

Fossil Wood of *Cassia* Linn. from Siwalik Group of Kathgodam area, Uttarakhand, India and its Biogeographic and Climatic implications.

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ABSTRACT

The paper presents anatomical details of a fossil wood collected for the first time from Siwalik sediments in the Kathgodam area, Uttarakhand, India. It shows close affinity with the modern taxa, *Cassia fistula* Linn. of the family, Fabaceae. The fossil wood is characterised by small to large, evenly distributed vessels having simple perforation and vestured pits, aliform to confluent and banded parenchyma, 1-4 mostly 2-3 seriate, homo to heterocellular xylem rays and non-septate fibres. The comparable species, *Cassia fistula* Linn. is a tropical moist deciduous tree, distributed throughout the forests of India, Myanmar and Sri Lanka. The presence of fossil remains in the Kathgodam area suggests that a moist deciduous forest existed under a tropical climate during the Siwalik sedimentation. Fossil woods of *Cassia* Linn. reported from Upper Cretaceous to the Mio-Pliocene sediments of India and abroad are also documented and showing their variable characters.

Key-words: *Fossil wood, Cassia Linn., Anatomy, Biogeography, Kathgodam area, Middle Siwalik, Tropical climate, Uttarakhand, India*

INTRODUCTION

The Himalayan foreland basin consists mainly of Neogene deposits known as the Siwalik Group. It extends from Potwar Plateau in the northwest to Brahmaputra in the north-east covering a distance of about 2400 km in length and 20–25 km in width (Ranga Rao *et al.*, 1979). Evolution of the Siwalik floras in the northern region has largely been influenced by the Himalayan orogeny. The Middle-Miocene orogeny of the Himalaya led to the proliferation of several gymnospermic groups and the appearance of several subtropical angiospermous taxa. The family Fabaceae is the result of one of the most spectacular radiations of flowering plants and ecologically diverse groups. This is the third most diverse family, consisting of about 730 genera and 19,400 species (Lewis *et al.*, 2005). The Fabaceae is widely distributed throughout the

world, especially in tropical rainforests and the dry forests. Until now, there were no fossils leaf and fruits unequivocally belonging to the Fabaceae before the Paleogene. However, the Palaeocene onwards, the family was already documented in many fossil assemblages around the world. They occur in the form of mostly silicified and carbonised woods and impressions of leaves fruits and seeds. In North America, fabaceous fossils are recorded in the beginning around 65.35 Mya (Lyson, *et al.*, 2019). The fabaceous fossils including vegetative and reproductive organs are reported in Mexico (Miranda, 1964; Cevallos-Ferriz *et al.*, 1994; Magallón-Puebla *et al.*, 1994; Martínez-Cabrera *et al.*, 2006; Poinar & Brown, 2002), South - east Asia (Kramer, 1974). This family also has a rich fossil record from the Siwalik of India and Nepal (Prasad, 2008; Prasad *et al.*, 2019) which are

especially documented in Middle and Upper Miocene sediments. In the present communication, the authors reported the fossil woods of a fabaceous genus *Cassia* Linn. for the first time from the Middle Siwalik (Upper

Miocene) sediments of Kathgodam area (Fig. 1) in the Himalayan foot-hills of Uttarakhand and discussed their phytogeographic and palaeoclimatic significance.



Fig.1. Map of District Nainital showing the location of fossil site from where the fossil woods were collected (After mapsofindia.com)

GEOLOGY OF STUDY AREA

The Siwalik rocks are exposed all along the Himalayan foothills in the Kathgodam area (29°19'09''N:79°35'38''E), Uttarakhand. The Lower and Middle Siwalik have been found well exposed (Fig. 2) and also, they are also

fossiliferous (Prasad *et al.*, 2004). The Siwalik represents clastic sediments of the nature of fresh water molasse which accumulated in a long narrow foredeep formed to the south of the rising Himalaya in the third episode of uplift of Himalaya during Middle Miocene.

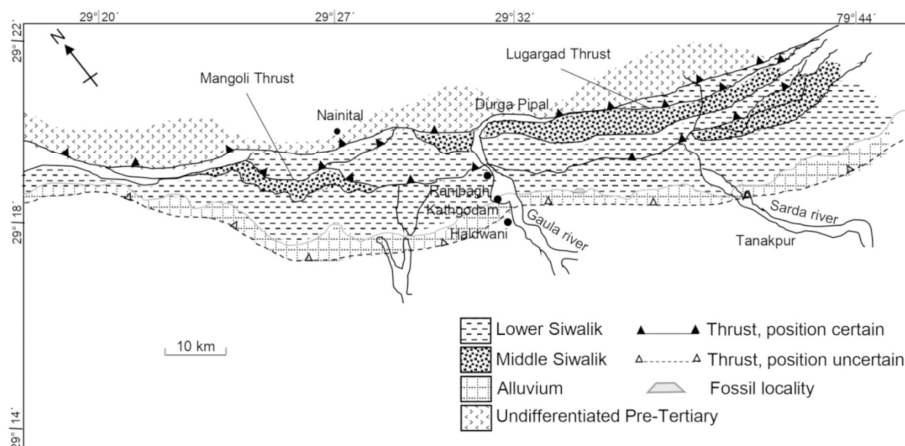


Fig. 2. Map showing the Siwalik formation in and around fossil locality.

A number of workers contributed to the general geology and stratigraphy of the Siwalik Group both in India and Pakistan. These include Falconer, 1868; Lydekker, 1880; Pilgrim, 1910; Colbert, 1935; Lewis, 1937, Opdyke *et al.*, 1979; Azzaroli and Napoleone, 1982; Johnson *et al.*, 1982, 1985; Chapon Sao *et al.*, 2024; Fawad, *et al.*, 2025; Sigdel, and Saki 2016; Shukla and Bora, 2019 and Yadav, *et al.*, 2015). The dated sections of the Siwalik range in age from (Middle Miocene- Lower Pleistocene (approximately 15 to 1 Ma) with the Lower Siwalik as the oldest unit and the Middle and Upper Siwalik as progressively younger. The local stratigraphy of the Siwalik succession has been worked out by Ranga Rao *et al.*, 1979; Gupta and Verma, 1988, and Gupta, 1997, 2000). Ranga Rao *et al.* (1979) divided the Siwalik Group into the Lower Siwalik (argillaceous unit, arenaceous unit), Middle Siwalik (sandstone dominant unit, alteration of sandstone and clay unit and pebbly sandstone unit) and the Upper Siwalik (Purmandal Sandstone, Nagrota Formation and Boulder Conglomerate).

Lithological and palaeomagnetic studies on a 2600 m thick Siwalik succession, exposed between Kathgodam and Ranibagh in the Kumaun Himalaya has been carried out by Kotlia *et al.* (2001). Lithologically, four units are recognized in the sequence. Units 1-2 are correlated with the upper part of the Lower Siwalik, whereas the Units 3-4 are correlated with the Middle Siwalik. As there is no record of the vertebrate fossils and absolute chronology from the area, they explain the magnetic polarity stratigraphy based on lithological boundaries and suggest that the lithological boundary between the Lower and Middle Siwalik (e.g., Chinji-Nagri) in the Kathgodam-Ranibagh section lies at ca. 850 m level and is palaeomagnetically estimated as ca. 9.8 Ma (Kotlia *et al.*, 2001).

MATERIALS AND METHODS

Two silicified wood specimens were collected for the first time from Sher Nala in Kisan Forest Range, Kathgodam area, Nainital district of Uttarakhand (Fig. 1, 3). Both the woods were small pieces of mature secondary xylem about 10x5.0cm and 5.6x3.0cm and black in colour.

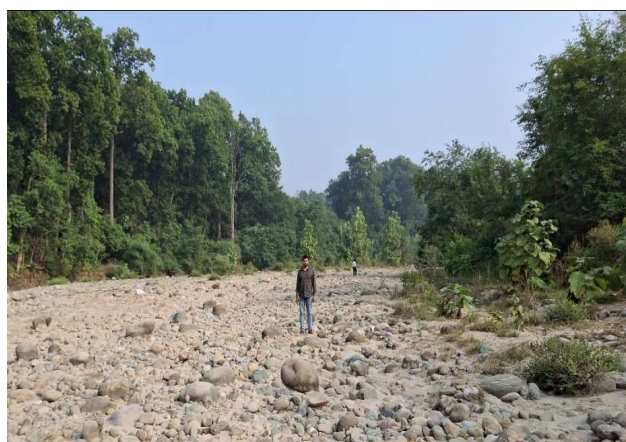


Fig. 3. Field photograph showing fossil site, Sher Nala in Kisan Forest Range, Kathgodam area, Nainital Uttarakhand, India.

Anatomical sections of required direction (TS, TLS, and RLS) were prepared by the rock cutting machine and grinding technique, as described by Weatherhead (1938). The anatomical study was made with a high power microscope in the College's laboratory. The identification has been done with the modern taxa on the basis of published literature on anatomy and through examination of wood slides of modern taxa in the Xylaria of Birbal Sahni Institute of Palaeosciences, Lucknow. For the description of the fossil wood, we follow the pattern given by Wheeler *et al.* (1986) and International Association of Wood Anatomists (1989). The photographs of the wood slide showing a variety of anatomical features have been taken with the help of camera attached to the microscope. The fossil specimens and Photographs/ slides have been deposited in the Department of Botany, Shiv Harsh Kisan P.G. College, Basti, Uttar Pradesh, India.

Systematics palaeobotany of fossil wood

Family-Fabaceae

Subfamily-Caesalpinioideae

Genus-*Cassinium* Prakash, 1975

Cassinium prefistulai Prakash, 1975 (Figs 4A, C, D; Figs 5A-C)

1974 *Peltophoroxylon parenchymatosum* Kramer p.124, pl.28, Figs107,108,110-112, 114,115; pl.29, Fig.116; text-Fig.14a-d.

1975 *Cassinium prefistulai* Prakash p.199, pl. 4, Figs14, 16,17. Awasthi and Srivastava, 1992, p.151, pl.4, Figs 1-2; Guleria, Gupta and Srivastava 2001, P. 225, Pl. 3, Figs 1-5.

1975 *Cassinium variegatum* (Ramanujam) Prakash, *Peltophoroxylon variegatum* (Ramanujam)

Muller-Stoll & Madel 1967. Ramanujam, 1960, p.120, pl.32, Figs 37-41; text-Fig.26.

1975 *Cassinium cassioides* (Prakash & Awasthi) Prakash; Prakash and Awasthi, 1970: p. 36, pl.3, Fig. 15,16; pl.4, Figs18, 20,21.

Prakash,Vaidyanathan and Tripathi,1994: p.129.pl.4, Figs30- 32; text -Fig.8.

1979 *Cassinium arcotense* Awasthi p.159, pl.2, Figs 8,9; pl.3, Fig.10.

1981 *Cassinium ballavpurens* Ghosh and Roy p.285, Figs 1-7.

Material

The species is consisting of two specimens with satisfactory preservation, measuring about 10 x5.0 cm and 5.6 x 3.0 cm. and black in colour.

Description-Wood diffuse-porous. *Growth rings* present, sometimes demarcated by 1-3, almost, continuous line of parenchymatous cells. *Vessels* small to large, tangential diameter 68-315 μm , radial diameter 75- 335 μm ; almost evenly distributed, 5-7 vessels per sq mm; solitary or in radial multiples of 2-5 (mostly2-3); circular to oval when solitary and while in radial multiples flattened at the place of contact (Fig.4A,5A); *tyloses* absent, occasionally illed with dark contents; vessel segments 140-430 μm long with mostly oblique end walls; perforations simple; inter-vessel pit-pairs alternate, hexagonal, vested with lenticular aperture (Fig. 4C;5B), 6-8 μm in diameter. *Parenchyma* paratracheal, vasicentric, aliform to aliform-confluent joining adjacent vessels and making 12- 16 cells thick wide, undulated bands (Fig. 4A, 5A); each cell 18-30 μm in diameter and 45-140 μm long; sometimes crystalliferous. *Xylem Rays* 1-4 (mostly 2-3) seriate (Fig. 3D); 8-10 rays per mm;15-25 cells in height irregularly storied; homocellular to weakly heterocellular (Fig. 4C, D,5C), mostly consisting of procumbent cells, sometimes the end cell of the rays become slightly enlarged like

upright cell, ray cells are also crystalliferous; uniseriate rays are occasionally present 8-15 cells or 160-400 μm long; procumbent cells 25-50 μm in tangential height and 30-60 μm in radial length (Fig.4C). **Fibres** aligned in radial rows, polygonal in cross section (Fig. 5A), semilibriform, 20-26 μm in diameter; non-septate; inter-fibre pits not seen.

Repository-Specimen nos. KT/15-16/24, Department of Botany, Shiv Harsh Kisan P.G. College, Basti, Uttar Pradesh, India

Locality- Sher Nala, Kisan Forest Range, Kathgodam area, Uttarakhand, India

Horizon- Middle Siwalik Formation.

Age- Upper Miocene.

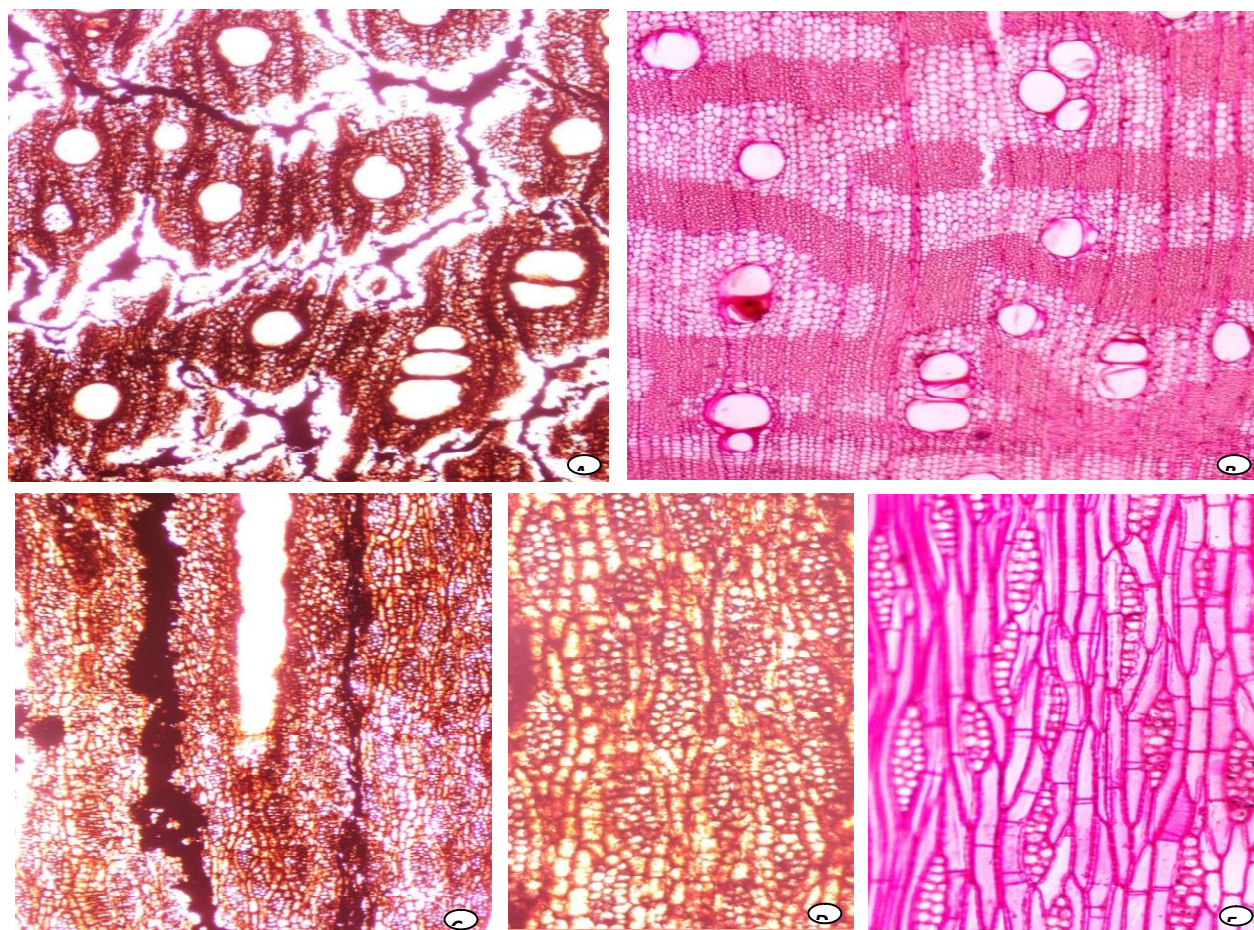


Fig. 4. *Cassinium prefistulai* Prakash **A.** Transverse section of fossil wood showing nature and distribution of vessels, parenchyma and fibres. x45. Slide no. KT/15-I. **B.** Transverse section of modern wood of *Cassia fistula* Linn. showing similar details of vessels, parenchyma and fibres. x45. BSIP Xylarium slide no. 477. **C.** Tangential longitudinal section of fossil wood showing nature and distribution of xylem rays. X45. Slide no. KT/15-II. **D.** Transverse longitudinal section of fossil wood magnified to show the details of xylem rays and their irregular storied arrangement. x100. Slide no. KT/15-II. **E.** Transverse longitudinal section of modern wood magnified to show the similar details of xylem rays. x100. BSIP Xylarium slide no. 477. Scale bar 1cm.

Modern Affinities - The characteristic anatomical features of the present fossil woods are small to large, mostly solitary sometimes in multiples with simple perforation plate vessels, vested intervessel pits; terminal apotracheal and aliform to mostly confluent and banded parenchyma; 1-3 (mostly 2-3 seriate), homocellular to weakly heterocellular xylem rays; presence of crystal in the ray and parenchyma cells and non-septate, thickwalled fibres. These above features indicate that the fossil wood belongs to the family Fabaceae. Among this family, a number of taxa show their resemblance in most of the characters especially in the nature of parenchyma distribution (Ramesh Rao *et al.*, 1972). These are *Bauhinia* spp., *Cassia* spp., *Delonix elata* (L.) Gamble, *Haematoxylum campachianum* L., *Ormosia robusta* Roxb., *Pahudia martabanica* Prain and *P. cochinchinensis* Pierre. The woods of all the species of the genus, *Bauhinia* possess confluent and banded parenchyma as found in the present fossil wood but the rays are mostly 1-2 seriate and storied in nature. The rays are also in most cases divisible into homo and heterocellular. *Delonix elata* (L.) Gamble shows similarity with the fossil in the shape, size and distribution pattern of the vessels but the rays are 1-3 cells thick and storied along with parenchyma and fibres strands. *Haematoxylum campachianum* L. is very similar with the fossil wood in the distribution pattern of apotracheal and paratracheal parenchyma but can be differentiated in being thin and large xylem rays. The woods of both the species of *Pahudia* Miq. (*P. martabanica* Prain. and *P. cochinchinensis* Pierre) although possess aliform- confluent and banded paratracheal parenchyma and irregularly storied rays as the present fossil wood but differ in having usually 1-2 seriate xylem rays. Similarly,

the woods of *Ormosia robusta* (Wight) Voigt. possess predominantly aliform and confluent paratracheal parenchyma along with comparatively thin 1-3 seriate xylem ray as compared to banded parenchyma and thick, 1-4 seriate xylem rays in the present fossil woods. In most of the anatomical features the present fossil woods show resemblance with the extant wood of the genus *Cassia* Linn. A large number of thin sections of woods of available *Cassia* species viz., *C. aubrevillei* Pellegr., *C. auriculata* Linn., *C. fistula* Linn., *C. grandis* Linn., *C. javanica* Linn., *C. uargillata* Roxb., *C. nodosa* Ham. ex Roxb., *C. siamea* Linn. were examined. Besides, the published literature including description and photographs of *C. aubrevillei* Pellegr., *C. bartonii* Bailey, *C. fistula* Linn., *C. fastuosa* Willd., *C. javanica* Linn., *C. timoriensis* DC. and *C. siamea* Lamk. (Normand, 1950; Illic, 1991; Kribs, 1959; Moll & Janssonius, 1914; Kanehira, 1924) were also consulted for the identification of our fossil woods and it has been found that amongst these the present fossil woods show best resemblance with the modern woods of *C. fistula* Linn. (BSIP wood slide no. 477; Fig. 4B, E, 5D). Both the fossil and modern woods of *C. fistula* Linn. possess small to large, mostly solitary sometimes in multiples vessels, vested inter-vessel pits, apotracheal and aliform to mostly confluent parenchyma, 1-4 (mostly 2-3 seriate), homocellular to weakly heterocellular xylem rays, crystalliferous rays and parenchyma cells and non-septate and thick-walled fibres.

Fossil records and Comparison- In 1882, Felix instituted the genus *Cassioxydon* for the fossil woods showing close similarity with the modern woods of genus *Cassia* Linn. of the family Fabaceae. Later on, Muller-Stoll and Madel (1967) examined the type slides of *Cassioxydon* and

pointed out that the above fossil wood does not show the characters of *Cassia* Linn. Thus, they established a new genus *Peltophoroxylon* to include woods of *Cassia* Linn., *Peltophorum* Vogel and *Xylia* Benth. of the same family due to their close similarity. In 1975, Prakash further studied the genus *Peltophoroxylon* and gave a new name *Cassinium* for the fossil woods resemble to modern woods of genus *Cassia* Linn. and transferred *Peltophoroxylon* species into the genus *Cassinium* Prakash. Kramer (1974) described a fossil wood, *Peltophoroxylon parenchymatosum* showing resemblance with the modern woods of another species of *Cassia* ie

Cassia siamea Lamk. from South-east Asia. Guleria *et al.* (2001) studied this fossil wood and pointed out that the rays in *Peltophoroxylon parenchymatosum* are relatively broad, mostly 3-4 seriate and parenchyma are relatively less than in the modern woods of comparable species, *Cassia siamea* Lamk. It usually possesses banded parenchyma and relatively fine 1-2 (3) seriate rays. Thus, in view of close similarity of fossil wood *P. parenchymatosum* with the modern woods of *Cassia fistula*, this fossil wood has been transferred under the genus *Cassinium* Prakash, and named it as *C. parenchymatosum*.

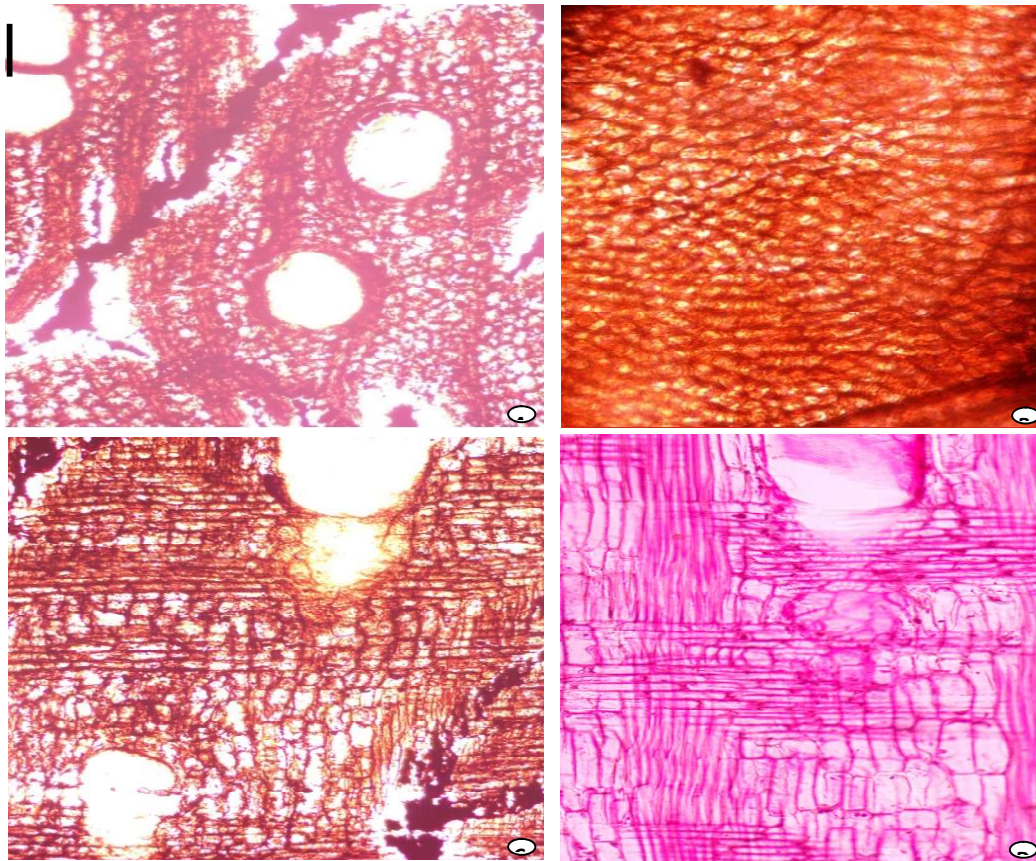


Fig. 5. *Cassinium prefistulai* Prakash A. Transverse section of fossil wood magnified to show the details of vessels, parenchyma and fibres. x100. Slide no. KT/15-I. B. Inter-vessel pits. x500. Slide no. KT/15-II. C. Radial longitudinal section of fossil wood showing weakly heterocellular nature of xylem rays. X100. Slide no. KT/15-III. D. Radial longitudinal section of modern wood, *Cassia fistula*, Linn. showing similar nature of xylem rays. x100. BSIP Xylarium slide no. 477. Scale bar 1 cm

So far, about 12 species of the genus *Cassinium* Prakash have been known from Cenozoic sediments of India and abroad (Table-1).

Table 1. Fossil wood of the genus *Cassia* Linn. known from Cainozoic sediments of India and abroad and their differentiate characters

Fossil taxa	Locality/Horizon/Age	Modern affinity	Differentiate characters
<i>Cassinium varigatum</i> (Ramanujam,1960) Prakash ,1975	Muratandichavadi, South Arcot District; Cuddalore Formation Mio-Pliocene	<i>Cassia</i> Linn.	Paratracheal parenchyma usually confluent- banded and the xylem rays are 1-3 seriate and presence of septate fibres
<i>Cassinium boroahii</i> Prakash, 1966; Prakash, 1975, 1978; Bande & Prakash, 1980; Mehrotra <i>et al.</i> , 1999; Bera &Benerjee, 2001	Dimapur-diphu Road, Assam, TipamSanstone, Middle Miocene; Santiniketan, West Bengal, Upper Miocene; Subansiri, District, Arunachal Pradesh; Mio-Pliocene; Bengal Basin, West Bengal, Upper Miocene	<i>Cassia siamea</i> Lam.	Vessels comparatively larger, up to t.d. 380µm, mostly solitary, presence of tyloses, Xylem Rays fine 1-3 seriate with greater length up to 30 cells high.
<i>Cassinium cassioides</i> (Prakash & Awasthi, 1970); Prakash,1975	Bhuri-Dehing River Bed near Jaipur, Assam; Middle Miocene; Nalagarh, Himachal Pradesh, Siwalik Formation, Lower Miocene	<i>Cassia fistula</i> Linn.	Xylem rays 1-3 seriate. Other anatomical characters are more or less similar to the present fossil wood.
<i>Cassinium cassinodosum</i> (Prakash , 1973), Prakash, 1975	Myanmar, Tertiary: Nalagarh, Himachal Pradesh, Siwalik Formation, Lower Miocene	<i>Cassia nodosa</i> Ham.	Vessels larger up to t.d.400µm, Xylem rays fine, 1-2 mostly 2 seriate with greater length, up to 30 cells high
<i>Cassinium parenchymatosum</i> Kramer, 1974	South Sumatra and West Java, Indonesia, Tertiary	<i>Cassia fistula</i> Linn., <i>Cassia siamea</i> Linn.	Xylem rays mostly 3-4 seriate with lesser frequency (only 5 rays per mm)
<i>Cassinium prefistulai</i> Prakash, 1975; Awasthi & Srivastava, 1992; Guleria <i>et al.</i> , 2001	Nalagarh, Himachal Pradesh, Lower Siwalik Formation, Middle Miocene; Kollam district, Kerala, Warkalai formation, Miocene;	<i>Cassia fistula</i> Linn.	It possesses almost Similar anatomical features as the present fossil wood

	Ramnagar, Jammu & Kashmir, Middle Siwalik Formation, Upper Miocene		
<i>Cassinium arcotense</i> Awasthi, 1979	Muratandichavadi, Pondicherry, Cuddalore Series, Mio-Pliocene	<i>Cassia javanica</i> Linn.	Vessels slightly smaller (t. d. 280µm). Fibres septate, Xylem rays 2-4 seriate as compared to usually 2-3 seriate in the present fossil wood
<i>Cassinium ballavpurens</i> Ghosh & Roy, 1980	Ballavpur, Birbhum District, West Bengal, Upper Miocene	<i>Cassia fistula</i> Linn. and <i>Cassia nodosa</i> Ham.	Xylem rays comparatively larger, up to 30 cells high and fibres septate
<i>Cassinium ethiopicum</i> Prakash et al., 1982	Blue Nile Valley, Ethiopia, Mio-Pliocene	<i>Cassia aubrevillei</i> Pellegr.	Vessels smaller (t. d. 30-160µm) with greater frequency (15-30/sqmm). Xylem rays up to 27 cells in height and homocellular
<i>Cassinium tripuranum</i> Achayya & Roy, 1986	Khowai, Tripura, Tipam Sandstone, Upper Miocene	<i>Cassia</i> Linn.	Vessels slightly smaller (t. d. 140-208µm). Xylem rays fine, 1-2, mostly 2 seriate
<i>Cassinium dongolense</i> Girad & Lejal-Nicol, 1989	Wadi Howar, Northern Sudan, Upper Cretaceous or Tertiary	<i>Cassia Siamea</i> Lam.	Xylem rays 1-3, mostly 2 seriate

Of these, *Cassinium varigatum* (Ramanujam) Prakash, *C. borooahii* (Prakash) Prakash, *C. ethiopicum* Prakash et al., *C. tripuranum* Acharya and Roy, *C. cassinodosum* Prakash, *Cassinium cassioides* (Prakash & Awasthi) Prakash, *C. dongolense* Giraud and Lejal-Nicol can easily be differentiated in being possessing 1-3 seriate xylem rays as compared to 1-4 seriate xylem rays in the present's fossil wood. Moreover, they also differ in the size of vessels which are either larger or smaller than the present fossil wood. There are septate fibres in the wood of *Cassinium varigatum*. It has also been observed that the xylem rays are comparatively more in height (up

to 30 cells) in the fossil woods of *C. borooahii*, *C. cassinodosum*, *C. dongolense* and *C. ballavpurens*. The wood of *Cassinium arcotense* differs from present fossil wood in having smaller vessels (t. d. 60-280µm) and septate fibres. Similarly, *C. ballavpurens* and *C. ethiopicum* can be differentiated in possessing the xylem rays with greater length and further the vessels are smaller in size (30-160µm) with greater frequency (15-30 per mm) in *C. ethiopicum*. Likewise, *Cassinium parenchymatosum* described from South east Asian region, majorly differentiated on the basis of their xylem rays which are mostly 3-4 seriate with lesser frequency (5-7per mm). Thus

the comparative study of already known fossil woods suggests that the present fossil wood is identical to those fossil woods described under *Cassinium prefistulai* Prakash, 1975. Therefore, this fossil wood has been kept under the same species, *Cassinium prefistulai* Prakash.

The modern comparable taxa, *Cassia* Linn. is a one of large genus of the family Fabaceae and the subfamily Caesalpinioideae. It consists of more than 37 species (on line valid) of herbs, shrubs and trees. The species are known commonly as cassias. This is pantropical in distribution occurring in both the eastern and western hemisphere excluding Europe (Record & Hess, 1943; Willis, 1973). The identical species, *Cassia fistula* Linn. is distributed throughout the forests of India, Myanmar and Sri Lanka. (Ramesh Rao *et al.*, 1972).

RESULT AND DISCUSSION

The fossil woods are collected for the first time from the Siwalik of Kathgodam area in the Siwalik foreland basin of Uttarakhand, India. The anatomical study on these woods revealed that they showed their resemblance with the modern taxa, *Cassia fistula* Linn. of the family Fabaceae which is a deciduous tree growing in the tropics of India, Myanmar, south east Asian region, and Australia etc. Thus, it is indicating that there was existence of moist deciduous forest under warm tropical climate. The family Fabaceae dominates the flora of Siwalik Group and it is an economically important family of flowering plants comprising about 670 genera and 19500 species of trees, shrubs and herbs distributed both in temperate and tropical regions of the world. More than 112 species based on plant mega fossils are recorded from the Siwalik Group of India, Nepal and Bhutan. These are belonging to

the genera, *Acacia*, *Acrocarpus*, *Adenanthera*, *Albizia*, *Bauhinia*, *Butea*, *Caesalpinia*, *Cassia*, *Canavalia*, *Dalbergia*, *Derris*, *Dialium*, *Entada*, *Indigofera*, *Koompassia*, *Mezoneuron*, *Millettia*, *Mucuna*, *Ormosia*, *Pahudia*, *Pongamia*, *Pterocarpus*, *Samanea*, *Saraca*, *Sindora*, *Spatholobus*, *Wagatea* and *Xylia*. There is also a variety of fabaceous fossils documented in different localities of all over world from the Upper Cretaceous to the Miocene. This record includes fossil woods, fruits, flowers, leaflets, and pollen and the oldest record of this family is a fruit from the Late Cretaceous of northern Mexico (Centeno-González *et al.*, 2021). *Cassia* is also a fabaceous genus of trees and large shrubs widely distributed in low altitude forests in tropical and subtropical America, Africa, Asia, Malaysia, and Australia (Larsen & Hou, 1996). It is native to Belize, Bolivia, Brazil North, Brazil Northeast, Brazil, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, El Salvador, French Guiana, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico Central, Mexico Gulf, Mexico Southwest, Mexico Southeast, Nicaragua, Panamá, Peru, Puerto Rico, Southwest Caribbean, Suriname and Venezuela. Besides fossil woods listed in table 1, the genus *Cassia* comprises a number of fossil leaves reported from Tertiary sediments of India. They are *Cassia miokachchensis* Lakhanpal & Guleria, 1982 from Khari Series of Kachchh, western India, *C. nepalensis* Prasad, 1990 and *C. neosophora* Prasad, 1994a from Lower Siwalik of Koilabas, western Nepal, *C. miosiamea* Prasad, 1994a from Middle Siwalik of Koilabas, western Nepal, *C. siwalica* Prasad 1994b Lower Siwalik of Kathgodam area, Uttarakhand, *Cassia praesophora* Agarwal, 2002 from Miocene of Neyveli Lignite Mine I, Tamil Nadu, South India, *C.*

antique Awasthi & Lakhanpal, 1990 from Upper Siwalik of Bhikhnathoree, Bihar and *C. satsangii* and *C. dayalii* Mathur *et al.*, 1996 from Lower Miocene of Himachal Pradesh, India. Thus, the above fossil records of both fossil woods and leaves of the genus *Cassia* Linn. from Tertiary sediments of different part of India suggests that the genus *Cassia* Linn. was widely spread all over India including adjacent area of Nepal during Tertiary period.

CONCLUSION

Two silicified fossil woods have been collected for the first time from the Middle Siwalik sediments of Kathgodam area in the Himalayan foot hills of Uttarakhand, India.

The anatomical study revealed their affinity with the modern taxa, *Cassia fistula* Linn of the family Fabaceae.

Comparative study of all the fossil woods of the genus *Cassia* Linn. reported from Cenozoic sediments of India and abroad has been carried out in detail.

The present finding is indicating that there was existence of moist deciduous forest under warm tropical climate in the vicinity of fossil locality.

The Fossil records of the genus *Cassia* Linn. as documented in the present communication suggests that this genus was widely spread all over India including adjacent area of Nepal during Cenozoic onwards.

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