

Leaf Impressions of *Michelia Butanensis* (Magnoliaceae) And *Gyocardia Mio-Odorata*(Flacourtiaceae) From The Siwalik Bed of Bhutan

NITI SRIVASTAVA¹, P.P. TRIPATHI²

^{1,2} Department of Botany, M.L.K. P.G. College, Balrampur, U.P.

Abstract- The fossil i.e. Leaves impression of *Michelia butanensis* (Magnoliaceae), *Gyocardia mio-odorata*(Flacourtiaceae), *Zizyphus aenoplica* (Rhamnaceae) and *Butea siwalicus* (Fabaceae) were collected from the Siwalik Sediments (Formation-II) near Darranga and Lakshmi river section in Bhutan for detailed systemic study. The habit, habitat and present day distribution of the comparable extant taxa indicates the existence of tropical to sub-tropical evergreen to semi evergreen forest with humid climate in the area during the deposition of the Siwalik sediments.

Indexed Terms- Fossils, Leaf impression, Siwalik period,

I. INTRODUCTION

The Siwalik foreland basin accumulated a huge pile of molasse sediments since the middle Miocene to early Pleistocene between the Lesser Himalaya in the north and the Indo-Gangetic Plain in the south (Valdiya,2002). A variety of plant megafossils including petrified woods and impressions of leaves, fruits, flowers and seeds have been recorded from Siwalik Sediments of India and Nepal (Prakash and Tripathi, 1992; Prasad and Awasthi, 1996 and Prasad *et al.*, 1999). Very little detailed work was carried out so far considering the wide extent of Siwalik Sediments in the Bhutan sub Himalaya (Prasad and Tripathi,2000). Banerjee and Dasgupta (1984) described a few leaf impressions from the Siwalik sediments of Lakshmi and Darranga River sections under some artificial genera such as, *Siwalikiphyllum*, *Dilcheria*, *Ghosia*, *Pseudopaxillatophyllum* and *Darrangiophyllum*. Unfortunately, these artificial genera could not be compared with any extant taxa, They have discussed the palaeoenvironmental and palaeoecology of the area only on the basis of

morphological features of fossil leaves. In the the Siwalik sediments of Lakshmi and Darranga River sections area a detailed plant megafossils study is still lacking. Therefore, this research is mainly focused on the identification of plant impressions recovered from this area.

II. GEOLOGY OF THE STUDY AREA

The various Siwalik outcrops along the Himalayan foot hills of eastern Bhutan have more or less steep northerly dip and include well exposed Derrathang Section which seems mainly to belong to the Middle and Upper Siwaliks. The youngest outcrops occur near the Main Boundary Thrust and the oldest along the southern margin. Mallet (1875) also described the Middle and Upper Siwaliks from western and eastern Bhutan. Ganseer (1983) observed the classical three fold division in this region but mentioned that the distinction between the Lower and Middle sub division is not easily recognizable. Jangpangi (1974) followed them and suggested three fold division for south-eastern Bhutan in addition to the locally Diklai boulder beds.

III. MATERIAL AND METHODS

Material i.e. leaf impressions for present study were collected from the Siwalik sediment of the Lakshmi river Section in the south eastern part of Bhutan. The leaf impression are found preserved on both grey as well as brown calcareous shale. The specimens were cleared with the help of chisel and hammer. The leaf impressions were studied with the help of either hand lens or low power microscope under reflected light. In order to identify the leaf impression, a number of herbarium sheets of extant taxa were examined at NBRI, Lucknow, Forest Research Institute, Dehradun and Central National Herbarium Shibpur, Hawrah,

West Bengal. The leaf impressions showing various morphological characters were photographed in natural light and have been described following the terminology given by Dilcher (1974). The photographs of leaf impressions showing various morphological characters were taken under the natural low angled light using a Canon digital camera. The study of structural features of fossil angiospermous leaves such as size, venation, density, texture, margin, shape and nature of leaf tip etc was done by foliar physiognomy method as this method is independent of the systemic relationship of the species and error in the interpretation of palaeoclimate are minimized as compared to the nearest living relative method.

IV. RESULTS AND DISCUSSION

1) Systematics

Family: Magnoliaceae

Genus- *Michelia bhutanensis* sp. nov. (Plate1. Fig. 1&2)

Description: Leaf appearing simple; lamina asymmetrical, elliptic, ovate; preserved lamina length 8.1 cm; maximum preserved width 3.5 cm; base partly broken seems acute; margin entire, apex acute; texture chartaceous; petiole not preserved; venation, pinnate; simple craspedodromous; primary vein (1⁰), massive (3.56%) single; slightly curved, unbranched; secondary vein (2⁰) moderate, angle of divergence ranges from 48⁰-50⁰; relative thickness moderate, uniformly curved, unbranched; tertiary veins (3⁰) fine, percurrent, origin AO or RR, higher order venation not possible.

Affinities: The present fossil leaf is represented by possessing elliptic ovate shape; entire margin; acute apex; chartaceous texture; craspedodromous venation and moderate secondaries at angle of divergence 48⁰-50⁰. Such features are observed in some of the species of the genus *Magnolia* Linn. and *Michelia* Linn., of family Magnoliaceae. However, the modern leaf of *Magnolia campbellii* H.F. and *T. exhibits* elliptic ovate shape and identical size similar to the present specimen but differ from it in having coriaceous texture and straightly curved secondaries in contrast to chartaceous texture and uniformly curved secondaries in the present fossil. After detailed comparison of the

present specimen with the leaves of various species of *Michelia*, it was found that the leaves of *Michelia champaca* Linn. show a closest resemblance and affinity with the present fossil leaf. Both the fossil and modern leaves of *Michelia champaca* Linn. possess elliptic ovate shape, entire margin, acute apex, shortly narrowed base, chartaceous texture and uniformly curved secondaries.

Fossil Records and Comparison: Fossil records of the genus *Michelia* Linn. are not known from Nepal, India and abroad. Therefore, the present leaf impression forms the first fossil record of the genus *Michelia* Linn. of the family Magnoliaceae from Middle Siwalik sediments of Bhutan. Hence, it is described and named as *Michelia bhutanensis* sp. nov., the specific name indicating its occurrence during in south-eastern Bhutan.

2) Systematics

Family: Flacourtiaceae

Genus- *Gynocardia mio-odorata* sp. nov. (Plate1. Fig. 3 & 4)

Description: Leaf simple; lamina symmetrical; narrow elliptic (3:1); preserved lamina length 11.2 cm; maximum preserved width 4.5 cm; base broken; margin entire; apex acute; texture chartaceous; petiole not preserved; venation pinnate brochidodromous; primary vein (1⁰) single, straight, unbranched, massive (4.4%); secondary veins (2⁰) moderate, angle of divergence 55⁰-60⁰; joining superadjacent secondaries at an acute angle; tertiary veins (3⁰) and higher order venation are not visible.

Affinities: The important characters exhibited by the present fossil are narrow elliptical shape, brochidodromous venation and uniformly curved secondaries with angle of divergence ranging between 55⁰-60⁰. In all these characters the fossil leaf shows closest similarity with the modern leaf of *Gynocardia odorata* R.Br. of the family Flacourtiaceae.

Fossil Records and Comparison: Fossil leaf of *Gynocardia* R.Br. is not known from India and Bhutan. However fossil leaf of *Gynocardia* R.Br. showing nearest resemblance with modern leaves *Gynocardia odorata* R.Br. is known from lower

Siwalik beds of Koilabas (Prasad *et al.*,1999) western Nepal. The present fossil leaves also show nearest resemblance with modern leaves *Gynocardia odorata* R.Br. and is also the first record from Middle Siwalik beds of Bhutan. Hence it is recorded from Bhutan as *Gynocardia mio-odorata*.

Discussion: The genus *Michelia* Linn. of the family Magnoliaceae includes about 50 species which are found growing in tropical Asia and China (Willis, 1966,p.720). The species *Michelia champaca* Linn. with which the present fossil resembles is found growing wild in the forest of the temperate Himalaya, from Nepal eastward, and in Pegu, Tenasserim, the Nilgiris and Travancore. It is also found wild growing in Java (Hooker, 1875,p.43). The genus *Gynocardia* R.Br. includes a single species (Wills,1966;p509.), *Gynocardia odorata* R.Br. which is closest in resemblance to the present fossil leaf is found growing from Sikkim and the Khasia hills eastwards to Chittagong, Rangoon and Tenasserim (Hooker,1875,vol.1,p.195).

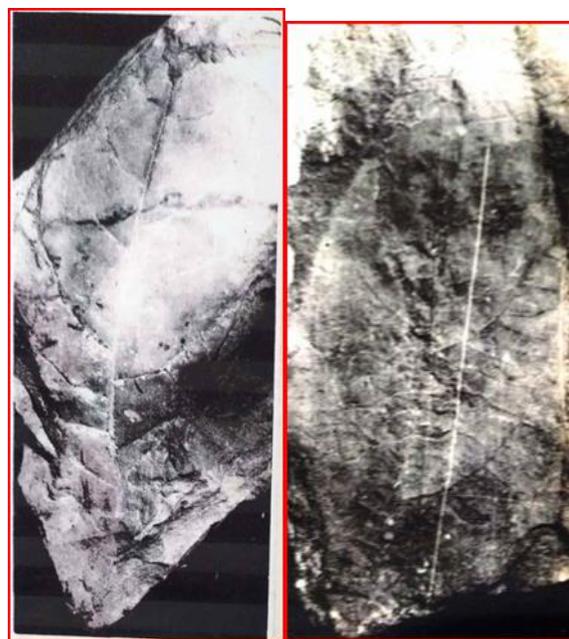
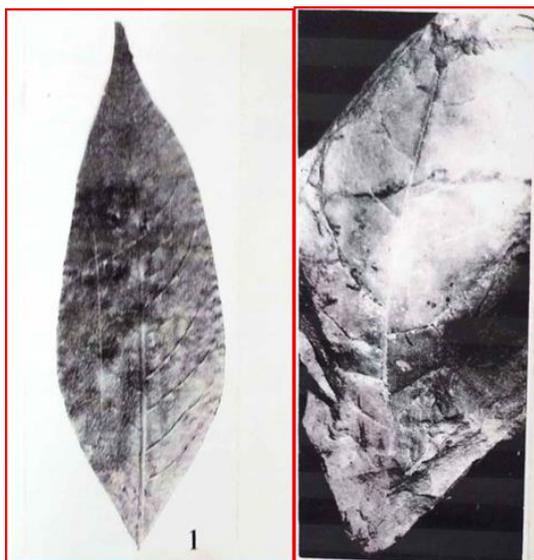


Plate-I.

Fig.1. Modern leaf of *Michelia champaca* in natural size showing similar shape, size and venation pattern.

Fig.2. Fossil leaf of *Michelia bhutanensis* magnified to show details of venation.

Fig.3. Modern leaf of *Gynocardia odorata* in natural size showing similar shape, size and venation.

Fig.4. . Fossil leaf of *Gynocardia mio-odorata* - magnified to show details of venation.

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