

# A PODOCARPACEOUS FOSSIL WOOD FROM THE DECCAN INTERTRAPPEAN BEDS OF MALABAR HILLS, BOMBAY

M. B. BANDE AND U. PRAKASH

*Birbal Sahni Institute of Palaeobotany, Lucknow*

## ABSTRACT

A fossil wood showing close affinities with the modern woods of *Podocarpus* has been described here from the Deccan Intertrappean Beds of Malabar Hills, Bombay. This is the first authentic record of Podocarpaceae in the Deccan Intertrappean flora of India.

## INTRODUCTION

Some months back Prof. R. C. Misra gave us a well preserved piece of fossil wood for investigation. The details regarding its collection are given by him (in litt.) as below :

“The fossil wood specimen was collected from the debris of the foundation of a building close to Hyderabad House at Nepean Sea Road, by MASTER VIKRAM AGNIHOTRI, and handed over to me. I visited the area and I am firmly of the opinion that the specimen must have come from the close-by Malabar Hill Intertrappean formation”.

Thus according to the information furnished by Prof. Misra the specimen was collected from the Deccan Intertrappean Beds of Malabar Hills, Bombay. After a detailed study it was found to show close similarity with the woods of the genus *Podocarpus* of Podocarpaceae and has been described in the following pages as *Podocarpoxylon vikramii* sp. nov.

The presence of Podocarpaceae in the Deccan Intertrappean flora of India has been suspected since 1931 when SAHNI described three coniferous cones, *Indostrobus bifidolepis*, *Takliostrobus alatus* and ?*Pityostrobus crassitesta* in his “Revision of Indian Fossil Plants, Part II. Coniferales (b. Petrifications)”. Of these, *Takliostrobus* and *Pityostrobus crassitesta* were collected from the Deccan Intertrappean beds of Takli near Nagpur but the exact locality of *Indostrobus bifidolepis* is not known. However, it was also believed to be collected from the area of Deccan. Although *Indostrobus bifidolepis* is fundamentally abietinean in nature, it shows some affinities also with Podocarpaceae in the possession of inverted ovules. The present finding thus becomes the first authentic record of Podocarpaceae in the Deccan intertrappean flora of India and confirms the presence of this family in India during the Early Tertiary.

The earlier record of plant fossils from the Bombay Intertrappeans consists of plants like conical bulbous roots, a segment of a small trunk of dicotyledonous tree with bark, an unsatisfactory piece of palm wood, fragments of wood similar to common bamboo, stems of grasses, two roundish leaves similar to the leaflets of *Acacia*, an impression resembling stem and flower or seed of a cyperaceous plant something like

*Scirpus lacustris*, seeds like that of *Artabotrys odoratissima* and some large seed-pods (BUIST, 1851; CARTER, 1852).

## SYSTEMATIC DESCRIPTION

FAMILY—PODOCARPACEAE

Genus—**Podocarpoxyton** Gothan, 1905

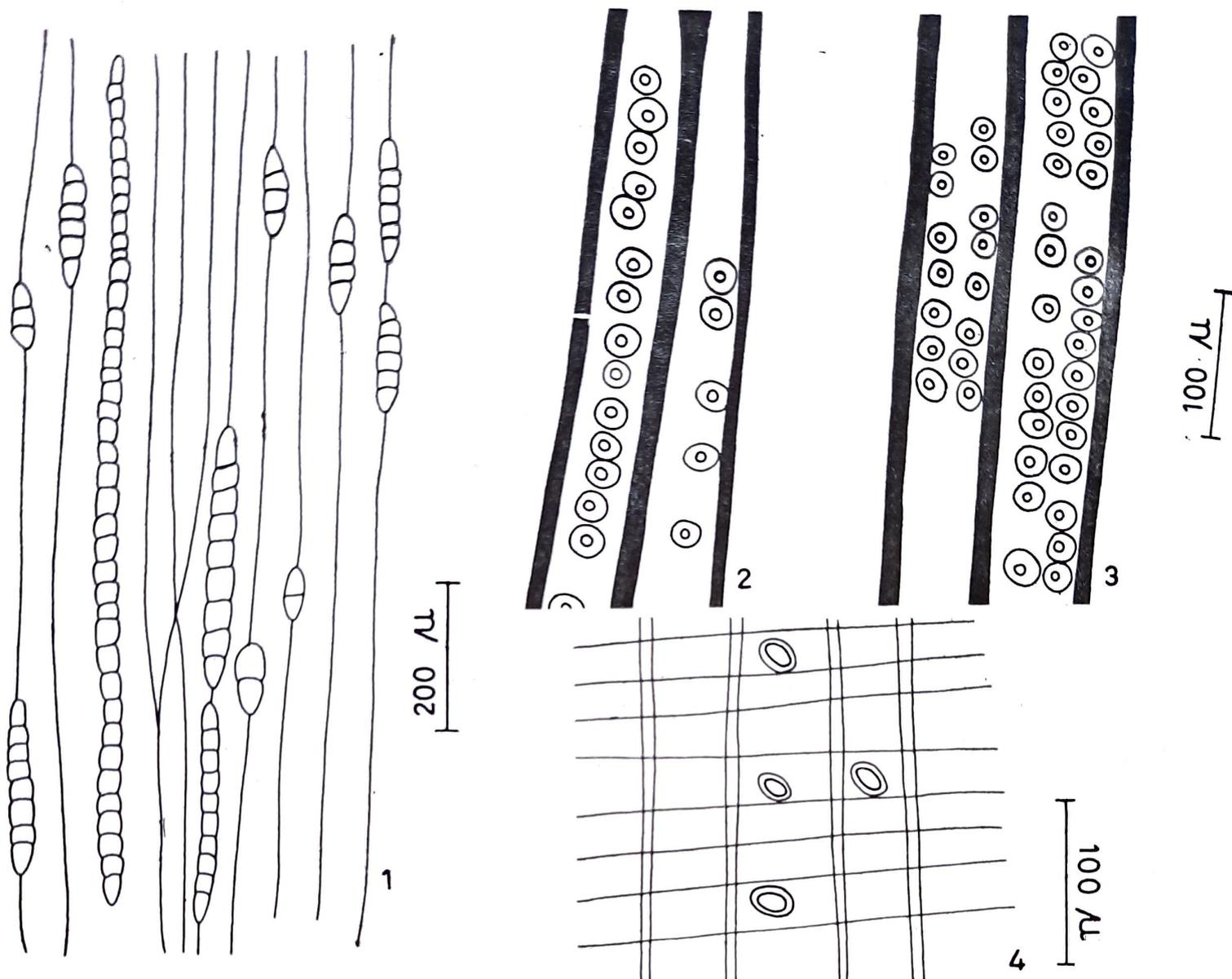
**Podocarpoxyton vikramii** sp. nov.

Pl 1, Figs 1-7, Text-figs. 1-4

*Material*—A single piece of secondary wood 20 cm in length and 5.5 cm in diameter.

*Description*—*Growth rings* present but not very conspicuous, delimited by thin bands of dark coloured, late wood tracheids (Pl. 1, Figs. 1,2 ). Transition from early to late wood abrupt (Pl. 1, Fig. 2). *Late wood* zone narrow, 2-7 cells wide, made up of dark coloured, thick-walled, tangentially flattened small tracheids with radial diameter 20-30  $\mu\text{m}$  and tangential diameter 30-40  $\mu\text{m}$ . *Early wood* zone comprises major portion of the growth ring, made up of about 25-30 cells in width ; early wood tracheids large, comparatively thinner walled with big lumen, usually polygonal in cross section, radially elongated, 40-80  $\mu\text{m}$  in radial diameter and 30-50  $\mu\text{m}$  in tangential diameter (Pl. 1, Fig. 2). *Parenchyma* scanty, diffuse, difficult to locate in cross section ; tangential walls of the tracheids smooth but their radial walls profusely pitted. *Pits* numerous, bordered, circular in shape with rounded apertures, 15-20  $\mu\text{m}$  in diameter, solitary, or contiguous, arranged in 1-2 rows, and opposite to sub opposite when biseriate (Pl. 1, Figs. 4, 5; Text-figs. 2, 3). *Bars of Sanio* seen at places (Pl. 1, Fig. 6). *Xylem rays* fine, uniseriate, 1-42 (usually 3-20) cells or 30-1200  $\mu\text{m}$  in height (Pl. 1, Fig. 3; Text fig. 1) ; ray cells thin-walled. *Pits in the cross field* 1-2 (mostly-1), bordered, circular to oval in shape, 10-15  $\mu\text{m}$  in diameter, with wide, usually oblique (very rarely horizontal) apertures (Pl. 1, Fig. 7, Text-fig. 4).

*Affinities*—The anatomical characters of the fossil wood indicate that it belongs to the conifers. However, absence of structural features like alternate, hexagonal pitting as well as spiral thickenings on the tracheid walls separates it from the families Araucariaceae and Taxaceae. Further, as resin ducts and pinoid type of pitting are absent in the fossil wood, the possibility of its belonging to Pinaceae is also ruled out. Of the remaining three conifer families, namely, Taxodiaceae, Cupressaceae and Podocarpaceae, the fossil can easily be differentiated from Taxodiaceae on the basis of the structure of the cross field pits. In Taxodiaceae the cross field pits are 1-5 (6) per field area and are typically taxodioid, i. e., with horizontally oriented apertures. Besides, growth ring boundaries are quite striking and sharp in the family Taxodiaceae (Greguss, 1955, p. 57). Compared to this, in the fossil wood under discussion the cross field pits are only 1-2, their apertures mostly oblique in orientation and the growth rings are not very conspicuous. Although the families Cupressaceae and Podocarpaceae are quite similar anatomically, in Cupressaceae the wood parenchyma is quite frequent and usually with resin contents. Besides, cross field pits are 1-3(4-5) or more and the height of the xylem rays does not exceed 30 cells in this family. In the present fossil wood from Deccan the parenchyma is scanty and diffuse, the number of



Text-Fig. 1. Tangential longitudinal section showing uniseriate xylem rays. B. S. I. P. slide no. 6932.

Text-Fig. 2. Tracheids in radial section showing uniseriate bordered pits. B. S. I. P. slide no. 6933.

Text-Fig. 3. Tracheids in radial section showing biseriate bordered pits. B. I. S. I. P. slide no. 6933.

Text-Fig. 4. Radial longitudinal section showing cross field pits. B. S. I. P. slides no. 6933.

cross field pits is mostly 1, rarely two and the xylem rays are upto 42 cells in height. Thus the family Cupressaceae is also eliminated and we are left only with the family Podocarpaceae to which the fossil wood shows a very close similarity.

The family Podocarpaceae consists of seven genera, viz., *Acropyle*, *Saxe-Gothaea*, *Dacrydium*, *Microcachrys*, *Phyllocladus*, *Microstrobos* and *Podocarpus*. (Florin, 1963). But except in *Podocarpus* where the height of the xylem rays is more than 30 cells similar to the present fossil wood, in all the rest of these genera it is only upto 22 cells (GREGUSS, 1955, Table III). Thus, the present fossil shows maximum similarity with the modern wood of *Podocarpus*. The similarity can be observed in the inconspicuous

nature of growth rings, structure and distribution of intertracheid pits, type and number of cross field pits and the height and structure of the xylem rays. After critically going through thin sections as well as descriptions and photographs of a large number of species of *Podocarpus* it has been found that the fossil wood<sup>1</sup> could not be assigned to any single species and its characters are distributed in various species of this genus (GREGUSS, 1955, 1974). However, in two extant species, viz., *Podocarpus dactyloides* A. Rich and *P. rumphii* Blume, long xylem rays and diffuse parenchyma similar to the fossil are present. But in *Podocarpus dactyloides* the growth rings are not as clearly defined as in the fossil wood from Deccan and in *P. rumphii* the parenchyma is abundant which is scanty in the fossil. Of the two Indian species of *Podocarpus*, viz., *Podocarpus neriifolius* D. Don and *P. wallichianus* C. Presl, the latter shows a closer resemblance with the fossil than the former. *Podocarpus neriifolius* differs from the fossil mainly in the height of the xylem rays which are much smaller, 1-12 cells high, in this species than in the fossil, where they are up to 42 cells high. The other Indian species, *Podocarpus wallichianus* resembles the fossil to a great extent. Thus, in the fossil as well as in the modern species, the xylem rays are uniseriate, nearly 40 cells in height, parenchyma is diffuse and there are 1-2 pits per cross field. However, in the modern species the apertures of the cross field pits are wider than in the fossil and the Bars of Sanio are also absent (Greguss, 1955, Pl. 70). Thus it is possible that the fossil represents a form from which the above species have originated.

*Comparison with the fossil species*—Fossil woods showing anatomical characters of the family Podocarpaceae were usually described under three generic names, viz., *Podocarpoxylon*, *Phyllocladoxylon* (GOTHAN, 1905), and *Mesembrioxylon* Seward (1919). Recently, LAKHANPAL *et al.* (1975) while discussing the problem of nomenclature of fossil woods of Podocarpaceae have suggested that the generic name *Mesembrioxylon* should be abandoned in favour of *Podocarpoxylon* Gothan. However, KRÄUSEL (1949) recognised three genera for the fossil woods of the family, viz., *Podocarpoxylon* Gothan, *Phyllocladoxylon* Gothan and *Circoporoxylon* Kräusel. He differentiated these genera mainly on the basis of the character of cross field pits. Accordingly, the cross field pits are small with perpendicular to oblique apertures or there is a single, large, simple pit, i. e., Eiporen in *Podocarpoxylon* (KRÄUSEL, 1949, p. 152). But in *Phyllocladoxylon* the cross field pits are big, mostly only 1 in the field and the pore is obliquely elliptical or the pit is single, large and simple, i. e., Eiporen (KRÄUSEL, 1949, p. 55). Lastly, in *Circoporoxylon* the structure is as in *Phyllocladoxylon* or *Podocarpoxylon* and the single, simple pit in every cross field (Eiporen) is almost circular or vertically oval, very rarely oblique elliptical (KRÄUSEL, 1949, p. 156). From the above three diagnoses it appears that the boundaries between these genera are vague and it may not always be possible to place a podocarpaceous fossil wood in any one particular genus. A critical study of the photographs and text-figures of a large number of modern species of *Podocarpus* and *Phyllocladus* given by GREGUSS (1955) also supports this observation. Thus in many species of *Podocarpus*, e. g., *Podocarpus blumei* (Pl. 43), *P. coriaceus* (Pl. 44), *P. elatus* (Pl. 47) and *P. gracilior* (Pl. 53) *Phyllocladoxylon* type of pitting is present. Moreover, in some of the species of *Podocarpus* e.g., *P. ferruginoides* (Pl. 51) and *P. spicatus* (Pl. 67) more than one type of cross field pitting is present in the same wood. Therefore, it is suggested that all the fossil woods showing anatomical characters of Podocarpaceae should be described under the generic name *Podocarpoxylon* Gothan, as against *Phyllocladoxylon* Gothan, *Circoporoxylon* Kräusel and *Mesembrioxylon* Seward.

A large number of fossil woods belonging to the family Podocarpaceae are known

from India and abroad (KRÄUSEL, 1949 ; RAMANUJAM, 1953, 1976, KRAUSEL & JAIN, 1964 ; AGASHE, 1969). Those described from the Tertiary are also many. However, only six species are described from the Tertiary of India. These are *Mesembrioxylon schmidianum* (Schleiden) Sahnii (1931) transferred to *Podocarpoxylon schmidianum* by KRÄUSEL (1949), *Mesembrioxylon Sahnii* Ramanujam (1953) ; *M. tiruvakkarianum* Ramanujam (1953), *M. speciosum* Ramanujam (1954), and *M. Mahabalei* Agashe (1969) from the Micene-Pliocene Cuddalore Series near Pondicherry and *Podocarpoxylon kutchensis* Lakhanpal, Guleria and Awasthi (1975), from the Pliocene Kankawati Series near Dhaneti in Kachchh. All these species differ quite distinctly from the present fossil wood in one or the other anatomical character. Thus, in *Podocarpoxylon schmidianum* the xylem rays are quite long (up to 100 cells, average 36 cells), which are only up to 42 cells (usually 3-20 cells) in the present fossil wood. Moreover, the parenchyma cells are resiniferous in *P. schmidianum*. In *Mesembrioxylon speciosum*, *M. sahnii* and *M. Mahabalei* the xylem rays are smaller than in the present fossil wood being only upto 18, 20 and 30 cells high respectively. Besides, in *Mesembrioxylon speciosum* the parenchyma is abundant, in *M. mahabalei* it is resiniferous and in *M. sahnii* it is totally absent. Compared to this the parenchyma is scanty and non resiniferous in the present fossil wood. In *Mesembrioxylon tiruvakkarianum* the structure of the xylem rays and the distributional pattern of the parenchyma is very similar to that of the present fossil wood. However, a single, large borderless pit is present per cross field area of this species whereas in the Deccan Intertrappean wood there are 1-2 bordered pits with oblique to horizontal apertures per cross field. Lastly, *Podocarpoxylon kutchensis* although similar to this fossil wood in the height of xylem rays and parenchyma distribution, the xylem rays in this species are 1-2 seriate which are only uniseriate in the present fossil wood. Besides, the parenchyma cells are resiniferous in *P. kutchensis* as against non-resiniferous parenchyma in the wood under discussion. Lastly, the Bars of Sanio which are present in the present fossil are absent in *P. kutchensis*. As the present fossil is distinct from all the known podocarpaceous fossil woods, it has been described under a new species, *Podocarpoxylon vikramii* the specific name is after Master Vikram Agnihotri who collected the present fossil from the Deccan Intertrappean beds of Malabar Hills, Bombay.

The family Podocarpaceae is basically a Southern Hemisphere family extending up to Japan, Central America and West Indies. The genus *Podocarpus* consists of 100 species growing in tropical to temperate climates of Southern Hemisphere but extending north to the Himalayas and Japan (WILLIS, 1973). The genus is represented in India by two species, *Podocarpus neriifolius* and *Podocarpus wallichianus*. *Podocarpus neriifolius* grows in Sikkim, Bhutan, Assam, Bangla Desh, Burma, Andamans and Malay Peninsula extending upto S. W. China and Sunda Islands. *Podocarpus wallichianus* occurs in the Western Ghats from Nilgiri southwards, Khasi Hills, Martaban, Tenasserim and Great Nicobar Islands (RAIZADA & SAHNI, 1960).

#### SPECIFIC DIAGNOSIS

Genus—**Podocarpoxylon** Gothan, 1905

*Podocarpoxylon vikramii* sp. nov.

Growth rings present but not very conspicuous ; transition from early to late wood abrupt. Late wood zone narrow, 2-7 cells wide, composed of thick-walled tangen-

tially flattened tracheids. *Early wood* 25-30 cells in width ; tracheids comparatively thinner walled and radially elongated. *Parenchyma* scanty, diffuse. *Pits* on radial walls of tracheids bordered, circular in shape with rounded apertures, 15-20  $\mu$ m in diameter, solitary or contiguous, arranged in 1-2 rows and opposite to subopposite when biseriate. *Bars of Sario* seen at places. *Xylem rays* uniseriate, 1-42 (usually 3-20) cells high. *Pits in the cross field* 1-2 (mostly 1), bordered, circular to oval, 10-15  $\mu$  in diameter, with wide, usually oblique (very rarely horizontal) spertures.

*Holotype*—B.S.I.P. Museum No. 35518

*Locality*—Malabar Hills, Bombay

*Horizon*—Deccan Intertrappean Beds

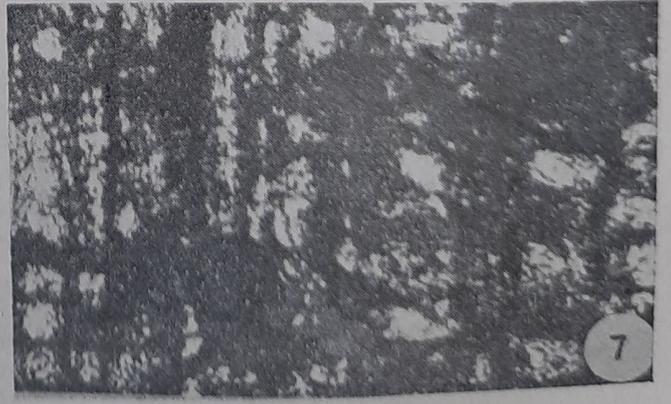
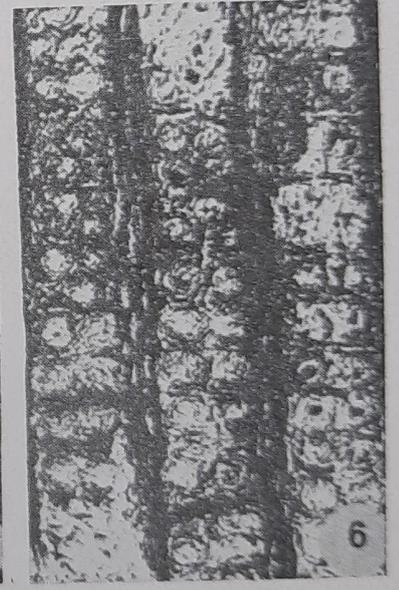
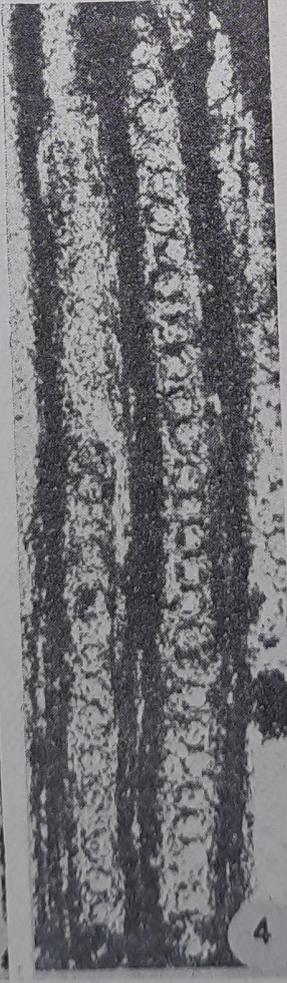
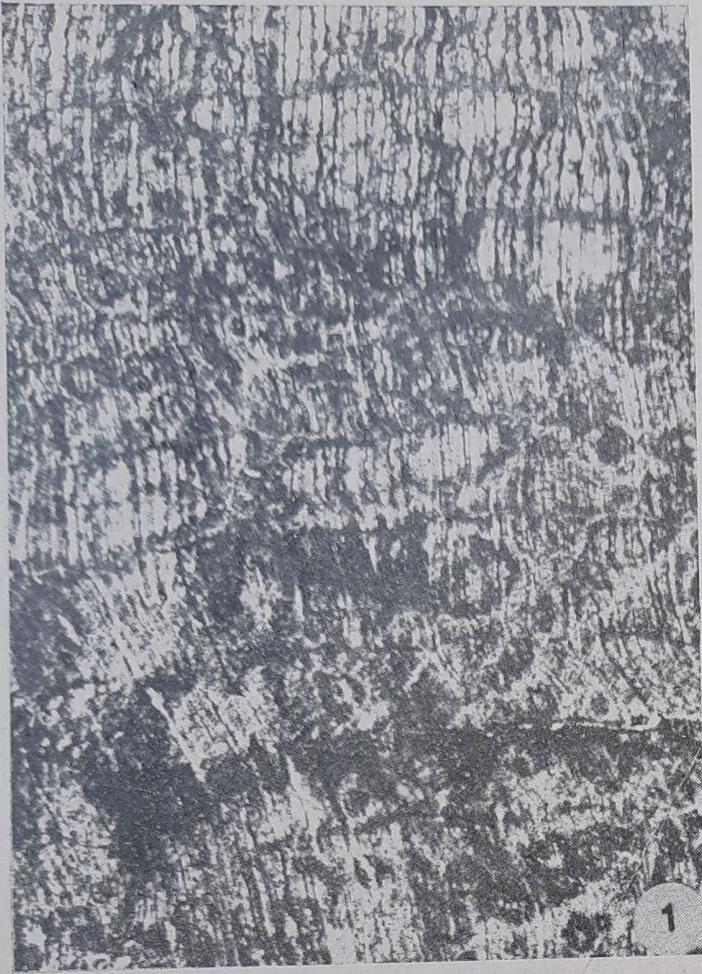
*Age*—Early Tertiary

#### ACKNOWLEDGEMENTS

The authors are grateful to Prof. R. C. Misra, Formerly Chairman, Wadia Institute of Himalayan Geology, for giving them the fossil wood specimen for investigation. They also express their sincere thanks to Dr. P. K. Maithy and Dr. R. S. Tiwari for translating some of the relevant German literature. Thanks are also due to Dr. J. S. Guleria for his kind help during this work.

#### REFERENCES

- AGASHE, S. N. (1969). Studies on the fossil Gymnosperms of India—Part I. A new species of *Mesembrioxylon*, *M. mahabalei* sp. nov. *Palaeobotanist*, **17**(3) : 312-316.
- BOSE, M. N. & MAHESHWARI, H. K. (1974). Mesozoic conifers. In Surange, K. R., Lakhanpal, R. N. & Bhargudwaj, D. C. (eds.): 212-223. *Aspects and Appraisal of Indian Palaeobotany*, Birbal Sahni Institute of Palaeobotany, Lucknow.
- BUIST, G. (1851). Geology of the Island of Bombay: *Trans. Bombay Geogr. Soc.*, **10** : P. 167. (Reprinted in *Geological Papers on Western India, including Cutch, Sindh and South-East coast of Arabia*, edited by Henry J. Carter in 1857. Education Society Press, Bombay, P. 169-206).
- CARTER, H. J. (1852). Geology of the Island of Bombay : *Jour Bombay Branch Royal Asiatic Soc.*, **4**, P. 161. (Reprinted in *Geological Papers on Western India*, edited by Henry J. Carter in 1857. Education Society Press, Bombay, P. 116-168.
- FLORIN, R. (1963). The distribution of conifer and taxad genera in time and space. *Acta Horti. Bergiani*, **20**(4) : 121-312.
- GOTHAN, W. (1905). Zur Anatomie lebender und fossiler, Gymnospermen-Hölzer. *Abh. preuss. geol. Landesanst.*, **44** : 1-108.
- GREGUSS, P. (1955). *Identification of living Gymnosperms on the Basis of xylotomy*. Budapest.
- GREGUSS, P. (1972). *Xylotomy of the Living Conifers*. Budapest.
- KRÄUSEL, R. (1949). Die fossilen Koniferen-hölzer (unter Ausschluss von *Araucarioxylon* Kraus) II. Teil. Kritische untersuchungen zur diagnostik lebender und fossiles Koniferen-hölzer. *Palaeontographica*, **89B** : 83-203.
- KRÄUSEL, R. & JAIN, K. P. (1964). New fossil coniferous wood from the Rajmahal Hills, Bihar, India. *Palaeobotanist*, **12**(1) : 59-67.
- LAKHANPAL, R. N., GULERIA, J. S. & AWASTHI, N. (1975). A podocarpaceous wood from the Pliocene of Kutch. *Geophytology*, **5**(2) : 172-177.
- RAIZADA, M. B. & SAHNI, K. C. (1960). Living Indian Gymnosperms Part I. (Cycadales, Ginkgoales and Coniferales). *Indian Forest Records*, **5**(2) : 73-150.
- RAMANUJAM, C. G. K. (1953). On two new species of *Mesembrioxylon* from the vicinity of Pondicherry, South India. *Palaeobotanist*, **2** : 101-106.
- RAMANUJAM, C. G. K. (1974). On some silicified woods from near Pondicherry, India. *Palaeobotanist*, **3** : 40-50.
- RAMANUJAM, C. G. K. (1976). Indian Gymnosperm-in time and space. *Aspects of Plant Sciences*, **1** : 73-126.



- SAHNI, B. (1931). Revision of Indian Fossil Plants, Part II. Coniferales (b. Petrifactions). *Mem. geol. Surv. India. Palaeont. Indica, n. s.* **11** : 51-124.
- SEWARD, A. C. (1919). Fossil Plants. **4**. *New York and London*.
- STOPES, M. C. (1915). *Catalogue of the Mesozoic Plants in the British Museum Natural History. The Cretaceous Flora. Part II-Lower Greensand (Aptain) Plants of Britain*. London.
- WILLIS, J. C. (1973). *A Dictionary of Flowering Plants and Ferns*. Univ. Press., Cambridge.

#### EXPLANATION OF PLATE 1

*Podocarpoxylon vikramii* sp. nov.

1. Cross section at low magnification showing growth rings with wide zones of early wood separated by thin zones of late wood.  $\times 7.5$  B. S. I. P. slide No. 6931.
2. Cross section magnified to show thin-walled early wood tracheids and thick-walled late wood tracheids and xylem rays  $\times 40$ . B. S. I. P. slide no. 6931.
3. Tangential longitudinal section showing uniseriate xylem rays  $\times 100$ . B. S. I. P. slide no. 6932.
4. Tracheids in radial longitudinal section showing uniseriate bordered pits.  $\times 150$ . B. S. I. P. slides no. 6933.
5. Tracheids in radial longitudinal section showing biseriate bordered pits.  $\times 150$ . B. S. I. P. slide no. 6933.
6. Tracheids in radial longitudinal section showing *Bars of Sanio*.  $\times 160$ . B. S. I. P. slide no. 6933.
7. Radial longitudinal section showing cross-field pits with oblique apertures.  $\times 220$ . B. S. I. P. slide no. 6933.