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Two new fossil leaf species, *Fissistigma himachalensis* (family: *Annonaceae*) and *Berberis siwalika* (family: *Berberidaceae*), from Middle Siwalik of Sarkaghat, Himachal Pradesh, India

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ABSTRACT

Singh H., Ranjan R., Singh P.K. & Prasad M. 2022. Two new fossil leaf species, *Fissistigma himachalensis* (family: *Annonaceae*) and *Berberis siwalika* (family: *Berberidaceae*), from Middle Siwalik of Sarkaghat, Himachal Pradesh, India. Geophytology 52(1&2): 57–66.

Morphotaxonomical study on the fossil leaves collected from Siwalik sediments of Sarkaghat, Himachal Pradesh, India revealed the occurrence of two new fossil species, *Fissistigma himachalensis* and *Berberis siwalika* belonging to the families, *Annonaceae* and *Berberidaceae*. The analysis of present day distribution of the comparable species, *Fissistigma rubiginosum* (A.DC.) Merr. and *Berberis manipurana* Ahrendt of the fossils suggests that they do not grow in and around the study area as well as sub-Himalayan zone of Himachal Pradesh but are presently distributed in the evergreen forests of north-east India and south-east Asian region. This suggests that after Miocene these taxa could not survive there and migrated towards north-east and south-east region. Based on the data available the palaeoclimatic and phytogeographical aspect of both the taxa has been discussed.

Keywords: Fossil leaves, *Annonaceae*, *Berberidaceae*, Siwalik Group (Upper Miocene), palaeoclimate, phytogeography, Sarkaghat, Himachal Pradesh, India,

INTRODUCTION

The sediments of Siwalik Group were deposited continuously by various rivers in the Himalayan foreland during last 20 million years (Johnson et al. 1985). These sediments provide an excellent opportunity to study plant macrofossils including fossil wood, leaf, fruit and seed impressions entombed in alluvial sediments. These sediments comprise mudstone, sandstone and coarsely bedded conglomerates and delimited in the south by the Main Frontal Thrust (MFT) and in the north by Main Boundary Thrust (MBT). A number of macrofossils have so far been reported from the Siwalik sediments exposed at different localities (e.g. Nalagarh, Nahan, Jawalamukhi, Ranital, Bilaspur and Sarkaghat) in the Himalayan foot hills of Himachal Pradesh, India (Lakhanpal 1965, 1969, Lakhanpal & Awasthi 1992, Lakhanpal et al. 1987. Prakash 1975, 1979, Yadav 1989, Prasad 2008, 2010, 2012, Prasad et al. 2013a, Tiwari et al. 2022). The present investigation is based on the collection of a variety of plant macrofossils from Sarkaghat, Mandi District, Himachal Pradesh, India.

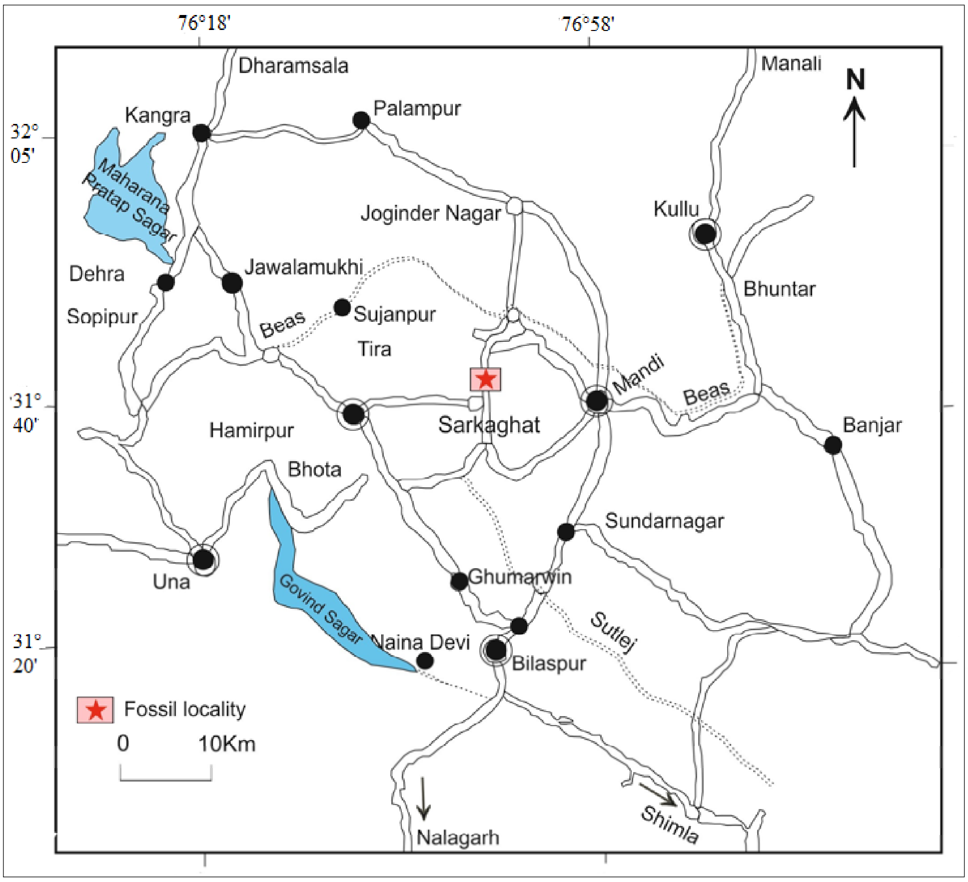

Figure 1. Map showing location of the study area, Sarkaghat in Mandi District, Himachal Pradesh, India.

The fossil locality, Sarkaghat (Lat. 31°44’26" N, Long. 76°43’33" E) lies along the National Highway 70, very near to Sarkaghat area of Mandi District, Himachal Pradesh (Figure 1). The fossil specimens of leaf impressions were collected from Middle Siwalik sediments exposed in a road cutting section (Lat. 31°44.265’ N, 76°43.339’ E) about 7 km from Sarkaghat town on the left side of main road which leads to Dharampur. The Middle Siwalik sediments are well developed in the area all along the road leading to Dharampur (Figure 2). The sediments consist of shale, sandstones and siltstones. A large number of well preserved leaf and fruit impressions are collected from thinly bedded shale units from the road cutting section. Out of the rich collection comprising variety of plant megafossils made earlier from the Middle Siwalik sediments of Sarkaghat area, only few of them were reported so far (Prasad et al. 2013a). Further study on the fossil leaves of this area revealed the occurrence of two new dicotyledonous taxa which have been described and discussed for their palaeoclimatic and phytogeographic perspectives in this communication.

GEOLOGICAL SET-UP

The Siwalik Group is delimited in the south by the Main Frontal Thrust (MFT) and in the north by Main Boundary Thrust (MBT). It consists of mainly fluvial deposits of Neogene age ranging from Miocene (15 Ma) to Pliocene (Tokuoka et al. 1994). This extends all along the Himalaya forming the southernmost hill range with width of 8-50 km. The general dip of the beds of the Siwalik Group has northward trend with varying angles and the overall strike is east west.

Sarkaghat Anticline is exposed in the northeastern part of the Kangra re-entrant of the Himachal Sub-Himalaya along the northerly dipping Main Boundary Fault (MBF) between the NNW-SSE trending Awah Devi-Lamba Graon Syncline in south and Main

Figure 2. Middle Siwalik section exposed along Sarkaghat-Dharampur Road from where fossil leaves were collected.

Boundary Fault (MBF) in north. It is a regional structure in the Paleogene-Siwalik belt around west Sarkaghat. Based on litho-association, grain size, compactness and internal geometry of beds, five mappable lithostratigraphic units of the Siwalik Group have been classified viz. Nahan Formation of the Lower Siwalik Subgroup, Dewal and Mohargarh Formations of the Middle Siwalik Subgroup and Pinjor and Kalar Formations of the Upper Siwalik Subgroup within the MBF related Sarkaghat Anticline structure.

Middle Siwalik consists predominantly of sandstones of light grey colour, which vary in thickness from 10 to 20 m. They are coarse grained and grade from greywacke in the lower portion to arkose in the higher portions. They are soft and friable because of lack of calcareous matter which occurs in segregation rather than disseminated throughout the mass as in the Lower Siwaliks. Pebbles are common in the coarser clastics especially towards the top where the clays are dull coloured and more arenaceous. The thickness of Middle Siwalik is ~1390 m. In Jammu foot-hills, the Middle Siwalik is made up of sandstones interbedded with clay bands and segregated calcareous nodules. The sandstones are coarse grained, arkosic, pebbliferous and contain pyrite. In the Jawalamukhi area, a thick prism of conglomerate occurs within the Middle Siwalik. In Sirmaur area, the Middle Siwalik is about 2000 m in thickness and consists of alternations of clays and sandstones in the upper part.

The fossil locality, Sarkaghat (Lat. 31°44'26" N, Long. 76°43'33" E), lies along the National Highway 70 in Mandi District, Himachal Pradesh. The fossil leaf bearing bed is a part of Middle Siwalik Sarkaghat anticline. About 8 km from the leaf fossil site is the Nalad Khad section (Lat. 31°46’N, Long. 76°43’E) which has been magnetostratigraphically studied and dated by earlier workers (Brozovic & Burbank 2000). The Nalad Khad section is located at, on the western limb of the Sarkaghat anticline, and in the Jawalamukhi thrust sheet. It is characterized by mainly thick units of fine to coarse, dark grey indurate, multistoried sandstones with red, yellow and brown pedogenic mudstones. They have also correlated the local magnetic polarity stratigraphy (MPS) to the global magnetic polarity stratigraphic time scale (MPTS) (Cande & Kent 1992).

MATERIAL AND METHOD

Three leaf impressions showing close resemblance with the genus, *Fissistigma* Griffith and *Berberis* Linn. are collected from Middle Siwalik (Upper Miocene) sediments exposed in a road cutting section (31°44'15.70" N, 76°43'20.19" E) near a well-known town, Sarkaghat which falls in Mandi District of Himachal Pradesh (Figure 1, 2). The fossil locality is situated on the left side of main road which leads to Dharampur and easily accessible through vehicle and the leaf impressions were devoid of cuticle and preserved on grey shale. Fossil leaves have been studied morphologically with the help of hand lens and low power microscope under reflected light. The herbarium sheets of several extant families and genera were examined at Central National Herbarium, Shibpur, Howrah, West Bengal in order to identify these leaf impressions. For the description of leaf impressions, the terminology given by Hickey (1973) and Dilcher (1974) has been followed. The photograph of the leaf of the modern comparable taxa has been provided to show similarity with the fossil leaves.

SYSTEMATIC PALAEOBOTANY

Phylum: *Tracheophyta* Sinnott ex Caval.-Sm.

Class: *Magnoliopsida* Brongn.

Order: *Magnoliales* Juss. ex Bercht & J. Persl.

Family: *Annonaceae* Juss.

Genus: *Fissistigma* Linn.

Fissistigma himachalensis Huk. Singh, R. Ranjan, P.K. Singh & Mah. Prasad **n. sp.**

Figure 3.e, g

Material: one specimen.

Diagnosis: Leaf oblong in shape; base wide acute, asymmetrical; margin entire; venation pinnate, eucamptodromous; secondary veins 8–9 pairs visible, angle of divergence moderately acute, uniformly curved up and join to their superadjacent secondary veins, curvature more pronounced near the margin, tertiary veins with angle of origin RR, percurrent, oblique to right angle (near the margin) in relation to midvein.

Description: Leaf simple, asymmetrical, oblong, preserved size 7.2 × 2.5 cm; apex indistinct; base wide acute, oblique; margin entire; texture thick chartaceous; petiole indistinct; venation pinnate, eucamptodromous; primary vein (1°) single, straight, prominent, stout; secondary veins (2°) about 8–9 pairs visible, less than 1.0 cm apart, alternate to sub-opposite, angle of divergence 55°–65°, moderately acute, uniformly curved up and join to their superadjacent secondary veins before the margin, curvature more pronounced near the margin, unbranched; tertiary veins (3°) slightly thick, angle of origin RR, percurrent, straight to sinuous, oblique to nearly right angle (near the margin) in relation to midvein, predominantly alternate and close to nearly distant.

Holotype: Specimen No. MLK/S/211.

Type locality: Sarkaghat-Dharampur Road section (31°44'15.70" N, 76°43'20.19" E), Sarkaghat, Mandi District, Himachal Pradesh, India.

Horizon and Age: Middle Siwalik Formation; Upper Miocene.

Etymology: The specific name is after Himachal Pradesh, name of the state to which fossil locality belongs.

Affinity: The distinguishing features of the present fossil leaf are oblong shape, oblique, wide acute base, entire margin, eucamptodromous venation, secondary veins with moderately acute angle of divergence having sharp curvature near the margin and RR, percurrent, straight to sinuous tertiary veins having oblique to right angle relation to midvein. These features collectively suggest its closest resemblance with extant taxon *Fissistigma rubiginosum* (A. DC.) Merr. of the family *Annonaceae* (C.N.H. Howrah, Herbarium Sheet no.12642, Figure 3.f, h). The fossil leaf also shows near resemblance with the modern leaves of some other annonaceous taxa, *Mitrephora macrophylla* Oliver (C.N.H. Howrah Herbarium Sheet no. 13318), *Unona longiflora* Roxb. and

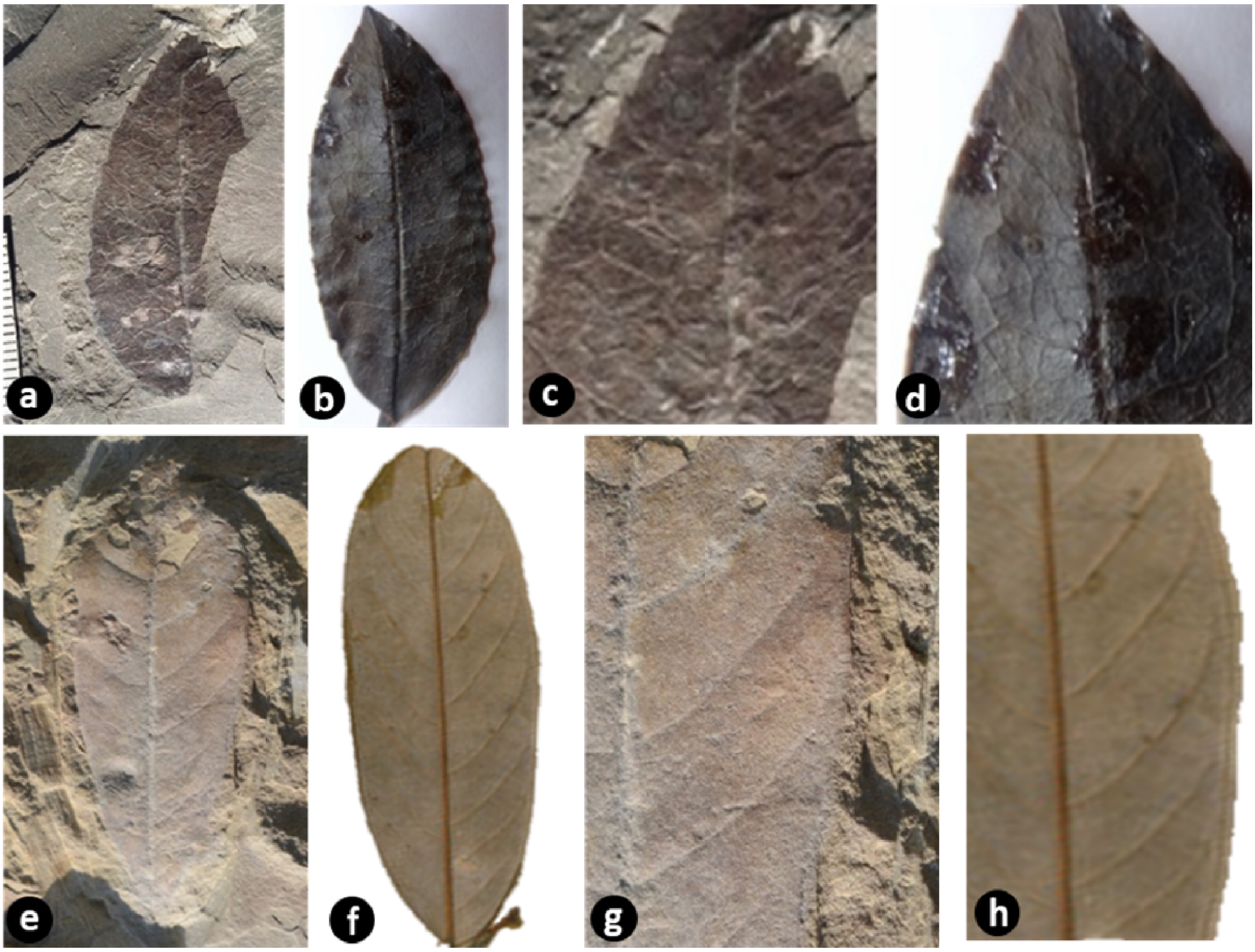

Figure 3. a-d. *Berberis siwalika* Huk. Singh et al. **n. sp. a.** Fossil leaf in natural size showing shape, size and venation pattern; Holotype specimen no. MLK/S/212. **b.** Modern leaf *Berberis manipurana* Ahrendt showing similarity with the fossil leaf. **c.** A part of fossil leaf magnified to show the details of margin and venation pattern. **d.** A part of modern comparable leaf magnified to show the similar details of margin and venation as the fossil. **e-h. *Fissistigma himachalensis*** Huk. Singh et al. **n. sp. e.** Fossil leaf in natural size showing shape, size and venation pattern; Holotype specimen no. MLK/S/211. **f.** Modern leaf *Fissistigma rubiginosum* A. DC. showing similarity with the fossil leaf. **g.** A part of fossil leaf magnified to show the details of venation pattern. **h.** A part of modern comparable leaf magnified to show the similar details of venation pattern as the fossil.

Cananga odorata Hook. F. & Th. (C.N.H. Howrah, Herbarium Sheet no. 1076). The comparative study revealed that the modern leaves of above mention taxa differ mainly in possessing larger size and the nature of base is generally normal as compared to oblique base in the present fossils.

Fossil records and comparison: So far, three fossil species under the genus, *Fissistigma* Griff. have been described from the Siwalik sediments of India and Nepal. Lakhanpal (1969) described a fossil leaf as *Fissistigma senii* from the Siwalik sediments of Jawalamukhi, Himachal Pradesh. Same species has also been reported by Prasad et al. (1997) from the Lower Siwalik sediments of Seria Naka at Indo-Nepal Border in Gonda District of Uttar Pradesh, Prasad (2006) from Lower Siwalik sediments of Bilaspur, Himachal Pradesh and Prasad (2012) from Lower Siwalik sediments of Sirmaur District, Himachal Pradesh. These leaf-impressions have been compared with the extant *Fissistigma wallichii* (Hook.f. & Th.) Merill. of the family *Annonaceae*. Lakhanpal and Awasthi (1992) reported another fossil leaf under the form species

Fissistigma siwalika from the Siwalik sediments of Jawalamukhi, Himachal Pradesh, India. This fossil is larger in size (14.5 x 5.3) having oblanceolate shape and rounded apex. The fossil leaf, *Fissistigma mioelegans* Prasad et al. 1999, described from Lower Siwalik sediments of Koilabas area, western Nepal has different nature of secondaries with distantly placed and arise less acutely in comparison to present fossil. Recently, Prasad et al., (2015) described a fossil leaf as *Fissistigma senii* Lakhanpal resembling with extant *Fissistigma bicolor* (Roxb.) Merr. Thus on critical comparison it has been found that the present fossil leaf *Fissistigma himachalensis* is entirely different from the above known fossil leaves in mainly venation pattern, specially the course and orientation of secondary and tertiary veins. Thus the present fossil leaf is described under the new species, *F. himachalensis*.

The genus, *Fissistigma* Griff. consists of about 75 species distributed in tropical Africa, China, North-east Australia and in Indo-Malayan region (Willis 1973). *Fissistigma rubiginosum* (A. DC.) Merr. With which fossil resembles is large, 30–40 feet evergreen woody climber distributed in Peninsular Malaysia (Kessler 1993).

Order: *Ranunculales* Juss. ex Bercht & J. Persl.

Family: *Berberidaceae* Juss.

Genus: *Berberis* Linn.

Berberis siwalika Huk. Singh, R. Ranjan, P.K. Singh & Mah. Prasad **n. sp.**

Figure 3. a, c

Material: one specimen.

Diagnosis: Leaf asymmetrical, elliptic; apex bluntly acute; wide acute to obtuse, oblique; margin non-entire; venation pinnate, eucamptodromous to brochidodromous; secondary veins 9–10 pairs visible, alternate to opposite, angle of divergence moderately acute to wide acute; tertiary veins moderate with angle of origin RR rarely AO, oblique in relation to midvein and almost close.

Description: Leaf simple, asymmetrical, elliptic, preserved size 4.2 × 1.5 cm; apex bluntly acute; base seemingly wide acute, oblique; margin non–entire, spinose; texture thick chartaceous; venation pinnate, eucamptodromous to brochidodromous; primary vein (1^0) single, straight, prominent, stout; secondary veins (2^0) 9–10 pairs visible, less than 0.5 cm apart, alternate to opposite, angle of divergence about 65°–80°, moderately acute to wide acute, uniformly curved up and joining superadjacent secondary veins, sometimes forming loop at acute angle; intersecondary veins present, simple; tertiary veins (3^0) moderate, angle of origin usually RR rarely AO, percurrent, straight to sinuous, oblique in relation to midvein, predominantly alternate and almost close.

Holotype: Specimen No. MLK/S/212.

Type locality: Sarkaghat-Dharampur Road section (31°44'15.70" N, 76°43'20.19" E), Sarkaghat, Mandi District, Himachal Pradesh, India.

Horizon and Age: Middle Siwalik Formation; Upper Miocene.

Etymology: The specific name is after Siwalik Group.

Affinity: The diagnostic features of the present fossil leaf, such as asymmetrical, small size with elliptic shape, acute apex, eucamptodromous to brochidodromous venation pattern, closely placed secondary, formation of loop and the nature and arrangement of tertiary veins show nearest affinity with the modern leaves of *Berberis manipurana* Ahrendt of the family *Berberidaceae* (C.N.H. Howrah, Herbarium Sheet no. 17248; Figure 3.b, d). The other species of *Berberis* like, *Berberis acida, B. alba, B. aquifolium, B. darwinii, B. dentate, B, edulis, B. thumbergii* and *B. vulgaris*, etc., differ mainly in the nature and arrangement of spines on the margin. This fossil also shows near resemblance with the extant leaves of the genus *Flacourtia* Comm. ex L'Herit. of the family *Achariaceae* but differs in possessing less number of secondary veins and its most of the species differ entirely in the nature of non-entire margin.

Fossil records and comparison: There is no record of fossil leaf resembling the genus *Berberis* Linn. from the Tertiary sediments of Indian subcontinent.

Although, a fossil species, *Berberis lyceum* Puri 1947 is known from Quaternary (Pleistocene) sediments of Karewa beds, Kashmir, India. So far, about 16 fossil species of *Berberis* Linn. have been reported from the Tertiary sediments of different parts of the world e.g. France, Hungary, Greece, Austria, Germany, Romania, United State, Japan and China etc. These are *Berberis lozanofolia*, *B. poblana, B. tepexiana* and *B. ahuehuetensis* from Oligocene sediments near Tepexi de Rodriguez Puebla, Mexico (Ramirez & Cevallos-Ferriz 2000), *B. coloradensis* and *B. hirsuta* Late Oligocene of Colorado, western United State (Axelrod 1987), *B. andreanszkyi* and *B. kymeana* (Saporta) from Oligocene sediments of Hungry, Europe (Kvaèek and Erdei,2001), *B. bursukensis* and *B. longipetiolata* from Miocene of Samata, Russia (Takhtajan 1974), *B. berberidifolia* (Heer) Palamarev and Petkova 1987 from Miocene sediments of Czeck Republic, Bulgaria, *B. teutonica* Kovar-Eder et al. 2004 from Miocene sediments of Styria, Austria, *B. goinai* and *B. cf. mougeotii* (Heer) from Miocene sediments of Romania (Givulescu 1990), *B. huziokai* Tanai & Suzuki 1963 from Miocene sediments of Hokkaido, Japan, *B. wuyunensis* Li et al. 2010 from Palaeocene sediments of Heilongjiang, China. The present Sarkaghat fossil leaf has been compared with above mentioned fossil leaves of the genus *Berberis* Linn. (Table 1) and concluded that none of them shows similarity with the present fossils. Thus, in being different from above known fossils, the present fossil leaf has been treated as new species, *Berberis siwalika.*

The genus *Berberis* Linn. comprises about 450–500 species of deciduous or evergreen shrubs distributed in tropical or subtropical regions of mainly in South America, Asia, Europe, Africa and North America. *B. manipurana* Ahrendt with which fossil shows affinity is an evergreen shrub found to grow in North- east Indian region (Hooker 1875).

DISCUSSION AND CONCLUSION

Morphotaxonomic study on the fossil leaves collected from Siwalik sediments of Sarkaghat area, Himachal Pradesh, India revealed the occurrence of two new angiospermous taxa. They show affinity to extant taxa, *Fissistigma rubiginosum* (A. DC.) Merr. of family *Annonaceae* and *Berberis manipurana* Ahrendt of family *Berberidaceae*. Based on habit and habitat and forest type of comparable extant species of the fossils suggests that a tropical, evergreen forest was flourishing in and around the study area during the Upper Miocene in contrast the mixed deciduous forests grow today. The present day distribution of the comparable species indicates that they occur in the evergreen forests of North-east India (Manipur) and South-East Asian region (Peninsular Malaya). It may therefore be surmised that a warm and humid climate was prevailed in Sarkaghat and nearby area during Upper Miocene. It also suggested that both the taxa do not grow now a day in the Himalayan foot hills of this region but migrated toward north east and south east because of change in climate after Miocene due to uplift of Himalaya.

In the Sarkaghat fossil assemblage, the family *Annonaceae* comprises only one fossil species, *Fissistima himachalensis* showing its affinity with *F. rubiginosum* (A. DC.). This is a pantropical family of tropical America and Africa (Mabberley 1997) occurring mainly in rainforests and with few species in temperate regions (Richardson et al. 2004). *Fissistigma* Griff. Consists of about 75 species distributed in tropical Africa, China, North-east Australia and in Indo-Malayan region (Willis 1973). However, more than 33 fossil taxa are recorded from Tertiary sediments of all over India (Prasad 2018; Table 2). The oldest known fossils of *Annonaceae* comprising seeds and pollen from the Maastrichtian of Nigeria and Colombia, respectively (Chesters 1955; Sole de Porta 1971) indicating a west Gondwanan origin for the family. The record of annonaceous fossils wood, *Polyalthioxylon parapaniense* (Guleria & Mehrotra 1999) and fossil leaves, *Polyalthia palaeosiamiarum* and *Miliusa pretomentosa* (Prasad et al. 2013b) from the Deccan Intertrappean beds (Maastrichtian-Danian) and fossil fruit and leaf of *Annona palustris* and *Polyalthia palaeosiamiarum* (leaf) from Palaeocene-Eocene of Cambay Shale Formation, India (Prasad et al. 2014, Singh et al. 2011) as well as other fossil report

Table 1. Fossil leaves resembling the genus *Berberis* Linn. from Tertiary sediments of India and abroad and their distinguishing characters from the present new fossil species.

Fossil Taxa	Locality/Horizon/Age	Distinguishing characters
Berberis lozanofolia Ramirez et Cevallos-Ferriz 2000	Oligocene sediments near Tepexi de Rodriguez Puebla, Mexico	Lamina elliptic obovate, symmetrical, margin entire or occasionally single tooth.
B. poblana Ramirez et Cevallos-Ferriz 2000	Oligocene sediments near Tepexi de Rodriguez, Puebla, Mexico	Leaf symmetrical, apex rounded, base cuneate and margin entire
B. tepexiana Ramirez and Cevallos-Ferriz 2000	Oligocene sediments near Tepexi de Rodriguez, Puebla, Mexico	Leaf symmetrical, obovate, apex rounded, acrodromous, margin with densely spinose teeth
B. ahuehuetensis, Ramirez and Cevallos-Ferriz 2000	Oligocene sediments near Tepexi de Rodriguez, Puebla, Mexico	Leaf symmetrical, obovate, apex narrowly rounded, margin serrate with large teeth
B. coloradensis Axelrod, 1987	Late Oligocene of Colorado, western United State	Leaf symmetrical, lanceolate, base cuneate, margin serrate with large teeth
B. hirsuta Axelrod 1987	Late Oligocene of Colorado, western United State	Leaf symmetrical, narrow oblong, apex and base rounded, margin entire or occasionally with single teeth
B. andreanszkyi Kvaček and Erdei 2001	Oligocene sediments of Hungry, Europe	Leaf symmetrical, apex acuminate, secondary uniformly spacing
B. kymeana (Saporta) Kvaček et Erdei 2001	Miocene sediments of Kymi, Greece, Europe	Leaf symmetrical, larger in size (L:W ratio 7:2), linear lanceolate
B. bursukensis Takhtajan 1974	Miocene of Samata, Russia	Leaf symmetrical, apex obtuse, base cuneate, decurrent, margin almost entire
B. longipetiolata Takhtajan 1974	Miocene of Samata, Russia	Leaf symmetrical, base cuneate, margin simple serrate, secondary veins arise more acutely from the midrib
B. teutonica Kovar-Eder et al. 2004	Miocene sediments of Styria, Austria	Leaf symmetrical, obovate, apex acuminate, base rounded, venation semicraspedodromous, random reticulate
B. berberidifolia (Heer) Palamarev and Petkova 1987	Miocene sediments of Czeck Republic, Bulgaria	Leaf obovate, apex obtuse, base decurrent, random reticulate
B. goinai Givulescu 1990	Miocene sediments of Romania	Late Leaf symmetrical, obovate, apex rounded, venation reticulodromous, random reticulate
B. cf. mougeotii (Heer) Givulescu 1990	Miocene sediments of Romania	Similar in shape and size, apex obtuse, base cuneate, venation reticulodromous, random reticulate
B. huziokai Tanai and Suzuki 1963	Miocene sediments of Hokkaido, Japan	Leaf symmetrical, narrow obovate, apex rounded, base cuneate venation semicraspedodromous
B. lyceum Puri 1947	Pleistocene of Karewa beds, Kashmir, India	Leaf symmetrical, linear oblong, base cuneate, venation semicraspedodromous
B. wuyunensis Li et al. 2010	Palaeocene sediments of Heilongjiang, China	Leaf symmetrical, oblong, apex rounded, margin serrate with densely spinose teeth, tertiaries random reticulate
Berberis siwalika Huk. Singh et al. n. sp.	Upper Miocene sediments of Sarkaghat, Himachal Pradesh, India	Leaf asymmetrical, small size with elliptic shape, margin non-entire, spinose, eucamptodromous to brochidodromous venation pattern, 9–10 pairs with closely placed secondary veins, angle of divergence 65^0–80^0

of *Annonaceae* from the Tertiary of India and Nepal (Prasad 2018, Table 2) support the view of a Gondwanan origin for the family.

Berberidaceae (Barberry family) is consisting of 18 genera and about 700 species of tree, shrub and herbaceous plant. This family has a disjunctive biogeography. Two species are disjunctly distributed between East Asia and North America with one in Japan and Korea and other one along the west coast of North America. *Berberis* Linn. is a large genus of deciduous and evergreen shrubs distributed throughout temperate or subtropical region of the world but the species density is greatest in South America and Asia, Europe Africa and North America. *Berberis* fossils were widely found in sediments of Palaeocene to Pleistocene age in the different part of Northern Hemisphere, (Table 1). In the Palaeocene (65.5–55.8 Ma), there was a land connection between Europe and North America; western North America and eastern Asia were connected via Beringia, while the Turgai Straits separated Asia from Europe (Scotese 1997). *Berberis* was recorded for the first time from Palaeocene of Wuyun, Heilongjiang, NE China, eastern Asia.

The fossil record of *Berberis* from Palaeocene sediments of N. E. China suggests its origin in eastern Asia during or before the Palaeocene (Li et al. 2010). Subsequently, it extended into western North America via Beringia during the Palaeogene and expanded southwards into Mexico in the Oligocene (Ramirez and Cevallos-Ferriz 2000). Later on, this genus probably arrived in Europe from Asia during the late Oligocene when Eurasia was reunited after the retreat of the Turgai Straits. *Berberis* could have migrated to India from eastern Asia during Miocene (based on present fossil) and flourished there in the Himalayan foot hills in Pleistocene (Puri 1947) and then moved eastwards in North-east Indian region after the last major upheaval of the Himalayas in the Pleistocene.

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