

WOOD OF *BAUHINIA* FROM THE SIWALIK BEDS OF UTTAR PRADESH, INDIA

U. PRAKASH & MAHESH PRASAD

Birbal Sahni Institute of Palaeobotany, 53 University Road, Lucknow 226 007, India

ABSTRACT

A fossil wood of *Bauhinia*, *Bauhinium palaeomalabaricum* sp. nov., is being described from the Lower Siwalik beds of Kalagarh in Pauri Garhwal District. It resembles the modern taxon, *Bauhinia malabarica* Roxb. which is widely distributed in the deciduous forests of almost all the states of India and Burma. It also grows in the forests of the Siwalik Range.

Key-words— Xylotomy, *Bauhinium*, Lower Siwalik beds, Miocene (India).

सारांश

उत्तर प्रदेश (भारत) के शिवालिक संस्तरों से उपलब्ध बाँहीनिआ का काष्ठाश्म — उत्तम प्रकाश एवं महेश प्रसाद

पौड़ी-गढ़वाल जनपद में कालागढ़ के अर्धरि शिवालिक संस्तरों से बाँहीनियम् मालाबारिकम् नामक काष्ठाश्म का वर्णन किया गया है। यह काष्ठाश्म बाँहीनिआ मालाबारिका रॉक्सबर्ग नामक वर्तमान वर्गक से समानता प्रदर्शित करता है जो कि बर्मा एवं भारत के प्रायः सभी प्रदेशों के पर्णपाती वनों में दूर-दूर तक पाया जाता है। इसके साथ-साथ यह शिवालिक श्रेणी के वनों में भी पाया जाता है।

INTRODUCTION

THE previous studies on the fossil flora of the Siwalik beds of Kalagarh in Pauri Garhwal District of Uttar Pradesh have revealed that there was a rich assemblage of plant taxa in this region during the Mio-Pliocene times. This consists of fossil woods of Leguminosae, Dipterocarpaceae, Anonaceae, Sterculiaceae, Anacardiaceae, Rosaceae, Combretaceae, Meliaceae and Ebenaceae (Trivedi & Misra, 1977, 1978, 1979; Trivedi & Ahuja, 1978a, 1978b, 1978c, 1979a, 1979b; Prakash, 1978, 1981; Awasthi, 1982). Further studies in this area have shown some more new fossil woods, one of which belongs to *Bauhinia* and is being described here. The fossil wood was collected from Nungarh Nala about 1.5 km ahead of a temple and is of black colour.

SYSTEMATIC DESCRIPTION

FAMILY — LEGUMINOSAE

Genus — *Bauhinium* Trivedi & Panjwani, 1983

Bauhinium palaeomalabaricum sp. nov.

Pl. 1, figs 1, 3; Pl. 2, figs 5-8

Material — The present species is based on a piece of decorticated secondary wood measuring about 10 cm in length and 8 cm in diameter. The preservation of anatomical structures is quite satisfactory.

Topography — Wood diffuse-porous. *Growth rings* indistinct. *Vessels* small to large, solitary as well as in radial rows of 2-7 (mostly 2-3) (Pl. 1, fig. 1) and 6-10 per sq mm, usually with rays contiguous on one or both the sides; tyloses absent, but vessels sometimes filled with brownish-black

contents. *Parenchyma* paratracheal, confluent forming slightly sinuate, ragged, mostly continuous, concentric bands which alternate with somewhat broader bands of fibres (Pl. 1, fig. 1; Pl. 2, fig. 5); parenchyma bands 3-4 per mm and 3-9 (usually 4-6) cells thick; *xylem rays* fine, 1-2 (mostly 1) seriate, 18-52 μm in width, 4-32 cells or 132-720 μm in height and storied (Pl. 1, fig. 3; Pl. 2, fig. 6); ray tissue heterogeneous, consisting of homo- to heterocellular rays composed either of procumbent cells only or both upright and procumbent cells (Pl. 2, figs 6, 7); upright cells 1-2 (usually 1) rows at the ends (Pl. 2, fig. 7) or sometimes in the middle part of rays. *Fibres* not aligned in radial rows.

Elements — *Vessels* round to oval in shape when solitary, usually tangentially compressed due to pressure during fossilization (Pl. 1, fig. 1; Pl. 2, fig. 5); those in radial multiples flattened at the places of contact, t.d. 80-220 μm , r.d. 102-300 μm ; vessel segments 152-750 μm in length with truncate ends and are irregularly storied; perforations simple; intervessel pit-pairs (Pl. 2, fig. 8) alternate, vestured, round to oval in shape, 6-8 μm in diameter with linear to lenticular apertures. *Parenchyma cells* thin-walled, 12-30 μm in diameter and 40-100 μm in length; parenchyma strands irregularly storied. *Ray cells* thin-walled, tangential height of procumbent cells 13-22 μm , radial length 30-65 μm ; upright cells 24-40 μm in tangential height and 12-18 μm in radial length. *Fibres* libriform to semilibriform, usually moderately thick-walled (Pl. 2, figs 5-7), nonseptate, polygonal in cross section, 8-17 μm in diameter and 440-1364 μm in length; interfibre pits could not be seen. *Ripple marks* present due to storied arrangement of vessel members, parenchyma strands and xylem rays.

Affinities — Among dicotyledonous woods such anatomical features as small to large vessels, banded parenchyma, 1-2 seriate, storied xylem rays alongwith irregularly storied vessel segments and the parenchyma strands are found in the woods of the family Leguminosae (Chowdhury & Ghosh, 1946) where these features are known to occur in *Bauhinia*, *Millettia*, *Pterocarpus*, *Dialium*, *Swartzia*, *Dalbergia* and *Crabia*. Of these, *Pterocarpus*, *Dialium* and *Dalbergia* can easily be differentiated from the present fossil wood in having predominantly narrow bands of parenchyma and homogeneous

almost homogeneous xylem rays (Pearson & Brown, 1932, pp. 362, 363, 382, 383; Prakash, 1975, pp. 203, 204) in contrast to broader bands of parenchyma and heterogeneous xylem rays seen in the present fossil wood. Besides, the xylem rays are comparatively short in *Pterocarpus* and *Dalbergia*. The woods of *Millettia* also differ from this fossil wood in possessing mostly solitary vessels, broader xylem rays and almost straight and continuous bands of apotracheal parenchyma, whereas the vessels are commonly in multiples, the xylem rays are fine and the parenchyma bands are sinuate and paratracheal in the present fossil. Further, *Swartzia* and *Crabia* can be distinguished in having predominantly narrow bands of parenchyma and regularly arranged storied parenchyma strands and the vessel segments. However, the vessel segments and the parenchyma strands are somewhat irregularly storied in this Siwalik fossil wood, thus, it is with the modern wood of *Bauhinia* Linn. that the fossil wood shows a nearest affinity. After a critical examination of thin sections of extant woods of a large number of species of *Bauhinia*, it has been found that the present fossil exhibits a closest resemblance with the modern woods of *Bauhinia malabarica* Roxb. (F.R.I. Slide no. 6343). Our examination included the study of thin sections of the woods of *Bauhinia foveolata* Dalz., *B. malabarica* Roxb., *B. mirandina* Pittier, *B. purpurea* Linn., *B. racemosa* Lam., *B. reticulata* DC., *B. retusa* Ham. and *B. variegata* Linn. Besides, the published anatomical descriptions and photographs of *Bauhinia anguina* Roxb., *B. malabarica* Roxb., *B. purpurea* Linn., *B. racemosa* Lam., *B. retusa* Ham., *B. vahlii* W. & A., and *B. variegata* Linn. were also consulted (Moll & Janssonius, 1914, pp. 112-119, fig. 158; Pearson & Brown, 1932, pp. 417-425, figs 144-146; Metcalfe & Chalk, 1950, pp. 493-501; Gamble, 1972, pp. 280-284; Ramesh Rao & Purkayastha, 1972, pp. 64-68, pl. 72, figs 428-432; pl. 73, fig. 433).

Both the present fossil wood and *Bauhinia malabarica* Roxb. possess mostly medium to large vessels with similar distribution pattern, vestured intervessel pits, simple perforations, almost similar banded parenchyma, 1-2 (mostly 1) seriate, homo- to heterocellular xylem rays with storied arrangement, libriform to semilibriform and nonseptate fibres and ripple marks due to

storied rays, vessel segments and the parenchyma strands.

In 1964-65 Rawat recorded a fossil wood of *Bauhinia* from the Siwalik beds of Mohand, District Saharanpur, Uttar Pradesh and named it as *Bauhinioxylon indicum* gen. et sp. nov. But because no description and figures have been given by the author, it has become an invalid publication vide Article 38 of the International Code of Botanical Nomenclature. Later, another fossil wood comparable to *Bauhinia* is also known from the Cuddalore Series of South India but no generic name was assigned to this fossil wood (Ramanujam & Rao, 1966). Recently, Trivedi and Panjwani (1983) instituted an organ genus *Bauhinium* to include the fossil woods of *Bauhinia* and described *Bauhinium miocenicum* from the Siwalik beds of Kalagarh. However, it can be differentiated from the present fossil in having medium-sized vessels (t.d. 132-176 μm), somewhat narrow parenchyma bands (2-6 seriate) and 1-3 (mostly 2) seriate xylem rays with 1-3 marginal rows of upright cells in contrast to small to large vessels (t.d. 80-220 μm), thick parenchyma bands (3-9 seriate) and 1-2 (usually 1) seriate rays with 1 or rarely 2 rows of upright cells present in our fossil wood. Further, the fossil wood described by Ramanujam and Rao (1966) as *Bauhinia* differs from this fossil in possessing predominantly medium-sized (t.d. 125-175 μm), solitary to sometimes paired vessels and short, 10-20 cells high rays as against small to large (t.d. 80-220 μm) and solitary as well as radial multiples of 2-7 (usually 2-4) vessels. However, from the anatomical description and figures given by the authors (Ramanujam & Rao, 1966, p. 376, figs 1-3) it appears that this Cuddalore fossil wood might belong to *Millettia*. Because the present fossil is quite different from so far known fossil woods of *Bauhinia* it is therefore being described here as a new species of *Bauhinium* Trivedi & Panjwani (1983) and named as *Bauhinium palaeomalabaricum* sp. nov., the specific name indicating a precursor of *Bauhinium malabarica* Roxb. with which it shows a close resemblance in wood structure.

Bauhinia Linn. consists of 300 species of shrubs and trees, widely distributed throughout the tropics of the world (Ramesh Rao & Purkayastha, 1972, p. 64; Willis, 1973, p. 127) and about 30 species occur in India and

Burma (Brandis, 1971). *Bauhinia malabarica* Roxb. with which the present fossil wood resembles closely is a moderate sized tree occurring from Ravi eastward to Assam through the Himalaya. It also grows in Bengal, the Central Provinces, Gujarat, Bihar, Orissa and west coast down to South India, and in mixed forests of Pegu Yomas and South Burma (Pearson & Brown, 1932).

SPECIFIC DIAGNOSIS

Bauhinium palaeomalabaricum sp. nov.

Wood diffuse-porous. *Growth rings* indistinct. *Vessels* mostly medium to large, solitary as well as in radial multiples of 2-7 (mostly 2-3), t.d. 80-220 μm , r.d. 102-300 μm , 6-10 per sq mm, sometimes plugged with dark to brown gummy deposits; vessel members 152-750 μm in length with truncate ends, irregularly storied; perforations simple; intervessel pit-pairs alternate, vestured, 6-8 μm in diameter with linear to lenticular apertures. *Parenchyma* confluent, banded, bands slightly sinuate, ragged, 3-9 (usually 4-6) cells thick, running in concentric arrangement, 3-4 per mm, alternating with somewhat broader bands of fibres; parenchyma strands irregularly storied. *Xylem rays* 1-2 (mostly 1 seriate), 18-52 μm in width, 4-32 cells or 132-720 μm in height and storied; ray tissue heterogeneous consisting of homo- to heterocellular rays composed either of procumbent cells only or both upright and procumbent cells; upright cells usually in one row at the ends or sometimes in the middle part of the rays. *Fibres* libriform to semilibriform, moderately thick-walled, polygonal in cross section, nonseptate, 8-17 μm in diameter and 440-1364 μm in length; inter-fibre pits not seen. *Ripple marks* present due to storied arrangement of xylem rays, vessel segments and parenchyma strands.

Holotype — Birbal Sahni Institute of Palaeobotany Museum specimen no. 35534.

Locality — Kalagarh, District Pauri Garhwal, Uttar Pradesh.

Age — Lower Siwalik (Middle Miocene).

ACKNOWLEDGEMENTS

We are thankful to the authorities of the Forest Research Institute, Dehradun for permission and facilities to work at the Wood Anatomy Branch of the Institute.

REFERENCES

- AWASTHI, N. (1982). Tertiary plant megafossils from the Himalaya: A review. *Palaeobotanist*, **30** (3): 254-267.
- BRANDIS, D. (1971). *Indian Trees*. 5th edition. Dehradun.
- CHOWDHURY, K. A. & GHOSH, S. S. (1946). On the anatomy of *Cynometroxylon indicum* gen. et sp. nov., a fossil dicotyledonous wood from Nailalung, Assam. *Proc. natn. Inst. Sci. India*, **12** (8): 435-447.
- GAMBLE, J. S. (1972). *A Manual of Indian Timbers*. Dehradun.
- 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.
- PEARSON, R. S. & BROWN, H. P. (1932). *Commercial Timbers of India*. **1 & 2**. Calcutta.
- PRAKASH, U. (1975). Fossil woods from the Lower Siwalik beds of Himachal Pradesh, India. *Palaeobotanist*, **22** (3): 192-210.
- PRAKASH, U. (1981). Further occurrence of fossil woods from the Lower Siwalik beds of Uttar Pradesh, India. *Palaeobotanist*, **28-29**: 374-388.
- RAMANUJAM, C. G. K. & RAO, M. R. R. (1966). A fossil wood resembling *Bauhinia* from the Cuddalore Series of South India. *Curr. Sci.*, **35** (22): 375-377.
- RAMESH RAO, K. & PURKAYASTHA, S. K. (1972). *Indian Woods*. **3**. Dehradun.
- RAWAT, M. S. (1964-65). *Bauhinioxylon indicum* gen. et sp. nov., a new dicotyledonous fossil wood from India. *Proc. 51st and 52nd Indian Sci. Congr., Calcutta*, **3**: 425 (Abst.).
- TRIVEDI, B. S. & AHUJA, M. (1978a). *Cynometroxylon siwalicus* n. sp. from the Siwalik Range. *Curr. Sci.*, **47** (17): 638-639.
- TRIVEDI, B. S. & AHUJA, M. (1978b). *Sterculioxylon kalagarhense* sp. nov. from Kalagarh (Bijnore District), U.P., India. *Curr. Sci.*, **47** (1): 24-25.
- TRIVEDI, B. S. & AHUJA, M. (1978c). *Glutoxylon kalagarhense* sp. nov. from Kalagarh. *Curr. Sci.*, **47** (4): 135.
- TRIVEDI, B. S. & AHUJA, M. (1979a). *Parinarioxylon splendidum* sp. nov. from Kalagarh. *Curr. Sci.*, **48** (3): 75-76.
- TRIVEDI, B. S. & AHUJA, M. (1979b). *Pentacmeoxylon ornatum* gen. et sp. nov. from the Siwaliks of Kalagarh. *Curr. Sci.*, **48** (14): 646-647.
- TRIVEDI, B. S. & PANJWANI, M. (1983). Occurrence of fossil wood of *Bauhinia* from the Siwalik beds of Kalagarh. *Geophytology* (in press).
- TRIVEDI, B. S. & MISRA, J. P. (1977). A new fossil wood from the Mio-Pliocene of Kalagarh, Bijnore District, U.P., India. *Proc. 64th Indian Sci. Congr., Bhubaneswar*, **3**: 95.
- TRIVEDI, B. S. & MISRA, J. P. (1978). *Dialiumoxylon kalagarhense* n. sp. from Mio-Pliocene of Kalagarh, U.P., India. *Indian J. Bot.*, **1 & 2**: 57-60.
- TRIVEDI, B. S. & MISRA, J. P. (1979). *Dysoxydendron kalagarhense* gen. et sp. nov. from Mio-Pliocene of Kalagarh, U.P., India. *J. Indian bot. Soc.*, **58**: 90-94.
- WILLIS, J. C. (1973). *A Dictionary of Flowering Plants and Ferns*. Cambridge.

EXPLANATION OF PLATES

Bauhinium palaeomalabaricum sp. nov.

PLATE I

- Bauhinium palaeomalabaricum* sp. nov.— Cross section in low power showing vessel distribution and banded parenchyma. $\times 35$; B.S.I.P. slide no 7037.
- Bauhinia malabarica*— Cross section of the modern wood showing similar shape, size and distribution of vessels and the parenchyma pattern. $\times 35$.
- Bauhinium palaeomalabaricum* sp. nov.— Tangential longitudinal section showing storied xylem rays. $\times 50$; B.S.I.P. slide no. 7038.
- Bauhinia malabarica*— Tangential longitudinal section of the modern wood showing similar xylem rays. $\times 50$.

PLATE 2

- Bauhinium palaeomalabaricum* sp. nov.— Cross section magnified to show the nature and distribution of vessels and parenchyma. $\times 45$; B.S.I.P. slide no. 7039.
- B. palaeomalabaricum* sp. nov.— Tangential longitudinal section magnified to show the nature of xylem rays. $\times 100$; B.S.I.P. slide no. 7040.
- B. palaeomalabaricum* sp. nov.— Radial longitudinal section showing heterocellular xylem rays. $\times 100$; B.S.I.P. slide no. 7041.
- B. palaeomalabaricum* sp. nov.— Magnified intervessel pit-pairs. $\times 530$; B.S.I.P. slide no. 7042.
- Bauhinia malabarica*— Magnified intervessel pit-pairs showing similar pits and apertures as in the fossil (fig. 8). $\times 530$.

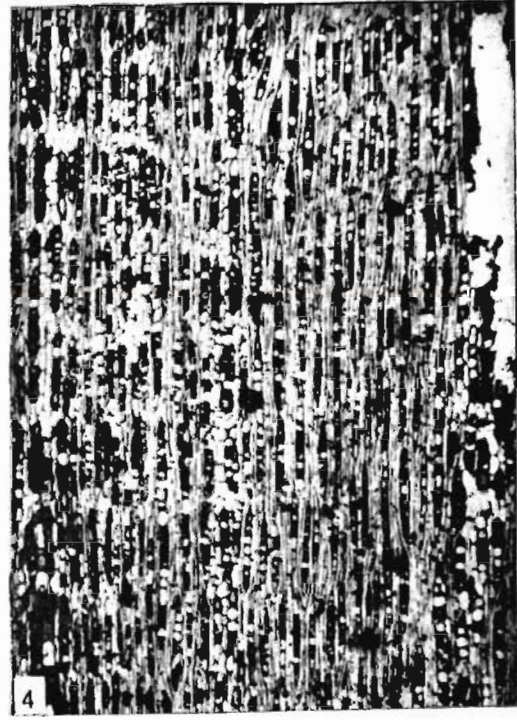
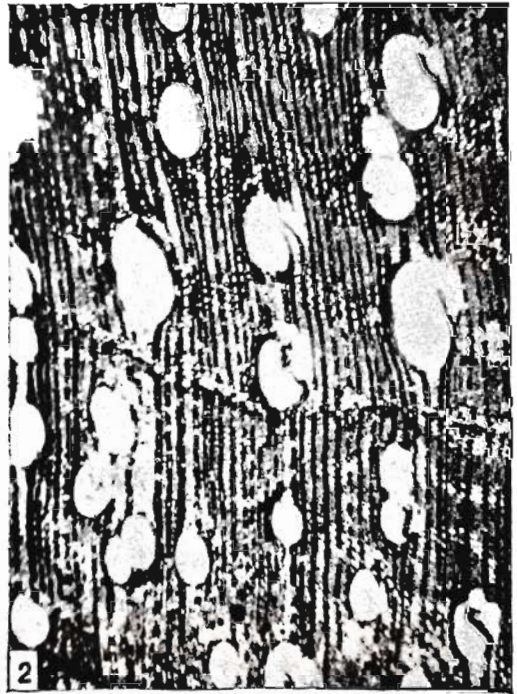


PLATE I

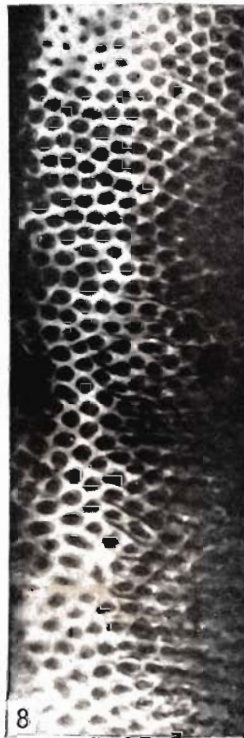
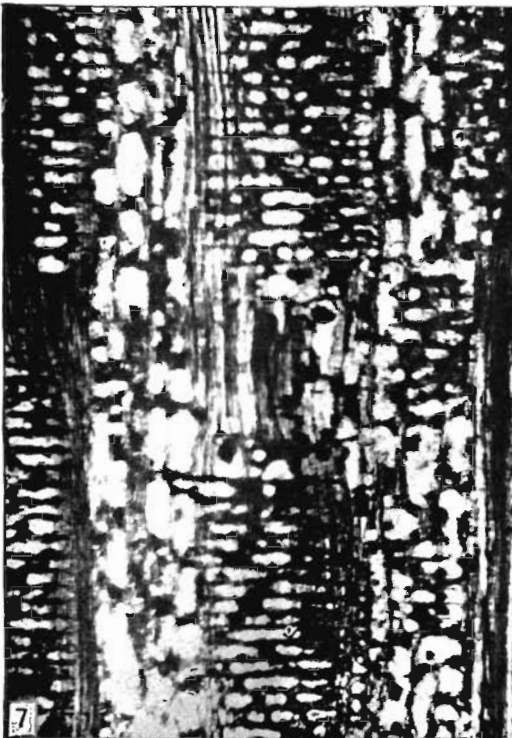
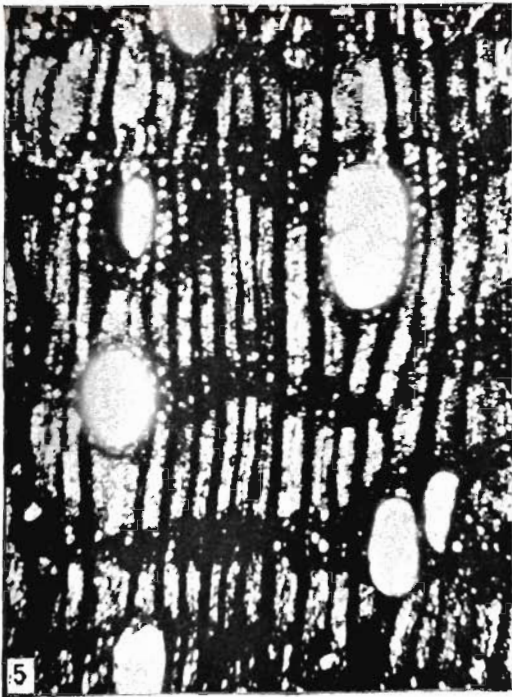


PLATE 2