RHEEDEA
Journal of the Indian Association for Angiosperm Taxonomy

Vol. 06(1): 59–66 (1996)
ISSN: 0971-2313 (Print edition)
ISSN: 2582-2438 (Online edition)

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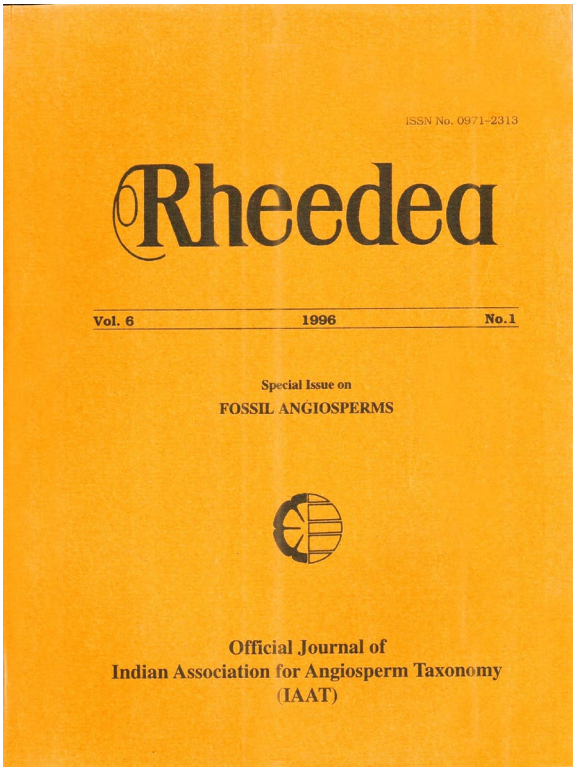


How to cite:

**Bamford M. 1996**. Comparison of Indian and Southern African fossil angiosperm woods. *Rheedea* 6(1): 59–66.

https://dx.doi.org/10.22244/rheedea.1996.06.01.05

*Published in print*: 30.06.1996 *Published Online*: 01.01.2022

**Published by Indian Association for Angiosperm Taxonomy**
This volume of Rheedea is published with partial financial assistance from Department of Science and Technology, Government of India, New Delhi

Rheedea Vol. 6 (1) : 59—66. 1996

# Comparison of Indian and southern African fossil Angiosperm woods

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**Abstract**

The few fossil woods that have been described from southern Africa are compared, at generic level, to woods from India. They belong to fairly large families and, except for *Xanthophyllum* and *Hedycarya,* have a similar extant distribution. The southern African fossil woods show that a tropical and wet climate extended much farther south during the Miocene than it does today. Evolutionary changes in the wood structures have occurred at the species level. The picture is incomplete and continuing research may show some interesting trends.

## INTRODUCTION

Comparatively few researchers have studied the southern African fossil woods. The Indian fossil woods from many localities have been described by quite a number of researchers. One only has to page through the relevant journals to find the detailed descriptions. In spite of the difference in the amount of data, comparisons can be drawn from the two regions as there are common elements in their floras. Probably the greatest similarities are in their Permian *Glossopteris* floras when the continents were joined into the huge landmass Gondwanaland (Pant, 1977; Kovacs-Endrody, 1991). By the Upper Cretaceous the continents were far apart but still connected by land.

At the family level there are common elements, especially of the widely distributed tropical and subtropical plants, in the present day flora. At the generic level there are fewer shared taxa but at the species level these are quite rare, as expected. As far as the angiosperm fossil woods are concerned, comparisons at the family and generic level are meaningful.

## SOUTHERN AFRICAN FOSSIL ANGIOSPERM WOODS

Probably the first angiosperm wood described from southern Africa was by Warren (1912) from lingite beds at Port Durnford in Natal (Fig. 1). This wood was identified as *Eugenia cordata* from Tertiary deposits. The hand-drawn diagrams show dicotyledonous wood but I have not seen the slides. Adamson (1934) described woods from Fort Grey, near East London, as being *Widdringtonia, Podocarpus* and *Curtisia* of Tertiary age. The woods

have since been found to be much older, Beaufort (Upper Permian), reworked into a younger silcrete. No angiosperm woods were found this time (Roberts *et al.* – in prep.).

In 1960 and 1962 Erika Mädel published descriptions of angiosperm woods from the Upper Cretaceous beds in Pondoland, eastern Cape (Fig. 1). She found two genera from the Monimiaceae, *Protoatherospermoxylon* (6 species) and *Hedycaryoxylon* (1 species) (Mädel, 1960). Of the Euphorbiaceae Mädel (1962) described four genera, *Paraphyllanthoxylon* (2 species), *Securinegoxylon* (1 species), *Bridelioxylon* (1 species) and *Euphorbioxylon* (1 species). These genera are present in today's flora in southern Africa except for *Hedycarya*.

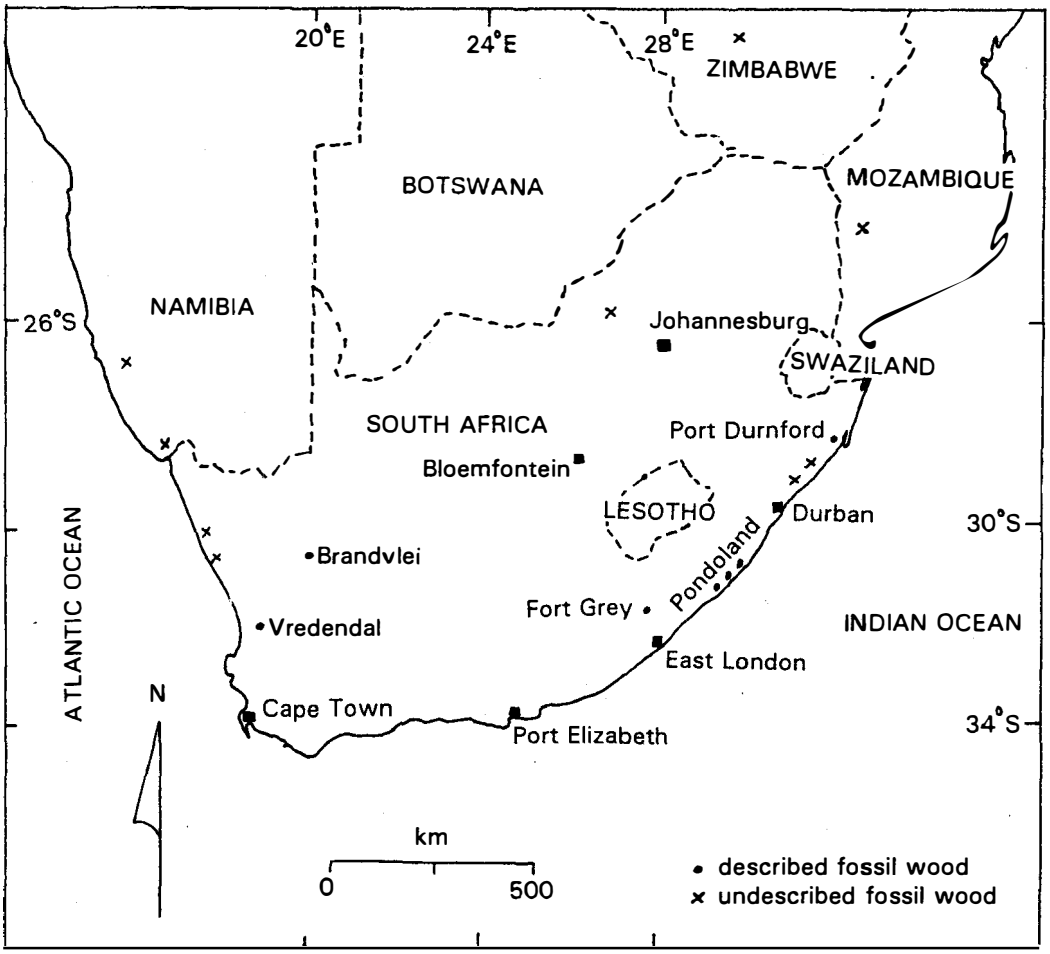


Fig. 1. Map of southern Africa showing localities from where fossil wood has been described, and also new localities.

Much more recently fossil woods have been described from Brandvlei, northwestern South Africa (Bamford & de Wit, 1993). The families represented in this Miocene deposit are the Dipterocarpaceae, Myrtaceae, Rutaceae, Oleaceae and Polygalaceae, all of which have representative genera in southern Africa today. From another Miocene site well to the south, at Vredendal, woods of the Combretaceae and Miliaceae, have been described (Bamford, in prep.). These two families, especially the Combretaceae, are common in southern Africa's modern flora.

These fossil woods will be described briefly and then compared with the Indian woods. The Monimiaceae has no Indian fossil record and so will not be described. The Euphorbiaceae is such a large and diverse group, and the slides have not been seen by this author, so those fossils too will not be described.

COMBRETACEAE

**Combretum imberbe** Wawra

Sample : BP/16/102

Locality : Vredendal, southwestern Cape, South Africa

Age : Miocene (Bamford, in prep.).

The wood is diffuse porous with indistinct growth rings but there are a few randomly spaced bands of terminal parenchyma. The vessels are predominantly solitary but there are a few radial multiples of 2 cells. Vessel outlines are round to oval. The vessel tangential diameter is 75-110-150µm (minimum - average - maximum, measured from a sample of 25) and the vessel member length is 446-535-672µm. There are 2 vessels per square mm, and perforation plates are simple, horizontal or oblique. The intervessel pits are alternately arranged, vestured and have a diameter of 5 - 7.5µm. Axial parenchyma is aliform only. The rays are uniseriate and low, 15-23 cells high (128-196-352µm), homocellular with procumbent cells only. The fibres are medium to thick-walled, non-septate, no visible pitting but with dark contents (gum/resin?).

**Terminalioxylon chowdhurii** Prakash & Navale

Sample : BP/16/101

Locality : Vredendal, southwestern Cape, South Africa

Age : Miocene (Bamford, in prep.)

The wood is diffuse porous and the growth rings have narrow bands of terminal parenchyma. The vessels are mostly solitary but about 20% are paired. The solitary vessels are round to oval and have a tangential diameter of 105-146-225µm. Vessel member length is 290-387-460µm. There are 3 vessels per square mm, and the perforation plates are simple and

horizontal. Intervessel pitting is alternate, closely packed, and the pits are oval and 5 - 5.7µm in diameter. There are black deposits in some vessels. The paratracheal parenchyma is aliform to confluent and the apotracheal parenchyma is in frequent but randomly arranged bands of 1-3 cells wide. It is difficult to distinguish between apotracheal and terminal parenchyma bands. The rays are uniseriate but sometimes have a low biseriate portion in the middle of the ray. There are 6-8 rays per mm and they are 7-20-25 cells high (125-221-350µm). The rays are homocellular with thin-walled procumbent cells only. Fibres are non-septate, non-storied, moderately thick-walled and with no pitting preserved.

DIPTEROCARPACEAE

**Monotes** *sp.*

Sample : BP/16/4

Locality : Brandvlei, northwestern Cape, South Africa

Age : Miocene (Bamford & de Wit, 1993)

The wood is diffuse porous and the vessel elements are randomly arranged, predominantly solitary and rounded in outline. The tangential diameter is 56-82-120µm and vessel member length is 104-195-256µm. There are 31 vessels per square mm and the perforation plates are simple and horizontal. Tyloses are common. The rays are exclusively uniseriate and on average 16 cells high (280µm), probably homocellular, with a frequency of 7 rays per mm. Parenchyma is absent or very rare. The fibres are non-septate and have a mean tangential diameter of 12µm with 4µm thick walls.

MELIACEAE

**Entandrophragma cylindricum** Sprague

Sample : BP/16/267

Locality : Vredendal, southwestern Cape, South Africa

Age : Miocene (Bamford, in prep.).

The wood is diffuse porous and has no growth rings. The vessels are solitary, round to oval and have a tangential diameter of 50-89-120µm. Vessel member length is 325-376-400µm. There are 2-3 vessels per square mm and the perforation plates are simple and horizontal. Intervessel pits are alternate, and 6µm wide. Paratracheal parenchyma is vasicentric to aliform and apotracheal bands of 4-5 cells wide occur randomly. The rays are 1-2-3-seriate, and 5-16 cells high with a frequency of 7 rays per mm. Rays are weakly heterocellular, mostly procumbent cells but some squarish, marginal cells are idioblasts containing crystals. Some ray cells have dark contents. (Ray width is 24-46-60µm, height 150-292-400µm). Walls of the fibres are thin to medium thick.

**Trichilia lanata** Chev.

Sample : BP/16/103

Locality : Vredendal, southwestern Cape, South Africa

Age : Miocene (Bamford, in prep.).

The wood is diffuse porous, has no growth rings and the vessels are in radial multiples of 2-3, rarely 4 or solitary, and are oval to polygonal in shape. Vessel tangential diameter is 75-120-200µm, length 255-345-465µm and a frequency of 8 per square mm. Intervessel pits are alternate and minute, 2.5 - 4µm in diameter and the vessel-ray pits are also alternate but 2.5 x 5 µm in size. Dark contents or crystals occur in most vessels. Aliform to confluent paratracheal parenchyma as well as apotracheal bands, 2-3 cells wide and 1-4 bands per mm are characteristic of this wood. Some parenchyma cells have chambered crystals and some have starch. Rays are 1-2-seriate and 7-22 cells high (250-356-475µm) and homocellular, procumbent. Dark and light (starch?) contents are found in the ray cells. Fibres are thick-walled with dark lumens.

POLYGALACEAE

**Xanthophyllum** *sp.*

Sample : BP/16/2

Locality : Brandvlei, northwestern Cape, South Africa

Age : Miocene (Bamford & de Wit, 1993).

The wood is diffuse porous and the growth rings are 1.5 to 2 mm apart. The vessels are predominantly solitary, oval and have a tangential diameter of 144-210-366µm and length of 200-270-440µm. The frequency of the vessels is 29 per square mm. Perforation plates are simple and horizontal and vessel-ray pits are oval, 7-9µm. Tyloses are present. Rays are exclusively uniseriate, 9-12 cells high, heterocellular with procumbent and square cells, 15 rays per mm. Parenchyma is absent or very rare. The fibres have bordered pits on both the radial and tangential walls with a pore diameter of 5-7µm (fibre-tracheids of Baas, 1986).

There are other woods from southern Africa but they are not as well preserved and so any comparison would be questionable.

## COMPARISON WITH INDIAN WOODS

COMBRETACEAE

*Combretum imberbe* is an African tree occurring in central, eastern and southern Africa today. Neither *Combretum* nor *Combretoxylon* ever occurred in India as far as can be ascertained.

*Terminalia* occurs today in both regions and has a good fossil record in India. *Terminalioxylon chowdhurii* was first described from Assam by Prakash and Navale (1962) and they compared it with other fossil members of *Terminalioxylon*. It was not compared, however, with any particular extant species of *Terminalia*. The Indian and South African fossils are very similar and differ only in the lack of diffuse apotracheal parenchyma cells in the South African wood. The Indian wood has slightly larger vessels but this could be a climatic feature or dependent on the position of the sections of wood relative to the whole tree. Today there are different species of *Terminalia* in both regions (van Vliet, 1979). The similarity of the *Terminalioxylon chowdhurii* from both regions is not reflected in the extant woods, an age difference of some 15 million years.

There are several other samples of southern African wood that belong to the Combretaceae but they are still to be described and published.

DIPTEROCARPACEAE

*Monotes sp.* is typical of the extant taxa in Africa. In tropical Africa there are about 48 species (Willis, 1966) and 3 of them in southern Africa. This family has an interesting distribution: the Monotoideae are essentially restricted to Africa and the Dipterocarpoideae have an Asian distribution, in other words, palaeotropical. Recently a new subfamily has been described from South America (Maguire & Ashton, 1977), the Pakaraimoideae, represented by one species in Guyana, thus expanding the distribution of this family to the neotropics. Londono *et al.* (1955) described another new species from Columbia which is very close to the Monotoideae, and called *Pseudomonotes tropenbosii*. These new finds show that the distribution of the Dipterocarpoideae is not simple and clear-cut.

The South African fossil is definitely a member of the Monotoideae. The Indian fossils described so far are all members of the Dipterocarpoideae. The occurrence of an intermediate fossil or Pakaraimoideae fossil remains to be found and would answer some questions about the radiation and distribution of this family.

MELIACEAE

*Entandrophragma* is an African genus with 35 species in tropical and southern regions (Willis, 1966). It does not occur in India. Fossil wood of this genus has been recorded from north Africa (Koeniguer & Louvet, 1968; Koeniguer, 1971; Louvet, 1974), and Europe (Wheeler & Baas, 1991). The South African fossil wood of *E. cylindricum* shows that some species used to have a much wider distribution during the Miocene. Today *E. cylindricum* is resricted to West tropical Africa.

*Trichilia* has 14 species in tropical Africa and 2 species in the Indo-Malayan area (Pennington & Styles, 1975). No record of fossil wood could be found, except of *Paratrichilioxylon russelli* (Niger, Palaeocene; Koeniguer, 1971) and *P. ludovici,* and *P. grambastii*

(Ethiopia, Miocene; Lemoigne, 1978), for woods which share the characters of *Trichilia* and *Guarea*.

POLYGALACEAE

There are about 60 species of *Xanthophyllum* in the Indomalaysian region today (Wills, 1966). In southern Africa there are only three other tree genera of the family and three species (Coates-Palgrave, 1981). One fossil species was described from India, *X. cuddalorense* (Mio-Pliocene; Awasthi, 1986) which is very similar to the South African wood, *Xanthophyllum sp.* (Bamford & de Wit, 1993). The latter, however, has poorly preserved parenchyma. No other fossil records could be found. The extant members of the Polygalaceae are predominantly herbaceous which may explain their impoverished fossil record.

## DISCUSSION

The families Combretaceae, Dipterocarpaceae, Euphorbiaceae, Meliaceae and Polygalaceae were common to both regions during the Tertiary, as they are today. These are large families with tropical to subtropical distributions so the fossil record is not extraordinary. At the generic level there are some discrepancies and at the species level there is only one wood in common. As far as the wood is concerned, evolutionary changes at the species level, have occurred since the Miocene, in these families.

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