

## Fossil woods of *Kingiodendron* and *Baubinia* from the Namsang beds of Deomali, Arunachal Pradesh

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Two fossil woods resembling those of *Kingiodendron* Harms and *Baubinia* Linn. of the family Leguminosae are described from the Namsang beds (Mio-Pliocene) exposed along Namsang River at Deomali in Arunachal Pradesh. They have been named as *Kingiodendron prepinnatum* sp. nov. and *Baubinia deomalica* sp. nov. respectively.

**Key-words**—Xylotomy, Leguminous woods, Namsang beds, Mio-Pliocene (India).

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### सारांश

अरुणाचल प्रदेश में देवमाली की नामसाँग संस्तरों से किंगिओडेन्ड्रॉन एवं बाँहीनिया की काष्ठाशम

नीलाम्बर अवस्थी एवं उत्तम प्रकाश

अरुणाचल प्रदेश में देवमाली के पास नामसाँग नदी के संग-संग विगोपित संस्तरों (मध्य-अतिनूतन) से लैगुमिनोसी कुल के किंगिओडेन्ड्रॉन हार्म्स एवं बाँहीनिया लिन्नैयस से मिलते-जुलते काष्ठाशम वर्णित किये गये हैं। इन काष्ठाशमों को क्रमशः किंगिओडेन्ड्रॉन प्रीपिन्नाटम् नव जाति तथा बाँहीनिया देवमालिका नव जाति से नामांकित किया गया है।

IN continuation of our previous studies on the petrified woods from the Namsang beds which are exposed along the Namsang River at Deomali (Prakash, 1965, 1966; Prakash & Awasthi, 1970, 1971; Lakhanpal, Prakash & Awasthi, 1981), we have further investigated a large number of woods collected during our field excursions to this area in 1972, 1975 and 1978. In addition to several already known taxa, about sixteen new woods have been recognised. Of these, two have been described here. They show close resemblance with the modern woods of *Kingiodendron* and *Baubinia* of Leguminosae.

### SYSTEMATIC DESCRIPTION

#### Family—Leguminosae

#### Genus—*Kingiodendron* Harms

*Kingiodendron prepinnatum* sp. nov.

Pl. 1, figs 1, 2, 5, 7, 9; Pl. 2, fig. 1

**Material**—Single piece of well preserved decorticated secondary wood.

**Description**—Wood diffuse-porous. *Growth rings* present, delimited by narrow lines of parenchyma and narrow zone of thick-walled fibres. *Vessels* small to medium and occasionally large, mostly circular to oval or elliptical due to compression, solitary and in radial multiples of 2-4, evenly distributed, up to 250  $\mu\text{m}$  in diameter, 6-12 vessels per sq.-mm; perforations simple; vessel-members truncate, about 150-750  $\mu\text{m}$  in length; intervessel pits medium to large, 6-12  $\mu\text{m}$  in diameter, alternate, vestured, apertures small, linear to lenticular; tyloses not seen. *Parenchyma* paratracheal and apotracheal; paratracheal parenchyma vasicentric, forming 2-3 cells wide sheath around vessels and occasionally aliform; apotracheal parenchyma occurring as fine lines of 2-3 cells in width delimiting the growth rings and also forming 3-6 cells wide sheath around gum canals, enclosing 1-3, sometimes up to 5 canals; parenchyma cells oval to angular, up to 44  $\mu\text{m}$  in diameter. *Rays* 1-4 (mostly 3) seriate, about 3-18 cells in height, 7-9 per mm in cross section; ray tissue heterogeneous; rays homocellular to heterocellular; multiseriate rays consisting of procumbent cells and

sometimes both procumbent and upright or square cells, the latter occurring as 1-2 marginal rows at one or both the ends, upright or square cells 30-60  $\mu\text{m}$  in tangential height and 24-32  $\mu\text{m}$  in radial length; procumbent cells 16-40  $\mu\text{m}$  in tangential height and 48-160  $\mu\text{m}$  in radial length. *Fibres* polygonal in cross-section, up to 32  $\mu\text{m}$  in diameter, moderately thick-walled, non-septate. *Gum canals* abundant, normal, vertical, occurring singly or in pairs and sometimes aligned tangentially in small groups of 3-5, enclosed by 3-6 layers of parenchymatous tissue, oval, up to 400  $\mu\text{m}$  in diameter.

*Affinities*—The above features of the fossil indicate that it is a leguminous wood. Presence of normal vertical gum canals is its most important character. Among the legumes such gum canals are known to occur in the secondary woods of *Copaifera*, *Detarium*, *Eperua*, *Sindora*, *Daniella*, *Gossweilerodendron*, *Oxystigma*, *Kingiodendron*, *Prioria* and *Pterygopodium*. In the first four genera the gum canals are in concentric rings while in the remaining six they are solitary or in pairs and sometimes in short tangential groups. Since in our fossil wood the gum canals are solitary or in pairs, it can be compared with those of the latter six genera. Among these the wood of *Kingiodendron pinnatum* Harms (Syn. *Hardwickia pinnata* Roxb.) shows close resemblance with our fossil wood. The other genera differ from it in some important features. In *Daniella* the xylem rays, parenchyma strands and vessel-members are storied (Normand, 1950, pl. 41, p. 109; Henderson, 1955, figs 193, 194, 201; Kribs, 1959, pp. 77-78) and in *Gossweilerodendron* the apotracheal parenchyma is also present in addition to vasicentric, aliform and confluent and the xylem rays are homogeneous (Kribs, 1959, pp. 81-82, fig. 196). *Oxystigma*, *Prioria* and *Pterygopodium* differ from the present fossil in having relatively higher frequency of uniseriate rays and the multiseriate rays often being longer.

*Nomenclature*—For naming the fossil woods new genera have generally been created by adding the suffix "Oxylon" or "inium" to extant genera with which the fossil woods show resemblance. But some palaeobotanists have used the modern generic names as such to designate the fossil woods. Besides, several other workers have also named the fossil dicotyledonous woods in various other ways without following any procedural uniformity. However, this problem was critically observed by Lakhanpal and Prakash (1980) who have given valid suggestions for naming the fossil dicot woods. One of the suggestions is that in those cases where anatomical details of fossil dicot woods are well preserved and it is possible to assign them to the modern genera based on a comparative study of authentic woods, the fossil should be given modern generic name without adding suffix "Oxylon". Since our fossil wood shows close resemblance with that of *Kingiodendron*, in accordance with the above

suggestion, it is being placed under the same genus. Specifically it is named as *Kingiodendron prepinnatum* sp. nov. indicating the antiquity of the species *Kingiodendron pinnatum*.

#### Genus—*Baubinia* Linn.

*Baubinia deomalica* sp. nov.

Pl. 2, figs 2-6

*Material*—Two pieces of fairly well preserved silicified secondary wood, measuring 9 × 4 cm and 12 × 8 cm respectively.

*Description*—Wood diffuse-porous. *Growth rings* not clearly marked. *Vessels* small to mostly medium, sometimes large, round to oval, solitary and in radial multiples of 2-3, occasionally up to 6, solitary and bigger vessels of radial multiples 60-160  $\mu\text{m}$  in tangential diameter, 160-280  $\mu\text{m}$  in radial diameter, uniformly distributed; vessel-members truncate, about 160-320  $\mu\text{m}$  in length, storied; perforations simple; intervessel pits medium to large, about 8  $\mu\text{m}$  in diameter, alternate to oval, vestured, aperture lenticular to circular. *Parenchyma* paratracheal, aliform-confluent to mostly banded, completely or partly enclosing the vessels, alternating with broader bands of fibres; parenchyma bands about 3-5 cells wide and 4-5 per mm, strands storied, some divided into several locules, each containing solitary crystals, cells about 20-40  $\mu\text{m}$  in diameter. *Rays* very fine, almost exclusively uniseriate, 8-12  $\mu\text{m}$  in width and 9-20 cells or 160-280  $\mu\text{m}$  in height, closely spaced, 20-25 per mm, storied; ray tissue heterogeneous, rays homocellular to heterocellular, consisting of procumbent cells only or sometimes with a single row of upright cells at one or both the ends; upright or square cells 20-24  $\mu\text{m}$  in tangential height, 16-12  $\mu\text{m}$  in radial length, procumbent cells 8-12  $\mu\text{m}$  in tangential height and 40-140  $\mu\text{m}$  in radial length. *Fibres* polygonal in cross section, 10-24  $\mu\text{m}$  in diameter, thick-walled, non-septate. *Ripple marks* present due to storied arrangement of vessel-members, parenchyma strands and xylem rays.

*Affinities*—The most important features of the fossil wood are: (i) ripple marks present due to storied arrangement of vessel-members, parenchyma strands and xylem rays; (ii) parenchyma aliform-confluent to mostly banded, and (iii) the xylem rays almost exclusively uniseriate. These features collectively indicate that the present fossil belongs to the family Leguminosae. Amongst legumes this combination of anatomical features is met with in *Baubinia* and to some extent in *Dalbergia* and *Pterocarpus*. Although both *Dalbergia* and *Pterocarpus* resemble the fossil in gross features, they can be differentiated from it in some other significant characters. In *Dalbergia* the rays are 1-3 seriate and very short, their maximum height being up to 12 cells, whereas in the present fossil the rays are uniseriate with

occasionally paired cells and 9-20 cells in height. Though the rays in *Pterocarpus* are also uniseriate yet they are comparatively much shorter than in the fossil. Moreover, the tylosis is absent in both *Dalbergia* and *Pterocarpus*.

From a detailed comparison of the fossil woods with the thin sections and published descriptions and illustrations of a number of species of *Baubinia* Linn. particularly those occurring in the Indomalayan region (Moll & Janssonius, 1914, pp. 112-119, fig. 158; Pearson & Brown, 1932, pp. 417-425, figs 144-146; Metcalfe & Chalk, 1950, pp. 493-501; Ramesh Rao & Purkayastha, 1972, pp. 64-68, p. 172, figs 428-432, pl. 13, fig. 433) it was found that the fossil is very similar in all its anatomical characters with *Baubinia foveolata* Dalz., and *B. racemosa* Lam. and also to some extent with *B. malabarica* Roxb.

Fossil woods and leaves of *Baubinia* are of common occurrence in the Neogene deposits of India. The fossil wood described so far are: *Baubinium miocenicum* Trivedi & Panjwani (1986) and *B. palaeomalabaricum* Prakash & Prasad (1983), both from the Siwalik beds of Kalagarh, Uttar Pradesh, and a fossil wood comparable to *Baubinia* from the Cuddalore Series of South India (Ramanujam & Rao, 1966). All these differ markedly from the present fossil wood. In *Baubinium miocenicum* the xylem rays are 1-3 (mostly 2) seriate and the vessels are medium-sized (t. d. 132-176  $\mu\text{m}$ ) whereas in our fossil the rays are almost exclusively uniseriate and the vessels are small to large (t.d. 60-160  $\mu\text{m}$ , r.d. 16-280  $\mu\text{m}$ ). *Baubinium palaeomalabaricum* Prakash & Prasad also differs from our fossil wood in possessing relatively broad, 3-9 seriate parenchyma bands and comparatively tall, 19-32 cells high xylem rays. In the present fossil the parenchyma bands are only 3-5 cells wide and the xylem rays are short, being about 9-20 cells in height. The fossil wood described by Ramanujam and Rao (1966) as *Baubinia* is also different in having the vessels predominantly medium-sized (t.d. 125-175  $\mu\text{m}$ ), solitary to sometimes paired and the parenchyma bands broad up to 9 seriate;

whereas in our fossil the vessels are small to large (t.d. 60-160  $\mu\text{m}$ , r.d. 160-280  $\mu\text{m}$ ) and solitary as well as in radial multiples of 2-3, occasionally up to 6 vessels and the parenchyma bands are 3-5 seriate. Besides, Rawat (1964-65) reported a fossil wood of *Baubinia* as *Baubinioxylon indicum* from the Siwalik sediments of Mohand near Dehradun. But the author has not given any description and illustration of this fossil wood.

Since the present fossil wood is quite distinct from all the known fossil woods of *Baubinia*, it is being described here as a new species, *Baubinia deomalica* sp. nov.; the specific name indicating its occurrence in Arunachal Pradesh, India.

## DISCUSSION

The genus *Kingiodendron* consists of four species, distributed in the Indomalayan region (Willis, 1973). In India *Kingiodendron* is represented by a single species, *Kingiodendron pinnatum* (Roxb.) Harms. It is a large tree occurring in the evergreen forests of Western Ghats from South Kanara to Kerala and Tirunelveli (Ramesh Rao & Purkayastha, 1972, pp. 79-81) mostly in association of *Vateria indica*, *Artocarpus hirsutus*, *Dysoxylum malabaricum*, *Dipterocarpus indicus*, *Filicium decipiens*, *Bischofia javanica*, *Toona ciliata* and *Elaeocarpus* species (Champion & Seth, 1968, p. 68). The other three species are known to occur each in Philippines, the Solomon and Fiji Islands.

*Baubinia* is a large genus consisting of about 300 species distributed throughout the tropics of the world. About 30 species occur in India and Burma. Of the two species with which the fossil shows resemblance, *Baubinia racemosa* Lam. occurs in sub-Himalayan tract ascending up to 1,500 m and throughout central, western and southern India in dry deciduous forest and also in dry regions of Burma and Sri Lanka. *Baubinia foveolata* Dalz. grows in moist forests of Konkan and North Kanara at an elevation of 600 m (Ramesh Rao & Purkayastha, 1972, pp. 65, 66, 68).

## PLATE 1

### *Kingiodendron prepinnatum* sp. nov.

- 1, 2. Cross section showing distribution of vessels, parenchyma, gum canals solitary or in pairs (bigger ones) and growth ring (Fig. 2) delimited by apotracheal parenchyma line.  $\times 40$ . Slide no. B.S.I.P. 35719-1.

### *Kingiodendron pinnatum*

3. Cross section showing similar type and distribution of vessels, parenchyma, gum canals solitary or in groups of 2-3 and growth ring delimited by apotracheal parenchyma line.  $\times 40$ .
4. Another cross section showing vessels and three gum canals together enclosed by parenchyma.  $\times 50$ .

### *Kingiodendron prepinnatum* sp. nov.

5. Tangential longitudinal section showing rays.  $\times 90$ . Slide no. B.S.I.P. 35719-2

### *Kingiodendron pinnatum*

6. Tangential longitudinal section showing rays similar to fossil.  $\times 90$ .

### *Kingiodendron prepinnatum* sp. nov.

7. Radial longitudinal section showing heterocellular xylem rays.  $\times 90$ . Slide no. B.S.I.P. 45719-4.

### *Kingiodendron pinnatum*

8. Radial longitudinal section showing heterocellular rays similar to fossil.  $\times 90$ .

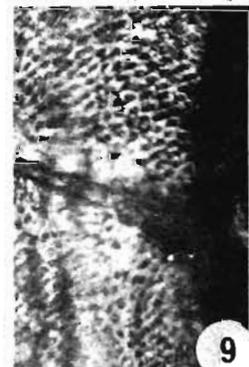
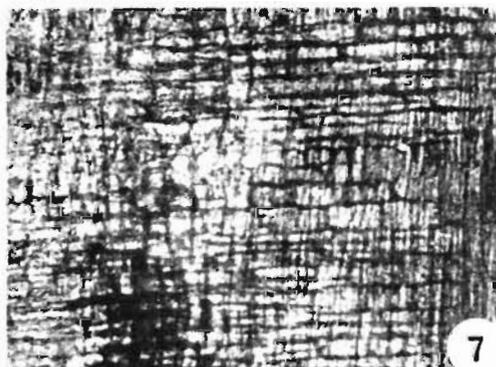
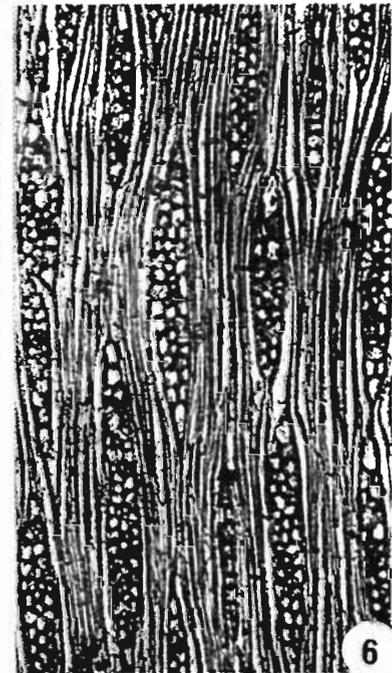
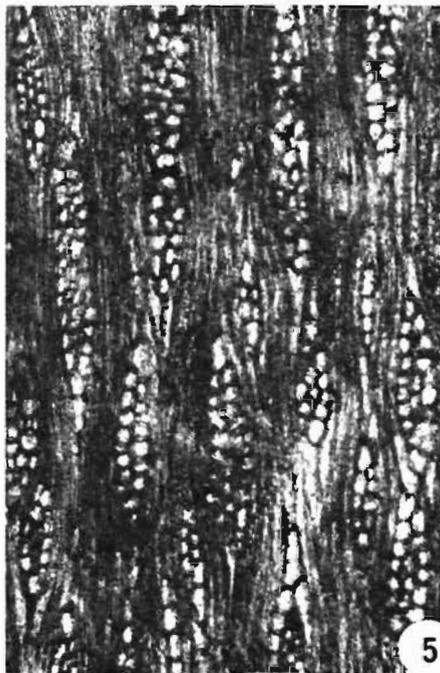
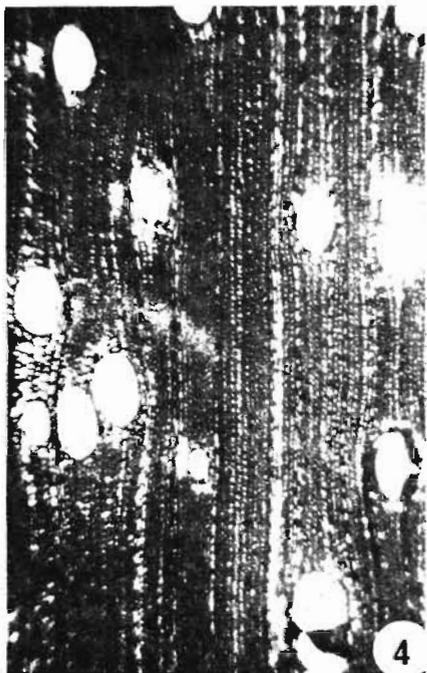
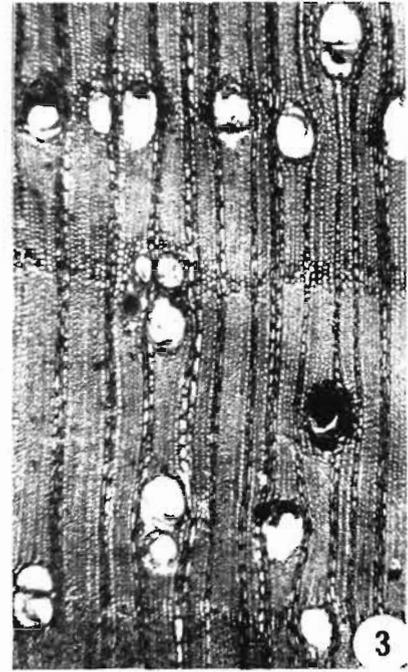


PLATE 1

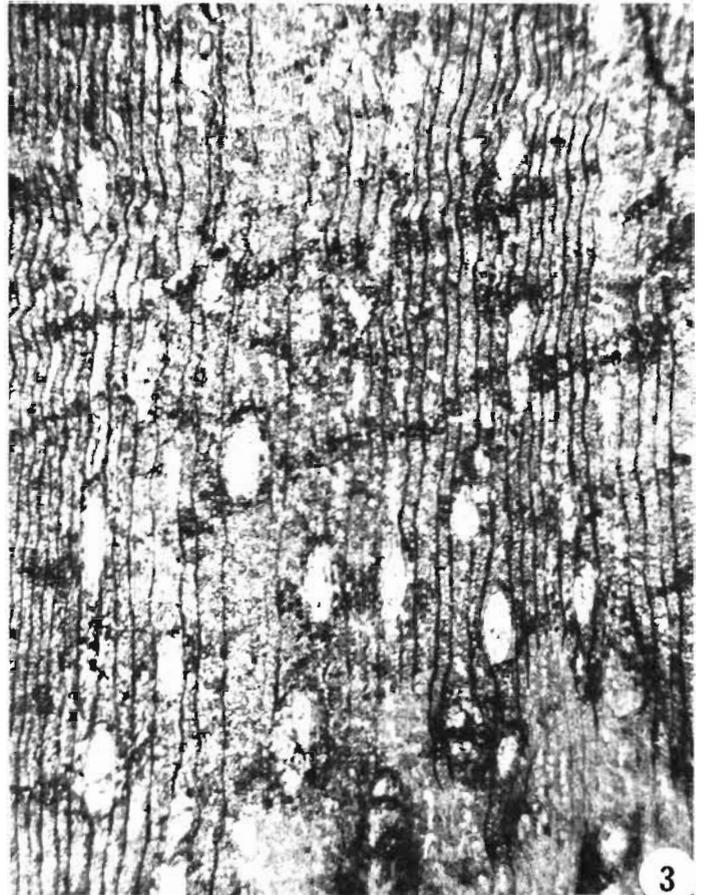
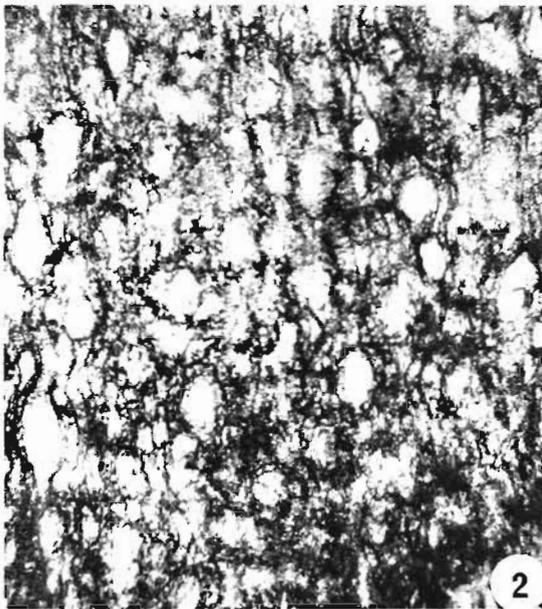
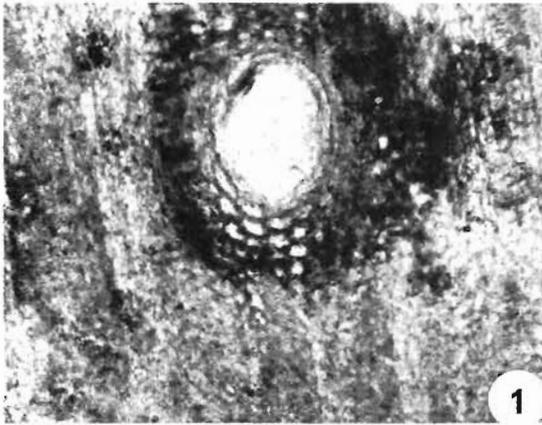


PLATE 2

Occurrence of leaves and woods of *Baubinia* in the Neogene deposits of Northeast India and the Himalayan foot-hills (Lakhanpal & Awasthi, 1984; Rawat, 1965; Trivedi & Panjwani, 1986; Prakash & Prasad, 1984) indicates that this genus was widely distributed during the Neogene and continues to flourish luxuriantly even today all along the North and Northeast India. Unlike *Baubinia*, the genus *Kingiodendron* has completely vanished from this region as there is no record of its occurrence at present in North-east India, Burma and adjoining regions. Presumably there has been considerable change in the environmental conditions in Northeast India since the Neogene period when plants like *Kingiodendron* flourished here. Since a large number of fossil woods from this area are under investigation, a detailed account of the floristics, palaeoecology and phytogeography of this region will be published in due course.

### REFERENCES

- Champion, H. G. & Seth, S. K. 1968. *A revised survey of the forest types of India*. Delhi.
- Henderson, F. Y. 1953. An atlas of end grain photo-micrographs for the identification of hard woods. *Forest Prod. Res. Bull.* **26**.
- Kribs, D. A. 1959. *Commercial Foreign Woods on the American Market*. Pennsylvania.
- Lakhanpal, R. N. & Prakash, Uttam 1980. Suggestion regarding the nomenclature of fossil dicotyledonous woods: in Symposium on modern trends in Plant Taxonomy, (Ed. P. K. K. Nair)—*Glimpses in Plant Research* **5** : 199-208.
- Lakhanpal, R. N., Prakash, Uttam & Awasthi, Nilamber 1981. Some more dicotyledonous woods from the Tertiary of Deomali, Arunachal Pradesh, India. *Palaeobotanist* **27**(3) : 232-252.
- Lalitha, C. & Prakash, Uttam 1980. Fossil wood of *Sindora* from the Tertiary of Assam with a critical analysis of the anatomically allied forms. *Geophytology* **10**(2) : 174-187.
- Metcalfe, C. R. & Chalk, L. 1950. *Anatomy of the Dicotyledons*. **1 & 2**. Oxford.
- Moll, J. W. & Janssonius, H. H. 1914. *Mikrographie des Holzes der auf Java vorkommenden baumarten*. **3** Leiden.
- Normand, D. 1950. *Atlas de bois de la cote d'ivoire*. 1. Nogent-sur-Mame (Seine), France.
- Pearson, R. S. & Brown, H. P. 1932. *Commercial timbers of India* **1 & 2**. Calcutta.
- Prakash, Uttam 1965. *Pabudioxylon deomaliense* sp. nov., a new fossil wood from the Tertiary of eastern India. *Curr. Sci.* **34**(14) : 433-434.
- Prakash, Uttam 1966. Some fossil dicotyledonous woods from the Tertiary of eastern India. *Palaeobotanist* **14**(1-3) : 223-235.
- Prakash, Uttam 1981. Further occurrence of fossil woods from the Lower Siwalik beds of Uttar Pradesh, India. *Palaeobotanist* **28 & 29** : 374-388.
- Prakash, Uttam & Awasthi, Nilamber 1970. Fossil woods from the Tertiary of eastern India—I. *Palaeobotanist* **18**(1) : 32-44.
- Prakash, Uttam & Awasthi, Nilamber 1971. Fossil woods from the Tertiary of eastern India. II. *Palaeobotanist* **18**(3) : 219-225.
- Prakash, Uttam & Prasad, Mahesh 1984. Wood of *Baubinia* from the Siwalik beds of Uttar Pradesh, India. *Palaeobotanist* **32**(2) : 140-145.
- Ramanujam, C. G. K. & Rao, M. R. R. 1966. A fossil wood resembling *Baubinia* from the Cuddalore Series of South India. *Curr. Sci.* **35**(22) : 375-377.
- Ramesh Rao, K. & Purkayastha, S. K. 1972. *Indian Woods*. **3** : Dehra Dun.
- Rawat, M. S. 1965. *Baubinioxylon indicum* gen. et sp. nov., a new dicotyledonous fossil woods from India. *Proc. 51st & 52nd Indian Sci. Congr., Calcutta*, **3** (Abst) : 425.
- Trivedi, B. S. & Panjwani, Madhu 1986. Fossil wood of *Baubinia* from the Siwalik beds of Kalagarh, U.P. *Geophytology* **16**(1) : 66-69.
- Willis, J. C. 1973. *A Dictionary of Flowering Plants and Ferns*. Cambridge.

### PLATE 2

#### *Kingiodendron prepinnatum* sp. nov.

1. Cross section magnified to show gum canal, with epithelial cells and 3-4 layers of parenchyma cells. × 90. Slide no. B.S.I.P. 35719-1.

#### *Baubinium deomalica* sp. nov.

2. Cross section showing distribution of vessels and parenchyma bands. × 35. Slide no. B.S.I.P. 35720-1
3. Another cross section showing vessels and parenchyma bands. × 46. Slide no. B.S.I.P. 35721-1.

4. Cross section magnified to show tylosed vessels and vasicentric parenchyma. × 90. Slide no. B.S.I.P. 35721-2.
5. Tangential longitudinal section showing uniseriate and storied rays. × 120. Slide no. B.S.I.P. 35721-2.
6. Radial longitudinal section showing homocellular to heterocellular rays. × 175. Slide no. B.S.I.P. 35721-3.