# ON A GYMNOSPERMOUS FOSSIL WOOD FROM SITAPURI, DISTRICT DHAR IN MADHYA PRADESH

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ABSTRACT

The present paper is a revision of the fossil wood species *Spiroxylon intertrappeum* U. Prakash & S. K. Srivastava (1959), which is now being referred to the form genus *Prototaxoxylon* Kräusel et Dolianiti (1958) as *Prototaxoxylon* (Syn. *Spiroxylon*) *intertrappeum* (U. PRAKASH & S. K. SRIVASTAVA, 1959) n. comb. This fossil wood was collected from a new locality discovered near the village Sitapuri in district Dhar of Madhya Pradesh.

## INTRODUCTION

THE petrified wood described in the present paper was collected from a new locality at about one and a half miles south of the village Sitapuri (22° 22′ 11″; 75° 5′ 24″), in district Dhar of Madhya Pradesh. There is a rich occurrence of fossil woods in this area, out of which a few selected specimens are included in the present study. At present the age of the beds containing this fossil wood is very doubtful. However, Dr. B. S. Tewari, of the Geology Department at the University of Lucknow, thinks that the fossil wood under consideration might have come from the Deccan Intertrappean beds exposed there. He has recently visited this area and has prepared a geological map of the Sitapuri hills, showing his idea about the sequence of the beds. His paper on this study will be published shortly. According to him there is no marked unconformity between the Bagh beds, considered to be of Cenomanian to Senonian age, and the overlying Deccan traps and associated Intertrappeans. In view of this we at present hesitate to comment more about the age of this fossil wood, until the geological position of the beds containing this fossil wood is definitely known.

Recently, we recorded (PRAKASH & SRIVASTAVA, 1959) this fossil wood as a new species of *Spiroxylon* Walton (1925), unfortunately not knowing that the form genus *Spiroxylon* of Walton (1925) was invalidated because this name had already been used by Hartig (1848) for an unclassifiable wood showing tracheids with spiral striations from Tertiary. Kräusel and Dolianiti (1958) realized this mistake of nomenclature and changed the name *Spiroxylon* to *Prototaxoxylon*, with the effect that *Spiroxylon africanum* Walton (1925) has now been referred to as *Prototaxoxylon africanum* (Walton) Kräusel and Dolianiti (1958). Therefore, in the present study we have changed *Spiroxylon intertrappeum* to *Prototaxoxylon intertrappeum* (PRAKASH & SRIVASTAVA) n. comb.

Our fossil wood specimens show satisfactory though irregular preservation; and for a detailed study a number of thin sections, both in transverse as well as vertical planes, were prepared. The presence of iron oxide in some parts of the section gave more clarity to different structures.

## DESCRIPTION

### Genus — *Prototaxoxylon* Kräusel et Dolianiti (1958)

*Prototaxoxylon intertrappeum*

(PRAKASH & SRIVASTAVA, 1959) n. comb.

The material consisted of four petrified specimens of decorticated secondary wood. The bigger piece measured 40 cm. in length and 8-12 cm. in diameter. The preservation of this wood is quite satisfactory.

Growth rings (PL. 1, FIGS. 1, 12) distinct, 5-18 mm. apart, with transition from spring to summer wood usually gradual, sometimes abrupt. False growth ring is present in one part of the wood. The summer wood is usually 12-25 (sometimes only 4-6) cells thick, composed of thick-walled, squarish to rectangular or rounded tracheids with narrow lumen (PL. 1, FIGS. 1, 12); the tracheids being 28-48 μ in diameter. The spring wood zone (PL. 1, FIGS. 1, 12) is very wide and consists of large tracheids, 44-72 μ in diameter, moderately thick-walled, circular to pentagonal, quite often irregular or squarish in shape, and with wide open lumina. There is no appreciable difference in the

TABLE 1 — SHOWING THE CHARACTERISTICS OF THE SPECIES OF *PROTOTAXOXYLON*

| Name of the wood | Growth rings | Autumn wood (Cross-section) | Spring wood (Cross-section) | Bordered pitting (Radial wall) | Bordered pitting (Tangential wall) | Spiral bands | Medullary rays | Field pitting | Xylem parenchyma |
|---|---|---|---|---|---|---|---|---|---|
| 1. *Prototaxoxylon africanum* (Walton) Kräusel & Dolianiti (1958) | Distinct, average growth zone 7 mm. wide, transition gradual | Tracheids 26 × 24 μ in size | Tracheids 33 × 26 μ in size | Normally uniseriate and contiguous, occasionally biseriate (mostly alternate and rarely opposite), often vertically compressed, 11-13 μ in size | Not seen | 1-2 seriate, confined to the wall between the pits | Almost uniseriate 1-18 cells high, average height of a ray cell 31 μ | 2-8, border not visible | Absent |
| 2. *Prototaxoxylon* (= *Spiroxylon*) *indicum* (Mehta) n. comb. | Probably well marked | Tracheids *ca.* 3 μ or less in diameter | Tracheids 23 μ in diameter | Uniseriate or irregularly biseriate (then alternate or opposite), contiguous (occasionally separate), circular or horizontally elliptical in shape, 14·5 × 11·5 μ (in spring tracheids), smaller pits 4 μ | — | 1-2 seriate, passing in between the pits or across the borders of contiguous pits | Uniseriate(?), one (or more ?) cell deep; ray cells fairly thick-walled, squarish, vertical height 20 μ, horizontal and tangential walls unpitted | 6-7, border elliptical, 6-8 × 3-4 μ in size | Absent |
| 3. *P. brasilianum* Kräusel & Dolianiti (1958) | Growth zones absent | — | — | Single series (usually crowded) occasionally 2-seriate and alternate | Absent | Close, narrow and nearly horizontal, bands across the pits, look like scalariform pitting | 1-6 (1-2) cells high, uniseriate, often biseriate, cells broadly oval | 1-4, broadly oval, slit like oblique opening | — |
| 4. *P. intertrappeum* (Prakash & Srivastava) n. comb. | Distinct, average growth zone 15-18 mm. wide. Transition usually gradual, sometimes abrupt | 4-25 cells wide, tracheids 28-48 μ in size, with 7-12 μ thick walls | 80-250 cells wide; tracheids 44-72 μ in size, with 7-10 μ thick walls | Normally uniseriate and contiguous, sometimes biseriate (mostly alternate, occasionally opposite), circular or vertically compressed in shape (sometimes hexagonal), 13-20 μ in size, pore circular or obliquely lenticular (inclined right or left) | Scarce (usually in late wood), normally uniseriate and separate, 9-13 μ in diameter | 2-3 seriate, 5-11 μ thick, close, both left and right-handed, inclined at 50°-70°, pass usually across the borders of contiguous pits or through the space between the separate pits or become thin and pass through the rim of the pore | 1-3 seriate (usually 1-2 seriate, exceptionally 3-seriate), 2-30 cells high (often up to 50); ray cells usually oblong, average height 24 μ, horizontal and tangential walls smooth and unpitted | 1-10, 6-11 μ in size, scattered or arranged in 1-3 horizontal rows; border circular or hexagonal, pore circular or obliquely lenticular | Absent |

wall thickness of summer and spring wood tracheids.

The xylem rays (PL. 1, FIGS. 2, 13; TEXT-FIGS. 11, 16) are simple, homogeneous, 1-3 seriate, usually 1-2 seriate (exceptionally triseriate) and 2-30 (or rarely up to 50) cells high. The ray cells are usually oblong, sometimes rounded or square with the end cells slightly pointed outside as seen in tangential sections. In radial sections, the ray cells are rectangular and unpitted; while the tangential walls are vertical, curved or slanting in position and also smooth and unpitted. Indentures are not seen. The cross-field pits (PL. 1, FIGS. 9, 14, 15; TEXT-FIGS. 9, 10, 13, 14, 15) are 1-10 in number, bordered, scattered or arranged in 1-3 horizontal rows, and circular or hexagonal through crowding, 6-11 μ in diameter, pore circular to obliquely lenticular. Ray-tracheids absent. Xylem parenchyma and resin canals or cells are also absent.

The bordered pits as well as true spiral thickenings are present both on the radial and tangential walls of the tracheids. The radial pits are circular or sometimes slightly vertically compressed, measuring 13-20 μ in diameter and are normally uniseriate and contiguous (PL. 1, FIG. 4; TEXT-FIG. 1). Sometimes the pits are in two series, when they usually alternate, but rarely opposite (PL. 1, FIGS. 10, 11, 16, 17, 18; TEXT-FIG. 2). The alternate pits are either separate (PL. 1, FIGS. 11, 16; TEXT-FIG. 2) or so closely adpressed that they are hexagonal in shape (PL. 1, FIGS. 10, 17; TEXT-FIG. 3). The pit-pores are either circular or obliquely lenticular (TEXT-FIG. 1). The latter may be inclined towards right or left. At certain places rims of Sanio appear to be present. The tangential pits are slightly smaller, comparatively scarce, and mostly uniseriate and separate (PL. 1, FIG. 3).

The spiral bands, on the radial walls of the tracheids, are 5-11 μ thick (sometimes only 1-2 μ), mostly biseriate (sometimes triseriate), close, both clock- (left-handed) and anti-clock-wise (both types never occur in the same tracheid), inclined at angles of 45-70° (PL. 1, FIGS. 5, 6, 7; TEXT-FIGS. 4, 5, 6). The bands run parallel and usually pass across the borders of the pits or often through the space between the separate pits (PL. 1, FIG. 5; TEXT-FIGS. 4, 5, 6). A third type of spiral band is seen only at very few places where a thin band (1-2 μ thick) after crossing the border of the pit (PL. 1, FIG. 19; TEXT-FIG. 7), bifurcates at the edge of the pore and follows its contour uniting again at the opposite end so as to proceed across the border at the same angle. Another peculiar condition is sometimes seen mostly near the region of xylem rays, when the bands become quite thin, more in number (unlike that of 'Spiralstreifung' of GOTHAN, 1905, pp. 67-87), and show a branched and intercrossed pattern (TEXT-FIG. 8). The spiral bands on the tangential walls are slightly thinner, otherwise they are almost similar to those of the radial walls (TEXT-FIG. 12).

*Diagnosis* — Growth-rings distinct, transition from spring to summer wood usually gradual, sometimes abrupt; summer wood tracheids 28-48 μ and spring wood tracheids 44-72 μ in diameter. Radial pits mostly uniseriate and usually alternate when in two rows, mostly contiguous; circular or vertically compressed or hexagonal in shape; 13-20 μ in diameter. Pit-pores circular or obliquely lenticular, inclined towards right or left. Spiral bands 5-11 μ thick, 2-3 seriate, both left- and right-handed, inclined at an angle of 45°-70°, and usually passing across the borders of the pits or often through the space between the separate pits. Tangential pits smaller, mostly uniseriate, and separate. Spiral bands on tangential walls almost similar to those of radial wall. Xylem rays 1-3 seriate, usually 1-2 seriate, 2-30 (or up to 50) cells high; ray cells usually oblong; indentures absent. Ray tracheids absent. Cross-field with bordered pits, 1-10; 6-11 μ in diameter; scattered or arranged in 1-3 horizontal rows; circular or hexagonal where crowded; pore circular or obliquely lenticular. Xylem parenchyma and resin canals or cells absent.

*Locality* — Near Sitapuri, district Dhar, Madhya Pradesh.

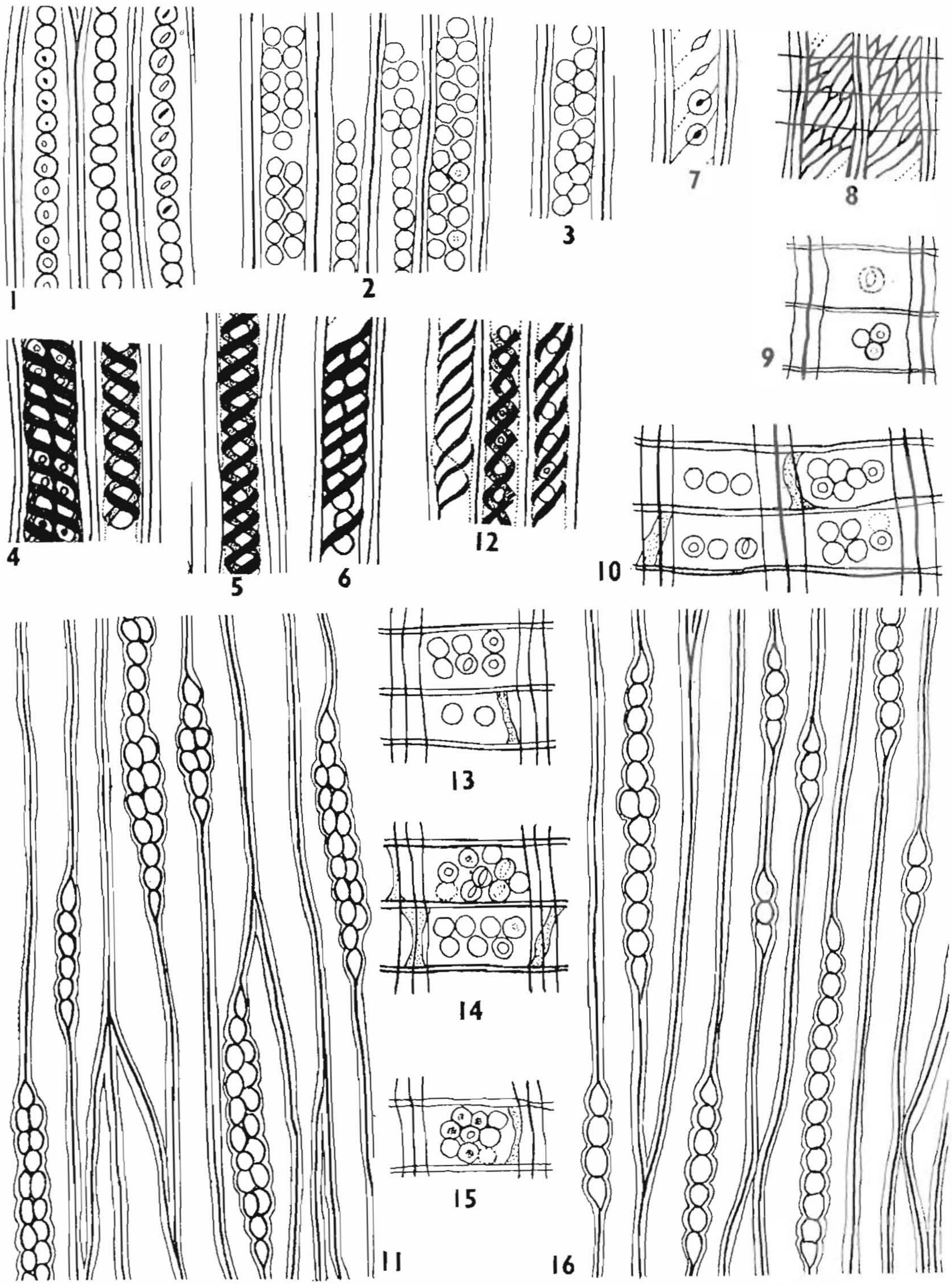
*Horizon* — (?)Deccan Intertrappean Series.

*Syntypes* — B.S.I.P. Museum Nos. 29837, 29840.

*Co-types* — B.S.I.P. Museum Nos. 29838, 29839.

## DISCUSSION

The petrified wood described here is characterized by the presence of true spiral thickenings (= 'spiral verdickung' of Gothan, 1905, p. 54) in addition to the bordered pits in the secondary tracheids; and the absence of transverse ray-tracheids, xylem parenchyma and resin canals or cells. The




*Prototaxoxylon intertrappeum* (PRAKASH & SRIVASTAVA) n. comb. (Semi-diagrammatic camera lucida sketches; figures 1-12 from specimen No. 29840 and 13-16 from specimen No. 29837) bordered pits of the tracheids are normally uniseriate and compressed (contiguous), but sometimes also showing biseriate condition in which case they are usually alternate. Walton (1925) established the genus *Spiroxylon* to include all the fossil woods in which the tracheids have spiral thickenings in addition to bordered pits which are characteristically in compressed series when uniseriate and normally alternate when in two series. The name of the Walton's form genus *Spiroxylon* has recently been changed to *Prototaxoxylon* by Kräusel and Dolianiti (1958) because of the fact that the name *Spiroxylon* used by Walton (1925) for his fossil woods is invalid, as the same name had already been used by Hartig (1848) for an unclassifiable fossil wood from the Tertiary of Germany. As our fossil wood, which was earlier named by us as *Spiroxylon intertrappeum* Prakash & Srivastava (1959), and which is described here in detail, closely agrees in all the characters with the diagnosis of *Prototaxoxylon*, it may now be referred to the latter genus, but with the previous specific name.

Up till now only two species of *Prototaxoxylon* were known. They are *Prototaxoxylon* (= *Spiroxylon*) *africanum* (Walton) Kräusel & Dolianiti (1958), from Harms-fontein in South Africa and *P. brasilianum* Kräusel & Dolianiti (1958) from the Permian of Brazil. A species of *Spiroxylon*, viz. *S. indicum* described by Mehta (1952) from the Lower Permian (?)Carbonaceous shales of Singrauli Coalfields, district Mirzapur, Uttar Pradesh, also shows characters by which it may be included within the genus *Prototaxoxylon* according to the new nomenclature. Kräusel (1954) has already suggested this fact. We take here the opportunity to refer Mehta's *Spiroxylon indicum* as *Prototaxoxylon indicum* (Mehta) n. comb., because its diagnosis affiliates very well with the genus *Prototaxoxylon*.

All these three species differ appreciably from our fossil wood *P. intertrappeum*. *P. africanum* differs from *P. intertrappeum* in characters such as, the size of the tracheids and radial bordered pits in it; absence of tangential tracheidal pits; structure of the medullary rays and the arrangement of spiral bands. Similarly, *P. indicum* can also be distinguished from *P. intertrappeum* in the size of the tracheids; the diameter and the shape of the radial bordered pits; absence of the tangential pits; number and arrangement of cross-field pits; and the thickness and arrangement of spiral bands. Also *P. brasilianum* differs from *P. intertrappeum*, in having narrow and close spiral bands which run almost horizontally; in the presence of only 1-4 cross-field pits; and in the absence of tangential tracheid pits. For a detailed comparison, reference may be made to Table 1 which gives complete data of the important xylotomical features of the species included under *Prototaxoxylon*.

Fossil woods possessing secondary xylem very much similar to *Prototaxoxylon* are known as *Taxopitys* Kräusel (in KRÄUSEL & RANGE, 1928) and *Parataxopitys* Maniero (1951). *Taxopitys africana* is known from South Africa, of which *Prototaxoxylon africanum* (Walton) Kräusel & Dolianiti is probably the secondary wood, as suggested by Kräusel (1928). Similar woods of Permian Age from Brazil are *Taxopitys alvespintoi* Kräusel & Dolianiti (1958), and *Parataxopitys americana* (Milanez & Dolianiti) Barbosa, 1957. They all have true spiral thickenings with alternate to more or less opposite tracheidal pits. Fossil woods of the genus *Taxoxylon* Unger (1850) also possess true spiral thickenings but show the abietinean type of pitting in the tracheids, similar to those found in the living genera of the family Taxineae. Here the bordered pits in the tracheids are normally separate and

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TEXT-FIG. 1-16 — Radial longitudinal section showing uniseriate and mostly contiguous pits. × 160. 2, R.L.S. showing alternate and opposite pits. × 160. 3, R.L.S. showing closely adpressed alternate pits. × 160. 4, R.L.S. showing left-handed, biseriate and triseriate spiral bands. × 186·5. 5, R.L.S. showing right-handed, biseriate spiral bands. × 186·5. 6, R.L.S. showing right-handed, triseriate spiral bands. × 160. 7, R.L.S. showing thin bands passing through the rim of the pit-pores. × 160. 8, R.L.S. showing thin and branched spiral bands at the region of medullary rays. × 160. 9, R.L.S. showing cross-field pits. × 433. 10, Another R.L.S. showing cross-field pits. × 433. 11, T.L.S. showing mostly biseriate medullary rays. × 160. 12, T.L.S. showing tangential pits and the right-handed spiral bands. × 160. 13, R.L.S. showing cross-field pits. × 433. 14, Another R.L.S. showing cross-field pits. × 433. 15, Another R.L.S. to show cross-field pits closely placed and arranged in three horizontal rows. × 433. 16, T.L.S. showing mostly uniseriate medullary rays. × 140.

uniseriate (or opposite when in two rows). In contrast to this the pitting in *Prototaxoxylon* corresponds more closely to the pits seen in the tracheids of araucarian and cordaitean woods. This may be regarded as showing a possible relationship between the Cordaitales on one hand and the Taxads on the other. But it is dangerous to draw any phylogenetic conclusions from the fact like this between the older Gymnosperms and the Taxads. However, workers like Bliss (1918), Sahni (1920a, 1920b) and Florin (1948) have suggested that the Taxads have evolved from the Cordaitalean type of ancestors as there are certain morphological homologies in the seed and the cone structures of the two groups. In the end we may say that the anatomical features of *Prototaxoxylon intertrappeum* are not in accordance with either any living conifer or other Tertiary woods. On the other hand, they absolutely correspond to some of the much older woods, especially Permian or Lower Gondwana. This may possibly speak for an earlier age of the beds containing these woods than that of the Intertrappean (Tertiary?) as suggested by Tewari (loc. cit.).

## ACKNOWLEDGEMENTS

The authors express their sincere appreciation to Professor R. Kräusel of the Research Institute and Natural History Museum, Senckenberg, Frankfurt, a.M., Germany, for critically going through the manuscript of this paper and for helpful suggestions. Thanks are also due to Drs. R. N. Lakhanpal and M. N. Bose for kind advice.

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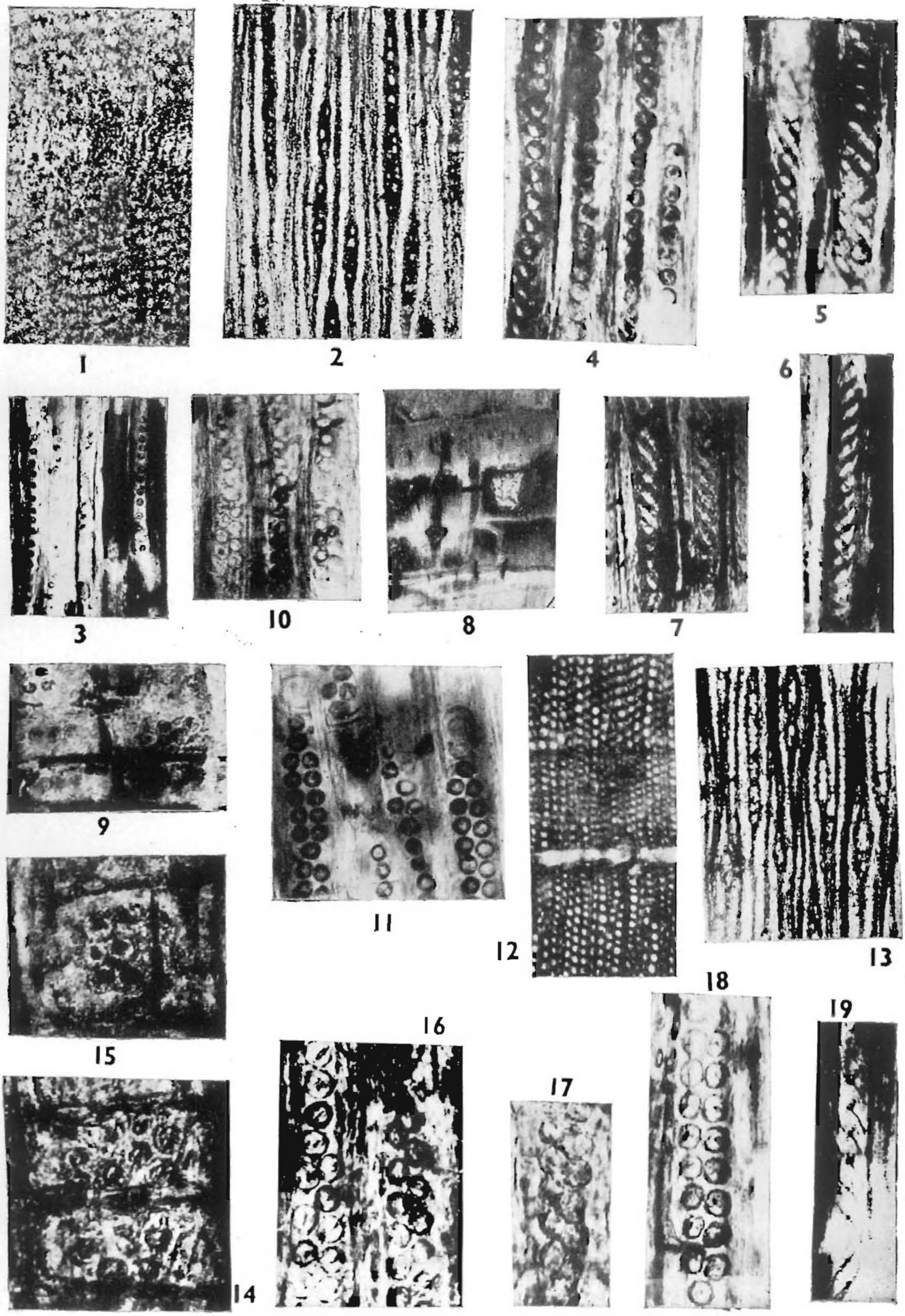
## EXPLANATION OF PLATE 1

(Figs. 1-11 from specimen No. 29840 and 12-19 from specimen No. 29837)

1. Cross-section of wood magnified to show a growth ring, spring and autumn wood tracheids. × 50.
2. Tangential longitudinal section showing mostly biseriate medullary rays. × 60.
3. T.L.S. showing the tracheid pitting. × 95.
4. R.L.S. showing the uniseriate and contiguous tracheid pitting. × 170.
5. R.L.S. showing 2-3 seriate, left-handed spiral bands. × 170.
6. R.L.S. showing right-handed, biseriate spiral bands. × 170.
7. R.L.S. showing left-handed, biseriate spiral bands. × 170.
8. Part of the type specimen cut transversely showing growth rings. Natural size.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9. R.L.S. showing cross-field pits. × 320.
10. R.L.S. showing biseriate, alternate tracheid pitting. × 130.
11. R.L.S. showing biseriate, alternate and opposite tracheid pits. × 170.
12. Cross-section of the wood magnified to show a growth ring, spring and autumn wood tracheids. × 35.
13. T.L.S. showing uniseriate medullary rays. × 60.
14. R.L.S. showing cross-field pits. × 650.
15. Another R.L.S. showing cross-field pits arranged in three, closely packed, horizontal rows. × 650.
16. R.L.S. showing biseriate, alternate tracheid pits. × 240.
17. R.L.S. to show biseriate, alternate pits, closely packed. × 240.
18. R.L.S. to show biseriate, mostly opposite pits. × 240.
19. R.L.S. showing arrangement of thin spiral bands. × 240.