International Journal of Ecology and Environmental Sciences 51: 63-73, 2025
ISSN: 2320-5199 (Online); https://doi.org/10.55863/ijees.2025.0497

Fossil Leaves of *Terminalia miopaniculata* n. sp. and *Calycopteris floribundoides* Prasad from Siwalik (Upper Miocene) Sediments of Sarkaghat Area, Mandi District, Himachal Pradesh, India

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ABSTRACT

A palaeobotanical study has been carried out on the plant fossils (Leaf impression) from the Middle Siwalik sediments of Sarkaghat, Mandi District, Himachal Pradesh, India, which revealed the presence of two new fossil leaves belonging to the extant taxa, *Terminalia paniculata* Roth. and *Calycopteris floribunda* Lam. of the family Combretaceae. These extant comparable taxa of the fossils reported here, are distributed chiefly in the tropical moist deciduous forests of South and Northeast and central India, respectively, which may suggest that a tropical forests under humid climate were prevalent during the Upper Miocene times in this region in contrast to a mixed deciduous forest under the tropical humid climate having reduced precipitation there at present. The fossil records of the genus, *Terminalia* Linn. indicate that this genus was widely distributed in the geological past. Its oldest record in India is from the Late Cretaceous of central India, which suggests that this genus is of Gondwana origin.

Key words: Fossils leaves, *Terminalia, Calycopteris* (Combretaceae), Sarkaghat, Himachal Pradesh, Middle Siwalik (Upper Miocene), Moist deciduous forest, Tropical climate

INTRODUCTION

The Siwalik zone is delimited on the south by the Main Frontal Thrust (MFT) and the north by the Main Boundary Thrust (MBT). It consists of fluvial deposits of the Neogene age (23-1.6 Ma). This zone extends all along the Himalaya, forming the southernmost hill range with a width of 8-50 km. It is very rich in both flora and fauna. A variety of plant megafossils including fossil leaves, fruit and seed impressions, have been reported earlier from the Siwalik of Himachal Pradesh, India (Lakhanpal 1965, 1967, 1968, 1969, Lakhanpal and Dayal 1966, Lakhanpal and Guleria 1987, Lakhanpal and Awasthi 1992, Prakash 1975, 1979, Yadav 1989, Lakhanpal et al. 1987, Ghosh and Ghosh 1958, Prasad 2006, 2010, 2012, Prasad et al. 2013, Pandey et al. 2023). Some fossil leaves have also been described from the Siwalik sediments of the study area showing their resemblance with the genus *Daemonorops* (Arecaceae), *Parthenocissus* (Vitaceae), *Fissistima* (Annonaceae), *Gynocardia* (Flacourtiaceae), *Millettia* and *Cynometra* (Fabaceae), *Ventilago* (Rhamnaceae), *Lagerstroemia* (Lythraceae) *Terminalia* (Combretaceae), *Artocarpus* (Artocarpaceae), *Phoebe* (Lauraceae), and *Antedesma* (Euphorbiaceae) etc. Given the meager work done on this aspect from the Sarkaghat area, an attempt has been carried out to study the fossil leaves collected from the Sarkaghat area. The study area Sarkaghat (31°41' 56" N 76°43'57" E) lies along National Highway 70 in Mandi District, Himachal Pradesh (Fig. 1) and is very rich in plant megafossils. The study on fossil leaves revealed the occurrence of two new fossil leaves, showing their affinity with the extant taxa *Terminalia paniculata* Roth. and *Calycopteris floribunda* Lam. of the family Combretaceae, which have been described and discussed in detail, along with their palaeobotanical significance.

GEOLOGY OF THE STUDY AREA

During the Middle Miocene, one of the most important episodes in the mountain building process happened resulting in a long and narrow depression on the northern border of India. This depression became the site of the deposition of massive alluvial detritus derived from the existing mountain and brought down by rain, rivers, and streams. This is known as Siwalik sediments. The term [1]Siwalik[1] was introduced by Cautley (1832) to designate the Himalayan foothill ranges between the Ganga and Yamuna rivers, yielding the memorable vertebrate fossils around Hardwar. Falconer (1868) also adopted this term to designate the nearly continuous Series of Tertiary Formation from Punjab down to Irrawaddy. They have an outcrop pattern more or less bounded by a major thrust, the Main Boundary Fault (MBF) in the north and the Indo-Gangetic alluvium in the south. They are generally 10-12 km wide with a steep scarp towards the south and a gentle slope on the north.

Based on the palaeontological study, Pilgrim (1913) provided a three-fold division (Lower, Middle and Upper Siwalik and proposed the subdivision of three groups of the Siwalik into seven formations- Boulder conglomerate, Pinjor Formation, Tatrot Formation, Dhok Pathan Formation, Nagri Formation, Chinji Formation, and Kamalial Formation) based on their faunal associations. Lower Siwalik constitutes grey and green greywacke with fine to medium grained clastic containing calcareous cement disseminated throughout the rock mass interbedded with well-developed chocolate and maroon-coloured sandy clays. The clay horizons often pass laterally into clay conglomerates. The lower part is characterized by rapid alternation of sandstones and clays, almost proportionally. Between the Ganga and Indo-Nepal border, the Lower Siwalik consists of thick sandstones with subordinate clays and clay stones alternating. Middle Siwalik, in which the study area falls, consists predominantly of sandstones of light grey colour, which vary in thickness from 10 to 20 m (Fig. 2). They are coarse-grained and grade from greywacke in the lower portion to arkoses in the higher portions. They are soft and friable because of the lack of calcareous matter which occurs in segregation rather than disseminated throughout the mass, as in the Lower Siwalik. Pebbles are common in the coarser clastics, especially towards the top, where the clays are dull and more arenaceous. The Upper Siwalik comprises variegated, soft, and massive pebbly sandstones with grey and brown clay bands and is predominantly conglomeratic in the upper portion.

MATERIAL AND METHODS

Various plant mega fossils (Leaf impressions) were collected from Middle Siwalik sediments exposed in a road-cutting section of Sarkaghat in Mandi District, Himachal Pradesh. The study areas are situated on both sides of the road which leads to Dharampur and are easily accessible by vehicle (Fig. 1). Well preserved specimens of leaf impressions were collected from Middle Siwalik beds of Sagoti Bridge Section near Bawali (31º44'26"N 76º43'33"E) about 7 km from Sarkaghat on Sarkaghat- Dharampur Road, Mandi District, Himachal Pradesh, India (Fig. 2). The fossil leaf impressions were devoid of cuticle and preserved on usually grey shale/ clay stones. The fossils have been studied morphologically with the help of either a hand lens or a low power microscope under reflected light. To identify fossil leaves, the herbarium sheets of several extant taxa were examined at Central National Herbarium, Shibpur, Howrah, West Bengal. The terminology given by Hickey (1973) and Dilcher (1974) has been followed to describe leaf impressions. Photographs of the extant taxa leaves have been provided to show similarity with the fossil leaves.

SYSTEMATIC PALAEOBOTANY OF THE FOSSILS

Family: **Combretaceae** Brandis
Genus: ***Terminalia*** Linn.
Terminalia miopaniculata **n.** sp. (Fig. 3 a, b)
Material: This species is represented by two well preserved leaf impressions.
Diagnosis: Leaf narrow elliptic; 16.0 x 5.0 cm; margin entire; venation pinnate, eucamptodromous; primary vein single, prominent; secondary veins about 12 pairs, 0.7-1.8 cm apart, usually alternate, angle of divergence 60º-80º, uniformly curved up; tertiary veins fine, angle of origin usually RR,

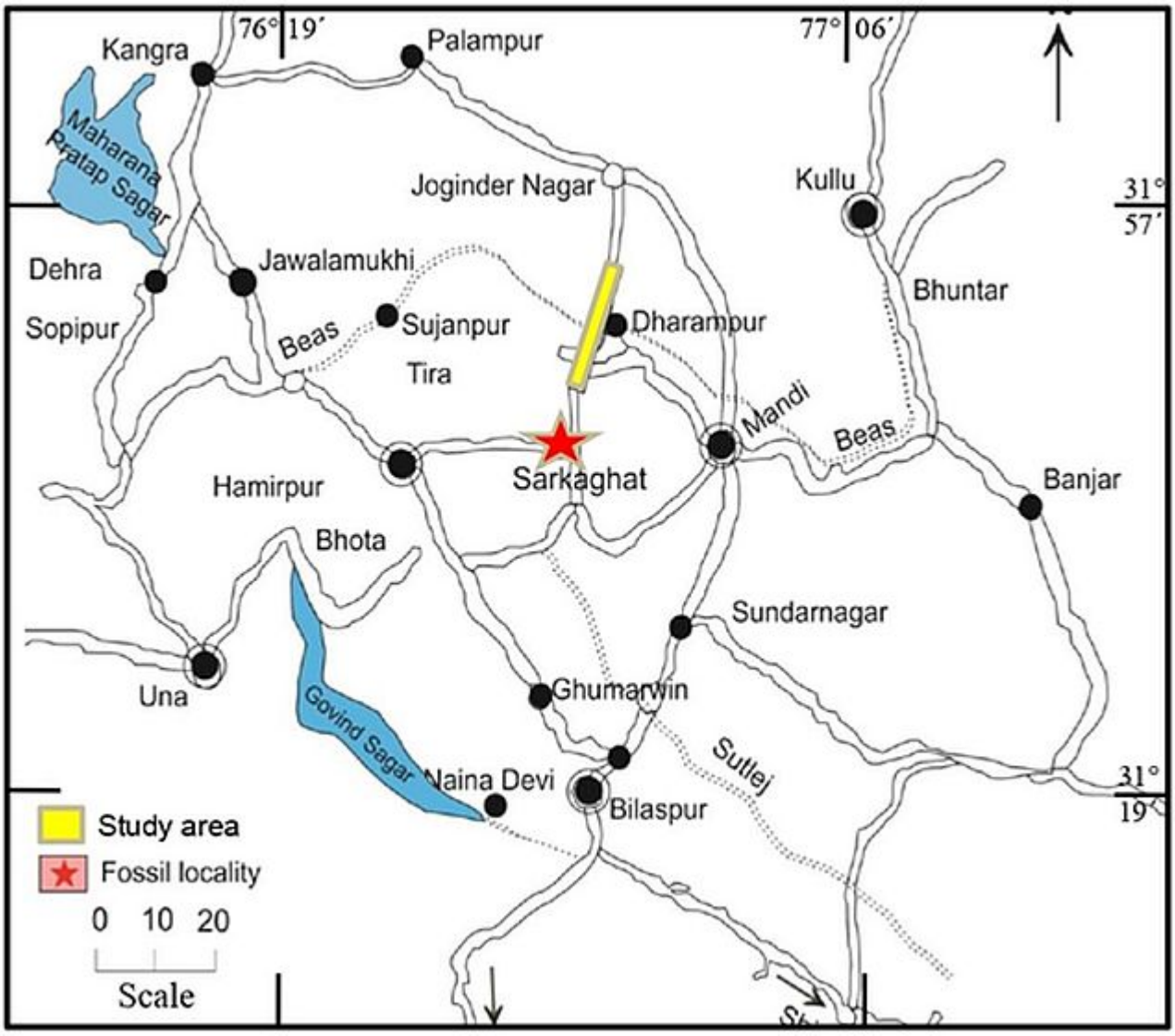

Figure1. Map showing location of the fossil locality, Sarkaghat in Mandi district, Himachal Pradesh, India and indicating the study area

percurrent, straight to sinuous, predominantly alternate and close.

Description: Leaf simple, symmetrical, narrow elliptic; preserved size 16.0 x 5.0 cm; apex and base slightly broken; margin entire; texture coriaceous; venation pinnate, eucamptodromous; primary vein (1º) single, prominent, stout, almost straight; secondary veins (2º) more than 12 pairs, 0.7-1.8 cm apart, usually alternate, angle of divergence 60º-80º, wide acute, uniformly curved up, unbranched; tertiary veins (3º) fine, angle of origin usually RR, percurrent, almost straight to sinuous, oblique in relation to midvein, predominantly alternate and close.

Holotype: BSIP Museum specimen no. 41267-41268.

Locality: Sagoti Bridge Section near Bawali (31º44.26' N 76º43.33' E) about 7 km from Sarkaghat on Sarkaghat- Dharampur Road, Mandi District, Himachal Pradesh, India.

Horizon and Age: Middle Siwalik Formation; Upper Miocene.

Etymology: The specific epithet is after the 'Miocene' epoch.

Remarks: The present fossil leaves are characterized by narrow elliptic shape, entire margin, eucamptodromous venation, the wide acute angle of divergence of secondary veins, and RR, percurrent, straight to sinuous tertiaries. The closely placed basal secondary vein with a greater angle is also an important character of the fossil leaf. A comparative

Figure 2. Field photograph of studied section exposed on Sarkaghat- Dharampur road in Himachal Pradesh from where the fossil leaves of family Combretaceae were collected

study of the herbarium sheets of different families shows that the above features are found common in the modern leaves of the genus *Terminalia* Linn. of the family Combretaceae. A critical examination of the modern leaves of this genus's available species revealed that these fossil leaves show their closest affinity with the leaves of *Terminalia paniculata* Roth. (C.N.H. Herbarium Sheet No. 57889, 801; Fig. 3c) in shape, size and venation pattern.

Fossil leaves resembling the Terminalia Linn. genus have been reported under three generic names *Terminalia* Linn., *Terminaliphyllum* Velenovsky and *Terminaliophyllum* Geyler from Tertiary - Cretaceous sediments of India and abroad (Table 1).

Of these, ten fossil species of *Terminalia* Linn. have been reported from the Siwalik Group of India and Nepal. The present fossil leaves show their differentiation from all the available known species of *Terminalia* Linn. and thus, do not match any of them. A Comparative study of these species revealed that most differ in shape and size or the course and arrangement of secondary veins. Given this the present fossil leaves have been assigned to a new species, *Terminalia miopaniculata*. The genus *Terminalia* Linn. consists of about 150 large tree species and is widely distributed in the world¹s tropics (Mabberely 1997) *Terminalia paniculata* Roth. with which fossil leaves closely resemble is a large tree presently found to grow in the dry and moist forests of Western Ghats from Kokan southwards through Kanara, Malabar, Coorg to Travancore (Pearson and Brown 1932, Rao and Purkayatha 1972)

Family: **Combretaceae** Brandis
Genus: ***Calycopteris*** Linn.
Calycopteris floribundoides Prasad, 1990 (Fig. 3 d, e)
Material: This species consists of a single well-preserved leaf- impression.
Description: Leaf simple, almost symmetrical, elliptic; preserved size 7.0 x 3.5 cm; apex acute; base wide acute, slightly inequalateral; margin entire; texture coriaceous; petiole not preserved; venation pinnate, simple craspedodromous to eucamptodromous; primary vein (1°) single, prominent, stout, almost straight; secondary veins

Table 1. List of fossil leaves of genus *Terminalia* Linn. reported from different geological ages in India and abroad and their distinguishing characters from present fossil leaf

Species	Locality/Period/Horizon	Distinguishing characters
Terminaliphyllum rectinervis Velenovsky 1884, 1889	Upper Cretaceous of Bohemia	Narrow elliptic, 6.0 x 2.5 cm, acute apex and base. secondary veins only 7 pairs and closely placed
Terminaliophyllum sp. Geyler 1887	Eocene of Borneo	-
T. keayi Puri 1965	Post Eocene of Nigeria	Size 6.0 x 4.8 cm, secondary veins 4-5 pairs, visible,1.3-2.0 cm apart, angle of divergence 70°-85°
T. faggei Puri 1965	Post Eocene of Nigrria	Elliptic, 8.0 x 2.03 cm, secondary veins 5-6 pairs, angle of divergence 55Ú-60Ú
Terminalia cf. *T. catapa* Nemejc 1975	Tertiary of Czeckoslovakia	Obovate, 12.0 x 3.3 cm, apex obovate, base cuneate, Secondary veins branched near margin
Terminalia claibornensis (Berry) Ball 1931	Eocene of Texas	Narrow elliptic,10.5 x 3.0 cm, base cuneate, secondary veins numerous, fine, closely placed
T. indicola (Berry) Ball 1931	Eocene of Texas	Lanceolate, 20.0 x 6.0 cm, base cuneate, venation camptodromous
T. elegans Schimper 1874	Miocene of Greenland	Oblong, apex obtuse, venation camptodromous, secondary veins closely placed
T. estimina Macginitie 1941	Middle Eocene of Central Sierra, Nevada, USA	Ovate- obovate, 11.0 x 5.0 cm., base cuneate, secondary veins 6-9 pairs, 0.4-1.4 cm apart, angle of divergence 40°-50°, loop formation,
T. europea Weyland 1942	Tertiary of Germany	Obovate- elliptic, 6.0-9.0 x 2.1-2.8 cm, base cuneate, venation camptdromous, angle of divergence 50°-55°
T. fenzliana (Unger) Nemejc 1975	Tertiary of Czeckoslovakia	Asymmetrical, obovate with serrate margin, apex obtuse
T. gypsorum (Saporta) Schimper 1874	-	-
T. italica Berry 1919	-	-
T. maxima Principi 1915	Tertiary of Brazil	-
T. miocenica Weyland 1942	Tertiary of Germany	Leaf ovate, apex cuneate
T. kachchhensis Lakhanpal and Guleria 1981	Tertiary of Kachchh	Elliptic-oblong, 8.0 x 6.0 cm, base rounded, secondary veins 10 pairs visible, angle of divergence 55°-80°
T. lauriana Krasser 1903	Tertiary of Brazil	-
T. lesleyana Berry 1916	Eocene of South-eastern N. America	Obovate,15.0 x 8.0 cm, venation camptodromous secondary veins numerous, closely placed, angle of divergence 45°
T. panandhroensis Lakhanpal and Guleria 1981; Awasthi and Prasad 1990; Prasad 1994	Tertiary of Kachchh, India, Siwalik of Surai Khola, Nepal, Siwalik of Koilabas, Nepal	Elliptic, 16.0 x 10.5 cm, wide, secondary veins 10 pairs, angle of divergence 75°-90°
T. panonica Unger 1867	Tertiary of South Guistine	Elliptic-ovate, 9.8 x 3.2 cm, base acute, secondary veins 5 pairs, 0.5-2.5 cm apart, angle of divergence about 60°
T. phaeocarpoide Berry 1914	Eocene of South Carolina, USA	Obovate, 16.0 x 8.0 cm, base cuneate, venation camptodromous, secondary veins 8 pairs, angle of divergence 50°
T. radobojana Unger 1867	Tertiary of Kumi, Euboea	Ovate, 8.0 x 3.9 cm., base acute, secondary veins 10 pairs, 0.3 0.9 cm apart, angle of divergence 60°
T. rottensis Weyland 1942	Tertiary of Germany	Obovate, 6.7 x 3.5 cm, apex obtuse, base cuneate, venation camptodromous, secondary veins 10 pairs, 0.4-1.2 cm, angle of divergence about 60°

Species	Locality/Period/Horizon	Distinguishing characters
T. tallyana Ett. Schimper 1874	Miocene of Greenland	Obovate to lanceolate, 10.0 x 3.0 cm, venation camptodromous, angle of divergence 40°-50°
T. trinitense (Berry) LaMotte 1952	Cenozoic of North America	-
T. ungeri (Ett.) Nemejc 1975	Tertiary of Czeckoslovakia	Oblong - lanceolate, venation brochidodromous
Terminalia sp. Hollik 1936	Tertiary of Alaska	Wide elliptic 6.0 x 5.8 cm, base acute, secondary veins 8-9 pairs visible, 0.5-1.3 cm apart, angle of divergence 60°-70°
Terminalia sp. Matsuo 1970	Palaeogene of Japan	Elliptic- ovate. 6.5 x 3.3 cm, apex wide acute, secondary veins about 20 pairs, angle of divergence 40°-70°
Terminalia sp. Tripathi and Tiwari 1983	Siwalik of Koilabas, Nepal	Elliptic 7.4 x 3.5 cm, base acute, secondary veins 6-7 pairs, 0.4-1.2 cm apart
T. koilabasensis Prasad 1990	Siwalik of Koilabas, Nepal	Narrow elliptic,7.0 x 6.0 cm, base cuneate, secondary veins 11 pairs, 0.6-1 cm apartangle of divergence, 65°-70°, more acute on one side
T. siwalica Prasad 1990	Siwalik of Koilabas, Nepal	Obovate, 8.9 x 4.0 cm, base acute, unequal, secondary veins 7-8 pairs, angle of divergence, 50°
T. palaeochebula Awasthi and Prasad 1990, Agarwal 2002, Khan et al. 2008	Siwalik of Suraikhola, Nepal, Miocene of Neyveli Lignite, South India, Siwalik of Arunachal Pradesh, India	Elliptic,12.0 x 6.5 cm, secondary veins 8-9 pairs, angle of divergence, 60°
T. chebula Singh and Prasad 2007	Late Tertiary of Mahuadanr, Jharkhand	Elliptic, 21 x 10.7 cm, base rounded, secondary veins 17-18 pairs, angle of divergence about 70°
T. tomentosa Bande and Srivastava 1990	Late Tertiary of Mahuadanr, Jharkhand	Fragment, 4.4 x 4.5 cm, acuminate apex, camptodromous – eucamtpdromous, secondary veins. Only 3-4 pairs visible, sharply curved near the margin
T. palaeopaniculata Agarwal 2002	Miocene of Neyveli Lignite, South India	Narrow elliptic, 6.8 x 5.0 cm, secondary veins 5-6 pairs, 0.7-0.8 cm apart, angle of divergence 50°-60°
Terminalia himachalensis Prasad et al. 2013	Siwalik of Sarkaghat, Himachal Pradesh	Nnarrow oblong, 12.6 x 4.5 cm, secondary veins 11-12 pairs visible, 0.8-1.4cm apart, angle of divergence 60°-70°
T. neyvelensis Agarwal 2002	Miocene of Neyveli Lignite, South India	Elliptic, 6.0 x 2.5 cm, secondary veins 5-6 pairs, 0.7-0.8 cm apart, angle of divergence 50°-60°
T. mulleri Trivedi and Srivastava 1985	Siwalik of Ranibagh, Uttaranchal	elliptic, 3.0 x 1.6 cm, apex obtuse, venation camptodromous, secondary veins 10 pairs, closely placed, angle of divergence 45°-65°
T. balugoloensis Lakhanpal and Awasthi 1992	Siwalik of Balugoloa, Himachal Pradesh	Narrow elliptic,18.5 x 5.0 cm, apex acuminate, secondary veins 16 pairs 0.8-1.4 cm apart
T. miobelerica Prasad 1994, Antal and Prasad 1998, Agarwal 2002	Siwalik of Kathgodam, UttaranchalSiwalik of West Bengal, Miocene of Neyveli Lignite, South India	Asymmetrical elliptic,12.0 x 6.5 -7.5 cm, secondary veins 6 pairs, 1.3-3.2 cm apart, angle of divergence 65°
T. obovata Awasthi and Mehrotra 1995	Oligocene of Makum Coalfield, Assam	Narrow obovate, 9.5 X 4.5 cm, apex rounded, secondary veins 9 pairs, 0.9-1.2 cm apart, angle of divergence 45°-65°

Species	Locality/Period/Horizon	Distinguishing characters
T. palaeocatapa Awasthi and Mehrotra 1995, Mehrotra 2000, Agarwal 2002	Oligocene of Makum Miocene of Neyveli lignite, South India Coalfield, Assam Tura Formation, Meghalaya, Upper Siwalik of Arunachal Pradesh	Narrow obovate, 13 X 8.5 cm, apex, obtuse-rounded, secondary veins 12 pairs visible 0.7-1.7 cm apart, angle of divergence 70º-80º, bifurcated
T. precatapa Tiwari and Mehrotra 2002	Oligocene of Mizoram	Obovate shape with obtuse apex
T. bhairauvensis Prasad et al. 2017	Siwalik of Tanakpur, Uttarakhand	Narrow elliptic, 8.0 x 3.0 cm, base wide acute, asymmetrical, secondary veins 9 pairs, angle of divergence 60º-65º

(2°) 6-7 pairs visible, 0.5-1.4 cm apart, angle of divergence acute, moderate (about 55°), uniformly curved up, usually alternate to sub-opposite, unbranched; tertiary veins, (3°) fine, poorly preserved with angle of origin usually RR, percurrent, unbranched, straight, oblique in relation to midvein, predominantly alternate and close.

Specimen: BSIP Museum specimen no. 41266.

Locality: Sagoti Bridge Section near Bawali (31º44.26' N 76º43.33' E) about 7 km from Sarkaghat on Sarkaghat- Dharampur Road, Mandi District, Himachal Pradesh, India.

Horizon and age: Middle Siwalik Formation; Upper Miocene.

Remarks: The characteristic features of the fossil leaf are elliptic shape, acute apex, and wide acute, inequalateral base, entire margin, coriaceous texture and craspedodromous to eucamptodromous venation and percurrent, RR tertiary veins. These characters tend to indicate their affinity with the genus *Calycopteris* Lam. of the family Combrataceae and show the nearest resemblance to *Calycopteris floribunda* Lam. (C. N. H. Herbarium Sheet No. 741; Fig. 3 f, g). The fossil leaf also bears superficial similarity with modern leaves of *Aeschynanthus ramosissima* Wall. of Gesneraceae, *Bignonia chamberlaynii* Sims. of Bignoniaceae, *Quisqualis indica* Blanco of Combretaceae and *Salvadora persica* Linn. of Salvadoracea in their shape, size, base, and apex, but entirely differ in venation pattern especially in nature and arrangement of secondary and tertiary veins.

As far as the author is aware there is a report of two fossil leaves resembling the genus, *Calycopteris* Lam. First is *Calycopteris floribundoides* Prasad (1990) from the Siwalik sediments of the Koilabas area, Western Nepal, and second is *Calycopters palaeofloribunda* Mehrotra, (2000) from the Tura Formation of Nangwalbibra, Garo Hills of Meghalaya. On comparison of the present fossil with those above known fossils it was found that *Calycopteris floribundoides* Prasad (1990) shows the closest similarity in almost all the features. *Calycopteris* Lam. is a monotypic genus represented by *Calycopteris floribunda* Lam. which is a large shrub growing in deciduous forests of the western peninsula, Assam, Chittagong and Upper and Lower Burma (Brandis 1971). It is also found in central and

Figure. 3. *Terminalia miopaniculata* n. sp. **(a)** Fossil leaf showing shape, size and venation pattern (B.S.I.P Museum specimen no. 41267). (b) *Terminalia miopaniculata* n. sp. -Another fossil leaf showing variation in size (B.S.I.P Museum specimen no. 41268). (c) *Terminalia paniculata* Roth.-Modern leaf showing similar shape, size and venation pattern. (d) *Calycopteris floribundoides* Prasad - Fossil leaf showing shape, size and venation pattern (B.S.I.P Museum specimen no. 41266). (e) *Calycopteris floribunda* Lam. -Modern leaf showing similar shape, size and venation pattern. (f) *Calycopteris floribundoides* Prasad .- Part of fossil leaf magnified to show details of venation. (g) *Calycopteris floribunda* Lam. - Part of modern leaf magnified to show similar details of venation

southern India, especially in deciduous forests along water courses in the Circars, Deccan and Bangladesh (Gamble 1972).

RESULTS AND DISCUSSION

Investigations on fossil leaves collected from the Middle Siwalik sediments of the Sarkaghat area revealed the occurrence of two new fossil leaves resembling the extant taxa *Terminalia paniculata* Roth. and *Calycopteris floribunda* Lam. belonging to the family Combretaceae. The morpho taxonomy of these fossil leaves has been illustrated in detail along with their description, affinity and comparisons with already known fossils of their genus. *Terminalia paniculata* Roth. is a large tree presently found to grow in the moist deciduous forests of the Western Ghats, while *Calycopteris floribunda* Lam. is a large shrub growing in deciduous forests of the western peninsula, Assam, Chittagong, and Myanmar. It is also found in waterlogging places in central and southern India (Rao and Purkayastha 1972, Gamble 1972). The distribution pattern of both the extant taxa indicates that the Sarkaghat area enjoyed a tropical humid climate during the Middle Siwalik period. It further shows the existence of moist deciduous forests during the deposition of Siwalik sediments in contrast to dry deciduous forests.

The Siwalik flora of India and Nepal shows that the family Combretaceae is represented by the genus *Terminalia, Anogiessus, Combretum,* and *Calycoptris* which presently thrives in tropical and subtropical regions, particularly along the tropical seacoasts in African Savannas, and in Asian monsoon forests. Of these, *Terminalia* Linn. is a large genus with more than 150 species of mainly large trees. Its oldest record is from the Upper Cretaceous of Bohemia (Velenovsky1884,1889) (Table 1). In India, the fossils of this genus have been reported as early as from Palaeocene–Eocene localities of eastern and western India (Prakash and Dayal 1968, Mehrotra 2000, Singh et al. 2011). *Terminalia* Linn. is also well represented in the fossil record by the carbonized and petrified fossil wood. Based on this, more than 42 fossil species have been reported from Cenozoic sediments in India and abroad (Prakash 1979, Prasad 1989, Guleria 1990, Srivastava and Bande 1992, Agarwal 1998). Thus, from the above discussion it is evident that *Terminalia* Linn. was widely spread during the geological past and continued from the Late Cretaceous to the present.

CONCLUSIONS

Two new leaf fossils resembling the extant taxa, *Terminalia paniculata* Roth. and *Calycoppteris floribunda* Lam. of the family Combretaceae have been reported from Siwalik (Upper Miocene) sediments of the Sarkaghat area, Himachal Pradesh, India. Nowadays, both the comparable extant taxa are distributed in the moist deciduous forests of Indian region. The presence of these taxa in the Himalayan foot hills of Himachal Pradesh during Upper Miocene times indicates that moist deciduous forest existed under tropical humid climate instead of mixed deciduous forest at present. The fossil records indicate that *Terminalia* Linn. was cosmopolitan in distribution during the geological past and continued from the Late Cretaceous to the present. Based on plant mega fossils, including fossil woods, leaves, and fruits, about 100 fossil species of this genus have been reported from Cenozoic sediments all over the world. Its oldest record is from the Upper Cretaceous.

ACKNOWLEDGEMENTS

We are grateful to the Director, Birbal Sahni Institute of Paleobotany, Lucknow for providing necessary facilities during the progress of this work. We are also grateful to the authorities of the Central National Herbarium, Sibpur, Howrah, West Bengal for giving permission to consult the Herbarium for the identification of the fossils.

Authors' contributions: All authors contributed equally.

Conflict of interest: The authors declare no conflict of interest.

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Received: 12th Septemeber 2024
Accepted: 16th November 2024