REVISION OF JURASSIC SPORES AND POLLEN GRAINS FROM ANDIGAMA, CEYLON

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ABSTRACT

The present paper describes in detail the dispersed spores and pollen grains from Andigama (Ceylon) shales which were previously recorded by one of us (SAH, 1953). The present study throws more light on the probable age of these beds. The assemblage points towards their being younger in age than the Rajmahal assemblage (Nipania, Sakrigalighat and Basko) and older than the Lower Cretaceous. It has been concluded that the Andigama beds are Upper Jurassic in age.

INTRODUCTION

THE present paper concerns mainly with the proper identification and diagnosis of the previously recorded (SAH, 1953) Jurassic mioflora from Andigama, Ceylon. The main object of reinvestigating this material is twofold: firstly to validate the assemblage by treating the dispersed spores and pollen grains like other plant organs, as form and organ genera and species, rather than as types. The second object is to reassess the value of the palynological assemblage in determining the age of the Andigama beds in the light of our present day knowledge regarding the miofloras from well dated horizons of the Mesozoic era from different parts of the world.

The palynological assemblage described here has been obtained by reworking the previous material (for material and location, *see* SAH, *l.c.*, pp. 1-2). The arrangement of the genera and species follows the system of classification first proposed by Potonié & Kremp (1954, 1955 & 1956) and subsequently enlarged by Potonié (1956, 1958 & 1960). It is the most widely accepted classification and therefore considerably facilitates comparison with the works of the other authors. Rules of 'Priority' and 'Typification' have been strictly adhered to as far as possible.

SYSTEMATIC DESCRIPTION

Anteturma — ***Sporites*** **H. Pot. 1893**
Turma — ***Triletes*** **(Reinsch) Dettm. 1963**
Subturma — ***Azonotriletes*** **(Luber) Dettm. 1963**
Infraturma — ***Laevigati*** **(Benn. & Kidst.) Pot. 1956**

Genus *Cyathidites* Couper 1953

Cyathidites concavus (Bolkhovitina) Dettm.

Pl. 1, Fig. 20

Syn.

1953 — *Leiotriletes* Naum., in Sah, p. 3; Pl. 1, Photo 6.

Description — Miospore trilete, amb concavely triangular, 45 μ in size, angles convex, somewhat pointed radial extremities, sides deeply concave; Y-mark distinct, laesura straight, reaching 3/4 of the spore radius. Exine 2·5 μ thick, smooth to faintly scabrate.

Distribution — Lower Cretaceous (DETTMANN, 1963, p. 24).

Genus *Deltoidospora* (Miner) Pot. 1956

Deltoidospora sp.

Pl. 2, Fig. 41

Syn.

1953 — *Leiotriletes* Naum., in Sah, p. 3; Pl. 1, Photo 9.

Description — Miospore trilete, amb triangular, 53 μ in diameter, sides weakly convex or sometimes straight, angles broadly rounded. Trilete distinct, lips open, laesura reaching 3/4 of the spore radius, labra thick. Exine smooth to slightly scabrate, 1-1·5 μ thick.

Genus *Stereisporites* Pflug 1953

Stereisporites psilatus (Ross) comb. nov.

P. 1, Figs. 1-2

Syn.

1949 — *Triletes psilatus* Ross, p. 32; Pl. 1, Fig. 12.

1958 — *Sphagnumsporites psilatus* (Ross) Couper, p. 131; Pl. 15, Figs. 1-2.

Description — Miospores trilete, amb broadly triangular, 20-25 μ in size, sides

convex, angles obtusely broad; Y-mark distinct, laesura short, less than 1/2 of the radius. Exine 2 μ thick, smooth to faintly scabrate, thicker and darker in colour along pyramic and peripheral areas.

Infraturma — *Apiculati* (Benn. & Kidst.) Pot. 1956
Subinfraturma — *Nodati* Dybora & Jachowiez 1957

Genus *Osmundacidites* Couper 1953

Osmundacidites wellmanii Couper

Pl. 1, Fig. 12

Description — Miospores trilete, amb spherical, 40-45 μ in diameter. Trilete distinct, laesura reaching up to or more than 3/4 of the spore radius. Exine 1-1·5 μ thick, granulose, grana irregularly distributed.

Distribution — Liassic to Middle Senonian (*see* COUPER, 1960, p. 38).

Genus *Acanthotriletes* (Naum.) ex. Pot. & Kr. 1954

Acanthotriletes levidensis Balme

Pl. 1, Fig. 14

Description — Miospores trilete, amb subtriangular, 32-50 μ in size, sides convex, angles rounded. Trilete distinct, laesura reaching equator, lips raised. Exine 1·5-2 μ thick, distally ornamented with 2 μ long and 1·5 to 2 μ broad spines, with pointed apex; proximal exine smooth.

Remarks — The spores extend the size range of this species otherwise they are indistinguishable from Balme's *A. levidensis* spores.

Distribution — ? Lower Cretaceous (BALME, 1957, p. 18).

Subinfraturma — *Verrucati* Dybora & Jachowiez 1957

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

Verrucosisporites sp. A

Pl. 1, Fig. 9

Description — Miospore trilete, amb broadly triangular, 48 μ in size, sides convex, angles obtusely rounded; Y-mark not very distinct, laesura reaching up to amb. Labra thick. Exine verrucose, verrucae 1-3 μ high, irregular, sometimes fusing.

Verrucosisporites sp. B

Pl. 1, Fig. 10

Description — Miospore trilete, amb triangular, elongated, 50 μ in size, sides convex, angles rounded. Y-mark indistinct. Exine 2 μ thick, verrucose, verrucae low, about 1 μ high, compact, not crowded and regularly distributed, very irregular, forming a sort of negative reticulum, verrucae uniform in height.

Genus *Concavissimisporites* (Delc. & Sprum.) Delc. *et al.*, 1963

Concavissimisporites exiguus sp. nov.

Pl. 1, Figs. 23-24

Holotype — Pl. 1, Fig. 24; Sl. No. 74/3, Reg. No. 33689.

Paratype — Pl. 1, Fig. 23; Sl. No. 56/1

Locality — Andigama School Well, Ceylon.

Diagnosis — Miospores trilete, amb triangular, 30-40 μ in diameter, sides concave, angles rounded, biconvex; Y-mark distinct, raised; laesura reaching up to amb. Exine dorsally verrucose, verrucae rounded, up to 2 μ high, evenly distributed, sometimes better developed at the centre and periphery; proximal surface smooth.

Comparison — *Concavissimisporites exiguus* sp. nov. differs from all the known species of the genus in its small size coupled with the evenly distributed verrucae on the distal surface.

Subinfraturma — *Baculati* Dybora & Jachowiez 1957

Genus *Ceratosporites* Cooks. & Dettm. 1958

Ceratosporites magnus sp. nov.

Pl. 1, Fig. 8; Pl. 2, Figs. 37-38

Syn.

1953 — *Acanthotriletes* Naum. in Sah, p. 4; Pl. 1, Photo 18; Pl. 2, Figs. 43-44.

1965 — *Ceratosporites* sp. Sah & Jain, p. 273; Pl. 2, Fig. 53.

Holotype — Pl. 2, Fig. 53, in Sah & Jain (*l.c.*).

Paratype — Pl. 1, Fig. 8; Sl. No. 19/8.

Locality — Sakrigalighat, Rajmahal Hills, Bihar, India.

Diagnosis — Miospores trilete, amb circular to oblong, 45-70 μ in size; Y-mark distinct, laesura reaching amb, lips raised.

Exine proximally smooth, distally ornamented with 7-10 μ long and 2-3 μ broad with bluntly tapering processes, truncated or sometimes dentate apex.

Comparison — *Ceratosporites magnus* sp. nov. differs from *C. equalis* Cooks. & Dettm. (1958) in having bigger processes, with truncated apex and more. or less circular amb.

Ceratosporites equalis Cooks. & Dettm.

Pl. 1, Fig. 5

Description — Miospores trilete, 30-40 μ in diameter, amb triangular, sides convex, apices rounded. Trilete distinct, laesura reaching amb, lips elevated. Exine 1·5 μ thick, proximally smooth, distally sculptured with up to 4 μ long and 1 μ broad processes placed 3-4 μ apart; apex pointed, sometimes bifurcated.

Remarks — So far *Ceratosporites equalis* has been reported from the Upper Mesozoic sediments of Australia (COOKSON & DETTMANN, 1958; DETTMANN, 1959 & 1963).

Ceratosporites sp.

Pl. 1, Figs. 6-7

Description — Miospores trilete, amb subcircular to suboval, 35 μ in diameter. Trilete indistinct (perhaps due to unsatisfactory preservation). Exine proximally smooth, distally ornamented with processes of unequal heights, measuring 2-3 μ in length and 1-1·5 μ in breadth with truncated apex.

Genus *Baculatisporites* Thoms. & Pflug 1953

Baculatisporites comaumensis (Cooks.) Pot.

Pl. 1, Fig. 18

Description — Miospores trilete, amb nearly circular, 40-45 μ in diameter. Trilete distinct, laesura reaching 3/4 of the spore radius. Exine sculptured with uneven baculae, <1 μ high.

Distribution — Upper Triassic to Upper Cretaceous (DETTMANN, 1963, p. 35).

Baculatisporites novus sp. nov.

Pl. 1, Figs. 11, 22

Syn.

1953 — *Lophotriletes* Naum., in Sah; p. 4; Pl. 1 , Photo 29.

Holotype — Pl. 1, Fig. 11; Sl. No. 83/9. Reg. No. 33689.

Locality — Andigama School Well, Ceylon.

Diagnosis — Miospores trilete, amb broadly subtriangular to circular, 40-50 μ in diameter. Y-mark distinct, laesura reaching up to periphery. Exine baculate, baculae unequal in size, closely placed, crowded, 1·5-2 μ high.

Comparison — *Baculatisporites novus* sp. nov. differs from *B. comaumensis* (Cooks.) Pot. (1956), in having longer laesura and crowded baculae.

Baculatisporites emarginatus Sah & Jain

Pl. 1, Fig. 17

Description — (*see* SAH & JAIN, 1965, p. 270).

Infraturma — *Tricrassati* Dettm. 1963

Genus *Gleicheniidites* (Ross, ex. Delc. & Sprum.) Dettm. 1963.

Gleicheniidites indicus Singh *et al.*

Pl. 1, Fig. 4

Description — (*see* SINGH *et al.*, 1964, pp. 284-285).

Infraturma — *Murornati* Pot. & Kr. 1954

Genus *Cicatricosisporites* Pot. & Gell. 1933

Cicatricosisporites typicus sp. nov.

Pl. 1, Figs. 31-32; Pl. 2, Fig. 35

Holotype — Pl. 1, Fig. 32; Sl. No. 18/2; Reg. No. 33689.

Paratype — Pl. 1, Fig. 37; Sl. No. 38/5.

Locality — Andigama School Well, Ceylon.

Diagnosis — Miospores trilete, 50 to 55 μ in diameter, amb triangular, interapical sides straight or slightly convex or concave, angles broadly rounded without any notch. Laesura straight, reaching up to amb, sometimes lips undulating. Exine 3 μ thick. Both proximal and distal surfaces sculptured. Proximal surface ornamented with three pairs of concentric muri running along the equatorial region covering a width of 15-20 μ towards the contact area. Muri 1 μ thick, rounded and 0·5 μ apart. Muri on distal surface showing altogether different pattern. Two series of narrow, occasionally bifurcating muri, each mural series consists of

8-10 muri, orientated parallel to two sides, terminating on one side from angle to angle while the muri of second series on the other side arise from one angle near the first series, some running parallel to that interapical side where they terminate.

Comparison — *Cicatricosisporites typicus* sp. nov. differs from the so far known species cf. the genus in having at hick exine, concentric proximal equatorial muri and two series of distal muri.

Cicatricosisporites australiensis (Cooks.) Pot.

Pl. 2, Fig. 40

Description — (*see* DETTMANN, 1963, p. 53)

Cicatricosisporites sp.

Pl. 1, Fig. 30

Description — Miospore trilete, 55 μ in diameter, radially symmetrical, amb triangular with straight to slightly convex interapical sides, angles very slightly projecting. Trilete indistinct. Exine distally and equatorially sculptured with three series of 4-5 rounded muri, muri of each series parallel to each other and also to the interradial sides of the amb, terminating along the triangle angle and coalescing with alternate muri of neighbouring series. Muri about 2 μ wide, lumina 1 μ wide; proximal exine sculptured with 2 or 3 muri at the equator.

Remarks — The present spore shows nearest resemblance with the spores described by Dettmann (1963, pp. 54-55) as *Cicatricosisporites pseudotripartitus* (Bolkhovitina) Dettmann. As only a single incomplete specimen has been recovered, further comparison has not been attempted.

Genus *Foveosporites* Balme 1957

Foveosporites canalis Balme

Pl. 1, Fig. 15

Description — Miospores trilete, amb broadly subtriangular to triangular, 40-47 μ in size, sides convex angles rounded; Y-mark distinct, reaching up to the equator. lips thin and low. Exine foveolate, foveolae circular in outline, about 1 μ in diameter, proximal foveolae sometimes coalescent forming canals.

Distribution — Oxfordian — Aptian. (BALME, 1957, p. 17; DETTMANN, 1963, p. 43).

Genus *Lycopodiumsporites* Thierg. ex. Delc. & Sprum. 1955

Lycopodiumsporites austroclavatidites (Cooks.) Pot.

Pl. 1, Figs. 25 & 28-29

Syn.

1953 — *Dictyotriletes* Naum., in Sah, p. 5; Pl. 1, Photos 16-17 & 21.

Description — Miospores trilete, amb circular to subtriangular, 40-45 μ in diameter. Y-mark distinct, laesura reaching almost up to equator. Exine distally sculptured with regular coarse reticulations, muri 2 μ high, lacunae 5-13 μ wide, penta- to hexa-gonal; proximal surface smooth.

Distribution — Widely distributed in Jurassic and Cretaceous.

Lycopodiumsporites eminulus Dettm.

Pl. 1, Figs. 26-27

Description — Miospores trilete, amb convexly triangular, Y-mark distinct, laesura undulating, reaching 3/4 of radius, Exine proximally smooth, ornamented distally with a regular and perfect reticulum, muri flat topped, 1-2·5 μ high, lumen 1-2·5 μ wide.

Distribution — Lower-Upper Cretaceous (DETTMANN, 1963, p. 46).

Genus *Ischyosporites* Balme 1957

Ischyosporites inusilatus sp. nov.

Pl. 1, Fig. 21

Holotype — Pl. 1, Fig. 21; Sl. No. 21/2; Reg. No. 33689.

Locality — Andigama School Well, Ceylon.

Diagnosis — Miospores trilete, 50-60 μ in diameter, amb triangular, sides valvate, angles obtusely broad, Y-mark distinct, laesura 3/4 of the spore radius. Exine thickened distally with unusually fused ridges forming a central shield, ridge concentration maximum at the angles, irregular reticulations absent. Proximal surface smooth.

Comparison — The spores are quite distinct and can be distinguished from the other species of *Ischyosporites* by their central distal shield of fused ridges.

Ischyosporites incompositus sp. nov.

Pl. 1, Fig. 13

Holotype — Pl. 1, Fig. 13; Sl. No. 39/4, Reg. No. 33689.

Locality — Andigama School Well, Ceylon.

Diagnosis — Miospores trilete, amb triangular, 40-45 μ in diamter, sides straight to weakly convex, angles obtuse, biconvex; Y-mark distinct, laesura reaching amb. Exine proximally smooth, distally ornamented with thick uneven ridges, anastomosing to form a complete or incomplete reticulum, lacunae irregular in shape, 3-8 μ in size; distal ridges rather delicate, less than 2 μ thick and poorly developed in the central region.

Comparison — *Ischyosporites incompositus* sp. nov. comes nearest to *Ischyosporites crateris* Balme in size and morphological features but differs in having a comparatively thick exine and much coarser ridges. It also differs from the other species in having thinner exine and delicate ridges.

Infraturma — *Perinotriliti* Erdtm. 1947

Genus *Perotriletes* (Erdtm.) ex. Couper 1953

Perotriletes punctatus sp. nov.

Pl. 1, Fig. 19

Holotype — Pl. 1, Fig. 19; Sl. No. 16/9, Reg. No. 33689.

Locality — Andigama School Well, Ceylon.

Diagnosis — Miospores trilete, size range 60-75 μ (including perispore), amb rounded triangular; body sub-triangular to circular, 40-46 μ in diameter, surrounded marginally by a thickening, sides convex, apices rounded; trilete distinct, laesura reaching up to the body margin. Exine 3-4 μ thick, structured with puncta. Perispore hyaline, loose, covering the whole body, 6-10 μ wide, ornamented with regular puncta.

Comparison — *Perotriletes punctatus* sp. nov. differs from *P. granulatus* Couper (1953), *P. perinatus* Hughes & Playford (1961) and *P. magnus* Hughes & Playford (*l.c.*) in its smaller size and also in possessing both punctate exine and perine. *P. punctatus* also compares well with the spores described and figured by Dettmann (1963, p. 82; Pl. 19, Figs. 1-3) as *Velosporites triquetrus* (Lantz) Dettm. It differs mainly in having broadly triangular shape and thicker perine. It is also important to point out here that the miospores described by Lantz (1958, p. 926) as *Laricoidites triquetrus* are alete and do not fit in the circumscription of the genus *Velosporites* Hughes & Playford (1961) which includes monosaccate and trilete miospores. The Australian miospores should therefore be described under the well established Mesozoic genus *Perotrilites*.

Turma — *Zonales* (Benn. & Kids. 1886) Pot. 1856
Subturma — *Zonotriletes* walt. 1935
Infraturma — *Cingulati* (Pot. & Kl.) Dettm. 1963

Genus *Contignisporites* Dettm. 1963

Contignisporites cooksonii (Balme) Dettm.

Pl. 1, Figs. 33-34; Pl. 2, Fig. 36

Syn.

1953 — *Chomotriletes* Naum., in Sah, p. 3 Pl. 1, Photos 7-8.

1956 — *Anemia dorsostriata* Bolkhv, p. 60; Pl. 7, Fig. 59a-b.

1964 — *Cicatricosisporites dorsostriatus* (Bolkhovitina) Singh *et al.*, p. 57; Pl. 6, Figs. 2-4.

Description — Miospore trilete, cingulate, biconvex, symmetrical along one plane, amb rounded triangular, 40-45 μ in size. Trilete distinct, laesura straight, extending up to the inner margin of the cingulum, lips thin. Exine 3 μ thick, distally sculptured with 6-9 parallel, low and rounded muri which coalesce with the cingulum towards the equator; muri 5 μ wide, lacunae 1·5 μ broad; proximal exine smooth near the poles; interradial area along the inner margin of cingulum ornamented with a single tangential ridge.

Distibution — Oxfordian to Aptian, common in Upper Jurassic and Lower Cretaceous (Balme, 1957; De Jersey & Paten, 1964).

Anteturma — *Pollenites* R. Pot. 1931
Turma — *Saccites* Erdtm. 1947

Remarks — Saccate pollen grains (mono-, di- and tri-saccate) abound in the Andigama shales and so form an important aspect of the assemblage. Unfortunately their preservation in general is not satisfactory enough or sometimes even too obscure to allow proper specific distinctions. Hence in such cases the specific comparisons have been avoided.

Subturma — *Monosaccites* (Chitaley) Pot. & Kr. 1954
Infraturma — *Aletesacciti* Leschik 1955

Genus *Callialasporites* (Balme) Dev 1961

Callialasporites dampeiri (Balme) Dev

Pl. 2, Fig. 42

Syn.

1953 — *Dictyotriletes* Naum., in Sah, p. 5; Pl. 1, Photo. 11.

Description — (*see* SAH & JAIN, 1965, p. 276).

Callialasporites segmentatus (Balme) Srivastava

Pl. 2, Fig. 45

Syn.

1953 — *Euryzonotriletes* Naum., in Sah, p. 6; Pl.. 1, Photo 14.

Description — (*see* SAH & JAIN, *l.c.*, p. 276)

Callialasporites trilobatus (Balme) Dev

Pl. 2, Figs. 43-44

Description — (*see* SAH & JAIN, *l.c.*, p. 275).

Subturma — *Disaccites* Cooks. 1947
Infraturma — *Pinosacciti* (Erdtm.) Pot. 1958

Genus *Alisporites* (Daugh.) Nilsson 1958

Alisporites sp.

Pl. 2, Fig. 46

Description — Pollen grain 64×64 μ in size, body oval, 64×36 μ in size, marginal rim absent; exine ornamentation not preserved; bladder haploxylonoid, furrow about 5 μ wide.

Genus *Podocarpidites* (Cooks.) Pot. 1958

Podocarpidites sp. cf. *alareticulosus* Sah & Jain

Pl. 2, Figs. 52-53

Description — Pollen grains disaccate, body oblong, 50-55 μ in diameter, marginal rim present; bladders smaller than the body (haploxylonoid), 32×24 μ in size, furrow 8 μ wide. Exine ornamentation on both body and bladder not preserved.

Remarks — The pollen grains are comparable to *P. alareticulosus* Sah & Jain (1965) in external characters, but their identification could not be confirmed due to the bad preservation of exine.

Podocarpidites sp. A

Pl. 2, Fig. 47

Syn.

1953 — *Oedemosaccus* Naum., in Sah, p. 7; Pl. 1, Photos 30 & 32.

Description — Pollen grains disaccate, 60×45 μ in size, body circular to oval, 30 μ in diameter, marginal rim prominent. Bladders 45×23 μ, projecting beyond the body. Body and bladder exine ornamentation not clear.

Remarks — *Podocarpidites* sp. A resembles *P. novus* Sah & Jain (1965) in the shape and size of the body and bladders. Their exact comparison is, however, not possible in the absence of details covering exine ornamentation.

Podocarpidites sp. B

Pl. 2, Fig. 48

Description — Pollen grains disaccate, 56×33 μ in size, body circular, 22·5 μ in diameter, bladder 33×22·5 μ in size, furrow, 7 μ wide. Ornamentation obscure.

Podocarpidites sp. C

Pl. 2, Fig. 49

Description — Pollen grains large, 90×60 μ in size, body oblong, 60×37·5 μ in size, bladders distally attached, furrow wide. Exine ornamentation not well preserved.

Genus *Vitreisporites* (Leschik) Jansonius 1962

? *Vitreisporites* sp.

Pl. 2, Figs. 50-51

Description — Pollen grains disaccate, 45-53×35-40 μ in size, body oval in polar view, marginal rim unevenly thickened, bladders attached on the median longitudinal plane, furrow narrow. Exine ornamentation not clear.

Subturma — *Polysaccites* Cooks. 1947

Genus *Trisaccites* Cooks. & Pike 1954

Trisaccites sp. cf. *microsaccatus* (Couper) Couper

Pl. 2, Fig. 59

Description — Pollen grains very small, 9 μ in diameter, body circular, rim prominent, bladders rudimentary, less than 4 μ in size.

Genus *Podosporites* Rao 1943

Podosporites tripakshii Rao

Pl. 2, Fig. 54

Syn.

1953 — Coniferous pollen with 3 bladders, in Sah; p. 7; Pl. 1, Photo 31.

Description — Pollen grains trisaccate, ± spherical, 42×30 μ in size. Bladders inflated, oblong, 21×10 μ in size. Exine ornamentation finely reticulate.

Turma — *Aletes* Ibrah. 1933
Subturma — *Azonaletes* (Luber,) Pot. & Kr. 1954
Infraturma — *Psilonapiti* Erdtm. 1947

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

Laricoidites communis Sah & Jain

Pl. 2, Fig. 55

Description — Pollen grains alete, amb circular, 80 μ in diameter, exine thick, finely granulate, secondary folds prominent, irregular.

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

Genus *Cycadopites* (Wodehouse) ex. Wils. & Webs. 1946

Cycadopites sp.

Pl. 2, Figs. 56-57

Syn.

1953 — *Azonomonoletes* Luber, in Sah; p. 6; Pl. 1, Photos 26-27.

Description — Pollen grains monocolpate, elongate-oblong in shape, 34×22 μ in size, sulcus uniform, ends slightly rounded. Exine scabrate.

Turma — *Polyplicates* Erdtm. 1952

Genus *Ephedripites* Bolkhovitina 1953

Ephedripites sp.

Pl. 2, Fig. 58

Description — Miospore elliptical, 24×16 μ in size; germinal aperture not seen; exine 1·5 μ thick, ornamented with fine parallel longitudinal ridges, about 1 μ apart, which appear to converge at the apical ends; lateral anastomoses present at places.

Remarks — Only a single grain of this type has been recorded. It can be distinguished by its small size and finer ridges.

INCERTAE SEDIS

Genus — *Exesipollenites* Balme 1957

Exesipollenites crassimarginatus sp. nov.

Pl. 1, Figs. 3 & 16

Holotype — Pl. 1, Fig. 16; Sl. No. 28/2. Reg. No. 33689.

Locality — Andigama School Well, Ceylon.

Diagnosis — Miospores circular, 20-38 μ in diameter, germinal aperture not seen. Exine differentially thickened towards the periphery, 4·5-7·5 μ thick, dark in colour, central depression up to 15 μ broad, surface microgranulose.

Comparison — *E. crassimarginatus* sp. nov. differs from *E. tumulus* Balme (1957) in having a larger central depression and a wider marginal thickening around the exine.

Exesipollenites sp.

Pl. 2, Fig. 39

Description — Miospore circular, 21 μ in diameter, alete. Exine 1·5-2 μ thick, differentially thickened and darker in colour in the central circular depression and between the equatorial margin; central area 3-4 μ in diameter; exine smooth to scabrate.

Remarks — The miospore described above closely compares with *E. tumulus* Balme but differs in not having coarsely granulate exine.

DISCUSSION

The miospore assemblage recovered from the Andigama (Ceylon) shales consists of 26 spore-pollen genera. Of these, 16 are pteridophytic and other trilete spore types while the rest are gymnospermous. The trilete spores and saccate (mono-, di- and tri-saccate) or non-saccate pollen grains are equally abundant, whereas the cycadophytic pollen grains are comparatively less abundant. The trilete spores are generally well preserved while the saccate pollen grains are not so well preserved. They have been assigned to their generic status on the basis of their external organization alone. For purposes of correlation more emphasis has been laid upon the trilete spores and only those saccate genera which have been found to be characteristic.

The pteridophytic and other trilete spore spectrum includes genera like, *Cyathidites*,

Deltoidospora, Gleicheniidites, Osmundacidites, Baculatisporites, Stereisporites, Perotriletes, Foveosporites, Ischyosporites, Lycopodiumsporites, Concavissimisporites, Cicatricosisporites, Contignisporites, Ceratosporites, Acanthotriletes and *Verrucosisporites* The gymnospermous pollen grains are, *Callialasporites, Podocarpidites, Alisporites, Podosporites, Vitreisporites, Laricoidites, Cycadopites, Trisaccites* and *Ephedripites.*

The Upper Mesozoic miospore assemblages from India are known from the Rajmahal Hills (RAO, 1943; VISHNU-MITTRE, 1954; SAH & JAIN, 1965); Vemavaram (RAMANUJAM, 1957); Jaiselmer (SRIVASTAVA, 1963); Jabalpur (DEV, 1961); Dhrangadhra (VARMA & RAWAT, 1964) and from Cutch (SINGH *et al.*, 1964).

Almost all the important trilete genera represented in the Andigama assemblage have also been described from the Rajmahal, Vemavaram and Jaiselmer miofloras, with a single exception of *Contignisporites cooksonii* which is quite common in the present assemblage. In spite of a number of common generic representatives in these four assemblages, the Andigama mioflora possesses some distinct element like, *Ceratosporites equalis, Acanthotriletes levidensis, Cyathidites concavus, Foveosporites canalis, Lycopodiumsporites eminulus,* and *Contignisporites cooksonii* which are entirely absent from the Rajmahal, Vemavaram and Jaiselmer miofloras. Singh *et al.* (*l.c.*, p. 302) have referred the schizaeaceous miospores described from Nipania by Vishnu-Mittre (1954, PL. 1, FIGS. 10, 14-16) to *Contignisporites.* This does not seem correct as the Nipania miospores do not possess a cingulum which characterises the genus *Contignisporites.* They come within the circumscription of the genus *Cicatricosisporites.* The association of these mixed species (Upper Jurassic and Lower Cretaceous) together with the abundance of *C. cooksonii* in the Andigama assemblage and a more purer Middle-Upper Jurassic element in the Rajmahal, Vemavaram and Jaiselmer microfloras suggests that the Andigama beds are younger in age than the latter.

A comparison with the Dhrangadhra mioflora indicates a closer agreement with the Andigama assemblage but the former essentially differs in having some angiospermic elements. The Dhrangadhra assemblage offers a peculiar association of forms which necessiates some comments. The Dhrangadhra miofloral assemblage has a typically Upper Jurassic aspect if the three angiospermic pollen grains are excluded. The presence of the angiospermic elements led the authors to ascribe a Lower Cretaceous age to the Dhrangadhra beds. A perusal of the Dhrangadhra miospore assemblage shows the entire absence of forms like, *Aequitriradites, Crassimonoletes, Umiaspora, Schizosporis* and *Leschikisporis* etc. which are found to be the essential components of the Cutch mioflora (Lower Cretaceous, SINGH *et al.*, *l.c.*). A few of these genera along with *Appendicisporites, Pyrobolospora, Pilosisporites, Crybelosporites, Kraeuselisporites, Rouseisporites* and *Contignisporites* (other than *C. cooksonii*) have been known to occur in practically all the Lower Cretaceous horizons known from the different regions of the world (DETTMANN, 1963; POCOCK, 1962; DELCOURT *et al.*, 1963; DELCOURT & SPRUMONT, 1955).

None of these genera have anywhere been known to go below Lower Cretaceous except *C. cooksonii* which is a very common form in the Upper Jurassic sediments. These characteristic Lower Cretaceous genera are absent both from the Dhrangadhra and Andigama miofloras. This leads us to presume that the angiospermic elements might have come in through contamination and the Dhrangadhra beds may really be Upper Jurassic in age. Also the similarity in abundance of *C. cooksonii* in both Andigama and Dhrangadhra might be regarded as supporting evidence in favour of an Upper Jurassic age for these beds.

Among the other known southern miofloras, the Oxfordian-Kimmeridgian miofloras of western Australia described by Balme (1957) shows its closest comparison with the Andigama mioflora.

Further comparing the Andigama mioflora with the other contemporary miospore assemblages of the other regions of the world, a close similarity is evidenced with the Upper Vanguard (Upper Jurassic mioflora) of Canada (POCOCK, 1962). The Mannville mioflora of Canada is distinct being characterized by the elements like *Schizosporis, Appendicisporites, Pilosisporites* and *Rouseisporites*, etc., which are entirely absent from the Vanguard assemblage of the same regoin as well as from the Andigama mioflora.

A comparison with the British Mesozoic miofloras (COUPER, 1958) shows that the Andigama assemblage is comparable to the

Upper Jurassic (Oxford Clay, E. Yorkshire and Kimmeridge Clay, Brora) rather than the Purbeckian or Aptian miofloras.

Sah (1953, p. 10) considered the Andigama mioflora as equivalent to the Rajmahal Intertrappean Series, but in view of the above comparisons it becomes apparent that the Andigama beds are younger than the Rajmahal and older than the Lower Cretaceous. The Rajmahal mioflora has been assigned a Middle-Upper Jurassic age (SAH & JAIN, 1965, p. 286). We are therefore inclined to conclude that the Andigama beds are Upper Jurrassic in age and younger in position to the Rajmahal Intertrappean Series.

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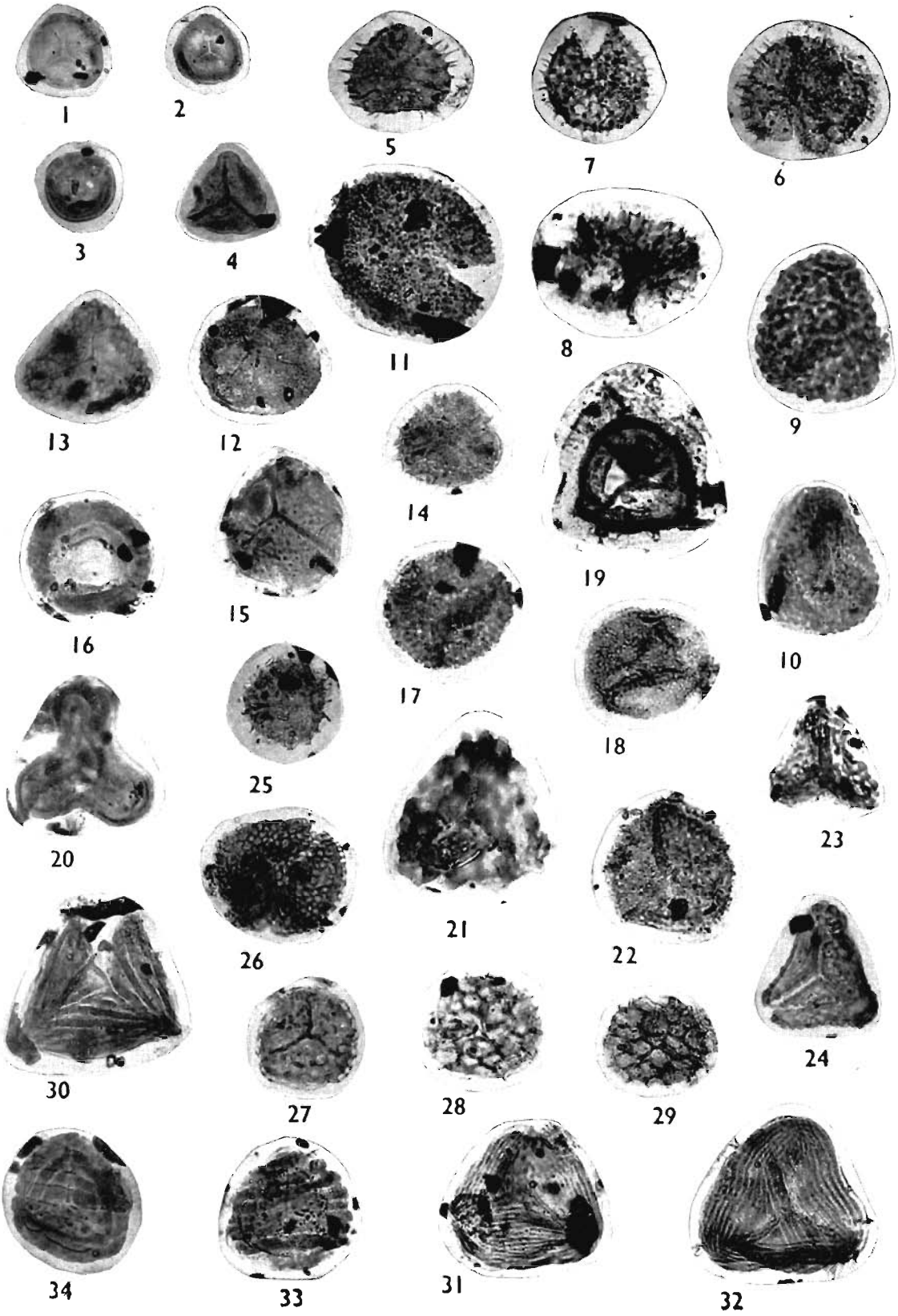
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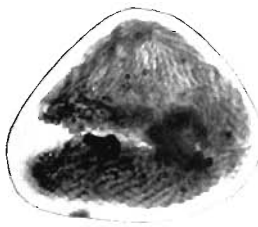
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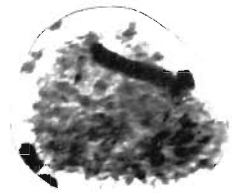
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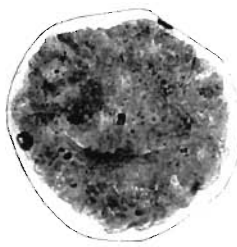
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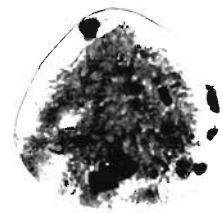
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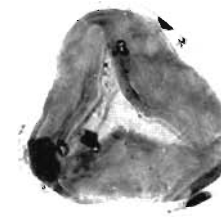
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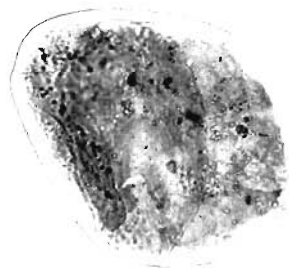
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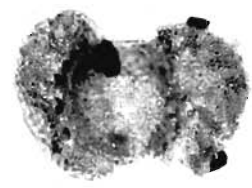
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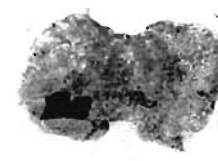
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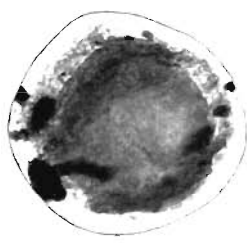
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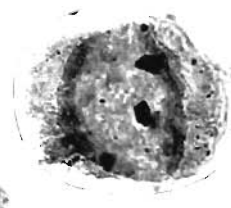
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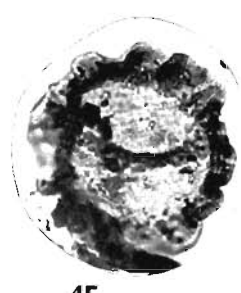
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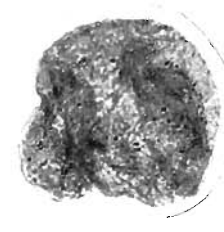
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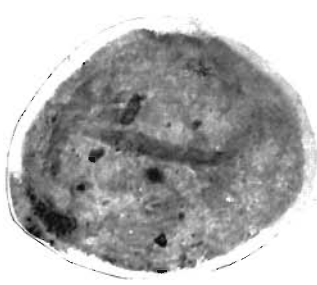
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EXPLANATION OF PLATES

(All spores and pollen grains magnified × 500)

PLATE 1

1-2. *Stereisporites psilatus* (Ross) comb., nov., Sl. Nos. 7/3 & 7/1.
3. *Exesipollenites crassimarginatus* sp. nov., Sl. No. 2/1.
4. *Gleicheniidites indicus* Singh *et al.*, Sl. No. 2/1.
5. *Ceratosporites equalis* Cooks. & Dettm., Sl. No. 59/3.
6-7. *Ceratosporites* sp., Sl. Nos. 15/2 & 36/6.
8. *Ceratosporites magnus* sp. nov., Sl. No. 19/8.
9. *Verrucosisporites* sp. A., Sl. No. 27/1.
10 *Verrucosisporites* sp. B., Sl. No. 20/3.
11. *Baculatisporites novus* sp. nov., Sl. No. 83/9.
12. *Osmundacidites wellmanii* Couper, Sl. No. 62/1.
13. *Ischyosporites incompositus* sp. nov., Sl. No. 39/4.
14. *Acanthotriletes levidensis* Balme, Sl. No. 19/4.
15. *Foveosporites canalis* Balme, Sl. No. 75/2.
16. *Exesipollenites crassimarginatus* sp. nov., Sl. No. 28/2.
17. *Baculatisporites emarginatus* Sah & Jain, Sl. No. 19/2.
18. *Baculatisporites comaumensis* (Cooks.) Pot., Sl. No. 64/1.
19. *Perotriletes punctatus* sp. nov., Sl. No 19/6.
20. *Cyathidites concavus* (Bolkh.) Dettm., Sl. No. 40/4.
21. *Ischyosporites inusilatus* sp. nov., Sl. No. 21/2.
22. *Baculatisporites novus* sp. nov., Sl. No. 20/1.
23-24. *Concavissimisporites exiguus* sp. nov., Sl. Nos. 56/1 & 74/3.
25. *Lycopodiumsporites austroclavatidites* (Cooks.) Pot., Sl. No. 19/3.
26-27. *Lycopodiumsporites eminulus* Dettm., Sl. Nos. 55/2 & 74/4.
28 - 29. *Lycopodiumsporites austroclavatidites* (Cooks.) Pot., Sl. Nos. 63/2 & 6/4.
30. *Cicatricosisporites* sp., Sl. No. 20/4.
31-32. *Cicatricosisporites typicus* sp. nov., Sl. Nos. 38/5 & 18/2.
33-34. *Contignisporites cooksonii* (Balme) Dettm,. Sl. Nos. 21/1 & 25/1.

PLATE 2

35. *Cicatricosisporites typicus* sp. nov., Sl. No. 42/1.
36. *Contignisporites cooksonii* (Balme) Dettm., Sl. No. 16/2.
37-38. *Ceratosporites magnus* sp. nov., Sl. No. 33/3 & 15/1.
39. *Exesipollenites* sp., Sl. No. 3/4.
40. *Cicatricosisporites australiensis* Cookson, Sl. No. 85/5.
41. *Deltoidospora* sp., Sl. No. 76/1.
42. *Callialasporites dampeiri* (Balme) Dev, Sl. No. 6/1.
43-44. *Callialasporites trilobatus* (Balme) Dev, Sl. Nos. 55/3 & 68/1.
45. *Callialasporites segmentatus* (Balme) Srivastava, Sl. No. 34/1.
46. *Alisporites* sp., Sl. No. 2/4.
47. *Podocarpidites* sp. A., Sl. No. 2/3.
48. *Podocarpidites* sp. B., Sl. No. 32/2.
49. *Podocarpidites* sp. C., Sl. No. 3/1.
50-51. ? *Vitreisporites* sp., Sl. Nos. 73/3 & 6/2.
52-53. *Podocarpidites* sp. cf. *alareticulosus* Sah & Jain, Sl. Nos. 34/3 & 2/5.
54. *Podosporites tripakshii* Rao, Sl. No.28/3.
55. *Laricoidites communis* Sah & Jain, Sl. No. 29/1.
56-57. *Cycadopites* sp., Sl. Nos. 35/1 & 3/3.
58. *Ephedripites* sp., Sl. No. 7/2.
59. *Trisaccites* sp. cf. *microsaccatus* (Couper) Couper, Sl. No. 83/5.