SAPINDOXYLON SCHLEICHEROIDES SP. NOV., A FOSSIL DICOTYLEDONOUS WOOD FROM THE DECCAN INTERTRAPPEAN BEDS OF MADHYA PRADESH

R. DAYAL

Birbal Sahni Institute of Palaeobotany, Lucknow

ABSTRACT

A new species of the genus *Sapindoxylon* Kräusel (1922), viz., *Sapindoxylon schleicheroides* is described from the fossiliferous locality of Keria (21° 59′ 40″ N; 79° 10′ 15″ E) in the Deccan Intertrappean beds of Madhya Pradesh. It resembles the wood structure of the living genus *Schleichera* Willd. of the Sapindaceae.

INTRODUCTION

KERIA is a comparatively newly discovered plant-bearing locality of the Deccan Intertrappean Series (In LAKHANPAL, 1955). It is situated about two miles south-west of the well known locality of Mohgaon Kalan in District Chhindwara, Madhya Pradesh. Although petrified woods occur in abundance in this locality, so far only a few of them have been described from here. These are *Palmoxylon surangei* Lakhanpal (1955), *Bridelioxylon kraeuselii* (PRAKASH) Mädel (1962) and *Mallotoxylon keriense* Lakhanpal and Dayal (1962). Recently the author (DAYAL, 1964) has reported the occurrence of fossil woods resembling the living genus *Boswellia* Roxb. of Burseraceae from the same area.

The fossil wood dealt with in the present paper was collected by an excursion party of the Birbal Sahni Institute of Palaeobotany, from the fossilferous locality of Keria (20° 59′ 40″N; 79° 10′ 15″). It has been studied in detail from its thin ground sections. The descriptive terminology conforms to that proposed by the International Association of Wood Anatomists (1957). Standard terms of length of vessel-members and wood fibres and for vessel diameter and ray width are those standardized by the International Association of Wood Anatomists (1937, 1939). Comparisons with large number of genera of the modern dicotyledons has revealed that the present fossil wood is closely related to the genus *Schleichera* Willd. of the Sapindaceae.

DESCRIPTION

The fossil investigated is a decorticated silicified wood consisting of secondary xylem only. It is about 3 cm. thick and 12 cm. in diameter. The preservation of structural details is satisfactory.

Topography— Wood diffuse-porous (PL. 1, FIGS. 1 & 2). *Growth rings* indistinct to the naked eye or with a hand lens; at one place there is some suggestion of a growth mark due to aggregation of vessels (PL. 1, FIG. 2). *Vessels* appearing as minute dots to the naked eye, the orifices not easily distinguishable without a hand lens, the majority solitary and in radial rows of 2-3 cells (PL. 1, FIGS. 1 & 2), less commonly in multiples of 4 or more cells, small to medium-sized, 5-16 per sq. mm., sometimes in small clusters; tyloses absent. *Parenchyma* present in limited amount, visible only under the microscope, paratracheal, usually as few cells or sometimes as 1 or 2 cells thick sheath round the vessels (PL. 1, FIG. 3), the sheath generally incomplete owing to the contiguous rays. *Xylem rays* indistinct to the naked eye or through a hand lens, clearly seen under high magnification, fine 1-3 (mostly 1-2) cells and 15-45 μ wide (PL. 1, FIG. 5), 17-23 per mm., short, 30-448 μ and 4-28 cells high, consisting usually of procumbent cells only, sometimes with occasional marginal square cell at the ends (PL. 1, FIG. 7); ray tissue homogeneous to weakly heterogeneous. *Fibres* forming the ground mass of the wood, aligned in radial rows between two consecutive rays (PL. 1, FIG. 1).

Elements — Vessels thin to slightly thick-walled, the walls about 4-6 μ thick, t.d. 60-165 μ, r.d. 75-192 μ, circular to oval in transverse section, those in radial multiples generally unequal in size and flattened at the place of contact (PL. 1, FIG. 1), contiguous with rays on one or both the sides; vessel-members short, up to 266 μ long, usually truncate or sometimes with slightly tapered

ends; perforations simple; intervessel pit-pairs distinct, small, about 4 μ in diameter, bordered, alternate (PL. 1, FIG. 6); vessel-ray and vessel-parenchyma pits not preserved. *Parenchyma cells* thinwalled, round or oval in cross-section, t.d. 14-19 μ without infiltration. *Ray cells* thickwalled, procumbent cells circular or oval, small, t.d. 16 μ r.d. 16 μ; square cells t.d. 16 μ, vertical height 24-28 μ, pits of the ray cells not observed. *Fibres* moderately thickwalled, septate (PL. 1, FIG. 4), circular to angular in the cross-section, lumen small (PL. 1, FIG. 1), t.d. 8-12 μ, r.d. 8-20 μ, interfibre pits not preserved.

AFFINITIES AND DISCUSSION

Comparison with the Living Species — From the charcteristics above described, the present fossil is clearly understood to be a typical dicotyledonous wood. The important structural features of the present wood that may help in its identification are (1) small to medium-sized vessels which are solitary and in radial multiples of 2-3 cells or more, (2) intervessel pit-pairs which are small and bordered, (3) sparse paratracheal parenchyma, (4) mostly 1-2 seriate, short, usually homogeneous rays and (5) the septate fibres. Among the modern dicotyledons there are a number of families which exhibit a combination of some or all the features present in the Intertrappean fossil. Of these the important ones are Combretaceae, Leguminosae, Anacardiaceae, Sonneratiaceae, and Sapindaceae, with which a detailed comparison is made below.

Among the living members of the Combretaceae (METCALFE & CHALK, 1950, pp. 612-620; GAMBLE, 1902 pp. 336-350) woods of some species of *Terminalia* Linn. and *Anogeissus* Wall. show resemblance with the present fossil wood. Of the various species of modern *Terminalia* examined only *T. oliveri* Brandis and *T. manii* King. resemble the present fossil in the presence of sparse paratracheal parenchyma, somewhat in the nature of the xylem rays and the fibres. However, in both the species the vessels are small to very small and their frequency is too large (in *T. oliveri* 85-115 per sq. mm., in *T. manii* 16-45 per sq. mm.) to be favourably compared with the fossil (PEARSON & BROWN, 1932, pp. 512-515). Moreover, in *Terminalia* the intervessel pit-pairs are vestured (BAILEY, 1933). As regards *Anogeissus* thin sections of *A. acuminata* Wall., *A. latifolia* Wall., *A. pendula* Edgew. and *A. sericea* Brandis were studied. Besides, description of *A. leiocarpus* (DC.) Guill and Perr. (NORMAND, 1960, pp. 293-294, PL. 194) was also consulted. In *Anogeissus*, however, the intervessel pit pairs are vestured, the frequency of the vessels and the amount of parenchyma is generally comparatively more and the ray cells are abundantly crystalliferous.

Some of the genera of Leguminosae (METCALFE & CHALK, 1950, pp. 476-535; NORMAND, 1950, pp. 98-142, PLS. 30, 34, 36, 40, 48 & 49) possess vessels and xylem rays somewhat similar to what is seen in the present fossil wood. However, they are easily distinguished by the presence of abundant parenchyma either predominantly paratracheal as round or diamond-shaped sheath or confluent or in moderately regular bands.

In the Anacardiaceae (METCALFE & CHALK, 1950, pp. 452-462; GAMBLE, 1902, pp. 207-224; HEIMSCH, 1942, pp. 136-144) some woods resemble the present fossil in having small to medium-sized vessels, scanty-vasicentric parenchyma and the uniseriate xylem rays. However, this family stands apart owing to the invariable occurrence of intercellular canals in the xylem rays and the intervessel pit-pairs are usually large.

In the Sonneratiaceae (METCALFE & CHALK, 1950, pp. 660-664) the wood structure of the modern *Sonneratia* Linn. f. shows some resemblance in gross-feature with the present fossil wood. Thin sections of *Sonneratia acida* Linn, and *S. apetala* Ham. were examined to compare the present fossil. Figures and description of other species of *Sonneratia* viz., *S. caseolaris* (LINN.) Engl. (PANSHIN, 1932, pp. 161-162, PL. 7; SCHNEIDER, 1916, p. 177; REYES, 1938, pp. 347-349, PL. 66, FIG. 3), *S. pagatpat* Blanco (KANEHIRA, 1924, p. 37; SCHNEIDER, 1916, p. 178, PL. 8, FIG. 58), *S. alba* Sm. (MOLL & JANSSONIUS, 1914, pp. 603-604) were also consulted. A detailed comparison has, however, revealed certain fundamental differences as in *Sonneratia* the intervessel pit-pairs are vestured and the parenchyma is absent. Occurrence of parenchyma has, however, been reported in *Sonneratia pagatpat* Blanco by Kanehira (1924, p. 37). But in this species it is scattered unlike the scanty-vasicentric type in the present fossil wood.

Among the living members of Sapindaceae the woods of *Pometia* Forst. *Allophylus* Linn.

Arytera Bl. and *Schleichera* Willd. show many similarity in anatomical characters with the present Intertrappean wood.

A number of species of the genus *Pometia*, viz., *P. tomentosa* Teysm. et Binn., *P. pinnata* Forst., *P. pinnata* var. *javanica* Koord. et Valet., *P. ridleyi* King, *P. alnifolia* Radlk. and *P. macrocarpa* Kurz, were examined some from their thin sections of the modern woods while others from their published descriptions and figures (BERGER, 1926, PL. 18; DESCH, 1954, pp. 533-535, PL. 107, FIG. 2; KANEHIRA, 1921, pp. 79-80, PL. 15, FIGS. 88, 89; METCALFE & CHALK, 1950, p. 426, FIG. 97 I; MOLL & JANSSONIUS, 1908, pp. 370-376, FIG. 125; REYES, 1938, pp. 225-226, PL. 38, FIG. 2). The woods of this genus, while resembling the present fossil wood in some characters, differ from it in other important anatomical details. In this genus the vessels are usually large, the vasicentric parenchyma is comparatively abundant, tending to become aliform in some species; there is a definite terminal parenchyma band about 1-6 cells thick and the parenchyma and the ray cells are crystalliferous.

The woods in the genus *Allophylus* (HEIMSCH, 1942; MELCALFE & CHALK, 1950) show parenchyma-like bands of thinwalled septate fibres which are large and round in transverse section with pronounced intercellular spaces. These bands alternate with the bands of thickwalled fibres which are more compact. This is very characteristic of the woods of this genus. This character has not been seen in the Intertrappean wood.

The wood structure of the genus *Arytera* (METCALFE & CHALK, 1950, pp. 425-429; MOLL & JANSSONIUS, 1908, pp. 381-384, FIG. 127) presents a close similarity in many anatomical features. But in this genus the vessels are small, their frequency is also more (about 25-30 per sq. mm.) and there are crystalliferous parenchyma strands scattered among the fibres.

In the genus *Schleichera* the living wood of *S. trijuga* Willd. was available for comparison. Wood structure of this species has also been described and figured by Gamble (1902, pp. 194-195, PL. 4, FIG. 6), Lecomte (1925, PL. 45), Metcalfe and Chalk (1950, p. 426, FIG. 97F), Moll and Janssonius (1908, pp. 354-359, FIG. 122) and Pearson and Brown (1932, pp. 291-294, FIG. 105). A detailed examination of the modern wood as well as the published literature has, however, revealed that the wood structure of *Schleichera* has much in common with the present fossil wood. The resembling features are the shape, size and distribution of the vessels, the type of intervascular pitting, presence of sparse paratracheal parenchyma, 1-3 seriate xylem rays with thickened ray cells and the septate fibres. However, there are some differences in both. In the modern wood the growth rings are distinct, there is little diffuse parenchyma besides the scanty-vasicentric type and the fibres are comparatively thicker walled.

Comparison with the Fossil Species — So far a number of fossil woods of the Sapindaceae have been described from many parts of the world. These include *Schmiedeliopsis zirkelii* Felix (1882) from the Tertiary of Antigua; *Fraasia sapindoides* Unger (1850) from the Tertiary of Hungary; *Sapindoxylon janssonii* Kräusel (1922) from the Tertiary of Sumatra; *Sapindopsoxylon klitzingi* Pfeiffer and Heurn (1928, see also EDWARDS, 1931) from the Tertiary of Java; *Sapindoxylon stromeri* Kräusel (1939) from the Tertiary of Egypt; *Sapindoxylon antioquiense* Schönfeld (1947) from the Tertiary of Colombia; *Sapindoxylon pleikuense* Boureau (1950) from the Tertiary of Indo-China; *Sapindoxylon* sp. Hofmann (1952) from the Tertiary of Prambachkirchen, Austria and *Sapindoxylon indicum* Navale (1956) from the Tertiary of South India. Besides, Kräusel (1922) described a fossil wood, viz., *Djambioxylon sumatrense* from the Tertiary of Sumatra without showing its affinity with any modern family. This wood according to Edwards (1931) perhaps belongs to the Sapindaceae.

Of all the fossil woods of Sapindaceae mentioned above the only comparable ones are *Sapindoxylon janssonii* Kräusel (1922), *Sapindoxylon stromeri* Kräusel (1939), *Sapindoxylon antioquiense* Schönfeld (1947) and *Sapindoxylon indicum* Navale (1956).

Sapindoxylon janssonii Kräusel (1922), however, differs from the present fossil wood in having larger vessels which are few about 2-8 per sq. mm. and there is sparse metatracheal and diffuse parenchyma with the cells containing crystals.

Similarly, *Sapindoxylon stromeri* Kräusel (1939) also differs from the Intertrappean wood in having small vessels which are in radial multiples of up to 15 cells, in the high frequency of the vessels which is 20-40 per

sq. mm., the rays are mostly uniseriate and the parenchyma is crystalliferous.

Sapindoxylon antioquiense Schönfeld (1947) while resembling in some features with the fossil wood, differs from it in having large vessels about 4-7 per sq. mm., very thick-walled fibres, crystalliferous parenchyma and the xylem rays which are only 5 per mm.

Sapindoxylon indicum Navale (1956) described from the Tertiary Rocks (Cuddalore Series) of South India differs from the present fossil in having larger vessels which are tylosed and in the xylem rays which are mostly uniseriate and composed of upright cells only.

It is evident from the above comparison that the fossil exhibits nearest approach to some members of the Sapindaceae, where it resembles in many structural details with the woods of the genus *Schleichera* and is also distinct from the already known fossil sapindaceous woods. It has, therefore, been described as a new species of the genus *Sapindoxylon* Kräusel, viz., *Sapindoxylon schleicheroides* sp. nov.

The living *Schleichera*, with which the present Intertrappean fossil resembles most, consists of but a single species, *S. trijuga* Willd., a large deciduous tree widely distributed throughout Southern Asia, the Malay Archipelago and the Philippines (Pearson & Brown, 1932, pp. 291-292; Willis, 1957, p. 594). It is found throughout dry, chiefly deciduous, forests in India, Burma and Ceylon, but not in Bengal and Assam. It is found in the Sub-Himalayan tract from the Sutlaj to Nepal, Chota Nagpur, Central India and the Peninsula generally, and throughout Burma. The tree is a typical of mixed deciduous forests, often of a somewhat dry type. In the sub-Himalayan tract and outer hills it is common on well-drained boulder deposits, often occurring in quantity along the sides of ravines or along the high banks marking the edges of terraces. It is common on the south side of the Siwalik range, often on the sides of ravines on sandstone or on boulder beds. In Madhya Pradesh it occurs scattered in mixed forest, chiefly near the banks of streams. In Burma it is common both in the upper mixed forests of the low hills and in the lower mixed forests of the plains; in the lower mixed forests it grows on good alluvial loam. In general it thrives best on a light well-drained gravelly or loamy soil. In its natural habitat the absolute maximum shade temperature varies from 100° to 118° F., the absolute minimum from 30° to 60°F, and the normal rainfall from 30″ to 100″ or more (Gamble, 1902, p. 195; Troup, 1921, p. 229).

SPECIFIC DIAGNOSIS

Sapindoxylon schleicheroides sp. nov.

Wood diffuse-porous. *Growth rings* indistinct. *Vessels* small to medium-sized, t.d. 60-165 μ, r.d. 75-192 μ, with slightly thicker walls, solitary and in radial multiples of 2-3 or more cells, 5-16 per sq. mm.; vessel-members short; perforations simple; intervessel pit-pairs small, bordered, alternate. *Parenchyma* as few cells or sometimes 1-2 cells thick sheath round the vessels. *Xylem rays* fine, 1-3 (mostly 1-2) seriate, moderately numerous, 17-23 per mm., short; ray tissue homogeneous to occasionally weakly heterogeneous; *Fibres* moderately thickwalled, septate, circular to angular in cross-section with small lumen.

Holotype — B.S.I.P. Museum No. 8224.

Locality — Keria, district Chhindwara, Madhya Pradesh, India.

Horizon — Deccan Intertrappean Series.

Age — Early Tertiary (Probably Eocene.)

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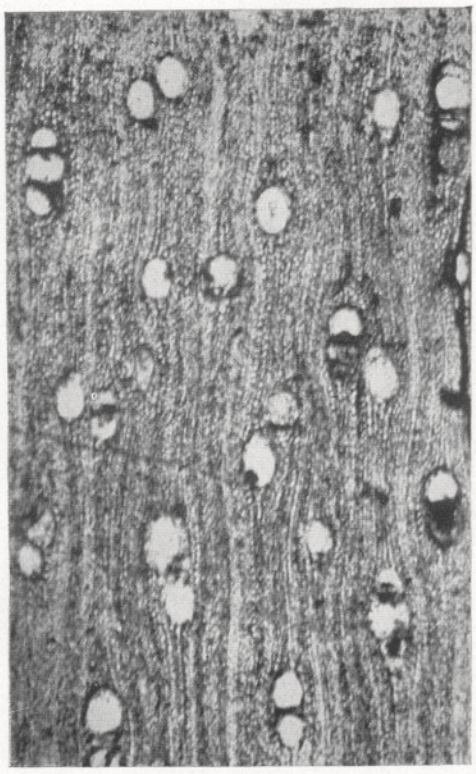

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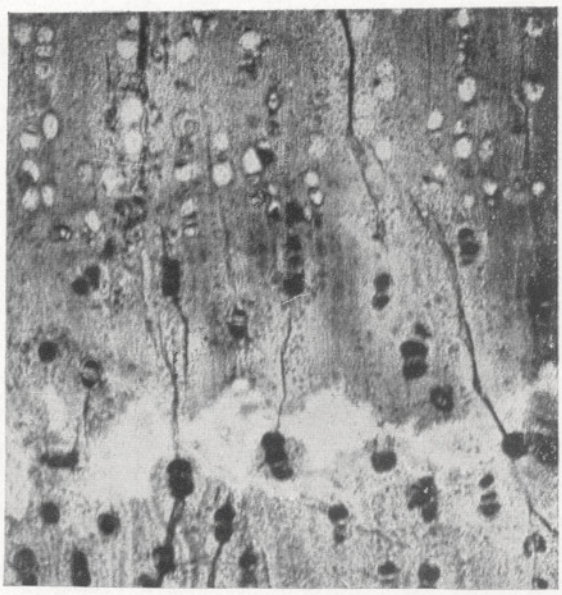

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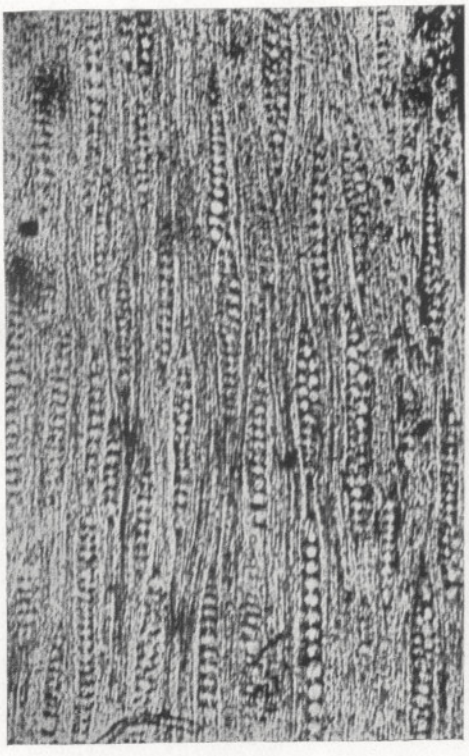

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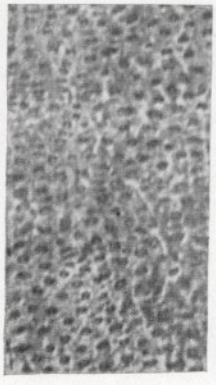

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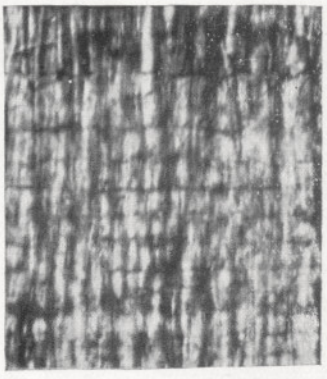

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EXPLANATION OF PLATE 1

Sapindoxylon schleicheroides sp. nov.

1. Cross-section showing the shape, size and distribution of the vessels. × 45.

2. Cross-section to show the distribution of the vessels and indistinctly seen growth mark. × 30.

3. Part of a cross-section magnified to show the vasicentric parenchyma round a vessel multiple. × 200.

4. Part of a tangential longitudinal section to show the septate fibres. × 526.

5. Tangential longitudinal section showing the nature and distribution of the xylem rays. × 100.

6. Intervessel pit-pairs. × 450.

7. Radial longitudinal section showing the procumbent cells and a row of square cells. × 240.