The Palaeobotanist **35**(3) : 267-280, 1986.

Palynology of the Barail (Oligocene) and Surma (Lower Miocene) sediments exposed along Sonapur-Badarpur Road Section, Jaintia Hills (Meghalaya) and Cachar (Assam). Part-III. Pteridophytic spores

M. R. Rao & H. P. Singh

Rao, M. R. & Singh, H. P. (1987). Palynology of the Barail (Oligocene) and Surma (Lower Miocene) sediments exposed along Sonapur-Badarpur Road Section, Jaintia Hills (Meghalaya) and Cachar (Assam). Part-III. Pteridophytic spores. *Palaeobotanist* **35**(3) : 267-280.

The present paper deals with the systematic description of pteridophytic spores recovered from the Barail (Oligocene) and Surma (Lower Miocene) sediments exposed along Sonapur-Badarpur Road Section, Meghalaya and Assam. The pteridophytic spores are represented by 18 genera and 32 species. Quantitative analysis of the assemblage reveals that the pteridophytic spores are the dominant (63%) elements of the assemblage. Palynological data reveals that tropical-subtropical humid climate prevailed during the deposition of the sequence of sediments.

Key-words—Palaeopalynology, pteridophytic spores, Oligocene-Lower Miocene (India).

M. R. Rao & H. P. Singh, Birbal Sahni Institute of Palaeobotany, 53 University Road, Lucknow 226 007, India.

सारांश

जयन्तिया पहाड़ियों (मेघालय) एवं कछार (असम) में सोनपुर-बदरपुर मार्ग खंड के संग-संग विगोपित बैरेल (पश्चनूतन) एवं सूरमा (अधरि मध्यनूतन) अवसादों का परागाणविक अध्ययन. भाग 3—टेरीडोफ़ाइटी बीजाणु

मुलागलापल्ली रामचन्द्र राव एवं हरिपाल सिंह

प्रस्तुत शोध-पत्र मेघालय एवं असम में सोनपुर-बदरपुर मार्ग खंड के संग-संग विगोपित बैरेल (पश्चनूतन) एवं सूरमा (अधरि मध्यनूतन) अवसादों से उपलब्ध टेरीडोफ़ाइटी बीजाणुओं के वर्गीकृत वर्णन से सम्बन्धित है। उपलब्ध टेरीडोफ़ाइटी बीजाणु 18 प्रजातियों एवं 32 जातियों से निरूपित हैं। समुच्चय के परिमाणात्मक विश्लेषण से व्यक्त होता है कि टेरीडोफ़ाइटी बीजाणु इस समुच्चय में प्रभावी (63 प्रतिशत) हैं। परागाणविक आँकड़ों से यह भी इंगित होता है कि इन अवसादों के निक्षेपण के समय उष्णकटिबन्धीय-उपोष्णकटिबन्धीय नम जलवायु विद्यमान थी।

THE Barail-Surma sediments are excellently exposed in between Sonapur-Badarpur Road Section (National Highway-44) located at south east of Shillong. The Barail Group is represented by Laisong, Jenam and Renji formations. The Renji Formation is unconformably overlain by the Surma Group. This group is divided into lower Bhuban and upper Bokabil formations. The Bhuban Formation is again divided into Lubha, Umkiang and Dona members. The lithostratigraphy of this section has been published by Saxena and Tripathi (1982). The details of rock samples from different formations and the palynological studies by different workers on the Tertiary sediments of north-eastern India have been discussed by Saxena and Rao (1984).

In all, 288 rock samples were collected from the Barail-Surma sediments of Sonapur-Badarpur Road Section, out of them 216 samples proved to be palynologically productive. The palynofossils recovered from these samples include dinoflagellate cysts, fungal remains, spore-pollen and micro remains of obscure origin. The present paper deals exclusively with the systematic description of 18 pteridophytic spore genera and 32 species, which constitutes only a part of the study. Six species belonging to different genera have been established as new. In addition, the diagnosis of *Lygodiumsporites lakiensis* has been emended. The systematic description of the dinoflagellate cysts

(Saxena & Rao, 1984) and fungal remains (Singh *et al.*, 1986) have already been published.

For the recovery of palynofossils, samples were treated with HCl, HF and HNO_3. The digestion period of samples varied from 7 to 10 days. The samples were then washed with distilled water and then treated with 5% KOH solution for about 5-10 minutes. The material was finally washed through 400 mesh sieve. The slides were prepared in polyvenyl alcohol and mounted in DPX Mountant. All slides and negatives were deposited in the repository of Birbal Sahni Institute of Palaeobotany, Lucknow.

The present palynological assemblage has been arranged following the classification proposed by Potonié and Kremp (1954, 1955, 1956) and subsequently modified by Potonié (1956, 1958, 1960, 1966, 1970) and Dettmann (1963).

SYSTEMATIC DESCRIPTION

Genus—*Cyathidites* Couper 1953

Type species—*Cyathidites australis* Couper 1953.

Cyathidites australis Couper 1953
Pl. 1, fig. 1

Distribution—*Cyathidites australis* Couper (1953) is widely distributed in the Upper Mesozoic and Tertiary strata of India.

Occurrence—Bhuban Formation, Surma Group.

Affinity—Cyatheaceae (Couper, 1953).

Cyathidites minor Couper 1953
Pl. 1, fig. 2; Pl. 2, fig. 16

Remarks—The miospores of *C. minor* reported from the Barail and Surma (Oligocene-Miocene) sediments of Sonapur-Badarpur Road Section, Meghalaya and Assam are slightly bigger in size (up to 52 μm) than those described by Couper (1953) from New Zealand.

Distribution—*C. minor* Couper (1953) is reported both from the Mesozoic and Tertiary sediments of India.

Occurrence—Laisong Formation, Barail Group; Lubha and Dona members, Bhuban Formation, Surma Group.

Affinity—Cyatheaceae (Couper, 1953, 1958).

Genus—*Lygodiumsporites* (Potonié, Thomson & Thiergart) Potonié 1956

Type species—*Lygodiumsporites adriennis* (Potonié & Gelletich, 1938) Potonié, Thomson & Thiergart 1950.

Lygodiumsporites lakiensis Sah & Kar 1969 emend.
Pl. 1, figs 3, 4

Emended diagnosis—Miospores triangular to subtriangular in equatorial view, apices broadly rounded, interapical sides convex. Size range 50-56 μm. Trilete mark distinct, Y-rays reaching 2/3-4/5 of the spore radius, labra distinct, enclosing the suture, ray-apex and vertex raised, broader near the apex, gradually narrowing towards the ray-ends. Proximal face convex, distal face almost flat. Exine 1.5 μm thick, laevigate. *Extrema lineamenta* smooth.

Remarks—The restated diagnosis of *L. lakiensis* is based on the study of about 25 specimens which have been recovered from the present assemblage. The presence of thick labra in the illustration of the type specimen of *Lygodiumsporites lakiensis* is clearly discernible though it has not been mentioned by Sah and Kar (1969, pl. 1, figs 15-17).

Distribution—Palaeocene, Eocene and Oligocene of Kachchh, Gujarat (Sah & Kar, 1969; Saxena, 1978; Kar, 1979).

Occurrence—Barail and Surma groups.

Affinity—Schizaeaceae.

Lygodiumsporites eocenicus Dutta & Sah 1970
Pl. 1, figs 5, 10

Restated diagnosis—Miospores subtriangular to triangular in equatorial view, apices broadly rounded, interapical sides usually convex. Size range 53-77 μm. Trilete mark distinct, Y-rays extending 2/3 of the spore radius, ray-apex conspicuously raised over a small area, ray-vertex almost flat and tapering towards the ray-ends. Exine 1-2 μm thick, laevigate often heavily folded. Proximal face of the exine almost flat, distal face deeply convex. *Extrema lineamenta* smooth.

Remarks—Most of the specimens of *Lygodiumsporites eocenicus* from the present assemblage possess very distinct trilete rays, extending usually 2/3 of the spore radius together with a flat proximal and deeply convex distal face in contrast to the observations of Dutta and Sah (1970). According to these authors the proximal face of *L. eocenicus* appears to be almost convex. This fact has not been confirmed by our observations on the specimens studied from the present assemblage as well as those illustrated by the original authors.

Distribution—Lower Eocene of South Shillong Plateau, Meghalaya (Dutta & Sah, 1970); Palaeocene-Eocene sediments of Tura Formation, Meghalaya (Singh, 1977); Palaeocene of Kachchh, Gujarat (Saxena, 1978).

Occurrence—Laisong and Jenam formations, Barail Group; Bhuban Formation, Surma Group.

Affinity—Schizaeaceae.

Lygodiumsporites donaensis sp. nov.
Pl. 1, figs 7, 16

Holotype—Pl. 1, fig. 7, size 60 μm; BSIP slide no. 8408.

Type locality—166.5 km-stone (from Shillong), Sonapur-Badarpur Road Section, Meghalaya

Type Horizon—Dona Member, Bhuban Formation, Surma Group, Lower Miocene.

Diagnosis—Miospores triangular to subtriangular. Size range 65-85 μm. Trilete mark distinct, Y-rays reaching ± half of the radius accompanied by thickened exine all along the Y-mark. Ornamentation laevigate-scabrate.

Description—Miospores mostly subtriangular in equatorial view, interapical sides straight to convex. Trilete mark distinct, Y-rays straight, tapering, reaching ± half of the radius accompanied by thickened exine in the vicinity of the Y-mark, thickening usually diffused but almost of uniform width. Exine uniformly thick, 1.5 μm. Ornamentation laevigate to finely scabrate. *Extrema lineamenta* smooth.

Comparison—*Lygodiumsporites donaensis* sp. nov. resembles *L. eocenicus* Dutta & Sah (1970) by its shape and general characters but can be distinguished by the presence of thickened exine all along the trilete mark. *L. adriennis* (Potonié & Gelletich) Potonié, Thomson & Thiergart (1950) possesses infrapunctate structure and hence it is not comparable. *L. lakiensis* Sah & Kar (1969) is distinguished by its smaller size (up to 60 μm). *L. padapakkarensis* Rao & Ramanujam (1978) can be distinguished by having intrapunctate exine. *L. pachyexinus* Saxena (1978) is different as it possesses thicker exine.

Occurrence—Dona Member, Bhuban Formation, Surma Group.

Affinity—Schizaeaceae.

Genus—*Todisporites* Couper 1958

Type species—*Todisporites major* Couper 1958

Todisporites major Couper 1958
Pl. 1, fig. 8

Remarks—The miospores assignable to *Todisporites major* Couper (1958) reported from this assemblage possess larger size (65-105 μm) than the forms of *T. major* (52-78 μm) described by Couper (1958).

Distribution—*Todisporites major* Couper, 1958 is a long ranging species which is distributed in the Mesozoic and Tertiary sediments of both the hemispheres.

Occurrence—Barail Group and Dona Member, Bhuban Formation, Surma Group.

Affinity—Osmundaceae.

Todisporites minor Couper 1958
Pl. 1, fig. 6

Distribution—It is widely distributed in the Mesozoic and Tertiary sediments of both the hemispheres.

Occurrence—Laisong Formation, Barail Group; Lubha and Dona members, Bhuban Formation, Surma Group.

Affinity—Osmundaceae.

Genus—*Biretisporites* (Delcourt & Sprumont) Delcourt, Dettmann & Hughes 1963

Type species—*Biretisporites potoniaei* Delcourt & Sprumont 1955.

Biretisporites oligocenicus sp. nov.
Pl. 1, figs 17, 15

Holotype—Pl. 1, fig. 15, size 88 μm; BSIP slide no. 8388.

Type locality—142 km-stone (from Shillong), Sonapur-Badarpur Road Section, Meghalaya.

Type Horizon—Laisong Formation, Lower Oligocene, Barail Group.

Diagnosis—Miospores subcircular to subtriangular. Size range 70-88 μm. Trilete mark distinct, Y-rays reaching 2/3 of the radius, commissures raised, enclosed within the extension of the upturned exine. Exine 2-4 μm thick, scabrate.

Description—Miospores mostly subcirular in equatorial view, apices bluntly rounded, interapical sides ± convex. Trilete mark distinct, Y-rays reaching 2/3 of the radius surrounded by thick labra, broader at the centre of the Y-mark and narrower at the ray-ends, enclosed within the extension of the upturned exine. Exine 2.5 μm thick, scabrate. Few folds present.

Comparison—*Biretisporites oligocenicus* sp. nov. compares with *B. meghalayaensis* sp. nov. by its raised trilete mark which lies within the extension of the upturned exine. However, the former can be distinguished in having thicker exine (4 μm thick) and broader labra at the centre which narrows down at the ray-ends and is usually straight. *B. potoniaei* Delcourt & Sprumont (1955) differs by having longer trilete rays, extending up to the periphery. *B. convexus* Sah & Kar (1969) is different in having smaller size (65 μm) and uniform thickening along the Y-mark. *B. spectabilis* Dettmann (1963) possesses conspicuous lips and extension of the trilete mark up to the equator, hence it is not comparable. *B. bellus* Sah & Kar (1970) and *B. singularis* Salujha, Kindra & Rehman (1974) are smaller in size. *B. crassisexinus* Venkatachala & Rawat (1973) possesses finely granulose ornamentation and hence it is not comparable.

Occurrence—Laisong Formation, Barail Group.

Affinity—?Hymenophyllaceae.

Biretisporites meghalayaensis sp. nov.
Pl. 1, figs 9, 13

Holotype—Pl. 1, fig. 9, size 61 μm; BSIP slide no. 9030.

Type Locality—169 km-stone (from Shillong), Sonapur-Badarpur Road Section, Meghalaya.

Type Horizon—Dona Member, Bhuban Formation, Surma Group, Lower Miocene.

Diagnosis—Miospores subtriangular. Size range 60-88.5 μm. Trilete mark distinct. Y-rays reaching 3/4 of the radius, enclosed within the extension of the upturned exine. Exine laevigate to finely scabrate.

Description—Miospores subtriangular in equatorial view, apices broadly rounded, interapical sides straight to convex. Trilete mark distinct, Y-rays reaching 3/4 of the radius, enclosed within the upturned extension of the exine, extension mostly spathulate in form with wavy margin. Exine 1 μm thick, sometimes finely scabrate otherwise laevigate.

Comparison—The present species closely compares with *Biretisporites convexus* Sah & Kar (1969) in shape and general characters but can be distinguished from the latter by having continuous extension of the upturned exine with wavy margin around the trilete. *B. potoniaei* Delcourt & Sprumont (1955) possesses a thicker exine (up to 5 μm thick) and trilete rays extending up to the periphery and hence, it is not comparable. *B. spectabilis* Dettmann (1963) is different by its conspicuous lips and the extension of trilete mark up to the equator. *B. bellus* Sah & Kar (1970) and *B. singularis* Salujha, Kindra & Rehman (1974) are smaller in size. *B. crassisexinus* Venkatachala & Rawat (1973) can be distinguished from the present species by its finely granulose ornamentation.

Occurrence—Dona Member, Bhuban Formation, Surma Group.

Affinity—?Hymenophyllaceae.

Genus—*Surmaspora* Singh & Rao 1984

Type species—*Surmaspora sinuosa* Singh & Rao 1984.

Surmaspora sinuosa Singh & Rao 1984
Pl. 2, fig. 6

Occurrence—Dona Member, Bhuban Formation, Surma Group.

Affinity—Unknown.

Genus—*Gleicheniidites* (Ross) Skarby 1964

Type species—*Gleicheniidites senonicus* Ross 1949.

Gleicheniidites senonicus Ross 1949
Pl. 2, fig. 17

Distribution—Palaeocene of Kachchh, Gujarat (Saxena, 1978).

Occurrence—Laisong Formation, Barail Group.

Affinity—Gleicheniaceae.

Genus—*Dictyophyllidites* Couper 1958

Type species—*Dictyophyllidites harrisii* Couper 1958

Remarks—The genus *Dictyophyllidites*, as diagnosed by Couper (1958), was emended by Dettmann (1963). She described even the ornate forms under the same genus. This has enlarged the original circumscription of the genus more than necessary a treatment to which we donot agree. In the present treatise *Dictyophyllidites* is understood *sensu stricto* Couper (1958).

Dictyophyllidites indicus sp. nov.
Pl. 1, figs 18-20

Holotype—Pl. 1, fig. 18, size 75 μm; BSIP slide no. 8392.

Type locality—146.25 km-stone (from Shillong), Sonapur-Badarpur Road Section, Meghalaya.

PLATE 1

→

(All photomicrographs are enlarged *ca.* × 500. Coordinates of the specimen refer to the stage of the Censico Microscope no. 13167).

1. *Cyathidites australis* Couper, slide no. BSIP 8739, coordinates 67.2 × 106.5.
2. *Cyathidites minor* Couper, slide no. BSIP 9024, coordinates 73.5 × 105.7.
3, 4. *Lygodiumsporites lakiensis* Sah & Kar emend. slide nos. BSIP 8390, coordinates 49.10 × 110.3; BSIP 9025, coornates 70.5 × 106.9.
5, & 10. *Lygodiumsporites eocenicus* Dutta & Sah, slide nos. BSIP 8736, coordinates 99.2 × 105.7; BSIP 8393; coordinates 48.8 × 109.10.
6. *Todisporites minor* Couper, slide no. BSIP 9029, coordinates 70.3 × *102.5.*
7 & 16. *Lygodiumsporites donaensis* sp. nov. slide nos. BSIP 8408, coordinates 62.0 × 103.3 (Holotype); BSIP 8408, coordinates 70.3 × 112.5.
8. *Todisporites major* Couper, slide no. BSIP 8389, coordinates 48.10 × 98.7.
9 & 13. *Biretisporites meghalayaensis* sp. nov., slide nos. BSIP 9030, coordinates 52.2 × 114.5 (Holotype); BSIP 8414, coordinates 54.9 × 108.9.
11 & 15. *Biretisporites oligocenicus* sp. nov., slide nos. BSIP 9031, coordinates 52.0 × 105.6; BSIP 8388, coordinates 62.4 × 99.6 (Holotype).
12. *Corrugatisporites* sp., slide no. BSIP 9034, coordinates 54.0 × 110.3.
14. *Garotriletes* sp., slide no. BSIP 9033, coordinates 54.0 × 110.3.
17. *Polypodiaceaesporites chatterjii* Kar, slide no. BSIP 9041, coordinates 74.7 × 102.5.
18-20. *Dictyophyllidites indicus* sp. nov., slide nos. BSIP 8392, coordinates 69.2 × 108.6 (Holotype); BSIP 9032, coordinates 59.5 × 100.8; BSIP 9032, coordinates 65.2 × 115.2.
21. *Foveosporites* sp., slide no. BSIP 9039, coordinates 43.5 × 95.10.

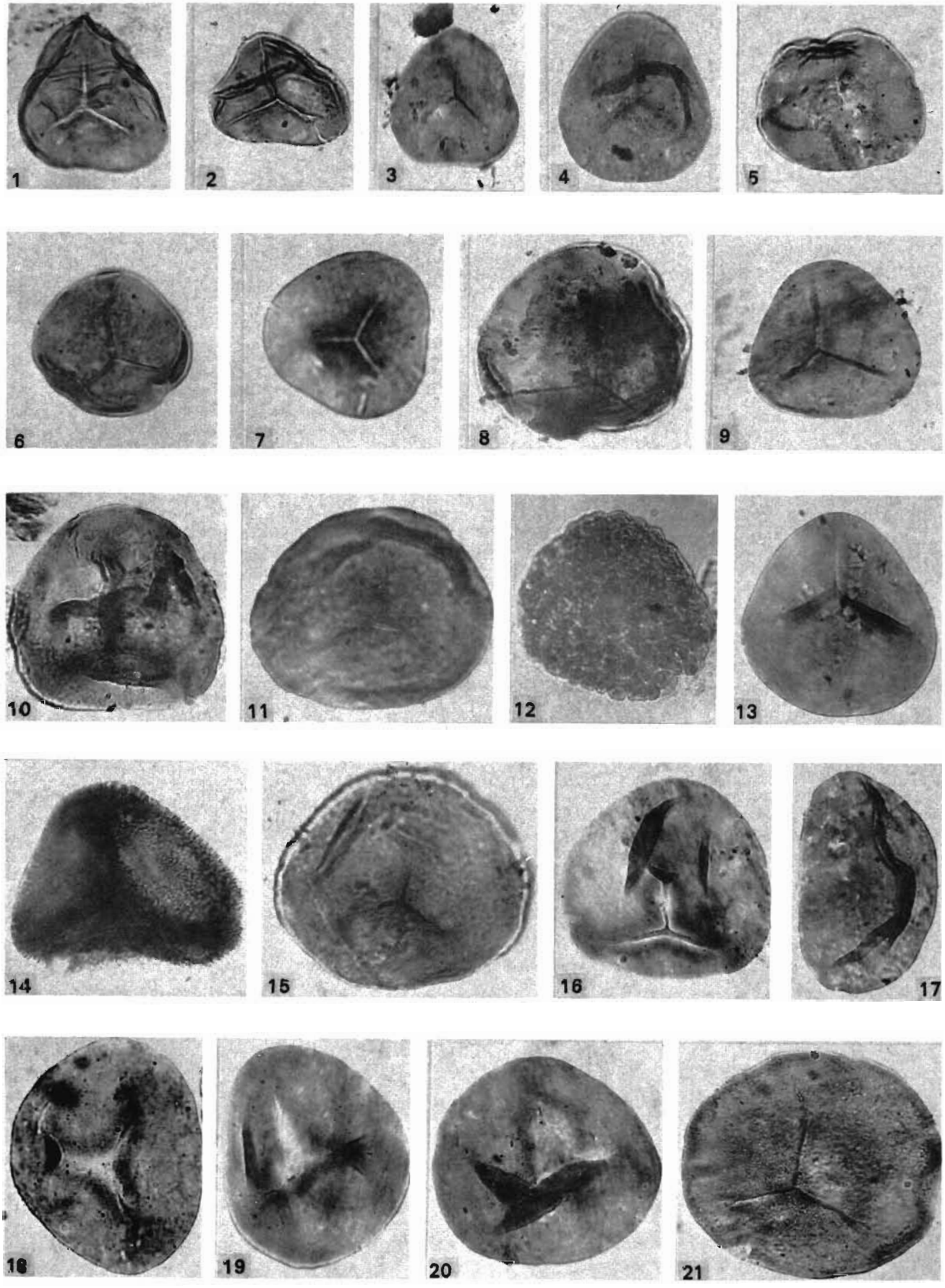

PLATE 1

Type Horizon—Renji Formation, Upper Oligocene, Barail Group.

Diagnosis—Miospores subtriangular to subcircular, size range 75-95 μm. Trilete mark distinct, Y-rays reaching more than half of the radius, commissures raised, flanked by distinct thick arcuate margo. Exine laevigate.

Description—Miospores mostly subcircular to subtriangular in equatorial view, apices bluntly rounded, interapical sides straight to convex. Trilete mark distinct, usually laesurae straight, accompanied by a distinct and thick, arcuate margo lying in close proximity to the Y-rays following an interradial pathway leaving a longer part of the exine as unthickened. Exine up to 1.5 μm thick, laevigate. Distal face of the exine distinctly convex, proximal face being plane to slightly convex. *Extrema lineamenta* smooth.

Comparison—*Dictyophyllidites harrisii* Couper (1958) is distinguished from the present species by its smaller size (up to 56 μm) and longer Y-rays, ± extending up to the equator. *D. pectinataeformis* (Bolkhovitina) Dettmann (1963) is different by its granulose exine and may perhaps have to be excluded from the limits of the genus *Dictyophyllidites*. *D. crenatus* (1963) is distinct from *D. indicus* sp. nov. in having sinuous laesurae and thicker exine (3.5 μm thick). *D. cymbatus* Venkatachala & Goczan (1964) possesses kyrtomic folds hence it is not comparable. *D. granulatus* Saxena (1978) is different by having thicker exine (5 μm) and granulose ornamentation, thus it is not comparable.

Occurrence—Renji Formation, Barail Group.

Affinity—? Matoniaceae.

Genus—*Garotriletes* Singh & Singh 1978

Type species—*Garotriletes assamicus* Singh & Singh 1978.

Garotriletes sp.

Pl. 1, fig. 14

Description—Miospore triangular in equatorial view, apices broadly rounded, interapical sides ± straight. Size ± 77 μm. Trilete mark distinct, reaching more than 3/4 of the radius, ray-ends bifurcated, labra around the trilete mark thick, ± globular at one of the ray-ends. Exine up to 3.5 μm thick, foveolate, foveolae compactly placed appearing foveo-reticulate in surface view.

Comparison—The present specimen is closely comparable to *Garotriletes assamicus* Singh & Singh (1978) in its shape and foveo-reticulate ornamentation of the exine. But the former is bigger in size (77 μm) and can also be distinguished by having distinct labra which is thick and almost encloses the Y-mark.

Occurrence—Laisong Formation, Barail Group.

Affinity—Not known.

PLATE 2

→

(All photomicrographs are enlarged *ca* × 500. Coordinates of the specimen refer to the stage of the Censico Microscope no. 13167).

1 & 13. *Striatriletes susannae* van der Hamnen emend. Kar, slide nos. BSIP 8385, coordinates 40.3 × 105.6; BSIP 8387, coordinates 54.4 × 104.2.

2-3. *Striatriletes sinuosus* sp. nov., slide nos. BSIP, 8397, coordinates 44.4 × 104.2; BSIP 8407, coordinates 66.10 × 95.10 (Holotype).

4-5. *Malayaeaspora costata* Trivedi *et al.*, slide nos. BSIP 8228, coordinates 43.10 × 100.7; BSIP 8229, coordinates 60.9 × 105.6.

6. *Surmaspora sinuosa* Singh & Rao, slide no. BSIP 8225, coordinates 69.5 × 118.8.

7 & 10. *Striatriletes pachyexinus* sp. nov. slide nos. BSIP 9040, coordinates 54.5 × 99.7; BSIP 8391, coordinates 56.0 × 101.5 (Holotype).

8 & 12. *Foveosporites triangulus* Sah & Dutta, slide nos. BSIP 8132, coordinates 53.2 × 105.5; BSIP 9037, coordinates 52.5 × 100.5.

9. *Foveotriletes* sp. B., slide no. BSIP 9036, coordinates 57.0 × 100.5.

11. *Foveotriletes* sp. A., slide no. BSIP 9035, coordinates 60.5 × 113.3.

14. *Cingutriletes* sp., slide no. BSIP 8112, coordinates 42.4 × 104.3.

15. *Lycopodiumsporites abundans* Salujha *et al.*, slide no. BSIP 8103, coordinates 47.6 × 105.3.

16. *Cyathidites minor* Couper, slide no. BSIP 9023, coordinates 65.8 × 104.8.

17. *Gleicheniidites senonicus* Ross, slide no. BSIP 8383, coordinates 40.4 × 96.10.

18. *Foveosporites miocenicus* Ramanujam, slide no. BSIP 8746, coordinates 64.7 × 106.8.

19. *Polypodiisporites speciosus* Sah, slide no. BSIP 8122, coordinates 40.0 × 118.2.

20. *Polypodiaceaesporites chatterjii* Kar, slide no. BSIP 8404, coordinates 74.5 × 102.2.

21, 27. *Polypodiaceaesporites tertiarus* Sah & Dutta, slide no. BSIP 8386, coordinates 70.7 × 105.2; BSIP 8411, coordinates 49.5 × 98.8.

22. *Polypodiisporites tuberculensis* (Baksi) comb. nov., slide no. BSIP 9045, coordinates 42.3 × 106.8.

23. *Polypodiisporites favus* (Potonié) Potonié, slide no. BSIP 9044, coordinates 51.7 × 110.8.

24, 25. *Monolites major* (Cookson) Potonié, slide nos. BSIP 8123, coordinates 40.3 × 98.8; BSIP 9042, coordinates 60.0 × 113.4.

26. *Polypodiisporites formosus* Salujha *et al.*, slide no. BSIP 9043, coordinates 49.2 × 111.3.

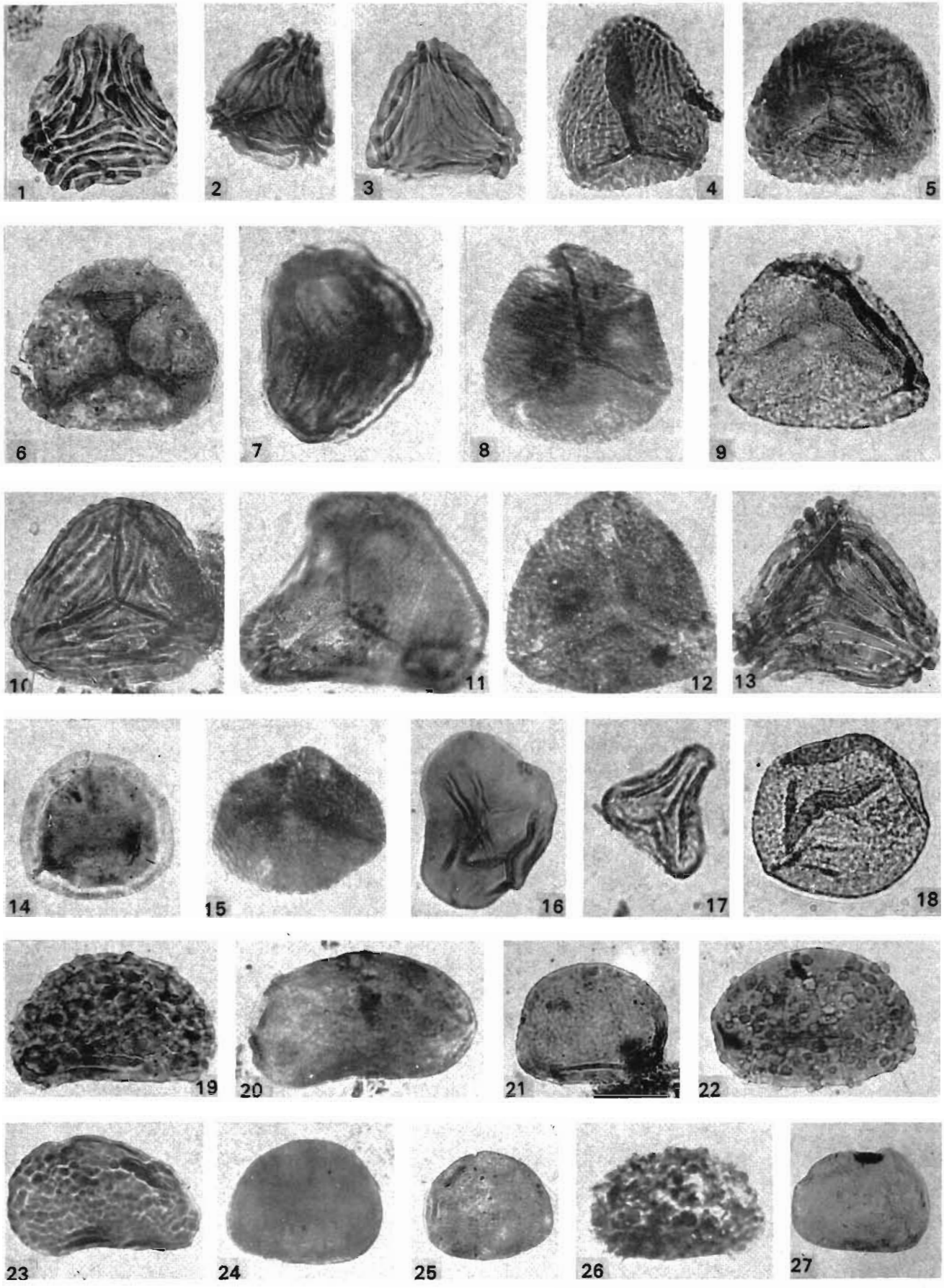

PLATE 2

Genus—*Corrugatisporites* (Thomson, Pflug & Ibrahim) Weyland & Griefeld 1953

Type species—*Corrugatisporites solidus* (Potonié) Thomson & Pflug 1953.

Remarks—Thomson and Pflug (1953) described three species under the genus *Corrugatisporites*, viz., *C. solidus, C. multivallatus* and *C. paucivallatus*. They presumed that the genus was instituted by Ibrahim (1933). Later, Weyland and Griefeld (1953) assigned a new species to the same genus, viz., *Corrugatisporites toratus*. Then it was observed that Ibrahim did not publish any genus with the name *Corrugatisporites*. Therefore Potonié (1956) proposed *C. toratus* as the type species for the genus *Corrugatisporites* and restated its diagnosis. But Jansonius and Hills (1976) in "*Genera file of fossil spores*" cited *C. solidus* as the type species for the genus *Corrugatisporites* because this species was placed first in order of its publication as described by the original authors (Thomson & Pflug, 1953). In the present treatise, systematic treatment as given by Jansonius and Hills (1976) of *Corrugatisporites* has been followed.

Corrugatisporites sp.
Pl. 1, fig. 12

Description—Miospores subtriangular, apices broadly rounded, interapical sides ± convex. Size up to 72 μm. Trilete mark not distinct due to heavy ornamentation. Exine 1.5 μm thick, verrucose, verrucae laterally fused both on the proximal and distal sides forming variously shaped small, irregular channels. Outline undulate.

Comparison—*Corrugatisporites* sp. compares closely to *C. terminalis* Sah & Dutta (1968) by its verrucose exine but the latter can be distinguished in having distinct trilete mark and different exine ornamentation on the proximal and distal surfaces.

Occurrence—Laisong and Jenam formations, Barail Group; Bhuban Formation, Surma Group.

Affinity—Not known.

Genus—*Foveotriletes* van der Hammen ex Potonié 1956

Type species—*Foveotriletes scrobiculatus* (Ross) Potonié 1956.

Foveotriletes sp. A
Pl. 2, fig. 11

Description—Miospore triangular in equatorial view, apices broadly rounded, interapical sides ± convex. Size 92 μm. Trilete mark distinct, Y-rays reaching almost up to the equator, ends bifurcated. Exine 4 μm thick, foveolate, foveolae compactly placed, bigger at the apices and smaller towards the Y-mark. Surface view foveoreticulate.

Comparison—*Foveotriletes* sp. closely compares with *F. scrobiculatus* (Ross) Potonié (1956) in having foveolate exine but the former can be distinguished by its bigger size (92 μm). *F. miocenicum* Ramanujam (1966, 1967) possesses an ill-developed trilete mark and smaller size (48.5 μm) thus it is not comparable. *F. pachyexinus* Dutta & Sah (1970), *F. bifurcatus* Rao & Ramanujam (1978) are distinguished by their smaller size. *F. microreticulatus* Couper (1958) differs by its raised commissures.

Occurrence—Laisong Formation, Barail Group.

Affinity—Not known.

Foveotriletes sp. B
Pl. 2, fig. 9

Description—Miospore triangular in equatorial view, apices broadly rounded, interapical sides ± convex. Size ± 77 μm. Trilete mark distinct, Y-rays reaching 3/4 of the spore radius. Exine 1.5 μm thick, foveolate, foveolae small, compactly placed. Surface view finely foveo-reticulate.

Comparison—*Foveotriletes* sp. A can be distinguished from *Foveotriletes* sp. B in possessing differential foveolate ornamentation at the apices and near the Y-mark.

Occurrence—Dona Member, Bhuban Formation, Surma Group.

Affinity—Not known.

Genus—*Foveosporites* Balme 1957

Type species—*Foveosporites canalis* Balme 1957.

Foveosporites triangulus Dutta & Sah 1970
Pl. 2, figs 8, 12

Remarks—The specimens of *Foveosporites triangulus* Dutta & Sah (1970) reported from the Sonapur-Badarpur Road Section (Middle Bhuban Formation, Surma Group) in the present study are bigger in size (up to 75 μm) than those (35-48 μm) described by Dutta & Sah (1970) from the Cherra Formation, Meghalaya.

Distribution—Lower Eocene of South Shillong Plateau, Meghalaya (Dutta & Sah, 1970).

Occurrence—Umkiang and Dona members, Bhuban Formation, Surma Group.

Affinity—*Lycopodium phlegmaria* (Lycopodiaceae).

Foveosporites miocenicus Ramanujam 1972
Pl. 2, fig. 18

Remarks—*Foveosporites miocenicus* Ramanujam (1972) is reported from the Upper Bhuban Formation, Surma Group. Its size ranges up to 62 μm.

Distribution—Miocene sediments around Warkalli Lignite, South India (Ramanujam, 1972).

Occurrence—Dona Member, Bhuban Formation, Surma Group.

Affinity—Unknown.

Foveosporites sp.

Pl. 1, fig. 21

Description—Miospore circular, size ± 99 μm. Trilete mark distinct, strongly built with bifurcated ends. Exine 2.5 μm thick, foveolate, foveolae small rounded, compactly placed. Surface view foveo-reticulate.

Comparison—*F. canalis* Balme (1957) differs from the present species by its smaller size and also in possessing coalescent foveolae.

Occurrence—Laisong Formation, Barail Group.

Affinity—Not known.

Genus—*Lycopodiumsporites* (Thiergart) Delcourt & Sprumont 1955

Type species—*Lycopodiumsporites agothoecus* (Potonié) Delcourt & Sprumont 1955.

Lycopodiumsporites abundans Salujha, Kindra & Rehman 1972

Pl. 2, fig. 15

Remarks—The present specimens of *Lycopodiumsporites abundans* are bigger in size (up to 60 μm) than those reported by Salujha *et al.* (1972) from the Palaeogene of Garo Hills (52 μm).

Distribution—Palaeogene of Garo Hills, Meghalaya (Salujha, Kindra & Rehman, 1972).

Occurrence—Dona Member, Bhuban Formation, Surma Group.

Affinity—Lycopodiaceae.

Genus—*Striatriletes* van der Hammen 1956 emend. Kar 1979

Type species—*Striatriletes susannae* van der Hammen 1956 emend. Kar 1979.

Striatriletes susannae van der Hammen 1956 emend. Kar 1979

Pl. 2, figs 1, 13

Remarks—In the diagnosis of *Striatriletes susannae* van der Hammen emend. Kar (1979) has mentioned that the exine of the miospores is ± laevigate. But in the present investigation some forms referable to *S. susannae* have imperceptibly punctate-microverrucose exine. Even such spores have also been included in the same species.

Distribution—Palaeogene of Garo and Khasi-Jaintia Hills (Salujha *et al.*, 1972, 1974); Oligocene of Kachchh (Kar, 1979).

Occurrence—Barail and Surma groups.

Affinity—*Ceratopteris thalictroides* (L) Brongn.

Striatriletes sinuosus sp. nov.

Pl. 2, figs 2, 3

Holotype—Pl. 2, fig. 3, size 55 μm; BSIP slide no. 8407.

Type locality—150.1 km-stone (from Shillong), Sonapur-Badarpur Road Section, Meghalaya.

Type Horizon—Lubha Member, Bhuban Formation, Surma Group, Lower Miocene.

Diagnosis—Miospores triangular to subtriangular. Size 50-70 μm. Trilete mark distinct, sinuous, strongly built, Y-rays reaching 3/4 of the radius. Exine 1-2.5 μm, costate, costae, arising at ray-ends, 4-6 in each concentric ring, very closely placed, laevigate.

Description—Miospores triangular, apices more or less pointed, interapical sides straight to more or less convex. Trilete-mark distinct, sinuous, strongly built, Y-rays tapering, reaching 3/4 of the radius, length of the ray ranges from 18 to 25 μm. Exine 1.5 μm thick, costate, costae mostly 4 in number at each ray-end and 4 in each concentric ring on the distal side opposite to each inter-ray area, sometimes branching of costae on the distal face evident, resulting in increase in number, 6 costae in each concentric ring, 2.5-3.5 μm wide and 2-3 μm high, closely placed, flat to well-developed, parallely arranged. Costae and intervening spaces between them laevigate.

Comparison—*Striatriletes sinuosus* sp. nov. is distinguished from all known species of *Striatriletes* (van der Hammen, 1956) Kar (1979) by its strongly built and tapering trilete mark. Also the Y-rays are longer reaching up to 3/4 of the spore radius together with a smaller size range (50-70 μm).

Occurrence—Lubha Member, Bhuban Formation, Surma Group.

Affinity—Parkeriaceae.

Striatriletes pachyexinus sp. nov.

Holotype—Pl. 2, fig. 10, size 70 μm; BSIP slide no. 8391.

Type locality—145.4 km-stone (from Shillong), Sonapur-Badarpur Road Section, Meghalaya.

Type Horizon—Jenam Formation, Upper Oligocene, Barail Group.

Diagnosis—Miospores subtriangular. Size range 60-70 μm. Trilete mark distinct, Y-rays strongly built, reaching 3/4 of the spore radius. Exine 2.5-3.5 μm thick, costate, costae ill-developed, ± laevigate.

Description—Miospores subtriangular in equatorial view, apices broadly rounded, interapical sides ± convex. Trilete mark distinct, commissures strongly built, Y-rays reaching 3/4 of the spore radius. Exine 3.5 μm thick, costate, costae ill-developed, nature of the costae on the distal side not clearly discernible. Costae and intervening spaces between them ± laevigate, outline undulate.

Comparison—*Striatriletes susannae* (van der Hammen, 1956) Kar 1979 is distinguished from *S.*

pachyexinus sp. nov. in having well-developed costae and bigger size range (77-115 μm). *S. pachyexinus* sp. nov. differs from *S. sinuosus* sp. nov. by its well developed commissures and thicker exine. *S. microverrucosus* Kar & Saxena (1981) possesses microverrucose costae and hence it is not comparable. *S. multicostatus* Kar & Saxena (1981) is distinguished by having more number of distinct costae (6-9) and shorter rays reaching only up to half of the radius. *S. pseudocostatus* Singh & Tripathi (1983) is distinct from *S. pachyexinus* by its ill developed, flat and unevenly wide costae. *S. attenuatus* Singh & Tripathi (1983) differs in possessing a thick and raised trilete mark, in having less number of costae with a lesser curvature and in possessing dilate costae ends.

Occurrence—Jenam Formation, Barail Group.

Affinity—Parkeriaceae.

Genus—*Malayaeaspora* Trivedi, Ambwani & Kar 1981

Type species—*Malayaeaspora costata* Trivedi, Ambwani & Kar 1981.

Malayaeaspora costata Trivedi, Ambwani & Kar 1981
Pl. 2, figs 4, 5

Distribution—Tertiary coal of Malaya (Trivedi *et al.*, 1981.

Occurrence—Dona Member, Bhuban Formation, Surma Group.

Affinity—?Schizaeaceae.

Genus—*Cingutriletes* (Pierce) Dettman 1963

Type species—*Cingutriletes congruens* Pierce 1961.

Cingutriletes sp.
Pl. 2, fig. 14

Description—Miospores subtriangular, apices rounded, interapical sides ± convex. Size ± 55 μm. Trilete mark distinct, slightly raised, Y-rays extending up to the equator. Cingulate, cingulum up to 8.5 μm thick. Exine 1.5 μm thick, laevigate.

Comparison—*Cingutriletes* sp. closely compares with *C. congruens* Pierce (1961) which can be distinguished by its smaller size (26 μm) and proximally smooth and distally punctate exine.

Occurrence—Umkiang and Dona members, Bhuban Formation; Bokabil Formation, Surma Group.

Affinity—Unknown.

Genus—*Polypodiaceaesporites* (Thiergart) ex. Potonié 1956

Type species—*Polypodiaceaesporites haardti* (Potonié & Venitez) Thiergart 1938.

Polypodiaceaesporites tertiarus Sah & Dutta 1968
Pl. 2, figs 21, 27

Remarks—The exine seems to be thinner at the polar region as compared to the peripheral area, a character which is seen in the illustration of the type species as given by the original authors though not mentioned in the systematic description.

Distribution—Tertiary Succession of Assam (Sah & Dutta, 1969); Lower Eocene of South Shillong Plateau, Meghalaya (Dutta & Sah, 1970).

Occurrence—Laisong and Jenam formations, Barail Group and Surma Group.

Affinity—Polypodiaceae.

Polypodiaceaesporites chatterjii Kar 1979
Pl. 1, fig. 17; Pl. 2, fig. 20

Distribution—Oligocene of Kachchh, Gujarat (Kar, 1979).

Occurrence—Lubha and Dona members, Bhuban Formation, Surma Group.

Affinity—Polypodiaceae.

Genus—*Monolites* (Cookson) Potonié 1956

Type species—*Monolites major* (Cookson) Potonié 1956.

Monolites major (Cookson) Potonié 1956
Pl. 2, figs 24, 25

Remarks—The specimens of *Monolites major* (Cookson) Potonié (1956) recorded from the present material have thicker exine (2.5 μm thick) as compared to those described by Cookson (1947).

Distribution—Lower Tertiary of Kerguelen (Cookson, 1947).

Occurrence—Umkiang and Dona members, Bhuban Formation, Surma Group.

Affinity—Polypodiaceae.

Genus—*Polypodiisporites* (Potonié) Potonié 1956

Type species—*Polypodiisporites favus* Potonié 1931 ex Potonié, 1956.

Polypodiisporites favus Potonié 1931 ex Potonié 1956
Pl. 2, fig. 23

Distribution—Eocene Germany (Potonié, 1931).

Occurrence—Bhuban Formation, Surma Group.

Affinity—Polypodiaceae.

Polypodiisporites speciosus Sah 1967
Pl. 2, fig. 19

Distribution—Upper Neogene profile from Rusizi Valley (Burundi) by Sah (1967); Tertiary Succession of Assam (Sah & Dutta, 1968); Palaeogene of Garo and Khasi-Jaintia Hills, Meghalaya (Salujha *et al.*, 1972, 1974).

Occurrence—Laisong Formation, Barail Group; Bhuban Formation, Surma Group.

Affinity—Polypodiaceae.

Polypodiisporites formosus Salujha, Kindra & Rehman 1972

Pl. 2, fig. 26

Distribution—Palaeogene of Garo Hills, Meghalaya (Salujha *et al.*, 1972).

Occurrence—Umkiang Member, Bhuban Formation, Surma Group.

Affinity—Polypodiaceae.

Polypodiisporites tuberculensis Baksi (1962) comb. nov.

Pl. 2, fig. 22

1962 *Polypodiaceaesporites tuberculensis* Baksi, *Bull. geol. Min. metall. Soc. India* **26** : 1-21, 19.

Description—Miospores oval, bean-shaped, extremities broadly rounded. Size range 45-60 μm. Monolete mark distinct, extending 2/3 along the longer axis. Exine up to 1.5 μm thick, verrucose, verrucae sparsely placed, 2-3 μm in diameter.

Remarks—Baksi (1962) published a new genus *Polypodiaceaesporites* from the Simsang River Tertiaries, South Shillong Front, Assam with a single species *P. tuberculensis*. *Polypodiaceaesporites* Baksi (1962) is a junior homonym of *Polypodiaceaesporites* Thiergart ex Potonié (1956). The characters of *Polypodiaceaesporites* Baksi (1962) do not conform with those of *Polypodiaceaesporites* Thiergart ex Potonié (1956). However, *Polypodiaceaesporites tuberculensis* Baksi (1962) falls within the generic circumscription of *Polypodiisporites* (Potonié) Potonié, 1956 and hence has been transferred to the latter as a new combination.

Occurrence—Jenam Formation, Barail Group.

Affinity—Polypodiaceae.

DISCUSSION

The pteridophytic spores described in this paper from the Barail and Surma groups (Oligocene-Lower Miocene) are represented by 18 genera and 32 species. Of these, *Biretisporites oligocenicus, B. meghalayaensis, Striatriletes pachyexinus, S. sinuosus, Dictyophyllidites indicus* and *Lygodiumsporites donaensis* have been established as new species. The distribution of different species is as follows :

PALYNOTAXA	Barail Group			Surma Group			
	Laisong Formation	Jenam Formation	Renji Formation	Lubha Member	Bhuban Formation Umkiang Member	Dona Member	Bokabil Formation
Gleicheniidites senonicus	+	—	—	—	—	—	—
Biretisporites oligocenicus	+	—	—	—	—	—	—
Foveosporites sp.	+	—	—	—	—	—	—
Foveotriletes sp. A	+	—	—	—	—	—	—
Garotriletes sp.	+	—	—	—	—	—	
Striatriletes pachyexinus	—	+	—	—	—	—	—
Polypodiisporites tuberculensis	—	+	—	—	—	—	—
Dictyophyllidites indicus	—	—	+	—	—	—	—
Striatriletes sinuosus	—	—	—	+	—	—	—
Polypodiisporites formosus	—	—	—	—	+	—	—
Foveotriletes sp. B	—	—	—	—	—	+	—
Malayaeaspora costata	—	—	—	—	—	+	—
Surmaspora sinuosa	—	—	—	—	—	+	—
Lygodiumsporites donaensis	—	—	—	—	—	+	—
Biretisporites meghalayaensis	—	—	—	—	—	+	—
Lycopodiumsporites abundans	—	—	—	—	—	+	—
Foveosporites miocenicus	—	—	—	—	—	+	—
Monolites major	—	—	—	—	+	+	—
Foveosporites triangulus	—	—	—	—	+	+	—
Cingutriletes sp.	—	—	—	—	+	+	—
Polypodiaceaesporites chatterjii	—	—	—	+	—	+	—
Polypodiisporites favus	—	—	—	+	+	+	—
Cyathidites australis	—	—	—	+	+	+	—
Corrugatisporites sp.	—	+	—	+	+	+	—
Todisporites major	+	+	+	—	—	+	—
Cyathidites minor	+	—	—	+	—	+	—
Todisporites minor	+	—	—	+	—	+	—
Polypodiisporites speciosus	+	—	—	+	+	+	—
Lygodiumsporites eocenicus	+	+	—	+	+	+	—
L. lakiensis	+	+	+	+	+	+	+
Striatriletes susannae	+	+	+	+	+	+	+
Polypodiaceaesporites tertiarus	+	+	—	+	+	+	+

The diagnosis of *Lygodiumsporites lakiensis* has been emended. *Lygodiumsporites lakiensis* Sah & Kar, 1969, from the present assemblage possesses very distinct trilete mark, reaching 2/3-4/5 of the spore radius, labra distinct, enclosing the suture, ray-apex and vertex raised, broader near the apex, gradually narrowing towards the ray-ends. The presence of thick labra in the illustration of the type specimen is clearly discernible though it has not been mentioned by Sah and Kar (1969). *Lygodiumsporites eocenicus* (Dutta & Sah, 1970) as studied possess trilete mark distinct, rays extending 2/3 of the spore radius, ray-apex conspicuously raised over a small area, ray-vertex almost flat and tapering towards the ray-ends. Proximal face of the exine almost flat, distal face deeply convex. Besides, the genus *Dictyophyllidites* as diagnosed by Couper (1958) was emended by Dettmann (1963). She described even the ornate forms under the genus. This has enlarged the original circumscription of the genus more than necessary. The miospores of *Striatriletes susannae* described by van der Hammen emend. Kar (1979) posses laevigate exine, but in the present study, some forms belonging to this species have imperceptibly punctate-microverrucose exine. So such spores have also been included in the same species. In *Polypodiaceaesporites tertiarus* Sah & Dutta (1968), the exine seems to be thinner at the polar region as compared to the peripheral area, a character which is seen in the illustration of the type species as given by the original authors though not mentioned in the systematic description.

On the basis of the possible affinities of the dispersed pteridophytic spores studied the presence of the following families is inferred. Taxa of uncertain botanical affinity are also listed below :

Taxon	*Family*
Cyathidites australis	Cyatheaceae
C. minor	Cyatheaceae
Lygodiumsporites lakiensis	Schizaeaceae
L. eocenicus	,,
L. donaensis	,,
Todisporites major	Osmundaceae
T. minor	,,
Biretisporites meghalayaensis	?Hymeno-phyllaceae
B. oligocenicus	,,
Surmaspora sinuosa	Unknown
Gleicheniidites senonicus	Gleicheniaceae
Dictyophyllidites indicus	?Matoniaceae
Garotriletes sp.	Unknown
Corrugatisporites sp.	Unknown
Foveotriletes sp. A	Unknown
Foveotriletes sp. B	Unknown
Foveosporites triangulus	Lycopodiaceae
F. miocenicus	Unknown
Foveosporites sp.	Unknown
Lycopodiumsporites abundans	Lycopodiaceae
Striatriletes susannae	Parkeriaceae
S. pachyexinus	,,
S. sinuosus	,,
Malayaeaspora costata	?Schizaeaceae
Cingutriletes sp.	Unknown
Polypodiaceaesporites tertiarus	Polypodiaceae
P. chatterjii	,,
Monolites major	,,
Polypodiisporites favus	,,
P. speciosus	,,
P. formosus	,,
P. tuberculensis	,,

These families possibly indicate tropical-subtropical humid climate during the sedimentation of the present sequence.

An analysis of the assemblage reveals that the pteridophytic spores dominate the Surma Group as compared to the Barail Group. The presence of *Biretisporites oligocenicus, Dictyophyllidites indicus, Striatriletes pachyexinus, Gleicheniidites senonicus, Foveosporites* sp. A, *Foveotriletes* sp. A, *Garotriletes* sp. and *Polypodiisporites tuberculensis* is restricted to the Barail Group, whereas *Striatriletes sinuosus, Malayaeaspora costata, Surmaspora sinuosa, Lygodiumsporites donaensis, Biretisporites meghalayaensis, Cyathidites australis, Foveosporites triangulus, F. miocenicus, Lycopodiumsporites abundans, Monolites major, Foveotriletes* sp. B, *Cingutriletes* sp., *Polypodiaceaesporites chatterjii* and *Polypodiisporites favus* are restricted to the Surma Group. The forms in common between the Barail and Surma groups are *Todisporites major, T. minor, Lygodiumsporites lakiensis, L. eocenicus, Striatriletes susannae, Cyathidites minor, Corrugatisporites* sp., *Polypodiaceaesporites tertiarus* and *Polypodiisporites speciosus.*

ACKNOWLEDGEMENT

The authors are thankful to Dr R. K. Saxena for collecting the rock samples in the field.

REFERENCES

Baksi, S. K. 1962. Palynological investigation of Simsang River tertiaries, South Shillong Front, Assam. *Bull. geol. min. metall. Soc. India* **26** : 1-22.

Balme, B. E. 1957. Spores and pollen grains from the Mesozoic of western Australia. *C.S.I.R.O. Austr. Coal Res. Sect. T.C.* **25** : 1-48.

Cookson, I. C. 1947 Plant microfossils from the lignites of Kerguelen Archipelago. *Rep. B.A.N.Z. Antarctic Res. Exped.* Ser. A. **2** : 127-142.

Couper, R. A. 1953. Upper Mesozoic and Cainozoic spores and pollen grains from New Zealand. *N.S. Geol. Surv. Palaeontol. Bull* **22** : 1-77

Couper, R. A. 1958. British Mesozoic microspores and pollen grains—A systematic and stratigraphic study. *Palaeontographica* **103B** : 75-179.

Delcourt, A. F. & Sprumont, G. 1955. Les spores et grains de pollen du Wealdien du Hainaut. *Mem. Soc. Belge. Geol.* **4** : 73.

Delcourt, A. F., Dettmann, M. E. & Hughes, N. F. 1963. Revision of some Lower Cretaceous microspores from Belgium. *Palaeontology* **6** : 282-292.

Dettmann, M. E. 1963. Upper Mesozoic microfloras from south-eastern Australia. *Proc. R. Soc. Victoria,* **77**(1) : 1-148.

Dutta, S. K. & Sah, S. C. D. 1970. Palynostratigraphy of the Tertiary sedimentary formations of Assam. 5. Stratigraphy and palynology of South Shillong Plateau. *Palaeontographica* **131B**(1-4) : 1-72.

Dybova, S. & Jachowitz, A. 1957. Microspores of the Upper Silesian coal measures. *Inst. geol.*, : 1-326.

Ibrahim, A. C. 1933. Sporenformen des Aegirhorizonts des Ruhr-Reviers. *Diss. Konard Triltsch, Wurzburg* : 1-47.

Jansonius, J. & Hills, L. V. 1976. Genera file of fossil spores. *Special publication, Canada, Department Geology* : 1-3287.

Kar, R. K. 1979. Palynological fossils from the Oligocene sediments and their biostratigraphy in the district of Kutch, western India. *Palaeobotanist* **26**(1) : 16-49.

Kar, R. K. & Saxena, R. K. 1981. Palynological investigation of a bore core near Rataria, southern Kutch, Gujarat. *Geophytology* **11**(2) : 103-124.

Luber, A. A. 1935. Les types petrographicques de charbons fossiles du Spitzbergen. *Chim. Combust. solide* **6**.

Pierce, R. L. 1961. Lower-Upper Cretaceous plant microfossils from Minnesota. *Minnesota. geol. Surv. Bull.* **42** : 1-86.

Potonié, H. 1893. Uber einige carbonfarne Pt. IV. *Jb. Kgl. preuss. Geol.* : 1-11.

Potonié, R. 1931. Zur Mikroskopie der Braunkohlen. I. Z. *Braunkohle,* **30** : 554-556.

Potonié, R. 1956. Synopsis der Gattungen der *Sporae dispersae* 1. Teil : Sporites. *Beih. geol. Jb.* **23** : 1-103.

Potonié, R. 1958. Synopsis der Gattungen der *Sporae dispersae.* II. Teil. Sporites Nachträge Saccites, Aletes, Praecolpates, Polyplicates, Monocolpates. *Beih. geol. Jb* **31** : 1-114.

Potonié, R. 1960. Synopsis der Gattungen der *Sporae dispersae* III. Teil : Nachträge Sporites, Fortsetzung pollenites mit general register Zu Teil I-III. *Beih. geol. Jb.* **39** : 1-189.

Potonié, R. 1966. Synopsis der Gattungen der *Sporae dispersae.* IV. Teil : Nachträge Zu allen Gruppen (Turmae). *Beih. geol. Jb.* **69** : 111-194.

Potonié, R. 1970. Synopsis der Gattungen der *Sporae dispersae* V. Teil : Nachträge Zu allen Gruppen (Turmae). *Beih. geol. Jb.* **87** : 1-172.

Potonié, R. & Gelletich, J. 1933. Uber pteridophyten-Sporen einer eözanen Braunkohle aus Dorog in Ungarn. *S. B. Gesch. naturf. Fr. Berl.* **33** : 517-526.

Potonié, R. & Kremp, G. 1954. Die Gattungen der Palaeozoischen *Sporae dispersae* und ihre Stratigraphie. *Geol. Jb.* **69** : 111-194.

Potonié, R. & Kremp, G. 1955. Die *Sporae dispersae* des Rukrkarbons ihre Morphographie und Stratigraphie mit aus blicken auf arten anderer gebiete und Zeitabschnitte : Teil. 1. *Palaeontographica* **98B** : 1-136.

Potonié, R. & Kremp, G. 1956. Die *Sporae dispersae* des Rukrkarbons ihre Morphographie und Stratigraphie mit aus blicken auf arten anderer gebiete und Zeitabchnitte. Teil. II. *Palaeontographica* **99B** : 85-191.

Potonié, R., Thomson, P. W. & Thiergart, F. 1950. Zur nomenklatur und klassifikation des Neogenen Sporomorphae (Pollen und Sporen). *Geol. Jb.* **65** : 35-70.

Ramanujam, C. G. K. 1966-67. Pteridophytic spores from the Miocene lignite of south Arcot District, Madras. *Palynol. Bull.* **2 & 3** : 29-40.

Ramanujam, C. G. K. 1972. Revision of pteridophytic spores from the Warkalli lignite of South India. *Proc. Sem palaeopalynol. Indian. Stratigr., Calcutta* : 248-254.

Rao, K. P. & Ramanujam, C. G. K. 1978. Palynology of the Neogene Quilon beds of Kerala State in South India 1-Spores of pteridophytes and pollen of monocotyledons. *Palaeobotanist* **25** : 397-427.

Ross, N. E. 1949. On a Cretaceous pollen and spore bearing clay of Scania. A preliminary report. *Bull. geol. Inst. Uppsala* **34** : 25-43.

Sah, S. C. D. 1967 Palynology of an Upper Neogene profile from Rusizi Valley (Burundi). *Annls Mus. r. Afr. Cent.*, Ser. 8°, **57** : 1-173.

Sah, S. C. D. & Dutta, S. K. 1968. Palynostratigraphy of the sedimentary formations of Assam 2. Stratigraphic significance of spores and pollen in the Tertiary succession of Assam. *Palaeobotanist* **16**(2) : 177-195.

Sah, S. C. D. & Kar, R. K. 1969. Pteridophytic spores from the Laki series of Kutch, Gujarat State, India. *J. Sen Mem. Vol., Bot. Soc. Bengal, Calcutta* : 109-121.

Sah, S. C. D. & Kar, R. K. 1970. Palynology of the Laki sediments in Kutch-3. Pollen from the bore holes around Jhularia, Baranda and Panandhro. *Palaeobotanist* **18**(2) : 127-142.

Salujha, S. K., Kindra, G. S. & Rehman, K. 1972. Palynology of the South Shillong front part-1. The Palaeogene of Garo Hills. *Prqc. Sem. Paleopalynol. Indian Stratigr., Calcutta* : 265-291.

Salujha, S. K., Kindra, G. S. & Rehman, K. 1974. Palynology of the South Shillong front, part II. The Palaeogenes of Khasi and Jaintia Hills. *Palaeobotanist* **21**(3) : 267-284.

Saxena, R. K. 1978. Palynology of the Matanomadh Formation in the type area, North Western Kutch India (part I). Systematic description of pteridophytic spores. *Palaeobotanist* **25** : 448-456.

Saxena, R. K. & Rao, M. R. 1984. Palynology of the Barail (Oligocene) and Surma (Lower Miocene) sediments exposed along Sonapur-Badarpur Road Section, Jaintia Hills (Meghalaya) and Cachar (Assam). Part-I. Dinoflagelate cysts. *Jour. Palaeont. Soc. India* **29** : 52-62.

Saxena, R. K. & Tripathi, S. K. M. 1982. Lithostratigraphy of the Tertiary sediments exposed along Jowai-Badarpur Road in Jaintia Hills (Meghalaya) and Cachar (Assam). *Palaeobotanist* **30**(1) : 34-42.

Skarby, A. 1964. Revision of *Gleichenitidites senonicus* Ross. *Stockholm contributions in Geology* **9**(3) : 59-77.

Singh, H. P. & Rao, M. R. 1984. *Surmaspora,* a new pteridophytic spore genus recovered from the Tertiary sediments of Meghalaya and Assam. *Curr. Sci.* **53**(15) : 803-805.

Singh, H. P. & Tripathi, S. K. M. 1983. A comparative study of spores of *Ceratopteris thalictroides* (L) Brongn. and *Striatriletes* van der Hammen emend. Kar. *Geophytology* **13**(2) : 219-226.

Singh, H. P., Saxena, R. K. & Rao, M. R. 1986. Palynology of the Barail (Oligocene) and Surma (Lower Miocene) sediments exposed along Sonapur-Badarpur Road Section, Jaintia Hills (Meghalaya) and Cachar (Assam). Part-II. Fungal remains. *Palaeobotanist* **35**(1) : 93-105.

Singh, R. Y. 1977a. Stratigraphy and palynology of the Tura Formation in the type area part II. Descriptive palynology. *Palaeobotanist* **23**(3) : 189-205.

Singh, R. Y. & Singh, H. P. 1978. Morphological observations on some spores and pollen grains from the Palaeocene subsurface assemblages of Garo Hills, Meghalaya. *Palaeobotanist* **25** : 475-480.

Thiergart, F. 1938. Die pollen-flora der Niederlausitzer Braunkohle, Besondern in profil der Grube Margo bei Senftenber. *Jb. preuss. geol. Landesanst. BergAkad.* **58** : 282-351.

Thomson, P. W. & Pflug, H. 1953. Pollen und Sporen des Mitteleuropaischen Tertiars. *Palaeontographica* **94** : 1-138.

Trivedi, B. S., Ambwani, K. & Kar, R. K. 1981. *Malayaeaspora costata* Trivedi *et al.* from the Tertiary coal of Malaya. *Curr. Sci.* **50**(20) : 910-911.

van der Hammen, T 1956. A palynological systematic nomenclature. *Boln. geol., Bogotá* **4**(2&3) : 63-101

Venkatachala, B. S. & Góczán, F. 1964. The spore-pollen flora of Hungarian "Kossen Facies" *Acta geol. lilloana* **VIII**(1-4) : 203-228.

Venkatachala, B. S. & Rawat, M. S. 1973. Palynology of the Tertiary sediments in the Cauvery Basin-2. Oligocene-Miocene palynoflora from the subsurface. *Palaeobotanist* **20**(2) : 238-263.

Weyland, H. & Greifeld, G. 1953. Uber Strukturbitende Blatter und pflanzliche mikrofossillen aus den untersenonen Tonen der Gegend Von quedlinburg. *Palaeontographica* **95B** : 30-502.