

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

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Abstract

The gymnospermous pollen grains recovered from the Barail (Oligocene) and Surma (Lower Miocene) sediments exposed along Sonapur-Badarpur Road Section, Meghalaya and Assam are represented by five genera and seven species, of which three species, viz., *Podocarpidites meghalayaensis*, *Pinuspollenites foveolatus* and *Abiespollenites surmaensis* have been proposed to be new. An analysis of the assemblage reveals that gymnospermous pollen grains have higher percentage of occurrence in the Surma Group than in the Barail Group.

Introduction

The Barail and Surma sediments are excellently exposed along Sonapur-Badarpur Road, Jaintia Hills (Meghalaya) and Cachar (Assam). Palynological assemblage recovered from these sediments consists of dinoflagellate cysts, fungal remains, pteridophytic spores, gymnospermous and angiospermous pollen grains. The study of the dinoflagellate cysts, fungal remains and pteridophytic spores has already been done by Saxena and Rao (1984), Singh, Saxena and Rao (in press) Rao and Singh (in press). The present paper which constituted the 4th part of the series of the study deals with the systematic description of gymnospermous pollen grains.

The palynological studies on the Tertiary sediments of north-eastern India have been carried out by Biswas (1962), Baksi (1962, 1965), Sah and Dutta (1966, 1968, 1974), Dutta and Sah (1970), Salujha, Kindra and Rehman (1972, 1974), Sein and Sah (1974), Singh (1977a, b), Mehrotra (1981, 1983), etc. These workers mainly worked on the Palaeocene-Eocene sediments whereas the Oligocene-Miocene sediments have largely remained uninvestigated. This paper is therefore deals with systematic description of the gymnospermous pollen grains from the Oligocene-Lower Miocene sediments exposed along the Sonapur-Badarpur Road Section, Meghalaya and Assam. The palynological studies by different workers on the Tertiary sediments of north-eastern India have been discussed by Saxena and Rao (1984).

The area of the present study is a part of the Shillong-Badarpur Highway (National Highway 44; Saxena & Tripathi, (1982) and is located in the south east of Shillong. The Barail Group of this area represented by Laisong, Jenam and Renji formations. The Laisong Formation represents mainly the arenaceous facies consisting of grey, very hard, thinly bedded, very fine to medium grained sandstones alternating with subordinate hard sandy shales. The Jenam Formation is mainly argillaceous and consists of shales and sandy shales with fine to medium grained sandstones. The Renji Formation is again arenaceous in nature and is made up of thickly bedded or massive, fine to medium grained hard

ferruginous sandstone alternated by thin shales. The Renji Formation is unconformably overlain by the Surma Group. This group is divided into Bhuban and Bokabil formations. The Bhuban Formation is divided into Lubha, Umkiang and Dona members; the lower and upper members being mainly arenaceous and the middle member argillaceous. The Bokabil Formation is made up of thick sandy shales with alternation of very fine grained laminated sandstone. The lithostratigraphy of this section has been published by Saxena and Tripathi (1982). The details of rock samples collected from different formations have been discussed by Saxena and Rao (1984). In all, 288 rock samples were collected, of which 216 samples proved to be productive.

For the recovery of palynofossils, samples were treated with HCl, HF and HNO₃ followed by KOH, if required. In many cases, the macerated residue was also acetolysed. The slides were prepared in polyvenyl alcohol and mounted with DPX mountant. The slides, negatives and unused material have been deposited in the repository of the Birlal Sahni Institute of Palaeobotany, Lucknow.

The records of bisaccate pollen grains from the Indian Tertiary sediments are meagre. The pollen grains reported so far have been referred to *Alisporites*, *Pityosporites*, *Podocarpidites*, *Cedripites*, *Coniferaepites*, *Pinuspollenites*, *Abietinaepollenites*, *Abiespollenites*, *Saccites*, *Disaccites*, *Pinus*, *Picea*, *Abies* and *Cedrus*. The latter four taxa reported by Nandi (1972) are after modern genera: *Disaccites* and *Saccites* described by Lukose (1968) and Mathur (1963) respectively are of suprageneric status, and *Coniferaepites* instituted by Biswas (1962) lacks generic diagnosis and designation of type species, hence it is nomen nudem (vide Art. 41. I. C. B. N. Stafleu, 1978). The diagnoses of the various bisaccate pollen genera from the Tertiary sediments are loosely circumscribed. They tend to either overlap or lack sharp quantitative demarcations. At times the diagnosis is incomplete and it ignores reference to some important morphological characters. As such, a lot of confusion prevails in the taxonomy of gymnospermous pollen genera and quite often it becomes difficult to determine correct and precise placement of species under different genera.

To overcome this difficulty and to clearly understand the morphology of the bisaccate pollen grains, pollen grains of living genera, viz., *Picea*, *Pinus*, and *Abies* were studied.

The following characters have been considered important for describing various bisaccate pollen genera and differentiating them from each other.

- i. Overall shape, size of the pollen grain.
- ii. Shape, size and sculpture of the central body.
- iii. Shape, size and sculpture of the sacci.
- iv. Size of sacci relative to the central body.
- v. Nature of attachment of sacci to the central body.
- vi. Width of saccus and free area.
- vii. Development of cap and marginal crest.

In the light of these observations on living bisaccate pollen grains and also on the fossil ones, specimens referable to *Pinuspollenites*, *Piceapollenites* and *Abiespollenites* have been critically studied and discussed in the latter part of the text.

Systematic Palynology

Genus—*PODOCARPIDITES* Cookson ex Couper emend. Potonié, 1958

Type species—*Podocarpidites ellipticus* Cookson, 1947

Podocarpidites classicus Salujha, Kindra & Rehman, 1972
Pl. 1, fig. 1

Remarks—The present specimens vary from those described by Salujha, Kindra and Rehman (1972) in having a narrower furrow and finely foveolate ornamentation of the central body but in all other characters they resemble the latter.

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

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

Affinity—Podocarpaceae.

Podocarpidites meghalayaensis sp. nov.

Pl. 1, figs. 2-3

Holotype—Pl. 1, fig. 2, size 91.5 μm , slide no. 8996.

Type locality—160 km stone (from Shillong), Sonapur-Badarpur Road Section, Meghalaya.

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

Diagnosis—Pollen grains bisaccate, oval elliptical in shape. Size range 75-95 \times 48.5-55 μm . Central body \pm circular in shape, size range 42-46 \times 48-55 μm , reticulate. Sacci diploxytonoid type, \pm hemispherical, size range 50-60 \times 52-55 μm , reticulate ornamentation.

Description—Pollen grains bilateral, central body distinct. Proximal attachment of sacci to corpus equatorial, distal attachment covering major part of the central body, reticulation of central body more clear than that of sacci.

Comparison—*Podocarpidites meghalayaensis* sp. nov. can be distinguished from *P. ellipticus* Cookson (1947) by its bigger size range (75-95 \times 48-55 μm) and pitted microreticulate ornamentation of the central body which is coarser in the latter. *P. khasiensis* Dutta & Sah (1970) differs from the present species by its bigger size range (60 \times 80—98 \times 125 μm) and well developed reticulum. *P. classicus* Salujha, Kindra & Rehman (1972) resembles the present species in ornamentation of the central body but can be distinguished by its smaller size range (46.4—74.4 μm), wider and straight sulcus. *P. cognatus* Kar (1979) also resembles in having microreticulate central body but the former can be distinguished by being haploxytonoid type with a smaller size range (84 μm).

Occurrence—Dona Member, Bhuban Formation, Surma Group.

Affinity—Podocarpaceae.

Podocarpidites sp.

Pl. 1, figs. 4-5

Description—Pollen grains bisaccate, oval in shape. Size range 90-120 \times 45-60 μm . Central body \pm circular, size range 47-57.5, \pm 45-60 μm , margin slightly thickened, finely reticulate, furrow not clearly seen. Sacci diploxytonoid type, attached along the whole body, \pm hemispherical, size range 46-52.5 \times 55-60 μm , ornamented with small meshed intrareticulum, meshes larger towards their equatorial margin.

Comparison—*Podocarpidites* sp. is distinguished from *P. ellipticus* Cookson (1947) by its bigger size range (120 \times 65 μm). *P. khasiensis* Dutta & Sah (1970, pl. 4, fig. 1) closely resembles in its shape, size and ornamentation but is distinct in having bigger sacci than the central body.

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

Affinity—Podocarpaceae.

Genus—*PINUSPOLLENITES* Raatz, ex Potonié, 1958

Type species—*Pinuspollenites labdacus* (Potonié) Raatz, 1937 ex Potonié, 1958

Remarks—The pollen grains of *Pinuspollenites foveolatus* have been recorded for the first time from the Barail and Surma sediments exposed along Sonapur-Badarpur Road Section, Jaintia Hills (Meghalaya) and Cachar (Assam). The frequency of this genus is low in the Laisong and Jenam formations and absent in the Renji Formation. However, its frequency has been in the Bhuban and Bokabil formations. The diagnosis of *Pinuspollenites* by Raatz (1938) and later amended by Potonié (1958) have not been systematically described. The general characters of the extant pollen grains of *Pinus* have been studied and compared with the fossil pollen of *Pinuspollenites*.

Description—The pollen grains are bisaccate and the overall shape is oval. The size range is $54-80 \times 32-55 \mu\text{m}$. The shape of the central body is sub-circular and the size range is $50-55 \times 30-50 \mu\text{m}$. The crest is well-developed and the sculpture is finely reticulate. The shape of the sacchi is kidney-shaped and the size range is $25-55 \times 25-45 \mu\text{m}$. The sacchi are smaller than the central body and the marginal crest is well-developed. The ornamentation of the sacchi is distinctly intrareticulate.

Pinuspollenites foveolatus sp. nov.

Pl. 1, figs. 6-9.

Holotype—Pl. 1, fig. 6, size $61.5 \mu\text{m}$, slide no. 8402.

Type locality—173 km stone (from Shillong), Sonapur-Badarpur Road Section, Meghalaya.

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

Diagnosis—Pollen grains bisaccate, oval in shape. Size range $59-76 \times 41-52 \mu\text{m}$. Central body subcircular to oval in shape, size of central body range $41-48.5 \times 33-49.5 \mu\text{m}$, finely foveolate, crest well-developed. Sacchi diploxylonoid type, bean-shaped, size range $29-55 \times 25-45 \mu\text{m}$, marginal ridge present, ornamented with very fine intrareticulum.

Description—Pollen grains bilateral. Central body having a thick cap, up to $4.5 \mu\text{m}$. Sacchi diploxylonoid type, marginal crest developed with small meshes of intrareticulum. Sculpture of the distal part of the body \pm laevigate to faintly pitted.

Comparison—*Pinuspollenites labdacus* Potonié (1958) closely resembles the present species in organisation but the latter can be distinguished by its finely foveolate ornamentation of the central body. Moreover, in *P. labdacus*, sacchi are bigger than the central body while reverse is the case with the present species.

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

Affinity—*Pinus*.

Genus—*PICEAPOLLENITES* Potonié, 1931

Type species—*Piceapollenites alatus* Potonié, 1931

Remarks—The genus *Piceapollenites* sp. was reported for the first time from the Surma Group (Lower Miocene) of Sonapur-Badarpur Road Section, Jaintia Hills (Meghalaya)

and Cachar (Assam). The present specimens are bigger in size ($75-90 \times 55-63 \mu\text{m}$) than those described by Potonié (70 μm). The line of attachment of sacci to the central body is equal to the diameter of the sacci. The exine of the sacci is fine reticulate. Cap and body can be distinguished easily and the crest is gradually thinning towards the wings and thicker in the middle.

Picea pollenites sp.

Pl. 1, fig. 12

Description—Pollen grains bisaccate, oval in equatorial view. Size range $75-90 \times 55-63 \mu\text{m}$. Central body subcircular in shape, size range $72-80 \times 58-65 \mu\text{m}$, microreticulate sculpture, bigger than sacci. Sacci very closely placed leaving no space in between, hemispherical in shape, size range $35-40 \times 52-60 \mu\text{m}$, ornamented with small meshes, marginal crest developed, crest gradually thinning to the wings though thicker in the middle.

Comparison—*Piceapollenites alatus* Potonié (1937) can be distinguished from the present species by its smaller size (70 μm in length) and comparatively coarser reticulum of the central body. *P. naeransus* Mathur & Mathur (1969) possesses bigger size range (up to 112 μm), thus it is not comparable.

Occurrence—Bhuban and Bokabil formations, Surma Group.

Affinity—*Picea*.

Genus—*ABIESPOLLENITES* Thiergart in Raatz, 1937

Type species—*Abiespollenites absolutus* Thiergart in Raatz, 1937

Remarks—*Abiespollenites surmaensis* was reported for the first time from the Surma Group of Sonapur-Badarpur Road Section, Meghalaya and Assam. This is dominant in the middle part of the Bhuban Formation. The general characters of the extant pollen grains of *Abies* have been studied and compared with the fossil pollen of *Abiespollenites*.

Description—The pollen grains are bisaccate and the overall shape is oval. The size range is $100-135 \times 72-90 \mu\text{m}$. The shape of the central body is \pm oval. The size range is $70-90 \times 60-85 \mu\text{m}$. The central body is bigger than the sacci and the sculpture is finely reticulate. The shape of the sacci is kidney-shaped and the size range is $65-80 \times 55-75 \mu\text{m}$. Cap is thick coarse and sharply differs from the distal part of the grain. The crest is narrow in the centre, widening to the sacci and again getting narrow in the centre. The sacci are sharply separated from the body forming an angle between the outer margin of the body and its proximal region. The exine of the saccus is coarsely intrareticulate.

Abiespollenites surmaensis sp. nov.

Pl. 1, figs. 10, 11

Holotype—Pl. 1, fig. 11, size 120 μm , slide no. 8402

Type locality—150-1 km stone (from Shillong), Sonapur-Badarpur Road Section, Meghalaya.

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

Diagnosis—Pollen grains bisaccate, oval in shape. Size range $110-135 \times 80-85 \mu\text{m}$. Central body \pm circular to oval in shape, size range $71-85 \times 66-82 \mu\text{m}$, sculpture pitted. Sacci \pm kidney-shaped, size range $70-75 \times 60-70 \mu\text{m}$, sacci forming an angle with the outer margin of the body, ornamented with fine intrareticulum,

Description—Pollen grains bilateral. Sacci smaller than the central body, sharply separated from the body forming an angle with the outer margin of the body. Cap thick, coarse, sometimes thickness variable, distal exine thicker, crest narrower in the centre and widening towards the wings. Sacci always not clear due to folding, distantly placed, ornamented with intrareticulum, meshes small, up to 3 μm in diameter.

Comparison—*Abiespollenites absolutus* Thiergart in Raatz (1937) differs from the present species by its granulose sculpture of the central body.

Occurrence—Bhuban Formation, Surma Group.

Affinity—*Abies*.

Genus—*LARICOIDITES* Potonié, Thomson & Thiergart 1950 ex Potonié, 1958

Type species—*Laricoidites magnus* (Potonié) Potonié, Thomson & Thiergart, 1950

Laricoidites punctatus Saxena, 1979

Pl. 1, figs. 13-14

Distribution—Palaeocene of Kaechhh, Gujarat (Saxena, 1979).

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

Affinity—Unknown.

Discussion

The gymnospermous pollen grains described are populated by 5 genera and 7 species. Of these, *Podocarpidites meghalayaensis*, *Pinuspollenites foveolatus* and *Abiespollenites surmaensis* have been proposed to be new. Quantitative analysis of the gymnospermous pollen grains reveals that in Laisong and Jenam formations they constitute 12.5% and 6.5% respectively. In Renji Formation, they are completely absent whereas their frequency is very high in Bokabil Formation (60.5%) and Bhuban Formation (26%). The distribution of the various species has been given below in Table 1.

Table 1

Groups Formations Members Taxa	BARAIL			SURMA			Bokabil
	Laisong	Jenam	Renji	Lubha	Bhuban Umkiang	Dona	
<i>Podocarpidites classicus</i>	+	+	—	+	+	+	—
<i>Podocarpidites meghalayaensis</i>	—	—	—	—	—	+	—
<i>Podocarpidites</i> sp.	+	+	—	—	—	+	—
<i>Pinuspollenites foveolatus</i>	+	+	—	+	+	+	+
<i>Piceapollenites</i> sp.	—	—	—	+	+	+	+
<i>Abiespollenites surmaensis</i>	—	—	—	+	+	+	+
<i>Laricoidites punctatus</i>	+	+	—	+	—	+	—

The rich representation of gymnospermous pollen grains in the Surma Group may be due to their derivation from the nearby upland region towards north of the present area.

It appears likely that the Himalayan chain would have been sufficiently high resulting into the gradual cooling of the climate during the Miocene epoch to support gymnospermous flora and would have been responsible for their abundant occurrence in the Surma sediments.

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Explanation of Plate

(All photomicrographs are enlarged, ca. $\times 500$, coordinates of the specimen refer to the stage of the Censico microscope no. 13167).

1. *Podocarpidites classicus* Salujha, Kindra & Rehman, slide no. 8995, Coordinates 54.2 \times 102.9.
- 2-3. *Podocarpidites meghalayaensis* sp. nov., slide nos. 8996, Coordinates 49.9 \times 93.9 (Holotype); 8395, Coordinates 66.6 \times 102.2.
- 4-5. *Podocarpidites* sp., Slide nos. 8997, Coordinates 66.8 \times 99.2; 8998, Coordinates 43.8 \times 99.4
- 6-9. *Pinuspollenites foveolatus* sp. nov., slide nos. 8412, Coordinates 56.9 \times 110.9 (Holotype); 8400, Coordinates 41.1 \times 100.0; 8406, Coordinates 42.5 \times 107.5; 8999, Coordinates 60.8 \times 102.8
- 10-11. *Abiespollenites surmaensis* sp. nov., slide nos. 9000, Coordinates 44.5 \times 114.2; 8402, Coordinates 65.7 \times 100.6 (Holotype).
12. *Piceapollenites* sp., slide no. 8402, Coordinates 67.2 \times 112.2.
- 13-14. *Laricoidites punctatus* Saxena, slide nos. 8394, Coordinates 41.1 \times 100.5, 9001, Coordinates 62.0 \times 114.8.

