

CARBONISED FOSSIL WOODS FROM THE SIWALIK GROUP OF HIMACHAL PRADESH, INDIA AND THEIR SIGNIFICANCE

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ABSTRACT

Investigation on carbonized fossil woods collected *in situ* for the first time from the Middle Siwalik (Mio-Pliocene) sediments of Hamirpur District, Himachal Pradesh reveals the occurrence of two new fossil woods having distinct anatomical features which enable us to identify with extant taxa, *Hopea sulcata* Sym. and *Duabanga grandiflora* (Roxb. ex DC.) Walp. of the families Dipterocarpaceae and Lythraceae respectively. Comparable species are not found to grow anywhere in and around the fossil locality as well as in the whole Himalayan foot hills of Himachal Pradesh but presently distributed in the evergreen forests of north-east India and the Malayan region. Thus, it indicates that the climatic changes must have taken place after Mio-Pliocene time due to which such moist loving species became extinct from the region.

Keywords: Fossil wood Palaeoclimate, Siwalik Group, systematic description, Himachal Pradesh

INTRODUCTION

The Siwalik Group of sediments is one of the well known Tertiary sequences exposed all along the Himalayan foot-hills. It extends from Potwar plateau in the north-west, forming a belt of 2,400km in length and 20-25km in width. It consists of clastic sediments of fresh water molasse facies, which accumulated in a long narrow foredeep formed to the south of rising Himalaya and ranges in age from Middle Miocene to Middle Pleistocene.

Siwalik sediments are well exposed along the foot-hills of Himachal Pradesh and contain diverse and important flora and fauna. The fossil flora based on petrified woods are documented mainly from the Nalagarh area in Solan District of Himachal Pradesh (Prakash, 1975, 1979; Yadav, 1989). The present investigation deals with carbonized fossil woods collected *in situ* for the first time from the Middle Siwalik (Mio-Pliocene) sediments exposed near Gasoti Bridge, Hamirpur District, Himachal Pradesh. Most of the fossil woods are badly preserved and do not exhibit their anatomical features. Out of them, only two fossil woods bearing distinct features have been identified with extant taxa, *Hopea sulcata* Sym. and *Duabanga grandiflora* (Roxb. ex DC.) Walp. of the families Dipterocarpaceae and Lythraceae respectively.

GEOLOGICAL SETTING OF THE AREA

The Siwalik Group is characterised by sandstone-mudstone alternations throughout the belt in the Lower, Middle and a considerable part of the Upper Siwalik Subgroups. The terminal part of the Upper Siwalik Subgroup is dominated by conglomerate sequence. The Compiled map of the Siwalik belt of Himachal Pradesh (Karunakaran and Ranga Rao, 1979) divides the Siwalik into three subgroups which occur as almost continuous belts stretching from Mohand to Nahan. The Siwalik section exposed around Gasoti Bridge in Hamirpur District, H.P. consists of sandstone dominated interval of the Middle Siwalik. The unique feature of the Middle Siwalik Subgroup is the presence of a thick pile of multistoried sandstone complex. The sandstones are grey to brownish grey, fine to medium-grained and in general friable but at some places indurated due to selective calcareous cementation. These sandstone beds contain within them both petrified and carbonised fossil woods.

MATERIAL AND METHOD

The fossil woods were collected *in situ* from the Middle Siwalik sediments exposed near Gasoti Bridge in Hamirpur District of Himachal Pradesh, India (Fig.1,2). The woods are brown black in colour showing satisfactory preservation of anatomical features. Several pieces of different size ranges from 2x3 cm to 5 x 6 cm were taken out from sandstone beds. They are sliced into thin wafers in three planes (TS TLS, RLS) and then thin

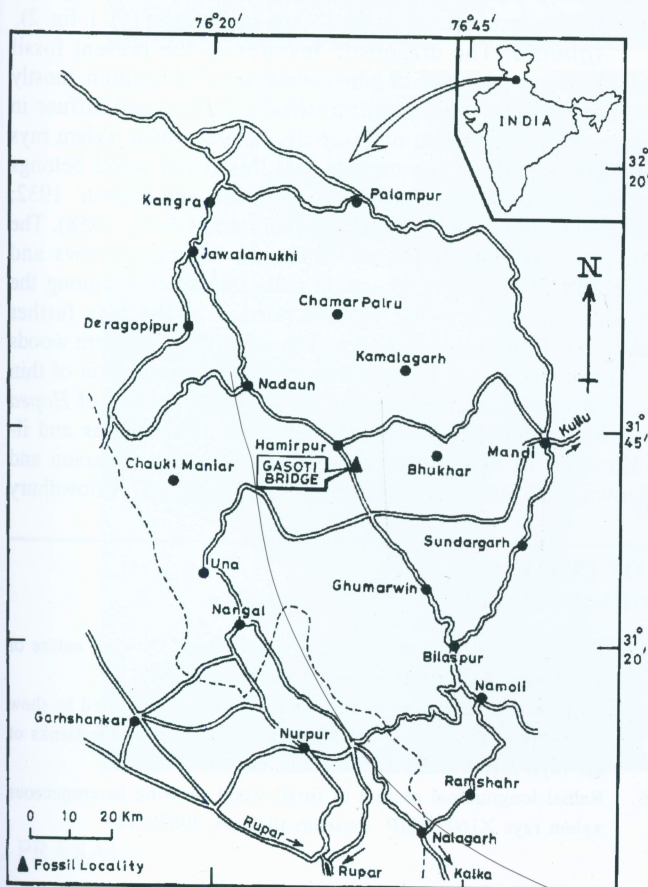


Fig. 1. Map showing the location of fossil locality.

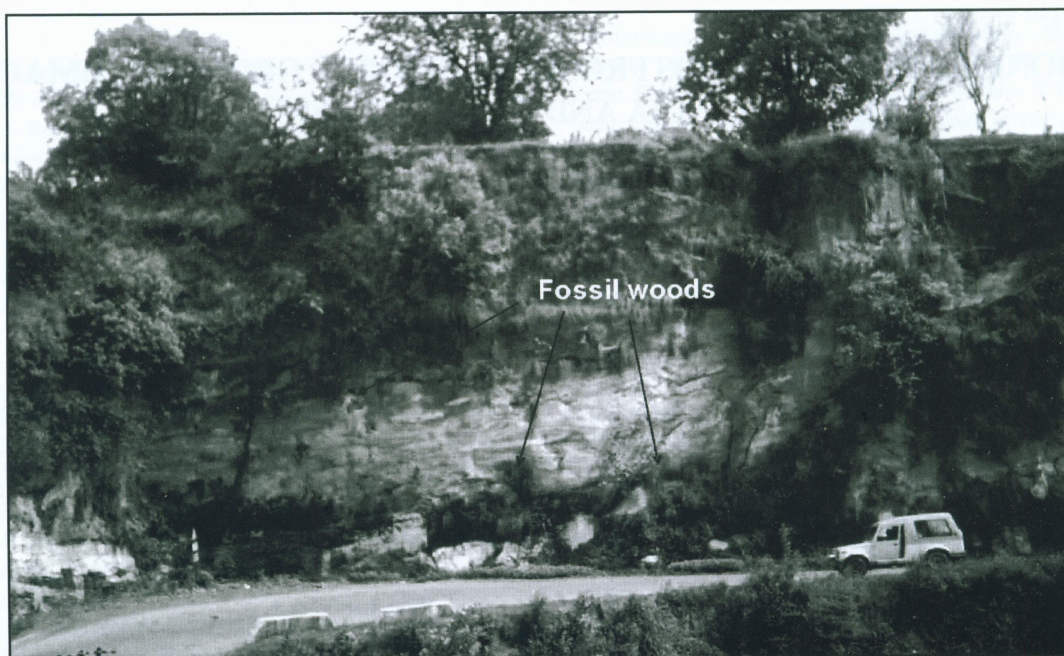


Fig. 2. Photograph showing *in situ* carbonised woods embedded in thick, multistoried sandstone beds.

sections were prepared by grinding on a disc using different grades of Carborandum powder. The fossil wood sections were studied under a high powder microscope. The photographs were taken on 35 mm colour film through the camera attached to the microscope. The specimens and slides were preserved in the museum of the Birbal Sahni Institute of Palaeobotany, Lucknow, India.

SYSTEMATIC DESCRIPTION

Order **Malpighiales**

Family **Dipterocarpaceae**

Genus ***Hopenium*** Awasthi, 1980

Hopenium kalagarhensis Prasad & Prakash, 1989

(Pl. I, figs. 1-6)

Description: Wood diffuse porous. *Growth rings* absent. *Vessels* mostly medium sized, t. d. 50-185 μ m, r.d. 55-195 μ m, mostly solitary, sometimes in radial multiples, tylosed (Pl. I, figs. 1, 3), perforations simple, intervessel pit-pairs alternate, vested, 4-8 μ m in diameter, *vasicentric tracheids* present. *Parenchyma* paratracheal and apotracheal, paratracheal parenchyma scanty to aliform; apotracheal parenchyma diffuse and diffuse aggregate, sometimes forming thick bands enclosing the gum canals (Pl. I, figs. 1,3). *Xylem ray* usually 1-4, rarely 5 seriate, 18-65 μ m in width, 3-45 cells and 70-1120 μ m in length (Pl. I, figs. 4,5); ray heterogeneous, rays tissues heterocellular

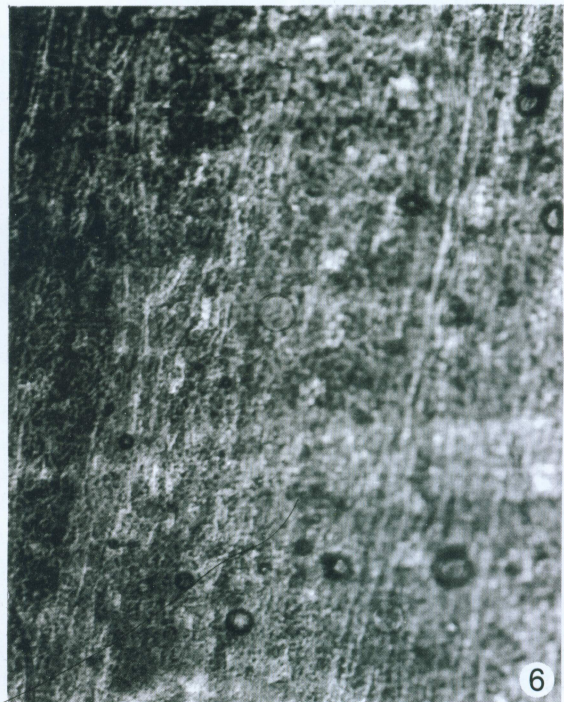
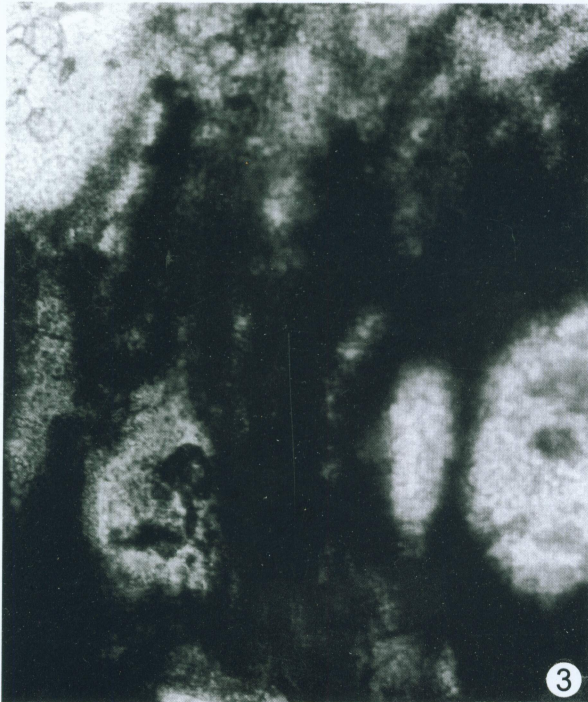
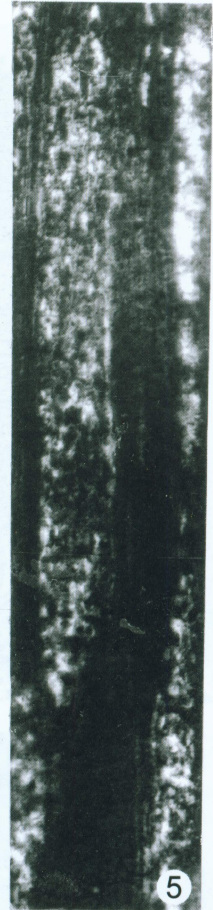
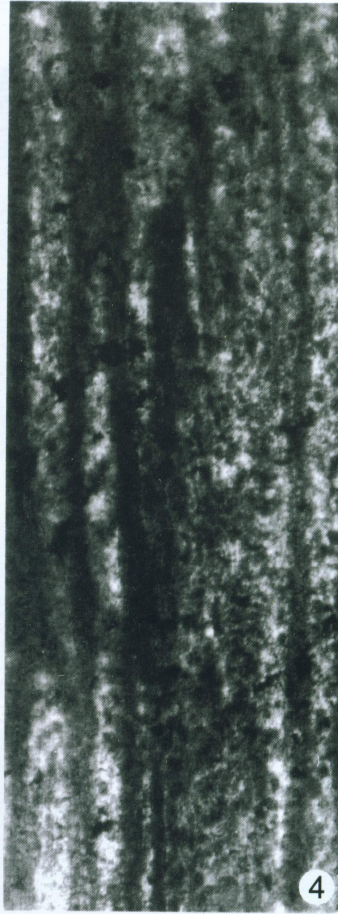
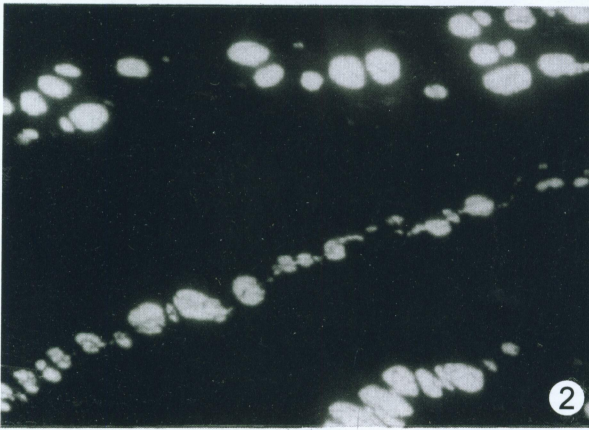
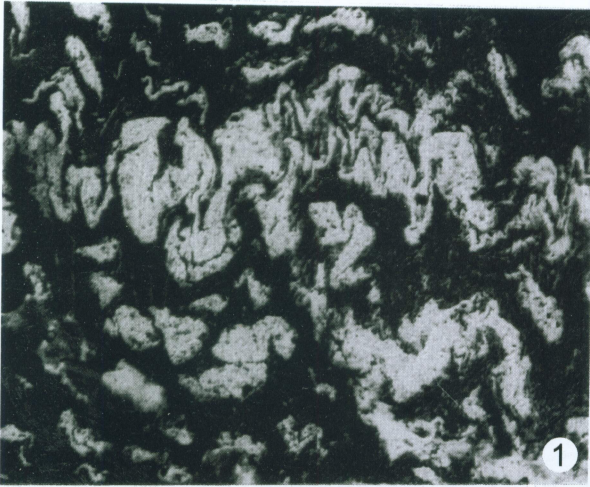
composed of procumbent cells in the median portion and 1-4 marginal rows of upright cells (Pl. I, fig. 5); ray cells oval to polygonal in cross section, thin walled; upright cells 25-45 μ m in tangential height, 20-30 μ m in radial length; procumbent cells 30-105 μ m in radial length and 18-30 μ m in tangential height (Pl. I, fig. 6), crystalliferous cells are interspersed in the median portion of the rays. *Fibres* semilibrifiform, moderately thick walled, non-septate. *Gum canals*, normal, vertical in tangential row of 2-3, circular to oval, 40-130 μ m in diameter (Pl. I, fig. 2).

Affinities: The diagnostic features of the present fossil wood such as presence of gum canals, small to medium, mostly solitary vessels, vasicentric tracheids, diffuse and diffuse in aggregate parenchyma, multiseriate, heterocellular xylem rays and non-septate fibres suggest that this fossil wood belongs to the family Dipterocarpaceae (Pearson and Brown' 1932; Metcalfe and Chalk, 1950; Chowdhury and Ghosh, 1958). The presence of bead-like gum canals in tangential rows and crystalliferous upright to square cells interspersed among the procumbent cells in the median portion of the rays further indicates the affinity of the fossil wood with the modern woods of the genus *Hopea* Roxb. From a critical examination of thin section of modern woods of all the available species of *Hopea* Roxb. and the consultation of published descriptions and illustrations of many other species of this genus (Pearson and Brown, 1932; Metcalfe and Chalk, 1950; Desh, 1957; Chowdhury

EXPLANATION OF PLATE I

Hopenium kalagarhensis Prasad & Prakash, 1989

1. Cross section of fossil wood showing nature and distribution of vessels, parenchyma and xylem rays X80. BSIP museum slide no. 39679-I.
2. Cross section of fossil wood showing nature and distribution of gum canals X 45. BSIP museum slide no. 39679-II.
3. Cross section magnified to show nature of vessels, parenchyma, fibres and vasicentric tracheids X 160. BSIP museum slide no. 39679-III.
4. Tangential longitudinal section of fossil wood showing nature of xylem rays X80. BSIP museum slide no. 39679-IV.
5. Tangential longitudinal section of fossil wood magnified to show multiseriate xylem rays having sheath cells at both the flanks of the rays. X160. BSIP museum slide no. 39679-V.
6. Radial longitudinal section of fossil wood showing heterogeneous xylem rays X160. BSIP museum slide no. 39679-VI.



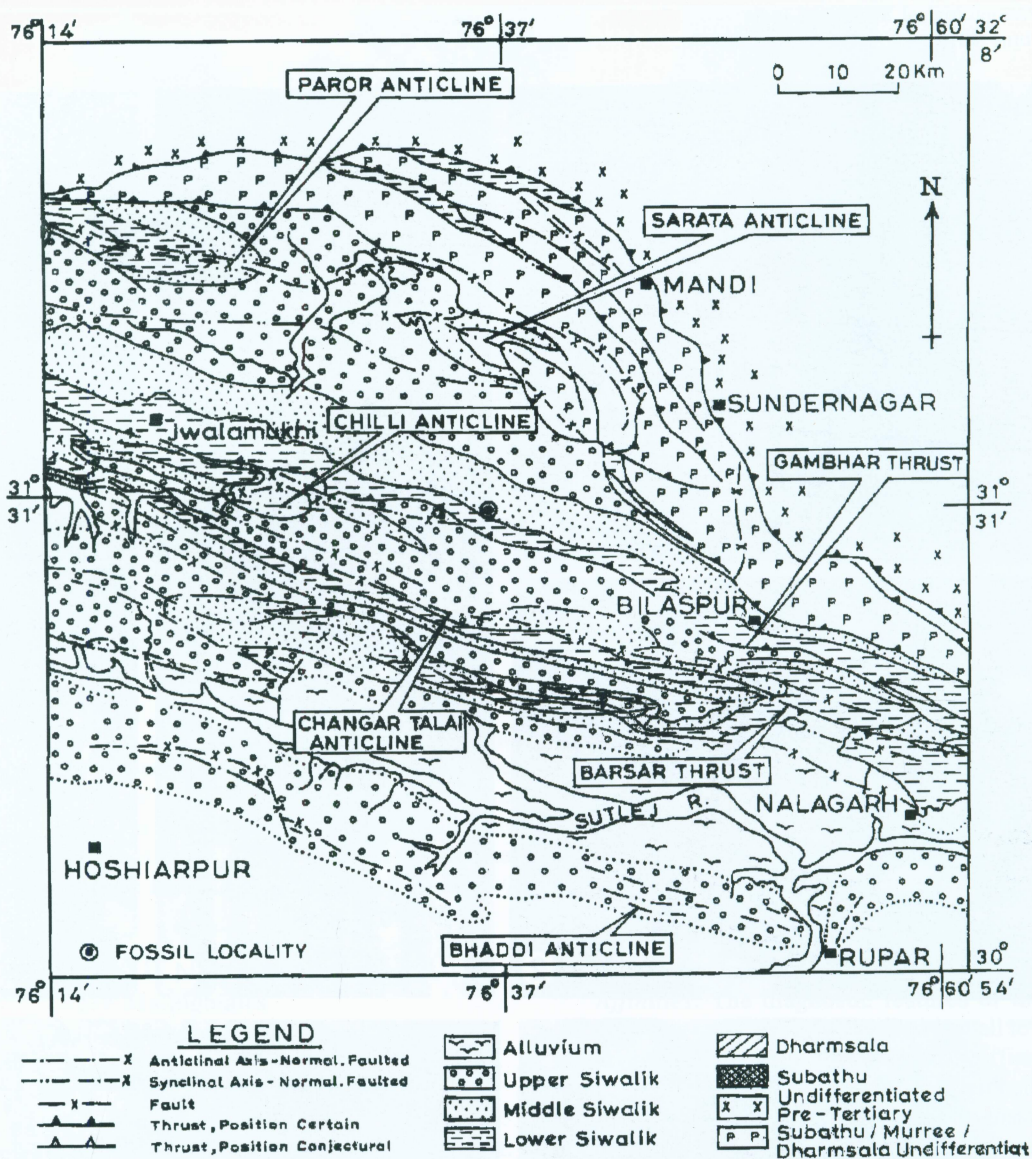


Fig. 3. Geological map showing Middle Siwalik Formation around fossil locality. (After Ranga rao *et al.*, 1979)

and Ghosh, 1958; Kirbs, 1959), it is seen that the fossil wood resembles closely the modern woods of extant species *Hopea sulcata* Sym.

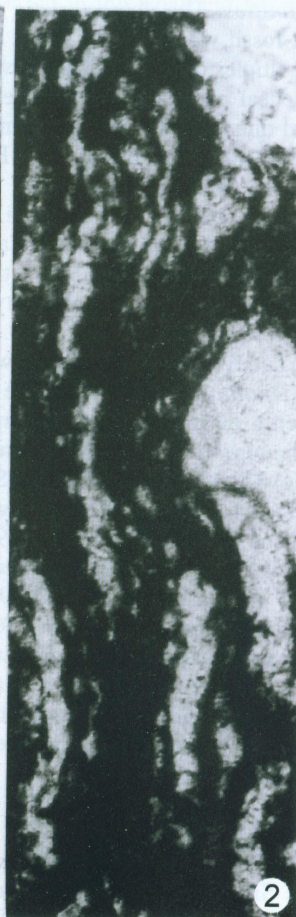
Fossil woods showing resemblance with the genus, *Hopea* Roxb. have been described under the form genus *Hopenium* Awasthi. So far five species of this genus have been reported from the Tertiary sediments of India. They are *Hopenium pondicherriense* from the Cuddalore series of South India (Awasthi, 1980) and Siwalik sediments of Kalagarh, Uttarakhand

(Prasad, 1994), *H. prenutansoides* and *H. kalagarhensis* Prasad and Prakash, 1987 from the Siwalik sediments of Kalagarh, Uttarakhand, *H. neyvelensis* Awasthi, 1984 from the Neyveli Lignite, *H. payangadiensis* Awasthi and Srivastava, 1990 from the Warkala beds of South India and *Hopenium* sp. cf. *Hopea obovata* Prakash, Vaidyanathan and Tripathi, 1994 from Tippam Sandstones, Assam. The present fossil wood has been compared with all the above-mentioned fossil species and it may be concluded that *H. kalagarhensis* Prasad and Prakash shows

EXPLANATION OF PLATE II

Duabangoxylon indicum (Navale) Awasthi, 1970

1. Cross section of fossil wood showing nature and distribution of vessels, parenchyma, fibres and xylem rays X80. BSIP museum slide no. 39680-I.
2. Cross section magnified to show vessels, vasicentric parenchyma, and xylem rays X 160. BSIP museum slide no. 39680-I.
3. Tangential longitudinal section of fossil wood showing mostly uniseriate xylem rays X80. BSIP museum slide no. 39680-II.
4. Tangential longitudinal section of fossil wood magnified to show details of xylem rays. X160. BSIP museum slide no. 39680-II.
5. Radial longitudinal section of fossil wood showing heterogeneous xylem rays X160. BSIP museum slide no. 39680-III.



the closest similarity with the present fossil. Thus, the present fossil wood has been attributed to the same species, *H. kalagarhensis* Prasad & Prakash.

Order Myrtales

Family Lythraceae

Subfamily Duabangoideae

Genus *Duabangoxylon* Awasthi, 1970

Duabangoxylon indicum (Navale) Awasthi, 1970

(Pl. II, figs. 1-5)

Description: Wood diffuse porous. Growth rings indistinct. Vessels small to medium sized, t. d. 50-170µm, r.d. 60-190µm, solitary as well as in radial multiples of 2-4 (Mostly 2-3), tylosed, 15-22 per sq. mm (Pl. II, figs. 1, 2), vessel members 160 - 600µm long with truncate ends, perforations simple, intervessel pit-pairs alternate, vested, 8-10 µm in diameter, circular to oval in shape with linear to lenticular apertures. Parenchyma paratracheal, scanty to vasicentric, thin walled (Pl. II, figs. 1, 2). Xylem rays fine, usually uniseriate, rarely biseriate, 12-24µm in width and up to 45 cells or 60-650µm in length; ray tissues heterogeneous, rays heterocellular, composed of both procumbent and upright cells; ray cells oval to polygonal in cross section, thin walled (Pl. II, figs. 3,4); upright cells 28-45µm in tangential height, and 15-30µm in radial length; procumbent cells 22-50 µm in radial length and 18-325µm in tangential height (Pl. II, fig.5), Fibres polygonal, semilibriform, non-septate, 8-20µm in diameter and 500-800µm in length (Pl. II, fig. 4).

Affinities: The characteristic anatomical features of the present fossil wood such as small to medium, solitary as well as in multiples of 2-4 and tylosed vessels, scanty to vasicentric paratracheal parenchyma, heterocellular xylem rays, non-septate and thin walled fibres are found common in the woods of the modern genus *Duabanga* Buch-Ham of the family Lythraceae (Metcalf and Chalk, 1950; Pearson and Brown, 1932). There are only two species, i.e. *D. grandiflora* (Roxb. ex DC. Walp.) and *D. moluccana* Bl. available for the comparison of the fossil wood. Considering the size and distribution of vessels and nature of parenchyma and xylem rays, *D. granaliflora* (Roxb. ex DC.) Walp. appears to be more closer.

So far five fossil woods showing resemblance with the genus *Duabanga* Buch-Ham are known from the Tertiary sediments of India under two species of the form genus *Duabangoxylon* Awasthi. They are *Duabangoxylon indicum* (Navale) Awasthi from Cuddalore Sandstones near Pondichery, South India (Awasthi, 1981) and Siwalik sediments of Kalagarh, Uttarkhand (Awasthi and Prasad, 1987) and *D. tertiara* Prakash and Awasthi from the Namsang beds near Deomali, Arunachal Pradesh (Prakash and Awasthi, 1970) and from Mio-Pliocene of Java and Sumatra (Kramer, 1974). All the above known fossil woods have been compared with present fossil and found that *Duabangoxylon indicum* (Navale) Awasthi shows closest similarity with the the present fossil wood in most of the anatomical features hence the later has been assigned to the same species.

CONCLUSIONS

The present study on the carbonised fossil woods from Middle Siwalik sediments of Hamirpur, H.P. added two new taxa, i.e. *Hopenium kalagarhensis* and *Duabangoxylon indicum* to the Siwalik flora of Himachal Pradesh, India. The

present-day distribution of both the comparable species, *Hopea sulcata* Sym. and *Duabanga grandiflora* (Roxb. ex DC.) Walp. indicates that they are not found presently anywhere in and around the fossil locality as well as in the whole Himalayan foot hills of Himachal Pradesh but distributed nowadays in the evergreen forests of north-east India and the Malayan region. Thus, it suggests that the climatic changes must have taken place in the area after Mio-Pliocene times due to which such moist loving species became extinct from the region.

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