A PALYNOLOGICAL ASSEMBLAGE FROM BARMER, RAJASTHAN

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ABSTRACT

Twenty two recognizable species of dispersed spores and pollen grains are described from a sample of a dark carbonaceous clay, exposed in a well 125 ft. south-east from the base of the Barmer Hill. Of these eight species are new. The assemblage is characterised by the dominance of angiospermous elements over the pteridophytic while gymnosperms are totally absent. Fungal elements are common. The occurrence of stratigraphically significant taxa have been discussed. The overall composition of the assemblage, especially the high frequency of *Proxapertites* type, together with low frequencies or absence of significant Upper Mesozoic and Lower Eocene forms indicate a Palaeocene age for this clay bed.

INTRODUCTION

The Barmer Sandstone forms the prominent physiographic feature around Barmer town, Rajasthan (25° 40′ N: 71° 25′ E). Coarse conglomerate occurs at the base, overlain by whitish or grey sandstone. The age of the Barmer Sandstone has remained a controversial problem since long because of the lack of evidence from both lithology and palaeontology. The first reference to the age of this sandstone was made by BLANFORD (1877, pp. 17-18), who considered it as one of the divisions of the Jurassic sequence in Jaisalmer. He compared them with similar sandstones developed towards east and south-east of Jaisalmer, locally known as Lathi Sandstone. Later, LA TOUCHE (1902, pp. 33-34) suggested that Barmer Sandstone could not be older than Cretaceous. OLDHAM (re-written PASCOE, 1959, p. 1012) states, "The fact that they have yielded some dicotyledonous woods and net-veined leaves makes it probable that they are not older than Lower Cretaceous (Aptian); this supposition is confirmed by the stratigraphical position of a fine unctuous Fuller's earth known as *Multani mitti* which, though not definitely seen in contact with the Barmer Sandstone, is believed to overlie them, and which, in the north-east of Jaisalmer and in Bikaner, is associated with nummulitic limestones of early Tertiary age". KRISHNAN and JACOB (1956, p. 24) indicated that the "Barmer sandstone may be even L. Eocene in age."

LA TOUCHE (1911) for the first time reported the occurrence of angiospermous leaves from Barmer Sandstone. Since then the only palaeobotanical or palynological information that is available from this area is in the form of a preliminary note (BOSE, 1949) with photographs of an impression and three pollen grains. This was followed by another short paper (BOSE, 1952) giving a few photographs of dicot leaves and line drawings of some spores, pollen and fungal remains.

The purpose of reinvestigating this material was twofold; first, to validate the palynological taxa recorded by BOSE (1949, 1952) as types and second, to reassess the value of the overall composition of the palynological assemblage in dating and correlating the Barmer Sandstone with equivalent rocks of other areas in the light of considerable advanced knowledge of the Upper Cretaceous, Palaeocene and Eocene palynological assemblages from India and other parts of the world.

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The palynological assemblage described here has been obtained by remacerating a part of the material collected earlier by BOSE (1949). The sample represents a dark carbonaceous clay which was exposed as the lowermost bed of a 110 ft, deep well, situated about 125 ft south-east from the base of the Barmer Hill (BOSE, 1949, p. 46). We take this opportunity to express our sincere thanks to Dr. M. N. Bose for the material and for allowing us to reinvestigate it.

Repository:—The type slides are deposited at the Museum of Birbal Sahni Institute of Palaeobotany, Lucknow.

SYSTEMATIC DESCRIPTION

Genus—**Cyathidites** Couper, 1953

Cyathidites minor Couper, 1953

Pl. 1, Figs. 6, 7, 8

Distribution—Jurassic and Cretaceous.

Affinity—Cyathiaceae.

Cyathidites australis Couper, 1953

Pl. 1, Fig. 6a

1952—Trilete spores, types 1-4, in Bose, p. 6; fig. 2 (22-25)

Distribution—Upper Mesozoic.

Affinity—Cyathiaceae.

Genus—**Trilites** Erdtman ex Couper emend. Dettmann, 1963

Trilites tuberculiformis Cookson, 1947

Pl. 1, Figs. 10-11

Distribution—Lower Tertiary.

Affinity—cf. *Dicksonia squarrosa* (Forst) (in HARRIS, 1955 and COUPER, 1960).

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

Corrugatisporites sp.

Pl. 1, Fig. 9

Description—Miospore trilete, subcircular, 50 μ; Y-mark distinct, laesurae reaching 2/3 radial distance. Exine 2-2.5 μ thick, verrucose, verrucae 2-3.5 μ high, fused at base.

Genus—**Cicatricosisporites** Potonié & Gelletich, 1933

Cicatricosisporites sp. A

Pl. 1, Fig. 12

Description—Miospore trilete, subtriangular, 52 μ, sides convex; Y-mark indistinct. Exine 1.5 μ thick, ornamented both proximally and distally with ridges. Ridges distantly placed, 2-2.5 μ thick, raised, uneven, small or large, continuous to discontinuous, arranged irregularly, sometimes knob like thickening occurs.

Comparison—The present species resembles *Cicatricosisporites macrocostatus* (Baksi) Sah & Dutta (1968) in shape and general organisation but is distinguished by its smaller size and well-developed ribs on both the surfaces.

Cicatricosisporites sp. B

Pl. 1, Fig. 13

Description—Miospore trilete, triangular, 40 μ in diameter, sides convex, angles obtusely rounded; Y-mark distinct, rays reaching up to equator. Exine 1.5 μ thick, muri on distal side not continuous, ill-developed; proximal exine scabrate.

Comparison—*Cicatricosisporites* sp. A. is distinguished from the present specimen by its well-developed ribs and bigger size. *C. macrocostatus* (Baksi) Sah & Dutta (1968) is also differentiated by its bigger size range and comparatively well-developed ribs.

Genus—**Seniasporites** Sah & Kar, 1969

Seniasporites verrucosus Sah & Kar, 1969

Pl. 1, Fig. 1

Affinity—Polypodiaceae.

Genus—**Monolites** (Erdtman) Potonié, 1956

Monolites sp. cf. **M. ovatus** Sah, 1967

Pl. 1, Figs. 2-4

1952—*Monosulcate* pollen grain, type G3, in Bose, p. 6; fig. 2(21).

Description—Miospores monolete, bilateral, rounded to oval in shape, 32-46 × 23-32 μ in size; laesura ½ the longer axis, lips thin. Exine 1 μ thick, smooth.

Remarks—The Barmer specimens compare very closely with *Monolites ovatus* Sah (1967) in most of the morphological features but differ in being smaller in size.

Genus—**Schizaeoisporites** Potonié, 1951

Schizaeoisporites sp.

Pl. 1, Fig. 31

Description—Miospore monolete, amb ± bean shaped; 50-55 μ in length along the longer axis, monolete ± as long as longer axis, indistinct. Exine 1 μ thick, ornamented by transverse ridges running parallel to each other.

Comparison—*Schizaeoisporites digitatoides* (Cookson) Potonié, (1960) recorded by Sah and Dutta (1968) from Assam closely resembles the present specimen in nature of the ribs but the latter is broader than the former. *Schizaeoisporites* sp. described by Sah and Kar (1969) from Kakdi Formation in Kutch has finer ribs than the present specimen.

Distribution—Cherra Formation, Assam, (Palaeocene); Kakdi Formation, Kutch (Lower Eocene).

Affinity—Schizaeaceae.

Genus—**Monosulcites** (Erdtman) Couper, 1953

Monosulcites sp. cf. **M. palisadus** Couper, 1953

Pl. 1, Fig. 5

1952—*Monosulcate* pollen grain, type G1, in Bose, p. 6; fig. 2 (10-11).

Description—Miospore bilateral, monocolpate, 40-45 μ in size, colpus extending 3/4 length of longer axis. Exine 1.5-2 μ thick, coarsely microgranulose.

Remarks—The type species of the genus *Monosulcites* has laevigate exine (COUPER, 1953).

Genus—**Couperipollis** Venkatachala & Kar, 1969

Couperipollis wodehousei (Biswas) Venkatachala & Kar, 1969

Pl. 1, Fig. 15; Pl. 2, Fig. 71

Affinity—Closely comparable to Palmae.

Distribution—Cherra Formation. Assam (Palaeocene).

Genus—**Palmaepollenites** Potonié, 1957

Palmaepollenites nadhamunii Venkatachala & Kar, 1969

Pl. 1, Fig. 16

Affinity—Palmae

Distribution—Madh Series (Palaeocene); Kakdi Formation (Lower Eocene), Kutch

Genus—**Liliacidites** Couper, 1953

Liliacidites magnus sp. nov.

Pl. 1, Fig. 41

Holotype—Pl. 1, Fig. 41; Slide no. 4271-3.

Type locality—Barmer Hill, Barmer, Rajasthan.

Diagnosis—Pollen grains bilateral, monosulcate, oval-elliptical, 70-80×45-50 μ, sulcus long, broad, elongate. Exine 1.5 μ thick, surface intramicroreticulate.

Comparison—*Liliacidites intermedius* Couper (1953) and *L. variegatus* Couper (1953) are comparable to the present species but differ mainly in their smaller size. *L. ellipticus* Venkatachala & Kar (1969) resembles the present species in intramicroreticulate exine but is distinguished by its smaller size. *L. baculatus* Venkatachala & Kar (1969) approximates the present species in size range but has baculate exine.

Affinity—Liliaceae.

Genus—**Longapertites** Hoeken-Klinkenberg, 1964

Longapertites sp. cf. **L. cuddalorense** Ramanujam, 1966

Pl. 1, Figs. 14, 22

Description—Pollen grains monocolpate, rounded oval, 25-40 μ in size, colpus narrow, running more than 2/3 along longer axis. Exine 2 μ thick, surface pitted.

Remarks—The present pollen grains resemble *L. cuddalorense* Ramanujam (1966) in having similar exine ornamentation but differ in being smaller in size.

Genus—**Cycadopites** Wodehouse ex Wilson & Webster, 1946

Cycadopites sp.

Pl. 1, Fig. 17

Description—Pollen grain monosulcate, small, 14×8 μ in size, sulcus equally broad at longitudinal ends, extending whole length, boat shaped. Exine scabrate.

Remarks—The present pollen grain differs from the known species of the genus by its very small size. But no specific assignment has been made as only one specimen is recovered.

Genus—**Proxapertites** (van der Hammen) van der Hammen, 1956

Proxapertites scabratus sp. nov.

Pl. 1, Fig. 18

1952—*Monosulcate* pollen grain, Type G2, in Bose, p. 6; fig. 2 (16-17).

Holotype—Pl. 1, Fig. 18; Slide no. 4277-8.

Type locality—Barmer Hill, Barmer, Rajasthan.

Diagnosis—Size 60×30 μ, amb oval to elliptical, flattened at poles dividing subequatorially into two equal boat-shaped halves. Exine 1 μ thick, scabrate.

Comparison—*Proxapertites scabratus* sp. nov. comes nearest to *P. crassimurus* (Sah & Dutta) comb. nov. in its shape and size but the former is distinguished by its scabrate exine. *P. operculatus* van der Hammen (1956) is bigger in size range and has psilate exine.

Remarks—Sah and Dutta (1966, p. 79; pl. 1, fig. 20) instituted *Schizosporis assamicus* which is morphologically similar to the type species of *Proxapertites*, viz., *P. operculatus* van der Hammen.

Proxapertites microreticulatus sp. nov.

Pl. 1, Figs. 19-21, 28

Holotype—Pl. 1, Fig. 19; Slide no. 4279-3

Type locality—Barmer Hill, Barmer, Rajasthan.

Diagnosis—Spores medium sized, equatorial diameter 40-60 μ, amb circular to subcircular or oval splitting into saucer-shaped halves. Exine 1-1.5 μ thick, intramicroreticulate.

Comparison—*P. microreticulatus* sp. nov. differs from all the known species of this genus by its characteristic intramicroreticulate exine. *P. crassimurus* (Sah & Dutta) comb. nov. is reticulate while *P. operculatus* van der Hammen (1956) is laevigate.

Proxapertites sp.

Pl. 2, Fig. 74

Description—Pollen grain oval, 96×68 μ, meshes uniform, fine, lumina 1-2 μ broad.

Comparison—*Proxapertites crassimurus* (Sah & Dutta) comb. nov, has coarser reticulation.

Genus—**Retitrescolpites** Sah, 1967

Retitrescolpites sp. cf. **R. decipiens** Sah, 1967

Pl. 2, Fig. 55

Description—Pollen grains tricolpate, colpus long, amb prolate-spheroidal, 25-30μ in diameter. Exine stratification retipilate, surface sculpture reticulate.

Remarks—The present specimens are morphologically similar to *R. decipiens* Sah (1967) but differ only in their smaller size.

Affinity—Oleaceae.

Genus—**Tricolpites** (Erdtman) Couper, 1953

Tricolpites minutus sp. nov.

Pl. 2, Figs. 54, 58

Holotype—Pl. 2, Fig. 54; Slide no. 4281-4

Type locality—Barmer Hill, Barmer, Rajasthan.

Diagnosis—Pollen grains tricolporoidate, spheroidal, 16-25 μ in diameter, prolate, sexine thicker than nexine, surface ornamented with warts, 0.5-1 μ in height.

Comparison—*Tricolpites levis* Sah & Dutta (1966) resembles the present species in size range but is distinguished by its laevigate-scabrate exine. *T. longicolpus* Sah & Dutta (1966) differs in having long colpi and laevigate exine. *Tricolpites* sp. 1 and sp. 2, described by VENKATACHALA and KAR (1969) have reticulate and intrabaculate exine respectively.

Affinity—Crucifereae.

Tricolpites reticulatus Cookson, 1947

Pl. 2, Fig. 62

Distribution—Palaeocene, Eocene.

Tricolpites baculatus sp. nov.

Pl. 1, Figs. 23-26; 34, 36; Pl. 2, Figs. 48, 61

Holotype—Pl. 1, Fig. 24; Slide no. 4279-8.

Type locality—Barmer Hill, Barmer, Rajasthan.

Diagnosis—Pollen grains tricolpate, sphaerical, 30-35μ, colpi long. Exine moderately thick, tegillate, surface baculate-spinose. Sculptural elements up to 3μ high.

Comparison—*Tricolpites baculatus* sp. nov. differs from *T. levis* Sah & Dutta (1966) and *T. longicolpus* Sah & Dutta (966) in having baculate-spinose ornamentation.

Tricolpites sp.

Pl. 2, Fig. 47

Description—Pollen grain in polar view 20µ, tricolpate, colpi long. Exine 2µ thick, faintly scrobiculate.

Comparison—*Tricolpites baculatus* sp. nov. has baculate sculptural elements.

Genus—**Araliaceoipollenites** Potonié, 1951

Araliaceoipollenites baculatus sp. nov.

Pl. 1, Figs. 37-38

Holotype—Pl. 1, Fig. 37; Slide no. 4286-1.

Type locality—Barmer Hill, Barmer, Rajasthan.

Diagnosis—Pollen grains tricolporate, 37-43µ, amb ovoid-rhomboidal, colpi long, or circular-lalongate. Exine thick, sexine as thick as nexine, surface baculate, bacula up to 5µ high.

Comparison—*Araliaceoipollenites matanamadhensis* Venkatachala & Kar (1969) resembles the present species in shape and size range but the former is distinguished by its laevigate and fine intramicroreticulate structure.

Affinity—Araliaceae.

Araliaceoipollenites matanamadhensis Venkatachala & Kar, 1969

Pl. 1, Figs. 39-40

Distribution—Kakdi Formation (Lower Eocene).

Genus—**Striacolporites** Sah & Kar, 1970

Striacolporites striatus Sah & Kar, 1970

Pl. 1, Figs. 29-30

Affinity—Solanaceae, Nolanaceae and Scrophulariaceae.

Distribution—Kakdi Formation, Kutch (Lower Eocene).

Genus—**Nyssoidites** Potonié, Thomson & Thiergart, 1937

Nyssoidites (**Nyssa**) **ingentipollinus** (Traverse) Potonié, 1960

Pl. 2, Fig. 42

1952—*Tricolporate* pollen grain, Types B_3-B_4, in Bose, p. 4; fig. 2 (5-6).

Size Range—30-45 µ.

Affinity—?Nyssaceae.

Distribution—Cherra Formation, Assam (Palaeocene); Kakdi Formation, Kutch (Lower Eocene).

Genus—**Nyssapollenites** Thiergart, 1937

Nyssapollenites sp. cf. **N. thompsonianus** (Traverse) Potonié, 1960.

Pl. 2, Fig. 45

Description—Pollen grains sub-triangular in polar view, 29µ, sides convex, tricolporate, colpi deep, wider at equator than poles, pores well defined. Sexine thicker than nexine, columellate; exine ornamentation obscure.

Remarks—The present specimen differs from *N. thompsonianus* (Traverse) Potonié (1960) in its obscure exine ornamentation. SAH (1967, p. 83) transferred *Nyassa thompsoniana* of TRAVERSE (1955, p. 62) to *Nyssapollenites* as new combination but POTONIÉ (1960, p. 104) has priority over the former and hence has been retained.

Affinity—Nyssaceae.

Distribution—Cherra Formation, Assam (Palaeocene); Kakdi Formation, Kutch (Lower Eocene).

Genus—**Compositoipollenites** Potonié, 1951

Compositoipollenites argutus Sah, 1967

Pl. 2, Figs. 56-57

1952—*Polyporate* pollen grain, Type F_1, in Bose, p. 6; fig. 2 (12)

Affinity—Compositeae.

Distribution—Upper Neogene, Congo.

Genus—**Triorites** (Erdtman) Couper, 1953

Triorites sp.

Pl. 2, Fig. 82

1949—Angiospermic pollen grain, in Bose, p. 2; fig. 4.

1952—*Triorate* pollen grain, Type A_2, in Bose, p. 4; fig. 2 (13).

Description—Pollen grains large, 40-45 μ, triangular; sides convex, 3 porate, pore 10-12 μ broad. Exine 3 μ thick, tapering towards apertures, forming a thick collar around the aperture, surface microreticulate.

Affinity—Onagraceae.

Genus—**Proteacidites** (Cookson) Couper, 1953

Proteacidites subscabratus Couper, 1960

Pl. 2, Fig. 49

Affinity—Proteaceae.

Distribution—Kakdi Formation, Kutch (Lower Eocene).

Genus—**Extratriporopollenites** Pflug, 1953

Extratriporopollenites sp.

Pl. 2, Fig. 83

Description—Pollen grains 3-porate, pore canal tubular, 20 μ long, ora not distinctly seen; amb triangular, 43 μ, sides complex, tapering towards pores. Exine surface microreticulate.

Remarks—The specimen reported here is the first of its kind found in India.

Genus—**Tetrapollis** Pflug, 1953

Tetrapollis sp.

Pl. 2, Fig. 50

Description—Pollen grains quadrangular, 22 μ, 4-porate, pores not very clear. Exine thin, ornamentation obscure.

Genus—**Polyporina** (Naumova) Potonié, 1960

Polyporina sp.

Pl. 2, Figs. 52-53

Description—Pollen grain polyporate, amb circular, 25 μ, foramina 20-24, pores 12 μ, sexine 1 μ thick, nexine microgranulose.

Affinity—Chenopodiaceae-Amaranthaecae.

Genus—**Quercoidites** Potonié, Thomson, & Thiergart, 1950

Quercoidites sp. A

Pl. 2, Fig. 63

Description—Pollen grain tricolpate, spindle shaped, 20 × 10 μ, colpi long, extending from one pole to another, margo prominent. Exine scabrate.

Remarks—The small size of the pollen grain and long colpi with margo supports its inclusion under the genus *Quercoidites*.

Affinity—Fagaceae (probably *Quercus*).

Quercoidites sp. B

Pl. 2, Figs. 64-65

Description—Pollen grain oval, 28 × 22 μ, tricolpate, colpi long, almost extending from one end to another. Exine ± finely scrobiculate.

Comparison—*Quercoidites* sp. A resembles the present species in shape but is distinguished by its smaller size and scabrate exine.

Genus—**Cupanieidites** Cookson & Pike, 1954

Cupanieidites granulatus sp. nov.

Pl. 2, Fig. 44

1966—*Cupanieidites* sp. Srivastava; pl. 7, fig. 20, p. 533.

Holotype—Pl. 2, Fig. 44; Slide no. 4283-5.

Type locality—Barmer Hill, Barmer, Rajasthan.

Diagnosis—Pollen grain tricolporate, angulaperturate, syncolpate, triangular 18-25 μ, sides slightly convex. Exine infragranulose.

Affinity—Sapindaceae.

Genus—**Polygalacidites** Sah & Dutta, 1966

Polygalacidites sp. cf. **P. clarus** Sah & Dutta, 1966

Pl. 2, Fig. 51

Description—Pollen grain small, 20 µ, pentacolporate, synorate, colpi long, ora faint. Exine thin, smooth.

Remarks—The present specimen compares very closely to *P. clarus* Sah & Dutta (1966).

Affinity—Polygalaceae.

Genus—**Salixipollenites** Srivastava, 1966

Salixipollenites trochuensis Srivastava, 1966

Pl. 2, Fig. 59

Affinity—Salicaceae.

Distribution—Cherra Formation, Assam (Palaeocene).

Salixipollenites sp.

Pl. 2, Fig. 60

Description—Pollen grain 30 µ, tricolpate, trilobed, isodiametric, slightly elongate, colpi long and tapering, no marginal thickening. Exine thin, scrobiculate.

Comparison—The present specimen is distinguished from *Salixipollenites trochnensis* Srivastava (1966) by its fine scrobiculate structure.

Affinity—*Salix* (Family-Salicaceae).

Genus—**Momipites** Wodehouse, 1933

Momipites sp.

Pl. 2, Fig. 66

Description—Pollen grain 32 µ, 3-porate; exine finely sculptured, nexine thicker than sexine, more conspicuous below ora.

Remarks—It resembles *M. tenuipolus* Anderson (1960) but due to its rare presence, no specific identification has been made.

Affinity—Ulmaceae or Juglandaceae.

Genus—**Rhoipites** Wodehouse, 1933

Rhoipites bradleyi Wodehouse, 1933

Pl. 1, Fig. 33

Affinity—Anacardiaceae.

Distribution—Lower Tertiary.

Genus—**Polycolpites** Couper, 1953

Polycolpites barmerensis sp. nov.

Pl. 2, Fig. 68

1952—*Heptacolpate* pollen grain, Type E_1, in Bose, p. 6; fig. 2 (14).
Holotype—Pl. 2, Fig. 68; Slide no. 4292-4.
Type locality—Barmer Hill, Barmer, Rajasthan.

Diagnosis—Pollen grains isopolar, 7-8 zoni-colpate, equatorial diameter 35-45 μ, brevicolpate. Exine 6 μ thick, pitted-scrobiculate, differentially thickened, thicker around periphery.

Comparison—*Polycolpites barmerensis* sp. nov. compares closely to *P. vimalii* Sah & Dutta (1966) in its most of the features but differs in possessing pitted-scrobiculate exine ornamentation.

Affinity—Polygalaceae (comparable to *Diclidanthus elliptica* Erdtman, 1947, p. 332).

Genus—**Hexacolpites** Couper, 1953

Hexacolpites sp.

Pl. 2, Fig. 69

Description—Pollen grain isopolar, prolate, 6-zoni-colpate, equatorial diameter 36 μ, amb rounded, brevicolpate, rims not thick, ends blunt. Exine 2 μ thick, collumellate, surface microgranulose.

Comparison—The present species is distinguished by its short colpi and microgranulose ornamentation.

Genus—**Polybrevicolporites** Venkatachala & Kar, 1969

Polybrevicolporites sp.

Pl. 2, Fig. 70

Description—Pollen grains subcircular, 30-44 μ; 5-6 colporate, brevicolporate, pore indistinct. Exine thick, scrobiculate.

Comparison—*Polybrevicolporites cephalus* Venkatachala & Kar (1969) is usually penta-colporate and pores are distinct. In the present species pores are not well defined.

Genus—**Sapotaceoidipollenites** Potonié, Thomson & Thiergart, 1950

Sapotaceoidipollenites sp.

Pl. 1, Fig. 32

Description—Pollen grain elliptical, 34×26 μ. Tricolporate, pore distinct. Exine 2 μ thick, ±laevigate.

Fungal spores

Genus—**Fusiformisporites** (Rouse) Elsik, 1968

Fusiformisporites sp.

Pl. 2, Fig. 77

Description—Fusiform, inaperturate, dicellate fungal spores, 76 × 40 μ, wall 0.5 μ thick, striae thin, occasionally open, apices thickened, smooth, septum two layered.

Remarks—The present specimen comes very close to *Fusiformisporites* sp. described by Elsik (1968, pl. 2, fig. 11; p. 272) from Palaeocene of Texas, but differs in being much bigger in size.

Genus—**Phragmothyrites** Edwards, 1922

Phragmothyrites sp. cf. **P. eocaenicus** Edwards, 1922

Pl. 2, Fig. 78

Description—Perithecium 60 μ, middle region ruptured. Hyphae radially arranged to form pseudoreticulate pattern, outer cells may be slightly setose.

Genus—**Dicellaesporites** Elsik, 1968

Dicellaesporites sp.

Pl. 2, Fig. 67

Description—Fungal spore, uniseptate, 24 μ, laevigate, no aperture observed, constricted in middle.

Comparison—*Dicellaesporites popovii* Elsik (1968) resembles the present specimen in size but the latter is distinguished by its constriction at the septal region.

Genus—**Monoporisporites** (van der Hammen) Elsik, 1968

Monoporisporites sp.

Pl. 2, Figs. 72, 73, 76

Description—Oval fungal spore, with a distinct pore at margin, 30 × 22 μ, pore distinct, slightly protruding.

Comparison—*Monoporisporites koenigii* Elsik (1968) resembles the present species in size but is differentiated by its ill-developed, small pore.

Genus—**Diporicellaesporites** Elsik, 1968

Diporicellaesporites stacyi Elsik, 1968

Pl. 2, Fig. 80

Diporicellaesporites sp.

Pl. 2, Fig. 79

Description—Multicellate, psilate, cylindrical fungal spore; biporate, pore at each end.

Comparison—*Diporicellaesporites stacyi* Elsik (1968) is tetracellate and thus can easily be distinguished from the present specimen.

INCERTAE SEDIS

Spore type-1

Pl. 2, Fig. 81

Description—Spore subtriangular, 40 μ. Trilete open. Exine 2.5 μ thick, laevigate.
Remarks—Only a solitary specimen has been recovered.

Fungal spore type-1

Pl. 2, Fig. 75

Description—Spore with radiating processes, 19 μ. Monoporate, pore distinct, laevigate.

CONCLUSION

The fossil spore and pollen assemblage obtained from the restudied Barmer clay sample consists of 22 recognized species. About an equal number of types could be identified only up to the generic level because of their extreme rarity. The palynological assemblage chiefly comprises angiospermous pollen, pteridophytic spores and fungal remains. An assemblage count of 1000 grains showed the dominance of both the species of *Proxapertites*, *P. scabratus* and *P. microreticulatus*. Amongst the angiosperms the other prominent taxa in the order of abundance, are: *Tricolpites baculatus*, *T. minutus*, *Araliaceoipollenies baculatus* *A. matanamadhensis*, *Palmaepollenites nadhamunii* and *Couperipollis wodehousei*. The remaining angiosperm taxa are either very rare or have not been observed in the count. Fern spores are comparatively rare. Only four recognized pteridophytic species figure in the count. These are: *Cyathidites australis*, *C. minor*, *Trilites tuberculiformis* and *Seniasporites verru osus*. Surprisingly, not a single species of *Dandotiaspora*, a well known Lower Tertiary form, could be observed in the assemblage. The fungal remains are generally represented by *Phragmothyrites*, *Dicellaesporites* and *Diporicellaesporites*. The present palynological assemblage is characterized by the dominance of *Proxapertites*, general paucity of spore species, complete absence of gymnospermous and other elements. A perusal of the palynological literature shows that although the Barmer assemblage has distinctiveness of its own, it compares nearest to the Palaeocene assemblages than with any other Upper Cretaceous or Eocene assemblages of the world.

The genus *Proxapertites* has shown a consistent vertical distribution throughout the world and seems to attain its peak period during the Palaeocene. *Proxapertites operculatus* forms the dominant and characteristic species of the Palaeocene Lisama Formation of Columbia (VAN DER HAMMEN, 1954, 1956, 1957). Similary, MULLER (1968) has also identified the same *Proxapertites operculatus* Zone for the Palaeocene of Venezuela and Malaysia. From India, BAKSI (MS.) has established a *Proxapertites* Zone for the Palaeocene of Assam and its equivalent in Bengal basin, earlier designated as Bengal Palynological Assemblage Zone II (BAKSI, 1971). VENKATACHALA and RAWAT (1971) have established *Proxapertites hammenii* Zone for the Palaeocene interval of the Cauvery basin, South India.

The other significant angiosperm taxa like *Araliaceoipollenites baculatus*, *A. matanamadhensis*, *Tricolpites baculatus*, *T. minutus*, *Palmaepollenites nadhamunii* are Palaeocene—Lower Eocene forms.

A rich palynological assemblage is known from the Lathi Formation of Jaisalmer

(SRIVASTAVA, 1966). This assemblage comprises fern spores, abundant gymnosperms-like, *Callialasporites, Ginkgocycadophytus, Podocarpidites, Classopollis* and no angiosperms. The homotaxiality of the Barmer Sandstone with Lathi Sandstone, on the basis of lithology alone is, therefore, not supported by palynological evidence.

On the other hand, the relative abundance of *Proxapertites, Tricolpites reticulatus, T. baculatus, Palmaepollenites nadhamunii, Araliaceoipollenites baculatus,* and *A. matanamadhenis* together with the rarity of forms like *Proteacidites, Extratriporopollenites* and *Triorites* (*Epilobium*-type) is in favour of a Palaeocene dating for the Barmer clay horizon. Since this clay horizon is at a lower stratigraphic level than the Barmer Sandstone, it is reasonable to assume that the age of the latter cannot be older than the Palaeocene. The Barmer Sandstone underlies the nummulitic limestone and Fuller's earth horizons of Bikaner area and hence the former cannot be younger than the Lower Eocene nummulitic beds.

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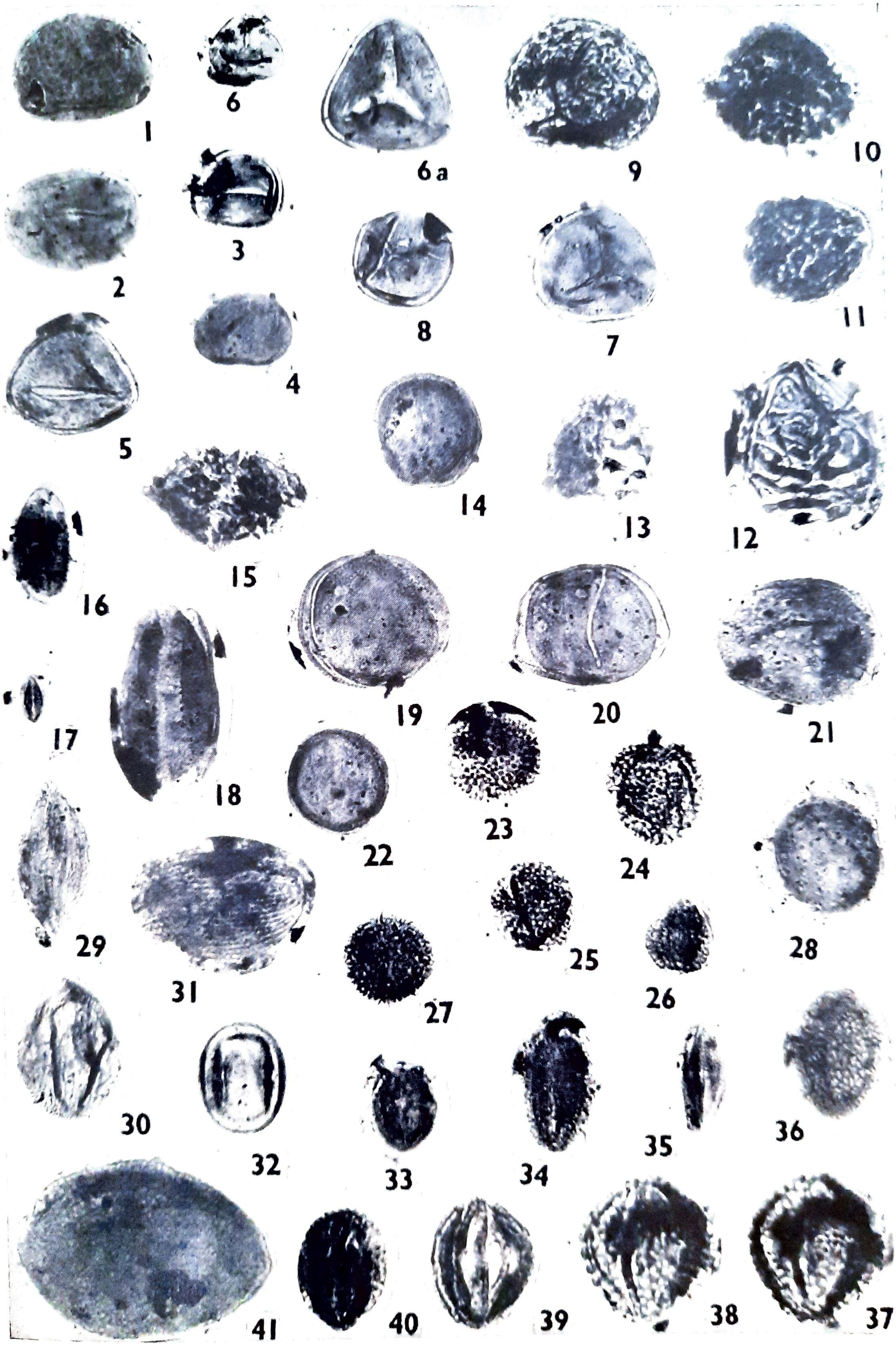
EXPLANATION OF PLATES

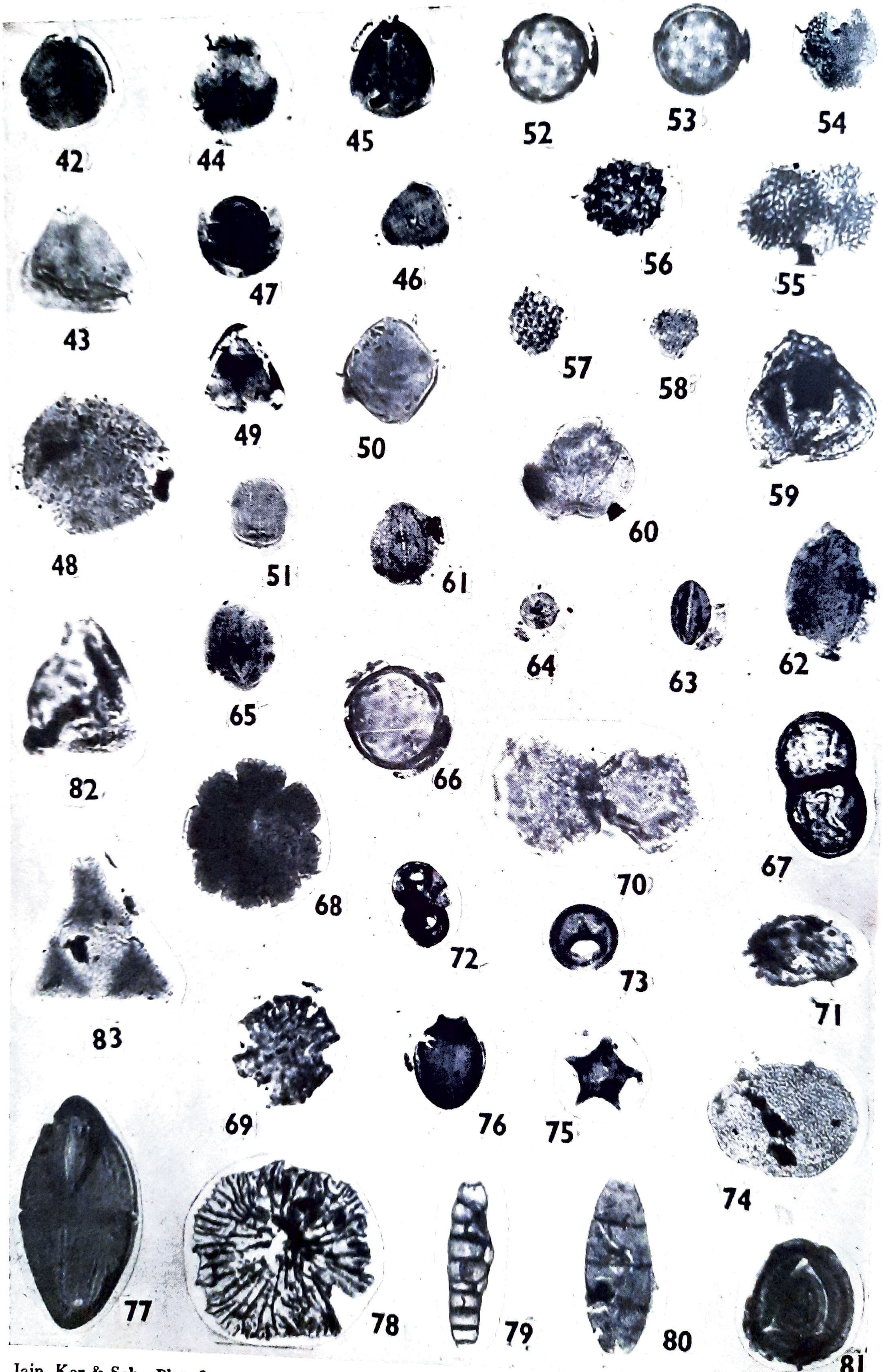
(All microphotographs are enlarged *ca* × 500)

PLATE-1

1. *Seniasporites verrucosus* Sah & Kar, Slide no. 4287/2.
2-4. *Monolites* sp. cf. *M. ovatus Sah*, Slide nos. 4283/9, 4281/33, 4277/6.
5. *Monosulcites* sp. cf. *M. palisadus* Couper, Slide no. 4285/13.
6, 7-8. *Cyathidites minor* Couper, Slide nos. 4283/18, 4286/2, 4289/1.
6a. *Cyathidites australis* Couper, Slide no. 4286/3.
9. *Corrugatisporites* sp., Slide no. 4277/18.
10-11. *Trilites tuberculiformis* Cookson, Slide nos. 4286/2, 4282/1.



 Jain, Kar & Sah—Plate 1



Jain, Kar & Sah—Plate 2

12. *Cicatricosisporites* sp. A, Slide no. 4286/4.
13. *Cicatricosisporites* sp. B, Slide no. 4283/1.
14, 22. *Longapertites* sp. cf. *L. cuddalorense* Ramanujam, Slide nos. 4277/2, 4287/9.
15. *Couperipollis wodehousei* (Biswas) Venkatachala & Kar, Slide no. 4288/1.
16. *Palmaepollenites nadhamunii* Venkatachala & Kar, Slide no. 4272/7.
17. *Cycadopites* sp., Slide no. 4288/3.
18. *Proxapertites scabratus* sp. nov., Slide no. 4277/8.
19-21, 28. *Proxapertites microreticulatus* sp. nov., Slide nos. 4279/3, 4275/1, 4276/1, 4279/2.
23-26, 34, 36. *Tricolpites baculatus* sp. nov., Slide nos. 4279/8, 4275/3, 4277/2, 4278/3, 4281/40.
27 *Nymphaeacidites* sp., Slide no. 4284/27.
29-30. *Striacolporites striatus* Sah & Kar, Slide nos. 4281/37, 4282/25.
31. *Schizacoisporites* sp., Slide no. 4286/3.
32. *Sapotaceoidipollenites* sp., Slide no. 4278/7.
33. *Rhoipites bradleyi* Wodehouse, Slide no. 4282/24.
35. *Tricolpopollenites* sp., Slide no. 4281/46.
37-38. *Araliaceoipollenites baculatus* sp. nov., Slide no. 4286/1.
39-40. *Araliaceoipollenites matanamadhensis* Venkatachala & Kar, Slide nos. 4283/1, 4282/24.
41. *Liliacidites magnus* sp. nov., Slide no. 4271/3.

PLATE 2

42. *Nyssoidites (Nyssa) ingentipollinius* (Traverse) Potonié, Slide no. 4291/1.
43. *Nyssoidites* sp., Slide no. 4281/18.
44. *Cupanieidites granulatus* sp. nov., Slide no. 4283/5.
45. *Nyssapollenites* sp. cf. *N. thompsonianus* (Traverse) Potonié, Slide no. 4274/10.
46. *Nyssapollenites* sp., Slide no. 4283/16.
47. *Tricolpites* sp., Slide no. 4286/11.
48, 61. *Tricolpites baculatus* sp. nov., Slide no. 4271/2.
49. *Proteacidites subscabratus* Couper, Slide no. 4276/11.
50. *Tetrapollis* sp., Slide no. 4281/2.
51. *Polygalacidites* sp. cf. *P. clarus* Sah & Dutta, Slide no. 4279/3.
52-53. *Polyporina* sp., Slide no. 4289/24.
54, 58. *Tricolpites minutus* sp. nov., Slide nos. 4281/4, 4293/4.
55. *Rettrescolpites* sp. cf. *R. decipiens* Sah, Slide no. 4287/3.
56-57. *Compositoipollenites argutus* Sah, Slide nos. 4281/9, 4272/15.
59. *Salixipollenites trochunsis* Srivastava, Slide no. 4282/10.
60. *Salixipollenites* sp., Slide no. 4285/4.
62. *Tricolpites reticulatus* Cookson, Slide no. 4290/2.
63. *Quercoidites* sp. A, Slide no. 4279/5.
64-65. *Quercoidites* sp. B, Slide nos. 4277/15, 4284/17.
66. *Momipites* sp., Slide no. 4286/10.
67. *Dicellaesporites* sp., Slide no. 4273/10.
68. *Polycolpites barmerensis* sp. nov., Slide no. 4292/4.
69. *Hexacolpites* sp., Slide no. 4277/4.
70. *Polybrevicolporites* sp., Slide no. 4280/17.
71. *Couperipollis wodehousei* (Biswas) Venkatachala & Kar, Slide no. 4272/1.
72-73, 76. *Monoporisporites* sp., Slide nos. 4295/2, 4284/3.
74. *Proxapertites* sp., Slide no. 4282/2.
75. Fungal spore type 1, Slide no. 4271/3.
77. *Fusiformisporites* sp., Slide no. 4285/1.
78. *Phragmothyrites* sp. cf. *P. eocaenicus* Edwards, Slide no. 4294/8.
79. *Diporicellaesporites* sp., Slide no. 4283/18.
80. *Diporicellaesporites stacyi* Elsik, Slide no. 4282/17.
81. Spore type -1, Slide no. 4276/4.
82. *Triorites* sp., Slide no. 4284/1.
83. *Extratriporopollenites* sp., Slide no. 4281/10.