PALYNOLOGY OF THE MATANOMADH FORMATION IN TYPE AREA, NORTH WESTERN KUTCH, INDIA (PART 1). SYSTEMATIC DESCRIPTION OF PTERIDOPHYTIC SPORES

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ABSTRACT

The present paper deals with the systematic description of the pteridophytic spores recovered from the Matanomadh Formation in its type area, north-western Kutch, India. The palynological assemblage described in this paper is represented by 27 species of pteridophytic spores assigned to 14 dispersed genera. Of these, 4 species are new.

INTRODUCTION

THE Matanomadh Formation constitutes the basal lithostratigraphic unit of the Tertiary sequence in Kutch. Wynne (1872), for the first time, recognized this succession as a separate stratigraphic unit. He named it Subnummulitic Group and assigned a Lower Eocene age. The Lower Eocene dating for this formation was subsequently supported by Oldham (1893), Tewari (1952, 1957), Nagappa (1959) and Poddar (1959, 1963). Pascoe (1964) on the other hand, opined that the Subnummulitic Group (= Matanomadh Formation) may be of Palaeocene age. Biswas (1965), who named this unit as Madh Series, also supported the Palaeocene age for this formation. He correlated the Madh Series with the Ranikot Series (Palaeocene) of Sind-Baluchistan. Biswas and Raju (1971, 1973) introduced the term Matanomadh Formation for the basal lithostratigraphic unit of the Tertiary sequence of Kutch, based on its certain lithological peculiarities and mappability.

Lately, Saxena (1977a) published an account of lithostratigraphy of this formation. He, on the basis of lithological distinctiveness, divided this formation into two members, viz., Laterite Member and Clastic Member. The litho-, bio- and chronostratigraphic status of the Matanomadh Formation has been discussed by Saxena (1977b).

The palynological studies on this formation were initiated by Mathur (1966). He, on the basis of the palynoflora, assigned a Palaeocene age. Algal and fungal microfossils from this formation have, for the first time, been described by Kar and Saxena (1976).

The palynological work on the overlying Naredi Formation (Lower Eocene) has been carried out by Mathur (1963), Venkatachala and Kar (1968, 1969a, 1969b) and Sah and Kar (1969, 1970).

MATERIAL AND METHOD

The samples for the present palynological work were collected from four measured sections around Matanomadh — the type area for the Matanomadh Formation. The sampling was done in such a way that top and bottom of each lithofacies were represented. The samples were collected at a stratigraphic interval of 0·3 m. The samples included almost all the rock types met within the Matanomadh Formation. The various lithic types, thus collected, were carbonaceous shale, tuff, tuffaceous shale, clay, sandstone, etc.

During collection of samples, special attention was paid to avoid surface contamination or mixing. Depth of weathering was considered important and all efforts were made to collect samples from fresh surfaces. In some cases where the rocks were much weathered, as in case of carbonaceous shales, exposures had to be removed upto more than 0·5 m to obtain a fresh face. Particular attention was paid to the collection of samples from thin tuffaceous or carbonaceous shale bands within sandstone or mottled clay beds. The larger pieces of hard rock samples, during collec-

tion, were reduced to approximately 100 gm. In case of soft and fragile material only bigger chips were collected while powdery material was completely rejected. The samples were simultaneously sealed after proper labelling and packing in polythene bags bearing the field number.

The maceration was done by using hydrofluoric acid in case of sandy shale, clay and tuffaceous shale and nitric acid in case of carbonaceous or lignitic shales. The digestion period of the samples varied from 2 to 3 days. The samples were then washed with water and treated with 3% KOH for about 5-10 minutes. The material was finally washed through 400 mesh seive. A number of test samples showed better results when the macerated residue was acetolysed. For acetolysis, Erdtman's (1952) method was followed. The slides were prepared in polyvenyl alcohol and mounted in canada balsam. All the slides have been preserved in the repository of the Birbal Sahni Institute of Palaeobotany, Lucknow.

SYSTEMATIC PALYNOLOGY

Anteturma — *Proximegerminantes* Potonié, 1970

Turma — *Triletes* (Reinsch) Dettmann, 1963

Suprasubturma — *Acavatitriletes* Dettmann, 1963

Subturma — *Azonotriletes* (Luber) Dettmann, 1963

Infraturma — *Laevigati* (Bennie & Kidston) Potonié, 1956

Genus — *Cyathidites* Couper, 1953

Type Species — *Cyathidites australis* Couper, 1953.

Cyathidites australis Couper, 1953

Pl. 1, fig. 1

Cyathidites minor Couper, 1953

Pl. 1, fig. 2

Remarks — Spores of this species recovered from Matanomadh Formation are slightly bigger (upto 50 μ) than the spores (31-45 μ) described by Couper (1953) from New Zealand.

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

Type Species — *Lygodiumsporites adriennis* Potonié, Thomson & Thiergart, 1950.

Lygodiumsporites lakiensis Sah & Kar, 1969

Pl. 1, fig. 3

Lygodiumsporites eocenicus Dutta & Sah, 1970

Pl. 1, fig. 4

Lygodiumsporites pachyexinus sp. nov.

Pl. 1, figs. 5, 6

Holotype — Pl. 1, fig. 5, size 52 μ. Slide no. 4766/12.

Type Horizon — Matanomadh Formation (Clastic Member).

Type Locality — Matanomadh, Kutch, India.

Diagnosis — Spores triangular-subtriangular in polar view, 40-65 μ. Trilete, rays extending upto 2/3 radius, commissure distinct. Exine up to 6 μ thick, laevigate.

Comparison — The present species approximates *L. lakiensis* Sah & Kar (1969) in shape and size but the former has a comparatively very thick exine. *L. eocenicus* Dutta and Sah (1970) has bigger size range and comparatively thinner exine.

Genus — *Todisporites* Couper, 1958

Type Species — *Todisporites major* Couper, 1958.

Todisporites major Couper, 1958

Pl. 1, fig. 7

Todisporites minor Couper, 1958

Pl. 1, fig. 8

Remarks — Most of the specimens referred to this species are degraded. The degradation is pronounced along the inter-radial region producing pseudopunctate pattern. The degradation might have been caused either by biological agencies or chemical action.

Todisporites kutchensis Sah & Kar, 1969

Pl. 1, fig. 9

Genus — *Dandotiaspora* Sah, Kar & Singh, 1971

Type Species — Dandotiaspora dilata (Mathur) Sah, Kar & Singh, 1971.

Dandotiaspora dilata (Mathur) Sah, Kar & Singh, 1971

Pl. 1, figs. 10,11

Remarks — Some of the specimens referred to this species are as small as 46 μ. Most of the specimens are infected by fungi, especially in the contact area, exhibiting a pseudopunctate pattern. One of the specimens (Pl. 1, fig. 11) has a verrucose ornamentation but other characters are similar to *D. dilata*.

Dandotiaspora plicata (Sah & Kar) Sah, Kar & Singh, 1971

Pl. 1, fig. 12

Dandotiaspora telonata Sah, Kar & Singh, 1971

Pl. 1, fig. 13

Dandotiaspora pseudoauriculata Sah, Kar & Singh, 1971

Pl. 1, fig. 14

Genus — *Dictyophyllidites* (Couper) Dettmann, 1963

Type Species — Dictyophyllidites harrisii Couper, 1958.

Dictyophyllidites granulatus sp. nov.

Pl. 1, figs. 15-17

Holotype — Pl. 1, fig. 15, size 68 μ. Slide no. 4777/10.

Type Horizon — Matanomadh Formation (Clastic Member).

Type Locality — Matanomadh, Kutch, India.

Diagnosis — Spores triangular-subtriangular in polar view, 52-70 μ. Trilete, rays distinct, extending upto 3/4 radius and surrounded by thickened, raised, granulose kyrtome, commissure distinct. Exine 1-2·5 μ thick, granulose, grana more concentrated towards the contact area.

Comparison — The present species closely resembles *D. pectinataeformis* (Bolkhovitina) Dettmann (1963) in having granulose exine but the latter can be distinguished by its thicker exine (3·5-5 μ). *Dictyophyllidites* spp. described by Venkatachala (1969) and Sah and Kar (1969) have laevigate kyrtome.

Genus — *Intrapunctisporis* Krutzsch, 1959

Type Species — Intrapunctisporis intrapunctis Krutzsch, 1959.

Intrapunctisporis intrapunctis Krutzsch, 1959

Pl. 1, fig. 18

Intrapunctisporis apunctis Krutzsch, 1959

Pl. 1, fig. 19

Remarks — The specimens of *Intrapunctisporis apunctis* Krutzsch (1959) in the present preparation are smaller in size (44-55 μ) than the holotype (60 μ).

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

Subinfraturma — *Granulati* Dybova & Jachowitz, 1957

Genus — *Osmundacidites* Couper, 1953

Type Species — Osmundacidites wellmannii Couper, 1953.

Osmundacidites minutus Sah & Jain, 1965

Osmundacidites cephalus sp. nov.

Pl. 2, figs. 20, 21

Holotype — Pl. 2, fig. 20, size 68 μ. Slide no. 4945/8.

Type Horizon — Matanomadh Formation (Clastic Member).

Type Locality — Matanomadh, Kutch, India.

Diagnosis — Spores subcircular-circular, 49-72 μ. Trilete, rays distinct, extending upto 3/4 radius, with raised commissure. Exine 2·5-4 μ thick, gr nulose, grana closely placed, 1·5-3 μ in size, sometimes imparting a verrucose appearance.

Comparison — *O. microgranifer* Sah & Jain (1965) described from Rajmahal Hills resembles in size range but can be distinguished by its small sculptural elements.

O. minutus also described by Sah and Jain (1965) is much smaller in size (19-27 μ). In *O. kutchensis* Sah & Kar (1969), grana are sparsely placed.

Remarks — In a few specimens, the grana appear to be less in number on the proximal surface and somewhat distantly placed.

Subinfraturma — *Verrucati* Dybova & Jachowitz, 1957

Genus — *Leptolepidites* Couper, 1953

Type Species — *Leptolepidites verrucatus* Couper, 1953.

Leptolepidites major Couper, 1958

Pl. 2, fig. 22

Infraturma — *Murornati* Potonié & Kremp, 1954

Genus — *Foveosporites* Balme, 1957

Type Species — *Foveosporites canalis* Balme, 1957.

Foveosporites sp.

Pl. 2, fig. 23

Description — Spores subcircular, 60-77 μ. Trilete, rays extending upto 3/4 radius. Exine upto 1·5 μ thick, foveolate, foveolae closely placed and uniformly distributed all over the exine.

Remarks — The Matanomadh specimens differ from *F. canalis* Balme (1957) in not having elongated foveolae.

Genus — *Lycopodiumsporites* Thiergart, 1938

Type Species — *Lycopodiumsporites agathoecus* (Potonié) Thiergart, 1938.

Lycopodiumsporites bellus Sah & Kar, 1969

Pl. 2, fig. 24

Lycopodiumsporites umstewensis Dutta & Sah, 1970

Pl. 2, fig. 25

Remarks — The specimens of *Lycopodiumsporites umstewensis* Dutta & Sah (1970) observed here, are slightly smaller in size (26-36 μ) than those described by Dutta and Sah (1970) from South Shillong Plateau, Meghalaya.

Genus — *Cicatricosisporites* Potonié & Gelletich, 1933

Type Species — *Cicatricosisporites dorogensis* Potonié & Gelletich, 1933.

Cicatricosisporites australiensis (Cookson) Potonié, 1956

Pl. 2, fig. 26

Cicatricosisporites pseudotripartitus (Bolkhovitina) Dettmann, 1963

Pl. 2, fig. 27

Cicatricosisporites sp.

Pl. 2, fig. 28

Description — Spores triangular, 60-68 μ. Trilete, rays straight, extending upto 3/4 radius. Exine 2·5-4 μ thick, ornamented by low, flat topped costae (*ca.* 1-2 μ high), wider (2-4 μ) than lumina (0·5 μ) and running parallel to each other, costae 5-8 in each contact area.

Comparison — The present grains differ from *C. australiensis* (Cookson) Potonié (1956) in having flat flappy costae. *C. pseudotripartitus* (Bolkhovitina) Dettmann (1963) has thinner exine.

Subturma — *Zonotriletes* Waltz, 1935
Infraturma — *Tricrassati* Dettmann, 1963

Genus — *Gleicheniidites* (Ross) Dettmann, 1963

Type Species — *Gleicheniidites senonicus* Ross, 1949.

Gleicheniidites senonicus Ross, 1949

Pl. 2, fig. 29

Turma — *Monoletes* Ibrahim, 1933
Suprasubturma — *Acavatomonoletes* Dettmann, 1963
Subturma — *Azonomonoletes* Luber, 1935
Infraturma — *Laevigatomonoleti* Dybova & Jachowitz, 1957

Genus — *Polypodiaceaesporites* Thiergart, 1938

Type Species—Polypodiaceaesporites haardti (Potonié & Venitz) Thiergart, 1938.

Polypodiaceaesporites levis Sah, 1967

Pl. 2, fig. 30

Polypodiaceaesporites major sp. nov.

Pl. 2, figs. 31-33

Holotype — Pl. 2, fig. 31, size 77×54 μ. Slide no. 4771/15.

Type Horizon — Matanomadh Formation (Clastic Member).

Type Locality — Matanomadh, Kutch, India.

Diagnosis — Spores bean-shaped, 58-86 ×38-56 μ. Monolete, laesura not well discernible, extending upto 3/4 of the longer axis. Exine 1·5-2·5 μ thick, laevigate, proximal exine thinner than distal.

Comparison — The present species compares to *P. tertiarus* Dutta & Sah (1970) in shape and size range but differs in having a thinner proximal surface and laevigate exine. *P. levis* Sah (1967) is much smaller in size.

Polypodiaceaesporites sp.

Pl. 2, fig. 34

Description — Spore bean-shaped, 72×43 μ. Monolete, ray not well discernible. Exine ± 1 μ thick, exoexine very thin and ornamented with very minute grana.

Comparison — The present specimen closely resembles *Polypodiaceaesporites major* in size range and shape but differs in having granulose ornamentation.

Infraturma — *Sculptatomonoleti* Dybova & Jachowitz, 1957

Genus — *Polypodiisporites* Potonié, 1934

Type Species — Polypodiisporites favus Potonié, 1934.

Polypodiisporites repandus Takahashi, 1964

Pl. 2, fig. 35

Polypodiisporites mawkmaensis Dutta & Sah, 1970

Pl. 2, fig. 36

Polypodiisporites sp.

Pl. 2, figs. 37, 38

Description — Spores oval, 68-92×58-68 μ. Monolete, laesura extending upto 2/3 of the longer axis. Exine upto 2 μ thick, verrucose, verrucae very closely placed.

Comparison — The species described here can be differentiated from *Polypodiisporites repandus* Takahashi (1964) and *P. mawkmaensis* Dutta & Sah (1970) by its low set verrucae. Other known species of *Polypodiisporites* differ in having bigger sculptural elements.

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EXPLANATION OF PLATES

(*All photomicrographs are enlarged ca.* × *500*)

Plate 1

1. *Cyathidites australis* Couper; Slide no. 4936/14.
2. *Cyathidites minor* Couper; Slide no. 4937/14.
3. *Lygodiumsporites lakiensis* Sah & Kar; Slide no. 4938/8.
4. *Lygodiumsporites eocenicus* Dutta & Sah; Slide no. 4781/16.
5, 6. *Lygodiumsporites pachyexinus* sp. nov.; Slide nos. 4766/12 (Holotype), 4766/11.
7. *Todisporites major* Couper; Slide no. 4939/20.
8. *Todisporites minor* Couper; Slide no. 4773/1.
9. *Todisporites kutchensis* Sah & Kar; Slide no. 4777/2.
10, 11. *Dandotiaspora dilata* (Mathur) Sah, Kar & Singh; Slide nos. 4940/6, 4792/13.
12. *Dandotiaspora plicata* (Sah & Kar) Sah, Kar & Singh; Slide no. 4941/14.
13. *Dandotiaspora telonata* Sah, Kar & Singh; Slide no. 4942/1.
14. *Dandotiaspora pseudoauriculata* Sah, Kar & Singh; Slide no. 4938/8.
15-17. *Dictyophyllidites granulatus* sp. nov.; Slide nos. 4777/10 (Holotype), 4798/6, 4943/30.
18. *Intrapunctisporis intrapunctis* Krutzsch; Slide no. 4944/2.
19. *Intrapunctisporis apunctis* Krutzsch; Slide no. 4791/7.

Plate 2

20, 21. *Osmundacidites cephalus* sp. nov.; Slide nos. 4945/8 (Holotype), 4940/7.
22. *Leptolepidites major* Couper; Slide no. 4767/3.
23. *Foveosporites sp.*; Slide no. 4773/13.
24. *Lycopodiumsporites bellus* Sah & Kar; Slide no. 4766/2.
25. *Lycopodiumsporites umstewensis* Dutta & Sah; Slide no. 4948/.1.
26. *Cicatricosisporites australiensis* (Cookson) Potonié; Slide no. 4771/19.
27. *Cicatricosisporites pseudotripartitus* (Bolkhovitina) Dettmann; Slide no. 4951/20.
28. *Cicatricosisporites* sp.; Slide no. 4951/23.
29. *Gleicheniidites senonicus* Ross; Slide no. 4938/30.
30. *Polypodiaceaesporites levis* Sah; Slide no. 4780/4.
31-33. *Polypodiaceaesporites major* sp. nov.; Slide nos. 4771/15 (Holotype), 4781/5, 4953/39.
34. *Polypodiaceaesporites* sp.; Slide no. 4943/21.
35. *Polypodiisporites repandus* Takahashi; Slide no. 4773/2.
36. *Polypodiisporites mawkmaensis* Dutta & Sah; Slide no. 4944/9.
37, 38. *Polypodiisporites* sp.; Slide nos. 4949/25, 4936/8.

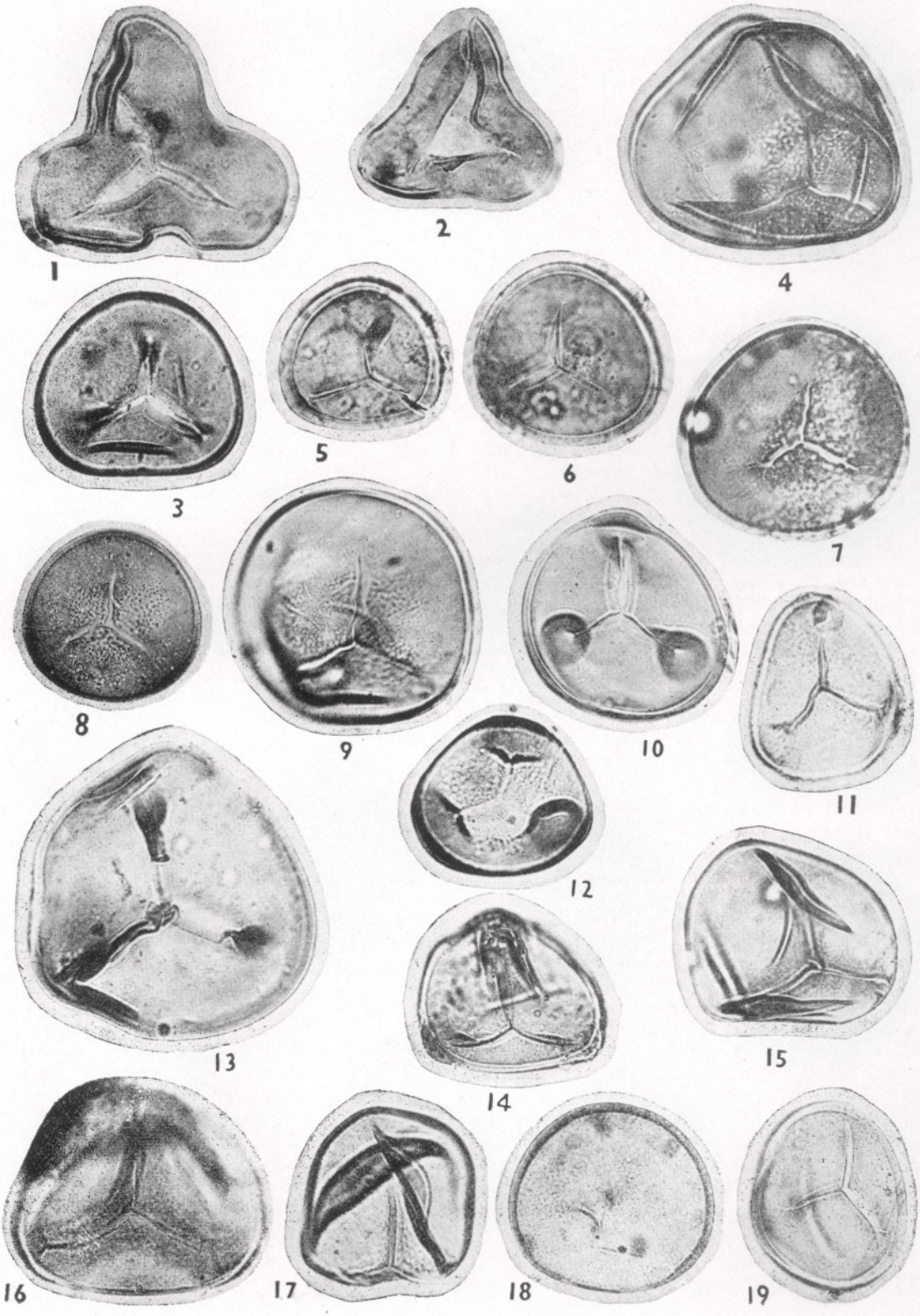

PLATE 1

PLATE 2