

# PALAEOBOTANY OF TATTITOLA BED IN PACHWARA COALFIELD, SANTHAL PARGANA, BIHAR WITH REMARKS ON THE AGE OF THE BED

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## ABSTRACT

Fossil plants and miospores from the Lower Gondwana Bed exposed in the Bansloi River near the village Tattitola, Pachwara Coalfield are recorded. The mega-fossil assemblage is characterized by the dominance of open mesh *Glossopteris* leaves alongwith the characteristic presence of *Schizoneura gondwanensis*, *Stellotheca robusta* and other Lower Gondwana ferns. The miospore assemblage shows a dominance of striated-disaccate forms alongwith *Scheuringipollenites*, *Densipollenites* and other trilete forms. These assemblages suggest an Upper Raniganj age for this bed.

*Key-words* — Megafossils, Miospores, Pachwara Coalfield, Upper Raniganj (India).

## सारांश

पछवारा कोयला-क्षेत्र, संथाल परगना, बिहार में स्थित टट्टीटोला संस्तर की पुरावनस्पतिकी तथा संस्तर की आयु पर टिप्पणियाँ—जगन्नाथ प्रसाद मंडल एवं प्रभात कुमार माहती

पछवारा कोयला-क्षेत्र में टट्टीटोला गाँव के समीप बंसलोई नदी में विगोपित अघर गोंडवाना संस्तर से प्राप्त पादपाश्म एवं सूक्ष्म-बीजाणुओं का वर्णन किया गया है। गुरुपादपाश्म समुच्चय खुली जालिकावत् ग्लॉसॉप्टेरिस पत्तियों के साथ-साथ शाइजोन्यूरा गोंडवानेन्सिस, स्टीलोथीका रोबस्टा तथा अन्य अघर गोंडवाना फर्नों की बाहुल्यता से विशेषित हैं। सूक्ष्म-बीजाणु समुच्चय में रेखित-डाइसेक्केट प्ररूपों के अतिरिक्त श्यूरिंगपोलिनाइडिस, डेन्सीपोलिनाइडिस एवं अन्य त्रिअरीय प्ररूपों का बाहुल्य है। ये समुच्चय इस संस्तर के लिए उच्च रानीगंज आयु इंगित करते हैं।

## INTRODUCTION

**S**URANGE and Prakash (1962) first reported the presence of *Stellotheca robusta* from the Lower Gondwana bed exposed in Bansloi River, near the village Tattitola in Pachwara Coalfield. Subsequently, Maheshwari and Prakash (1965) reported megafossils from a number of localities of Pachwara Coalfield. Recently Maithy (1977) has reported a new fern genus *Santhalea bansloiensis* from Tattitola Bed. Maithy and Mandal (1976) have also reinvestigated the genus *Stellotheca* Surange & Prakash.

Miospore assemblage from the Pachwara Coalfield has been described by Maheshwari (1967a). In this paper he mentioned that the details of the assemblage are based on the localities as given in the paper of

Maheshwari and Prakash (1965). However, we find that the assemblage have been mostly recorded only from two localities (i) near Bargo, locality no. 1, and (ii) near Alubera, locality no. 4. Maheshwari (1965) has also discussed the age of these Lower Gondwana beds on the basis of fossil plants and miospores. According to him all the Lower Gondwana beds of Pachwara Coalfield are of Barakar age.

Recently a rich collection of megafossils has been made from the Lower Gondwana Bed exposed in the Bansloi River near Tattitola Village. Miospores have also been obtained by macerating the shale samples collected from both the banks of the river. The present records of megafossils and miospores from Tattitola do not confirm the view on the age of this bed as expressed by Maheshwari (1966). The present paper,

therefore, deals with the records of megafossils and miospores from Tattitola bed and with a discussion on the possible age of the bed on the basis of fossil evidence.

#### MATERIAL

The material was collected from the beds exposed on both the banks of Bansloi River near the village Tattitola. The geological succession is as detailed in Maheshwari and Prakash (1965, locality no. 5).

#### DESCRIPTION

##### MEGAFOSSILS

Megafossils are preserved as impressions on the ferruginous shales.

1. The following fossil plants recorded previously (Maheshwari & Prakash, 1965) are also present in our collection:

*Paracalamites* sp. (*Phyllothea* sp. of Maheshwari & Prakash), *Stellothea robusta* Surange & Prakash, *Schizoneura gondwanensis* Feistmantel, *Trizygia speciosa* Royle, *Dizeugotheca phegopteroides* Maithy, *Neomariopteris lobifolia* Maithy, *N. hughesii* Maithy, *Santhalea bansloiensis* Maithy, *Glossopteris communis* Feistmantel, *G. indica* Schimper, *G. retifera* Feistmantel, *G. emarginata* Maheshwari, *G. formosa* Feistmantel, and *Vertebraria* sp.

2. The following are new records:

*Neomariopteris hughesii* Maithy (fertile fronds), *Dichotomopteris ovata* Maithy, *Glossopteris conspicua* Feistmantel, *G. divergens* Feistmantel, *G. damudica* Feistmantel, *G. angustifolia* Brongniart, *G. browniana* Brongniart, *Plumsteadia* sp., scale leaves (6 types), *Samaropsis raniganjensis* Seward & Sahni, *Noeggerathia*? (*Cyclopteris*?) *hislopi* Bunbury.

No Gangamopteroid leaf has been recorded in this collection. The specimen referred to *Gangamopteris* sp. (1965, pl. 3, fig. 25) by Maheshwari and Prakash (1965) has also been re-examined by us. It is a badly preserved specimen of *Glossopteris*.

##### SCALE LEAVES

###### Type-1

Thick convex leaves, lanceolate in outline with broad base and acute apex.

The length of the specimens vary from 13-23 mm and all of them measure 6 mm broad at the broadest point. In some specimens on the outer surface a few irregular vertical ridges are present in the central region (Pl. 1, fig. 3).

*Comparison* — The specimens are without any stalk and venation but can be compared with the fertile scales of *Eretmonia emarginata* Chandra & Surange (1977).

###### Type-2

Specimens are ovate-lanceolate in shape. All of them are concave in preserved state. Concavity is  $\pm 1$  mm. They are 10-13 mm long and 6-10 mm broad at the middle. Margins are entire with acute to nearly acuminate apex. Venation or ridges are not marked (Pl. 1, fig. 4).

*Comparison* — The present specimens are comparable with *Eretmonia ovoides* Surange & Chandra (1974a).

###### Type-3

Flat, ovate-lanceolate specimen with mucronate apex and long drawn base. The leaf appears to be coriaceous, 31 mm long and 11 mm broad at the broadest part and about 3.5 mm at the base. Extreme basal region is devoid of veins. In the upper portion the veins are raised and stout, 8-9 veins enter the base (about 8 mm above from base) and run nearly parallel without forking. The forking of veins increases as it proceeds upward. The marginal veins show gentle curve towards margin. Rarely the veins form meshes. Meshes are narrow and elongated. Near the base the veins are 2 per mm and towards apex 4 per mm. (Pl. 1, fig. 5).

*Comparison* — The seed bearing leaf of *Lidgettonia mucronata* Surange & Chandra (1974b) compares with the present form but differs in being about half in size.

###### Type-4

Single broad-ovate scale leaf with broad acute apex. It is about 11.5 mm long and 11 mm broad. The scales have an inner coriaceous zone which is 9.5 mm long and 6 mm broad. This zone is surrounded by a thin smooth layer all around without any marking, 2.5-1.2 mm broad and narrow



towards the apex. The inner zone bears stout veins which are about 10 at the base. They run almost parallel in the central region while the lateral ones are gently curved towards base. Veins fork occasionally and form a few elongate rectangular meshes (Pl. 1, fig. 6).

*Comparison* — This leaf is morphologically similar with the veined half of *Scutum* of Surange and Chandra (1975).

#### Type-5

Scale leaves are incomplete, spatulate with obtuse apex; 21-27 mm long and 7-16 mm broad at broadest point. Three to four veins enter at the base, run parallel for a short distance. They are 3-4 in number at the centre which run straight and fork sparsely forming a few meshes. The lateral ones on both sides fork repeatedly forming meshes of different sizes. They curve gently towards margin. The texture appears to be firm rather than coriaceous (Pl. 1, fig. 7).

*Comparison* — Morphologically this form is similar to *Partha spatulata* Surange & Chandra (1973).

#### Type-6

Single broad-lanceolate specimen with acute apex and contracted base, 3 cm long and 13 mm broad. Four broad veins enter at the base. Veins on either side fork and form meshes of irregular shape and size. Meshes near the centre are very long and narrow (Pl. 1, fig. 8).

This form is not comparable to any known type. In view of the solitary record, it is described here without any name.

#### *Plumsteadia* sp.

Pl. 1, fig. 10

Specimens are elliptical-oval in shape. They have slightly undulated to entire margin, rounded apex and almost truncated base. There is an indication of stout stalk by the presence of 1 mm wide crescentic attachment mark. The length varies from 18-25 mm and width 9-14 mm. The outer margin is in the form of wing, about 1.0-1.5 mm broad. The wing is partitioned at regular intervals by some raised lines.

In the central region, a few short raised lines lie in between the depressed areas from base to apex and laterally these lines arched towards margin where the depressed areas are alternately arranged. In some specimens a few scattered, subcircular depression, about 1 mm in diameter is marked in the lower portion near the margin suggesting the position of ovule or seed.

#### *Samaropsis raniganjensis* Seward & Sahni

Pl. 1, fig. 9

The seed is cordate-ovate, bilaterally symmetrical and measures 4 mm vertically and 3.5 mm transversely. The specimen is flat and shows a vertically elongated central area surrounded by a thin narrow area, about 1.2 mm wide except at the apex. At the apex this thin area touches the acute end of the central body. The central area is lanceolate, appears to be fleshy, 3 mm long and 2 mm broad. It has a few irregular striae parallel to the pole.

#### *Noeggerathia* ? (*Cyclopteris* ?) *hislopi* Bunbury

Pl. 1, figs 1, 2

Leaves are incomplete, only basal portions are preserved. Apical portion is not known. The biggest leaf in the collection measures 11.5 cm long and 9-22 mm broad. Leaves narrow with contracted base. One of the margin shows greater curvature than the other margin. Veins distinct, non-divergent and run  $\pm$  parallel to one another. Generally veins are preserved near the basal region. The veins dichotomise once or twice near the base and subsequently they do not dichotomise further, rather the same number of veins are preserved at the entire laminal length. The veins are widely spaced towards the apical portion as the width of lamina increases.

#### DISCUSSION

Bunbury (1861) recorded *Noeggerathia* ? (*Cyclopteris* ?) *hislopi* with parallel venation from the Kamthi beds of Bhartwada, Nagpur. The specimen was characterized as detailed below:

'The leaf was of a narrow wedge-shape, widening gradually upwards from a narrow



base not, however, quite symmetrical, but very slightly oblique; the terminal portion, which is well seen in one fragment, very conspicuously oblique rounded at the actual apex and from then sloping away with a gentle curve and forming a very obtuse and rounded angle with the other (lower) margin. The leaf (as far as can be judged from mere impressions) appears to have been of a firm and rather rigid texture, with a smooth surface. The largest fragment seen is about 5.5 inches long; the breadth is no part seemingly much exceeding 1 inch. Veins numerous, all equal and uniform, with no appearance of a midrib, strong and rather coarse, radiating from the base, but spreading very gradually and forming very small angles with one another, so that for any short distance they appear nearly parallel; they are once or twice forked but very sparingly, the branches diverging very gradually, and all the end in the terminal margin.

Feistmantel (1879) recorded *Noeggerathiopsis* from the Talchir and Karharbari formations of India. The specimens were characterized by simple leaves, linear to lanceolate shape, apex obtuse, base narrow tapering to a point and entire margin. Veins arise from the base, frequently dichotomise,  $\pm$  parallel, angle of divergence commonly less than  $5^\circ$ , density 14-16 veins per cm.

Further, Feistmantel (1879) thought that the specimens earlier described by Bunbury (1861) are alike to *Noeggerathiopsis* recorded from Talchir-Karharbari. Therefore, he transferred the specimens described by Bunbury (1861) under his new genus *Noeggerathiopsis*.

The present study shows that the specimens of Bunbury (1861) and Feistmantel (1879) do not resemble morphologically with each other. In Bunbury's specimens, as appears from the description and photograph, the veins dichotomise once or twice near the base and subsequently all the veins run parallel and straight up to the terminal portion of the leaf without any further dichotomy. On the other hand, the specimens described by Feistmantel (1879) and by other authors, viz., Lele and Maithy (1964), Pant and Verma (1964) and Maithy (1965), show that the veins dichotomise repeatedly in the entire length of leaf. Moreover, many of the veins meet the lateral margin

of leaves in addition to the terminal region. Therefore, the specimens described by Bunbury differs from that of Feistmantel and others by the rare dichotomy and non-divergent nature of veins towards the lateral margin. Hence, both the leaf-forms belong to two distinct entity. Therefore, it is proposed to treat both these distinct types of leaves separately. The genus *Noeggerathiopsis* should be used sensu Feistmantel (1879). The present recorded specimens should be described under *Noeggerathia*? (*Cyclopteris*?) *hislopi* Bunbury pending the discovery of complete specimens. It can be placed under a new genus, when more details are known.

#### MIOSPORES

Miospores from the bands of sandy carbonaceous shales lying in between ferruginous bands have been obtained. The miospore assemblage comprises of 24 genera belonging to 31 species.

The following forms have been recorded:

#### *Triletes*

*Leiotriletes brevis* Sinha (Pl. 2, fig. 1), *Calamospora tenuis* Bharadwaj & Salujha (Pl. 2, fig. 2), *Verrucosiporites diversus* Bharadwaj & Salujha (Pl. 2, fig. 6), *Apiculatisporis inconspicuus* Salujha (Pl. 2, fig. 5), *A. levis* (Balme & Hennelly) Tiwari (Pl. 2, fig. 7), *Acanthotriletes filiformis* (Balme & Hennelly) Tiwari (Pl. 2, fig. 3), *Acanthotriletes* sp., *Lophotriletes rectus* Bharadwaj & Salujha (Pl. 2, figs 4, 8), *L. novus* Kar, *Horriditriletes brevis* Bharadwaj & Salujha (Pl. 2, fig. 9), *H. novus* Tiwari, *Indospora clara* Bharadwaj (Pl. 2, fig. 11), *Cyclogranisporites gondwanensis* Bharadwaj & Salujha (Pl. 2, fig. 10), *Granulatisporites* sp., *Eupunctisporites* cf. *E. gravus* Bharadwaj & Salujha.

#### *Monoletes*

*Latosporites colliensis* (Balme & Hennelly) Bharadwaj (Pl. 2, fig. 12).

#### *Monosaccites*

*Densipollenites invisus* Bharadwaj & Salujha (Pl. 2, fig. 15), *D. densus* Bharadwaj & Srivastava (Pl. 2, fig. 14).



### Disaccates

*Scheuringipollenites maximus* Tiwari, *Scheuringipollenites* sp. cf. *S. tentulus* Tiwari (Pl. 2, fig. 16), *Faunipollenites varius* Bharadwaj (Pl. 2, fig. 17), *F. parvus* Tiwari, *F. minor* Salujha, *F. perexiguus* Bharadwaj & Salujha, *Striatites subtilis* Bharadwaj & Salujha, *S. varius* Kar (Pl. 2, fig. 18), *Lahirites rotundus* Bharadwaj & Salujha (Pl. 2, fig. 19), *Cuneatisporites* sp., *Ptiyosporites papillionis* Potonié & Klaus, *Verticopollenites gibbosus* Bharadwaj (Pl. 2, figs 20, 21), *Hindipollenites* sp., *Striatopodocarpites decorus* Bharadwaj & Salujha, *Striapollenites saccatus* Bharadwaj, *Distriatites bilateris* Bharadwaj (Pl. 2, fig. 22).

### Polyplicates

*Gnetaceaepollenites sinuosus* (Balme & Hennelly) Bharadwaj (Pl. 2, fig. 13).

### QUANTITATIVE ANALYSIS

The genus *Densipollenites* is most dominant constituent and *Scheuringipollenites* comes next in order. The trilete genera occur quite frequently. The monolete and plicate forms do not encounter during quantitative estimation of microflora.

The percentage counts of miospore genera are as given below:

*Lophotriletes* (6.5%), *Apiculatisporites* (6.5%), *Granulatisporites* (3.4%), *Verrucosiporites* (0.5%), *Acanthotriletes* (1%), *Horriditriletes* (2.8%), *Cyclogranisporites* (1.4%), *Leiotriletes* (3.2%), *Eupunctisporites* (1%), *Indospora* (2.8%), *Laevigatosporites* (2.1%), *Densipollenites* (35.7%), *Scheuringipollenites* (16.3%), *Faunipollenites* (7%), *Striatites* (2.8%), *Striatopodocarpites* (3%), *Lahirites* (0.5%), *Verticopollenites* (0.5%).

### COMPARISON AND DISCUSSION

The Lower Gondwana beds of Bansloi Valley, Pachwara Coalfield have been assigned to the Barakar Stage by Maheshwari (1966). This view was expressed by him on the basis of the studies of megafossils and miospores from different localities of Pachwara Coalfield. Although earlier workers have expressed different views. Ball (1877) thought that the rocks of Lower Gondwana ex-

posures in the northern area were younger and corresponded with the Raniganj Stage and the rocks of the southern area corresponded with the typical Barakars. Feistmantel (1880, p. 25) assigned the Damuda in the vicinity of Lohundia (Hura tract) and Dubrajpur to Raniganj Stage with a question mark. But he regarded the rocks in the vicinity of Bargo to be of Barakar Stage. Pascoe (1959) also thought that the rocks of Hura tract possibly belonged to Raniganj Stage, while rest of Damudas of the Rajmahal Hills at least belong to Barakar Stage. Sah and Shah (1974) while discussing the stratigraphic section around Dubrajpur have considered the flora described from Bansloi Valley by Maheshwari and Prakash (1965) to be ? part of Barakar Formation of Damuda Basin. Thus we find that no precise age has been assigned to the Lower Gondwana beds of Rajmahal Hills.

The megafossil record of Tattitola shows that the flora is characterized by the dominance of *Glossopteris* with open meshes, viz., *G. conspicua*, *G. formosa*, *G. retifera* and *G. divergens*. Among pteridophytes *Schizoneura gondwanensis*, *Stellotheca robusta*, *Trizygia speciosa*, *Dizeugotheca phegopteroides*, *Neomariopteris hughesii* and *Santhalea bansloiensis* are characteristic. Recently Maithy (1974a, b, c) and Surange (1974) has discussed the stratigraphical zonation of Lower Gondwanas on the basis of megafossils. According to them the flora of Raniganj Formation is characterized by the dominance of open mesh forms of *Glossopteris* along with the presence of pteridophytes, viz., *Schizoneura* and ferns. Shah, Singh and Sastry (1971) have also opined that the Raniganj Formation is characterized by *Glossopteris retifera* — *G. conspicua* zone.

Therefore, the megafloristic evidence suggests that the age of Lower Gondwana beds exposed in Bansloi Valley near Tattitola is Raniganj due to dominance of open mesh *Glossopteris* forms and characteristic pteridophytic remains.

Miospores from the Bansloi Valley, Pachwara Coalfield have earlier been described by Maheshwari (1967a) from two localities, one near the Bargo and the other near Alubera. The assemblage shows dominance of monosaccates, viz., *Plicatipollenites*, *Virkkipollenites*, *Parastriapollenites* and *Potonieisporites*. The miospores recorded by us from Tattitola do not compare with the assemblage



described by Maheshwari (1967a) due to the dominance of *Densipollenites*, *Scheuringipollenites* and other trilete genera.

The miospore assemblage from Tattitola, as described above, comprises triletes, monoletes, monosaccates, disaccates and plicates. The triletes are commonly represented by *Granulatisporites*, *Lophotriletes*, *Apiculatisporis*, *Verrucosisporites*, *Acanthotriletes*, *Indospora*, *Horriditriletes*, and *Cyclogranisporites*. The monosaccates are represented by a single genus *Densipollenites*. Disaccates are represented both by striated and non-striated forms. The common striated forms are *Striatites*, *Faunipollenites*, *Striatopodocarpites*, *Verticypollenites* and *Lahirites*. The common non-striated forms are *Scheuringipollenites* and *Cuneatisporites*.

Thus miospore assemblage compares very well with the *Striatopodocarpites-Densipollenites* Assemblage zone of Upper Raniganj described by Tiwari (1980). It's close likeness to this assemblage is due to *Densi-*

*pollenites*, *Scheuringipollenites* and other striate-disaccates have been described by Maheshwari (1967b) from Gopad River beds about 1.5 miles east of Nidpur, Madhya Pradesh. These beds have been assigned to Raniganj Formation. This assemblage differs only from the miospore assemblage of Tattitola by the poor representation of trilete forms.

Thus from the above discussion it is clear that the Lower Gondwana bed exposed on the bank, near the village Tattitola is not of Barakar in age as expressed by Maheshwari (1966). The evidence of fossil both megaflores and miospores indicates an Upper Raniganj age for this Lower Gondwana bed.

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#### REFERENCES

- BALL, V. (1877). Geology of the Rajmahal Hills. *Mem. geol. Surv. India*, 13 (2): 1-94.
- BUNBURY, C. J. F. (1861). Notes on a collection of fossil plants from Nagpur, Central India. *Q. Jl. geol. Soc. Lond.*, 17: 325-346.
- CHANDRA, S. & SURANGE, K. R. (1977). Fertile bracts and scales of *Glossopteris* fructifications from the Lower Gondwana of India. *Palaeobotanist*, 24 (3): 195-201.
- FEISTMANTEL, O. (1879). The fossil flora of the Lower Gondwanas 1. The flora of Talchir-Karharbari beds. *Mem. geol. Surv. India Palaeont. indica*, Ser. 12, 3 (1): 1-48.
- FEISTMANTEL, O. (1880). The fossil flora of Gondwana System (Lower Gondwanas)-2. The flora of Damuda-Panchet divisions (1st part). *Mem. geol. Surv. India Palaeont. indica*, Ser. 12, 3 (2): 1-77.
- LELE, K. M. & MAITHY, P. K. (1964). Studies in the Glossopteris Flora of India-15. Revision of the epidermal structure of *Noeggerathiopsis*. *Palaeobotanist*, 12 (1): 7-17.
- MAHESHWARI, H. K. (1966). Studies in the Glossopteris Flora of India-30. Remarks on the age of the Lower Gondwana beds in Bansloi Valley, Santhal Parganas, Bihar, pp. 110-120 in—*Symposium on Floristics and Stratigraphy of Gondwanaland*. Birbal Sahni Institute of Palaeobotany, Lucknow.
- MAHESHWARI, H. K. (1967a). Studies in the Glossopteris Flora of India-29. Miospore assemblage from the Lower Gondwana exposures along Bansloi River in Rajmahal Hills, Bihar. *Palaeobotanist*, 15 (3): 258-280.
- MAHESHWARI, H. K. (1967b). Note on a miospore assemblage from Gopad River Valley, M.P. *Curr. Sci.*, 36 (7): 181.
- MAHESHWARI, H. K. & PRAKASH, G. (1965). Studies in Glossopteris Flora of India-21. Plant megafossils from the Lower Gondwana exposures along Bansloi River in Rajmahal Hills, Bihar. *Palaeobotanist*, 13 (2): 115-128.
- MAITHY, P. K. (1965). Studies in the Glossopteris Flora of India-20. *Noeggerathiopsis* and allied remains from the Karharbari beds, Giridih Coalfield, India. *Palaeobotanist*, 13 (1): 94-100.
- MAITHY, P. K. (1974a). A revision of the Lower Gondwana *Sphenopteris* from India. *Palaeobotanist*, 21 (1): 70-80.
- MAITHY, P. K. (1974b). Megaflores subdivision of Damudas, pp. 386-391 in K. R. Surange *et al.* (Eds) — *Aspects and Appraisal of Indian Palaeobotany*. Birbal Sahni Institute of Palaeobotany, Lucknow.
- MAITHY, P. K. (1974c). The Lower Gondwana plants of India and their stratigraphic significance. *7th International Carboniferous Congress, Krefeld, 1971*, 3: 385-390.
- MAITHY, P. K. (1977). Three new fern fronds from the Glossopteris Flora of India. *Palaeobotanist*, 24 (2): 96-101.
- MAITHY, P. K. & MANDAL, J. (1978). Further observations on *Stellotheca robusta* Surange & Prakash. *Palaeobotanist*, 25: 279-289.
- PANT, D. D. & VERMA, B. K. (1964). The cuticular structure of *Noeggerathiopsis* Feistmantel and *Cordiatia* Unger. *Palaeontographica*, B 115: 21-44.

- PASCOE, H. E. (1959). *A Manual of the Geology of India and Burma*, 2: Calcutta.
- SAH, S. C. D. & SHAH, S. C. (1974). Dubrajpur Formation and its biozones, pp. 447-451 in Surange, K. R. et al. (Eds) — *Aspects and Appraisal of Indian Palaeobotany*. Birbal Sahni Institute of Palaeobotany, Lucknow.
- SAH, S. C., SINGH, GOPAL & SASTRY, M. V. A. (1971). Biostratigraphic classification of Indian Gondwanas. *Proc. Internatn. Gond. Symp. Ali-garh*: 306-326.
- SURANGE, K. R. (1974). Indian Lower Gondwana floras: A review. *3rd Gondwana Symposium, Australia*: 135-147.
- SURANGE, K. R. & CHANDRA, S. (1973). *Partha* a new type of female fructification from the Lower Gondwana of India. *Palaeobotanist*, 20 (3): 356-360.
- SURANGE, K. R. & CHANDRA, S. (1974a). Fructification of Glossopteridae from India. *Palaeobotanist*, 21 (1): 1-17.
- SURANGE, K. R. & CHANDRA, S. (1974b). *Lidgettonia mucronata* sp. nov., a female fructification from the Lower Gondwana of India. *Palaeobotanist*, 21 (1): 121-126.
- SURANGE, K. R. & CHANDRA, S. (1975). Morphology of the gymnospermous fructifications of the Glossopteris Flora and their relationship. *Palaeontographica*, 149 B: 153-180.
- SURANGE, K. R. & PRAKASH, G. (1962). Studies in the Glossopteris Flora of India 12. *Stellotheca robusta* nov. comb.: A new equisetaceous plant from the Lower Gondwanas of India. *Palaeobotanist*, 9 (1, 2): 49-52.
- TIWARI, R. S. (1980). Palynostratigraphy of Permian-Triassic transition of India. *Proc. 4th Internatn. Palynol. Conf., Lucknow (1976-77)* 2: 199-207.

## EXPLANATION OF PLATES

## PLATE 1

1. *Noeggerathia* ? (*Cyclopteris* ?) *hislopi* Bunbury, specimen no. 35286.  $\times$  1.
2. A portion of the specimen in fig. 1 enlarged to show the nature of veins.  $\times$  3.
3. Scale leaf type-1, specimen no. 35287.  $\times$  2.
4. Scale leaf type-2, specimen no. 35288.  $\times$  2.
5. Scale leaf type-3, specimen no. 35289.  $\times$  2.
6. Scale leaf type-4, specimen no. 35290.  $\times$  2.2.
7. Scale leaf type-5, specimen no. 35291.  $\times$  2.
8. Scale leaf type-6, specimen no. 35292.  $\times$  2.
9. *Samaropsis raniganjensis* alongwith scale leaf type-1, specimen no. 35293.  $\times$  3.
10. *Plumsteadia* sp., specimen no. 35294.  $\times$  2.5.
5. *Apiculatisporis inconspicuus* Salujha, slide no. 5493.
6. *Verrucosisorites diversus* Bharadwaj & Salujha, slide no. 5494.
7. *Apiculatisporis levis* (Balme & Hennelly) Tiwari, slide no. 5493.
9. *Horriditriletes brevis* Bharadwaj & Salujha, slide no. 5492.
10. *Cyclogranisporites gondwanensis* Bharadwaj & Salujha, slide no. 5492.
11. *Indospora clara* Bharadwaj, slide no. 5492.
12. *Latosporites colliensis* (Balme & Hennelly) Bharadwaj, slide no. 5494.
13. *Gnetaceapollenites sinuosus* (Balme & Hennelly) Bharadwaj, slide no. 5495.
14. *Densisorites densus* Bharadwaj & Salujha, slide no. 5494.
15. *D. invisus* Bharadwaj & Salujha, slide no. 5494.
16. *Scheuringipollenites* sp. cf. *S. tentulus* Tiwari, slide no. 5494.
17. *Faunipollenites varius* Bharadwaj, slide no. 5493.
18. *Striatites varius* Kar, slide no. 5494.
19. *Lahirites rotundus* Bharadwaj & Salujha, slide no. 5495.
- 20, 21. *Verticipollenites gibbosus* Bharadwaj, slide nos. 5494 and 5492.
22. *Distriatites bilateris* Bharadwaj, slide no. 5492.

## PLATE 2

1. *Leiotriletes brevis* Sinha, slide no. 5495.
2. *Calamospora tenuis* Bharadwaj & Salujha, slide no. 5495.
3. *Acanthotriletes filiformis* (Bharadwaj & Salujha) Tiwari, slide no. 5493.
4. *Lophotriletes rectus* Bharadwaj & Salujha, slide no. 5493.



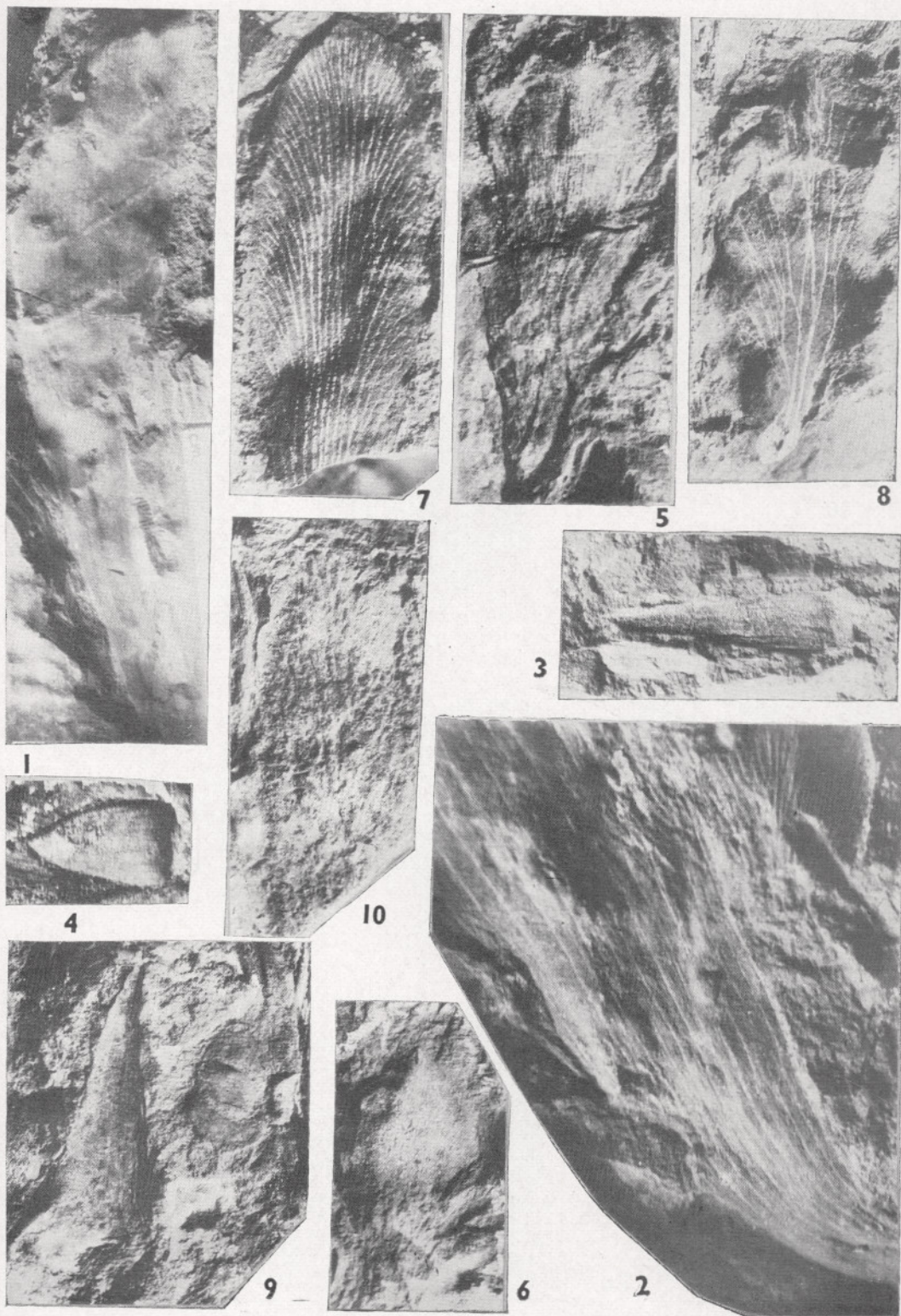


PLATE 1



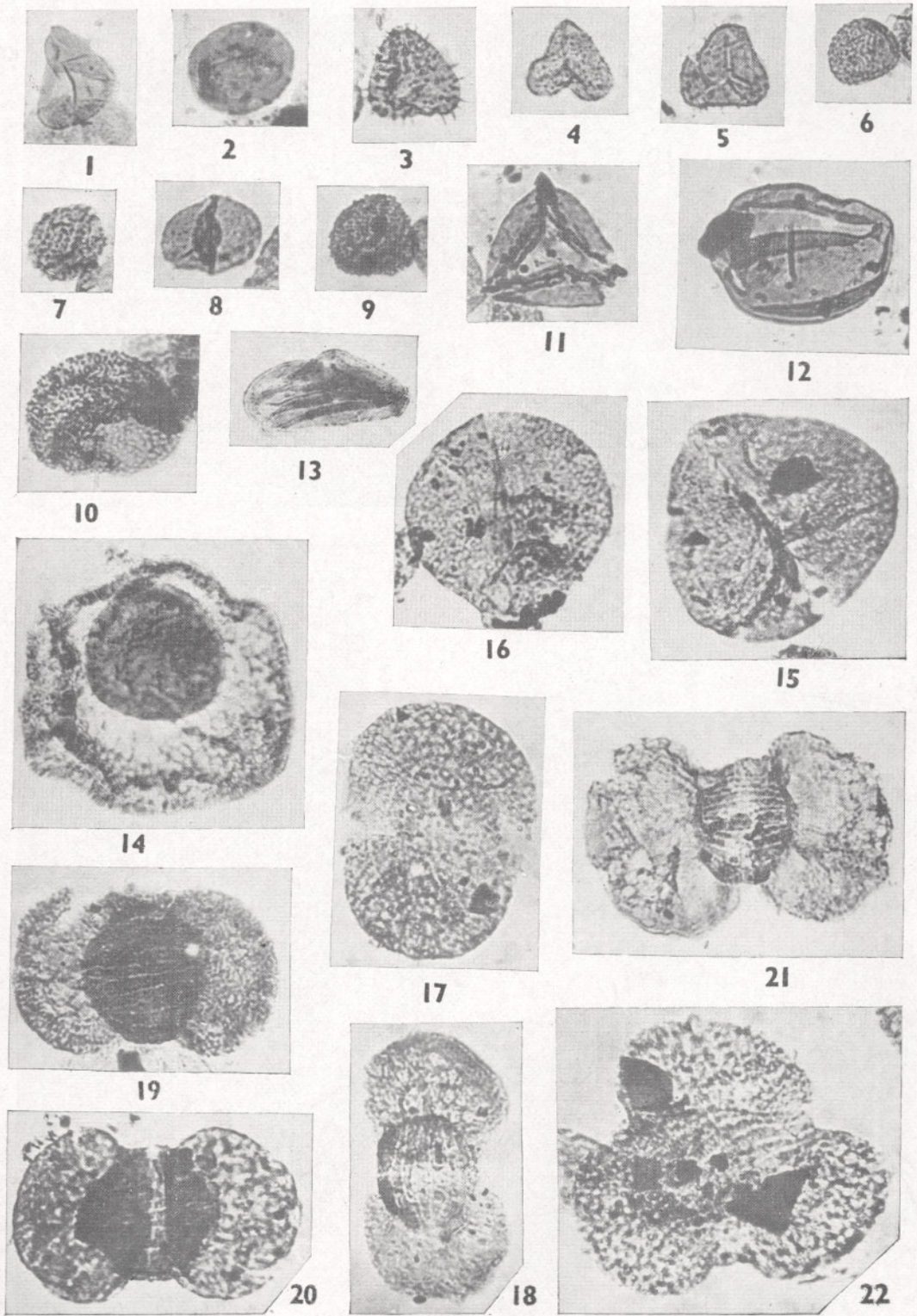


PLATE 2