

TWO NEW TRILETE SPORE GENERA FROM THE PERMIAN OF INDIA

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ABSTRACT

Trilete spores associated with regular folds along the trilete rays with restricted distal ornamentation or possessing differential ornamentation pattern on two faces have been reported by Balme & Hennelly (1956) from Australia, Bharadwaj (1962) and others from India.

The present paper deals with two new genera viz. *Didactylites* and *Laciniotrites* recovered from the carbonaceous shale from the Upper Barakar Stage (Permian) at Badam, North Karanpura coalfield, Bihar. Both the genera are characterized by triangular to sub-triangular shape in polar view, trilete rays associated with folds and possessing differential ornamentation on proximal and distal sides. They have been separated from each other on the nature of sculptural elements of exine and included in a new sub-infraturma *Varitritei* along with *Microfoveolatispora* Bharadwaj and *Microbaculispora* Bharadwaj. Presently the group of spores included under this group seems to be restricted only to the Lower Gondwana sediments.

INTRODUCTION

SPORES bearing triradiate germinal aperture form an important component of spore-pollen assemblages of the Palaeozoic sediments. Simple, triangular, trilete spores without any equatorial modification or appendages included under division *Azonotrites* Lubert, 1935 (POTONIÉ & KREMP, 1954) are known to be produced by fern and fern allies (see POTONIÉ, 1962), and thus their occurrence and relative abundance are significant in the understanding of palaeofloras.

The morphology of the trilete spores is relatively simple; their shape, size, nature and distribution of sculptural elements, structure of the exine, nature and limitation of the tetrad scar are some of the characters that are used in taxonomic considerations for delimitation of various taxa. Bharadwaj (1962), Jansonius (1962), Leschik (1955, 1956, 1959), Potonié & Kremp (1954), Venkatachala & Bharadwaj (1963), Wilson (1962) and others have described the morphology of this group of spores.

As opposed to simple trilete mark found in the spore genera like *Leiotrites* (Naumova) Potonié & Kremp, *Calamospora* Schopf, Wilson and Bentall, *Punctatisporites* (Ibrahim) Potonié & Kremp, *Lophotrites* (Naumova) Potonié & Kremp and the like, Bharadwaj (1962) recognized yet another type of trilete organisation in *Microbaculispora* Bharadwaj and *Microfoveolatispora* Bharadwaj. These genera are characterized by possessing ornamentation only on the distal side or having differential ornamentation on the two faces and a trilete mark associated with folds. Balme and Hennelly (1956) though recorded spores assignable to genera described by Bharadwaj (1962) and the ones proposed here, did not recognize them as distinct and different from *Leiotrites* (Naumova) Potonié & Kremp, *Granulatisporites* (Ibrahim) Schopf, Wilson & Bentall and *Acanthotrites* (Naumova) Potonié & Kremp.

The genera under consideration here are from the Barakar Stage (Permian) of India and are characterized by sub-triangular to triangular shape in polar view with well developed trilete mark associated with overlapping folds and characterized by prominent distal and laevigate to scanty proximal ornamentation. The spores were recovered from carbonaceous and coaly shales exposed near the village Badam of North Karanpura coalfield, Bihar. The material was treated with commercial nitric acid for three to four days, followed by a wash with 5 per cent potassium hydroxide solution. It was then sieved and the residue kept in 40 per cent hydrofluoric acid for two to three days. After several subsequent washings the slides were prepared with glycerine jelly.

SYSTEMATIC PALYNOLOGY

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| Anteturma | — <i>Sporites</i> H. Potonié, 1893 |
| Turma | — <i>Triletes</i> (Reinsch) Potonié & Kremp, 1954 |
| Subturma | — <i>Azonotrites</i> Lubert, 1935 |

Infraturma — *Apiculati* (Bennie & Kidston) Potonié & Kremp, 1954
Subinfraturma — *Varitriteleti* Subinfraturma nov.

Diagnosis — Subtriangular to subcircular spores possessing differential ornamentation on surfaces; germinal aperture associated with folds.

Genus *Didecitriletes* gen. nov.

Type species — *Didecitriletes horridus* sp. nov.

Generic diagnosis — Triangular to subtriangular spores in polar view and cordate in lateral compressions. Trilete distinct, associated with folds. Exine 2-4 microns thick, ornamentation proximally sparsely granulose, distally densely spinose, spines bulbous or broad based with pointed or blunt tips.

Generic description — Spores mostly triangular in polar view and cordate with triangular apices and rounded base in lateral compressions. Apices rounded, interapical margins straight to slightly convex. Over all size 50-60 × 55-64 microns. Trilete distinct, extends more or less up to equator; rays straight, equal in size; accompanied with fold on proximal side; commissure well marked. Exine more or less 2 microns thick, ornamented with 5-1 micron large grana on proximal side which are sparsely, ± evenly distributed, distally densely spinose, spines 4-10 microns long, 2-4 microns broad at base; size and shape of the spines variable; base bulbous or broad and tips achinate, acuminate or broad and lacerated.

Generic comparison — Balme & Hennelly (1956) have illustrated comparable specimens under *Acanthotriletes* (Naumova) Potonié & Kremp. In shape and general organisation *Didecitriletes* is closely comparable to *Microbaculispora* Bharadwaj (1962), however, *Microbaculispora* distinguishes in possessing distinct bacula for its ornamentation. *Anapiculatisporites* Potonié & Kremp (1954) differs in possessing a smooth proximal surface as opposed to sparsely granulose one in *Didecitriletes* and the distal surface ornamented with "coni or spinae". In most of the species attributed to *Anapiculatisporites*, the distal ornamentation is conate with sharp tipped as long as broad coni. The trilete mark in the case of *Anapiculatisporites* is not associated

with folds which are prominent in *Didecitriletes*. The type species of *Anapiculatisporites*, *A. isselburgensis* Potonié & Kremp (1954) unfortunately is not well-illustrated. The holotype specimen is laterally folded and hence haptotypic characters associated with the trilete mark cannot be made out. *Acanthotriletes* (Naumova) Potonié & Kremp has a simple trilete without any associated folds and has uniform achinate ornamentation on proximal as well as distal faces.

Derivation of name — Latin *di* = two, *decus* = ornamentation.

Distribution — Presently known from the Lower Gondwana (Permian) sediments of Australia and India.

Species referable to *Didecitriletes*:

Didecitriletes horridus sp. nov.

Pl. 1, Figs. 1-7

Holotype — Pl. 1, Fig. 1. Size: 59 × 59 microns. Slide No. 2435/6.

Type Locality — Badam, North Karanpura coalfield, Bihar; Barakar Stage (Permian).

Specific diagnosis — Spores triangular in polar view, cordate in lateral compressions, 50-64 microns. Trilete almost going up to equator, associated with folds. Exine proximally granulose, distally achinate with bulbous spines.

Description — Overall size range 50-59 × 55-64 microns. Distinctly triangular, apices bluntly rounded, inter-apical margin convex. Trilete well developed, rays equal, tapered at ends; commissure well marked. Exine more or less 2 microns thick; proximally sparsely granulose; distally spinose; 2-6 microns long and 2-3 microns broad at base; spines may be bulbous at base or gradually tapered with pointed tips. Spines interspersed with bacula.

Didecitriletes ericianus (Balme & Hennelly, 1956) comb nov.

Syn. — *Acanthotriletes ericianus* Balme & Hennelly, 1956. *Anapiculatisporites ericianus* (BALME & HENNELLY) Bharadwaj, 1962.

Holotype — Balme & Hennelly, 1956; Plate 3, Figure 30.

Type Locality — Lithgow seam, Wallerawang Colliery, Western coalfield, N.S.W.

For diagnosis and description — See Balme & Hennelly, 1956, p. 248.

Remarks — Balme & Hennelly (*l.c.*) recognize the differential ornamentation in this species as well as the overfolded trilete apparatus. The presence of folds associated with the trilete mark and differential ornamentation allows specimens referred to this species to be transferred to *Didecitriletes*. *Anapiculatisporites* lacks the characteristic folds found here.

Didecitriletes dentatus (Balme & Hennelly, 1956) comb. nov.

Syn. — *Acanthotriletes dentatus* Balme & Hennelly, 1956.

Holotype — Balme and Hennelly, 1956; Pl. 3, fig. 34.

Type Locality — Seam at 755 ft., Newston No. 2, D. D. H. Bore, upper part of the New Castle Stage, N. S. W.

Didecitriletes uncinatus (Balme & Hennelly, 1956) comb. nov.

Syn. — *Acanthotriletes uncinatus* Balme & Hennelly, 1956.

Holotype — Balme & Hennelly 1956; Pl. 3, fig. 35.

Type Locality — Seam at 688 ft. South Wallarah No. 5, D.D.H. Bore, upper part of the New Castle Stage, N. S. W.

Genus *Lacinitriletes* gen. nov.

Type species — *Lacinitriletes badamensis* sp. nov.

Generic diagnosis — Spores triangular to subtriangular. Trilete, rays \pm up to equator; associated with folds. Exine proximally laevigate and distally granulose to microverrucose.

Generic description — Spores mostly triangular in polar view; cordate in lateral flattening. Apices mostly acutely rounded, interapical margin convex. Overall size 32-59 \times 36-69 microns. Trilete distinct, rays equal, elevated, tapering at ends; commissure well marked, associated with folds. Exine more or less 2 microns thick, distally distinctly granulose to microverrucose; proximally smooth.

Generic comparison — *Lophotriletes* (Naumova) Potonié & Kremp distinguishes in possessing simple trilete mark and uniform laevigate or infragranulose structure. *Acanthotriletes* (Naumova) Potonié & Kremp

(1954) differs in possessing spinose ornamentation. *Didecitriletes* is proximally granulose and distally spinose. *Microbaculispora* Bharadwaj (1962) is distally baculate. *Anapiculatisporites* Potonié & Kremp (1954) is distally conate and the trilete is not associated with any fold system. *Lacinitriletes* can be distinguished from all of the known genera by its proximal laevigate exine and distal granulose to microverrucose ornamentation and the trilete mark accompanied with infold system.

Derivation of name — Latin: *lacinia* = flap.

Lacinitriletes badamensis sp. nov.

Pl. 1, Figs. 8-15

Holotype — Pl. 1, fig. 7. Size 69 \times 59 microns. Slide No. 2435/8.

Type Locality — Badam, North Karanpura coalfield, Bihar, Barakar Stage (Permian).

Specific diagnosis — Spores triangular, size range 50-68 \times 55-69 microns. Trilete accompanied with folds. Exine proximally laevigate and distally granulose to microverrucose.

Description — Spores triangular — subtriangular in polar view, cordate due to lateral foldings. Apices sharp and acutely rounded; interapical margins slightly convex. Trilete well marked, rays equal, extend three-fourths radius of equator; commissure distinct. Exine up to 2 microns thick, granulose; grana ranging from .5-1 micron in size, sparsely spaced.

DISCUSSION

Microbaculispora and *Microfoveolatispora* described by Bharadwaj (1962) and *Didecitriletes* and *Lacinitriletes* proposed here have the same organisation, sharing in common a subtriangular to triangular shape with well marked trilete mark constantly associated with a fold pattern and differential proximal-distal ornamentation. The constant occurrence of a fold along the trilete mark in polar compressions is perhaps due to the elevation of the proximal face or its being pyramidal in shape. The fold pattern is to accommodate the proximal curvature.

The similarity of organisation between these genera being so great, the necessity

of maintaining the four genera may be questioned. The variation in the ornamental pattern being so wide, i. e., grana, coni, bacula, spine and muri forming foveola, it is thought best to maintain them as separate genera for the present. It is proposed to include them in a new sub-infraturma *Varitriteleti*.

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EXPLANATION OF PLATE 1

(All Microphotographs magnified $\times 500$; slides are preserved at the Birbal Sahni Institute of Palaeobotany, Lucknow, India)

1-7. *Didicitriteles horridus* gen. et sp. nov.

8-15. *Lacinitriteles badamensis* gen. et sp. nov.

