporites*. Qualitatively the *Werfener schiefer* spore complex is much less diverse in forms but quantitatively the distribution of *Lueckisporites* and *Gigantosporites* is surprisingly abundant.

Lueckisporites is represented by 8 species i.e. *L.* cf. *virkkiae, L. tattooensis, L. hallstattensis, L. klausii, L. monosaccoides, L. interruptus, L. pallidus* and *L. jansonii*, of these the former two have a copious distribution.

Gigantosporites represented by 2 species, i.e. *G. grebei* and *G. hallstattensis*, is dominant in occurrence.

Klausipollenites is represented by *K. schaubergeri, K.* cf. *vestitus* and *K.* sp. which are not frequently represented.

Illinites represented by one species i.e. *I. delasaucei* is rare.

The pollen grains referable to the genera *Lunatisporites, Platysaccus, Crustaesporites* and *Culleisporites* are rare constituents of the mioflora.

Klaus (1953a) reports the occurrence of *Nuskoisporites* from the Werfen shales in addition to the genera recorded by me.

Werfener schiefer spore flora described here is compared with the assemblage known from the Austrian sediments of Upper Permian described by Potonie and Klaus (1954). From the alpine salt hills these authors have referred the spore taxa to the following 5 miospore genera, i.e. *Angui-*

sporites, Nuskoisporites, Lueckisporites, Pityosporites (in part *Klausipollenites*) and *Platysaccus*. Both the assemblages, i.e. from Werfen and alpine salt hills possess 5 genera in common i.e. *Lueckisporites, Klausipollenites, Platysaccus, Illinites* and *Nuskoisporites*. The former assemblage is different from the latter by the presence of *Lunatisporites, Crustaesporites* and *Gigantosporites* in addition to the common genera and the absence of *Anguisporites*.

From the Upper Permian (Zechstein) of European sediments, Leschik (1956) has described a fairly well diversified mioflora from Neuhof (near Fulda). It compares with the *Werfener schiefer* spore complex by having *Nuskoisporites, Culleisporites, Crustaesporites, Illinites, Lueckisporites* and *Platysaccus*.

Grebe (1957) and Grebe & Schweitzer (1962) have reported Upper Permian *Sporae dispersae* from the European sediments which is distinct from the *Werfener schiefer* assemblage by being more diversified. Among the three assemblages the genera in common are *Lueckisporites, Illinites, Klausipollenites, Platysaccus, Nuskiosporites, Crustaesporites* and *Culleisporites*.

Klaus (1963) has sporologically investigated Permian strata of southern Alps. Genera like *Nuskoisporites, Illinites, Gigantosporites, Lueckisporites, Klausipollenites* and *Platysaccus* are in common with the *Werfener schiefer* assemblage.

Hennelly (1958) reports that the zone above the Bulli seam in N.S.W. Australia is characterized by a dominant species of *Apiculatisporis* along with *Quadrisporites* (cristate tetrads) in association with some other types appearing to be early Triassic age. The *Werfener schiefer* mioflora as compared to that of Australian assemblage is distinctly different by the absence of *Apiculatisporis* and *Cirratriradites* together with *Quadrisporites* and megaspores.

The palynological differentiation of the Permian to Lower Triassic rocks in Western Canada has been successfully achieved by Jansonius (1962). The abundant occurrence of striate and non-striate bisaccate pollen grains is reported to be very characteristic for the Lower Triassic assemblage a feature which is in common with that of the *Werfener schiefer* mioflora and is strikingly significant.

Taeniaesporites (= *Lueckisporites*), *Platysaccus* and *Crustaesporites* occurring in the early Triassic of Western Australia (BALME 1963) are in common with that of the *Werfener schiefer* mioflora, but the other qualitative differences between the two assemblages are significant as the former altogether lacks the preponderance of *Gigantosporites* which is characteristic for the *Werfener schiefer* and the latter lacks the characteristic type of trilete mio- and megaspores so well represented in the early Triassic of Western Australia.

CONCLUSION

The *Werfener schiefer* mioflora, though less diversified, appears to be a continuation of the European Zechstein forms, the former being distinguishable from the latter by the dominance of *Lueckisporites* and *Gigantosporites* whereas in the latter *Lueckisporites* along with *Pityosporites* and *Klausipollenites* are dominant.

The abundant occurrence of both striate and non-striate bisaccate pollen grains in the Lower Triassic miofloras of the Canadian and European formations indicates a closer similarity between the two plant communities.

The Upper Triassic (Keuper) miofloras described by Leschik (1955), Klaus (1960) and Bharadwaj and Singh (1964) from the European formations exhibit both qualitative and quantitative amplification of trilete, and monosulcate forms in contrast to the striate and non-striate bisaccate pollen grains so well represented in the Lower Triassic sediments of Canada and Austria.

ACKNOWLEDGEMENTS

I am grateful to Dr. D. C. Bharadwaj for making available the material to me which forms the subject of this paper. My thanks are also due to him for his valuable suggestions and helpful guidance

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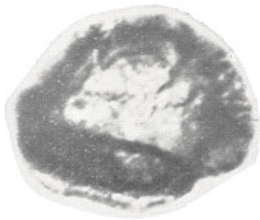
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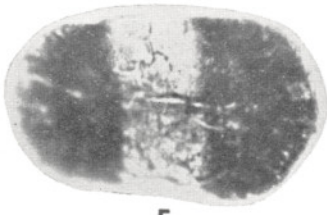
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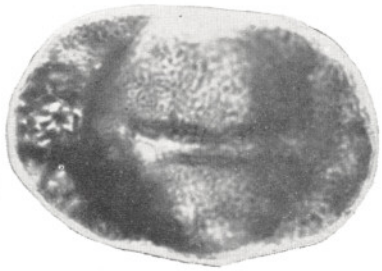
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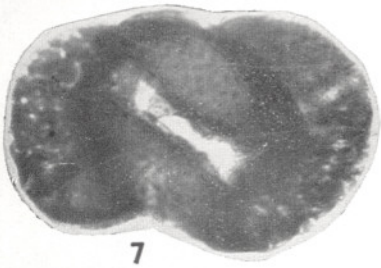
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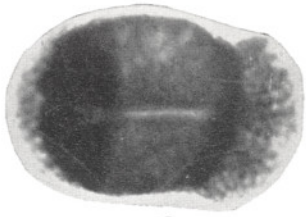
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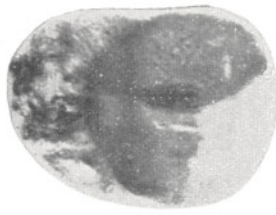
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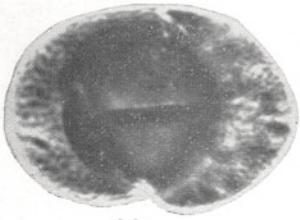
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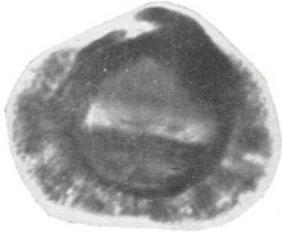
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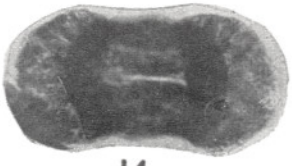
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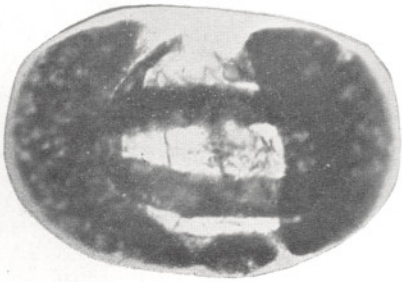
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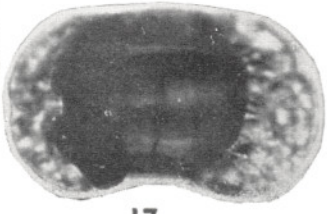
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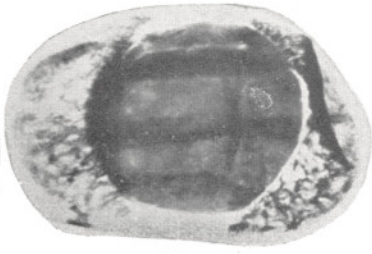
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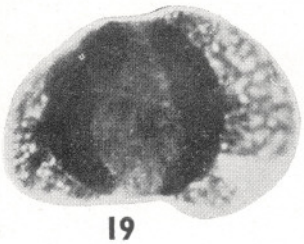
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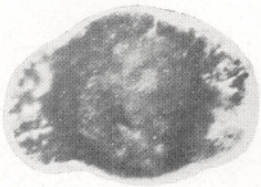
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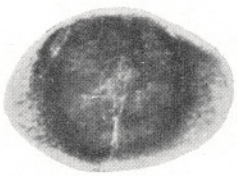
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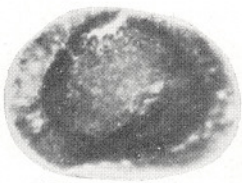
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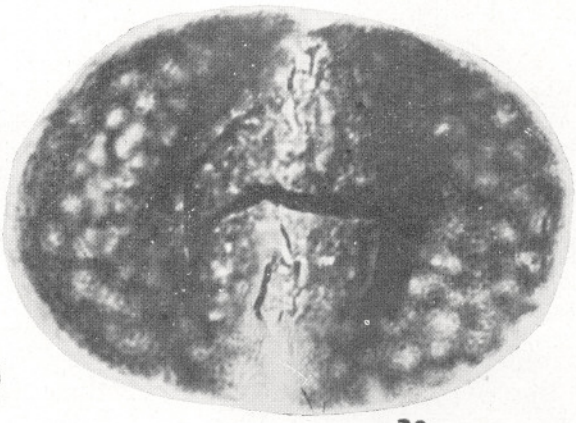
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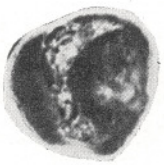
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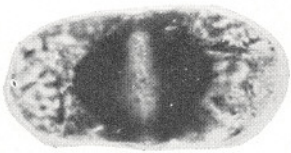
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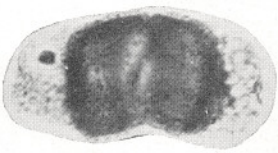
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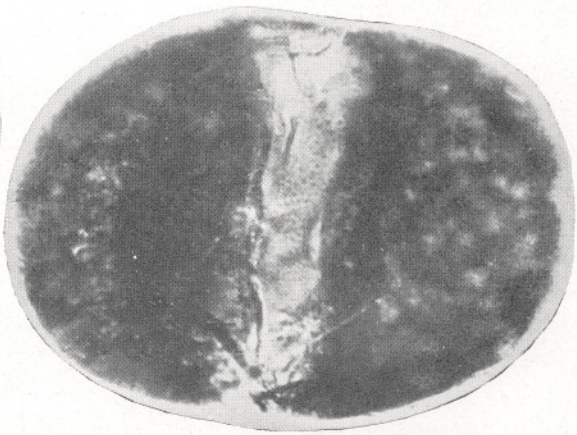
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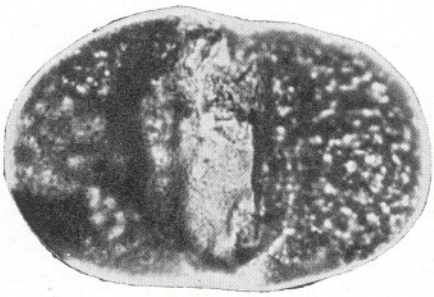
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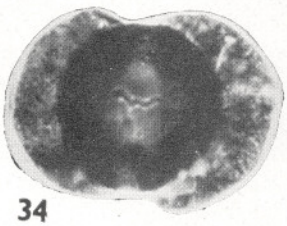
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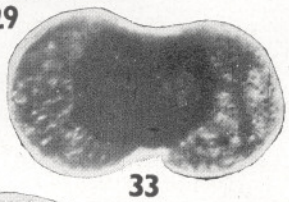
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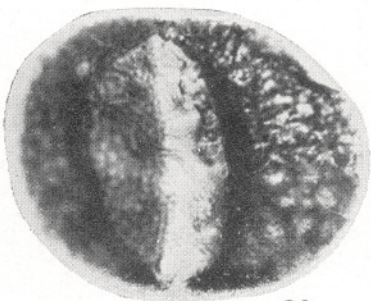
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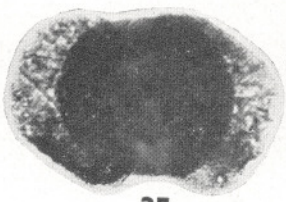
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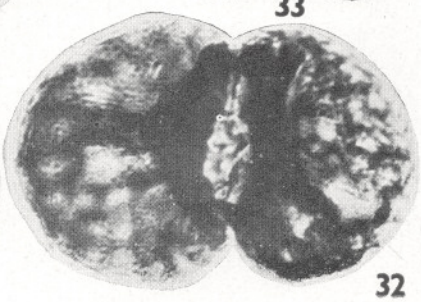
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EXPLANATION OF PLATES

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

PLATE 1

1. *Crustaesporites* cf. *globosus* Leschik, Ph. No. 249/28.

2. *Culleisporites* cf. *densus* Leschik, Ph. No. 249/9.

3. *Lueckisporites* cf. *virkkiae* Potonié & Klaus, Ph. No. 249/1.

4, 5. *L. tattooensis* Jansonius, Ph. Nos. 249/7, 248/31.

6, 7. *L. hallstattensis* sp. nov. Ph. Nos. 249/10, 248/29.

8, 9. *L. klausii* sp. nov. Ph. Nos. 248/24, 248/6.

10, 11. *L. monosaccoides* sp. nov. Ph. Nos. 249/12, 249/16.

12-14. *L. interruptus* (Jans.) comb. nov. Ph. Nos. 249/15, 248/21, 31/41.

15-16. *L. jansonii* sp. nov. Ph. Nos. 248/38, 248/27.

17, 18. *L. pallidus* sp. nov. Ph. Nos. 249/20, 248/1.

PLATE 2

19. *Lunatisporites* sp. Ph. No. 249/3.

20. *Illinities delasaucei* (Pot. & Kl.) Grebe and Schweitzer, Ph. No. 249/23.

21-24. *Klausipollenites schaubergeri* (Pot. & Kl.) Jansonius, Ph. Nos. 248/24, 249/4, 249/29.

25, 26. *K.* cf. *vestitus* Jansonius, Ph. Nos. 249/30, 249/24.

27. *K.* sp. Ph. No. 249/9.

28, 29. *Gigantosporites hallstattensis* Klaus, Ph. Nos. 249/20, 248/3.

30, 31. *G. grebei* sp. nov. 249/5, 248/10.

32. *Platysaccus* cf. *papilionis* Potonié & Klaus, Ph. No. 249/32.

33-35. *P.* sp. Ph. Nos. 249/31, 249/22, 249/28.