Occurrence of Australian element in the Deccan Intertrappean flora of India

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Three new fossil woods, viz., Eucalyptus dbarmendryae sp. nov., Tristania confertoides sp. nov. and Callistemonoxylon deccanensis gen. et sp. nov. resembling the modern Myrtaceous taxa Eucalyptus, Tristania conferta and Callistemon-Melaleuca respectively and an infructescence Callistemonites indicus, also resembling Callistemon-Melaleuca, have been described from the Deccan Intertrappean beds of Mandla District, Madhya Pradesh. As all these genera are Australian, their presence in the Deccan Intertrappean flora is phytogeographically important.

Key-words—Xyotomy, Eucalyptus, Tristania, Callistemon, Melaleuca, Myrtaceae, Infructescence, Deccan Intertrappean beds (India).

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INTRODUCTION

The fossil plants described from the Deccan Intertrappean beds of Mandla District, Madhya Pradesh have added considerably to our knowledge about the early Tertiary flora of India. Their study during the last nearly 15 years has developed a better understanding of the vegetation, climate and phytogeography of Central India during the early Tertiary.

The fossil taxa described from Mandla District were listed by Bande and Prakash (1983) and Mehrotra, Prakash and Bande (1984). Since then three more records have been added. These are: (i) a palm peduncle Palmostroboxylon arenegidum Ambwani (1984a), (ii) a palm wood Palmoxylon dilacunosum Ambwani (1984b), and (iii) a dicot wood Canarioxylon shahpuraensis Trivedi & Srivastava (1985).

Recent investigations on plant fossils on these beds have revealed the occurrence of four characteristic Myrtaceous taxa representing Australian element. As the Australian element has so far not been reported from the early Tertiary beds of India, the present discovery is significant and is reported here. Out of these four new taxa, three are based on silicified woods and one on a petrified infructescence. They represent the taxa Eucalyptus, Tristania, Melaleuca and Callistemon.

Regarding the nomenclature of fossil woods the recommendations given by Lakhanpal and Prakash (1980) and further enumerated by Bande (1986) have been followed. Accordingly, two of the fossil woods,
because of their close anatomical similarities with the modern genera, have been assigned modern generic names. The third wood shows affinities with two genera which can not be distinguished anatomically and hence has been assigned to an organ genus with the suffix *auxylon* added to one of them. As regards the fruiting axis, it has also been placed under an organ genus because more precise identification is not possible on the basis of available data.

**SYSTEMATIC DESCRIPTION**

**Family—Myrtaceae**

**Genus—Eucalyptus L'Hérit**

*Eucalyptus dharmendrae* sp. nov.

Pl. 1, figs 1, 3, 4, 6, 7

**Material**—A single piece of well-preserved secondary wood measuring about 7 cm in length and 5 cm in width.

**Description**—Wood diffuse-porous (Pl. 1, fig. 1). Growth rings distinct, demarcated by crowding of vessels and thick-walled fibres. Vessels usually small to medium-sized, rarely very small, t.d. 47-157 µm, r.d. 51-185 µm, usually in definite echelon arrangement of 2-10 vessels, sometimes solitary and in clusters, evenly distributed, 13-21 per sq mm, usually circular to oval (Pl. 1, figs 1,3); vessel members 450-690 µm long with oblique to horizontal ends; perforations simple; vessel-tracheid pits usually 1-2 serate, bordered, in vertical rows, small, about 4-6 µm in diameter, oval to circular in shape (Pl. 1, fig. 7); tyloses present. Tracheids vasicentric, associated with parenchyma forming a sheath of 2-5 cells around most of the vessels or vessel groups and joining the vessels radially and tangentially (Pl. 1, fig. 3). Parenchyma paratracheal and apotracheal, paratracheal parenchyma occurring as few cells around the vessels; apotracheal parenchyma diffuses and sparse (Pl. 1, figs 1,3); parenchyma cells thin-walled, 13-17 µm in diameter and 20-26 µm in length. Xylem rays almost exclusively uniseriate, rarely biseriate, usually made up of procumbent cells only. 13-25 µm in width and 4.36 cells or 90-600 µm in height, 13-18 per mm (Pl. 1, fig. 4); ray tissue mostly homogeneous to rarely weakly heterogeneous due to occasional presence of upright cells (Pl. 1, fig. 6); ray cells thin-walled, usually filled with dark-coloured deposits, 13-26 µm in tangential height and 34-52 µm in radial length. Fibres semi-libriform to libriform, circular to angular in cross section, septate, 12-20 µm in diameter and 390-900 µm in length (Pl. 1, figs 3,4).

**Affinities**—The important anatomical characters of the fossil wood, namely small to medium-sized vessels arranged in echelon pattern, both paratracheal and apotracheal type of parenchyma, narrow, homogeneous to weakly heterogeneous xylem rays and vasicentric tracheids, strongly indicate its affinities with the genus *Eucalyptus* L'Hérit of Myrtaceae (Mecalf & Chalk, 1950; Miles, 1978). For further comparison wood slides of 22 modern species of *Eucalyptus* were examined at the xylaria of the Forest Research Institute, Dehradun and the Birbal Sahni Institute of Palaeobotany, Lucknow. Besides, the photographs and published descriptions of a number of its species were also consulted (Greguss, 1945, p. 128, fig. 156; Kribs, 1959, pp. 122-126, figs 263-272, 439; Miles, 1978, pp. 153-158). It was found that although *Eucalyptus* has some characteristic anatomical features there is a lot of variation within its numerous species. Hence, it is very difficult to differentiate the species on the basis of wood anatomy. However, the fossil was found to have maximum similarity with *E. resinifera* Sm. (F.R.I. Slide no. F. 1236) in the shape, size and distribution of the vessels, structure of the xylem rays and fibres, parenchyma pattern and the presence of vasicentric tracheids and tyloses.

As far as we are aware this is the first record of a fossil wood of *Eucalyptus*. Therefore it has been described as a new species *E. dharmendrae*. The specific name is after Dr Dharmendra Prasad, who was of great help to us in the collection of this material.

There are not many references to the occurrence of *Eucalyptus* in fossil state. Berry (1915) had mentioned about 50 fossil records of *Eucalyptus* from the

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**PLATE 1**

1. *Eucalyptus dharmendrae* sp. nov.—Cross section of the fossil wood in low power showing shape, size and distribution of the vessels X 30; slide no. 35882-1.
2. *Eucalyptus paniculata*—Cross section of the modern wood showing similar shape, size and distribution of the vessels X 30.
3. *Eucalyptus dharmendrae* sp. nov.—Magnified cross section of the fossil wood showing oblique pattern of the vessels and the parenchyma distribution. X 80; slide no. 35882-1.
4. *Eucalyptus dharmendrae* sp. nov.—Tangential longitudinal section of the fossil wood showing structure of xylem rays. X 80; slide no. 35882-II. 
5. *Eucalyptus paniculata*—Tangential longitudinal section of the modern wood showing similar structure of xylem rays. X 80.
6. *Eucalyptus dharmendrae* sp. nov.—Radial longitudinal section of the fossil wood showing homocellular xylem rays X 160; slide no. 35882-III.
7. *Eucalyptus dharmendrae* sp. nov.—Magnified vasicentric tracheids of the fossil wood X 325; slide no. 35882-IV.
8. *Tristania confertifolia* sp. nov.—Magnified vasicentric tracheids of the fossil wood X 660; slide no. 35883-II.
Cretaceous and Tertiary deposits of North America, Europe and Asia. A leaf fragment showing affinities with *Eucalyptus* was described as *Eucalyptophyllum oblongifolium* from the Cretaceous of Virginia, U.S.A. (Fontaine, 1889). From India the only record is by Varma (1968) who described a leaf impression, *Eucalyptophyllum raoi*, from the Middle Siwalik beds of Hardwar. Awasthi (1982) considered this finding in the Tertiary of India as highly improbable. However, in the light of the present discovery, the occurrence of *Eucalyptus* in the Neogene flora of India should not be ruled out and deserves a verification.

**Holotype**—B.S.I.P. Museum specimen no. 35882.

**Locality**—Ghughuas (23°7' N 80°37' E) near Shahpur, Madhya Pradesh.

**Horizon**—Deccan Intertrappean beds.

**Age**—Early Tertiary.

**Genus**—*Tristania* R. Br.

*Tristania conforoides* sp. nov.

Pl. 1, fig. 8; Pl. 2, figs 9, 11, 13

**Material**—A single piece of secondary wood measuring 12 cm in length and 8 cm in width.

**Description**—Wood diffuse-porous (Pl. 2, fig. 9). Growth rings absent. Vessels mostly medium-sized, occasionally small to large, t.d. 65-258 μm, r.d. 75-280 μm, almost exclusively solitary, rarely in radial pairs, evenly distributed, 8-16 per sq mm, usually circular to oval when solitary, with flat contact walls when in pairs (Pl. 2, fig. 9); vessel members 250-900 μm long with transverse to oblique ends; perforations simple; vessel-tracheid pits 1-2 seriate, bordered, opposite to alternate, small, about 4 μm in diameter, circular to oval in shape with linear apertures (Pl. 1, fig. 8); tyloses occasionally present. Tracheids vasicentric, forming a thin sheath around most of the vessels. Parenchyma apotracheal appearing scanty diffuse (Pl. 2, fig. 9); parenchyma cells thin-walled, 16-20 μm in diameter and 48-64 μm in length. Xylem rays closely spaced, 8-11 per mm, usually uniseriate, sometimes biseriate, made up of procumbent cells only, 24.52 μm in width and 6-26 cells or 82-430 μm in height (Pl. 2, fig. 11); ray tissue homogeneous (Pl. 2, fig. 13); ray cells thin-walled, 34-56 μm in radial length and 12-20 μm in tangential height. Fibres semi-libriform with big lumen, polygonal in cross section, non-septate, 8-12 μm in diameter and 300-775 μm in length (Pl. 2, figs 9, 11).

**Affinities**—Presence of almost exclusively solitary vessels, diffuse parenchyma, usually uniseriate xylem rays, non-septate fibres and vasicentric tracheids are the important anatomical characters of the fossil wood, which indicate its affinities with the family Myrtaceae (Pearson & Brown, 1932; Metcalfe & Chalk, 1950; Kribs, 1959; Normand, 1960; Miles, 1978). Amongst the various genera of Myrtaceae the fossil wood shows maximum resemblance with *Xanthostemon* F. Muell. and *Tristania* R. Br. in distribution of vessels, parenchyma pattern, structure of the fibres and presence of usually uniseriate xylem rays (Kribs, 1959; Miles, 1978). However, in *Xanthostemon* and some species of *Tristania*, the xylem rays are heterogeneous as against the homogeneous xylem rays of the present fossil wood (Metcalfe & Chalk, 1950, p. 627; Kribs, 1959, p. 127; Miles, 1978, p. 159). Consequently, the affinities of the fossil wood should be traced among those species of *Tristania* which possess homogeneous xylem rays. Three such species of *Tristania*, viz., *T. conferta* R. Br., *T. laurina* R. Br. and *T. suaveolens* Sm. were available for study. After a detailed comparison it was found that the fossil wood is very close to *T. conferta* (B. S. I. P. slide nos. 919, 1214, 762; Pl. 2, figs 10, 12) in almost all the anatomical characters.

This is the first record of a fossil wood of *Tristania* and hence has been placed under a new species, *T. conforoides*, indicating its close resemblance with modern *T. conferta*.

Fossil records of the genus *Tristania* are very few. *Tristania*-like fruits have been described as *Tristanites* by Saporta (1865) who described its infructescence as *T. cloeziaeformis* from the Tertiary of Armissan, France (Andrews, 1970). Fruits resembling *Tristania* are also

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**PLATE 2**

9. *Tristania conforoides* sp. nov.—Cross section of the fossil wood showing shape, size and distribution of the vessels. × 30; slide no. 35883-I.

10. *Tristania conferta*—Cross section of the modern wood in low power showing similar shape, size and distribution of the vessels. × 30.

11. *Tristania conforoides* sp. nov.—Tangential longitudinal section of the fossil wood showing structure of the xylem rays and fibres. × 80; slide no. 35883-I.

12. *Tristania conferta*—Tangential longitudinal section of the modern wood showing similar structure of the xylem rays and fibres. × 80.

13. *Tristania conforoides* sp. nov.—Tangential longitudinal section of the fossil wood showing homocellular xylem rays. × 125; slide no. 35883-III.

14. *Calistemonoxylon deccanensiss* gen. et sp. nov.—Cross section of the fossil wood showing shape, size and distribution of the vessels. × 40; slide no. 35884-I.

15. *Melaleuca quinqueverna*—Cross section of the modern wood showing similar shape and distribution of the vessels. × 40.

16. *Calistemonoxylon deccanensiss* gen. et sp. nov.—Radial longitudinal section of the fossil wood showing heterocellular rays. × 80; slide no. 35884-III.

17. *Calistemonoxylon deccanensiss* gen. et sp. nov.—Magnified vasicentric tracheids of the fossil wood. × 325; slide no. 35884-III.
known from the Miocene of Australia (Berr, 1915, p. 490). Deane (1902, 1923) has also described *Tristanites angustifolia* as well as leaves resembling *Tristania* from the Tertiary of Australia (Andrews, 1970).

**Holotype**—B. S. I. P. Museum specimen no. 35883.

**Locality**—Umaria (23° 6' N 80° 38' E) near Shahpura, Madhya Pradesh.

**Horizon**—Deccan Intertrappean beds.

**Age**—Early Tertiary.

**Genus**—*Callistemonoxylon* gen. nov.

**Callistemonoxylon deccanensis** sp. nov.

Pl. 2, figs 14, 16, 17; Pl. 3, fig. 18

**Material**—A piece of secondary wood measuring about 10 cm in length and 6 cm in width.

**Description**—Wood diffuse-porous (Pl. 2, fig. 14). *Growth rings* absent. Vessels small to large-sized, t.d. 60-250 µm, r.d. 80-215 µm, almost always solitary, very rarely in radial and tangential pairs, evenly distributed, 15-25 per sq mm, circular to oval, sometimes variously shaped (Pl. 2, fig. 14); vessel members 190-525 µm long with oblique to transverse ends; perforations simple; vessel tracheids 1-2 seriate, bordered, alternate, about 6-8 µm in diameter, circular to oval in shape (Pl. 2, fig. 17); tyloses rarely present. *Tracheids* vasicentric forming a thin sheath around the vessels. *Parenchyma* scanty paratraceal (Pl. 2, fig. 14); parenchyma cells thin walled, 50-84 µm in length and 16-25 µm in diameter. *Xylem rays* 1-3 (rarely 4) seriate, 7-10 mm; ray tissue heterogeneous (Pl. 2, fig. 16); rays of two types, (a) uniseriate rays made up of upright cells only, 8-12 µm in width and 1-8 cells or 45-290 µm in height, (b) multiseriate rays made up of procumbent cells in the central portion and 1-4 rows of upright cells at one or both the ends, 16-34 µm in width and 8-24 cells or 240-856 µm in height (Pl. 3, fig. 18); sheath cells occasionally present; ray to ray fusion observed; ray cells thin-walled, procumbent cells 28-64 µm in radial length and 12-21 µm in tangential height; upright cells 16-30 µm in radial length and 54-85 µm in tangential height (Pl. 2, fig. 16). *Fibres* semi-libriform, oval to angular in cross section, usually non-septate, occasionally septate, 12-20 µm in diameter and 425-935 µm in length (Pl. 2, fig. 14; Pl. 3, fig. 18).

**Affinities**—The important anatomical characters of the fossil wood, viz., almost exclusively solitary vessels, vasicentric tracheids, scanty paratracheal parenchyma and narrow to moderately broad, heterogeneous xylem rays, indicate its affinities with the family Myrtaceae (Pearson & Brown, 1932; Metcalfe & Chalk, 1950; Kribs, 1959; Miles, 1978; Purkayastha, Shahi & Taneja, 1982). A detailed comparison of the present fossil with various genera of Myrtaceae from their wood slides, published descriptions and figures (Metcalfe & Chalk, 1950, pp. 624-628, figs 140-141; Kribs, 1959, pp. 122-127, figs 263-275, 439; Miles, 1978, pp. 153-159; Purkayastha, Shahi & Taneja, 1982, pp. 1-17, figs 559-584) indicates that its affinities should be traced amongst various species of *Callistemon* R. Brown and *Melaleuca* L.

Thin sections of eight species of *Callistemon* and 16 species of *Melaleuca* were studied and it was found that it is not possible to distinguish these two genera anatomically. A detailed comparison of the fossil wood with all the available species of both these genera indicates that its closest affinities are with two species of *Melaleuca, M. quinquenervia* (Cav.) S. T. Blake and *M. linearifolia* Sm. However, our fossil differs from *M. quinquenervia* in the structure of xylem rays which are comparatively narrower in the modern species. On the other hand *Melaleuca linearifolia* shows closer proximity in having similar rays but it differs from the fossil in having apotracheal parenchyma and comparatively smaller vessels.

As it is not possible to differentiate the genera *Callistemon* and *Melaleuca* on the basis of wood anatomy, a new organ genus *Callistemonoxylon* has been constituted to include fossil woods of both these genera and the fossil has been assigned to it. Its specific name *C. deccanensis* indicates its occurrence in the Deccan Intertrappean flora.

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**PLATE 3**

18. *Callistemonoxylon deccanensis* gen. et sp. nov.—Tangential longitudinal section of the fossil wood showing structure of the xylem rays and fibres × 90; slide no. 35884-II.

19. *Melaleuca quinquenervia*—Tangential longitudinal section of the modern wood showing similar structure of the xylem rays and fibres × 90.

20. *Callistemonites indicus* gen. et sp. nov.—Fossil infructescence 1 under reflected light showing shape, size and arrangement of the fruits × 1; specimen no. 35885.

21. *Callistemonites indicus* gen. et sp. nov.—Fossil infructescence 2 under reflected light showing shape, size and arrangement of the fruits × 1; specimen no. 35885.

22. *Callistemonites indicus* gen. et sp. nov.—Fossil infructescence 3 under reflected light showing shape, size and arrangement of the fruits × 1; specimen no. 35885.

23. *Melaleuca lanceolata*—Infructescence of the modern plant showing similar shape, size and arrangement of the fruits × 1.

24. *Callistemon lanceolatus*—Infructescence of the modern plant showing similar shape, size and distribution of the fruits × 1.
GENERIC DIAGNOSIS

*Callistemonoxyon* gen. nov.

Wood diffuse-porous. Growth rings usually absent or indistinct, demarcated by denser zone of fibres. Vessels small to large-sized, usually exclusively solitary, very rarely in radial or tangential pairs; perforations simple. *Tracheids* vasicentric. *Parenchyma* scanty paratracheal. Xylem rays 1-4 seriate; ray tissue heterogeneous. Fibres libriform to non-lirmiform, septate or non-septate.

Genotype—*Callistemonoxyon deccanensis* sp. nov.

SPECIFIC DIAGNOSIS

*Callistemonoxyon deccanensis* sp. nov.

Wood diffuse-porous. Growth rings absent. Vessels small to large-sized, t.d. 60-250 µm, r.d. 80-215 µm, usually exclusively solitary, rarely in radial or tangential pairs, 15-25 per sq mm; tyloses rarely present; vessel members 190-525 µm long with oblique to transverse ends; perforations simple; vessel-tracheid pits 1-2 seriate, bordered, alternate, about 6-8 µm in diameter, circular to oval in shape. *Parenchyma* scanty paratracheal. Xylem rays 1-3 (rarely 4) seriate, 7-10 mm per mm; ray tissue heterogeneous, uniseriate rays made up of upright cells, multisieriate rays made up of procumbent cells in the central portion and 1-4 rows of upright cells at one or both the ends. Fibres semi-libriform, oval to angular in cross section, mostly non-septate, occasionally septate, 12-20 µm in diameter and 425-935 µm in length; interfibre pits could not be seen.

Holotype—B. S. I. P. Museum specimen no. 35884.

Locality—Ghughua (23°7'N 80°37'E) near Shahpura, Madhya Pradesh.

Horizon—Deccan Intertrappean beds.

Age—Early Tertiary.

Genus—*Callistemonites* gen. nov.

*Callistemonites indicus* gen. et sp. nov.

Pl. 3, fgs 20-22

Material—The material consists of two chert pieces, one of them bearing two and the other with three incomplete infuscences. Transverse and longitudinal sections of some of the fruits were prepared to study their internal structure but due to poor preservation no anatomical details were available. This study is, therefore, based only on the external morphological characters.

Description—The infuscences are 4-12 cm in length and 1-2 cm in diameter, made up of 6-34 small fruits (Pl. 3, fgs 20-22). The fruits are sessile and usually spirally arranged giving the appearance of a spike. They are mostly ovoid, measuring 8/4 mm in size. A cup-shaped perianth encloses each fruit to most of its length with a circular to truncate opening about 2-3 mm in diameter near the apex.

Affinities—The important morphological characters of the fossil are spike-like infuscences consisting of a number of fruits enclosed by persistent, cup-shaped perianth. These features are found in both the monocotyledons and dicotyledons and show affinities of the fossil with the families Bromeliaceae and Burmanniaceae of monocotyledons and Phytolaccaceae, Basellaceae, Lauraceae, Lythraceae, Myrtaceae, Plumbaginaceae, Smplocaceae and Plantaginaceae amongst the dicotyledons (Hooker, 1872-1897; Lawrence, 1964; Hutchinson, 1979). After going through the various genera belonging to these families at the Herbaria of the Forest Research Institute, Dehradun and National Botanical Research Institute, Lucknow, it was found that the fossil infuscence shows close resemblance with that of *Callistemon* R. Br. and *Melaleuca* L. of Myrtaceae. Ten species of *Callistemon* and 17 species of *Melaleuca* were examined in detail and it was found that fruits of both *Callistemon* and *Melaleuca* are almost identical and it is not possible to separate them from each other (N. B. R. I. Herbarium Sheet nos. 41318, 20258, 72405, 72452) on the basis of external morphology. However, the present fossil shows maximum similarities with the infuscences of *Callistemon brachyandrus* Lindl., *C. lanceolatus* DC., *C. paludosa* R. Br., *C. salignus* DC., *Melaleuca gibbosa* Labill., *M. glicerata* F. Mueller., *M. leucadendron* Linn., *M. styphelioides* Sm. and *M. uncinata* R. Br. especially in shape, size and arrangement of the fruits (Pl. 3, fgs 23, 24).

As the present fossil shows close affinities with *Callistemon* and *Melaleuca* whose infuscences can not be differentiated, it has been placed under a new organ genus *Callistemonites* which stands for the fossil infuscences of both *Callistemon* and *Melaleuca*. The species has been named as *Callistemonites indicus* indicating its occurrence in the Indian strata.

As far as the authors are aware, *Melaleuca* is not known in the fossil state, whereas *Callistemon* has been identified in both the Upper Cretaceous and the Tertiary of Europe. According to Berry (1915) not less than 25 fossil species have been referred to the genus *Callistemophyllum* Ettingshausen. These include Upper Cretaceous forms in both America and Europe, Eocene or Oligocene forms from Greenland, and numerous Oligocene and Miocene species in Europe and Australia.

GENERIC DIAGNOSIS

*Callistemonites* gen. nov.

Spine-like infuscence made up of a number of ovoid, small fruits enclosed by persistent, cup-shaped perianth.

Genotype—*Callistemonites indicus* sp. nov.
SPECIFIC DIAGNOSIS

*Callistemonites indicus* sp. nov.

Incomplete spike-like inflorescence, 4.12 cm in length and 1.2 cm in diameter, made up of 6-34, small fruits. Fruits spirally arranged, ovoid in shape measuring 8/4 mm in size and enclosed by persistent, cup-shaped perianth. Each fruit has a circular to truncate opening at the apex measuring 2.3 mm in diameter.

*Holotype*—B. S. I. P. Museum specimen no. 35885.

*Paratype*—B. S. I. P. Museum specimen no. 35886.

*Locality*—Ghughua (23°7′N 80°37′E) near Shahpura, Madhya Pradesh.

*Horizon*—Deccan Intertrappean beds.

*Age*—Early Tertiary.

DISCUSSION

Ever since the discovery of *Rodeites dakshini* Sahni (1943) and *Cyclanthodendron sahini* (Rode) Sahni & Surange (1944, 1953) the possible occurrence of plant taxa belonging to the Gondwanaland continents other than India, has been suspected in the Deccan Intertrappean flora. While *Rodeites* shows affinities with *Regnellidium*, a water fern of Brazil, *Cyclanthodendron* has been said to possess affinities with the tropical American family Cyclanthaceae. Like the Central and South American forms, the presence of tropical African element in the Deccan Intertrappean flora is evidenced by a fossil fruit comparable with the branched palm *Hyphaene* from Ghughua (Bande, Prakash & Ambwani, 1982). Although one species of this palm *Hyphaene indica* does grow along the western coast in India, all the other 40 species of this genus are distributed in tropical and subtropical Africa and Arabia. Similarly, the occurrence of a palm wood (from the same locality—Ghughua) resembling *Chrysalidocarpus*, a genus presently growing in Madagasgar is a further evidence in the same direction (Ambwani & Prakash, 1983).

*Araucariaceae* is supposed to be a southern hemisphere family (Sporne, 1971). It is represented in the Deccan Intertrappean flora as a cone as well as a petrified wood (Prakash, 1957, 1962; Lakhanpal, Prakash & Bande, 1977). This is yet another evidence of the occurrence of some common plant taxa in India and other Gondwanaland continents during the Early Tertiary.

With this background it should not be surprising to find in the Deccan Intertrappean flora also an element from Australia, another continent belonging to the Gondwanaland. However, its occurrence in these beds deserves a critical analysis.

Although plantations of *Eucalyptus* are a common sight at present in various parts of the country, phyogeographically the genus is not indigenous to India. It was introduced in this country in the late 18th Century (Gamble, 1972). The genus consisting of about 500 species is mainly distributed in Australia.
The other genus *Tristania* comprises trees or tall shrubs, of which about 50 species are distributed in Malaysia, Queensland, New Caledonia, Australia, Fiji, Burma and India. However, *Tristania conferta* with which the fossil wood described in this paper shows affinity is found in North Australia, Queensland and New South Wales (Bentham, 1866; Santapau & Henry, 1973; Willis, 1973).

The third genus, *Melaleuca* is also a tropical form consisting of about 100 species of trees and shrubs which occur in Australia and the Pacific (Bentham, 1866; Willis, 1973). Only one species *M. leucadendron* is found in the Indian subcontinent. However, *M. linariifolia* and *M. quinquenervia*, with which the fossil wood described here shows close resemblance, are confined to Australia.

Lastly, the genus *Callistemon* with which the fruiting axis described in the previous page shows resemblance is also a tropical genus of about 25 species of tall shrubs or small trees distributed in Australia and New Caledonia (Bentham, 1866; Willis, 1973). Thus the finding of all these Australian taxa in the Deccan Intertrappean beds of Mandla District furnishes a definite evidence for the occurrence of some common plants in India and Australia during the early Tertiary times when these beds were deposited.

The study of the Mesozoic and Cenozoic palaeocontinental maps given by Smith and Briden (1979) indicates that as late as mid-Cretaceous (100 million years back) India and Australia were situated roughly at the same latitudes and interconnected through Antarctica (Map 1). In their revised reconstruction of the southern continents Barron, Harrison and Hay (1978) have even suggested that the north eastern tip of India lay in direct contact with Australia (Map 2).

*Map 2—Position of India, Antarctica and Australia showing direct connections of the Indian Plate with the Australian Plate (after Barron, Harrison & Hay, 1978).*

*Map 3—Position of the Indian Plate 80 million years ago (after Smith & Briden, 1979).*
Whether we accept the position of India, Australia and Antarctica as suggested by Smith and Briden or by Barron, Harrison and Hay, it is apparent that during the Late Cretaceous or even a little later India and Australia must have enjoyed a similar type of climate permitting the existence of some common plant taxa. A study of the palaeocontinental maps of successive ages shows that Late Cretaceous onwards India started its northward journey towards Asia. Subsequently, this resulted in an entirely different latitudinal position for India in comparison to Australia, and a consequent change of climatic conditions ultimately leading to the extinction of Australian taxa from India.

The occurrence of Myrtaceous genera in the Deccan Intertrappean flora raises another point which needs consideration. Myrtaceae is considered to be one of the most primitive families of the dicotyledons with an advancement index of 27 (Sporne, 1977). Long ago, Berry (1915) suggested that America was the original home of the family. However, in the light of present finding Berry's statement needs critical analysis. Obviously, further studies are needed to throw more light on the origin and diversification of this family.

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