A PODOCARPACEOUS WOOD FROM THE PLIOCENE OF KUTCH

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ABSTRACT

A fossil wood resembling that of modern *Podocarpus* is described from the Pliocene beds of Dhaneti, near Bhuj, District Kutch. This is the first record of a gymnospermous wood from the Tertiary of Kutch.

INTRODUCTION

The Tertiary of Kutch is represented by a more or less complete sequence from the Palaeocene to Pliocene. It is best developed in the south-western coastal plain and is fairly rich in plant fossils. Although considerable work has been done on the Tertiary palynology of Kutch (KAR, 1974), the plant megafossils of that period have not been given adequate attention so far. Megafossils collected from different localities indicate that the flora of this region must have been quite rich during the Tertiary and fuller investigations may yield new and interesting data about the palaeo-phytogeography and palaeo-climatic conditions of this region.

The material on which the present study is based was collected in 1971 by Miss S. PANT and Dr. N. AWASTHI, along with a large number of dicot woods, from the Pliocene beds exposed near Dhaneti, about 24 km east of Bhuj.

DESCRIPTION

Family: PODOCARPACEAE

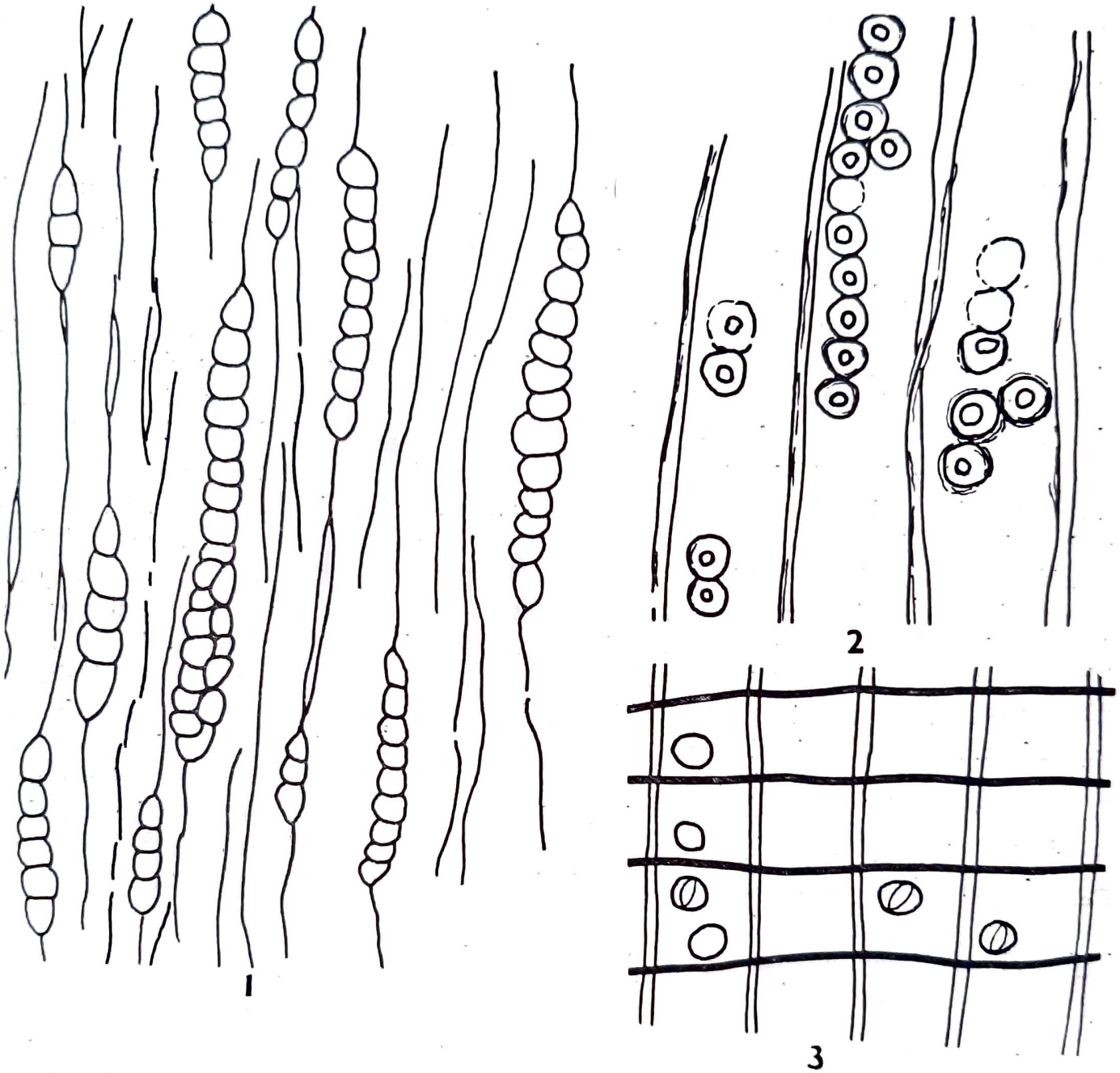
Genus: **Podocarpoxylon** Gothan, 1905

Podocarpoxylon kutchensis sp. nov. (Pl. 1, Figs. 1-6; Text-figs. 1-3)

This species is based on two small pieces of decorticated wood measuring 15×5 cm. and 7×4 cm. respectively. The wood is light brown with yellowish tinge and shows fairly good preservation.

Growth rings discernible but not conspicuous, wall thickness of tracheids hardly changes from early to late wood (Pl. 1, Figs. 1-2). *Tracheids* of early wood zone quite wide, occupying greater portion of wood and consisting of 31-62 tracheidal cells (Pl. 1, Figs. 1-2); tracheids thin walled, polygonal, with wide lumen, having radial diameter of 37-67 μ m and tangential diameter of 22-45 μ m. Late wood forming a narrow band of 2-4 thick walled cells, radial diameter 30-60 μ m and tangential diameter 22-45 μ m, cells flattened to elliptical, 360-500 tracheids per sq. mm., tangential walls of tracheids smooth; crystals rarely present. *Parenchyma* seen in cross-section as small cells filled with resinous substance, thin walled, end walls as well as tangential walls smooth. *Xylem rays* fine, predominantly uniseriate, rarely biseriate, homocellular (Pl. 1, Fig. 3; Text-fig. 1), 1-41 cells or 45—135 μ m in height, usual height 5-18 cells, ray cell walls thin and smooth. *Pitting* seen on radial as well as tangential walls of tracheids; pits on radial walls mostly in one row, rarely in two, in the latter case opposite or sub-opposite due to lateral compression; solitary or contiguous, oval,

circular, simple and bordered (mostly bordered), 12-20 μ m in diameter, aperture 4-8 μ m (Pl. 1, Figs 5-6); rarely uniseriate pits present on tangential walls of tracheids, solitary, 8-16 μ m in diameter, pit aperture 4-6 μ m. *Field Pits* 1-2, small, circular, oval, simple, borcered, podocarpoid to taxodioid (Pl. 1, Fig. 4), vertically or horizontally arranged, 8-12 μ m in diameter, pit aperture upto 4 μ m (Pl. 1, Fig. 4; Text-fig. 3).



Text-figs. 1-3. *Podocarpoxylon kutchensis* sp. nov. 1, Tangential longitudinal section showing 1-2 seriate xylem rays. ×125. (B.S.I.P. Museum Slide No. 4925-35195/1336); 2, Radial longitudinal section showing pits on the radial walls of tracheids. ×330. (B.S.I.P. Museum Slide No. 4923-35195/1336); 3, Radial longitudinal section showing cross-field pits. ×330. (B.S.I.P. Museum Slide No. 4923-35195/1336).

DISCUSSION

Affinities—The general structure of the wood is obviously coniferous. The absence of the alternately arranged hexagonal tracheidal pits rules out the possibility of Araucariaceae. Further, the absence of resin ducts and abietenian or pinoid type of pitting excludes the possibility of Pinaceae or Abietineae. In all the remaining families—Taxaceae, Taxodiaceae, Cupressaceae, and Podocarpaceae—resin canals are normally absent except sometimes in the wounded parts.

An important feature of Taxaceae is the presence of spiral thickening in the secondary tracheids, which is not seen in the present wood. In Taxodiaceae annual ring boundaries are striking and sharp as compared to Podocarpaceae and Cupressaceae In the present fossil the growth rings are hardly discernible. Thus it precludes the possibility of Taxodiaceae also. The last two families, viz., Cupressaceae and Podocarpaceae, show very close xylotomical features. However, they can be differentiated on the basis of the following characters. Both have similar xylem parenchyma but in Podocarpaceae the amount of parenchyma is less as compared to Cupressaceae. Further, in the region of spring wood the cross-field pits are vertical or vertically oblique in Podocarpaceae whereas they tend to be horizontal in some members of Cupressaceae although in others they may be similar to those of the Podocarpaceae. Taking into consideration all the above characters collectively the present fossil wood shows affinities with Podocarpaceae. The genera of Podocarpaceae can be distinguished from each other on the basis of absence or presence of xylem parenchyma and the height of the xylem rays.

In *Phyllocladus* and *Sciadopitys* the wood parenchyma is absent. In the rest of the genera the xylem rays do not exceed 25 cells in height excepting *Podocarpus* where the height of rays goes upto 60 cells. Since in the fossil wood the xylem parenchyma is present and the rays are upto 41 cells in height, it shows close resemblance with the wood of *Podocarpus.*

After going through the thin sections as well as descriptions and figures of a large number of the modern species of *Podocarpus* it was found that the fossil shows resemblance with *Podocarpus dacrydioides* A. Rich, *P. usambarensis* Pilger, *P. beccarii* Parlatore, *P. decipiens* (Back) N. Gray and *P. wallichianus* C. Presl. (Greguss, 1955, 1972). However, excepting *P. wallichianus*, all the above noted species can be easily differentiated from the present fossil on the basis of a few significant characters. In the first four species the cross-field pits vary from 0-1-2-(3). Three pits per cross-field are rare. In our fossil wood pits are 1-2 per cross-field. Besides, *P. dacrydioides* further differs from the present fossil in having triple the number of tracheids per sq. mm. In *P. usambarensis* the width of the xylem rays goes up to 1-2-(3)-seriate whereas it is mostly 1-seriate or rarely 2-seriate in the present fossil. *P. beccarii* can also be distinguished in having bars of sanio, separating the pits when crowded. They are totally absent in our specimens. In *P. decipiens* radial walls of xylem parenchyma exhibit small circular pits which are lacking in our specimen.

In *P. wallichianus* growth rings are occasional to rare, xylem rays 1-15 (40-50) cells high and exclusively uniseriate, pitting present on the tangential walls, pit diameter 16-20 μ m, walls of wood parenchyma smooth, number of pit rows on tracheids 1-2 and cross-field pits 1-2, diameter of pits 10-16 μ m (18 μ m), and resin is present in the parenchyma cells. In all these features *P. wallichianus* closely resembles the present fossil wood excepting that the rays are exclusively uniseriate in the former whereas in the latter the rays are sometimes biseriate. Further the tracheids in *P. wallichianus* are 720/sq. mm. whereas in the fossil specimens they are 360-500/sq. mm.

Comparison with fossil podocarpaceous woods—For fossil woods agreeing in structure with modern species of *Podocarpus* and *Dacrydium*, Gothan (1905) had instituted the genus *Podocarpoxylon.* He had also formed another genus, *Phyllocladoxylon*, for fossil woods similar to *Podocarpoxylon* but differing chiefly in the occurrence of large, simple pits in the field (Eiporen).

Stopes (1915) said that the variability in the pitting in the ray cells is such that the different species of *Podocarpoxylon* and *Phyllocladoxylon* cannot be separated reliably from each other. So she merged *Podocarpoxylon* and *Phyllocladoxylon* of Gothan (1905) into the better known genus *Podocarpoxylon.*

SEWARD (1919, p. 203) agreed with Stopes that Gothan's two genera *Podocarpoxylon* and *Phyllocladoxylon* differed from one another in features which "are too inconstant to justify the retention of both designations". Further, saying that the use of Gothan's names implied affinities to recent genera for assuming which there were no adequate reasons, he replaced the two genera by a single generic name, *Mesembrioxylon*. In it he also included *Paraphyllocladoxylon* Holden (1913). Recently BOSE AND MAHESHWARI (1974, p. 215) have pointed out that as *Podocarpoxylon* of Gothan is a validly and legitimately published name, it is inadvisable to replace it by *Mesembrioxylon*. They have, therefore, suggested that the name *Mesembrioxylon* be abandoned in favour of *Podocarpoxylon* Gothan which has priority. However, they have not given any opinion regarding *Phyllocladoxylon*. Obviously, they include it in *Podocarpoxylon* itself, as earlier suggested by STOPES (1915).

Contrary to the above view of combining all podocarpaceaous fossil woods under the genus *Podocarpoxylon*, KRÄUSEL (1949) had divided them under three different genera: *Podocarpoxylon*, *Phyllocladoxylon*, and *Circoporoxylon*. He had based their distinction on anatomical characters of the living members of Podocarpaceae as critically observed by PHILLIPS (1941) in his study on the identification of coniferous woods by their microscopic structure. KRÄUSEL (1949) has given definite diagnostic characters of these three genera of which the first two are Gothan's and the third, *Circoporoxylon* was a new genus instituted by himself (KRÄUSEL 1949, p. 156). Thus it is evident that there are three valid genera of podocarpaceous woods. Consequently instead of changing en bloc all species of *Mesembrioxylon* to *Podocarpoxylon* they should first be critically examined in this light and then assigned to any of these three genera with which they show closest affinities.

Our specimen, showing resemblance with the wood of *Podocarpus wallichianus* evidently belongs to *Podocarpoxylon*. So far five species of podocarpaceous woods have been described from the Tertiary of India, all of them from the Cuddalore Series near Pondicherry. Out of these, the oldest, *Mesembrioxylon schmidianum* (Sahni, 1931), has already been transferred to *Podocarpoxylon schmidianum* by KRÄUSEL (1949). The remaining four viz., *Mesembrioxylon sahnii* Ramanujam (1953), *M. tiruvakkarianum* Ramanujam (1953), *M. speciosum* Ramanujam (1954) and *M. mahabalei* (Agashe, 1969) still need critical study to decide whether they are *Podocarpoxylon*, *Phyllocladoxylon* or *Circoporoxylon*. For the present we can compare our fossil with them using their existing names.

Mesembrioxylon sahnii is quite different in having 1-3 seriate xylem rays and the absence of xylem parenchyma, whereas in our fossil the rays are usually uniseriate, rarely biseriate and xylem parenchyma is present. Of the remaining species, *M. tiruvakkarianum* is different in having only uniseriate rays and a large single borderless pit filling the cross-field. In *M. mahabalei* also there is a single large cross-field pit and the rays are comparatively short. In *M. speciosum* the rays are still shorter, bars of Sanio distinctly present and the number of cross-field pits is 2-4 while in our fossil bars of Sanio are absent and there are only 1-2 cross-field pits. Comparatively closer resemblance is shown by *Podocarpoxylon schmidianum* but it also differs in a few characters. Its rays are longer (2-100 cells, average 36 cells) than our specimens (1-41 cells, average 5-18 cells). While solitary pits are present on the tangential walls of the tracheids of our specimen, no such pits have been reported from *P. schmidianum*.

From the above comparison it is apparent that the present fossil is distinct from all the known podocarpaceous woods from the Tertiary beds of India. It is, therefore, being described as a new species *Podocarpoxylon kutchensis*, named after the district from which it has been collected.

DIAGNOSIS

Podocarpoxylon kutchensis sp. nov.

Growth rings present. *Parenchyma* present. *Tracheidal pitting* uniseriate to biseriate, oval, circular; when biseriate opposite to sub-opposite, solitary to contiguous, simple and bordered; rarely uniseriate pits present on the tangential walls of trachcids. *Xylem rays* mostly uniseriate, rarely biseriate, 1-41 (average 5-18) cells in height. *Cross-field pits* 1-2 small, circular, oval, simple or bordered, podocarpoid to taxodioid.

Holotype: B.S.I.P. Museum No. 35195/1336.
Locality: Dhaneti, about 24 Km east of Bhuj, District Kutch, Gujarat.
Horizon: Kankawati Series.
Age: Pliocene.

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, 1968.

Bose, M. N. & Maheshwari, H. K. (1974). Mesozoic conifers. In Surange, K. R., Lakhanpal, R. N. & Bharadwaj, D. C. (editors): 212-223, *Aspects and Appraisal of Indian Palaeobotany*, Birbal Sahni Institute of Palaeobotany, Lucknow.

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.

Holden, R. (1913). Contributions to the anatomy of the Mesozoic Conifers. No. 1. Jurassic coniferous woods from the Yorkshire. *Ann. Bot.* **27** (107): 533-545.

Kar, R. K. (1974). Palynostratigraphy in western region. In Surange, K. R., Lakhanpal, R. N. & Bharadwaj, D. C. (editors): 561-568, *Aspects and Appraisal of Indian Palaeobotany*, Birbal Sahni Institute of Palaeobotany, Lucknow.

Kräusel, R. (1949). Die fossilen Koniferen-hölzer (unter Ausschluss von *Araucarioxylon* Kraus.) II. Teil. Kritische untersuchungen zur diagnostik lebender und fossiles Konifern-hölzer. *Palaeontographica.* **89B**: 83-203.

Phillips, E. W. J. (1941). The identification of coniferous woods by their microscopic structure. *J. Linn. Soc. Botany.* **52**: 259-320.

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. (1954). On some silicified woods from near Pondicherry, South India. *Palaeobotanist.* **3**: 40-50.

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.

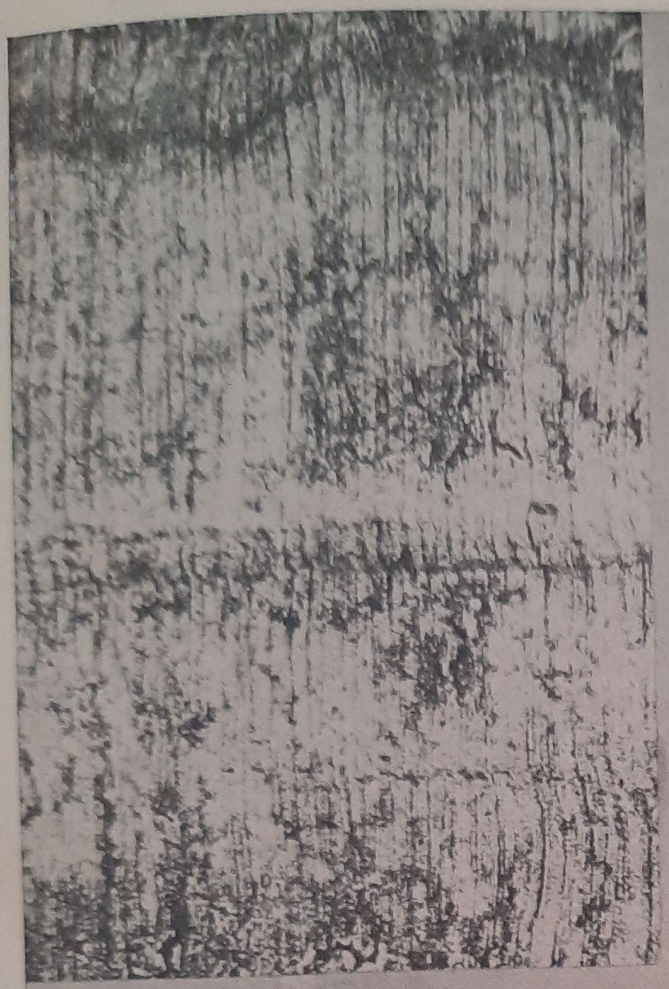
Stafleu, F. A. (1972). International Code of Botanical Nomenclature. *Regnum. Veg.* **82**: Utrecht.

Stopes, M. C. (1915). *Catalogue of the Mesozoic plants in the British Museum (Natural History). The Cretaceous flora. Part II—Lower Greensand (Aptian) Plants of Britain.* London.

EXPLANATIONS OF PLATE 1

Podocarpoxylon kutchensis sp. nov.

1. Cross-section showing the nature and distribution of tracheids, xylem rays and growth rings. ×10. (B.S.I.P. Museum Slide No. 4921-35195/1336).
2. Cross-section magnified to show the nature and distribution of tracheids, xylem rays and growth rings. ×50. (B.S.I.P. Museum Slide No. 4921-35195/1336).
3. Tangential longitudinal section showing xylem rays. ×85. (B.S.I.P. Museum Slide No. 4922-35195/1336).



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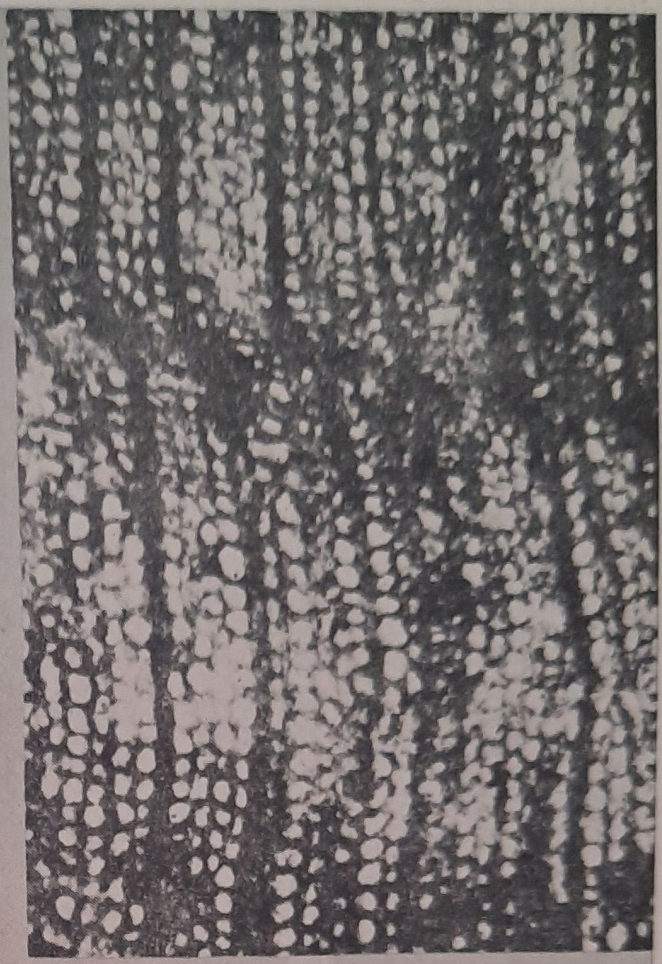

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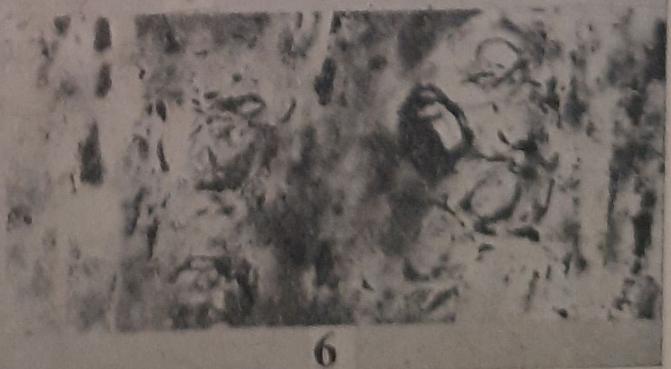

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4. Radial longitudinal section showing cross-field pits. ×500. (B.S.I.P. Museum, Slide No. 4923-35195/1336).
5. Radial longitudinal section showing round, circular, uniseriate radial pitting. ×500. (B.S.I.P.Museum, Slide No. 4923-35195/1336).
6. Another radial longitudinal section showing uniseriate to biseriate, bordered pits arranged in opposite to sub-opposite fashion. ×500. (B.S.I.P. Museum, Slide No. 4924-35195/1336).