

OCCURRENCE OF ARAUCARIAN WOOD FROM THE NEOGENE OF WEST BENGAL, INDIA

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ABSTRACT

A fossil wood of Araucariaceae is described from the Miocene beds of Bolpur near Santiniketan in West Bengal. The wood shows mostly biseriate, alternate and contiguous hexagonal pits on the tracheidal walls. This finding forms the first record of Araucariaceae in the Neogene of India.

Key-words — Xylotomy, Araucariaceae, *Araucarioxylon*, Neogene, India.

सारांश

पश्चिम बंगाल के पश्च-तृतीयक युग से अॅराकेरिएसी कुल की काष्ठ - गजेन्द्र प्रताप श्रीवास्तव एवं उत्तम प्रकाश

पश्चिम बंगाल में शांतनिकेतन के पास बोलपुर की मध्यनूतन युगीन संस्तरों से अॅराकेरिएसी कुल की काष्ठ का वर्णन किया गया है। इस काष्ठाश्म में वाहिनिकीय भित्ति पर प्रायः द्विपंक्तिक, एकान्तर एवं संलग्न षष्टभुजी गर्त विद्यमान हैं। भारत के पश्च-तृतीयक युग में अॅराकेरिएसी कुल की उपस्थिति का यह सबसे पहला अभिलेख है।

INTRODUCTION

THIS paper deals with an araucarian fossil wood collected from the Tertiary exposures near Santiniketan in Birbhum District of West Bengal where large number of silicified woods of varying dimensions are found in the ferruginous concretionary beds. The geology of West Bengal has been worked out in detail by Hunday and Banerjee (1967) who state that the presence of Tertiary rocks is known both in peninsular and extrapeninsular regions of this state and these rocks are considered to be of Miocene age. However, it is only in the peninsular region of the state that small patches of Tertiary grits and gravel beds occasionally with clays and dicotyledonous fossil woods have been reported from the parts of Midnapur, Bankura, Birbhum and Bardhaman districts. These isolated patches of the Tertiary rocks over a wide area suggest the presence of a continuous belt of Tertiary formations in this part of the state. Hunday (1954) has shown the resemblance of these formations of Bankura and Midnapur districts with the formations overlying the Baripada lime-

stones (Miocene) in the Mayurbhanj District of Orissa and thought that these might be equivalent to the rocks of Tipam Series of Assam. However, from the palaeobotanical evidence as reflected by the assemblage, a Neogene age was also suggested for the petrified woods by Bande and Prakash (1980) because the presence of dipterocarps and the dominance of legumes is characteristically indicative of a Neogene age in the Tertiary of India.

A rich flora, comprising mainly the fossil woods, has been worked out from the Tertiary of West Bengal by various workers. These include a variety of taxa of petrified woods of *Dipterocarpoxyton bolpurensis* Ghosh & Roy (1979c), *Shoreoxyton bengalensis* Roy & Ghosh (1979a), *S. tipamense* Prakash & Awasthi (Bande & Prakash, 1980), *S. robustoides* Roy & Ghosh (1981a) and *Anisopteroxyton santiniketanense* Ghosh & Roy (1980b) of Dipterocarpaceae, *Calphyloxyton bengalense* Ghosh & Roy (1979e) of Guttiferae, *Chischetnoxyton bengalensis* Ghosh & Roy (1979d) of Meliaceae, *Dracontomelumoxyton mangiferumoides* (Ghosh & Roy, 1979b; Roy & Ghosh, 1981b), *Glutoxyton burmense* (Holden) Chowdhury

(Roy & Ghosh, 1979b), *Melanorrhoeoxylon garbetaense* (Ghosh & Roy, 1980d; Roy & Ghosh, 1981b), *Mangiferoxylon assamicum* Prakash & Tripathi (Roy & Ghosh, 1981b), *Lanneoxylon grandiosum* Prakash & Tripathi (Roy & Ghosh, 1981b) and *Buchnioxylon indicum* (Ghosh & Roy, 1980d; Roy & Ghosh, 1981b) of Anacardiaceae, *Canari-oxylon indicum* Ghosh & Roy (1978) of Burseraceae, *Pahudioxylon bankurensis* Chowdhury, Ghosh & Kazmi (1960), *P. bengalensis* Ghosh & Roy (1982), *Millettioxylon bengalensis* Ghosh & Roy (1979a), *M. pongamiensis* Prakash (Ghosh & Roy, 1981a), *Cassinium baroohii* Prakash (Bande & Prakash, 1980; Ghosh & Roy, 1982), *C. ballavpurensis* Ghosh & Roy (1981b), *Cynometroxylon holdeni* (Gupta) Prakash & Bande (Bande & Prakash, 1980), *Koompasioxylon elegans* Kramar (Bande & Prakash, 1980), *Ormosioxylon bengalensis* Bande & Prakash (1980), *Albizzinium eolebbekianum* Prakash (Ghosh & Roy, 1981a) and *Peltophoroxylon ferrugineoides* Bande & Prakash (1980) of Leguminosae, *Terminalioxylon tertiarum* Prakash (Ghosh & Roy, 1980a), *Terminalioxylon* sp. Deb & Ghosh (1974) and *Anogeissusoxylon bengalensis* Roy & Ghosh (1979b) of Combretaceae, *Mallo-toxylon cleidionoides* Roy & Ghosh (1982) of Euphorbiaceae and a palm wood belonging to *Palmoxylon coronatum* Sahnii (Roy & Ghosh, 1980).

The present finding forms the first record of an araucarian wood from the Tertiary of West Bengal indicating the presence of this family in the Neogene of India for the first time. Woods of *Araucaria* and *Agathis* are so similar anatomically that there is no certain way of distinguishing them (Greguss, 1955; Jane, 1955, p. 319).

SYSTEMATIC DESCRIPTION

FAMILY — ARAUCARIACEAE

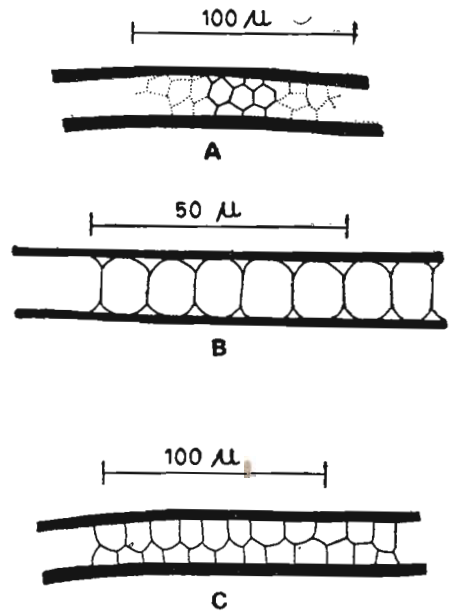
Genus — *Araucarioxylon* Kraus, 1870

Araucarioxylon sp.

Pl. 1, figs 1-5; Text-figs 1-3

The study is based on a piece of secondary wood measuring about 12 cm in length and 3.5 cm in diameter. The preservation is good enough to show most of the structural details except field pits.

Wood non-porous. Growth rings distinct, consisting of growth zones 8-42 cells or 646-1520 μ m in width, delimited by a thin band of late wood tracheids. Transition from early to late wood abrupt (Pl. 1, figs 1, 2). Late wood about 2-5 cells or 115-200 μ m in width composed of thick-walled, compactly arranged, squarish to tangentially elongated tracheids measuring about 10-16 μ m in radial diameter and 10-25 μ m in tangential diameter (Pl. 1, fig. 2). Early wood contributes more than 80 per cent of the growth zone (Pl. 1, figs 1, 2), about 6-40 cells or 275-1370 μ m in width consisting of comparatively thin-walled, quadrangular, radially elongated tracheids with big lumen arranged in radial rows and measuring 36-40 μ m in radial diameter and 24-32 μ m in tangential diameter. Tangential walls of the tracheids appear smooth without any pits but radial walls are found pitted at places. Parenchyma absent. Intertracheidal pits 1-3 (mostly 2) seriate (Pl. 1, fig. 5; Text-fig. 1A-C), alternate, contiguous, hexagonal in shape, and 8-10 μ m in diameter. Bars of Sanio absent. Xylem rays evenly distributed, 7-8 per mm, homogeneous,



TEXT-FIG. 1—A, Radial longitudinal section showing alternate, triseriate tracheid pitting, slide no. 35590-IV; B, radial longitudinal section showing uniseriate tracheid pitting, slide no. 35590-IV; C, radial longitudinal section showing alternate, biseriate tracheid pitting, slide no. 35590-IV.

almost uniseriate (Pl. 1, figs 3, 4), 1-7 (mostly 2-3) cells or 40-240 μm in height made up of oval to barrel-shaped cells as seen in tangential section. *Cross-field pits* could not be seen due to ill preservation. *Resin canals* not present.

Specimen — B.S.I.P. Museum no. 35590.

Locality — Near Santiniketan, Birbhum District, West Bengal.

Age — Miocene.

DISCUSSION

Presence of growth rings, almost uniseriate xylem rays and tracheids with alternate, hexagonal bordered pits on the radial walls indicate the affinities of the present fossil wood with the family Araucariaceae among the living conifers. Fossil woods showing such characters are usually described either under the generic name *Dadoxylon* Endlicher (1847) or *Araucarioxylon* Kraus (1870, in Schimper, 1870-72). However, there is a difference of opinion among the palaeobotanists as to the nomenclature of fossil woods with araucaroid pitting. For a long time all fossil woods of this type from the Palaeozoic were included in *Dadoxylon* while those from the younger formations were put under *Araucarioxylon* (Seward, 1963) because the former were thought to belong to Cordaitales and the latter to Araucariaceae. Some palaeobotanists thought that the name *Dadoxylon* be used for secondary wood with araucaroid type of tracheidal pitting irrespective of the age of fossil woods (Potonié, 1902; Gothan, 1905). Contrary to this White (1908) opined that the age must be taken into account while distinguishing *Dadoxylon* from *Araucarioxylon*. However, Maheshwari (1972) while revising Lower Gondwana wood taxa suggested that the secondary woods with araucaroid radial pitting and cupressoid cross-field pits having uniseriate or rarely partly biseriate rays should be assigned to the genus *Araucarioxylon* and those with usually more than 1-seriate rays should be placed under *Dadoxylon*. From this it seems that Maheshwari has laid much stress on the width of the rays which according to others (Bailey & Faull, 1934; Dayal, 1972; Laxhanpal, Prakash & Bande, 1977; Prasad, 1978, 1982) is not a constant feature and is quite variable. Lepekhina (1972) has also given a classification of fossil woods with

araucaroid pitting (*Dadoxyleae*). According to her there is no difference in the secondary wood of *Araucarioxylon* and *Dadoxylon*, the xylem rays in both of them as a rule are uni-biseriate and rarely up to 5 seriate. The difference lies in the presence of endarch primary xylem with rather large, nonseptate pith without secretory canals which occur in *Dadoxylon* as against the secondary wood found only in *Araucarioxylon*. Lepekhina's view is also in accordance with the original diagnoses given separately for *Araucarioxylon* Kraus and *Dadoxylon* Endlicher. Recently Prasad (1982), while dealing with Indian Palaeozoic woods, has also instituted a new genus *Parapalaeoxylon* to accommodate exclusively the secondary woods which show araucaroid tracheidal pitting and bordered cross-field pits. As the present fossil wood consists only of secondary xylem and possesses growth rings, almost uniseriate xylem rays and the tracheids with alternate, hexagonal bordered pits on the radial walls, it is assigned to the genus *Araucarioxylon* Kraus. Because the cross-field pits and some other anatomical features could not be ascertained in the present specimen due to bad preservation, the present fossil wood has been described here as *Araucarioxylon* sp. without assigning it to any particular species till better preserved specimens with more details are available.

A survey of literature dealing with the araucarian woods shows that a considerable number of these woods have been recorded from India and abroad (Florin, 1963; Ramanujam, 1976, 1978; Stockey, 1982). The oldest record in India is from the Upper Triassic Maleri beds near Tiki in Central India (Sahni, 1931). The other records are those from the Jurassic onwards (Shukla, 1938, 1944; Billimoria, 1948; Bharadwaj, 1953; Sah & Jain, 1964; Chitale, 1949; Suryanarayana, 1956; Singhai, 1958; Laxhanpal, *et al.*, 1977; Bose & Maheshwari, 1974). However, we are dealing here only with the araucarian woods which have been described from the Tertiary of the Indian subcontinent. So far only six woods have been described from the Deccan Intertrappean beds. They are *Dadoxylon deccani* Shukla (1938), *D. resionosum* Shukla (1944), *D. chhindwarensis* Billimoria (1948), *D. eocenium* Chitale (1949), *D. shuklai* Singhai (1958) and *Araucarioxylon mohgaensis* Laxhanpal, Prakash & Bande (1977).

Prakash and Bande (1980) have also described an araucarian wood as *Araucarioxylon* sp. from the Tertiary of Burma. Besides, an araucarian wood has been discovered recently from the Tertiary sediments near Jaisalmer in Rajasthan (J. S. Guleria—personal communication). On superficial comparison with these fossil woods we have found that in most of the structural details our fossil wood comes very near to the wood described by Prakash and Bande (1980) from the Tertiary of Burma. However, a detailed comparison is not possible due to lack of some important characters like the cross-field pits in both the fossil woods.

The family Araucariaceae contains two extant genera, *Agathis* Salisbury and *Araucaria* de Jussieu. They are tall coniferous trees and are today confined to the southern hemisphere. The genus *Agathis* has presently been revised by Whitmore (1980) and consists of 13 species and exclusively found in the eastern part of southern hemisphere extending from Philippines to New Zealand and Malaya to New Caledonia. The genus *Araucaria* according to De Laubenfels (1972) has 18 species and is presently distributed in New Caledonia, New Guinea, eastern Australia, Chilean-Argentine Cordillera and Brazil. The fossil records of *Agathis* are meagre and seem to be confined to the southern hemisphere (Florin, 1963), whereas the records of *Araucaria* are much more complete. Thus this genus appears to have been more wide spread in past both in northern and southern hemispheres (Kendall, 1949, 1952; Harris, 1979; Stockey

1981, 1982; Florin, 1963; Ramanujam, 1976, 1977).

The araucarian remains have so far been recorded till the Palaeocene-Eocene in India and it was thought that the family Araucariaceae became extinct afterwards. But the present record of the fossil wood of Araucariaceae from the Neogene of West Bengal extends the presence of this family till the Neogene in India. Besides, a fossil wood of Araucariaceae has also been recorded from the Mio-Pliocene Irrawaddy Series of Burma. However, between the Palaeocene-Eocene of the Deccan Intertrappean beds and the Neogene of West Bengal, we do not have any records of Araucariaceae from the Oligocene and other Neogene formations of the peninsular India. Even the Cuddalore Series of South India, the Kankawati Series of north-west India, the Tipam and Dupitla Series of north-east India from where the fossil woods and other plant remains have extensively been worked out, do not have so far any record of fossil wood or mega- or microremains of Araucariaceae. The absence of Araucariaceae from the Oligocene and other contemporary Neogene floras of India is quite puzzling. However, further extensive studies on the Neogene floras of India would solve its present erratic distribution during the Neogene.

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REFERENCES

- BAILEY, I. W. & FAULL, A. F. (1934). The Cambium and its derivative tissues No. IX, structural variability in the Red wood, *Sequoia sempervirens*, and its significance in the identification of fossil woods. *J. Arnold Arbor.*, **15** (3): 233-254.
- BANDE, M. B. & PRAKASH, U. (1980). Fossil woods from the Tertiary of West Bengal, India. *Geophytology*, **10** (2): 146-157.
- BHARADWAJ, D. C. (1953). Jurassic woods from the Rajmahal hills, Bihar. *Palaeobotanist*, **2**: 59-70.
- BILLIMORIA, J. J. (1948). A new species of *Dadoxylon* from C.P. Palaeobotany in India-VI. *J. Indian bot. Soc.*, **26** (4): 260.
- BOSE, M. N. & MAHESHWARI, H. K. (1974). Mesozoic conifers, pp. 212-223 in Surange *et al.* (eds)—*Aspects & Appraisal of Indian Palaeobotany*. Birbal Sahni Institute of Palaeobotany, Lucknow.
- CHITALEY, S. D. (1949). On a new species of *Dadoxylon*, *Dadoxylon eocenum* sp. nov., from the district Chhindwara, C.P., India. *J. Indian bot. Soc.*, **28**: 227-237.
- CHOWDHURY, K. A., GHOSH, S. S. & KAZMI, M. H. (1960). *Pahudioxylon bankurensis* gen. et sp. nov., a fossil wood from the Miocene beds of Bankura District, West Bengal, India. *Proc. natn. Inst. Sci. India*, **26B** (1): 22-28.
- DAYAL, R. (1972). Importance of correct interpretation of anatomical structure in the identification of fossil woods with special reference to variability. *Proc. Indian natn. Sci. Acad.*, **37B** (3): 114-123.
- DEB, URMILA & GHOSH, A. K. (1974). On the occurrence of *Terminalioxylon*, an angiosperm fossil wood from the vicinity of Santiniketan,

- Birbhum District, West Bengal. *Indian J. Earth Science*, 1 (2): 208-213.
- DE LAUBENFELS, D. J. (1972). *Flore de la Nouvelle-Caledonie et dependances*, 4. Gymnosperms. Mus. Nat. Hist. Natr., 168 pp.
- ENDLICHER, S. (1847). *Synopsis Coniferarum*. Sangalli.
- FLORIN, R. (1963). The distribution of conifer and taxad genera in time and space. *Acta Horti Bergiani*, 20 (4): 121-312.
- GHOSH, P. K. & ROY, S. K. (1978). Fossil wood of *Canarium* from the Tertiary of West Bengal, India. *Curr. Sci.*, 47 (21): 804-805.
- GHOSH, P. K. & ROY, S. K. (1979a). A new species of *Millettia* from the Tertiary of West Bengal, India. *Curr. Sci.*, 48 (4): 165-166.
- GHOSH, P. K. & ROY, S. K. (1979b). Fossil wood of *Dracontomelum* from the Tertiary of West Bengal, India. *Curr. Sci.*, 48 (8): 362.
- GHOSH, P. K. & ROY, S. K. (1979c). *Dipterocarpoxyylon bolpurensis* sp. nov., a fossil wood of Dipterocarpaceae from the Tertiary of West Bengal, India. *Curr. Sci.*, 48 (11): 495-496.
- GHOSH, P. K. & ROY, S. K. (1979d). *Chisochetoxylon bengalensis* gen. et sp. nov., a new fossil wood of Meliaceae from the Tertiary beds of Birbhum District, West Bengal, India. *Curr. Sci.*, 48 (16): 737-739.
- GHOSH, P. K. & ROY, S. K. (1979e). A new species of *Calophyllum* from the Miocene beds of Birbhum District, West Bengal, India. *Curr. Sci.*, 48 (18): 823-824.
- GHOSH, P. K. & ROY, S. K. (1980a). Fossil wood of *Terminalia* from the Tertiary of West Bengal. *Curr. Sci.*, 49 (14): 556-557.
- GHOSH, P. K. & ROY, S. K. (1980b). Fossil wood of *Anisoptera* from the Miocene of Birbhum District, West Bengal, India. *Curr. Sci.*, 49 (17): 665-666.
- GHOSH, P. K. & ROY, S. K. (1980c). *Melanorrhoeoxylon garbetaense* sp. nov., a fossil wood of Anacardiaceae from the Tertiary of West Bengal, India. *Curr. Sci.*, 49 (21): 828-829.
- GHOSH, P. K. & ROY, S. K. (1980d). A new fossil dicotyledonous wood from Tertiary beds. *Sci. Cult.*, 46: 137-138.
- GHOSH, P. K. & ROY, S. K. (1981a). Fossil wood of *Millettia* and *Albizia* from the Tertiary beds of West Bengal, India. *Curr. Sci.*, 50 (6): 288.
- GHOSH, P. K. & ROY, S. K. (1981b). *Cassinium ballavpurensis* sp. nov. from the Miocene of West Bengal, India. *Acta bot. indica*, 9: 285-289.
- GHOSH, P. K. & ROY, S. K. (1982). Fossil wood of Caesalpinioideae from the Miocene of West Bengal, India. *Acta bot. indica*, 10: 50-55.
- GOTHAN, A. (1905). Zur Anatomie lebender und fossiler Gymnospermen-Holzer. *Abh. K. Preuss. geol. Landesanst.*, 44: 1-108.
- GREGUSS, P. (1955). *Identification of Living Gymnosperms on the Basis of Xylotomy*. Akad. Kiado, Budapest.
- HARRIS, T. M. (1979). *The Yorkshire Jurassic Flora. V. Coniferales*. Br. Mus. (Nat. Hist.), 803: 166 pp.
- HUNDAY, A. (1954). On the newly found Tertiary patches in Bankura, West Bengal. *Sci. Cult.*, 19: 245-246.
- HUNDAY, A. & BANERJEE, S. (1967). Geology and mineral resources of West Bengal. *Mem. geol. surv. India*, 97: 1-302.
- JANE, F. W. (1956). *The Structure of Wood* (1st edn). Adam & Charles Black, London.
- KENDALL, M. W. (1949). A Jurassic Member of the Araucariaceae. *Ann. Bot. N.S.*, 13 (50): 151-161.
- KENDALL, M. W. (1952). Some conifers from the Jurassic of England. *Ann. Mag. nat. Hist., Ser.*, 12 (51): 583-594.
- LAKHANPAL, R. N., PRAKASH, U. & BANDE, M. B. (1977). An araucarian fossil wood from the Deccan Intertrappean beds of Mohgaonkalan. *Palaeobotanist*, 24 (2): 125-131.
- LEPEKHINA, V. G. (1972). Woods of Palaeozoic pycnoxylic gymnosperms with special reference to North Eurasia representatives. *Palaeontographica*, 138B (1-4): 44-106.
- MAHESHWARI, H. K. (1972). Permian woods from Antarctic and revision of some Lower Gondwana wood taxa. *Palaeontographica*, 138B (1-4): 1-43.
- POTONIÉ, H. (1902). Fossile Holzer aus der oberen Kreide Deutsch-Ostafrikas. *Wiss. Beih. Dtsch. Kolonialbl.*, 15 (4): 227-229.
- PRAKASH, U. & BANDE, M. B. (1980). Some more fossil woods from the Tertiary of Burma. *Palaeobotanist*, 26 (3): 261-278.
- RAMANUJAM, C. G. K. (1976). Indian gymnosperms — in time and space. *Aspects of Plant Sciences*, 1: 73-126.
- RAMANUJAM, C. G. K. (1978). Geological history of Araucariaceae in India. *Botanique*, 9 (1-4): 1-12.
- ROY, S. K. & GHOSH, P. K. (1979a). *Shoreoxylon bengalensis* sp. nov., a fossil wood of Dipterocarpaceae from the Miocene beds of West Bengal, India. *Proc. 66th Indian Sci. Cong., Hyderabad*, 3: 64.
- ROY, S. K. & GHOSH, P. K. (1979b). On the occurrence of fossil woods of *Gluta* and *Anogeissus* in the Tertiary of Birbhum District, West Bengal, India. *Geophytology*, 9 (1): 16-21.
- ROY, S. K. & GHOSH, P. K. (1980). On the occurrence of *Palmoxylon coronatum* in West Bengal, India. *Ameghiniana*, 17 (2): 130-134.
- ROY, S. K. & GHOSH, P. K. (1981a). *Shoreoxylon robustoides* sp. nov., a new fossil wood of Dipterocarpaceae from the Tertiary of West Bengal, India. *J. Indian bot. Soc.*, 60 (3-4): 307-311.
- ROY, S. K. & GHOSH, P. K. (1981b). Fossil woods of Anacardiaceae from the Tertiary of West Bengal, India. *Palaeobotanist*, 28-29: 338-352.
- ROY, S. K. & GHOSH, P. K. (1982). Fossil woods of Euphorbiaceae from the Tertiary of West Bengal, India. *Feddes Repertorium*, 93 (5): 363-367.
- SAH, S. C. D. & JAIN, K. P. (1964). Some fossil woods from the Jurassic of Rajmahal Hills, Bihar, India. *Palaeobotanist*, 12 (2): 169-180.
- SAHNI, B. (1931). Revisions of Indian fossil plants, pt. 2, Coniferales (b. Petrifications). *Mem. geol. Surv. India Palaeont. indica*, n. ser., 11: 51-124.
- SCHIMPER, W. PH. (1870-72). *Traite de Palaeontologie vegetale ou la Flore du Monde primitif dans es rapports avec les formations geologiques et la flore du Monde actuel*, 2. J. B. Bailliere et Fils, Paris.
- SEWARD, A. C. (1963). *Fossil Plants*. 3. New York and London.
- SHUKLA, V. B. (1938). On a new species of *Dadoxylon*, *D. deccani* sp. nov., from the Deccan

- Intertrappean series. *J. Indian bot. Soc.*, **18** (5 & 6): 355-367.
- SHUKLA, V. B. (1944). *Dadoxylon resinsum* sp. nov., from the Chhindwara District of Central Provinces. *J. Indian bot. Soc.*, **23** (3): 83-90.
- SINGHAI, L. C. (1958). On a new species of *Dadoxylon*, *D. shuklai* sp. nov., from Deccan Intertrappean beds of Chhindwara District, Madhya Pradesh. *J. Palaeobot. Soc.*, **3**: 136-141.
- STOCKEY, R. A. (1981). Some comments on the origin and evolution of conifers. *Cand. J. Bot.*, **59** (10): 1932-1940.
- STOCKEY, R. A. (1982). The Araucariaceae: An evolutionary perspective. *Rev. Palaeobot. Palynol.*, **37**: 133-154.
- SURYANARAYANA, K. (1956). *Dadoxylon rajmahalense* Sahnii from the coastal Gondwanas of India. *Palaeobotanist*, **4**: 89-90.
- WHITE, D. (1908). Report on the fossil flora of the coal measures of Brazil. Part III of the Final Report of Dr. I. C. White. Rio-de Janeiro, pp. 337-617.
- WHITMORE, T. C. (1980). A monograph of *Agathis*. *Plant Syst. Evol.*, **135**: 41-69.

EXPLANATION OF PLATE

1. Cross section in low power showing growth rings with early and late wood tracheids. $\times 40$; slide no. 35590-I.
2. Cross section magnified to show thin-walled early wood tracheids thick-walled late wood tracheids and the xylem rays. $\times 100$; slide no. 35590-I.
3. Tangential longitudinal section showing uniseriate xylem rays. $\times 100$; slide no. 35590-II.
4. Radial longitudinal section to show homogeneous xylem rays. $\times 120$; slide no. 35590-III.
5. Radial longitudinal section showing biseriate, alternate, hexagonal tracheid pits. $\times 300$; slide no. 35590-III.

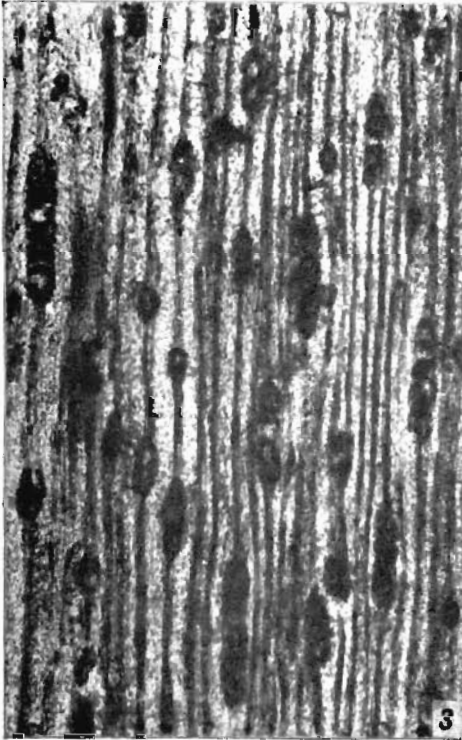
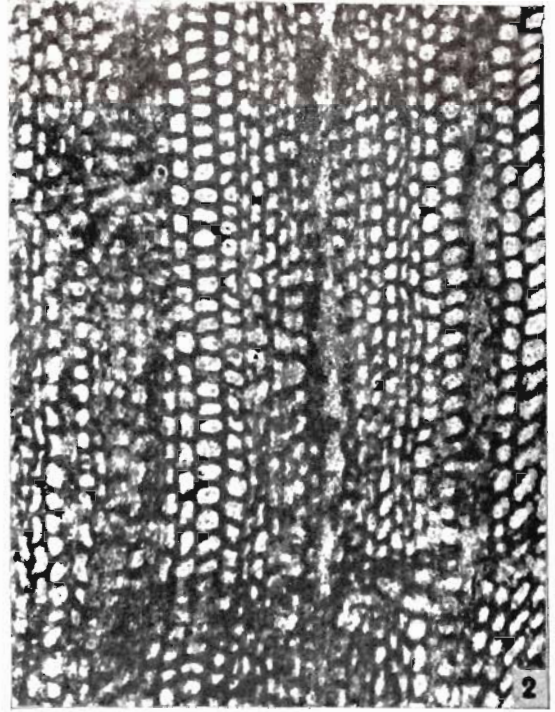
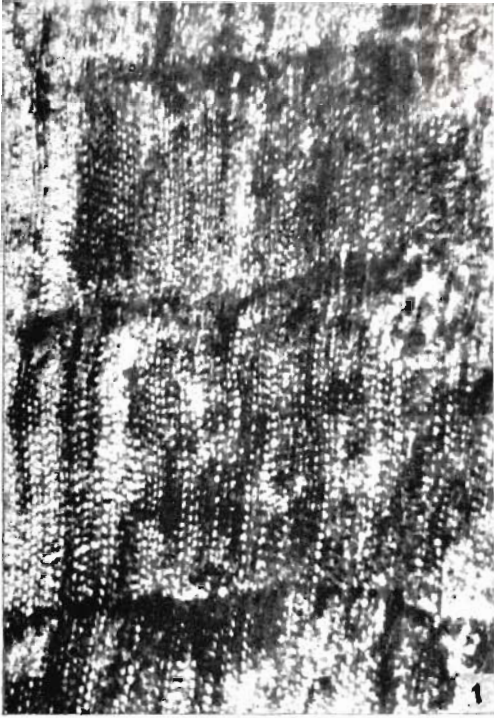


PLATE I