PALYNOLOGY OF THE BARAIL (OLIGOCENE) AND SURMA (LOWER MIOCENE) SEDIMENTS EXPOSED ALONG SONAPUR-BADARPUR ROAD SECTION, JAINTIA HILLS (MEGHALAYA) AND CACHAR (ASSAM). PART—V. ANGIOSPERMOUS POLLEN GRAINS

M. R. RAO, R. K. SAXENA AND H. P. SINGH

Birbal Sahni Institute of Palaeobotany, 53 University Road, Lucknow 226 007, India

Abstract

The present paper incorporates the study of the angiospermous pollen grains recovered from the Barail (Oligocene) and Surma (Lower Miocene) sediments exposed along Sonapur-Badarpur Road Section, Meghalaya and Assam. The angiospermous pollen grains are represented by 18 genera and 24 species, of which 4 species, viz., *Couperipollis donaensis*, *C. ramanujamii*, *Echistephanocolpites meghalayaensis* and *Polyadopollenites sahii* have been proposed as new. The dicotyledonous pollen grains, being represented by 11 genera and 14 species, dominate over the monocotyledonous pollen grains which are represented by 7 genera and 10 species only. The angiospermous pollen grains are rather poorly represented, being only 5.5% of the overall assemblage. Their stratigraphic distribution in the various formations of this section has been discussed. The assemblage has been compared with the known contemporaneous assemblages from northeastern India and also from other areas in order to point out similarities and differences amongst them.

Introduction

The Barail and Surma sediments are excellently exposed along the Sonapur-Badarpur Road Section (National Highway-44) located in the southeast of Shillong. The Barail Group is divided into Laisong, Jenam and Renji formations and is unconformably overlain by the Surma Group. The Surma Group is divided into Bhuban and Bokabil formations. The Bhuban Formation is again divided into Lubha, Umkiang and Dona members. The lithostratigraphy of this section has already been published by Saxena and Tripathi (1982).

Altogether, 288 rock samples were collected from this section, of which 216 samples proved to be palynologically productive. Details of the rock samples collected from different formations have been given by Saxena and Rao (1984). The palynomorphs recovered from these samples include dinoflagellate cysts, fungal remains, pteridophytic spores and gymnospermous and angiospermous pollen grains. The papers dealing with the dinoflagellate cysts (Saxena and Rao, 1984), fungal remains (Singh, Saxena & Rao, in press), pteridophytic spores (Rao & Singh, in press) and gymnospermous pollen grains (Rao, in press) are under publication. The present paper which constitutes the next part of the study, deals exclusively with the angiospermous pollen grains.

For the recovery of palynomorphs, 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 treated with 5% KOH solution for 5-10 minutes. The slides were prepared in polyvenyl alcohol and mounted in DPX mountant. All slides, negatives and

unused material have been deposited in the repository of the Birbal Sahni Institute of Palaeobotany, Lucknow.

Systematic Description

Anteturma *Variegerminantes* Potonié, 1970
Turma *Aletes* Ibrahim, 1933
Subturma *Azonaletes* Luber, 1935 emend. Potonié & Kremp, 1954
Infraturma *Subpilonapiti* Erdtman, 1947 ex Vimal, 1952

Genus—*RETIPILONAPITES* Ramanujam, 1966

Types species—*Retipilonapites arcotense* Ramanujam, 1966 (designated by Potonié, 1970)

Retipilonapites delicatissimus Ramanujam, 1966
Pl. 1, Fig. 1

Remarks—The specimens recorded in the present assemblage are bigger in size (45-50 μm) and have thicker exine (3.5 μm) than those described by Ramanujam (1966, size range 30-34 μm; exine up to 2.2 μm thick) from South Arcot lignite, Tamil Nadu.

Distribution—South Arcot lignite (Upper Miocene), Tamil Nadu (Ramanujam, 1966).

Occurrence—Umkiang Member, Bhuban Formation, Surma Group.

Affinity—Potamogetonaceae.

Infraturma—*Tuberini* Pant, 1954

Genus—*VERRUALETES* Singh & Saxena, 1984

Type species—*Verrualetes assamicus* Singh & Saxena, 1984

Verrualetes assamicus Singh & Saxena, 1984
Pl. 1, Fig. 2

Distribution—Upper Siwalik sediments of Una District, Himachal Pradesh (Singh & Saxena, 1981), Neogene sediments of Jorajan well 3, Upper Assam (Singh & Saxena, 1984).

Occurrence—Umkiang Member, Bhuban Formation, Surma Group.

Affinity—Unknown.

Verrualetes sp.
Pl. 1, Fig. 3

Description—Pollen grain subcircular, size 50.5 μm. Inaperturate, with central depression on one side. Exine 2.5 μm thick, ornamented with ±3 μm high verrucae/gemmae, sexine slightly thicker than nexine.

Comparison—The specimen recorded here closely compares with *Verrualetes assamicus* Singh & Saxena (1984) in its shape and size but the latter can be distinguished by its bigger and robustly built verrucae forming pseudoreticulum in surface view.

Occurrence—Lubha Member, Bhuban Formation, Surma Group.

Affinity—Unknown.

Genus—*ASSAMIAPOLLENITES* Singh, 1975 emend. Singh & Saxena, 1984

Type species—*Assamiapollenites browni* (Biswas, 1962) Singh, 1975

Assamiapollenites sp.
Pl. 1, fig. 4

Description—Pollen grains subcircular in shape, size range 35-45 μm. Inaperturate. Exine about 5 μm thick, baculate/pilate, bacula/pila subcircular, 6-7 μm in size.

Comparison—*Assamiapollenites browni* (Biswas, 1962)Singh (1975) can be distinguished from the present species by its pseudoreticulate exine.

Occurrence—Bokabil Formation, Surma Group.

Affinity—Unknown.

Genus—*SPINAINAPERTURITES* Pierce, 1961

Type species —*Spinainaperturites recurvatus* Pierce, 1961

Spinainaperturites sp. A.
Pl. 1, Figs. 5-6

Description—Pollen grains subcircular, size range 45-75 μm. Inaperturate. Exine 2-2.5 μm thick, spinose, spines 2-4.5 μm long, sparsely placed, interspinal area laevigate, exinal folds present.

Comparison—*S. recurvatus* Pierce (1961) can be distinguished from the present species by its smaller size (26 ×21 μm) and thinner exine (1 μm). *S. magnificus* Ramanujam (1966) closely compares with the present species in its shape, size and the nature of ornamentation, but the former can be distinguished by its longer spines (7 μm long) and in often having one or two folds.

Occurrence—Lubha Member, Bhuban Formation, Surma Group.

Affinity—Unknown.

Spinainaperturites sp. B
Pl. 1, Figs. 7-8

Description—Pollen grains subcircular, size range 42-51 μm. Inaperturate. Exine 2.5 μm thick, spinose, spines up to 4 μm long, simulating a pseudoreticulate apparaance in surface view.

Comparison—The present species can be distinguished from *S. recurvatus* Pierce (1961) by its thicker exine (2.5 μm) and pseudoreticulate appearance in surface view.

Occurrence—Umkiang Member, Bhuban Formation, Surma Group.

Affinity—Unknown.

Turma—*Plicates* (Naumova, 1937) Potonié, 1960
Subturma—*Monocolpates* Iversen & Troels-Smith, 1950
Infraturma—*Retectines* Malyavkina, 1949 emend. Potonié, 1958

Genus—*PALMIDITES* Couper, 1953

Type species—*Palmidites maximus* Couper, 1953

Palmidites maximus Couper, 1953
Pl. 1, Fig. 9

Distribution—Palaeocene of Kachchh, Gujarat (Saxena, 1979) and Upper Siwalik of Hoshiarpur-Una Road section, Himachal Pradesh (Saxena & Singh, 1982).

Occurrence—Dona Member, Bhuban Formation, Surma Group.
Affinity—Palmae.

Genus—*COUPERIPOLLIS* Venkatachala & Kar, 1969

Type species—*Couperipollis perspinosus* (Couper, 1953) Venkatachala & Kar, 1969

Couperipollis robustus Saxena, 1979
Pl. 1, Fig. 10

Remarks—The specimens recorded here have thicker exine (up to 3.5 μm) than those described by Saxena (1979) from the Matanomadh Formation of Kachchh.
Distribution—Palaeocene of Kachchh, Gujarat (Saxena, 1979)
Occurrence—Umkiang Member, Bhuban Formation, Surma Group.
Affinity—Palmae.

Couperipollis donaensis sp. nov.
Pl. 1, Figs. 11-13

1977—*Couperipollis* sp. cf. *C. wodehousei* (Biswas) Venkatachala & Kar; in Singh, pp. 194-195, Pl. 2, figs. 29-30

Holotype—Pl. 1, fig. 12, size 51 μm, slide no. 8409.
Type locality—169.1 kilometre stone (from Shillong), Sonapur-Badarpur Road, Jaintia Hills, Meghalaya.
Type horizon—Dona Member, Bhuban Formation, Surma Group, Lower Miocene.
Diagnosis—Pollen grains subcircular to oval-elliptical, size range 42-51 μm. Monosulcate. Exine spinose, interspinal area laevigate to slightly granulose.
Description—Pollen grains mostly oval, ± elliptical in shape. Sulcus mostly distinct, sometimes indistinct due to heavy ornamentation, extending from one end to the other. Exine 1-2 μm thick, spines 4-9 μm long, 1.5-2 μm wide, sparsely placed, interspinal area laevigate, sometimes weakly ornamented with grana.
Comparison—*Couperipollis longispinosus* Salujha & Kindra (1981) closely resembles the present species in its nature of spines but the former can be distinguished by having microreticulate ornamentation in between the spines. *C. wodehousei* (Biswas, 1962) Venkatachala & Kar (1969) is also comparable with the present species but can be distinguished by its longer spines with bulbous base and rounded tips. *C. exsertus* Salujha, Kindra & Rehman (1974) is different from the present species in having closely placed spines giving pseudoreticulate appearance. *C. Punctitectatus* Rao & Ramanujam (1978) has spines with bulbous bases and punctate interspinal area, thus not comparable. *C. microreticulata* Kar (1979) differs in having finely reticulate exine.
Remarks—Singh (1977, pl.2, figs. 29-30) described *Couperipollis* sp. cf. *C. wodehousei* (Biswas, 1962) Venkatachala & Kar (1969) from the Tura Formation of Garo Hills, Meghalaya, which exactly resembles the present species and hence have been merged in it.
Occurrence—Dona Member, Bhuban Formation, Surma Group.
Affinity—Palmae.

Couperipollis ramanujamii sp. nov.
Pl. 1, Figs. 14-16

1977—*Couperipollis* sp. 1 in Singh, p. 195, pl. 2, figs. 32, 37-38.

Holotype—Pl. 1, fig. 16, size 49 μm, slide no. 8741,.

Type locality—169.1 kilometre stone (from Shillong), Sonapur-Badarpur Road, Jaintia Hills, Meghalaya.

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

Diagnosis—Pollen grains subcircular to elliptical, size range 40-49 μm. Monosulcate. Exine spinose, spines sparsely placed, interspinal area laevigate to finely ornamented.

Description—Pollen grains mostly oval-elliptical, occasionally subcircular. Sulcus distinct, up to 8 μm wide, sometimes indistinct due to heavy ornamentation of spines. Exine 1-2μm thick. Spines bulbous at the base and pointed at the apex, 4-6.5 μm long and 2-3.5 μm wide, sparsely placed, interspinal area generally laevigate but may be finely sculptured.

Comparison—*Couperipollis brevispinosus* (Biswas, 1962) Venkatachala & Kar (1969) compares well with the present species in shape, size range and the spines having bulbous bases but the former can be distinguished by its densely placed spines and finely pitted-reticulate sculpture of exine. *C. kutchensis* Venkatachala & Kar (1969) also resembles the present species in general organisation but is distinct by its closely placed spines. *C. exsertus* Salujha, Kindra & Rehman (1974) also has spines with bulbous bases but it differs by having foveolate interspinal area and coalescing spines to give a reticulate appearance which is not the case with the present species. *C. donaensis* sp. nov. possesses longer spines without having bulbous bases, hence it is not comparable.

Derivation of name—This species is named after Dr. C. G. K. Ramanujam, Botany Department, Saifabad Science College, Hyderabad.

Remarks—*Couperipollis* sp. 1 described by Singh (1977, pl. 2, figs. 32, 37 & 38) from the Tura Formation of Garo Hills, Meghalaya exactly resembles the present species and hence has been included in the same.

Occurrence—Dona Member, Bhuban Formation, Surma Group.

Affinity—Palmae.

Couperipollis sp. cf. *C. wodehousei* (Biswas, 1962) Venkatachala & Kar, 1969
Pl. 1, Fig. 17

Description—Pollen grains subcircular, size 47 μm. Monosulcate, sulcus not clearly seen. Exine 2 μm thick, spinose, spines 4.5-6.5 μm long, bulbous at the base and tapering towards the apex.

Comparison—The present specimen is closely comparable to *C. wodehousei* (Biswas, 1962) Venkatachala & Kar (1969) but the latter can be distinguished by its longer spines (9-14 μm).

Remarks—Biswas (1962, pl. 12, fig. 30) published *Arecipites wodehousei* from the Sylhet Limestone (Eocene) of Meghalaya, India. Sah and Dutta (1966) transferred it to *Monosulcites* as *Monosulcites* (*Arecipites*) *wodehousei*. Venkatachala & Kar (1969) instituted a new genus *Couperipollis* and shifted this species therein as *Couperipollis* (*Monosulcites*) *wodehousei* (Biswas). Since Biswas (1962) described this species under *Arecipites* and not under *Monosulcites*, it should not have been referred to *Monosulcites* as given by Venkatachala & Kar (1969).

Occurrence—Dona Member, Bhuban Formation, Surma Group.

Affinity—Palmae.

Infraturma—*Sphaerozonisulcates* Venkatachala & Kar, 1969

Genus—*PROXAPERTITES* van der Hammen, 1956 emend. Singh, 1975

Type species—*Proxapertites operculatus* van der Hammen, 1956

Proxapertites sp.
Pl. 1, Fig. 18

Description—Pollen grain broadly oval, size 46 ×40 μm. Zonisulcate, sulcus distinct, equatorially placed. Exine tectate, up to 2.5 μm thick, coarsely reticulate, muri finely punctate.

Remarks—*Proxapertites* sp. can be distinguished from all the known species of *Proxapertites* van der Hammen, 1956 emend. Singh (1975) by having coarsely reticulate exine.

Occurrence—Lubha Member, Bhuban Formation, Surma Group.

Affinity—Palmae.

Subturma—*Tryptyches* (Naumova, 1939) Potonié, 1960

Genus—*TRICOLPITES* Cookson, 1947 emend. Potonié, 1960

Type species—*Tricolpites reticulatus* Cookson, 1947

Tricolpites sp.
Pl. 1, Fig. 20

Description—Pollen grain subcircular in polar view, size 60.5 ×50.5 μm. Tricolpate, colpi distinct, 14 μm in width. Exine about 1 μm thick coarsely reticulate, lumina circular oval, small, 2-3 μm in diameter, muri 5-7 μm in thickness.

Occurrence—Laisong and Jenam formations, Barail Group.

Affinity—Uncertain.

Genus—*VERRUTRICOLPITES*, Pierce, 1961

Type species—*Verrutricolpites sphaeroides* Pierce, 1961

Verrutricolpites sp.
Pl. 1, Fig. 19

Description—Pollen grain subcircular in polar view, size 61.5 ×56 μm. Tricolpate, colpi distinct. Exine tectate, 3.5 μm thick, ornamented with verrucae/coni, sculptural elements up to 4 μm high, sparsely placed.

Comparison—The present specimen differs from *V. perverrucatus* Ramanujam (1966) by its bigger size and sparsely placed verrucae/coni.

Occurrence—Laisong Formation, Barail Group.

Affinity—Unknown.

Genus—*RETITRESCOLPITES* Sah, 1967

Type species—*Retitrescolpites typicus* Sah, 1967

Retitrescolpites sp.
Pl. 1, Fig. 21

Description—Pollen grain elongated-oval in equatorial view, size 60.5 ×42 μm. Tricolpate, colpi distinct, narrow, extending from one end to the other. Exine 4.5 μm thick, retipilate/retibaculate, pila/bacula up to 4 μm long, very closely placed, tegillate.

Comparison—*Retitrescolpites* sp. closely compares with *R. typicus* Sah (1967) in its retipilate/retibaculate ornamentation but the former can be distinguished in having distinct colpi and undifferentiated exine.

Occurrence—Dona Member, Bhuban Formation, Surma Group.

Affinity—Oleaceae.

Genus—*TRIFOSSAPOLLENITES* Rouse, 1957

Type species—*Trifossapollenites ellipticus* Rouse, 1957

Trifossapollenites constatus Dutta & Sah, 1970
Pl. 2, Fig. 22

Remarks—Some of the specimens recorded here have thicker exine (2 μm) than that (1 μm) of the pollen grains reported from the Cherra Formation of Khasi Hills, Meghalaya by Dutta and Sah (1970, pl. 6, figs. 21-23).

Distribution—Cherra Formation, Meghalaya (Dutta & Sah, 1970).

Occurrence—Dona Member, Bhuban Formation, Surma Group.

Affinity—Labiatae.

Genus—*BOMBACACIDITES* Couper, 1960

Type species—*Bombacacidites bombaxoides* Couper, 1960

Bombacacidites inausus Venkatachala & Rawat, 1973
Pl. 2, Figs. 23-26

Remarks—Couper (1953) proposed *Bombacacidites* for triangular, tricolporate pollen grains having reticulate exine and germinal apertures in the middle of the interapical margins. Sah (1967) instituted *B. clarus* which is triporate with no colpi. On the other hand, Venkatachala and Rawat (1973) proposed a new species *B. inausus* which is tricolpate with no pore. In the present assemblage also, most of the pollen are tricolpate though some are tricolporate with ill-developed pores. The specimens recovered here are bigger in size (45-60 μm) and have longer colpi (about 8 μm) than those reported by Venkatachala and Rawat (1973) from the subsurface Tertiary sediments of Cauvery Basin.

Occurrence—Laisong Formation, Barail Group.

Affinity—Bombacaceae.

Subturma—*Polyptyches* (Naumova, 1937) Potonié, 1960
Infraturma—*Stephanocolpati* van der Hammen, 1954 ex Potonié, 1970
Subinfraturma—*Sculptatostephanocolpati* Saxena, 1982

Genus—*ECHISTEPHANOCOLPITES* Wijmstra, 1971

Type species—*Echistephanocolpites echinatus* Wijmstra, 1971

Echistephanocolpites meghalayaensis sp. nov.
Pl. 2, Figs. 27-30

1964—*Stephanocolpites* van der Hammen: in Banerjee, p. 6, pl. 2, fig. 29.
1974—*Stephanocolpites* sp. in Sein and Sah, pl. 1, fig. 3.

Holotype—Pl. 2, fig. 30, size 66 μm, slide no. 8116.

Type locality—147.6 kilometre stone (from Shillong), Sonapur-Badarpur Road, Jaintia Hills, Meghalaya.

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

Diagnosis—Pollen grains subcircular in polar view, size range 50-66 μm. Tetracolpate. Exine up to 2.5 μm thick, echinate.

Description—Pollen grains mostly subcircular, sometimes subquadrangular in polar view. Tetracolpate, longicolpate, colpi sometimes very narrow. Exine up to 2.5 μm thick, ornamented with sparsely placed coni, coni 1-2 μm long.

Comparison—*Echistephanocolpites meghalayaensis* sp. nov. differs from *E. echinatus* Wijmstra (1971) in possessing four colpi and sparsely placed coni.

Remarks—*Stephanocolpites* van der Hammen described by Banerjee (1964, p. 6, pl. 2, fig. 29) is similar to the present species. Sein and Sah (1974, pl.1, fig. 3) figured *Stephanocolpites* sp. which also resembles the present species. Both these forms are, therefore, included here.

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

Affinity—? Labiatae.

Echistephanocolpites sp. cf. *E. echinatus* Wijmstra, 1971
Pl. 2, Fig. 31

Description—Pollen grains subcircular in polar view, size range 55-66 μm. Pentacolpate, colpi distinct sometimes very narrow. Exine up to 2.5 μm thick, ornamented with sparsely placed coni, coni 1-2 μm long.

Comparison—The present specimens closely compare with *Echistephanocolpites echinatus* Wijmstra (1971) in all the general characters but the latter can be distinguished in having compactly placed coni.

Occurrence—Umkiang Member, Bhuban Formation, Surma Group.

Affinity—Unknown.

Genus—*GEMMASTEPHANOCOLPITES* van der Hammen & Garcia de Mutis, 1965

Type species—*Gemmastephanocolpites gemmatus* van der Hammen & Garcia de Mutis, 1965

Gemmastephanocolpites sp.
Pl. 2, fig. 32

Description—Pollen grain circular in polar view, size 57 μm. Pentacolpate, colpi distinct, 12 μm in length, Exine tectate, 2 μm thick, gemmate, gemmae 2.5 μm high.

Comparison—*Gemmastephanocolpites* sp. differs from *Gemmastephanocolpites gemmatus* van der Hammen & Garcia de Mutis (1965) in being bigger in size (57 μm).

Occurrence—Laisong Formation, Barail Group.

Affinity—Unknown.

Subturma—*Triporines* Naumova, 1939 emend. Potonié, 1960

Genus—*TRIPOROPOLLENITES* Pflug & Thomson in Thomson & Pflug, 1953

Type species—*Triporopollenites coryloides* Pflug *in* Thomson & Pflug, 1953

Triporopollenites sp.
Pl. 2, Fig. 33

Description—Pollen grains subtriangular in polar view, size range 75-90 μm. Tri-

porate, pores simple, without annulus. Exine 3.5 μm thick, verrucose, verrucae closely placed, exhibiting negative reticulum in surface view.

Comparison—*Triporopollenites* sp. closely compares with *T. verrucatus* Kar & Jain (1981) in its shape and verrucose ornamentation, but the former can be distinguished by its bigger size (75-90 μm) and negative reticulum in surface view. *Triporopollenites coryloides* Pflug *in* Thomson & Pflug (1953) can be differentiated from the present speces by its smaller size (25-35 μm) and smooth to faintly rugulate exine.

Occurrence—Laisong Formation, Barail Group.

Affinity—Unknown.

Subturma—*Polyporines* Naumova, 1939 emend. Potonié, 1960
Infraturma—*Stephanoporiti* (van der Hammen, 1954) Potonié, 1960

Genus—*STEPHANOPOROPOLLENITES* Pflug & Thomson in Thomson & Pflug, 1953

Type species—*Stephanoporopollenites hexaradiatus* (Thiergart, 1940) Thomson & Pflug, 1953

Stephanoporopollenites sp.
Pl. 2, Fig. 34

Description—Pollen grain subcircular in shape, size 62 μm. Tetraporate, pore circular-oval, 8 μm in diameter. Exine 2.5 μm thick, laevigate.

Comparison—*Stephanoporopollenites solitus* Salujha, Kindra & Rehman (1972) resembles the present specimen in its shape but can be differentiated in being hexaporate and in having foveolate exine. *S. proprius* also instituted by Salujha *et al.* (1972) is pentaporate and has microreticulate exine.

Occurrence—Laisong and Jenam formations, Barail Group.

Affinity—Unknown.

Infraturma—*Periporiti* (van der Hammen, 1954) Potonié, 1960

Genus—*MALVACEARUMPOLLIS* Nagy, 1962

Type species—*Malvacearumpollis bakonyensis* Nagy, 1962

Malvacearumpollis sp.
Pl. 2, Fig. 35

Description—Pollen grains subcircular, size range 60-70 μm. Polyporate, panporate, only few pores discernible. Exine tectate, spinose, spines bulbous at the base and pointed at the apex, 5-8 μm long and 7 μm wide at the base, compactly placed.

Comparison—*Malvacearumpollis* sp. closely compares in all the characters with *M. bakonyensis* Nagy (1962) but the latter can be distinguished by its pilate exine. *M. grandis* Sah (1967) is much bigger in size (115-139μm) and possesses numerous and distinct pores. *M. africana* Sah (1967) differs from the present species in having fewer spines. *M. rudis* Kar (1979) is panporate with numerous pores whereas in the present specimens only a few pores have been observed.

Occurrence—Barail and Surma groups.

Affinity—Malvaceae.

Turma—*Jugates* (Erdtman, 1947) Potonié, 1960
Subturma—*Polyaditi* Pant, 1954

Genus—*POLYADOPOLLENITES* Pflug & Thomson *in* Thomson & Pflug, 1953

Type species—*Polyadopollenites multipartitus* Thomson & Pflug, 1953

Polyadopollenites sahii sp. nov.
Pl. 2, Figs. 36-38

1974—*Polyadopollenites* sp. in Sein and Sah, pl. 1, figs. 4-5.

Holotype—Pl. 2, fig. 38, size 75 μm, slide no. 8758.

Type locality—141.5 kilometre stone (from Shillong), Sonapur-Badarpur Road, Jaintia Hills, Meghalaya.

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

Diagnosis—Polyad subquadrangular consisting of 16 cells size range 66-79 μm. Individual grains monoaperturate. Exine laevigate—faintly scabrate.

Description—Polyad made up of 16 (4+4+8) pollen grains, flattened. Eight cells in the centre surrounded by a peripheral row of 8 cells. Peripheral cells 25-27 ×14-19.5μm and central cells 19-22 ×19-22 μm in size. Single pore present in each grain, pores obscure, sometimes absent in central cells. Exine 1.5 μm thick, laevigate to faintly scabrate.

Comparison—*Polyadopollenites sahii* sp. nov. closely compares with *P. miocenicus* Ramanujam (1966) in having 16 cells but the latter can be distinguished by its smaller size range (45-60 μm) and 3 pores in each grain. *P. granulatus* Sah (1967) is bigger in size range (104-110 μm) and possesses 4-6 pores in each grain and granulate exine, hence it is easily distinguishable. *P. multifedus* Potonié & Sah (1960) is irregularly rounded and the grains are more than 20 in a massula, thus it is not comparable. *P. varpalotaensis* Nagy (1962) has bigger peripheral cells (30 μm) and finely intrabaculate structure between the nexine and tegillum.

Derivation of name—This species is named after Dr S. C. D. Sah, Director, Wadia Institute of Himalayan Geology, Dehradun.

Remarks—Sein and Sah (1974, pl. 1, figs. 4-5) figured *Polyadopollenites* sp. which resembles the present species, and therefore has been considered here as synonym of the latter.

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

Affinity—Mimosaceae.

Discussion

The angiospermous pollen grains described here from the Barail and Surma sediments (Oligocene—Lower Miocene) are represented by 18 genera and 24 species. Of these 4 species, viz., *Couperipollis donaensis*, *C. ramanujamii*, *Echistephanocolpites meghalayaensis* and *Polyadopollenites sahii* have been proposed as new. Quantitative analysis of the overall assemblage reveals a comparatively poor representation of angiospermous pollen grains (5.5%). Their frequency in the various formations is as follows : Laisong-2.7%, Jenam—3.3%, Renji—0.6%, Bhuban—3.7% and Bokabil-21.2%.

Gemmastephanocolpites sp., *Tricolpites* sp., *Verrutricolpites* sp., *Bombacacidites inausus*, *Triporopollenites* sp. and *Stephanoporopollenites* sp. are restricted to the Barail Group whereas *Retipilonapites delicatissimus*, *Verrualetes assamicus*, *Verrualetes* sp., *Assamiapollenites* sp., *Spinainaperturites* spp. A. & B, *Palmidites maximus*, *Couperipollis robustus*, *C. donaensis*, *C. ramanujamii*, *Couperipollis* sp. cf. *C. wodehousei*, *Proxapertites* sp., *Retitrescolpites* sp., *Trifossapollenites constatus* and *Echistephanocolpites* sp. cf. *E. echinatus* are restricted to the Surma Group. The

forms common to both Barail and Surma groups are *Polyadopollenites sahii*, *Echistephanocolpites meghalayaensis* and *Malvacearumpollis* sp. The stratigraphic distribution of different species is given in Table 1.

Table 1

Groups	BARAIL			SURMA			
Formations	Laisong	Jenam	Renji	Bhuban			Bokabil
Taxa Members				Lubha	Umkiang	Dona	
Bombacacidites inausus	+	—	—	—	—	—	—
Verrutricolpites sp.	+	—	—	—	—	—	—
Gemmastephanocolpites sp.	+	—	—	—	—	—	—
Triporopollenites sp.	+	—	—	—	—	—	—
Proxapertites sp.	—	—	—	+	—	—	—
Spinainaperturites sp. A	—	—	—	+	—	—	—
Verrualetes sp.	—	—	—	+	—	—	—
Retipilonapites delicatissimus	—	—	—	—	+	—	—
Spinainaperturites sp. B	—	—	—	—	+	—	—
Couperipollis robustus	—	—	—	—	+	—	—
Verrualetes assamicus	—	—	—	—	+	—	—
Echistephanocolpites sp. cf. *E. echinatus*	—	—	—	—	+	—	—
Couperipollis ramanujamii	—	—	—	—	—	+	—
C. donaensis	—	—	—	—	—	+	—
Couperipollis sp. cf. *C. wodehousei*	—	—	—	—	—	+	—
Trifossapollenites constatus	—	—	—	—	—	+	—
Retitrescolpites sp.	—	—	—	—	—	+	—
Palmidites maximus	—	—	—	—	—	+	—
Assamiapollenites sp.	—	—	—	—	—	—	+
Tricolpites sp.	+	+	—	—	—	—	—
Stephanoporopollenites sp.	+	+	—	—	—	—	—
Echistephanocolpites meghalayaensis	+	—	—	+	+	+	—
Polyadopollenites sahii	+	+	+	+	+	+	—
Malvacearumpollis sp.	+	+	+	+	+	+	+

Palynofloral Comparison

North-eastern India

The Barail palynofloras have been recorded by Baksi (1962), Salujha, Kindra and Rehman (1972, 1974), Banerjee, Misra and Koshal (1973), Sein and Sah (1974) and Singh and Tewari (1979) whereas the Surma palynoassemblages have been described by Baksi (1962), Banerjee (1964) and Salujha, Rehman and Kindra (1973). A comparison of the present Barail and Surma assemblages with the above mentioned assemblages is given ahead in order to point out the similarities and differences amongst them.

Barail Palynoflora—Baksi (1962) described palynomorphs from the Simsang River section, South Shillong Front, Meghalaya and recognized four palynozones. Of these, the 3rd zone is assigned to Oligocene age. The palynotaxa present in the 3rd zone of Simsang River section but absent from the present assemblage are : Gemmate-syncolpate pollen, *Bauhinia burdwanensis*, *Tetradopites granularis*, *Spinosopites acolporata*, *Tricolpopites spinosa*, *T. prolati*, *T. shorti*, *Tricolporipites minima*, *T. dicoti*, *Monocolpopites broadcolpusi* and *Simsangia trispinosa*. The palynotaxa represented in the present Barail assemblage but absent from the 3rd zone of Simsang River section are : *Gemmastephanocolpites* sp., *Tricolpites* sp., *Bombacacidites inausus*, *Stephanoporopollenites* sp., *Polyadopollennites sahii*, *Echistephanocolpites meghalayaensis* and *Malvacearumpollis* sp.

Salujha, Kindra and Rehman (1972) described 42 genera and 65 species from the Palaeogene of Garo Hills, South Shillong Front, Meghalaya. This assemblage is not comparable to the present Barail assemblage as only *Tricolpites*, *Echistephanocolpites* (± = *Stephanocolpites*), *Triporopollenites* and *Stephanoporopollenites* are common to both the assemblages. Similarly, palynoassemblage described by Salujha, Kindra and Rehman (1974) from the Palaeogene of Khasi and Jaintia Hills is also distinct from the present assemblage because the same four genera are common to the two assemblages.

Sein and Sah (1974) attempted for a palynological demarcation between the Eocene and Oligocene sediments exposed along the Jowai-Badarpur Road Section. According to them, *Meyeripollis* is a significant genus in the Oligocene sediments but in the present assemblage from the same area, the present authors have not been able to recover this genus. However, *Polyadopollenites* and *Echistephanocolpites* (± = *Stephanocolpites*) are common to both the assemblages.

Banerjee, Misra and Koshal (1973) reported palynofossils from the Tertiary subcrops of Upper Assam. Of these, only *Echistephanocolpites* (± = *Stephanocolpites*) is present in both the assemblages. Hence both the assemblages are dissimilar.

Singh and Tewari (1979) published palynoflora from the Barail Group of Upper Assam which is also not comparable to the present assemblage. However, *Tricolpites* is the only genus common to both the assemblages.

Surma Palynoflora—Baksi (1962) established 4 biozones in the Simsang River section, South Shillong Front, Meghalaya. Of these, the 4th palynozone is assigned to Miocene age. The palynotaxa present in the present Surma assemblage but absent from the zone-4 of Simsang River section, Meghalaya are : *Retipilonapites delicatissimus*, *Verrualetes assamicus*, *Verrualetes* sp., *Assamiapollenites* sp., *Spinainaperturites* spp. A & B, *Palmidites maximus*, *Couperipollis robustus*, *C. donaensis*, *C. ramanujamii*, *Trifossapollenites constatus*, *Polyadopollenites sahii*, *Echistephanocolpites meghalayaensis* and *Malvacearumpollis* sp. The palynotaxa present in the 4th zone of Simsang River section and absent from the present assemblage are : *Polygonaceaepites zonoides*, *Tricolpopites radiistriaei*, *T. granulosa*, *T. spinosa*, *Spinosopites acolporata*, *Bauhinia burdwanensis* and gemmate—synocolpate pollen.

Banerjee (1964) published some palynotaxa from the Surma sediments (Miocene) of Garo Hills, Meghalaya. Of this assemblage, *Palmidites* (±=*Monocolpites*) and *Echistephanocolpites* (±=*Stephanocolpites*) also occur in the present Surma assemblage. A comparative study reveals that the assemblage of Garo Hills is not closely comparable to the present assemblage.

Salujha, Rehman and Kindra (1973) attempted a palynological demarcation of Bhuban and Bokabil sediments exposed along the southern edge of Shillong Plateau. The only genus common to this and the present Surma assemblage is *Couperipollis*. The palynotaxa present in the Bhuban and Bokabil sediments of South Shillong Front but absent from the Surma Group of the present section are : *Dicolpopollis*, *Marginipollis*, *Favitricolporites*, *Ilexpollenites*, *Stephanoporopollenites*, *Ovoidites*, *Paleocaesalpiniaceaepites*, *Tetracolporites*, *Striadiporites*, *Nyssapollenites* and *Triporopollenites*. The following palynotaxa of the present Surma assemblage are completely unrepresented in the Surma assemblage recorded by Salujha *et al.* (1973) : *Verrualetes*, *Retipilonapites*, *Spinainaperturites*, *Proxapertites*, *Echistephanocolpites*, *Gemmastephanocolpites*, *Trifossapollenites*, *Retitrescolpites*, *Polyadopollenites* and *Malvacearumpollis*. The two assemblages, therefore, do not appear to be closely comparable.

Eastern India

Baksi (1972) made a detailed palynostratigraphic study of the Upper Mesozoic and Tertiary succession of Bengal Basin, subdividing it into 7 palynological zones. Of these, the 4th zone is assigned to Oligocene and 5th zone to Miocene age.

The palynoflora present in the 4th zone of Bengal Basin (Baksi, 1972) and absent from the present Barail assemblage are : *Meyeripollis naharkotensis*, *Bauhinia burdwanensis*, *Spinosopites acolporata*, *Tricolpopites spinosus*, *T. shorticus* and *Cupuliferoidaepollenites liblarensis* whereas reverse is the case with *Gemmastephanocolpites* sp., *Bombacacidites inausus*, *Triporopollenites* sp., *Stephanoporopollenites* sp., *Polyadopollenites sahii*, *Echistephanocolpites meghalayaensis* and *Malvacearumpollis* sp.

The palynotaxa present in the 5th zone of Bengal Basin (Baksi, 1972) and absent from the present Surma assemblage are : *Barringtonia*, *Polygonaceaepites zonoides* and *Bauhinia burdwanensis*. The palynotaxa represented in the present Surma assemblage and absent from the 5th zone of Bengal Basin are : *Retipilonapites delicatissimus*. *Verrualetes assamicus*, *Verrualetes* sp., *Assamiapollenites* sp., *Spinainaperturites* spp. A & B, *Palmidites maximus*, *Retitrescolpites* sp., *Trifossapollenites constatus*, *Polyadopollenites sahii*, *Echistephanocolpites meghalayaensis* and *Malvacearumpollis* sp.

Western India

Kar (1979) reported a rich palynoflora, being represented by 39 genera and 33 identifiable species, from the Maniyara Fort Formation (Oligocene) of Kachchh, Gujarat. Amongst them, 12 genera and 9 species belong to angiospermous pollen grains. The following palynotaxa of this assemblage have also been recorded from the present Barail assemblage : *Tricolpites*, *Triporopollenites*, *Stephanoporopollenites* and *Malvacearumpollis*. The palynotaxa represented in the present Barail assemblage but absent from the Maniyara Fort assemblage of Kachchh are : *Bombacacidites*, *Polyadopollenites*, *Echistephanocolpites*, *Verrutricolpites* and *Gemmastephanocolpites* whereas reverse is the case with *Couperipollis*, *Proxapertites*, *Trisyncolpites*, *Araliaceoipollenites*, *Retibrevitricolpites*, *Paleosantalaceaepites* and *Monoporopollenites*. The above account indicates that the two assemblages are broadly comparable.

Andaman Islands

Banerjee (1966) reported 10 genera and 17 species from the Port Blair Formation (Palaeogene) of Andaman Islands. Two genera in common with the Palaeogene assemblage of Port Blair Formation and the present Barail assemblage are : *Tricolpites* and *Echistephanocolpites* (± = *Stephanocolpites*).

Mathur & Mathur (1980) described 6 genera and 7 species of angiospermous pollen grains from Baratang Formation, Andaman Islands. Of these, only *Tricolpites* is present in both the assemblages. Hence the two assemblages are different from each other.

Southern India

Ramanujam (1966) reported 54 genera and 83 species of palynomorphs from South Arcot lignite, Tamil Nadu, wherein angiospermous pollen grains are the dominant constituents. The assemblage is distinctly different from the present assemblage as only three genera, viz., *Retipilonapites*, *Spinainaperturites* and *Polyadopollenites* are common to both the assemblages.

Navale and Misra (1979) described 11 genera and 21 species of angiospermous pollen grains from the Neyveli lignite, Tamil Nadu. Of these , only *Malvacearumpollis* is present in both the assemblages. Hence the two assemblages are dissimilar.

Rao and Ramanujam (1978) described 14 genera and 20 species assignable to pteridophytic spores and monocotyledonous pollen grains from the Quilon Beds of Kerala. The angiospermous pollen genera common to the two assemblages are : *Retipilonapites*, *Spinainaperturites* and *Couperipollis*. In 1982, the same authors reported 54 genera and 62 species of dicotyledonous pollen grains from the Quilon Beds of Kerala. Except for *Retitrescolpites*, none of the genera of this assemblage is represented in the present Surma assemblage.

Kar and Jain (1981) reported 44 genera and 56 species from the Quilon Beds and Warkalli lignite of Kerala. Of these, 20 genera and 32 species are represented by the angiospermous pollen grains. This assemblage is very distinct from the present assemblage though *Palmidites maximus*, *Proxapertites*, *Tricolpites* and *Malvacearumpollis* are common to both the assemblages.

The palynological assemblage described by Venkatachala and Rawat (1973) from the subsurface Oligocene-Miocene sediments of Cauvery Basin is not largely comparable with the present assemblage. However, common palynomorphs between the two assemblages are : *Spinainaperturites*, *Couperipollis*, *Tricolpites*, *Bombacacidites*, *Echistephanocolpites* (± = *Stephanocolpites*) and *Malvacearumpollis*.

The above discussion makes it clear that the present angiospermous pollen assemblage is not closely comparable with those from the various Oligocene-Miocene sediments of India. However, Maniyara Fort assemblage from Kachchh is broadly comparable with the present Barail assemblage.

References

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

BAKSI, S. K. (1972). On the palynological biostratigraphy of Bengal Basin. *Proc. Sem. Paleopalynol. Indian Stratigr., Calcutta*, : 188-206.

BANERJEE, D. (1964). A note on the microflora from Surma (Miocene) of Garo Hills, Assam. *Bull. geol. min. metall. Soc. India*, **29** : 1-8.

BANERJEE, D. (1966). A note on Tertiary microflora from Andaman Islands, India. *Pollen Spores*, **8**(1) : 205-212.

BANERJEE, D., MISRA, C. M. & KOSHAL, V. N. (1973). Palynology of the Tertiary subcrops of Upper Assam. *Palaeobotanist*, **20**(1) : 1-6.

BISWAS, B. (1962). Stratigraphy of the Mahadeo, Langpar, Cherra and Tura formations, Assam, India. *Bull. geol. min. metall. Soc. India*, **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. Z. Geol. Surv. Palaeontol. Bull.*, **22** : 1-77.

COUPER, R. A. (1960). New Zealand Mesozoic and Cainozoic plant microfossils. *N. Z. Geol. Surv. Palaeontol. Bull.*, **32** : 1-82.

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.

ERDTMAN, G. (1947). Suggestions for the classification of fossil and recent pollen grains and spores. *Svensk. bot. Tidskr.*, **41**(1) : 104-114.

IBRAHIM, A. C. (1933). Sporenformen des Aegirhorizonts des Ruhr-Reviers. *Diss. Konard Triltsch, Wurzburg*, 1-47.

IVERSEN, J. & TROELS-SMITH, J. (1950). Pollenmorfologiske definitioner og typer *Danmarks. Geol. Unders.*, **3**(8) : 1-52.

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. & JAIN, K. P. (1981). Palynology of Neogene sediments around Quilon and Varkala, Kerala coast, South India-2. Spores and pollen grains. *Palaeobotanist*, **27**(2) : 113-131.

LUBER, A. A. (1935). Les types petrographiques de Charbons fossiles du Spitzbergen. *Chim. Combust. solide*, **6.**

MALYAVKINA, W. S. (1949). Identification of spores and pollen of the Jurassic and Cretaceous VNIGRI *Tr. All Union Petrol. Sci. Res. Geol. expl. Inst.*, **33** : 137. (in Russian).

MATHUR, Y. K. & MATHUR, K. (1980). Barail (Laisong) palynofossils and late Oligocene nanofossils from the Andaman Island, India. *Geosci. Jour.*, **1**(2) : 51-66.

NAGY. E. (1962). New pollen species from the Lower Miocene of the Bakony Mountain (Varpalota) of Hungary. *Acta bot.*, **8**(1-2) : 153-163.

NAUMOVA, S. N. (1939). The spores and pollen of the coals of U. S. S. R. *Rec. 17th. Int. Geol. Congr. Moscow*, **1** : 353-364.

NAVALE, G. K. B. & MISRA, B. K. (1979). Some new pollen grains from Neyveli lignite, Tamil Nadu, India. *Geophytology*, **8**(2) : 226-239.

PANT, D. D. (1954). Suggestions for the classification and nomenclature of fossil spores and pollen grains, *Bot. Rev.*, **20** : 33-60.

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

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 generalregister Zu Teil I-III. *Beih. Geol. Jb.*, **39** : 1-189.

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

POTONIÉ, R. & KREMP, G. O. W. (1954). Die Gattungen der Palaeozoischen *Sporae dispersae* und ihre Stratigraphie *Goel. Jb.*, **69** : 111-194.

POTONIÉ, R. & SAH, S. C. D. (1967). Sporae dispersae of the lignites from Cannanore beach on the Malabar coast of India. *Palaeobotanist*, **7**(2) : 121-135.

RAMANUJAM, C. G. K. (1966). Palynology of the Miocene lignite from South Arcot district, Madras, India. *Pollen Spores*, **8**(1) : 149-203.

RAO, K. P. & RAMANUJAM, C. G. K. (1978). Palynology of the Neogene Quilon Beds of Kerala state in South India-I. Spores of pteridophytes and pollen of monocotyledons. *Palaeobotanist*, **25** : 397-427.

RAO, K. P. & RAMANUJAM, C. G. K. (1982). Palynology of the Quilon Beds of Kerala state in South India II. Pollen of dicotyledons and discussion. *Palaeobotanist*, **30**(1) : 68-100.

RAO, M.R. (in press). Palynology of the Barail (Oligocene) and Surma (Lower Miocene) sediments exposed along Sonapur-Badarpur Road Section, Jaintia Hills (Meghalaya) and Cachar (Assam). Part-IV. Gymnospermous pollen grains. *Geophytology*.

RAO, M. R. & SINGH, H. P. (in press). 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.*

ROUSE, G. E. (1957). The application of a new nomenclatural approach to Upper Cretaceous plant microfossils from western Canada. *Canad. J. Bot.*, **35** : 349-375.

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. (1966). Palynostratigraphy of the sedimentary formations of Assam. 1. Stratigraphical position of the Cherra Formation. *Palaeobotanist*, **15**(1-2) : 72-86.

SALUJHA, S. K. & KINDRA, G. S. (1981). Palynological fossils from the Langpar Formation exposed along South Shillong Front, Meghalaya, India, *Geosci. Jour.*, **2**(1) : 43-62.

SALUJHA, S. K., KINDRA, G. S. & REHMAN, K. (1972). Palynology of the South Shillong Front Part-1. The Palaeogene of Garo Hills. *Proc. Sem. palaeopalynol. 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.

SALUJHA, S. K., REHMAN, K. & KINDRA, G. S. (1973). Distinction between the Bhuban and Bokabil sediments on the southern edge of Shillong Plateau based on palynofossil assemblages. *Bull. Oil. Nat. Gas. Commn*, **10**(1-2) : 109-117.

SAXENA, R. K. (1979). Palynology of the Matanomadh Formation in type area, north-western Kutch, India (Part-2). Systematic description of gymnospermous and angiospermous pollen grains. *Palaeobotanist*, **26**(2) : 130-143.

SAXENA, R. K. (1982). Taxonomic study of the polycolpate pollen grains from the Indian Tertiary sediments with special reference to nomenclature. *Rev. Palaeobot. Palynol.*, **37** : 283-315.

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. Dinoflagellate cysts. *J. Palaeont. Soc. India*, **29**: 52-62.

SAXENA, R. K. & SINGH, H. P. (1982). Palynological investigation of the Upper Siwalik sediments exposed along Hoshiarpur-Una Road section in Punjab and Himachal Pradesh. *Geophytology*, **12**(2) : 287-306.

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.

SEIN, M. K. & SAH, S. C. D. (1974). Palynological demarcation of Eocene-Oligocene sediments in the Jowai-Badarpur road section, Assam. *Symp. Strat. Palynol. Spl. publs. Birbal Sahni Inst. Palaeobot* : 99-105.

SINGH, H. P. & SAXENA, R. K. (1981). Palynology of the Upper Siwalik sediments in Una district, Himachal Pradesh. *Geophytology*, **11**(2) : 173-181.

SINGH, H. P. & SAXENA, R. K. (1984). Palynology of the Neogene sediments of Jorajan Well-3, Upper Assam. *Proc. Symp. Evolutionary Botany & Biostratigraphy. Prof. A. K. Ghosh. Commemoration Volume* : 613-631.

SINGH, H. P., SAXENA, R. K. & RAO, M. R. (in press). 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.*

SINGH, R. Y (1975). Morphological study of the *Retialeles complex* from Indian Tertiaries. *Geophytology*, **5**(1) : 93-104.

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

SINGH, R. Y. & TEWARI, B. S. (1979). A note on the palynostratigraphy of the Tertiary sediments of Upper Assam. *Bull. Ind. Geol. Assoc.*, **12**(2) : 151-159.

THIERGART, F. (1940). Die Mikropaläontologie als pollen analyse in Dienst der Braunkohlen forschung. *Brenn. geol.* **13** : 1-82.

THOMSON, P. W. & PFLUG, H. (1953). Pollen und Sporen des Mitteleuropäischen Tertiärs. *Palaeontographica*, **94B** : 1-138.

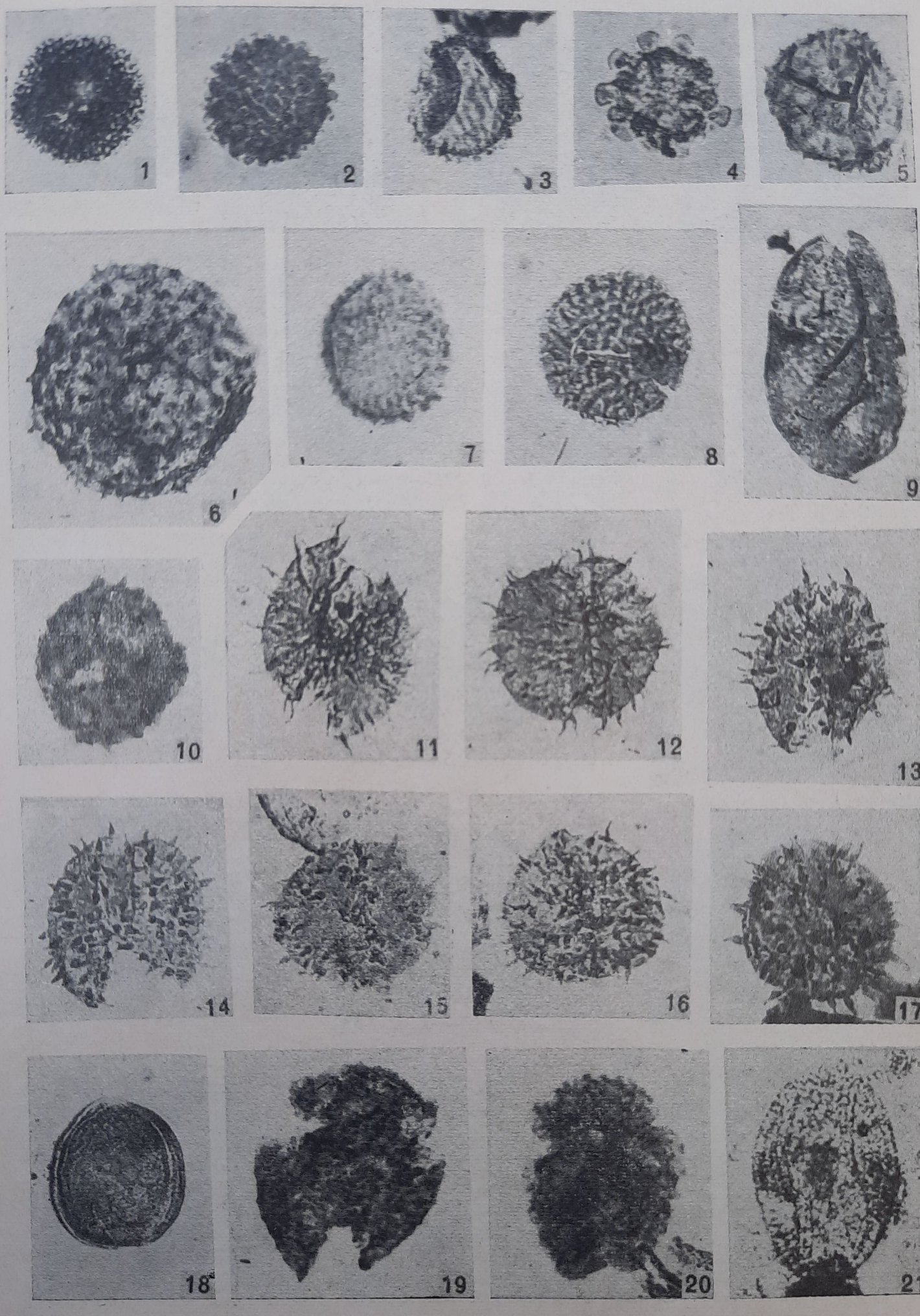
VAN DER HAMMEN, T. (1954). El desarrollo de la flora Colombiana en los periodos geologicos 1. Maestrichianto Hasta Ter Ciario mas Inferior. *Boln geol., Bogota*, **2**(1): 49-106.

VAN DER HAMMEN (1956). A palynological systematic nomenclature. *Boln geol. Bogota*, **4** (2 & 3) : 63-101.

VAN DER HAMMEN, T. & GARCIA DE MUTIS, C. (1965). The Paleocene pollen flora of Colombia. *Leidse. Geol. Mededel.* **35** : 105-116.

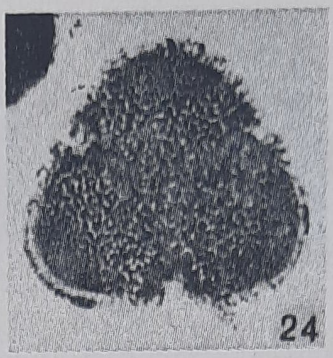
VENKATACHALA, B. S. & KAR, R. K. (1969). Palynology of the Tertiary sediments of Kutch-1. Spores and pollen from bore hole No. 14. *Palaeobotanist*, **17**(2) : 157-178.

VENKATACHALA, B. S. & RAWAT, M. S. (1973). Palynology of the Tertiary sediments in the Cauvery


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21


22


23


24

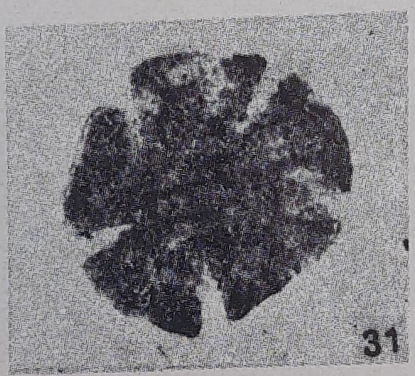

25

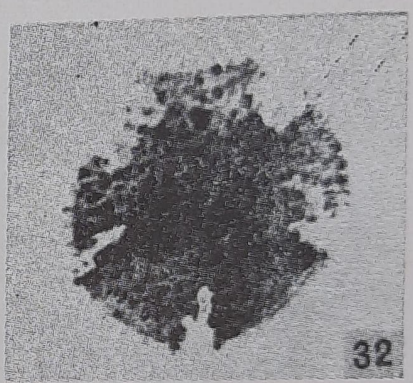

26

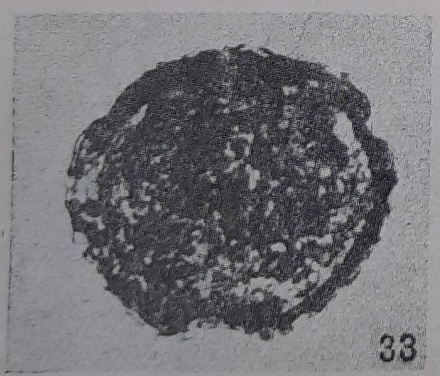

28


29

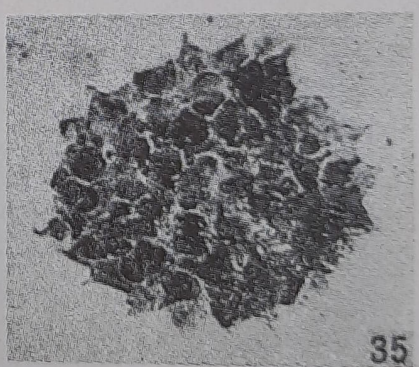

30

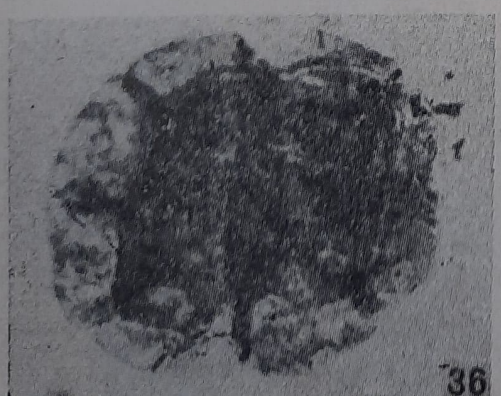

31

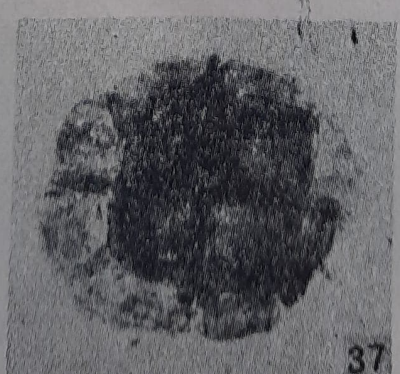

32

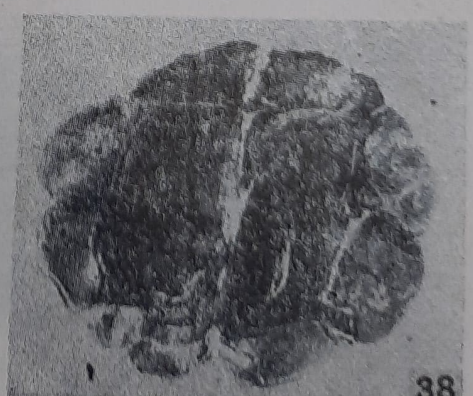

33


34


35


36


37


38

Basin-2. Oligocene-Miocene palynoflora from the subsurface. *Palaeobotanist*, **20**(2) : 238-263

VIMAL, K. P. (1952). Spores and pollen from Tertiary lignites from Dandot, West Punjab (Pakistan). *Proc. Indian Acad. Sci.*, **36** : 135-147.

WIJMSTRA, T. A. (1971). The palynology of the Guiana coastal basin. Publ. No. 56, Hugo de Vries Laboratory, Amsterdam, C : 1-62.

Explanation of Plates

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

PLATE 1

1. *Retipilonapites delicatissimus* Ramanujam, Slide no. 8735, Coordinates 58.0×97.5.
2. *Verrualetes assamicus* Singh & Saxena, Slide no. 8736, Coordinates 52.2×104.3.
3. *Verrualetes* sp., Slide no. 8737, Coordinates 52.2×103.7.
4. *Assamiapollenites* sp., Slide no. 8410, Coordinates 66.0×102.8.
5,6. *Spinainaperturites* sp. A, Slide nos. 8733, Coordinates 68.2×102.3; 8138 Coordinates 46.2×102.5.
7,8. *Spinainaperturites* sp. B, Slide nos. 8739, Coordinates 73.7×113.4; 8407, Coordinates 43.3×109.3.
9. *Palmidites maximus* Couper, Slide no. 8740, Coordinates 61.5×98.8.
10. *Couperipollis robustus* Saxena, Slide no. 8399, Coordinates 63.0×105.1.
11-13. *Couperipollis donaensis* sp. nov., Slide nos. 8741, Coordinates 51.5×104.3; 8409, Coordinates 37.4×105.6 (Holotype) ; 8409, Coordinates 33.0×93.9.
14-16. *Couperipollis ramanujamii* sp. nov., Slide nos. 8742, Coordinates 67.4×93.1; 8742, Coordinates 39.2×109.4; 8741, Coordinates 62.0×103.7 (Holotype).
17. *Couperipollis* sp. cf. *C. wodehousei* (Biswas) Venkatachala & Kar, Slide no. 8742, Coordinates 68.8×101.5.
18. *Proxapertites* sp., Slide no. 8743, Coordinates 65.4×112.1.
19. *Verrutricolpites* sp., Slide no. 8744, Coordinates 67.7×112.5.
20. *Tricolpites* sp., Slide no. 8745, Coordinates 66.2×101.3.
21. *Retitrescolpites* sp., Slide no. 8746, Coordinates 55.7×106.3.

PLATE 2

22. *Trifossapollenites constatus* Dutta & Sah, Slide no. 8404, Coordinates 43.3×101.7.
23-26. *Bombacacidites inausus* Venkatachala & Rawat, Slide nos. 8747, Coordinates 31.2×105.8;8748, Coordinates 40.8×106.4; 8749, Coordinates 68.7×113.3; 8750, Coordinates 56.2×105.5.
27-30. *Echistephanocolpites meghalayaensis* sp. nov., Slide nos. 8414, Coordinates 54.9×105.9; 8751, Coordinates 67.0×107.0; 8752, Coordinates 5.4×100.8; 8116, Coordinates 54.2×112.3 (Holotype).
31. *Echistephanocolpites* sp. cf. *E. echinatus* Wijmstra, Slide no. 8753, Coordinates 56.2×118.2.
32. *Gemnastephanocolpites* sp., Slide no. 8754, Coordinates 69.6×111.8.
33. *Triporopollenites* sp., Slide no. 8755, Coordinates 31.4×108.7.
34. *Stephanoporopollenites* sp., Slide no. 8756, Coordinates 63.4×108.6.
35. *Malvacearumpollis* sp., Slide no. 8403, Coordinates 65.4×108.5.
36-38. *Polyadopollenites sahii* sp. nov., Slide nos. 8757, Coordinates 42.5×118.2; 8396, Coordinates 45.3×102.2; 8758, Coordinates 42.5×118.2 (Holotype).