

SOME NEW MIOSPORE GENERA FROM UPPER GONDWANA COALS OF INDIA

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ABSTRACT

Seven new miospore genera have been described from the Upper Gondwana Coals of the Jabalpur Stage, Jabalpur Series, represented in the Satpura Coal Basin, Madhya Pradesh, India. Among these, 5 genera are trilete viz., *Haradisporites* gen. nov., *Coniatissporites* gen. nov., *Biformaesporites* gen. nov., *Lametriletes* gen. nov., *Venusteaesporites* gen. nov., and 2 are monolete, viz., *Metamonoletes* gen. nov., and *Dettmannites* gen. nov. *Haradisporites* is characterised by having small, triangular miospores with characteristically sinuous Y-rays near the apex. *Coniatissporites* possesses exine sculptured with coni, grana or small bacula in varying proportions. *Biformaesporites* incorporates circular to subcircular, trilete miospores having exine sculptured with bacula, coni and spines. *Lametriletes* is characterised by having variably thickened exine, more at the angles, sparsely punctate ornamentation, puncta prominently distributed in several linear rows along the Y-rays. *Venusteaesporites* has got two layered exine, outer punctate all over but for the region of angles, inner structureless as well as thicker at the angles. *Metamonoletes* is characterised by having ornamented exine with coni and verrucae, the latter elements being rare. *Dettmannites* is a monolete form and has verrucose exine. Verrucae are small and low around the monolete mark. Distal polar area has fainter ornamentation of the exine, grading into thicker exine and bigger verrucae towards the periphery.

THE present paper deals with the morphological description of seven new miospore genera, viz. *Haradisporites* gen. nov., *Coniatissporites* gen. nov., *Biformaesporites* gen. nov., *Lametriletes* gen. nov., *Venusteaesporites* gen. nov., *Metamonoletes* gen. nov., and *Dettmannites* gen. nov. These genera have been recovered from the coals of Lameta Ghat (Jabalpur district), Sehora and Hathnapur (Narsinghpur district) belonging to the Jabalpur Stage of the Jabalpur Series, represented in the Satpura Coal Basin, Madhya Pradesh, India. A detailed study of the new genera exhibits that the sinuous Y-rays, presence of sculptural elements viz., coni, grana, bacula, verrucae and puncta, their distribution in varying proportion and peculiar arrangement on the exine surface together with variable thickness of the exine are some of the notable

morphographical characters. Such characters have been described in detail later in the text.

A palynological study of the Jabalpur Stage has been done by Shrivastava (1954), Dev (1961), Singh (1966) and Singh & Kumar (1966 & 1969). Kumar (MS) has further dealt with the *Sporae dispersae* of the Jabalpur Series from the Satpura Coal Basin.

The new genera have been classified according to the artificial system of classification as proposed by Potonié (1956 & 1960) and Dettmann (1963). The terminology used here is after Potonié and Kremp (1955). The material and the type slides are preserved at the museum of the Birbal Sahni Institute of Palaeobotany, Lucknow.

MATERIAL

The coaly material for the present study was collected by one of us (SINGH, 1962 & 1963) from the Jabalpur Series at Sehora (22° 53' : 79° 22'), Hathnapur (22° 45' : 79° 5') in Narsinghpur district and Lameta Ghat (23° 6' : 79° 53') in Jabalpur district, Madhya Pradesh, India.

DESCRIPTION OF SPORE GENERA

Anteturma	— <i>Sporites</i> H. Potonié 1893
Turma	— <i>Triletes</i> (Reinsch) Dettmann 1963
Suprasubturma	— <i>Acavatrilletes</i> Dettmann 1963
Subturma	— <i>Axonotrilletes</i> (Luber) Dettmann 1963
Infraturma	— <i>Laevigati</i> (Bennie & Kidston) Potonié 1956

Genus — *Haradisporites* gen. nov.

Genotype — *Haradisporites mineri* sp. nov.

Generic Diagnosis — Miospores small, biconvex, triangular with straight to ± convex sides and rounded to sharply rounded angles. Trilete, Y-rays more than 3/4 of the spore radius, characteristically

sinuous near the apex, labra membraneous narrowly raised and crumpled. Exine thin, smooth to faintly sculptured and may be folded.

Reconstruction — See Text-figs. 1a-b.

Generic Description — Miospores are 20-48 μ in equatorial diameter, biconvex, triangular in equatorial view with straight to more or less convex sides and rounded to sharply rounded angles. Trilete mark is distinct, Y-rays reach more than 3/4 of the spore radius. They are slightly sinuous but characteristically sinuous near the pole and have membraneous labra which are rather raised and crumpled. Exine

is less than 1.5 μ thick in optical section and smooth but some specimens have faintly sculptured exine and few have irregularly folded exine. *Extrema lineamenta* is smooth.

Comparison — *Psilatriteles* (V.D. Hammen) Potonié (1956) is distinct from *Haradisporites* gen. nov. in having roundly triangular shape, prominent, simple trilete mark and is apparently without any elevated labra. *Deltoidospora* (Miner) Potonié (1956) is also distinguishable from the present form by virtue of its simple, flat Y-rays and straight to concave sides. *Biretisporites* (Delcourt & Sprumont) Delcourt *et al.* (1963) does not compare with *Haradisporites* gen. nov. in having bigger size, convexly triangular shape and fairly elevated labra which are upturned over the proximal polar region and also along the Y-rays. *Leiotriteles* (Naumova) Potonié & Kremp (1954), though closely comparable, can be distinguished by virtue of its convexly triangular outline and simple trilete mark.

Derivation of name — After Harad river (Hathnapur) — the locality.

Haradisporites mineri sp. nov.

Pl. 1, Figs. 1-5

Holotype — Pl. 1, Figs. 1-2; 34 \times 32 μ ; Regd. Sl. No. 3417/8.

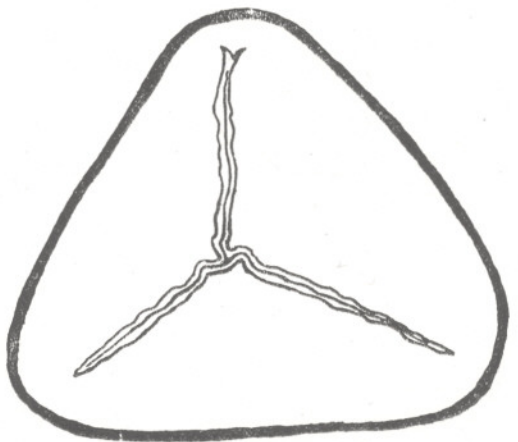
Isotype — Pl. 1, Fig. 4; Regd. Sl. No. 3420/8.

Locus typicus — Harad river near Hathnapur, Narsinghpur district, Madhya Pradesh, India.

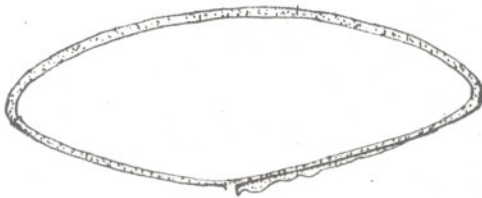
Stratum typicum — Jabalpur Stage, Jabalpur Series, Upper Gondwana, India.

Diagnosis — Size 25-42 μ . Deltoid in shape. Trilete, Y-rays characteristically sinuous near the polar region. Exine thin and irregularly folded.

Description — Miospores are biconvex appearing deltoid in equatorial view with straight to more or less convex sides and narrowly rounded angles. Trilete mark is distinct and Y-rays reach more than 3/4 of the spore radius or may run up to the corners. Y-arms are slightly sinuous but characteristically sinuous near the apex. Labra are membraneous, narrowly raised and crumpled. Exine is less than 1 μ thick in optical section. Distal exine is irregularly folded. Folds are present at



1 a



1 b

TEXT-FIG. 1a-b — a. Diagrammatic sketch of *Haradisporites* gen. nov., showing characteristically sinuous Y-rays at the apex. b. Meridional section of *Haradisporites* gen. nov.

or near the end of one of the Y-arms, usually arching along the Y-arm. *Extrema lineamenta* is smooth.

Infraturma — *Apiculati* (Bennie & Kidston) Potonié 1956

Genus — *Coniatisporites* gen. nov.

Genotype — *Coniatisporites haradensis* sp. nov.

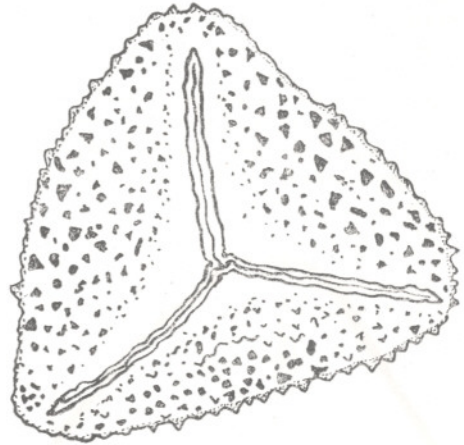
Generic Diagnosis — Miospores biconvex, triangular with straight to slightly convex or concave sides and rounded angles. Trilete, Y-rays $3/4$ of the spore radius or approximating the equator with slightly raised labra. Exine thin, sculptured with coni, grana or small bacula in varying proportions, bases of the sculptural elements free or confluent, area of the Y-mark smooth or beset with reduced sculptural elements.

Reconstruction — See Text-figs. 2a-b

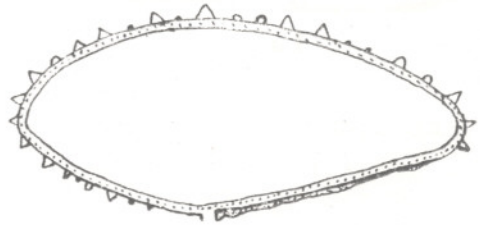
Generic Description — Miospores are 17-30 μ in equatorial diameter, biconvex, triangular in equatorial view. Sides of the spore are straight or may be slightly convex or concave with narrowly rounded angles. Trilete mark is clearly visible, Y-rays reach more than $3/4$ of the spore radius or may run up to the respective angles and are straight or may become slightly sinuous. Labra are narrowly raised and slightly crumpled. Exine is thin and ornamented with coni, grana or small bacula in varying proportions. Sculptural elements are closely spaced. Their bases are mostly free but sometime become confluent with the neighbouring ones. The area at the vicinity of the Y-mark is smooth or sometime shows reduced sculptural elements. *Extrema lineamenta* shows projecting sculptures.

Comparison — *Coniatisporites* gen. nov. is closely comparable with *Pilosporites* Delcourt & Sprumont (1955) which distinguishes itself from the former by exhibiting shorter trilete mark and ornamented exine beset with hairs, spinules or bristle-like processes. *Lunzispores* Bharadwaj & Singh (1964) has much similarity with the present genus in shape and in the nature of the trilete mark but is distinct in having verrucae, bacula and coni in varying proportions as an ornamentation of the exine together with inter-ray thickening. *Conbaculatisporites* Klaus (1960) is reported to have solely baculate exine with shorter

Y-rays and hence is different. *Anapiculatisporites* Potonié & Kremp (1955) possesses roundly triangular to circular equatorial outline, shorter Y-rays and proximally ornamented exine with coni to spines. *Lophotriletes* (Naumova) Potonié & Kremp (1955) can be distinguished from



2 a



2 b

TEXT-FIG. 2a-b — a. Diagrammatic sketch of *Coniatisporites* gen. nov., showing sculptural elements on the exine. b. Meridional section of *Coniatisporites* gen. nov.

Coniatisporites gen. nov. in having concave sides, shorter and simple Y-mark. *Acanthotriletes* (Naumova) Potonié & Kremp (1955) is also distinguishable from the present spore genus in having spinose

exine. The genus *Ceratosporites* Cookson & Dettmann (1958) is a tetrahedral spore having blunt or sharply pointed processes restricted to distal surface only. *Toriipunctisporites* Krutzsch (1959) closely compares with *Coniatisporites* gen. nov. in having similar shape and the trilete mark but the former is distinguishable from the latter in having punctate to granulose exine and by the presence of a torus on the proximal face.

Derivation of name — After the ornamentation, mainly composed of coni.

Coniatisporites haradensis sp. nov.

Pl. 1, Figs. 6-9

Holotype — Pl. 1, Fig. 6; $26 \times 30 \mu$; Regd. Sl. No. 3421/8.

Isotype — Pl. 1, Fig. 9; Regd. Sl. No. 3421/10.

Locus typicus — Harad river near Hathnapur, Narsinghpur district, Madhya Pradesh, India.

Stratum typicum — Jabalpur Stage, Jabalpur Series, Upper Gondwana, India.

Diagnosis — Size $17-30 \mu$. Triangular. Trilete. Exine $\pm 1 \mu$ thick, having coni, grana or small bacula in varying proportions.

Description — Miospores are biconvex, triangular in equatorial view with straight to more or less convex or concave sides and sharply rounded angles. Trilete mark is distinct and Y-arms extend more than $3/4$ of the spore radius or may extend up to the corners. They are straight or may be slightly sinuous with slightly raised ($1-1.5 \mu$ high) and crumpled labra. Exine is $\pm 1 \mu$ thick in optical section, more or less smooth around the tetrad mark otherwise ornamented with coni, grana or small bacula on both the surfaces. Sculptural elements are coarse and closely spaced, often fusing with the neighbouring ones. *Extrema lineamenta* is marked by projecting ornamentation of the exine.

Genus — *Biformaesporites* gen. nov.

Genotype — *Biformaesporites baculosus* sp. nov.

Generic Diagnosis — Miospores biconvex, circular to subcircular. Trilete. Exine thick, ornamented with densely packed bacula, coni and spines and having partially confluent sculptural bases.

Generic Description — Miospores are $57.5-90.5 \mu$ in equatorial diameter, biconvex, circular to subcircular in equatorial view. Trilete mark is faintly visible, Y-arms extend $2/3$ to $3/4$ of the spore radius. Exine is $2.5-5.5 \mu$ thick in optical section and is ornamented with densely packed sculptural elements which consist of bacula, coni and spines distributed on both the surfaces. Bacula possess flat to round apices, smooth to slightly dentated or to mostly truncated tips in equatorial view and their sides near the bases are partially confluent. In surface view, small irregular pit-like interbaculate areas are visible. Spines are straight to slightly curved at the apices. Coni are irregularly distributed and their sides are free or partially confluent with the neighbouring ones. *Extrema lineamenta* possesses projecting sculptural elements.

Reconstruction — See Text-figs. 3a-b.

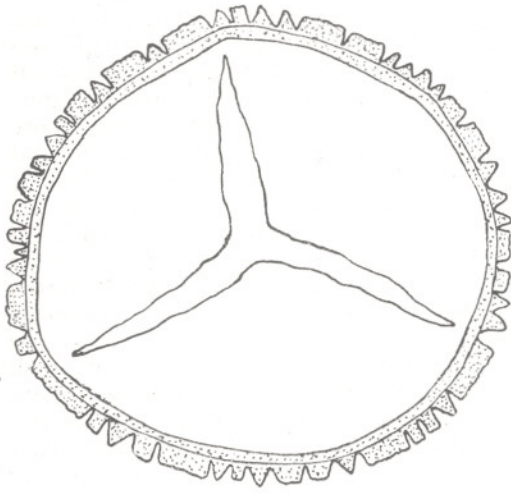
Comparison — *Baculatisporites* Thomson & Pflug (1953) differs from *Biformaesporites* gen. nov. in having a prominent trilete mark, shorter and weaker baculate processes which are smaller and sparsely distributed around the Y-rays. *Neorais-trickia* (Potonié) Bharadwaj & Kumar (MS) is distinct in possessing roundly triangular shape and only distally baculate exine, bacula being slender and free from each other. *Bhujiasporites* Venkatachala, Kar & Raza (1969) is distinct in possessing ornamentation only on the distal surface and triangular to subtriangular outline with convex to concave sides and rounded angles. The genus *Rais-trickia* (S.W. & B.) Potonié & Kremp (1955) also distinguishes itself by the presence of cylindrical bacula all over which have either forked or truncated tips and a well defined trilete mark. *Sporopollenites* (Erdtman) Thiergart (1949) resembles *Biformaesporites* gen. nov. in having similar size range, shape and nature of the Y-mark but differs in the type of ornamentation of the exine and is reported to be cingulate.

Derivation of name — After the mixed type of ornamentation (Latin — *Biformis* = of double form).

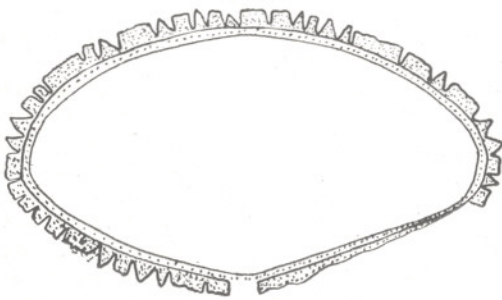
Biformaesporites baculosus sp. nov.

Pl. 1, Figs. 10-13

Holotype — Pl. 1, Figs. 10-11; $90-95 \mu$; Regd. Sl. No. 3416/3.



3 a



3 b

TEXT-FIG. 3a-b— a. Diagrammatic sketch of *Biformaesporites* sp. nov., showing densely packed sculptural elements at the equatorial outline having free to partially confluent bases. b. Meridional section of *Biformaesporites* gen. nov., showing sculptural elements on proximal and distal surfaces.

Isotype — Pl. 1, Fig. 13; Regd. Sl. No. 3414/14.

Locus typicus — Sehora, Narsinghpur district, Madhya Pradesh, India.

Stratum typicum — Jabalpur Stage, Jabalpur Series, Upper Gondwana, India.

Diagnosis — Size 57.5-90.5 μ . Circular to subcircular outline. Trilete. Exine 2-5.5 μ thick, ornamented with bacula, coni and spines. Bacula usually outnumbering the coni in proportion.

Description — Miospores are biconvex, circular to subcircular in equatorial view.

Trilete mark is present and Y-rays extend $2/3-3/4$ of the spore radius. They are simple and faintly visible. Exine is 2-5.5 μ thick in optical section. Both the surfaces are decorated with densely packed bacula which are mixed with coni and spines. Bacula are 5-7 μ long and 4-12 μ broad at the bases, having mostly truncated or flat rounded heads, margin of the truncated bacula is slightly dentate and their sides are partially confluent at the bases thus leaving a narrow space between the two elements in equatorial view. Coni measures 2.5-5 μ long and 3.5-6.5 μ broad at the bases and are free or may be partially confluent. In surface view (top focus) small irregular pits are perceptible, in mid focus irregular inter-baculate areas are visible. In deep focus anastomosing sculptural elements simulating pseudoreticulum are noticeable. *Extrema lineamenta* has sculptural elements.

Remarks — It is very difficult to count the number of individual processes because they are densely crowded along the perimeter and overlap each other at the same focus.

Subturma — *Zonatriletes* Waltz 1933

Infraturma — *Auriculati* (Schopf) Dettmann 1963

Genus — *Lametriletes* gen. nov.

Genotype — *Lametriletes indicus* sp. nov.

Generic Diagnosis — Miospores biconvex, triangular with straight to more or less concave or convex sides and rounded angles. Trilete, Y-rays reaching $3/4$ of the spore radius, straight to slightly sinuous with slightly raised membraneous labra. Exine variably thick (1.5-7.5 μ), more at the angles, slightly differentially thickened (Margo) along the Y-mark, shallowly punctate, puncta sparse on the distal and proximal face except along the Y-rays, where distributed prominently in several linear rows.

Reconstruction — See Text-figs. 4a-b.

Generic Description — Miospores are 42-98 μ in equatorial diameter and biconvex. They are triangular in equatorial view, sides are straight to slightly concave or convex and have rounded corners. Trilete mark is well pronounced, Y-rays reach generally $3/4$ of the spore radius, straight or may become slightly sinuous.

Labra are membraneous, narrowly raised and slightly crumpled. Exine is variably thick ($1.5-7.5 \mu$), thicker at the angles and slightly differentially thickened (Margo) at the vicinity of the Y-rays. Exine is punctate. Puncta on the distal face and proximo-equatorial regions are shallower, sparsely distributed and visible only under oil immersion, but for at the vicinity of the Y-rays, i.e. on the thickened area, they are prominently arranged in several linear rows. *Extrema lineamenta* is uneven.

Comparison — The genus *Lametriletes* gen. nov. differs from *Cyathidites* Couper (1953) in having convex sides, punctate exine, puncta more prominently arranged in rows along the Y-mark and raised membraneous labra enclosing the Y-mark. *Foveotriletes* (Van der Hammen) Potonié (1956) is distinct in having densely pitted exine on both the faces. *Matonisporites* (Couper) Bharadwaj & Kumar (MS) differs from the present genus by possessing concave sides and smooth exine.

Other species — *Cyathidites grandis* Singh et al. 1964; Pl. 1, Figs. 10, 11. Occurrence: Ghuneri, Kutch, India.

Matonisporites cooksonii Dettmann 1963 Pl. 1, Fig. 1-8. Occurrence: SE. Australia.

Derivation of name — After Lameta Ghat — the locality.

Lametriletes indicus sp. nov.

Pl. 1, Figs. 14-16

Holotype — Pl. 1, Fig. 14; $72 \times 84 \mu$; Regd. Sl. No. 3406/5.

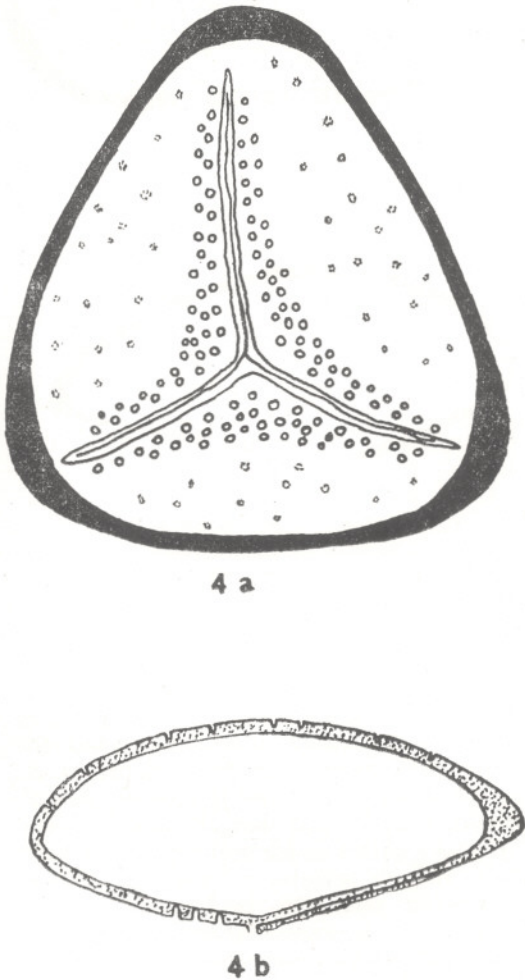
Isotype — Pl. 1, Fig. 15; Regd. Sl. No. 3409/7.

Locus typicus — Lameta Ghat, Jabalpur district, Madhya Pradesh, India.

Stratum typicum — Jabalpur Stage, Jabalpur Series, Upper Gondwana, India.

Diagnosis — Size $56-98 \mu$. Triangular with \pm convex sides. Trilete with thickening along the Y-rays. Exine thicker at angles ($4.5-6 \mu$), puncta along the Y-rays arranged in 2-5 rows.

Description — Miospores are biconvex, triangular in equatorial view with straight to more or less convex sides and rounded angles. Some specimens are often slightly obliquely flattened. Trilete mark is distinct and Y-rays reach $3/4$ of the spore radius, or may run up to the inner margin of the thickened angles with open, raised and slightly crumpled labra. Exine is differentially thickened, $1.5-4.5 \mu$ thick at the sides and $4.5-6 \mu$ thick at the angles, faintly differentially thickened (Margo) along the Y-rays and also punctate. Puncta are prominent, deep, closely spaced and arranged in 2-5 linear rows in the vicinity of the Y-rays, measuring $0.5-0.75 \mu$ in diameter. Distal puncta are shallower and sparsely distributed. *Extrema lineamenta* is \pm smooth but for shallow pits.



TEXT-FIG. 4a-b — a. Diagrammatic sketch of *Lametriletes* gen. nov., showing linear arrangement of prominent puncta along Y-rays, faintly and sparsely punctate distally together with thicker exine at the angles. b. Meridional section of *Lametriletes* gen. nov., showing distally punctate exine.

Remarks — The specimens, figured in Pl. 1, Fig. 16, show dense, irregular bodies at the polar region on the inner surface of the distal exine. These bodies appear to be some inclusions and not the structure or sculpture of the exine.

Genus — *Venusteasporites* gen. nov.

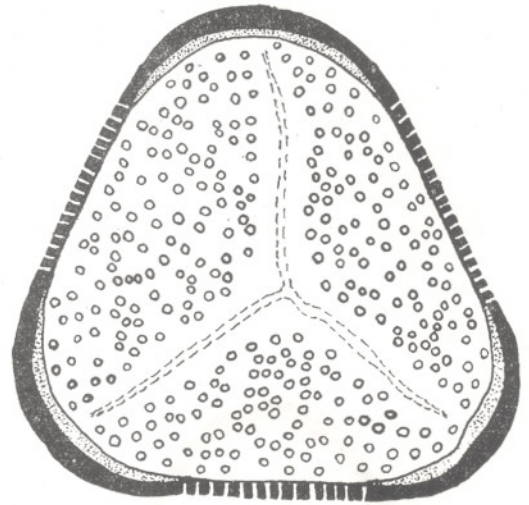
Genotype — *Venusteasporites pallidus* sp. nov.

Generic Diagnosis — Miospores biconvex, triangular, sides straight occasionally slightly concave having rounded to flat angles. Trilete, Y-rays reaching $\pm 3/4$ of the spore radius, \pm straight with thin and slightly raised labia. Exine two-layered, outer punctate all over but for the region of angles. Puncta distinct on both the faces, \pm circular, arrangement simulating a negative reticulum in surface view and rod-like elongated in meridional view. Inner layer structureless. Exine thicker at the angles.

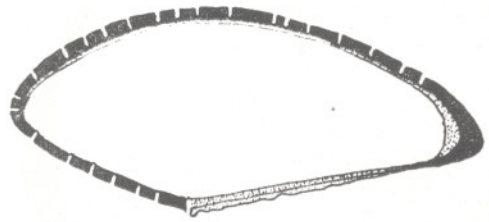
Reconstruction — See Text-figs. 5a-b.

Generic Description — Miospores are 71-90 μ in equatorial diameter and biconvex. They are triangular in equatorial view with straight to slightly concave sides and usually rounded angles but sometimes one or two angles become flat equatorially. Trilete mark is distinct, Y-rays reach more or less $3/4$ of the spore radius. They are more or less straight. Labra are thin and slightly raised. Exine is two layered. Inner one is structureless but the outer layer is distinctly punctate on both the surfaces. Puncta, in surface view, are more or less circular, free to anastomosing and simulating a negative reticulum in surface view. In meridional view, puncta are rod-like elongated present only at the sides but they are absent at the region of the angles. Both the exinal layers are thicker at the angles (3-4 μ thick at the angles and 1.5-2.5 μ thick at the sides). *Extrema lineamenta* is punctate at the sides only but smooth at the angles.

Comparison — *Venusteasporites* gen. nov. closely resembles *Foveotriletes* (Van der Hammen) Potonié (1956) in having almost similar exinal ornamentation but differs from the latter in having biconvex spores which have differentially thickened exine and shorter Y-rays. *Matonisporites* Couper) Bharadwaj & Kumar (MS) is also closely comparable to the present genus by the



5 a



5 b

TEXT-FIG. 5a-b — a. Diagrammatic sketch of *Venusteasporites* gen. nov., showing two layered exine, outer punctate all over except at the thicker angles. b. Meridional section of *Venusteasporites* gen. nov.

presence of a differentially thickened exine and biconvex nature of the spores but the former is distinguishable by virtue of its unsculptured exine, well developed unsculptured valvae and longer trilete mark. *Callispora* (Dev) Bharadwaj & Kumar (MS), though seemingly similar to *Venusteasporites* gen. nov. in having punctate exine, differs in possessing incipient thickening at the angles and single layered exine. *Lametatriletes* gen. nov. is also comparable to *Venusteasporites* gen. nov. by the presence of thickening at the corners but differs from the latter in having thickening and puncta in rows along the Y-mark as well as single-layered exine.

Venusteasporites pallidus sp. nov.

Pl. 1, Figs. 17-18

Holotype — Pl. 1, Fig. 17; $82 \times 86.5 \mu$; Regd. Sl. No. 3416/5.

Isotype — Pl. 1, Fig. 18; Regd. Sl. No. 3416/5.

Locus typicus — Sehora, Narsinghpur district, Madhya Pradesh, India.

Stratum typicum — Jabalpur Stage, Jabalpur Series, Upper Gondwana, India.

Diagnosis — Size $71-90 \mu$. Triangular. Trilete. Exine two-layered, thicker at the angles ($3-4 \mu$ thick), outer layer punctate ($0.5-1 \mu$ in diameter), puncta prominent and sparsely spaced.

Description — Miospores are biconvex, triangular in equatorial view with straight to more or less concave sides and rounded to flat angles. Trilete mark is distinct and Y-rays reach $3/4$ of the spore radius but rarely joining the inner margin of the radially thickened angles. They are straight to slightly sinuous with simple, slightly raised and crumpled labra. Exine is two-layered, the outer is continuous ($1.5-2.5 \mu$ thick) broader at the angles ($3-4 \mu$ thick). Exine is punctate all over except at the angles, puncta being deep, sparsely spaced on both the faces, $0.5-1 \mu$ in diameter in surface view, $1.5-2.5 \mu$ deep and $1-1.5 \mu$ apart. They are separated by smooth intervening areas and radial grooves are clearly visible at the sides in equatorial view. Inner layer is $\pm 1 \mu$ thick, structureless, continuous and smooth. *Extrema lineamenta* is punctate.

Turma	— <i>Monoletes</i> Ibrahim 1933
Suprasubturma	— <i>Acavatomonoletes</i> Dettmann 1963
Subturma	— <i>Azonomonoletes</i> Luber 1935
Infraturma	— <i>Sculptatomonoleti</i> Dybová & Jachowicz 1957

Genus — *Metamonoletes* gen. nov.

Genotype — *Metamonoletes haradensis* sp. nov.

Generic Diagnosis — Miospores bilateral, plano-convex, broadly oval to oval. Monolete. Exine thick, ornamented with coni, rarely mixed with verrucae.

Reconstruction — See Text-fig. 6.

Generic Description — Miospores are $29-42 \mu$ long and $18-29 \mu$ broad and bilateral in polar view, plano-convex and broadly oval to oval in equatorial view.

Monolete mark is distinct with slightly raised labrum. Exine is thick and ornamented with mostly coni and some verrucae. Sculptural elements are free, sometimes anastomosing and forming vermiculate pattern in surface view. *Extrema lineamenta* beset with projecting coni and other ornamentation of the exine.

Comparison — The monolete genera like *Polypodisporites* Potonié (1934), *Polypodiidites* Ross (1949), *Verrucosporites* (Pflug) Potonié (1956) and *Thymospora*



TEXT-FIG. 6 — Diagrammatic sketch of *Metamonoletes* gen. nov., showing coni and verrucae as the ornamentation of the exine.

Wilson & Venkatachala (1963) are reported to have bean-shaped to oval outline together with low or well pronounced warts or verrucae on the exine. *Punctatosporites* Ibrahim (1933) is distinct in having finely granulose exine. *Tuberculatosporites* Imgrund (1960) possesses coni and spinulae on the exine. *Spinosporites* Alpern (1959) has fine and densely set spines for ornamentations. *Metamonoletes* gen. nov. is different from these monolete genera by having coni and verrucae as ornamentation of the exine. Coni are sparsely distributed on the proximal face and outnumber the verrucae but the distal face has closely spaced and larger verrucae which outnumber the coni. Hence, the spore genus *Metamonoletes* differs from all the above mentioned spore genera.

Derivation of name — Latin — Meta = coni.

Metamonoletes haradensis sp. nov.

Pl. 1, Figs. 19-21

Holotype — Pl. 1, Fig. 19; $32 \times 26 \mu$; Regd. Sl. No. 3418/1.

Isotype — Pl. 1, Fig. 21; Regd. Sl. No. 3421/6.

Locus typicus — Harad river near Hathnapur, Narsinghpur district, Madhya Pradesh, India.

Stratum typicum Jabalpur Stage, Jabalpur Series, Upper Gondwana, India.

Diagnosis — Size $29-42 \mu$ long and $18-29 \mu$ broad. Broadly oval to bean-shaped. Monolete. Exine thin or thick and ornamented with coni and verrucae. Proximal face beset with more coni than verrucae in contrast to the distal face.

Description — Miospores are bilateral and appear plano-convex in lateral view, broadly oval to bean-shaped in polar view. Monolete mark is distinct, simple, mostly straight or slightly curved and is $15-30 \mu$ long. Labrum is slightly raised, open and crumpled. Exine is $1-2 \mu$ thick beset with mostly coni and some verrucae which are $1.5-2 \mu$ high and $1.5-3 \mu$ wide at the base. Sculptural elements are free, rarely anastomosing or appearing as vermiculate in surface view. Distal verrucae are slightly bigger and more pronounced than the proximal ones. Proximal face has more coni with pointed apices which are clearly visible at the perimeter. *Extrema lineamenta* is serrate or dentate.

Genus — *Dettmannites* gen. nov.

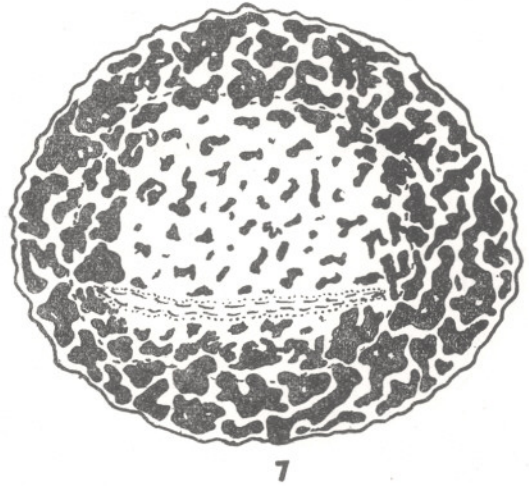
Genotype — *Dettmannites attenuarus* sp. nov.

Generic Diagnosis — Miospores subcircular to oval. Monolete. Exine verrucose, verrucae low, small, free to confluent and fainter around the monolete mark, forming a vermiform pattern in surface view. Distal polar area subcircular to oval and thinner with fainter ornamentation of the exine, grading into thicker exine and bigger verrucae towards the periphery.

Reconstruction — See Text-figs. 7a-b.

Generic Description — Miospores are $28.5-48 \mu$ long and $23-43 \mu$ broad and bilateral in polar view. They are subcircular to oval in equatorial view and have deeply convex distal face. Monolete mark is distinct, long and simple and may be

slightly curved. Exine is thin or thick and verrucose. Verrucae are low, small and closely spaced. They are free to confluent at the base, forming a vermiform pattern in surface view and are fainter around the monolete mark. The distal polar area is subcircular to oval and thinner having fainter ornamentation of the exine which grades into thicker exine and bigger verrucae towards the periphery. *Extrema lineamenta* is beaded.



TEXT-FIG. 7 — Diagrammatic sketch of *Dettmannites* gen. nov., showing low, small verrucae of vermiform pattern in surface view. Distally a polar thinner area with fainter ornamentation grading into bigger verrucae towards the periphery.

Comparison — *Thymospora* Wilson & Venkatachala (1963) closely resembles *Dettmannites* gen. nov. in having more or less similar shape and size but the former has equally thickened exine all over and more pronounced verrucae. The other monolete genera like *Polypodisporites* Potonié (1934), *Polypodiidites* Ross (1949) and *Verrucatosporites* (Pflug) Potonié (1956) have equally thickened exine and bean-shaped outline. *Tuberculatosporites* Imgrund (1960) has coni to spinulae as ornamentation on the exine and it is bean-shaped. *Metamonoletes* gen. nov. is distinguishable from the present new genus by having ornamentation consisting of coni mixed with verrucae and in lacking differentially thickened distal polar region.

Derivation of name — After Dr. M. E. Dettmann who has made valuable contributions to Upper Mesozoic palynology.

Dettmannites attenuarus sp. nov.

Pl. 1, Figs. 22-25

Holotype — Pl. 1, Fig. 22; $38 \times 33 \mu$; Regd. Sl. No. 3417/3.

Isotype — Pl. 1, Fig. 24; Regd. Sl. No. 3417/6.

Locus typicus — Harad river near Hathnapur, Narsinghpur district, Madhya Pradesh, India.

Stratum typicum — Jabalpur Stage, Jabalpur Series, Upper Gondwana, India.

Diagnosis — Size $28.5-48 \mu$ long and $23.5-42 \mu$ broad. Subcircular to oval. Monolete. Exine $1-3 \mu$ thick, verrucae $2-3 \mu$ high and appearing vermiculate in pattern. Distal polar area subcircular to oval, $15-30 \mu$ and thinner with fainter ornamentation of

the exine grading into thicker exine and bigger verrucae towards the periphery.

Description — Miospores are bilateral, distal surface is deeply convex, subcircular in polar view appearing oval in lateral view. Monolete mark is distinctly perceptible, $12-43 \mu$ long, simple, straight to slightly curved, open and sometimes sinuous. Exine is $1-3 \mu$ thick and verrucose. Verrucae are unequal, usually closely spaced, irregularly distributed, $2-3 \mu$ high free to anastomosing simulating a vermiciform pattern. Distally at the polar region a subcircular to oval thinner area is present which measures $14-30 \mu$ in diameter. The proximal surface around the monolete mark has fainter verrucae, which are very small and narrow but gradually become bigger towards the periphery. *Extrema lineamenta* appear beaded.

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EXPLANATION OF PLATE 1

(All photomicrographs $\times 500$ and are from unretouched negatives)

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|---|--|
| 1-5. <i>Haradisporites mineri</i> sp. nov., Regd. Sl. Nos. 3417/8, 3417/8, 3420/4, 3420/8, 3421/8. | Sl. Nos. 3406/5, 3409/7, 3407/8. |
| 6-9. <i>Coniatisporites haradensis</i> sp. nov., Regd. Sl. Nos. 3421/8, 3417/9, 3421/3, 3421/10. | 17-18. <i>Venusteaesporites pallidus</i> sp. nov., Regd., Sl. Nos. 3416/5, 3416/5. |
| 10-13. <i>Biformaesporites baculosus</i> sp. nov., Regd. Sl. Nos. 3416/3, 3416/3, 3416/13, 3414/14. | 19-21. <i>Metamonoletes haradensis</i> sp. nov., Regd. Sl. Nos. 3418/1, 3417/3, 3421/6. |
| 14-16. <i>Lametriletes indicus</i> sp. nov., Regd. | 22-25. <i>Deltmannites attenuarus</i> sp. nov., Regd. Sl. Nos. 3417/3, 3417/5, 3417/2, 3417/1. |

