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Palynology of the Barail (Oligocene) and Surma (Lower Miocene) sediments exposed along Sonapur-Badarpur Road Section, Jaintia Hills (Meghalaya) and Cachar (Assam). Part-VI. Palynostratigraphic zonation

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Excellent exposures of Barail and Surma groups are developed along the sonapur-Badarpur Road Section in Jaintia Hills (Meghalaya) and Cachar (Assam). Frequency analysis and variation pattern observed in the palynoassemblage from these sediments provide ample evidence for their biostratigraphic zonation. On the basis of the first appearance, maximum development and decline of the various palynofossils, six cenozones have been recognized in the sequence. These are in ascending order: (i) *Polysphaeridium subtile* Cenozone, (ii) *Todisporites major* Cenozone, (iii) *Lygodiumsporites eocenicus* Cenozone, (iv) *Striatriletes sinuosus* Cenozone, (v) *Pinuspollenites foveolatus* Cenozone, and (vi) *Malayaeaspora costata* Cenozone. A formal description of each cenozone, as to their type section, lithology, thickness, nature of contacts, restricted and characteristic spore-pollen species and other salient features, if any, have also been given. The lateral extension of these cenozones has a potential in the correlation and demarcation of equivalent strata in other parts of this region.

Key-words—Palynostratigraphy, Barail-Surma groups, Oligocene-Lower Miocene, Meghalaya-Assam (India).

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सारॉंश

जयन्तिया पहाड़ियों (मेघालय) एवं कछार (असम) में सोनपुर-बदरपुर मार्ग खंड के संग-संग विगोपित सूरमा (अधरि मध्यनूतन) एवं बैरेल (अल्पनूतन) अवसादों का परागाणविक अध्ययन. भाग 6—परागाणुस्तरिक मंडलन

रमेश कुमार सक्सेना, मलागलापल्ली रामचन्द्र राव एवं हरिपाल सिंह

जयन्तिया पहाड़ियों (मेघालय) एवं कछार (असम) में सोनपुर-बदरपुर मार्ग खंड के संग-संग बैरेल एवं सूरमा समूहों के सुस्पष्ट अनावरण विद्यमान हैं। इन अवसादों से उपलब्ध परागाणविक-समुच्चय में प्रेक्षित बारम्बारता विश्लेषण एवं विभिन्नता के ढंग से इनके जैवस्तरिकीय मंडलन हेतु पर्याप्त प्रमाण मिले हैं। प्रथम प्रादुर्भाव, अधिकतम् विकास एवं विभिन्न परागाणविकरूपकों के निम्नीकरण के आधार पर इस अनुक्रम में छः नवमंडल अभिनिर्धारित किये गये हैं। आरोही क्रम में ये (अ) पोलिस्फ़ेयरीडियम् सबटिल नवमंडल, (आ) टॉडिस्पोराइटिस मेजर नवमंडल, (इ) लाइगोडियमस्पोराइटिस ईओसेनिकस नवमंडल, (ई) स्ट्रआट्राइलिटीज़ साइनुओसस नवमंडल, (ए) पाइनसपोलिनाइटिस फ़ोविओलेटस नवमंडल, तथा (ऐ) मलायाइआस्पोरा कोस्टेटा नवमंडल हैं। प्रत्येक नवमंडल का एक संक्षिप्त विवरण दिया गया है जिसमें उनका प्रारूप खंड, शैलिकी, मोटाई, सम्पर्श प्रकृति, सीमित एवं लाक्षणिक जातियाँ तथा अन्य मुख्य लक्षण सम्मिलित हैं। इन नव-मंडलों के पार्श्व विस्तार से इस क्षेत्र के अन्य भागों में विद्यमान समतुल्य स्तरों के सहसम्बन्धन तथा परिसीमन में सहायता मिली है।

A FIELD study of the Tertiary sediments of north-eastern India reveals that various rock formations developed in this region are subjected to a large scale lateral variation and therefore lithological markers prove to be of limited value in stratigraphic correlation and demarcation of various levels therein. In such cases, biostratigraphic zones play an important role in demarcation and identification of stratal sequences and also in dividing them into finer units (zones). These are some of the important aspects of any palaeo-palynological study. A few efforts have so far been made in using the palynofossils for the above purpose by Baksi (1962), Dutta and Sah (1970), Banerjee, Misra and Koshal (1973), Sah and Dutta (1974) and Sah and Singh (1974),

as far as the Tertiary sediments of north-eastern India are concerned.

The authors have studied the palynology of the Barail (Oligocene) and Surma (Lower Miocene) sediments exposed along the Sonapur-Badarpur Road Section in Jaintia Hills (Meghalaya) and Cachar (Assam). Systematic description of the palynofossils recovered from this section has been published by Rao (1983), Singh and Rao (1984), Saxena and Rao (1984), Rao *et al.* (1985), Rao (1986), Singh *et al.* (1986) and Rao and Singh (MS). The present paper deals with the palynostratigraphic zonation of the Barail-Surma sequence exposed along this section. These zones, when traced laterally, may prove to be helpful in correlation and demarcation of equivalent strata in other parts of north-eastern India.

The palynoassemblages recovered from the Barail (Oligocene) and Surma (Lower Miocene) groups are rich in pteridophytic spores and gymnospermous pollen grains, whereas the angiospermous pollen grains and algal and fungal remains are comparatively less represented. The assemblage consists of 62 genera and 112 species of palynomorphs. Of these, some species have a wide range of distribution while others are restricted to a small stratigraphic interval.

For the quantitative analysis of the assemblage, 200 specimens per sample were counted. However, in cases where the yield was poor, only 150 palynomorphs were counted. The frequencies of all the species per 100 specimens, were calculated and plotted in the range chart under the five slabs, viz., very rare (below 2%), rare (2-10%), common (11-20%), abundant (21-35%) and predominant (above 35%) (Text-fig. 1).

On the basis of the qualitative and quantitative analyses of the palynoflora, it seems possible to divide the Barail-Surma sequence of the present section into six cenozones. To establish and recognize these cenozones, parameters like the first and last appearance of various palynotaxa and their maximum development, decline, restricted occurrence and absence have been taken into consideration. Each cenozone has been formally instituted in accordance with the code of Stratigraphic Nomenclature of India (1971).

PALYNOSTRATIGRAPHY

The six cenozones established in the Barail-Surma sequence of Sonapur-Badarpur Road Section, are given below in the ascending order of stratigraphy.

(vi) *Malayaeaspora costata* Cenozone
(v) *Pinuspollenites foveolatus* Cenozone
(iv) *Striatriletes sinuosus* Cenozone
(iii) *Lygodiumsporites eocenicus* Cenozone
(ii) *Todisporites major* Cenozone
(i) *Polysphaeridium subtile* Cenozone

Polysphaeridium subtile Cenozone

Type section—Lower Laisong Formation exposed along Sonapur-Badarpur Road Section between 140 km and 142 km.*

Lithology—This zone is mainly composed of grey, very hard, thinly bedded, very fine to medium grained sandstones alternating with subordinate hard, sandy shale and intraformational conglomerate. Massive and moderately well bedded sandstones are also common. Generally the shales are carbonaceous. Thickness of this zone is ± 900 m.

Nature of contact—This cenozone constitutes the lower biostratigraphic unit of the Laisong Formation and conformably overlies the Kopili Formation (*Densiverrupollenites eocenicus* Cenozone, Tripathi & Singh, 1984). The upper limit of this cenozone is conformably overlain by the *Todisporites major* Cenozone, which is made up of thick sandstones intercalated with carbonaceous shale bands.

Species restricted to this cenozone—Adnatosphaeridium vittatum, Tricolpites sp.

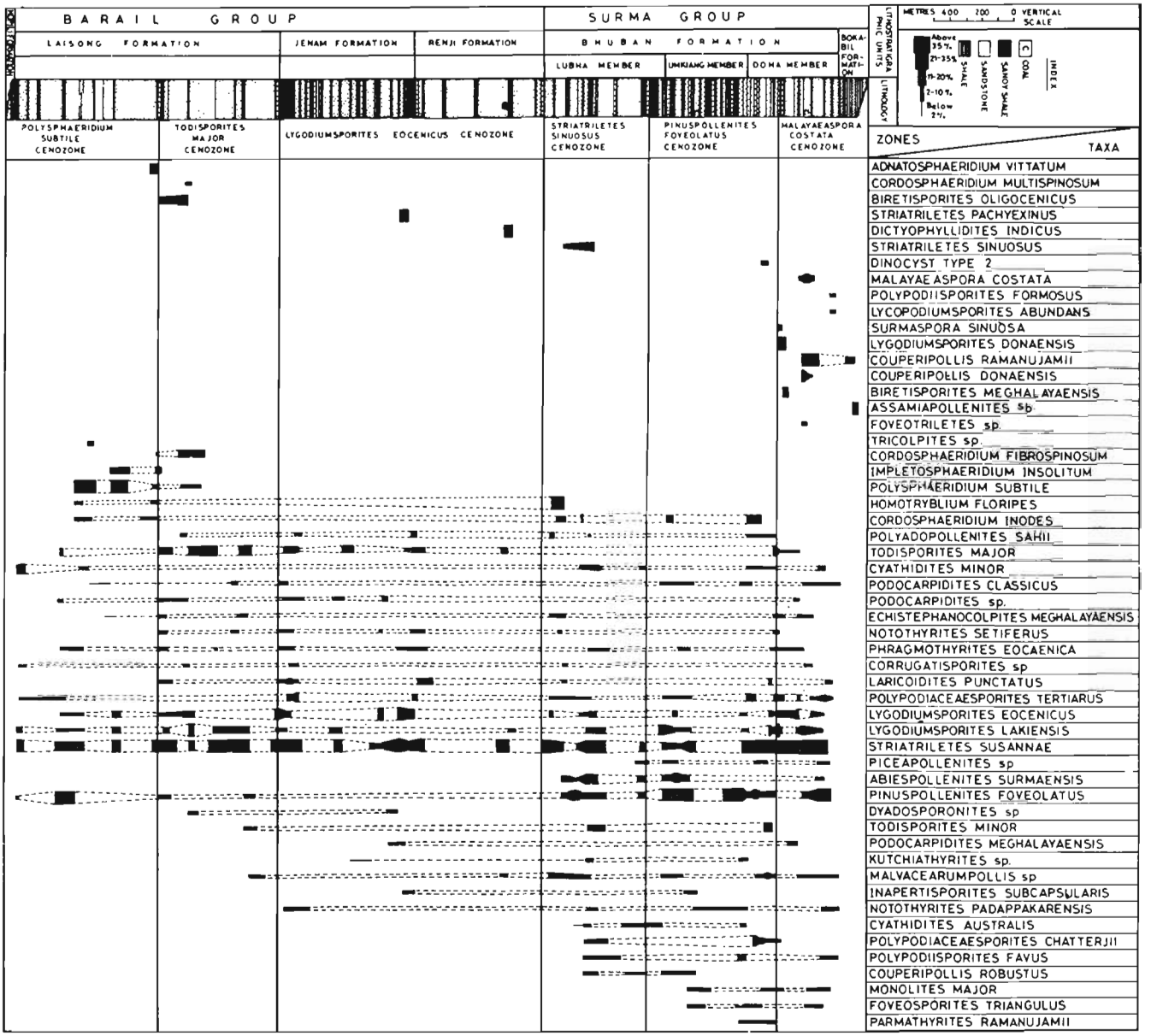
Characteristic palynofossils—Adnatosphae-ridium vittatum, Polysphaeridium subtile, Cordosphaeridium inodes, Impletosphaeridium insolitum, Homotryblium floripes, Striatriletes susannae, Lygodiumsporites lakiensis, L. eocenicus, Cyathidites minor and *Pinuspollenites foveolatus* (Pl. 1, figs 1-9).

Remarks—The significant feature of this cenozone is that the dinoflagellate cysts are represented by 23 per cent. These cysts dominate in this zone while in the other zones they are insignificantly represented. *Polysphaeridium subtile* constitutes the major part (35%) of the dinoflagellate cysts and in some samples its percentage reaches up to 45 per cent or even more. The dominance of this taxon is, therefore, important and helps in distinguishing this cenozone from the overlying *Todisporites major* Cenozone. In addition, *Adnatosphaeridium vittatum, Cordosphaeridium inodes*, and *C. fibrospinosum* are also present in appreciable frequency. This cenozone is also rich in the pteridophytic (50%) and gymnospermous pollen grains (25%), while angiospermous pollen grains and fungal remains (2%) are insignificantly represented. Among the pteridophytic spores, *Striatriletes* is very abundant. Since this genus occurs in good frequency in all the cenozones, it can not be taken as marker taxon for any of them.

Todisporites major Cenozone

Type section—The upper part of the Laisong Formation, exposed along Sonapur-Badarpur Road Section between 142 km and 143.2 km.

*The distances are given with reference to Shillong along Shillong-Silchar Highway (National Highway-44).



Text-fig. 1—Palynostratigraphic zonation of the Barail and Surma groups of Jaintia Hills (Meghalaya) and Cachar (Assam).

Lithology—The lithology mainly consists of grey, very hard, thinly bedded, very fine to medium grained sandstone alternating with carbonaceous shales. The thickness of this cenozone is ± 750 m.

Nature of contact—The upper part of this cenozone is composed of grey, medium grained sandstone which is conformably overlain by grey and carbonaceous shales of the basal part of the *Lygodiumsporites eocenicus* Cenozone.

Species restricted to this cenozone—Biretisporites oligocenicus and *Cordosphaeridium multispinosum.*

Characteristic palynofossils—Cordosphaeridium multispinosum, C. fibrospinosum, Polysphaeridium subtile, Striatriletes susannae, Biretisporites oligocenicus, Todisporites major, Lygodiumsporites lakiensis, L. eocenicus, Polyadopollenites sahii and *Echistephanocolpites meghalayaensis* (Pl. 1, figs 10-17).

Remarks—Pteridophytic spores are dominant (77%) in this cenozone. *Todisporites major* constitutes 30 per cent of the pteridophytic spores while in the underlying and overlying zones, its percentage is almost insignificant. Such a high frequency of this species has been taken as a reliable feature for the identification of this cenozone. Algal remains are represented by 5 per cent, fungal remains 8 per cent, gymnospermous pollen grains 8 per cent and angiospermous pollen grains 2 per cent.

Lygodiumsporites eocenicus Cenozone

Type section—Jenam and Renji formations exposed along Sonapur-Badarpur Road Section between 143.2 km and 147.5 km.

Lithology—The lower part of this zone is mainly argillaceous and consists of shales and sandy shales with fine to medium grained sandstones whereas the upper part is characterised by thickly bedded or massive, fine to medium grained, hard, ferruginous, occasionally cross-bedded sandstone with alternation of shales. Generally the shales are carbonaceous throughout this cenozone. The thickness of this cenozone is ± 1650 m.

Nature of contact—The contact of this cenozone with the overlying *Striatriletes sinuosus* Cenozone is unconformable. This contact coincides with Barail-Surma contact.

Species restricted to this cenozone—*Striatriletes pachyexinus* and *Dictyophyllidites indicus.*

Characteristic palynofossils—*Striatriletes susannae, S. pachyexinus, Lygodiumsporites eocenicus, L. lakiensis, Todisporites major, Polypodiaceaesporites tertiarus, Podocarpidites meghalayaensis, Laricoidites punctatus* and *Polyadopollenites sahii* (Pl. 1, figs 18-21).

Remarks—This cenozone is characterised by very high frequency of pteridophytic spores (82%). *Lygodiumsporites* constitutes the most dominant element (about 30%) of the assemblage and is represented by two species. Of these, *Lygodiumsporites eocenicus* constitutes 20 per cent of the assemblage, hence the zone is named after it. It is also characterised by the decline in gymnospermous pollen grains (8%) and *Todisporites major.* Besides, the dinoflagellate cysts are very rare in this cenozone. Fungal remains and the angiospermous pollen grains are represented by 6 per cent and 4 per cent respectively.

Striatriletes sinuosus Cenozone

Type section—Lubha Member, Lower Bhuban Formation, exposed along Sonapur-Badarpur Road Section between 147.5 km and 151.1 km.

Lithology—This zone consists of thin to fairly thick beds of fine to very fine grained, fawn, grey or brown sandstone with subordinate shales. The thickness of this cenozone is ± 650 m.

Nature of contact—The upper part of this cenozone is made up of sandstone bed which is conformably overlain by the carbonaceous shale of *Pinuspollenites foveolatus* Cenozone.

Species restricted to this cenozone—*Striatriletes sinuosus.*

Characteristic palynofossils—*Cordosphaeridium inodes, Homotryblium floripes, Striatriletes sinuosus, S. susannae, Lygodiumsporites lakiensis, L. eocenicus, Cyathidites australis, Polypodiisporites favus, Polypodiaceaesporites chatterjii, Abiespollenites surmaensis, Pinuspollenites foveolatus, Couperipollis robustus, Polyadopollenites sahii, Echistephanocolpites meghalayaensis* and *Malvacearumpollis* sp. (Pl. 2, figs 1-9).

Remarks—*Striatriletes sinuosus* Cenozone is characterized by the dominance of the genus *Striatriletes* (about 60%). Out of this, *Striatriletes sinuosus* represents 20 per cent of the assemblage and is restricted to this cenozone only. For this reason, the cenozone is named after this taxon. This cenozone also shows the comparative increase of gymnospermous pollen up to 20 per cent and the reappearance of dinoflagellate cysts. *Todisporites major* is conspicuous by its complete absence in this cenozone. Algal remains are represented by 10 per cent, fungal remains by 3 per cent and angiospermous pollen grains by 5 per cent.

Pinuspollenites foveolatus Cenozone

Type section—Umkiang and Dona (in part) members of Bhuban Formation of Surma Group, exposed along Sonapur-Badarpur Road Section between 151.1 km and 165.75 km.

Lithology—This zone consists of thick shale beds with brown, fine to medium and occasionally coarse grained, thinly bedded, lenticular sandstones and a few thin intraformational conglomerate in the lower part and grey and brown, very fine to medium grained, often argillaceous, fairly hard sandstone, alternating with thin sandy and carbonaceous shales in the upper part. The thickness of the cenozone is ± 800 m.

Nature of contact—The upper part of this cenozone is represented by sandy and carbonaceous shales which are conformably overlain by the basal sandstone bed of *Malayaeaspora costata* Cenozone.

Species restricted to this cenozone—Dinocyst type-2, *Parmathyrites ramanujamii.*

Characteristic palynofossils—*Cordosphaeridium inodes,* Dinocyst type-2, *Todisporites minor, Lygodiumsporites eocenicus, L. lakiensis, Striatriletes susannae, Polypodiaceaesporites tertiarus, P. chatterjii, Pinuspollenites foveolatus, Abiespollenites surmaensis* and *Malvacearumpollis* sp. (Pl. 2, figs 10-18).

Remarks—This cenozone is characterized by the dominance of gymnospermous pollen grains (33%). Among the gymnospermous pollen grains, *Pinuspollenites foveolatus* constitutes about 60 per cent of the assemblage and as such is a dominant taxon of this cenozone. In other cenozones it is sporadically represented.

This cenozone is also characterized by the dominance of *Polypodiaceaesporites tertiarus, P. chatterjii, Todisporites minor, Lygodiumsporites lakiensis* and *Malvacearumpollis* sp. Besides, the reappearance of *Todisporites major* and *Cordosphaeridium inodes* are among the other important features of this cenozone.

The algal remains are represented by 4 per cent, fungal remains 3 per cent, pteridophytic spores 57 per cent, and angiospermous pollen grains 3 per cent.

Malayaeaspora costata Cenozone

Type section—The upper part of Bhuban Formation (Dona Member) and Bokabil Formation exposed along Sonapur-Badarpur Road Section between 165.75 km and 180 km.

Lithology—The lower part of this cenozone mainly consists of grey and brown, very fine to medium grained, often argillaceous, fairly hard sandstone alternating with thin sandy and carbonaceous shales whereas the upper part is characterized by thick sandy shales with alternation of very fine grained laminated sandstones. The thickness of this cenozone is ± 550 m.

Species restricted to this cenozone—Malayaeaspora costata, Surmaspora sinuosa, Lygodiumsporites donaensis, Lycopodiumsporites abundans, Foveotriletes sp., *Biretisporites meghalayaensis, Polypodiisporites formosus, Couperipollis donaensis, C. ramanujamii* and *Assamiapollenites* sp.

Characteristic palynofossils—Malayaeaspora costata, Lygodiumsporites eocenicus, L. lakiensis, L. donaensis, Biretisporites meghalayaensis, Striatriletes susannae, Polypodiaceaesporites tertiarus, P. chatterjii, Monolites major, Pinuspollenites foveolatus, Abiespollenites surmaensis, Assamiapollenites sp., *Couperipollis donaensis, C. ramanujamii* and *Malvacearumpollis* sp. (Pl. 2, figs 19-27).

Remarks—Among the pteridophytic spores, *Malayaeaspora costata* constitutes about 20 per cent of the assemblage and is restricted to this cenozone only. For this reason, it is named after *M. costata, Lygodiumsporites donaensis, Surmaspora sinuosa, Lycopodiumsporites abundans, Couperipollis* spp. and *Assamiapollenites* sp. are also restricted to this cenozone. In addition, the percentages of angiospermous pollen is comparatively higher and *Lygodiumsporites eocenicus* and *L. lakiensis* again appear in it. The dinoflagellate cysts are absent. The assemblage also consists of fungal remains (3%), pteridophytic spores (63%), gymnospermous pollen grains (22%) and angiospermous pollen grains (12%).

DISCUSSION

The range and relative frequency of the various palynotaxa, as shown in the Text-fig. 1, reveal that a few miofloral changes can be marked in the Barail-Surma sequence of the present Sonapur-Badarpur Road Section. Some of these changes correspond with the physical features like unconformity and lithological boundaries.

The first such change was observed in the middle of the Laisong Formation dividing it into a lower *Polysphaeridium subtile* Cenozone and an upper *Todisporites major* Cenozone. The former is characterized by the rich representation of dinoflagellate cysts (23%), especially *Polysphaeridium subtile* and *Adnatosphaeridium vittatum* along with pteridophytic spores (50%), whereas in the latter dinoflagellate cysts

PLATE 1

(All photomicrographs are enlarged *ca.* × 500. The coordinates of the specimens refer to the stage of Censico Microscope no. 13167).

Polysphaeridium subtile Cenozone

1. *Adnatosphaeridium vittatum* Williams & Downie *in* Davey *et al.*; Slide no. 8383, coordinates 75.1 × 120.0.
2, 3. *Cordosphaeridium inodes* (Klumpp) Eisenack, Slide no. 8370; coordinates 56.0 × 110.3, 75.6 × 117.5.
4. *Striatriletes susannae* van der Hammen emend. Kar; Slide no. 8387, coordinates 52.2 × 103.3.
5. *Impletosphaeridium insolitum* Eaton; Slide no. 8373, coordinates 42.0 × 110.5.
6. *Tricolpites* sp.; Slide no. 8745, coordinates 66.2 × 101.3.
7. *Lygodiumsporites lakiensis* Sah & Kar; Slide no. 9023, coordinates 73.5 × 105.7.
8. *Polysphaeridium subtile* Davey & Williams *in* Davey *et al.*; Slide no. 8369, coordinates 62.2 × 106.4.
9. *Pinuspollenites foveolatus* Rao; Slide no. 8400, coordinates 41.1 × 100.0

Todisporites major Cenozone

10. *Cordosphaeridium multispinosum* Davey & Williams *in* Davey *et al.*; Slide no. 8369, coordinates 35.6 × 103.4.
11. *Cordosphaeridium fibrospinosum* Davey & Williams *in* Davey *et al.*; Slide no. 8369, coordinates 53.3 × 101.6.
12. *Polyadopollenites sahii* Rao *et al.*; Slide no. 8758, coordinates 42.5 × 118.2.
13. *Striatriletes susannae* van der Hammen emend Kar; Slide no. 9503, coordinates 54.9 × 117.3.
14. *Todisporites major* Couper; Slide no. 8389, coordinates 48.1 × 98.7.
15. *Biretisporites oligocenicus* Rao & Singh; Slide no. 8388, coordinates 62.4 × 99.6.
16. *Lygodiumsporites lakiensis* Sah & Kar emend. Rao & Singh; Slide no. 8390, coordinates 49.1 × 110.3.
17. *Echistephanocolpites meghalayaensis* Rao *et al.*; Slide no. 8116, coordinates 54.2 × 112.3.

Lygodiumsporites eocenicus Cenozone

18. *Striatriletes pachyexinus* Rao & Singh; Slide no. 8391, coordinates 56.0 × 101.5.
19. *Dictyophyllidites indicus* Rao & Singh; Slide no. 8392, coordinates 69.2 × 108.6.
20. *Lygodiumsporites eocenicus* Dutta & Sah; Slide no. 8393, coordinates 48.8 × 109.1.
21. *Polyadopollenites sahii* Rao *et al.*; Slide no. 8396, coordinates 45.3 × 102.2.

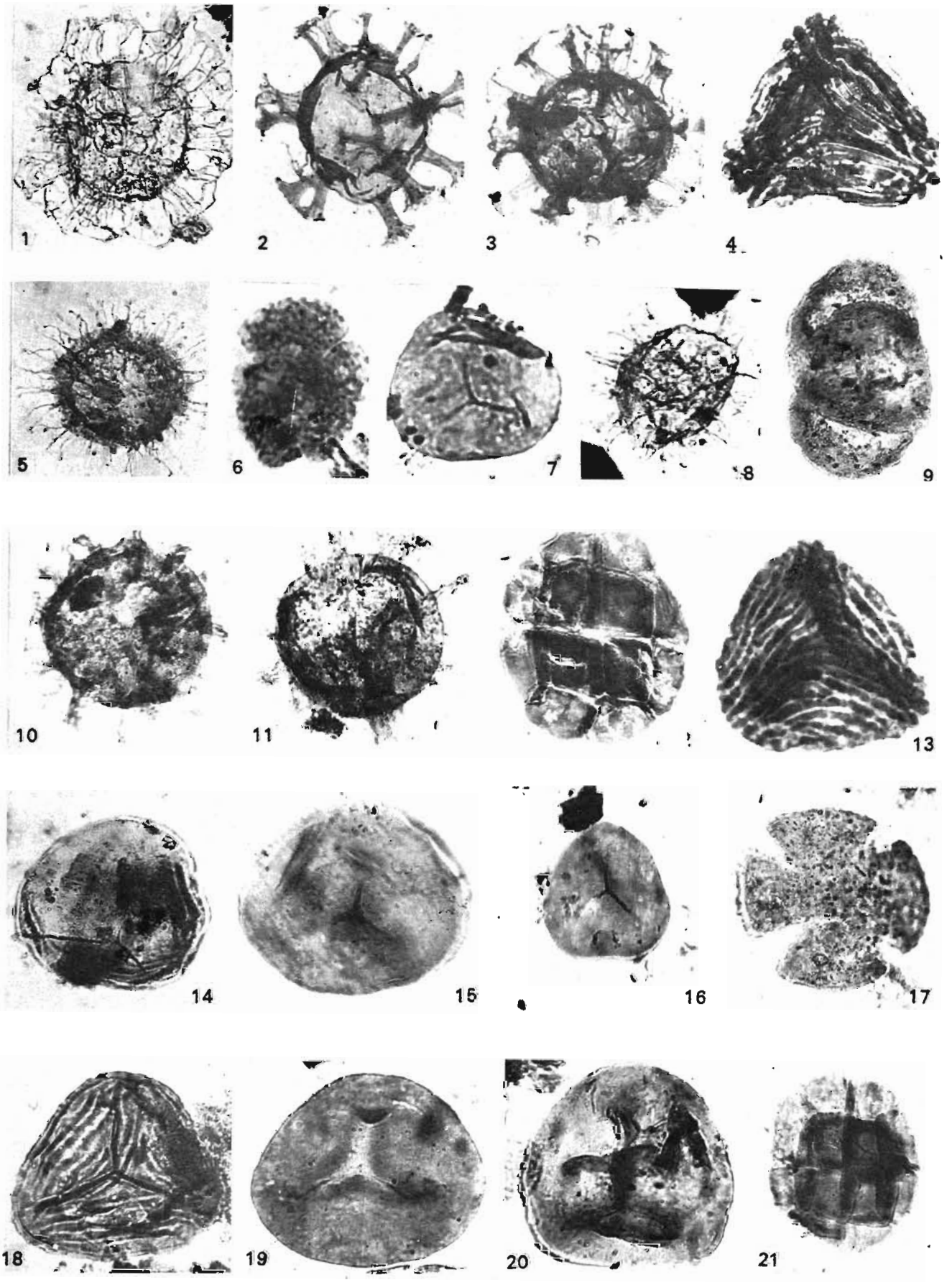


PLATE 1

decrease (5%) with corresponding increase in pteridophytic spores (77%). This miofloral change is not associated with any lithological boundary. The second miofloral change was marked between the *Todisporites major* and *Lygodiumsporites eocenicus* Cenozones, corresponding with the Laisong-Jenam boundary. While, both the zones are rich in pteridophytic spores, the latter is distinguished from the former by the high representation (30%) of *Lygodiumsporites* and restricted occurrence of *Striatriletes pachyexinus*. The *Lygodiumsporites eocenicus* Cenozone covers very thick sequence including both Jenam and Renji formations.

It is interesting to note that no floral change could be recognised at Jenam-Renji contact, though the two formations are well distinguishable on lithological grounds. The third miofloral change was recognized at the Barail-Surma contact and is thus associated with lithological boundary as well as with regional Oligo-Miocene unconformity. The cenozone across this boundary is named as *Striatriletes sinuosus* Cenozone and is characterized by 60 per cent representation of *Striatriletes*, restricted occurrence of *Striatriletes sinuosus* and increasing frequency (20%) of gymnospermous pollen grains. This cenozone corresponds with the Lubha Member of the Bhuban Formation. Its upper contact with the overlying *Pinuspollenites foveolatus* Cenozone marks the fourth miofloral change and is associated with a lithological boundary. In the *Pinuspollenites foveolatus* Cenozone, gymnospermous pollen show further increase (33%) with significant representation of *Pinuspollenites foveolatus* and decline in the pteridophytic spores, particularly *Striatriletes*. The fifth and the last change observed in the miofloral succession of the present section is at the contact of *Pinuspollenites foveolatus* and *Malayaeaspora costata* Cenozones dividing the Dona Member into two parts. The *Malayaeaspora costata* Cenozone covers the upper part of the Dona Member and Bokabil Formation and is characterized by rich representation (20%) and restricted occurrence of *Malayaeaspora costata* and also by the restricted occurrence of *Lygodiumsporites donaensis, Surmaspora sinuosa, Lycopodiumsporites abundans, Couperipollis* spp. and *Assamiapollenites* sp.

The above discussion also makes clear that the gymnospermous pollen grains increase in frequency in Surma Group as compared to Barail Group. These pollen might have migrated from the extra-peninsular region in the north which would have been sufficiently high during Lower Miocene to support coniferous flora.

It is significant that while no floral change has been observed in the entire Jenam-Renji sequence, finer units could be established in Laisong Formation (*Polysphaeridium subtile* Cenozone and *Todisporites major* Cenozone) and Bhuban Formation (*Striatriletes*

PLATE 2 →

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

Striatriletes sinuosus Cenozone

1. *Striatriletes sinuosus* Rao & Singh; Slide no. 8407, coordinates 66.9 × 95.9.
2. *Striatriletes susannae* van der Hammen emend. Kar; Slide no. 8385, coordinates 39.9 × 104.6.
3. *Polypodiisporites favus* Potonié; Slide no. 8401, coordinates 56.1 × 103.1.
4. *Couperipollis robustus* Saxena; Slide no. 8399, coordinates 63.0 × 105.1.
5. *Pinuspollenites foveolatus* Rao, Slide no. 8412, coordinates 56.9 × 110.9.
6. *Homotryblium floripes* (Deflandre & Cookson) Stover; Slide no. 8374, coordinates 73.5 × 110.5.
7. *Abiespollenites surmaensis* Rao; Slide no. 8407, coordinates 63.5 × 99.7.
8. *Lygodiumsporites lakiensis* Sah & Kar. emend. Rao & Singh; Slide no. 9025, coordinates 70.5 × 106.9.
9. *Polypodiaceaesporites chatterjii* Kar; Slide no. 8404, coordinates 74.5 × 101.3.

Pinuspollenites foveolatus Cenozone

10. Dinocyst type-2; Slide no. 8380, coordinates 52.9 × 97.7.
11. *Cordosphaeridium inodes* (Klumpp) Eisenack; Slide no. 8370, coordinates 60.2 × 110.5.
12. *Parmathyrites ramanujamii* Singh *et al.*; Slide no. 8109, coordinates 48.4 × 93.5.
13. *Malvaceaepollis* sp.; Slide no. 8403, coordinates 66.5 × 108.5.
14. *Lygodiumsporites lakiensis* Sah & Kar emend Rao & Singh; Slide no. 8405, coordinates 48.4 × 93.5.
15. *Polypodiaceaesporites tertiarus* Sah & Dutta; Slide no. 8411, coordinates 49.5 × 98.8.
16. *Pinuspollenites foveolatus* Rao; Slide no. 8999, coordinates 60.8 × 102.8.
17. *Todisporites minor* Couper; Slide no. 9029, coordinates 70.3 × 102.5.
18. *Polypodiaceaesporites chatterjii* Kar; Slide no. 9041, coordinates 74.7 × 102.5.

Malayaeaspora costata Cenozone

19. *Lygodiumsporites eocenicus* Dutta & Sah; Slide no. 8736, coordinates 99.2 × 105.7.
20. *Couperipollis ramanujamii* Rao *et al.*; Slide no. 8742, coordinates 67.4 × 93.1.
21. *Lygodiumsporites donaensis* Rao & Singh; slide no. 8408, coordinates 62.0 × 103.3.
22. *Couperipollis donaensis* Rao *et al.*; Slide no. 8409, coordinates 37.4 × 105.6.
23. *Assamiapollenites* sp.; Slide no. 8410, coordinates 66.0 × 102.8.
24. *Malayaeaspora costata* Trivedi *et al.*; Slide no. 8229, coordinates 60.9 × 105.6.
25. *Biretisporites meghalayaensis* Rao & Singh; Slide no. 8413, coordinates 43.5 × 104.5.
26. *Surmaspora sinuosa* Singh & Rao; Slide no. 8228, coordinates 69.5 × 118.8.
27. *Foveotriletes* sp.; Slide no. 9036, coordinates 57.0 × 100.5.

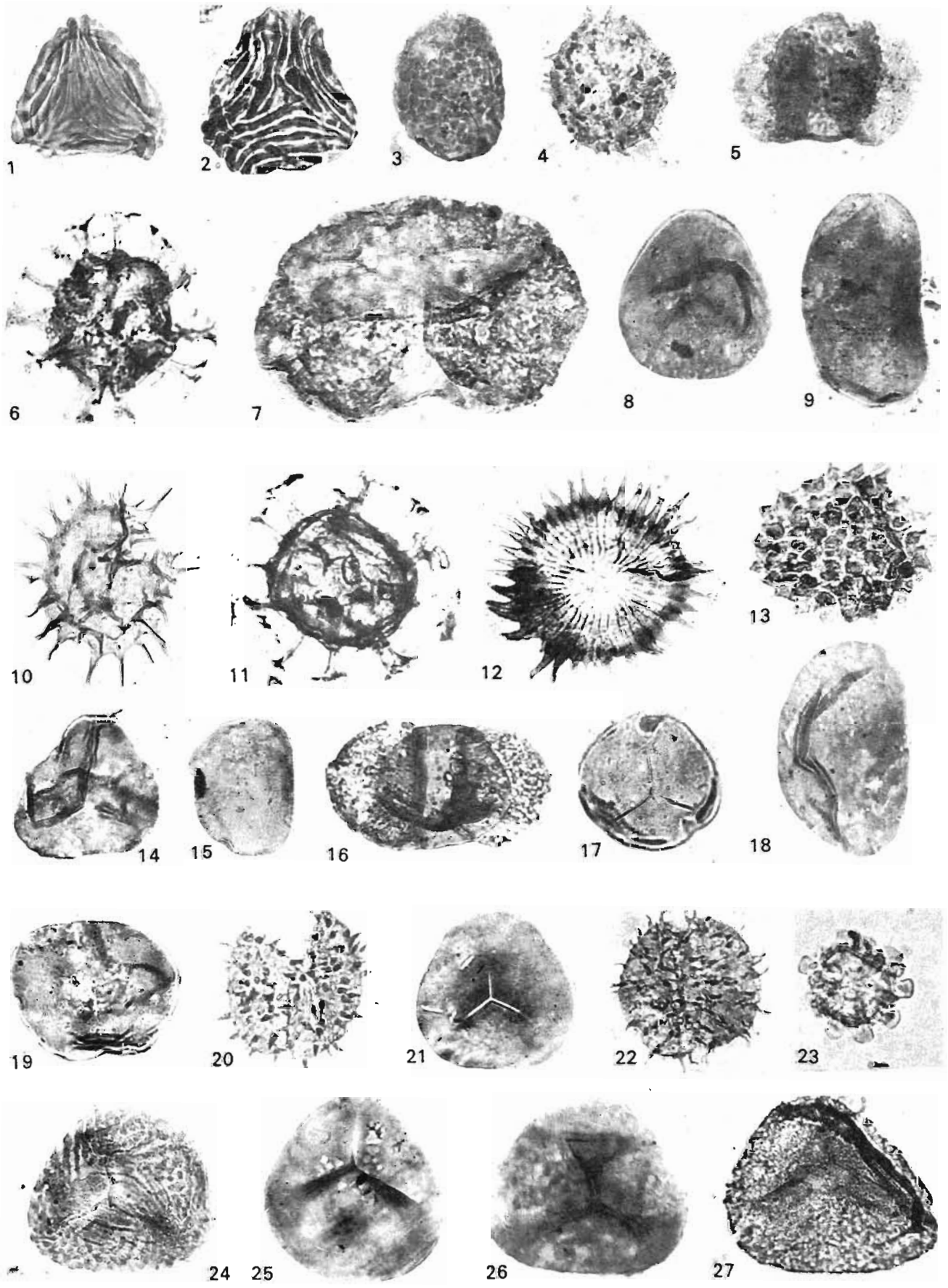


PLATE 2

sinuosus Cenozone, *Pinuspollenites foveolatus* Cenozone and part of *Malayaeaspora costata* Cenozone). It is hoped that future palynological studies on Oligocene-Miocene sediments of this region may prove the lateral persistence of these cenozones and may further split them into subzones for more precise demarcation of the stratal units and finer biostratigraphic zonation.

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