A LOWER JURASSIC MIOSPORE ASSEMBLAGE FROM THE VARIEGATED SHALE, NAMMAL GORGE, SALT RANGE (WEST PAKISTAN)

K. P. JAIN & S. C. D. SAH
Birbal Sahni Institute of Palaeobotany, Lucknow

ABSTRACT

Present communication deals mainly with the morphological and taxonomical revision of the miospores previously recorded and described by Sah (1955) from the variegated shale sample, collected from Nammal Gorge, Salt Range, W. Pakistan. Apart from its botanical considerations, the spore-pollen assemblage has also been chronologically valued. It has been concluded on the miospores evidence that the Variegated Stage is older than the Rajmahal Intertrappean Series.

INTRODUCTION

OUR knowledge of plant fossils from the Variegated Stage is very meagre. Sitholey (1949) for the first time reported *Protopteris nammalensis*, a cyatheaceous tree fern from this stage. Later Sah (1955) and Sah and Jain (1968) described some plant micro- and megaspores respectively from the same horizon. The present study is the result of remaceration of the type material (for details of location and sample, see SAH, 1955, p. 60 and SAH & JAIN, 1968, p.288). The artificial system of classification by Potonié (1956, 1958 & 1960) has been followed here for the systematic description.

SYSTEMATIC DESCRIPTION

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

Genus — *Todisporites* Coup., 1958

Todisporites major Coup., 1958

Pl. 1, Figs. 1-2

1955 *Leiotriletes* Type 7; in Sah, p. 62; pl. 1, fig. 10.

Remarks — Spores of *Todites goeppertianus* (Munst.) Krass. described by Harris (1931) from the Rhaetic — Liassic of Greenland show close similarity with the present miospores.

Distribution — Lower Triassic to Middle Jurassic (COUPER, 1958; p. 134).

Genus — *Divisisporites* (Thoms., in Thoms. & Pflug) Pot., 1956

Divisisporites nammalensis sp. nov.

Pl. 1, Figs. 3-4

Holotype — Pl. 1, Fig. 4; Reg. No. 6403; Sl. No. 3044-9.

Type Locality — Variegated Stage, Nammal Gorge, Salt Range, W. Pakistan.

Horizon — Lower Jurassic.

Diagnosis — Miospores trilete, amb broadly triangular, measuring 50-55 μ in diameter; apices obtusely rounded; sides slightly convex; Y-mark distinct, reaching 3/4 or some times upto spore margin, laesura flanked by faint margo, ray ends bifurcated; exine 1-1·5 μ thick, scabrate; distal folds prominent.

Comparison — *Divisisporites nammalensis* sp. nov. differs from *D. ovalis* Sah & Jain (1965) and other species of the genus in its bigger size, folded distal exine and broadly triangular shape.

Genus — *Spongiosisporis* Krutzsch, 1959

Spongiosisporis obovata (Rogalska) comb. nov.

Pl. 1, Figs. 5-7

1954 *Clathropteris obovata* var. *magna* Tur.-Ket., in Rogalska, p. 11; pl. 3, figs. 3-5.
1955 *Leiotriletes* Type 5, in Sah; p. 62; pl. 1, fig. 5.
1956 *Clathropteris obovata* var. *magna* Tur.-Ket., in Rogalska, p. 15; pl. 5, fig. 1.
1958 *Concavisporites crassexinius* Nilsson, p. 35; pl. 1, fig. 11.
1963 *Concavisporites* Type A, B & C, in Saad, p. 120; pl. 33, figs. 9-15.

Description — Miospores toriate, amb triangular, measuring 35-45 μ along the equatorial diameter. Y-mark distinct, laesura reaching upto the spore body. Tori prominent and of full fold filled type. Exine 2-3 μ thick, laevigate.

Comparison — *Spongiosisporis obovata* (Rogalska) comb. nov. differs from the known species of the genus in having a laevigate exine.

Remarks — Similar spores have been reported to occur in *Thaumatopteris schenki* Nathorst (HARRIS, 1931, p. 93; PL. 18, FIG. 1).

Genus — *Dictyophyllidites* (Coup.) Dettm. 1963

Dictyophyllidites equiexinus (Coup.) Dettm., 1963

Pl. 1, Figs. 8-9

1954 *Sporites adriennis* Potonié f. *mesozoicus* Thierg. in Rogalska, p. 11; pl. 2, figs. 7-8; pl. 3, figs. 1-2.

1955 *Leiotriletes* Type 9, in Sah; p. 63; pl. 1, fig. 23.

Distribution — Liassic to Lower Cretaceous.

Dictyophyllidites sp.

Pl. 1, Fig. 28

Description — Miospore trilete. Amb triangular, angles rounded, sides striaght to slightly convex and measuring 60 μ in equatorial diameter. Y-mark distinct, reaching 3/4 of the spore radius, laesura slightly sinuous, bordered by weakly thickened margins, enclosed within the membraneous elevated lips. Exine smooth, 1-1·5 μ thick.

Remarks — This particular spore shows its closest resemblance with the spores of *Dictyophyllum muensteri* (Göpp.) Nath. described by Harris (1931, p. 86) from the Liassic of Greenland.

Genus — *Cosmosporites* Nilsson, 1958

Cosmosporites sp.

Pl. 1, Fig. 27

Description — Miospore trilete. Amb triangular, measuring 16-20 μ in diameter. Y-mark distinct, reaching almost upto the equator. Exine 2-2·5 μ thick, distally thickened at the angles, surface smooth.

Remarks — Only two miospores of this type have been recorded and therefore no specific comparison is attempted.

Infraturma — *Auriculati* (Schoff) Dettm., 1963

Genus — *Matonisporites* (Coup.) Dettm., 1963

Matonisporites phlebopterioides Coup., 1958

Pl. 1, Figs. 10-14

1955 *Leiotriletes* Type 1, 2, 3 in Sah; p. 62; pl. 1, figs. 1-4 and 8-8a.

Remarks — Miospores only vary in size, measuring 40-50 μ in equatorial diameter.

Distribution — Liassic to Aptian (DETTMANN, 1963, p. 58).

Affinities — This miospore type has been recorded from the Mesozoic *Phlebopteris* and certain living species of *Dicksonia* L' Herit (BOLKHOVITINA, 1956; PL. 7, FIGS. 100c-d).

Infraturma — *Murornati* Pot. & Kr., 1954

Genus — *Staplinisporites* Pocock, 1962

Staplinisporites pocockii sp. nov.

Pl. 1, Figs. 15-18

Holotype — Pl. 1, Fig. 18; Reg. No. 2604; Sl. No. 3036-10.

Type Locality — Variegated Stage, Nammal Gorge, Salt Range, W. Pakistan.

Horizon — Lower Jurassic.

Diagnosis — Miospores trilete, amb broadly triangular, measuring 30-37×24-32 μ in size, apices obtusely rounded, inter-radial sides straight to sometimes slightly convex; Y-mark prominent, laesura reaching upto amb. Exine proximally thin and scabrate; distally ornamented with a single concentric and several radial bands of exinal thickenings. Concentric band separating a 10-13 μ wide equatorial zone. *Extrema lineamenta* sinuous.

Comparison — *Staplinisporites pocockii* sp. nov. differs from *S. caminus* (Balme) Pocock (1962) in having only a single concentric band of thickening and in the absence of central thickened granular boss.

Remarks — Rogalska (1956, p. 39; PL. 28, FIG. 5) described some spores as *Lycosporites* sp. from the Liassic beds of Poland which appear to be conformable to the spores of the form genus *Staplinisporites*.

Genus — *Lycopodiumsporites* Thierg., 1938

Lycopodiumsporites sp.

Pl. 1, Fig. 22

Description — Miospores trilete, spherical to ovoid in shape, 45 μ in diameter. Y-mark distinct, laesura ± reaching upto the margin, 28 μ long. Exine 2-3 μ thick, proximally smooth; distally reticulate, muri thick, 1-1·5 μ high, lacunae small, less than 0·5 μ in diameter. *Extrema lineamenta* sinuous.

Genus — *Tigrisporites* Kl., 1960

Tigrisporites minor sp. nov.

Pl. 1, Figs. 19-21

Holotype — Pl. 1, Fig. 20; Reg. No. 2604; Sl. No. 3047-7.

Locality — Variegated Stage, Nammal Gorge, Salt Range, W. Pakistan.

Horizon — Lower Jurassic.

Diagnosis — Miospores trilete. Amb broadly triangular to subtriangular, measuring 28-42 μ in equatorial diameter; Y-mark distinct, laesura reaching upto the periphery, straight to slightly wavy. Exine thin, proximally smooth; distally heavily ornamented with longer than broad, 2-4 μ high or sometimes fused rugae. Rugae surround a distal central granulose patch or boss, boss 12 μ in diameter. *Extrema lineamenta* sinuous.

Comparison — *Tigrisporites minor* sp. nov. differs from the type species *T. halleinis* Klaus (1960, p. 140) in its much smaller size and sometimes fused rugae.

Genus — *Ischyosporites* Balme, 1957

Ischyosporites sp.

Pl. 1, Fig. 26

Description—Miospore trilete. Amb broadly triangular measuring 48 μ in size. Y-mark distinct, laesura reaching 1/2 of the spore radius. Exine 2-3 μ thick, distally ornamented with thick, 3 μ high ridges which anastomose to form negative reticulum; proximal surface granulose, granules densely placed along the pyramic area to form a sort of thick margo.

Remarks — The specimen differs from all the other species of the genus *Ischyosporites* in having densely granulose pyramic area.

Infraturma — *Apiculati* (Benn. & Kidst.) Pot. 1956

Genus — *Osmundacidites* Coup., 1953

Osmundacidites sp.

Pl. 1, Fig. 23

1955 *Trachytriletes* type 1; in Sah; pl. 1, fig. 29.

Description — Miospore trilete. Amb oval to subcircular, measuring 42 μ in diameter. Y-mark prominent, laesura reaching upto the spore body. Exine thin, 0·5 μ thick, microgranulose.

Remarks — *Trachytriletes* Type 2 described by Sah (1955, p. 63; PL. 1, FIG. 24) from the same material shows its closest similarity with this spore than any other.

Genus — *Baculatisporites* Thoms. & Pflug, 1953

Baculatisporites sp.

Pl. 1, Figs. 24-25

Description — Miospore trilete, amb oval, 41 μ in diameter; Y-mark indistinct. Exine thickly sculptured with mixed baculae and verrucae.

Remarks — There being the only two specimens therefore, provisionally it has been placed under the genus *Baculatisporites* and no further attempt for specific identification has been made.

Turma — *Monoletes* Ibr., 1933
Subturma — *Azonomonoletes* Luber, 1935
Infraturma — *Psilamonoleti* Hamm., 1955

Genus — *Monolites* (Erdtm.) Pot., 1956

Monolites sp.

Pl. 1, Fig. 29

Description — Moispore monolete, broadly oval in shape, 75 × 96 μ in size. Monolete small, 40 μ in size, lips thin. Exine smooth. *Extrema lineamenta* smooth.

Remarks — The attached miospore shows its nearest resemblance with the spores of *Asterotheca meriani* Bharad. & Singh (1956), the dispersed spores of which have been assigned to the genus *Latosporites* Pot. & Kr. 1954.

Anteturma — *Pollenites* Pot., 1931
Turma — *Perinosaccati* Jain (1969)

Genus — *Perinopollenites* Coup. emend. Jain

1958 *Perinopollenites*, Couper, p. 152; pl. 27, figs. 9-11.
1961 *Applanopsis*, Döring, p. 112; pl. 16, figs. 9-15.

Emended diagnosis — Miospores monoporate, pore not always clearly seen, spherical; body circular, enveloped by a loose fitting cover or perinosaccus. Body exine and perinosaccus surface structured or sculptured.

Remarks — *Perinopollenites* (Coup.) can easily be distinguished from *Triangulopsis* Döring emend. Jain (1969) in having monoporate circular body and thin perinosaccus without a prominent crassitudo.

Genotype — *Perinopollenites elatoides* Couper, 1958; pl. 27, fig. 9; p. 152.

Perinopollenites elatoides (Couper) emend. Jain

Pl. 1, Figs. 30-34; Pl. 2, Figs. 35-36

1955 *Hymenozonotriletes* Naum., in Sah; p. 64; pl. 1, fig. 17.
1958 *Perinopollenites elatoides*, Couper, p. 152; pl. 27, figs. 9-11.
1958 *Zonalapollenites dampieri* Balme, in Lantz, p. 928; pl. 3, fig. 34.
1958 *Laricoidites triquetrus*, Lantz, p. 926; pl. 5, fig. 51.
1961 *Callialasporites monoalasporus*, Dev, p. 48; pl. 4, fig. 25.
1961 *Applanopsis dampieri*, Döring, p. 113; pl. 16, figs. 11-15.
1962 *Perinopollenites elatoides* Couper, in Pocock, p. 60; pl. 9, figs. 136-137.
1962 *Pflugipollenites dampieri* (Balme), Pocock, p. 72; pl. 12, figs. 183-184.
1964 *Tsugaepollenites dampieri* (Balme) Dettmann, in De Jersey; p. 12; pl. 7; fig. 8.
1964 *Perinopollenites elatoides* Couper, in Singh, p. 107; pl. 14, fig. 9.
1965 *Callialasporites monoalasporus* Dev in Sah & Jain, p. 276; pl. 4, figs. 95-96.
1965 *Applanopsis dampieri* (Balme) Döring 1961, in Goubin *et al.*, p. 227; pl. 1, figs. 1-5.
1965 *Applanopsis dampieri* (Balme) Döring 1961, in Goubin, p. 1420; pl. 1, figs. 1-2.
1966 *Callialasporites barragaonensis*, Srivastava, p. 94; pl. 5, fig. 1.

Emended Diagnosis — Miospores monoporate, pore not always seen, perinosaccate, spherical in shape, 30-70 μ in diameter; body circular, 15-55 μ in diameter, enveloped by perinosaccus. Exine smooth. Perinosaccus well developed without marginal thickenings, thin, expanded, extending upto 20 μ beyond the body margin, surface scabrate, radial folds prominent to sometimes absent.

Distribution — Liassic on wards (COUPER, 1958).

Affinity — Coniferae.

Remarks — *Simplicesporites granulosus* Leschik (1955, p. 35; PL. 5, FIG. 3) is doubtful for its being a zonate form but seems to be perinosaccate. Potonié (1958, p. 83) is also of the opinion that it is not zonate but saccate.

Perinopollenites segmentatus (Balme) comb. nov. Jain

Pl. 2, Figs. 37-38

1957 *Zonalapollenites segmentatus*, Balme, p. 33; pl. 9, figs. 93-94.
1958 *Zonalapollenites segmentatus* Balme, in Lantz, p. 925; pl. 4, figs. 41-42.
1963 *Callialasporites segmentatus* (Balme) Dev. in De Jersey, p. 9; pl. 3, fig. 6.
1964 *Perinopollenites elatoides* Couper, in De Jersey, p. 13; pl. 6, fig. 9.
1964 *Callialasporites segmentatus* (Balme) Srivastava, in Singh *et al.*, p. 297; pl. 7, fig. 92.
1965 *Callialasporites* (al. *Zonalapollenites*) *segmentatus* (Balme) Srivastava, in Sah & Jain, p. 276; pl. 3, figs. 77-78; pl. 4, figs. 90, 93, 94.
1966 *Callialasporites jaisalmerensis*, Srivastava, p. 94; pl. 4, fig. 6.

Emended Diagnosis — Miospores monoporate, spherical, 35-50 μ in diameter, body circular, 30-40 μ in diameter, enveloped by thin perinosaccus without crassitudo. Perinosaccus surface scabrate, extending 4-8 μ beyond the body, folds irregular. Body exine smooth.

Comparison — *Perinopollenites segmentatus* (Balme) comb. nov. differs from *P. elatoides* (Coup.) in having less expanded perinosaccus beyond the body and its much convoluted nature with irregular folds.

Perinopollenites dubius sp. nov., Jain

Pl. 2, Fig. 39

Holotype — Pl. 2, Fig. 39; Reg. No. 2604; Sl. No. 3022-1.

Locality — Variegated Shale, Nammal Gorge, Salt Range, W. Pakistan.

Horizon — Lower Jurassic.

Diagnosis — Miospores monoporate, pore not always clearly seen, spherical in outline measuring 60 μ in diameter; body triangular 30-35×50-55 μ in size, enveloped by well developed perinosaccus, extending 20 μ beyond the body, surface scabrate. Body exine smooth.

Comparison — *Perinopollenites dubius* sp. nov. Jain differs from all the species of the genus in having a broad perinosaccus with a triangular body. The miospores possess features of both *Triangulopsis* (Döring) Jain (1969) and *Perinopollenites* (Couper) Jain but most of the features favour their placement under the genus *Perinopollenites* at the present moment.

Perinopollenites microreticulatus sp. nov. Jain

Pl. 2, Figs. 40-42

1956 ? *Sporites* sp. (Type 13/a), in Góczán, p. 187; pl. 9, fig. 9.

Holotype — Pl. 2, Fig. 42; Reg. No. 2604; Sl. No. 3050-11.

Locality — Variegated shale, Nammal Gorge, Salt Range, W. Pakistan.

Horizon — Lower Jurassic.

Diagnosis — Miospores probably monoporate, small, 30-40 μ in diameter; body 15-25 μ in diameter, distinct from outer covering (Perinosaccus). Body exine scabrate. Perinosaccus extending upto 20 μ beyond the body margin, surface intra-microreticulate.

Comparison — *P. microreticulatus* sp. nov. Jain differs from all other species of the genus in having smaller size with ornamented body and perinosaccus.

Turma — *Aletes* Ibr., 1933
Subturma — *Azonaletes* (Luber) Pot. & Kr., 1954
Infraturma — *Granulonapiti* Cooks., 1947

Genus — *Araucariacites* Cooks., 1947

Araucariacites australis Cooks., 1947

Pl. 3, Figs. 43-44

1954 cf. *Agathis ovata* Warbg., in Rogalska, p. 17; pl. 8, fig. 1.

1956 cf. *Agathis ovata* Warbg., in Rogalska; p. 28; pl. 13, figs. 1-4.

Distribution — Jurassic to Tertiary.

Remarks — *Chasmatosporites rimatus* Nilsson (1958, p. 55; PL. 4; FIGS. 1-2) has been described as a monolete spore, but from its photograph it seems doubtful.

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

Genus — *Alisporites* (Daugh.) Nilsson, 1958

Alisporites sp.

Pl. 2, Fig. 45

Description — Pollen grains disaccate, 64×56 μ in size; body indistinct; bladders well develped, longer than broad, surface microreticulate.

Infraturma — *Podocarpoiditi* Pot., Thoms. & Thierg., 1950

Genus — *Podocarpidites* (Cooks.) Pot., 1958

Podocarpidites typicus Sah & Jain, 1965

Pl. 2, Figs. 46 & 49

Remarks — The Variegated shale specimens are indistinguishable from *P. typicus* in its morphological features but they extend the body and overall size range upto 40 μ and 40 μ×50 μ respectively.

Podocarpidites sp. A

Pl. 2, Figs. 50-51

Description — Pollen grains disaccate, 60×48 μ in size; body and bladder measuring 45-30 μ and 20×48 μ respectively. Furrow 16 μ broad, folds along the wing attachment with the body prominent. Body rim present. Exine microreticulate. Bladder surface reticulate.

Remarks — Some of the disaccate forms described by Sah and Jain (1965) from the Rajmahal Intertrappean beds and by Srivastava (1966) from Jaisalmer are comparable.

Podocarpidites cf. *P. novus* Sah & Jain, 1965

Pl. 2, Figs. 47-48 & 52

Remarks — The variegated shale specimens differ from *P. novus* only in having wings of two different size. Otherwise are indistinguishable from it.

Subturma — *Polysaccites* Cooks., 1947

Genus — *Podosporites* Rao, 1943

Podosporites tripakshi Rao, 1943

Pl. 2, Figs. 53-54

1955 *Trisaccus*, in Sah, p. 65; pl. 1, fig. 26.

Turma — *Eupollenites* Kl., 1960
Subturma — *Operculati* Venkat. & Góczán, 1964

Genus — *Classopollis* (Pflug) Pocock & Janson., 1961

Classopollis classoides (Pflug) Pocock & Janson., 1961

Pl. 2, Figs. 55-59

1955 *Liratoaletes* Type 1-2, in Sah; p. 65; pl. 1, figs. 11, 11a.
Striatoaletes Type 1, in Sah; p. 64; pl. 1, fig. 18.
Stenozonotriletes Naum., in Sah; p. 64; pl. 1, fig. 27.
Trachyaletes Type 1, in Sah; p. 64; pl. 1, fig. 25.
Azonomonoletes Type 2, in Sah; p. 64; pl. 1, fig. 30.

Genus — *Gliscopollis* Venkat., 1966

Gliscopollis meyeriana (Kl.) Venkat., 1966

Pl. 2, Figs. 60-64

Gliscopollis nammalensis sp. nov.

Pl. 2, Figs. 65-67 & 79

Holotype — Pl. 2, Fig. 65; Reg. No. 2604; Sl. No. 3026-10.

Locality — Variegated shale, Nammal Gorge, Salt Range, W. Pakistan.

Horizon — Lower Jurassic.

Diagnosis — Miospores probably monoporate, trilete faintly discernable. Pollen grains circular, small, 20-28 μ in diameter. Distally exine thins out forming the operculum. Exine 1-1·5 μ thick, radial striations prominent along the margin, rest of the surface punctate.

Comparison — *Gliscopollis nammalensis* sp. nov. differs from other species of the genus in having wide tinuitus or weakened area separating the operculum and less prominent pore and trilete.

Turma — *Aletes* Ibr., 1933
Subturma — *Azonoletes* (Luber) Pot. & Kr., 1954

Genus — *Spheripollenites* Coup., 1958

Spheripollenites subgranulosus Coup., 1958

Pl. 2, Figs. 68-71 & 80-81

Remarks — Size range of our specimens 18-25 μ.

Affinity — Probably taxaceae (COUPER, 1958, p. 159).

Turma — *Praecolpates* Pot. & Kr., 1954

Genus — *Eucommiidites* (Erdtm.) Hughes, 1961

Eucommiidites troedssonii (Erdtm.) Hughes, 1961

Pl. 2, Figs. 72-76

Turma — *Monocolpates* Ivers. & Tr. Smith, 1950
Subturma — *Intortes* (Naum.) Pot., 1958

Genus — *Cycadopites* Wodeh. ex Wils. & Webest., 1956

Cycadopites gracilis Sah & Jain, 1965

Pl. 2, Figs. 77-78

DISCUSSION

Elements of the Flora — The miospore assemblage recovered from the Variegated Shale member exposed at the Nammal Gorge section of Salt Range, West Pakistan, is composed of the following 22 constituent genera — *Todisporites, Divisisporites, Spongiosisporis, Dictyophyllidites, Matonisporites, Lycopodiumsporites, Staplinisporites, Tigrisporites, Ischyosporites, Baculatisporites, Osmundacidites, Cosmosporites, Classopollis, Gliscopollis, Perinopollenites, Podocarpidites, Eucommiidites, Cycadopites, Podosporites, Spheripollenites, Alisporites* and *Araucariacites.*

The dominant spore and pollen constituents in the assemblage are *Classopollis* complex 50 per cent, *Perinopollenites* 22 per cent; while *Matonisporites phlebopterioides* 4 per cent, *Dictyophyllidites* 4 per cent, *Eucommiidites troedssonii* 3 per cent, *Podocarpidites* 4 per cent, *Araucariacites* 4 per cent and *Tigrisporites* 1 per cent, form the other characteristic elements.

The Salt Range palynological assemblage is further characterized by the comparatively poor representation of saccate pollen grains and the absence of striate and monosaccate pollen grains. The trilete genera together with the *Classopollis* complex (*Classopollis*, *Gleiscopollis* and *Spheripollenites*) and the perinosaccate miospores are quite abundant.

Comparison with Triassic miofloras

A perusal of the well known Triassic literature published by various authors, viz., Thiergart (1949), De Jersey (1959, 1962), Malyavikina (1953), Leschik (1955), Potonié and Klaus (1954), Pautsch (1958), Klaus (1960), Reinhardt (1961), Sierotin (1961), Schulz (1962), Jansonius (1962) Balme (1963), Bharadwaj and Singh (1964), Mädler (1964), Clarke (1965) and Venkatachala and Góczán (1964) clearly indicates that the striated — disaccates dominated the Lower Triassic. They appear to dwindle gradually during the Upper Triassic and completely disappear in the Lower Jurassic.

Chaloner (1962, p. 339) is of the opinion that it is possible to differentiate the Upper Keuper-Rhaetic from the Lower Jurassic assemblages. He noted that the genera *Aratrisporites*, *Succinctisporites* and *Camerosporites* are restricted to the Trias while *Ovalipollis* and *Lueckisporites* both range through Keuper extending upto the Rhaetic, and *Classopollis torosus* appears in the basal part of the Rhaetic extending into the Jurassic.

Although the Salt Range mioflora is dominated by *Classopollis* elements, the two important Rhaetic genera *Ovalipollis* and *Aratrisporites* are unrepresented. Venkatachala and Góczán (1964, p. 226) comparing their Hungarian "Kössen Facies" assemblage with the Middle Keuper mioflora of Leschik (1955) and Keuper assemblage of Pautch (1958) remarked that *Aulisporites*, *Accinctisporites*, *Ovalipollis* and *Anapiculatisporites* are common to all the three assemblages and hence are good indicator of Keuper age. The absence of these genera from the present assemblage tends to preclude an Upper Triassic age.

Comparison with Jurassic Miofloras

The general composition of the Salt Range palynological assemblage shows considerable diversity from the Middle and Upper Jurassic assemblages described by Sah and Jain (1965), Jain and Sah (1966), Saad (1963), Pocock (1962) and others.

The Middle-Upper Jurassic palynological assemblages are characterized by the predominance of saccate pollen grains followed by the trilete spore genera, viz., *Trilobosporites*, *Cicatricosisporites*, *Contignisporites* and the meager representation of *Classopollis* and *Perinopollenites*. Since all these trilete genera are absent from the present assemblage, and on the other hand the percentage of *Classopollis* and *Perinopollenites* is very high, it is reasonable to assume that the variegated shale assemblage is older than Middle Jurassic.

The present palynological assemblage shows close relationship with the well known Liassic miofloras described by Reissinger (1950), Rogalska (1954,1956), Góczán (1956), Nilsson (1958), De Jersey (1963, 1965), Playford and Dettmann (1965) and Srivastava (1966) from various parts of the world. Because of their geographical proximity, the present miospore assemblage has been compared in detail with the Rajasthan assemblage described by Srivastava (1966) and with the Leigh Creek assemblage described by Playford and Dettmann (1965) from Australia.

Both palynological and geological evidences point towards a Lower-Middle Jurassic age to the Lathi Formation of Jaisalmer, Rajasthan (SRIVASTAVA, 1966, p. 98). But absence of genera like *Trilobosporites*, *Cicatricosisporites* and *Foveosporites* from the Lathi formation clearly indicate that Srivastava's assemblage is older than the Rajmahal assemblage described by Sah and Jain (1965). Srivastava (*l.c.*, p. 100) also did not overlook the possibility of the Lathi assemblage being older than the Rajmahal.

It is therefore, reasonable to assume a Lower Jurassic age for the Lathi and Jaisalmer formations. Like the present assemblage, the Lathi mioflora is dominated by the *Classopollis* elements. Besides a number of common elements, both the assemblages are characterized by the complete absence of *Ovalipollis* and *Aratrisporites* on the one hand and *Cicatricosisporites*, *Trilobosporites* and *Contignisporites* on the other. This similarity in composition points towards the homotaxial nature of the two assemblages.

Another important miospore assemblage, described by Playford and Dettmann (1965) from the Leigh Creek Coal Measure, South Australia also needs closer comparison. The Rhaetic-Liassic age for the Leigh Creek Coal Measures is based on palynological evidences from samples of two localities, viz., (1) North Basin and (ii) Telford Basin. The mioflora recovered from the North Basin shows the presence of *Aratrisporites*, *Lundbladispora* and the striate — disaccate pollen grains of *Hamiapollenites* type. This composition together with the absence of *Classopollis*, *Ischyosporites*, *Lycopodiumsporites*, *Osmundacidites* evidently indicates a Rhaetic age. The Telford Basin mioflora compares very closely with the present Salt Range mioflora in the absence of striate disaccate elements and *Aratrisporites* or *Lundbladispora*, and the abundance of *Classopollis* and other elements. This composition also suggests a Liassic age for the Telford Basin mioflora.

Thus, from the evidence provided by comparative analysis and the known distribution of characteristic Mesozoic genera and species, it is concluded that the palynological assemblage from the variegated stage member of the Salt Range Jurassic corresponds more to the Lower Jurassic (Liassic) than Middle Jurassic, as suggested earlier by Sah (1955, p. 70).

Palaeoecological considerations — The abundance of *Classopollis* and *Perinopollenites* pollen grains, together with trilete spores and lesser frequency of saccate pollen grains suggest that the place of deposition might have been coastal environment with dry climatic conditions (Pocock & Jansonius, 1961, p. 446; Srivastava, 1966, p. 98).

REFERENCES

Balme, B. E. (1957). Spores and pollen grains from the Mesozoic of Western Australia. *Comm. Sci. Ind. Res. Org. T.C.*, **25**: 1-48.

Idem (1963). Plant microfossils from the Lower Triassic of Western Australia. *Palaeontology*, **6** (1): 12-40.

Idem (1964). An Upper Triassic miospore assemblage from the coals of Lunz, Austria. Ibid., **12** (1): 28-44.

Bhardwaj, D. C. & Singh, H. P. (1956). *Asterotheca meriani* (Brongn.) Stur and its spores from the Upper Triassic of Lunz (Austria) *Palaeobotanist*, **5** (2): 51-55.

Bolkhovitina, N. A. (1956). Atlas of spores and pollen in Jurassic and Lower Cretaceous of the Viliusk Basin. *Trudy. Inst. geol. Acad. Nauk.*, **2**: 1-185.

Chaloner, W. G. (1962). British Rhaetic and Triassic spores (Resumé). *Mus. nat. Hist. Nat.*, **4** (1): 1-419.

Clarke, R. F. A. (1965). Keuper miospores from Worcestershire England. *Palaeontology*, **8**(2): 294-321.

Couper, R. A. (1958). British Mesozoic microspores and pollen grains. A systematic and stratigraphic study. *Palaeontographica*, **103(B)** (4-6): 75-179.

De Jersey, N. J. (1959). Jurassic spores and pollen grains from the Rose Wood coalfield. *Qd. Min. J.*, **60**: 346-366.

Idem (1962). Triassic spores and pollen grains from the Ipswich coalfield. *Geol. Surv. Qd.*, **307**: 1-15.

Idem (1963). Jurassic spores and pollen grains from the Marburg Sandstone. *Ibid.*, **321**: 1-21.

Idem (1965). Plant microfossils in some Queensland crude oil samples. *Ibid.*, **329**: 1-9.

De Jersey, N. J. & Paten, R. J. (1964). Jurassic spores and pollen grains from the Surat Basin. **322**: 1-18.

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

Dev, S. (1961). The fossil flora of the Jabalpur series — 3. Spores and Pollen grains. *Palaeobotanist*, **8** (1-2): 43-56.

Döring, H. (1961). Planktonartige Fossilien des Jura/Kreide-Grenzbereichs der Bohrungen werle (Mecklenburg). *Geologie*, **10** (32): 110-121.

Góczán, F. (1956). Pollen analytische (Palynologische) untersuchungen zur identifizierung der Liassischen schwarzkohlenflöze von Komló. *Ann. Inst. Geol. Hungary*, **45** (1): 167-212.

Goubin, N. (1965). Description et répartition des principaux pollenites Permiens, Triasiques et Jurassiques des sondages du bassin de Morondova. *Inst. Franc. Petrole*, **20** (10): 1415-1461.

Goubin, N., Taugourdeau, J. & Balme, B. E. (1965). Considerations taxinomiques sur deux espéces de pollen du Mesozoique. *Rev. Micropalaeont.*, **7** (4): 225-227.

Harris, T. M. (1931). The fossil flora of Scorsby Sound, East East Greenland, Part 1 — Cryptogams (exclusive of Lycopodiales). *Medd. Grønland*, **85** (2): 1-102.

Helal, A. H. (1966). Jurassic plant microfossils from the subsurface of Kharga basin, Western Desert, Egypt. *Palaeontographica*, **117B** (4-6): 83-98.

JAIN, K. P. (1969). Morphology and taxonomy of the genus *Triangulopsis* Döring. *Palaeobotanist*, **17** (1):

JAIN, K. P. & SAH, S. C. D. (1966). Revision of Jurassic spores and pollen grains from Andigama, Ceylon. *Ibid.*, **14** (1-3): 106-115.

JANSONIUS, J. (1962). Palynology of Permian and Triassic sediments, peace river area, Western Canada. *Palaeontographica*, **110B** (1-4): 35-98.

KLAUS, W. (1960). Sporen der karnischen Stufe der ostalpinen Trias. *Jb. geol.*, **5**: 107-183.

KRISHNAN, M. S. (1960). Geology of India and Burma, *Madras*.

LANTZ, J. (1958). E'tude palynologique de quelques echantillous Mesozoiques du Dorset (Grande-Bretange). *Rev. Inst. Franc. petrole*, **13** (6): 917-929.

LESCHIK, G. (1955). Die Keuper-flora von Neuewelt bei Basel II. Die Iso-und Mikrosporen. *Schweiz. Paläeont. Abh. Basel*, **72**: 1-70.

MALYAVIKINA, V. S. (1953). Spores and pollen from the Upper Triassic and the Lower and Middle Jurassic in the western and eastern parts of the Ural district. *Palaeobot. Sporn. VNIGIN*, **75**: 95-159.

MÄDLER, K. (1964). Bemerkenswerte sporenformen aus dem keuper und unteren Lias. *Fortscher. Geol. Rheinild.*, **12**: 169-200.

NILSSON, T. (1958). Über das Vorkommen eines Mesozoischen Sapropelgesteins in Schonen. *Inst. Min. Palento. Quart. geol. Univ. Lund. Sweden*, **53**: 1-112.

PAUTSCH, M. E. (1958). Keuper sporomorphs from Swierczyna, Poland. *Micropaleontology*, **4** (3): 321-325.

PLAYFORD, G. & DETTMANN, M. E. (1965). Rhaeto-Liassic plant microfossils from the Leigh Creck Coal Measures, South Australia. *Senck. Leth.*, **46** (2-3): 127-181.

POCOCK, S. A. J. (1962). Microfloral analysis and age determination of strata at the Jurassic — Cretaceous boundary in the Western Canada plains. *Palaeontographica*, **111 (B)**: 1-95.

POCOCK, S. A. J. & JANSONIUS, J. (1961). The pollen genus *Classopollis* Pflug, 1953. *Micropaleontology*, **7** (4): 439-449.

POTONIÉ R. (1956). Synopsis der gattungen der Sporae dispersae. Teil. I. Sporites. *Geol. J. Beih.*, **23**: 1-103.

Idem (1958). Synopsis der gattungen der Sporae dispersae II. *Ibid.*, **31**: 1-114.

Idem (1960). Synopsis der gattungen der Sporae dispersae III. *Ibid.*, **39**: 1-189.

POTONIÉ, R. & KLAUS, W. (1954). Einige Sporengattungen des alpinen Salzgebirges. *Geol. Jb.*, **68**: 517-544.

REINHARDT, P. (1961). Sporae dispersae aus dem Rhät Thüringens. *Mber. Deutsch. Akad. Wiss.*, **3**: 704-711.

REISSINGER, A. (1950). Die "Pollen-analyse" ausgedehnt auf alk sedimentgesteine der geologischen vergangen-heit. *Palaeontographica*, **90 (B)**: 99-126.

ROGALSKA, M. (1954). Spores and pollen analysis of the Liassic coal of Blanowice in Upper Silesia. *Bull. Inst. Geol.*, **89**: 1-47.

Idem (1956). Spore and pollen analysis of the Liassic deposits of the Mroczków-Rozwady area in the Opoczno district. *Ibid.*, **104**: 1-89.

SAAD, S. I. (1963). Pollen and spores recently discovered in the coals of Sinai region. I Euone Moussa district. *Palaeontographica*, **113 (B)** (5-6): 117-125.

SAH, S. C. D. (1955). Plant microfossils from a Jurassic shale of Salt Range, West Punjab (Pakistan). *Palaeobotanist*, **4**: 60-71.

SAH, S. C. D. & JAIN, K. P. (1965). Jurassic spores and pollen grains from the Rajmahal Hills, Bihar; a discussion on the age of the Rajmahal Intertrappean beds. *Ibid.*, **13** (3): 264-290.

Idem (1967). Palynological dating of Variegated Shale, Salt Range (W. Pakistan). *Curr. Sci.*, **36** (14): 380.

Idem (1968). Lower Mesozoic megaspores from the Variegated Stage, Salt Range, (W. Pakistan). *Palaeobotanist*, **16** (3): 288-291.

SCHULZ, E. (1962). Sporen paläontogische Untersuchungen zur Rhät-Lias — Grenze in Thuringen und der Actmark. *Geologie*, **11**: 308-319.

SIEROTIN, Th. (1961). Sporae dispersae in Rhät und Lias von Grossbell hoffen (Mittelfrauken). *Diss. Fr. Univ. Berlin*: 1-77.

SINGH, C. (1964). Microflora of the Lower Cretaceous Mannville group, East-central Alberta. *Bull. Res. Coun. Alberta*, **12**: 1-238.

SINGH, H. P., SRIVASTAVA, S. K. & ROY, S. K. (1964). Studies on the Upper Gondwana of Cutch-1. Mio- and macrospores. *Palaeobotanist*, **12** (3): 282-306.

SITHOLEY, R. V. (1949). *Protopteris nammalensis* sp. nov., A Jurassic cyatheaceous tree fern from the Salt Range, Punjab. *Natn. Inst. Sci. India*, **15** (1): 1-10.

SRIVASTAVA, S. K. (1966). Jurassic microflora from Rajasthan, India. *Micropaleontology*, **12** (1): 87-100.

THIERGART, F. (1949). Der Stratigraphische wert Mesozoischer pollen und sporen. *Palaeontographica*, **89(B)**: 1-34.

VENKATACHALA, B. S. (1966). Mesozoic operculate pollen and their morphology. *Palaeobotanist*, **15** (1-2): 98-101.

VENKATACHALA, B. S. & GÔCZÁN, F. (1964). The spore-pollen flora of the Hungarian "Kössen Facies". *Acta Geologica*, **8** (1-4): 203-228.

EXPLANATION OF PLATES

(*All photographs magnified* 500 ×)

PLALE 1

1-2. *Todisporites major* Couper; Sl. Nos. 3032-5, 3031-7.

3-4. *Divisisporites nammalensis* sp. nov., Sl. Nos. 3035-3, 3044-9.

5-7. *Spongiosisporis obovata* (Rogalska) comb. nov., Sl. Nos. 3023-5, 3038-1, 3032-13.

8-9. *Dictyophyllidites equiexinus* (Couper) Dettmann, Sl. Nos. 3031-12, 3026-1.

10-11. *Matonisporites phlebopterioides* Couper, showing proximal and distal surfaces of the same spore respectively. Sl. No. 3031-8.

12-14. *Matonisporites phlebopterioides* Couper, Sl. Nos. 3055-1, 3031-5, 3030-2.

15-16. *Staplinisporites pocockii* sp. nov. Sl. Nos. 3044-7, 3044-1.

17-18. *Staplinisporites pocockii* sp. nov. showing the proximal and distal surfaces of the spore respectively. Sl. Nos. 3045-1, 3036-10.

19-21. *Tigrisporites minor* sp. nov. Sl. Nos. 3050-3, 3047-7, 3028-2.

22. *Lycopodiumsporites* sp., Sl. No. 3032-10.

23. *Osmundacidites* sp., Sl. No. 3025-1.

24-25. *Baculatisporites* sp., Sl. Nos. 3031-2 & 3027-4.

26. *Ischyosporites* sp., Sl. No. 3031-1.

27. *Cosmosporites* sp., Sl. No. 3032-15.

28. *Dictyophyllidites* sp., Sl. No. 3047-1.

29. *Monolites* sp., Sl. No. 3030-6.

30-34. *Perinopollenites elatoides* (Couper) emend. Sl. Nos. 3037-1, 3045-1, 3033-5, 3024-4 and 3036-1.

Plate 2

35-36. *Perinopollenites elatoides* (Couper) emend. Jain Sl. Nos. 3047-8, 3025-1.

37-38. *Perinopollenites segmentatus* (Balme) comb. nov., Jain Sl. Nos. 3022-5, 3044-11.

39. *Perinopollenites dubius* sp. nov., Jain Sl. No. 3022-1.

40-42. *Perinopollenites microreticulatus* sp. nov., Jain Sl. Nos. 3022-5, 3043-2, 3050-11.

43-44. *Araucariacites australis* Cookson. Sl. Nos. 3032-8, 3047-10.

45. *Alisporites* sp., Sl. No. 3024-3.

46. *Podocarpidites typicus* Sah & Jain, Sl. No. 3026-3.

47-48. *Podocarpidites* sp. cf. *novus* Sah & Jain, Sl. Nos. 3039-3, 3040-3.

49. *Podocarpidites typicus* Sah & Jain, Sl. No. 3023-6.

50-51. *Podocarpidites* sp. A., Sl. Nos. 3024-1, 3058-2.

52. *Podocarpidites* sp. cf. *novus* Sah & Jain, Sl. No. 3058-6.

53-54. *Podocarpidites tripakshii* Rao, Sl. Nos. 3032-5, 3032-6.

55-59. *Classopollis classoides* (Pflug) Pocock & Jansonius, Sl. Nos. 3033-1, 3057-3, 3032-11, 3044-12, 3032-12.

60-64. *Gleiscopollis meyeriana* (Naum.) Venkatachala, Sl. Nos. 3038-2, 3029-7, 3032-14, 3030-8.

65-67. *Gliscopollis nammalensis* sp. nov., Sl. Nos. 3026-10, 3043-11, 3042-6.

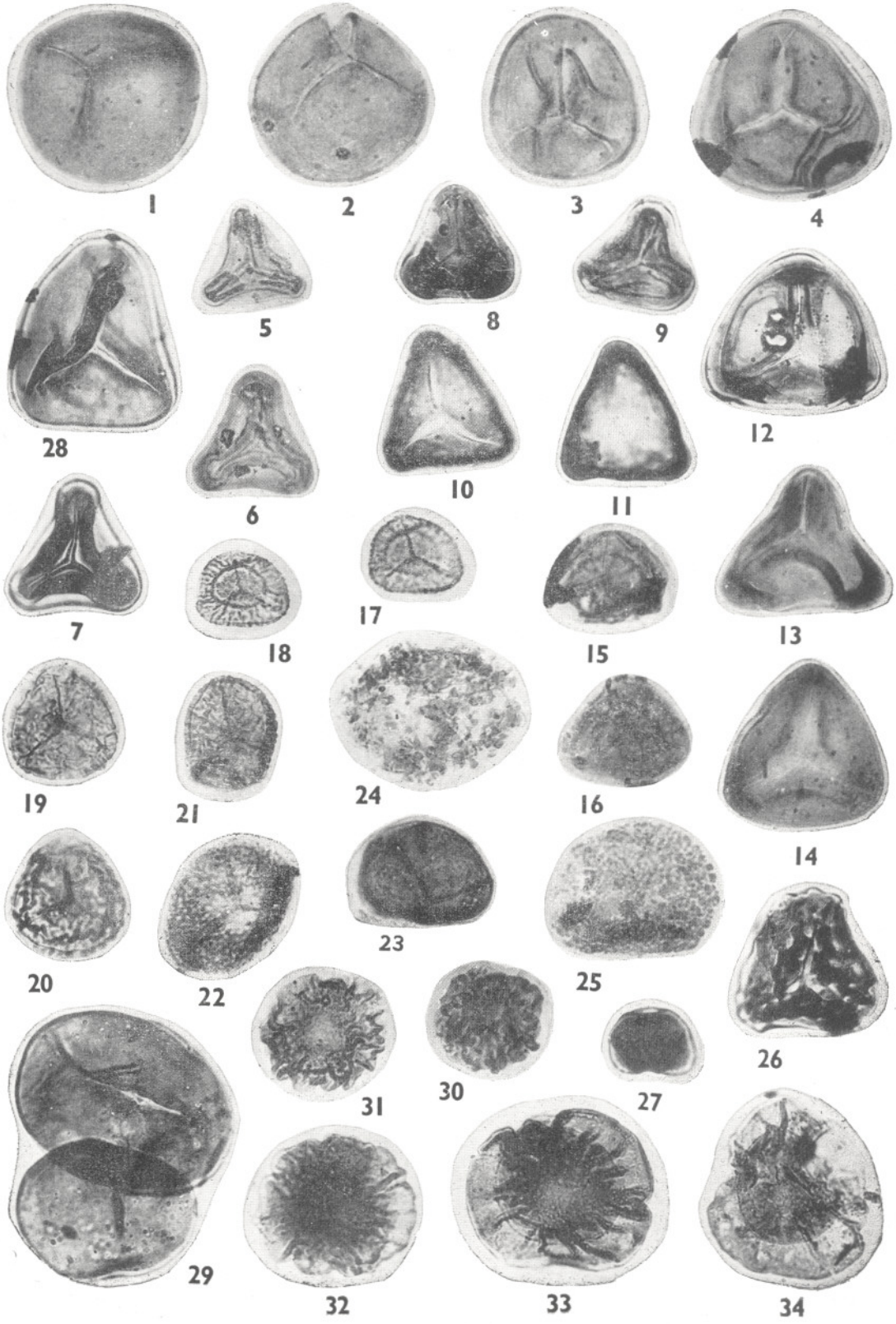
68-71. *Spheripollenites subgranulosus* Couper, Sl. No. 3051-3.

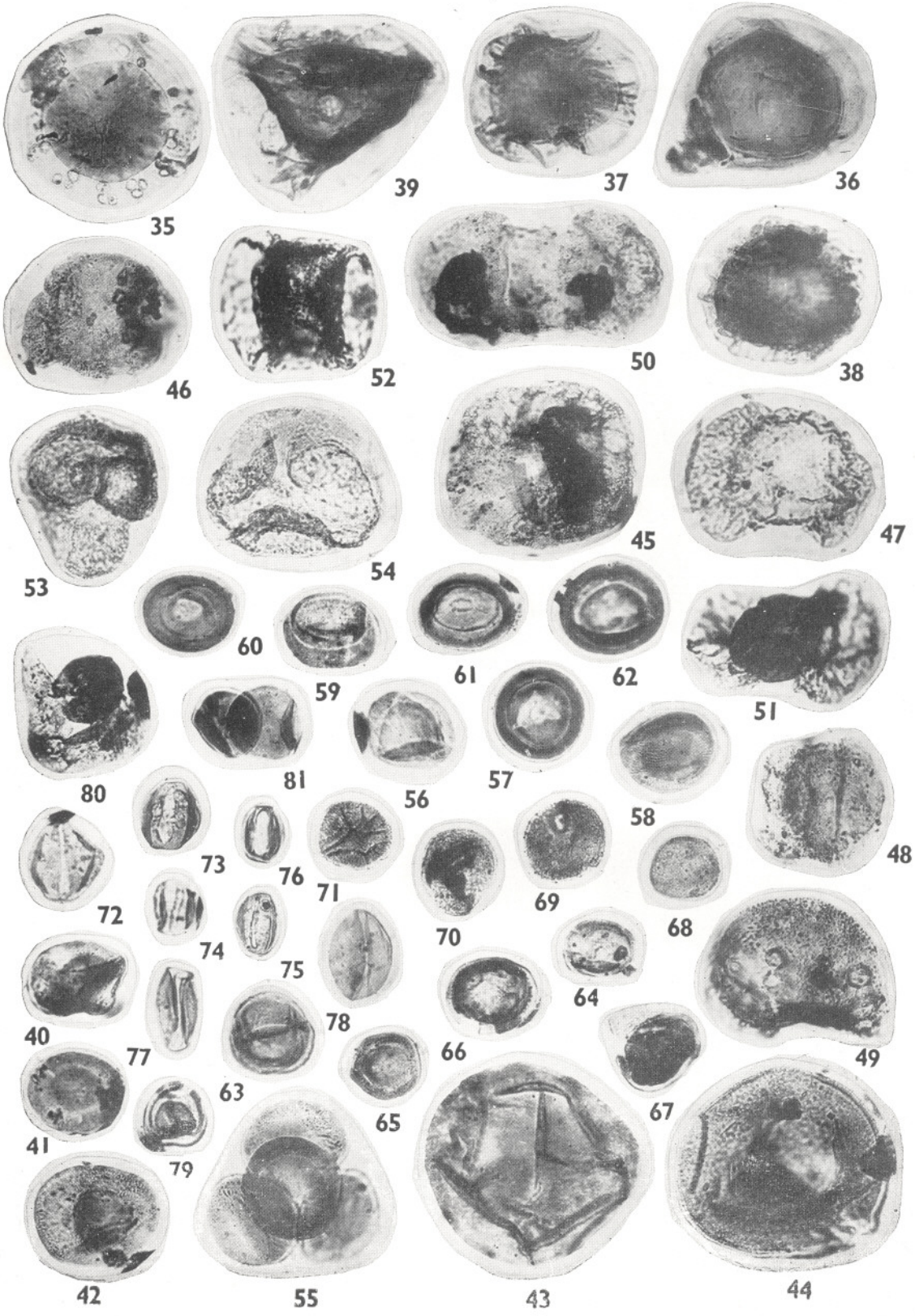
72-76. *Eucommiidites troedssonii* (Erdtman) Hughes, Sl. Nos. 3056-2, 3051-7, 3044-5, 3030-4, 3025-7.

77-78. *Cycadopites gracilis* Sah & Jain, Sl. Nos. 3052-1, 3027-2.

79. *Gliscopollis nammalensis* sp. nov., Sl. No. 3044-14.

80-81. *Spheripollenites subgranulosus* Couper, Sl. Nos. 3047-21, 3024-1.


1
2
3
4
5
8
9
28
12
6
10
11
7
17
18
15
13
19
21
24
16
14
20
22
23
25
26
31
30
27
29
32
33
34


35
39
37
36
46
52
50
38
53
54
45
47
60
59
61
62
51
80
81
56
57
58
48
73
76
71
69
72
74
75
70
68
64
40
77
78
66
49
41
63
65
67
79
42
55
43
44