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LEGUMINOUS WOODS FROM THE TERTIARY OF DISTRICT KACHCHH, GUJARAT, WESTERN INDIA

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ABSTRACT

The paper deals with eight fossil leguminous woods representing the modern woods of *Albizia*, *Afzelia-Intsia*, *Cynometra*, *Dialium*, *Isoberlinia* and *Millettia-Pongamia*. They have been reported for the first time from the Tertiary (Pliocene?) of district Kachchh. The first two genera are represented by two species each and the remaining by a single species. Among these, *Dialium* and *Isoberlinia* have been reported for the first time from India. The occurrence of tropical African genus *Isoberlinia* is phytogeographically important as it indicates the possibility of migration of some of the African and Arabian elements in the Indian flora.

Key-words — Xylotomy, *Albizinium*, *Cynometroxylon*, *Dialiumoxylon*, *Isoberlinioxylon*, *Millettioxylon*, *Pahudioxylon*, Kachchh, Pliocene? (India).

सारांश

गुजरात (पश्चिमी भारत) में कच्छ जनपद से प्राप्त तृतीयक युगीन लैगुमिनोसीय काष्ठाश्म – जसवंत सिंह गुलेरिया

इस शोध-पत्र में एल्बीजिया, ऑफ्जीलिआ-इन्टसिआ, सायनोमेट्रा, डाएॅलियम्, आइसोबर्लीनिया एवं मिलॅट्टिआ-पोंगॅमिआ की वर्तमान काष्ठों से निरूपणीय आठ लैगुमिनोसीय काष्ठाश्मों का वर्णन किया गया है। ये काष्ठाश्म कच्छ जनपद के तृतीयक (अतिनूतन ?) युग से पहली बार अभिलिखित किये गये हैं। पहले दो वंश दो-दो जातियों से निरूपित तथा अन्य प्रत्येक वंश एक जाति से निरूपित है। इनमें से डाएॅलियम् तथा आइसोबर्लीनिया का भारत से पहली बार वर्णन किया गया है। उष्णकटिबंधीय अफ्रीकी वंश, आइसोबर्लीनिया, की प्राप्ति पादप-भौगोलिक दृष्टि से महत्वपूर्ण है क्योंकि इससे भारतीय वनस्पति में कुछ अफ्रीकी एवं अरबी तत्वों के अभिगमन की संभावना व्यक्त होती है।

INTRODUCTION

So far only a few fossil woods are known from the Tertiary (Kankawati Series) of Kachchh. These are *Podocarpoxylon kutchensis* of Podocarpaceae (Lakhanpal *et al.*, 1975); *Dipterocarpoxylon malavii* and *D. pondicherriense* of Dipterocarpaceae (Ghosh & Ghosh, 1959; Guleria, 1983); *Pterospermoxylon kutchensis* (Awasthi *et al.*, 1980) and *Sterculinium kalagarhense* (Guleria, 1983) of Sterculiaceae; *Euphorioxylon indicum* and *Schleicheroxylon kachchhensis* of Sapindaceae (Awasthi *et al.*, 1982); *Terminalioxylon felixii* and *T. burmense* of Combretaceae and *Palmoxylon kachchhensis* of Palmae (Guleria, 1983). Thus it is obvious that no leguminous wood has yet been recorded from the Kankawati Series of Kachchh which according to Biswas and Raju (1973) is of probable Pliocene age. But the occurrence of Leguminosae in the Lower Miocene megaflora of Kachchh has already been recorded by Lakhanpal and Guleria (1982). The assemblage consists of *Bauhinia*, *Cassia*, *Millettia* and a large number of small legume leaflets and pods. This family is still unreported in the Eocene megaflora of Kachchh (Lakhanpal & Guleria, 1981; Guleria & Lakhanpal, in press).

SYSTEMATIC DESCRIPTION

Family — Leguminosae
Subfamily — Mimosaceae

Genus — *Albizinium** Prakash, 1975

Albizinium eolebbekianum Prakash, 1975

Pl. 1, figs 1, 2

This species is represented by two small pieces of fairly well-preserved petrified wood.

Topography — Wood diffuse-porous (Pl. 1, fig. 1). *Growth rings* present, delimited by thin lines of terminal parenchyma. *Vessels* medium to large (mostly large), mostly solitary or in radial multiples of 2-3, rarely 4, sometimes forming small clusters, evenly distributed, about 3-6 per sq mm, tyloses not seen; vessels sometimes filled with gummy material; round to oval in cross section (Pl. 1, fig. 1), t.d. 120-480 μm, r.d. 220-480 μm, wall 4-6 μm thick; vessel members 160-360 μm long with truncated ends; perforations simple; intervessel pits oval to elliptical, 4-8 μm in diameter, bordered, alternate, vestured. *Parenchyma* paratracheal and apotracheal (Pl. 1, fig. 1); paratracheal parenchyma forming narrow sheaths round the vessels, vasicentric, mostly aliform with very short extensions, sometimes aliform-confluent due to aggregation of vessels; apotracheal parenchyma represented by thin terminal lines of 1-3 cells wide; parenchyma cells round, oval to elliptical in cross section, thin-walled, t.d. 16-24 μm; crystalliferous parenchyma strands containing solitary crystals in each chamber. *Xylem rays* 1-5 (mostly 3-4) seriate (Pl. 1, fig. 2) or 12-100 μm broad, 6-9 rays per mm; ray tissue homogeneous; rays homocellular, consisting of procumbent cells, 3-25 cells or 48-360 μm high; elongated, tangential height 12-32 μm and radial length 40-100 μm, infiltration dark. *Fibres* aligned in radial rows, circular to oval in cross section, t.d. 12-20 μm, wall 4-6 μm thick, septate, fibre length 40-100 μm, interfibre pits present, simple, round to oval, 2-4 μm in diameter.

*Originally spelt as *Albizzinium* which is now spelt as *Albizinium*.

AFFINITIES

The above characters collectively indicate that the fossil belongs to the genus *Albizia* Durazz. The present fossil agrees in all its features with the extant wood of *Albizia lebbek* Benth.

So far only two species of *Albizinium* are known, viz., *A. eolebbekianum* Prakash (1975) and *A. pondicherriensis* Awasthi (1979). The former has been reported from Himachal Pradesh, Burma, Arunachal Pradesh and West Bengal by Prakash (1975), Prakash and Bande (1980), Lakhanpal *et al.* (1981) and Ghosh and Roy (1981) respectively. The latter has been reported from near Pondicherry by Awasthi (1979). Prakash and Barghoorn (1961) described a fossil wood as *Albizia vantagiensis* from the Miocene beds of Columbia Basalt, U.S.A. which has, however, been transferred to *Tetrapleuroxylon* by Müller-Stoll and Mädel (1967, p. 117). In addition, Greguss (1969, pp. 50, 51) described a fossil wood *Albizzioxylon hungaricum* from the Tortonian (Mid-Miocene) of Hungary which he thought to be comparable to the genus *Acacia*. However, due to the occurrence of septate fibres in the fossil he named it as *Albizzioxylon*. As the fibres in *Acacia* woods are non-septate (Pearson & Brown, 1932, p. 438; Metcalfe & Chalk, 1950, p. 485; Ramesh Rao & Purkayastha, 1972, pp. 6, 8, 12), this wood cannot be compared with *Acacia*; obviously it represents the fossil wood of *Albizia*. Since the fossil woods of *Albizia* are now named as *Albizinium* Prakash (1975), the author has taken this opportunity to rename *Albizzioxylon hungaricum* Greguss as *Albizinium hungaricum* (Greguss) comb. nov. Out of the known *Albizinium* species, the present wood shows close similarity with *Albizinium eolebbekianum* Prakash (1975) and hence it is placed under the same.

Albizia lebbek Benth. occurs throughout India, ascending up to 1,200 m in Himalaya and is common in the Andamans (Ramesh Rao & Purkayastha, 1972, p. 36).

Specimen — B.S.I.P. Specimen nos. 36017 and 36018.

Locality — Mothala, about 66 km WWS of Bhuj on the Bhuj-Naliya Road and Dhaneti, 24 km east of Bhuj on the Bhuj-Bhachau Road, district Kachchh, Gujarat.

Horizon — Kankawati Series.

Albizinium pondicherriensis Awasthi, 1979

Pl. 1, figs 3, 4

This species is represented by a single piece of well preserved petrified wood measuring 30 cm long and 15 cm in diameter.

Topography — *Wood* diffuse-porous (Pl. 1, fig. 3). *Growth rings* delimited by inconspicuous lines of parenchyma and thick-walled fibres. *Vessels* small to large, usually medium, mostly solitary or in multiples of 2-3, rarely in 4, sometimes forming small clusters, evenly distributed, about 3-6 vessels per sq mm, tyloses not seen; empty or filled with gummy material (Pl. 1, fig. 3); round to oval in cross section, t.d. 60-270 μm, r.d. 60-320 μm, wall 4 μm thick; vessel-members 120-300 μm in height with truncated ends; perforations simple; intervessel pits round to oval, about 4-6 μm in diameter, bordered, alternate, vestured. *Parenchyma* paratracheal and apotracheal; paratracheal parenchyma vasicentric, mostly aliform to aliform-confluent, aliform extensions moderate (Pl. 1, fig. 3), occasionally enclosing 2(3) vessels; apotracheal parenchyma represented by thin terminal lines of 1-2 cells wide; parenchyma cells polygonal in cross section, thin-walled; crystalliferous strands rare containing solitary crystals in each chamber. *Xylem rays* fine, 1-2 to rarely 3-seriate and 12-32 μm (mostly 20 μm) broad, 10-15 rays per mm; ray tissue homogeneous; rays homocellular, consisting of procumbent cells, short 3-20 cells or 60-360 μm high (Pl. 1, fig. 4); ray cells thin-walled, tangential height 8-16 μm, radial length 40-120 μm, filled with dark contents. *Fibres* aligned in radial rows, polygonal in shape, 4-6 μm thick, 8-20 μm in diameter, septate, interfibre pits not seen.

Affinities

The anatomical characters enumerated above indicate its similarity with the woods of *Albizia*, particularly *A. amara* Boivin and *A. odoratissima* Benth. In size, shape and number of rays the fossil resembles *Albizia amara* whereas *A. odoratissima* shows closest similarity with the fossil in the size of vessels. Thus, the present fossil combines the characters of both *A. amara* and *A. odoratissima*. The fossil wood is also closely comparable in all its characters (except for some slight differences in the size of vessels which may be due to variation) with the known species *Albizinium pondicherriensis* Awasthi (1979) described from South India near Pondicherry. Hence, it is placed under the same species.

Albizia amara, a moderate sized deciduous tree, occurs in the dry forests of the Indian Peninsula from Khandesh in west to Vishakhapatnam in the east, extending southwards to dry places in the west coast up to 900 m and also in Sri Lanka (Ramesh Rao & Purkayastha, 1972, p. 34). *A. odoratissima* is a large tree distributed throughout India ascending to 1,500 m in the sub-Himalayan tract. It is common in both the dry and deciduous forests of Siwaliks, Ajmer, Mewar and Konkan. Further, it is frequently seen on grasslands and in open forests throughout Travancore up to 900 m (Ramesh Rao & Purkayastha, 1972, pp. 37, 38).

Specimen — B.S.I.P. Specimen no. 36019.

Locality — Dhaneti, about 24 km east of Bhuj, on the Bhuj-Bhachau Road, district Kachchh, Gujarat.

Horizon — Kankawati Series.

Subfamily — Caesalpiniaceae

Genus — *Pahudioxylon* Chowdhury, Ghosh & Kazmi, 1960

Pahudioxylon sahnii Ghosh & Kazmi, 1961

Pl. 3, figs 13, 14

Topography — *Wood* diffuse-porous (Pl. 3, fig. 13). *Growth rings* present, delimited by fine lines of apotracheal parenchyma. *Vessels* small to large (mostly medium), mostly solitary or in multiples of 2-4, evenly distributed, 4-6 per sq mm, occasionally filled with dark contents (Pl. 3, fig. 13), round to oval in cross section, t.d. 60-220 μm, r.d. 40-320 μm, wall about 4 μm thick, vessel members 180-420 μm in height with truncated ends; perforations simple, intervessel pits alternate, oval to slightly elliptical or polygonal, 4-10 μm in diameter, vestured. *Parenchyma* paratracheal, vasicentric, mostly aliform, sometimes aliform-confluent (Pl. 3, fig. 13), apotracheal parenchyma forming narrow lines 1-3 cells in

width; parenchyma cells round or oval to elliptical in cross section, 16-32 μm in diameter, 80-140 μm in length, thin-walled, crystalliferous strands occasionally present with several locules containing solitary crystals. *Xylem rays* fine, 1-3 seriate (mostly 2 seriate) or 10-48 μm (usually 20-30 μm) wide, 3-25 cells or 72 to 380 μm (average 240-280 μm) high, 10-13 rays per mm; showing tendency towards storied arrangement (Pl. 3, fig. 14); ray tissue homogeneous; rays homocellular, consisting of procumbent cells (Pl. 3, fig. 14); ray cells thin-walled, 8-20 μm in vertical height. *Fibres* aligned in radial rows, circular or oval to angular in cross section, thick-walled, 8-16 μm in diameter, nonseptate, interfibre pits not seen.

Affinities

The fossil wood shows close similarity with the woods of *Afzelia* Sm. and *Intsia* Thou. (Metcalfe & Chalk, 1950, pp. 476-535; Ramesh Rao & Purkayastha, 1972, pp. 63, 64, 84, 85). These genera are, however, indistinguishable xylotomically.

In 1960, Chowdhury *et al.* established the genus *Pahudioxylon* for the fossil woods showing similarity with that of *Pahudia* Miq. Since *Pahudia* has already been merged with *Afzelia* by Léonard (1950), Prakash (1966a, p. 231) redefined the genus *Pahudioxylon* to include the fossil woods of *Afzelia* and *Intsia*. Prakash *et al.* (1967) listed *Pahudioxylon* species known till then. At present, there are 13 species of *Pahudioxylon* known from the Tertiary of India and abroad. These are *Pahudioxylon bankurensis* Chowdhury *et al.* (1960) from West Bengal; *P. sahnii* Ghosh & Kazmi (1961) from Tripura, Burma, Thailand (Prakash, 1973, 1979a), Pondicherry (Awasthi, 1975b) and Indonesia (Kramer, 1974); *P. arcotense* Navale (1963) from Pondicherry; *P. deomaliense* Prakash (1965) from NEFA; *P. assamicum* Prakash & Tripathi (1975) from Assam and *P. indicum* Prakash (1979b) from Himachal Pradesh. From outside India (in addition to *P. sahnii* mentioned above) are *P. afzelioides* (Boureau) Prakash *et al.* (1967) from the Tertiary of South Anam, Indo-China; *P. irregulare* (Felix) Müller-Stoll & Mädel (1967) from the ?Tertiary of Antigua; *P. pannonicum* (Felix) Müller Stoll & Mädel (1967) from Hungary; *P. kiliani* (Louvet) Prakash *et al.* (1967) from the Tertiary of Algeria; *P. wilkitii* Lemoigne & Beauchamp (1972) from the Miocene of Ethiopia; *P. paracochinchinense* from the Neogene of South Vietnam Vozenin-Sera (1981) and *P. bengalensis* Ghosh & Roy (1982) from the Miocene of West Bengal. Besides, Koeniguer (1973) and Lemoigne *et al.* (1974) described two fossil woods, viz., *Afzelioxylon furoni* and *A. aethiopicum* from the Neogene of Tchad and Ethiopia respectively. These fossils are being renamed as *Pahudioxylon furoni* (Koeniguer) comb. nov. and *P. aethiopicum* (Lemoigne *et al.*) comb. nov. respectively, since all the fossil woods resembling *Afzelia* and *Intsia* are placed under the genus *Pahudioxylon*. It is to be pointed out here that all these species of *Pahudioxylon* need critical re-examination as quite a few are likely to merge into one another. Out of all these, *P. sahnii* shows the closest similarity with the fossil in having mostly 2 seriate rays and also in all other anatomical details. Hence, the present fossil is assigned to it.

The genus *Afzelia* Sm. consists of 14 species distributed in tropical Africa and Asia (Willis, 1973, p. 30), whereas *Intsia* Thou. comprises 9 species found in offshore islands of tropical East Africa, Madagascar and tropical Asia (Willis, 1973, p. 593). In India only *Afzelia bijuga* A. gray [*Intsia bijuga* (Colebr.) O. Ktze.] and *Afzelia retusa* Kurz are found. *Afzelia bijuga* occurs in the tidal forests of Bengal, Andaman islands and Burma while *Afzelia retusa* is found in the coast forests of Sunderbans and the Andamans (Gamble, 1902, p. 280).

Locality — Dhaneti, about 24 km east of Bhuj on the Bhuj-Bhachau Road, district Kachchh, Gujarat.

Horizon — Kankawati Series.

Pahudioxylon assamicum Prakash & Tripathi, 1975

Pl. 2, figs 11, 12

This species is represented by a large number of fairly well-preserved pieces of silicified woods.

Topography — Wood diffuse-porous (Pl. 2, fig. 11). *Growth rings* present, delimited by terminal parenchyma lines, 2-5 per cm

(Pl. 2, fig. 11). *Vessels* small to large, mostly medium, mostly solitary or in multiples of 2-4, occasionally filled with dark contents (Pl. 2, fig. 11), round to oval in cross section, t.d. 64-220 μm, r.d. 70-280 μm, wall about 4 μm thick, vessel members 160-360 μm in height, usually with truncate ends; perforations simple; intervessel pits alternate, oval to slightly elliptical, 4-8 μm in diameter, vestured. *Parenchyma* paratracheal, vasicentric, mostly aliform, sometimes aliform-confluent, apotracheal parenchyma forming narrow lines of 1-3 cells wide (Pl. 2, fig. 11); parenchyma cells round to oval, 12-24 μm in diameter, 80-160 μm in length, thin-walled, crystalliferous strands occasionally present with several locules containing solitary crystals. *Xylem rays* fine to medium, 1-4 seriate (mostly 3 seriate), rarely 4 seriate or 8-72 μm wide (Pl. 2, fig. 12), 2-30 cells or 66-404 μm (average 15-18 cells or 240-320 μm) in height, 5-8 per mm; occasionally showing tendency towards storied arrangement; ray tissue homogeneous, rays homocellular, consisting of procumbent cells (Pl. 2, fig. 12); ray cells thin-walled, 8-16 μm in vertical height. *Fibres* aligned in radial rows, circular oval or slightly elliptical in cross section, nonlibriform to semilibriform, 8-22 μm in diameter with wide lumen, nonseptate, interfibre pits not seen.

Affinities

The above characters of the fossil wood show that it belongs to *Afzelia-Intsia*. The fossil woods resembling *Afzelia-Intsia* are known by the genus *Pahudioxylon Chowdhury et al.* (1960) and thus the present fossil is also placed under the same. Out of 13 species of this genus known so far (see p. 241), *P. assamicum* Prakash & Tripathi (1975) has been found to be almost identical with the present specimen in all anatomical features, therefore it is placed in the same species.

Specimens — B.S.I.P. Specimen nos. 36020 and 36021.

Localities — Dhaneti, about 24 km east of Bhuj, on the Bhuj-Bhachau Road and Mothala, about 66 km WWS of Bhuj, on the Bhuj-Naliya Road, district Kachchh, Gujarat.

Horizon — Kankawati Series.

Genus — *Cynometroxylon* Chowdhury & Ghosh, 1946

*Cynometroxylon holdenii** (Gupta) Prakash & Bande, 1980

Pl. 2, figs 9, 10

1982 *Cynometroxylon indicum* Ghosh & Roy, p. 53, figs. 7-9.

The material consists of a large number of fairly well-preserved pieces of petrified wood.

Topography — Wood diffuse-porous (Pl. 2, fig. 9). *Growth rings* discernible but not conspicuous. *Vessels* small to medium, solitary and in radial multiples of 2-5 (mostly 2-3), sometimes forming small clusters, uniformly distributed, 7-9 vessels per sq mm; tyloses absent; vessels sometimes filled with dark contents, oval to elliptic in cross section, t.d. 60-140 μm, r.d. 75-180 μm, thick-walled, 4-8 μm in thickness, vessel-members 160-480 μm in height ending slightly obliquely; perforations simple; intervessel pits small, 4-5 μm in diameter, alternate, bordered, vestured, apertures linear to lenticular. *Parenchyma* abundant, in regular concentric bands, alternating with fibre bands of more or less the same width, undulating, often surrounding the vessels, sometimes bands bifurcating and joining adjacent ones, bands 3-9 cells wide, 4-5 per mm (Pl. 2, fig. 9); parenchyma cells circular to oval in cross section, 12-28 μm in diameter and 60-120 μm in height, non-storied. *Xylem rays* 1-4 seriate (mostly 2-3), 6-43 cells and 120-750 μm (often 13-20 cells and 270-380 μm) high, 6-12 rays per mm; ray tissue heterogeneous, rays homocellular to mostly heterocellular, consisting of 1-2 marginal rows of upright or squarish cells at one or both the ends and procumbent in the median portion (Pl. 2, fig. 10); ray cells upright to squarish and procumbent, vertical height of upright or squarish cells 30-44 μm and radial length 20-40 μm, vertical height of procumbent cells 16-25 μm and radial length 60-100 μm; crystals rarely seen, dark gummy infiltration present. *Fibres* almost of the same width as alternating parenchyma bands (Pl. 2, fig. 9), polygonal to angular, 6-20 μm in diameter,

*Prakash and Bande (1980) have spelt the species as *Cynometroxylon holdeni*.

libriform, thick-walled with narrow lumen, 4-6 μm thick, nonseptate, pits not seen.

Affinities

The above characters of the present fossil wood indicate its closest resemblance with the woods of *Cynometra polyandra* Roxb. and *C. ramiflora* Linn. of the family Leguminosae which are anatomically indistinguishable from each other.

The generic name *Cynometroxylon* was first proposed by Chowdhury and Ghosh (1939) to include all the fossil woods of *Cynometra*. Subsequently in 1946, they emended the diagnosis of the genus *Cynometroxylon* to include all the fossil woods of *Cynometra* except *Cynometra alexandri* Wright. Müller-Stoll and Mädel (1967, p. 130) have pointed out that *Cynometra fisheri* Bak. f., *C. hankei* Harms and *C. lujae* De Wild also possess storied arrangement. In addition, *C. hankei* and *C. lujae* possess aliform to confluent parenchyma. Keeping these facts in view they further circumscribed the genus *Cynometroxylon*, which according to them corresponds only with those species of the living *Cynometra* which are anatomically similar to *Cynometra polyandra* Roxb. So far only five species of *Cynometroxylon* are known and these are *C. indicum* Chowdhury & Ghosh (1946), *C. schlagintweitii* Müller-Stoll & Mädel (1967), *C. siwalicus* Trivedi & Ahuja (1978), *C. dakshinense* Navale (1958) and *C. parainaequifolium* Prakash (1979a). However, recently Prakash and Bande (1980) while describing some fossil woods from the Tertiary of Burma reinvestigated the woods of *Dipterocarpoxylon holdenii* Gupta (1935) and found that it belongs to *Cynometroxylon* Chowdhury & Ghosh (1946). Accordingly, they transferred it to *Cynometroxylon* and named *C. holdenii* (Gupta) comb. nov. Since both the woods, *Cynometroxylon holdenii* (Gupta) comb. nov. and *C. indicum* are identical, they considered the latter species as a synonym of the former. In addition, they merged the first three species under the new combination and opined that the fourth does not belong to *Cynometra*. As the present fossil resembles *Cynometroxylon holdenii* Prakash & Bande (1980) in all its characters so it is assigned to the same species. Besides its earlier records (Prakash & Bande, 1980), the species has recently been reported from the Neogene of Kerala Coast and West Bengal (Awasthi & Ahuja, 1982; Ghosh & Roy, 1982).

The genus *Cynometra* Linn. consists of 60 species (Willis, 1973, p. 329) of evergreen trees or shrubs distributed throughout the tropics in the Indo-Malayan region, Phillippines, Australia, Pacific islands, Mexico, Brazil and Africa. Only six species grow in India (Ramesh Rao & Purkayastha, 1972, p. 76) of which *C. cauliflora* Linn. is an introduced species from Malaya. *Cynometra polyandra* is a large evergreen tree found in Cachar, Garo, Lushai and Khasi Hills of Assam in Sylhet and Chittagong. *C. ramiflora* is a small to medium sized tree found in sea coast tidal forests of Sunderbans, South India, Burma, Andamans and Sri Lanka (Gamble, 1902).

Specimens — B.S.I.P. Specimen nos. 36022, 36023 and 36024.

Locality — Dhaneti, about 24 km east of Bhuj, on the Bhuj-Bhachau Road and Mothala, about 66 km WWS of Bhuj, on the Bhuj-Naliya Road, district Kachchh, Gujarat.

Horizon — Kankawati Series.

Genus — **Isoberlinioxylon* Lakhanpal & Prakash, 1970

Isoberlinioxylon congoense Lakhanpal & Prakash, 1970

Pl. 3, figs 15-18

The present description is based on two small pieces of well-preserved woods 10.0 × 2.0 cm and 10.5 × 3.5 cm in length and diameter respectively.

Topography — *Wood* diffuse-porous (Pl. 3, figs 15, 16). *Growth rings* delimited by narrow lines of parenchyma, smaller vessels and thick-walled fibres (Pl. 3, fig. 16). *Vessels* small to large (mostly medium), solitary or in radial multiples of 2-4 (mostly solitary), evenly distributed, 4-6 per sq mm; tyloses not seen; vessels occasionally filled with dark contents (Pl. 3, figs 15, 16), round to oval in cross section, t.d. 75-225 μm (mostly 135-150 μm), r.d.

*Lakhanpal and Prakash (1970) have spelt the genus as *Isoberlineoxylon*.

90-225 μm (mostly 180 μm), wall about 4-6 μm thick, vessel members 160-480 μm (often 200-220 μm) in height with truncated ends; perforations simple; intervessel pits alternate to subopposite, 3-6 μm in diameter, vestured. *Parenchyma* paratracheal and apotracheal, paratracheal parenchyma abundant, vasicentric, aliform (forming prominent halo around the vessels with very short tangential extensions) to confluent; apotracheal parenchyma scanty, diffuse, occasionally seen as shining whitish cells and forming narrow lines of 1-2 cells wide delimiting the growth rings (Pl. 3, figs 15, 16); parenchyma cells round to oval in cross section, 12-40 μm in diameter, 80-200 μm in height, crystalliferous strands occasionally present with single crystal in each locule. *Xylem rays* fine, 1-3 seriate (3-seriate rarely seen), or 10-36 μm wide, 3-28 cells or 50-450 μm (often 200-220 μm) in height, 5-11 per mm; ray tissue homogeneous to weakly heterogeneous; rays homocellular to weakly heterocellular, consisting of procumbent cells and sometimes with a single marginal row of square or upright cells at one or both the ends (Pl. 3, figs 17, 18), upright ray cells 32-44 μm in vertical height, procumbent cells 8-24 μm in vertical height, radial length could not be measured, cells filled with dark contents. *Fibres* aligned in radial rows, round, oval to polygonal in cross section, walls 4-6 μm thick, 4-16 μm in diameter, probably nonseptate (but sometimes septa-like walls seen*), interfibre pits not seen.

Affinities

The important characters shown by the present fossil wood collectively indicate its affinity with the woods of Leguminosae. From the examination of a large number of thin sections of modern woods of Legumin sae and the published literature and photographs (Pearson & Brown, 1932; Moll & Janssonius, 1914; Metcalfe & Chalk, 1950; Normand, 1950; Lebacq, 1957; Kribs, 1959; Rajnesh Rao & Purkayastha, 1972) it was observed that the genus *Isoberlinia* Craib & Stapf. shows the closest similarity with the present fossil and hence it is assigned to the genus *Isoberlinioxylon* Lakhanpal & Prakash (1970). From the published account and photographs of three species of *Isoberlinia*, viz., *I. angolensis* (Welw.) Hoyle & Breman, *I. niembaensis* Duvingn and *I. tomentosa* (Harms) Craib & Stapf. (Lebacq, 1957, pls 79-81) as well as from the thin sections of the first two species available for comparison it was found that the present fossil shows closest resemblance with *I. niembaensis* and *I. angolensis* which are very similar to each other anatomically.

As far as the author is aware, there is only one species of the genus *Isoberlinioxylon*, *I. congoense* described by Lakhanpal and Prakash (1970) from the Miocene of lake Albert, Congo. Except for some minor variable differences the present fossil* resembles in all its xylotomical characters with *Isoberlinioxylon congoense*. Hence, it is placed under the same species.

The genus *Isoberlinia* Craib & Stapf. consists of 6 species which are confined to tropical Africa (Willis, 1973, p. 598). The presence of this genus in India during Pliocene? is important palaeophytogeographically.

Specimens — B.S.I.P. Specimen nos. 36025 and 36026.

Locality — Dhaneti, about 24 km east of Bhuj, on the Bhuj-Bhachau Road, district Kachchh, Gujarat.

Horizon — Kankawati Series.

Genus — *Dialiumoxylon* Lemoigne, 1978

Dialiumoxylon indicum sp. nov.

Pl. 1, figs 5, 6; Pl. 3, fig. 19

The present species is based on a single piece of fairly well-preserved petrified wood.

Topography — *Wood* diffuse-porous (Pl. 1, fig. 5). *Growth rings* not seen. *Vessels* small to medium, solitary as well as in radial multiples of 2-5 (mostly 2-4), rarely more, uniformly distributed, 9-13 vessels per sq mm; tyloses not seen; vessels occasionally filled with gummy material, round to oval in cross section, t.d. 50-140 μm (average

*Septa-like walls also seen sometimes in thin sections of the modern *Isoberlinia* spp.

*Weakly heterocellular rays observed in the duplicate slide no. RG 2249/3 of *Isoberlinioxylon congoense* Lakhanpal & Prakash and sometimes septa-like walls also seen in the fibres.

80 μm), r.d. 56-160 μm (average 120 μm); perforations simple, vessel-members 160-400 μm in length with truncated ends, storied with parenchyma strands and rays; intervessel pits alternate, bordered, vestured, 4-6 μm in diameter. *Parenchyma* in regular concentric bands alternating with relatively broad fibre bands (Pl. 1, fig. 5); parenchyma bands straight to slightly undulating touching or enclosing the vessels, 4-6 bands per mm, each 2-5 (mostly 2-4) cells wide, *parenchyma strands* storied, 4 cells per strand, cells round to oval in cross section, 12-28 μm in diameter, 60-100 μm long, crystalliferous strands present with solitary crystals in each locule. *Xylem rays* fine, 1-3 seriate (mostly biseriate), 16-40 μm wide, 5-17 cells or 120-360 μm in height, storied (Pl. 1, fig. 6), sometimes irregularly storied, 8-11 rays per mm, ray tissue homogeneous, rays homocellular, consisting of procumbent cells only (Pl. 1, fig. 6; Pl. 3, fig. 19). *Ray cells* 10-24 μm in vertical height, radial length could not be measured, dark infiltration present. *Fibres* forming concentric bands alternating with relatively narrow parenchyma bands (Pl. 1, fig. 6), oval to angular in cross section, 6-10 μm in diameter with narrow lumen, thick-walled, wall about 4 μm thick, nonseptate. *Ripple marks* present, visible due to storied arrangement of vessel-segments, parenchyma strands and rays.

Affinities

The important features of the present fossil are: intervessel pits vestured; parenchyma in regular concentric bands, 2-5 (mostly 2-4) cells wide, touching or enclosing the vessels, alternating with relatively broad fibre bands; rays 1-3 seriate (mostly 2 seriate), homocellular, storied, ripple marks traceable due to storied arrangement of xylem rays, vessel segments and parenchyma strands.

All the aforesaid characters are collectively present in the following leguminous woods: *Alexa* Moq., *Bauhinia* Linn., *Craibia* Harms & Dunn, *Cynometra* Linn., *Dialium* Linn., *Geoffroea* Jacq., *Lonchocarpus* Kunth., *Machaerium* Per., *Millettia* Wight & Arn., *Piscidia* Linn., *Pongamia* Vent., *Pterocarpus* Linn., *Schefflerodendron* Harms and *Swartzia* Schreb.

Out of these, *Bauhinia*, *Lonchocarpus*, *Piscidia* and *Pongamia* differ from the present fossil in having broader parenchyma bands. In *Geoffroea*, *Machaerium* and *Pterocarpus* rays are exclusively uniseriate or only occasionally biseriate. In *Alexa* the frequency of vessels is low which is less than 5 vessels per sq mm. Of the various species of *Cynometra*, only *C. alexandri* Wright shows resemblance with the fossil in having banded parenchyma and storied xylem rays. However, in *Cynometra alexandri* the frequency of vessels is more than in the fossil. Two species of *Millettia*, i.e. *M. pulchra* Kurz and *M. drastica* Welw. ex Baker also show similarity with the fossil in possessing narrow parenchyma bands. The former differs in having homo- to heterocellular rays, much bigger vessels and their lesser frequency whereas the latter differs in having relatively broad and distantly placed parenchyma bands (which quite frequently run without touching the vessels) along with much broad fibre bands and in having vessels quite frequently in clusters. *Craibia affinis* (De Wild) De Wild. which possesses the narrow parenchyma bands differs from the present fossil in having very broad zonate fibrous tissue and frequently parenchyma runs without touching the vessels. *Schefflerodendron usambarense* Harms ex Engl. and *S. gilbertianum* Léonard et Latour though show quite close similarity with the fossil yet differ in having aliform to confluent parenchyma and frequently clustered vessels. Further, the frequency of vessels is more in *Schefflerodendron* than in the fossil. Of the different species of *Swartzia*, *S. fistuloides* Harms, *S. cubensis* (Britton & Wilson) Stanley and *S. bannia* Sandw. show apparent resemblance with the present fossil. *S. fistuloides*, however, differs in having bigger vessels, relatively broad parenchyma bands and short rays. *S. bannia* and *S. cubensis* though show close similarity, yet differs in having occasionally aliform to aliform confluent parenchyma. Moreover, diffuse parenchyma is also present in the former.

The genus *Dialium* agrees with the present fossil in almost all its xylotomical characters. To know the nearest modern equivalent of the fossil, thin sections of the woods of *Dialium*, viz., *Dialium excelsum* Louis ex Steyaert, *D. maingayi* Baker, *D. platysepalum* Baker, *D. laurinum* Baker, *D. travan-*

coricum Bourd. and *Dialium* sp. were examined. In addition, published anatomical descriptions and photographs of the woods of *D. angolense* Welw. ex. Oliv., *D. corbisieri* Staner, *D. excelsum* Louis ex. Steyaert, *D. gossweilerii* Aak. f., *D. pachyphyllum* Harms, *D. pantandrum* Louis ex. Steyaert, *D. zenkeri* Harms (Lebacq, 1957, pls 107-113), *D. dinklagei* Harms, *D. guinense* Willd. (Normand, 1950, p. 118, pl. XLIII; Kribs, 1959, pp. 79-80, fig. 407), *D. indum* Linn. (Moll & Janssonius, 1914, pp. 108-112, fig. 157), *D. cochinchinense* Pierre (Lecomte, 1926, pl. XIX) and *D. travancoricum* Bourd. (Ramesh Rao & Purkayastha, 1972, p. 78, pl. 74, fig. 441) were also consulted. From this it was found that *Dialium angolense*, *D. gossweilerii*, *D. laurinum*, *D. pentandrum*, *Dialium* sp., *D. travancoricum* and *D. zenkeri* show close resemblance with the fossil although the vessels in the present fossil are comparatively smaller.

In 1974, Lemoigne *et al.* described a fossil wood resembling the extant genus *Dialium* from the Miocene beds of Mush Valley, Ethiopia as *Dialioxylon aethiopicum* sp. nov. They did not give any diagnosis of the genus and species. *Dialioxylon aethiopicum*, however, shows superficial resemblance with the modern *Dialium* and differs in having heterogeneous rays (Lemoigne *et al.*, 1974, p. 274, pl. 42, fig. 17), whereas in *Dialium* the rays are homogeneous (Metcalfe & Chalk, 1950, p. 497; Lebacq, 1957, pls 107-113; Kribs, 1959 pp. 79-80; Ramesh Rao & Purkayastha, 1972, p. 14). Hence, *Dialioxylon aethiopicum* Lemoigne *et al.* (1974) cannot be regarded as the fossil wood of *Dialium*.

Again in 1978, Lemoigne described a fossil wood of *Dialium* under a different generic name *Dialiumoxylon* Lakhanpal & Prakash (1970) from the Tertiary of Welkite, Ethiopia. Surprisingly, the author did not mention anything about his earlier created genus *Dialioxylon* Lemoigne *et al.* (1974) though he merged *Leguminoxylon aethiopicum* Lemoigne & Beauchamp (1972) under the genus *Dialiumoxylon*. The genus *Dialiumoxylon* was never created by Lakhanpal and Prakash (1970). Similarly, Trivedi and Misra (1978) also described a fossil wood comparable to *Millettia pulchra* from the Siwalik beds of Uttar Pradesh, India and placed it under the genus *Dialiumoxylon* Prakash (1975). However, Prakash (1975, pp. 203-204) never validly instituted this genus, instead he merely suggested that certain woods may be grouped together under the genus *Dialiumoxylon* while describing a species of *Millettioxylon*. He also did not describe any fossil wood of *Dialium*. Thus, the fossil wood *Dialiumoxylon kalagarhense* Trivedi & Misra (1978) has no valid generic name and as it resembles *Millettia pulchra*, it is transferred to the genus *Millettioxylon* Awasthi (1967) and now named as *Millettioxylon kalagarhense* (Trivedi & Misra) comb. nov. As *Dialiumoxylon aethiopicum* described by Lemoigne (1978) represents the fossil wood of *Dialium* and forms the first record of fossil *Dialium* so the credit of instituting the genus *Dialiumoxylon* goes to Lemoigne. Consequently the genus is named *Dialiumoxylon* Lemoigne (1978) by the author who is also giving its generic diagnosis. The present fossil differs from *D. aethiopicum* mainly in the seriation and height of xylem rays and in the arrangement of parenchyma bands. In *D. aethiopicum* the parenchyma bands are in straight concentric bands and the xylem rays up to 4 seriate (mostly 2-3 seriate) and 200 to 300 μm in height whereas in the present fossil the concentric parenchyma bands are mostly wavy sometimes anastomosing and the xylem rays are 1-3 (mostly 1-2) seriate and 120-360 μm in height. Thus, the present fossil has been assigned to a new species, *Dialiumoxylon indicum* sp. nov.

The genus *Dialium* Linn. consists of 40 species found in the tropics of South America, Africa, Madagascar and Malaysia (Willis, 1973, p. 352). In India, only one species occurs i.e. *D. travancoricum* Bourd. which is found in the forests of South Travancore between 300 to 600 m (Ramesh Rao & Purkayastha, 1972, p. 78).

Generic Diagnosis

Dialiumoxylon Lemoigne, 1978

Wood diffuse-porous. *Growth rings* not seen. *Vessels* small to large, solitary as well as in multiples of 2-4, rarely more; t.d. 50-200 μm; tyloses wanting. *Parenchyma* in regular concentric lines or narrow

bands, alternating with relatively broad fibre bands; bands straight to slightly undulating, often touching or enclosing the vessels, 4-6 bands per mm, each 2-5 cells wide. *Xylem rays* fine, 1-3 seriate (exceptionally 4 seriate), 16-40 μm or more in width, 5-17 cells or 120-360 μm in height, storied, sometimes irregularly storied; 8-14 rays per mm; ray tissue homogeneous; rays homocellular, consisting of procumbent cells only. *Fibres* forming concentric bands alternating with relatively narrow parenchyma bands, thick-walled, nonseptate. *Ripple marks* present due to storied arrangement of vessel segments, parenchyma strands and rays.

Genotype — Dialiumoxylon aethiopicum Lemoigne, 1978.

Specific Diagnosis

Dialiumoxylon indicum sp. nov.

Vessels small to medium, t.d. 50-140 μm (average 80 μm), r.d. 56-160 μm (average 120 μm), solitary as well as in radial multiples of 2-5 (mostly 2-4), rarely more; 9-13 vessels per sq mm; vessel-members 160-400 μm with truncated ends, storied; perforations simple; intervessel pits 4-6 μm in diameter, tyloses wanting. *Parenchyma* in regular concentric narrow bands, alternating with relatively broad fibre bands, parenchyma bands straight to slightly undulating, often touching or enclosing the vessels, 4-6 bands per mm, each 2-5 (mostly 2-4) cells wide, parenchyma strands storied. *Xylem rays* fine, 1-3 seriate (mostly biseriate), 16-40 μm wide, 5-17 cells or 120-360 μm in height, storied; ray tissue homogeneous; rays homocellular, consisting of procumbent cells only. *Fibres* oval to angular, 6-10 μm in diameter with narrow lumen, thick-walled, wall about 4 μm thick, nonseptate; forming concentric bands alternating with relatively narrow parenchyma bands. *Ripple marks* present, visible due to storied vessel-segments, parenchyma strands and rays.

Holotype — B.S.I.P. Specimen no. 36027.

Locality — Dhaneti, about 24 km east of Bhuj on the Bhuj-Bhachau Road, district Kachchh, Gujarat.

Horizon — Kankawati Series.

Subfamily — Papilionaceae

Genus — *Millettioxylon* Awasthi, 1967

Millettioxylon indicum Awasthi, 1967

Pl. 2, figs 7, 8

The material consists of two pieces of silicified wood with fairly good preservation.

Topography — Wood diffuse-porous (Pl. 2, fig. 7). *Growth rings* not seen. *Vessels* small to large, mostly medium, solitary or in radial multiples of 2-4, sometimes forming clusters, evenly distributed, 3-6 vessels per sq mm; tyloses not seen; vessels sometimes filled with dark contents, circular to oval in cross section, t.d. 64-224 μm, r.d. 80-288 μm; perforations simple, vessel-members 280-460 μm in length with truncated ends, storied with parenchyma strands and rays; intervessel pits alternate, bordered, vestured, about 4 μm in diameter. *Parenchyma* in regular concentric bands alternating with fibre bands of more or less the same width or of relatively greater width (Pl. 2, fig. 7), bands slightly undulating, s metimes bifurcating and joining the adjoining bands; 4-5 bands per mm; each 3-8 cells wide, parenchyma strands storied, 4 cells per strand; cells round to oval in cross section, 16-28 μm in diameter. *Xylem rays* fine, 1-3 (mostly 2, very rarely 3) seriate or 8-28 μm wide, 3-20 cells or 80-360 μm high, storied, 11-14 rays per mm; ray tissue homogeneous to weakly heterogeneous; rays homocellular to weakly heterocellular, consisting of procumbent cells and sometimes with a single marginal row of square or upright cells at one or both the ends (Pl. 2, fig. 8), upright or square *ray cells* 24-32 μm in vertical height, 36-40 μm in radial length, procumbent cells 12-20 μm in vertical height, 60-100 μm in radial length. *Fibres* forming concentric bands, alternating with parenchyma bands of more or less same width (Pl. 2, fig. 8), circular, oval to angular, in cross section, 8-16 μm in diameter, nonseptate, thick-walled, walls 4-8 μm thick with narrow lumen. *Ripple marks* present, visible due to storied vessel-segments, parenchyma strands and rays.

Affinities

All the above features are collectively seen in a few leguminuous woods, viz.,

Bauhinia Linn., *Craibia* Harms & Dunn, *Cynometra* Linn., *Dialium* Linn., *Lonchocarpus* Kunth., *Millettia* Wight & Arn., *Pongamia* Vent., *Piscidia* Linn., *Schefflerodendron* Harms and *Swartzia* Schreb. Out of these, *Millettia* and *Pongamia* are the only genera which show closest resemblance with the present fossil. A study of a large number of thin sections of the woods of *Millettia* and *Pongamia* revealed that the present fossil shows closest similarity with *Millettia pendula* Benth., *M. prainii* Dunn and *Pongamia glabra* Vent. and the rest of the species can be differentiated on the basis of width of parenchyma bands and rays. As the woods of *Millettia pendula*, *M. prainii* and *Pongamia glabra* are almost similar and difficult to distinguish xylotomically, these have been put together in a single genus *Millettioxylon* Awasthi (1967, 1975a). Consequently, the present wood is assigned to this genus.

So far only six species of *Millettioxylon* are known, viz., *M. indicum* Awasthi (1967, 1975a) from the Cuddalore Series of South India and Upper Tertiary of Thailand (Prakash, 1979a); *M. pongamiensis* Prakash (1975) from the Lower Siwalik of Himachal Pradesh and also from the Tertiary of West Bengal (Bande & Prakash, 1980; Ghosh & Roy, 1981); *M. palaeopulchra* from Mio-Pliocene beds of Deomali, Lakhanpal *et al.* (1981); *M. embergeri* Lemoigne (1978) from the Miocene of Ethiopia; *M. bengalensis* Ghosh & Roy (1979) from Midnapur District, West Bengal; and *M. kalagarhense* (Trivedi & Misra) comb. nov. (see p. 246) from the Mio-Pliocene beds of Kalagarh, Bijnor District, Uttar Pradesh. Out of these, *Millettioxylon indicum* Awasthi shows closest similarity with the present fossil in almost all its characters and hence it is placed under the same species.

Of the two species of *Milletia* with which fossil shows resemblance, *M. pendula* is found in the drier forests of Burma, common in Pegu Yoma, Shweba, Upper Chindwin and Tenasserim while *M. prainii* occurs in the eastern Himalayas in the foot-hills of Sikkim extending a short distance into the plains of North Bengal and also in Assam along the right bank of the river Manas in Goalpara and in the Garo Hills (Ramesh Rao & Purkayastha, 1972, pp. 116-117). The genus *Pongamia* consists of a single species, viz., *P. glabra*, a medium-sized tree, occurs throughout the greater part of India and Burma, chiefly along streams and rivers, being common in the tidal and beach forests and very common in the Andamans. It is also found in Sri Lanka and Malaya extending to North Australia and China (Ramesh Rao & Purkayastha, 1972, p. 122).

Specimens — B.S.I.P. Specimen nos. 36028 and 36029.

Localities — Dhaneti, about 24 km east of Bhuj, on the Bhuj-Bhachau Road and Mothala, about 66 km WWS of Bhuj, on the Bhuj-Naliya Road, district Kachchh, Gujarat.

Horizon — Kankawati Series.

The fossil woods corresponding to *Albizia lebbek*, *A. amara*, *A. odoratissima*, *Isoberlinia* spp. and *Millettia* spp. are the representatives of inland and moist to dry deciduous types of vegetation whereas *Cynometra polyandra* and *Dialium* are the indicators of moist conditions. *Afzelia-bijuga-A. retusa*, *Cynometra ramiflora* and *Pongamia glabra* are denizens of tidal and beach forests.

The occurrence of *Isoberlinia* in the Pliocene? of Kachchh is quite interesting and important palaeophytogeographically, since it provides a strong evidence to the fact that certain African elements did extend into India in the past thereby confirming that this region had been the meeting ground for the western floral elements (African & Arabian) like the present day (Bharucha & Meher-Homji, 1965; Blatter *et al.*, 1929; Chatterjee, 1940, 1962; Puri, 1960; Legris, 1963; Mahabale, 1966).

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EXPLANATION OF PLATES

PLATE 1

Albizinium eolebbekianum Prakash, 1975

1. Cross section showing the nature and distribution of vessels, parenchyma and fibres. × 40. Slide no. 6661.
2. Tangential longitudinal section showing the nature and distribution of rays and fibres. × 120. Slide no. 6662.

Albizinium pondicherriensis Awasthi, 1979

3. Cross section showing the nature and distribution of vessels and parenchyma. × 15. Slide no. 6663.
4. Tangential longitudinal section showing the nature and distribution of rays and septate fibres. × 120. Slide no. 6664.

Dialiumoxylon indicum sp. nov.

5. Cross section showing narrow bands of parenchyma and distribution of vessels. × 50. Slide no. 6674.
6. Tangential longitudinal section showing storied vessel-segments, parenchyma strands and rays. × 100. Slide no. 6675.

PLATE 2

Millettioxylon indicum Awasthi, 1967

7. Cross section showing the nature and distribution of vessels, parenchyma and fibres. × 30. Slide no. 6677.
8. Tangential longitudinal section showing the nature of rays and their storied arrangement. × 120. Slide no. 6678.

Cynometroxylon holdenii (Gupta) Prakash & Bande, 1980

9. Cross section showing the nature and distribution of vessels, parenchyma and fibres. × 32. Slide no. 6669.
10. Tangential longitudinal section showing heterocellular rays. × 120. Slide no. 6670.

Pahudioxylon assamicum Prakash & Tripathi, 1975

11. Cross section showing growth ring and distribution of vessels, parenchyma and rays. × 32. Slide no. 6667.
12. Tangential longitudinal section showing the nature and distribution of rays and their storied tendency. × 120. Slide no. 6668.

PLATE 3

Pahudioxylon sahnii Ghosh & Kazmi, 1961

13. Cross section showing growth ring, nature and distribution of vessels and parenchyma. × 35. Slide no. 6665.
14. Tangential longitudinal section showing the nature and distribution of rays and their storied tendency. × 140. Slide no. 6666.

Isoberlinioxylon congoense Lakhanpal & Prakash, 1970

15. Cross section at low magnification showing the nature and distribution of vessels and parenchyma. × 10. Slide no. 6671.
16. A portion of cross section magnified to show the growth ring, nature and distribution of vessels and parenchyma. × 30. Slide no. 6671.
17. Tangential longitudinal section showing nature and distribution of rays. × 95. Slide no. 6672.
18. Radial longitudinal section showing homogeneous rays. × 120. Slide no. 6673.

Dialiumoxylon indicum sp. nov.

19. Radial longitudinal section showing homogeneous rays. × 100. Slide no. 6676.

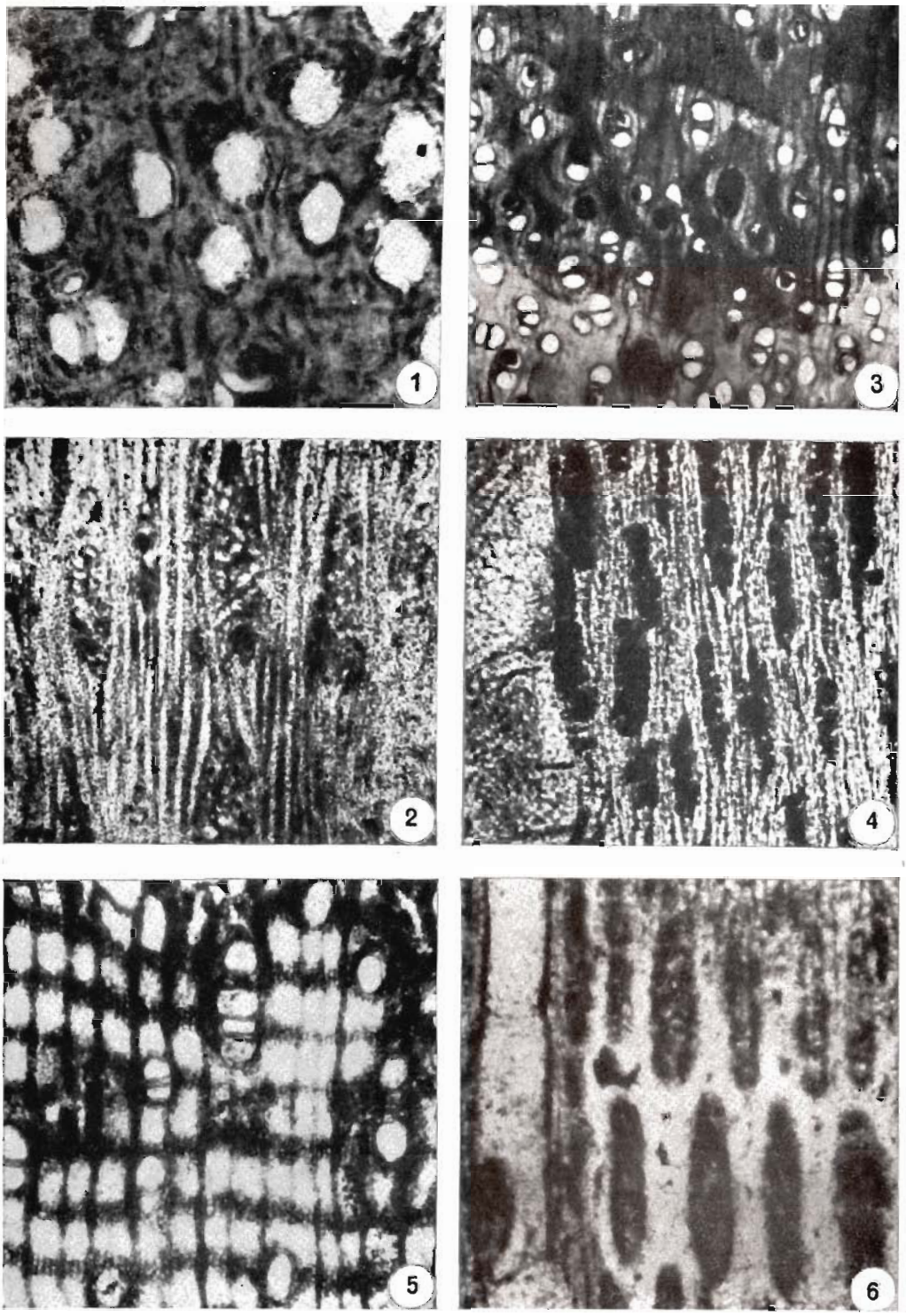
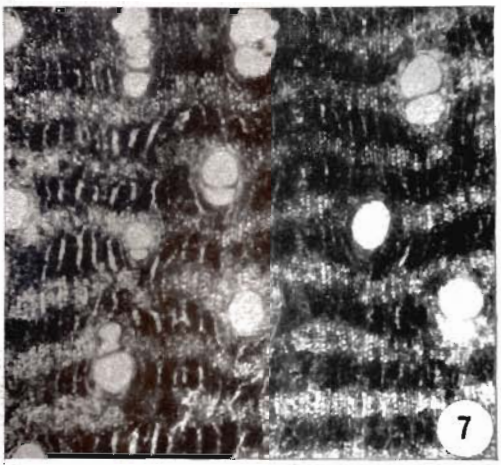
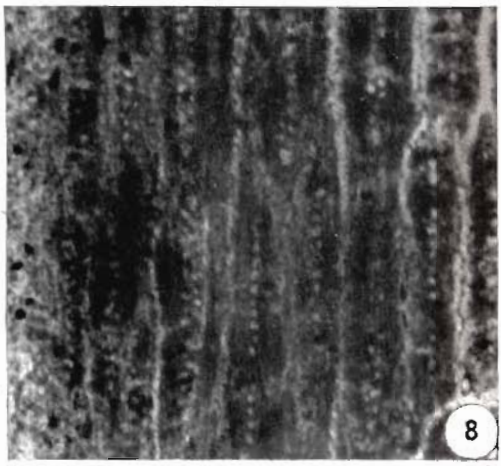
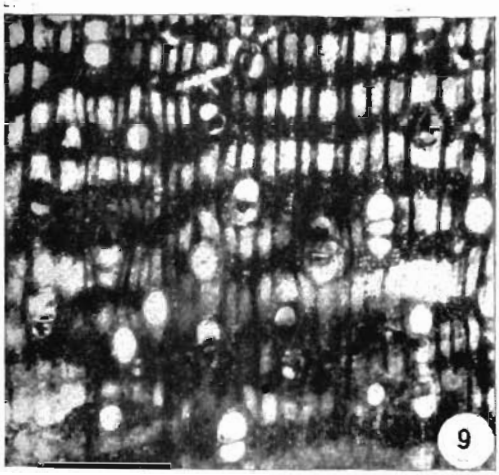
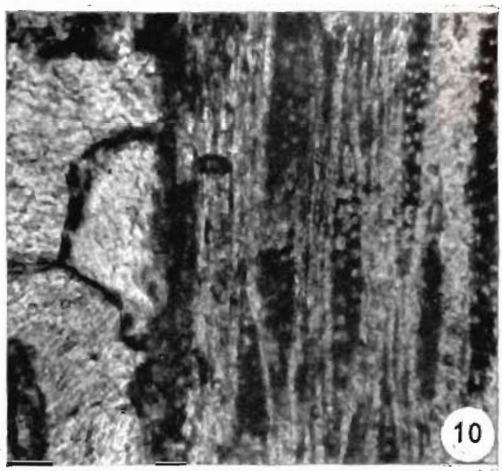


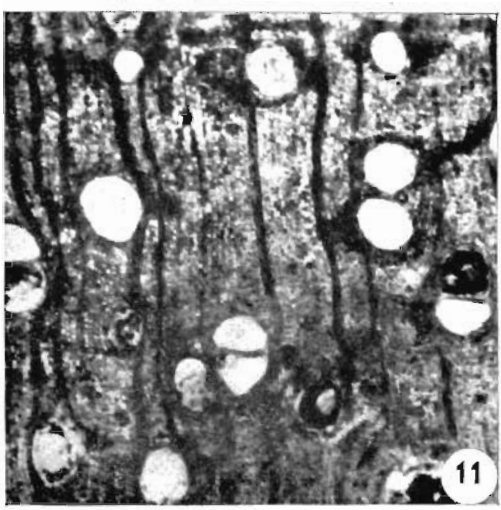
PLATE 1











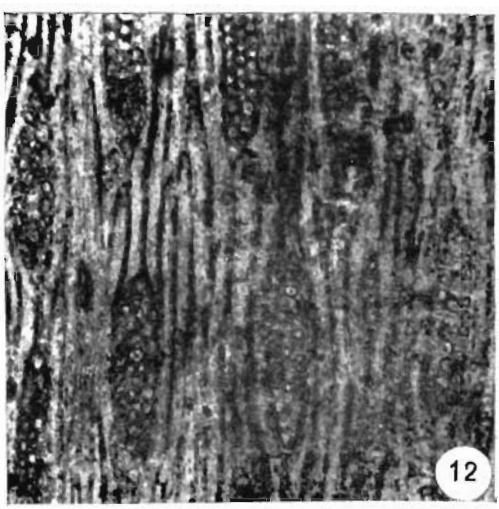
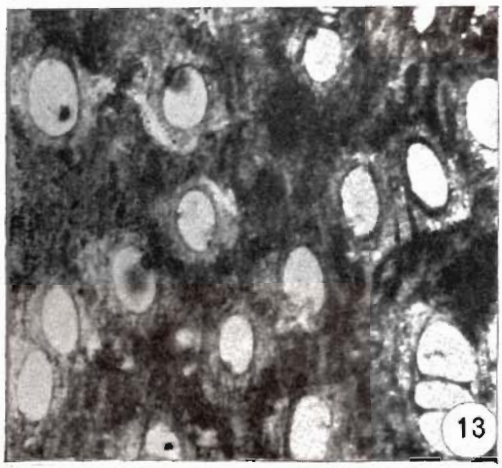
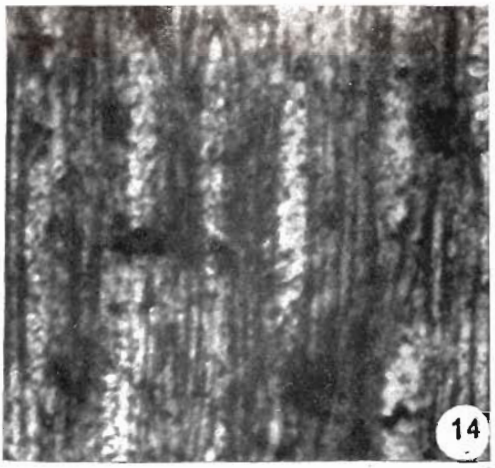
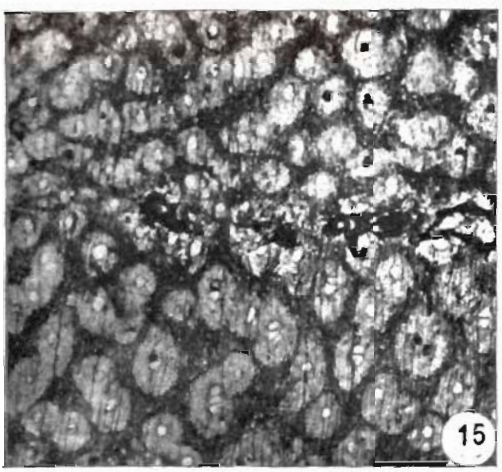
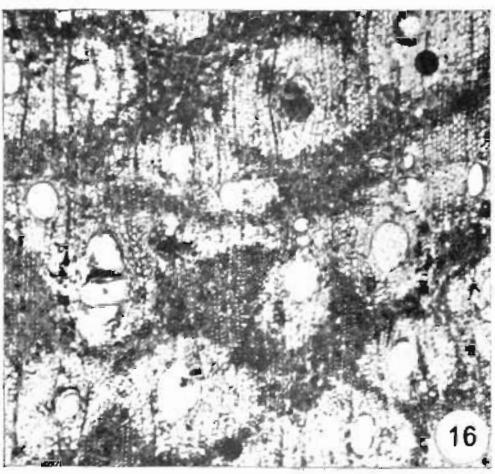


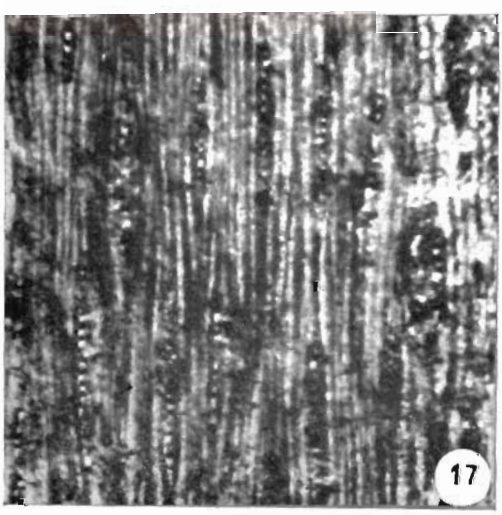
PLATE 2

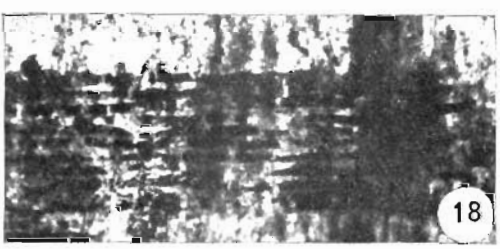












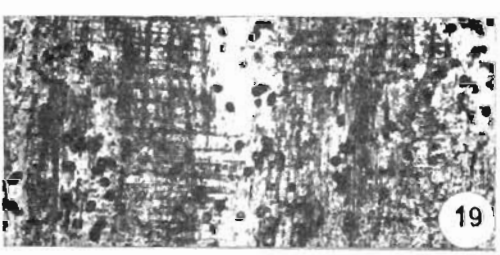


PLATE 3