# Further contribution to the Late Cenozoic flora of Mahuadanr, Palamu District, Bihar

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Impressions of leaves belonging to *Grewia, Murraya, Schleichera, Mangifera, Vitex* and four different flowers are described from near Mahuadanr, Palamu District, Bihar. The floral evidence supports Late Cenozoic age for the sediments.

**Key-words**—Angiosperms, leaves, flowers, Late Cenozoic, Bihar, India.

## INTRODUCTION

A WELL preserved angiospermic flora, comprising impressions of leaves, fruits and flowers and silicified woods, has been described from the Late Cenozoic beds of Mahuadanr, Palamu District, Bihar (Prakash *et al.*, 1988; Bande & Srivastava, 1990; Srivastava & Bande, 1992). It consists of twenty seven species belonging to twenty four genera of seventeen dicotyledonous families. The geology of the area has been worked out in detail by Puri and Mishra (1982). Pyroclastic sediments, conglomerate, sandstone and shale are the main rock types of the area. The underlying conglomerate/sandstone units have yielded petrified woods whereas impressions of leaves, flowers and fruits etc. have been described from the overlying shale unit.

## SYSTEMATIC DESCRIPTION

### LEAVES

### Family — Tiliaceae

*Grewia tiliaefolia* Vahl
Pl.1, fig.1

*Material* - One incomplete specimen without apical portion.

*Description* - Leaf simple, preserved length 11.5 cm, width 5.5 cm, asymmetrical, wide elliptic, apex not preserved; base unequal, auriculate; margin serrate, serration axes inclined to the tangent of the margin, apical angle obtuse, serration type convex/convex, spacing regular, teeth of one size; texture chartaceous; petiole present, normal; venation acrodromous, basal, perfect; primary veins ($1^0$) moderate, middle primary vein straight while the laterral primaries markedly curved; secondary veins ($2^0$) with acute (moderate) angle of divergence, variation in angle of divergence nearly uniform, moderately thick, uniformly curving without forming loop, inter-secondary and intramarginal veins absent; tertiary veins ($3^0$) AR, percurrent, simple, unbranched, tertiaries arising from the middle primary approximately at right angles while those arising from lateral primaries oblique, alternate, opposite in about equal proportions, closely spaced; highest vein order of leaf $4^0$, which also shows highest vein order showing excurrent branching, quaternary veins thin, orthogonal; marginal ultimate venation incomplete; areoles well developed, oriented, quadrangular in shape, veinlets none.

*Discussion* - The fossil leaf is characterised by its elliptic shape, toothed margin, unequal base, and acrodromous venation with percurrent tertiaries that suggest its nearest comparison with the modern leaves of *Helicteres isora, Mallotus philippensis, Ziziphus mauritiana* and various species of *Grewia*. Out of these it shows closest resemblence with *Grewia tiliaefolia* Vahl. (F.R.I. herb. sheet no. 9552; B.S.I.P. herbarium collection no. 14023; pl.1, fig.2).

Fossil woods and leaf-impressions of *Grewia* are known from various Cenozoic sediments of India. The

woods are described from the Deccan Intertrappean beds viz., *Grewioxylon mahurzariense* (modern comparable form *Grewia leavigata,*) and *Grewioxylon* sp. (Prakash & Dayal, 1965; Lakhanpal, Prakash & Bande, 1978). Lakhanpal (1955) described a fossil leaf *Grewia foxii* from the Eocene of Garo Hills, Meghalaya and compared it with *Grewia tiliaefolia* var. *argentea* Burret.

*Grewia tiliaefolia* is a moderate-size tree found in the sub-Himalayan tract from Yamuna to Nepal, throughout central and southern India (Pearson & Brown, 1932). It also grows in Chotanagpur region (Wood, 1903; Haines, 1910).

## Family — Rutaceae

*Murraya paniculata* (Linn.) Jack
Pl.1, figs 5,7

*Material* - Two complete specimens with a counterpart.

*Description* - Leaflet 3.5 cm. in length and 1.4 cm in width; symmetrical; elliptic; apex attenuate, base acute, normal; margin entire; texture chartaceous; petiole (ule) normal; venation brochidodromous; primary vein ($1^0$) stout, straight, slightly curved near the apex; secondary veins ($2^0$) with acute (moderate) angle of divergence, nearly uniform, curved abruptly, joining super adjacent secondary at acute angle; tertiary veins ($3^0$) AR, reticulate, orthogonal; highest vein order of leaf $4^0$, highest vein order showing excurrent branching $3^0$, marginal ultimate venation looped; areoles well developed, random, irregular, veinlets none.

*Discussion* - Elliptic form, attenuate apex, brochidodromous venation and well developed areoles are the important characters of the fossil leaflet. A detailed comparison with the leaves/leaflets of extant taxa indicates its resemblance with that of *Murraya paniculata* (F.R.I.herb. nos. 25866, 7252; pl.1, fig.6).

The occurrence of *Murraya* in fossil state was first reported by Puri (1948), who described the leaf cf.? *Murraya* sp. from the Karewa beds of Kashmir. Lakhanpal and Guleria (1982) and Lakhanpal *et al.* (1984) described a leaflet *Murraya khariensis* from the Miocene of Kutch, western India and compared it with that of *Murraya paniculata*.

*Murraya paniculata* is a large shrub or small evergreen tree, distributed from Ravi eastward to Assam ascending to 1,350 m, and also occurring in Uttar Pradesh, Bihar (also in Chotanagpur region), Orissa, South and West India (Santapau and Henry, 1973).

## Family — Sapindaceae

*Schleichera oleosa* (Lour.) Oken
Pl. 1, fig.4

*Material* - A single, almost complete leaflet impression.

*Description*-Leaflet 8.8 cm. in length and 6 cm. in width, symmetrical ovate; apex acuminate, base rounded; margin entire; texture chartaceous; petiole partly present, normal; venation brochidodromous; primary vein ($1^0$) stout, almost straight; secondary veins ($2^0$) with acute (moderate) angle of divergence, angle of divergence nearly uniform, moderately thick, curving abruptly, joining superadjacent secondary veins at right angle, intersecondary veins present, simple intramarginal veins absent; tertiary veins ($3^0$) RR to RA (mostly RR), reticulate, orthogonal, predominantly alternate; highest vein order of leaf $4^0$, highest vein order showing excurrent branching $3^0$, quaternary veins orthogonal, marginal ultimate venation incomplete; areoles well developed, oriented, mostly pentagonal, veinlets none.

*Discussion*-The leaf is characterized by ovate shape, acuminate apex, entire margin, brochidodromous venation with well developed areoles, which show near resemblance with the leaflets of *Schleichera oleosa* (F.R.I. herbarium no. 109/11730; pl.1 fig. 3).

The record of fossil wood of *Schleichera* from India described by Awasthi *et al.* (1982) is *Schleicheroxylon kachchhensis* (modern comparable form *Schleichera oleosa)* from the Pliocene of Kutch, in western India.

*Schleichera oleosa* is a large deciduous tree found in the sub Himalayan tract from Sutlej eastward ascendintg to 900m., Central India, western Peninsula, Chotanagpur region of Bihar and Burma (Wood 1903; Brandis, 1906; Haines, 1910.)

## Plate 1

(All the figured specimens have been deposited with the repository of G.S.I. at Calcutta.
All the figures are of natural size unless otherwise mentioned)

*Grewia tiliaefolia* Vahl

1. Fossil specimen, G.S. I. Type No. 20410.
2. Modern leaf.
   *Schleichera oleosa* (Lour) Oken.
3. Modern leaflet.
4. Fossil leaflet, G.S.I.Type No.20412.
   *Murraya paniculata* (Linn.) Jack
5. Fossil leaflet enlarged to show details of venation, x2.
6. Modern leaflet.
7. Fossil leaflet, G.S.I. Type No.20411a.

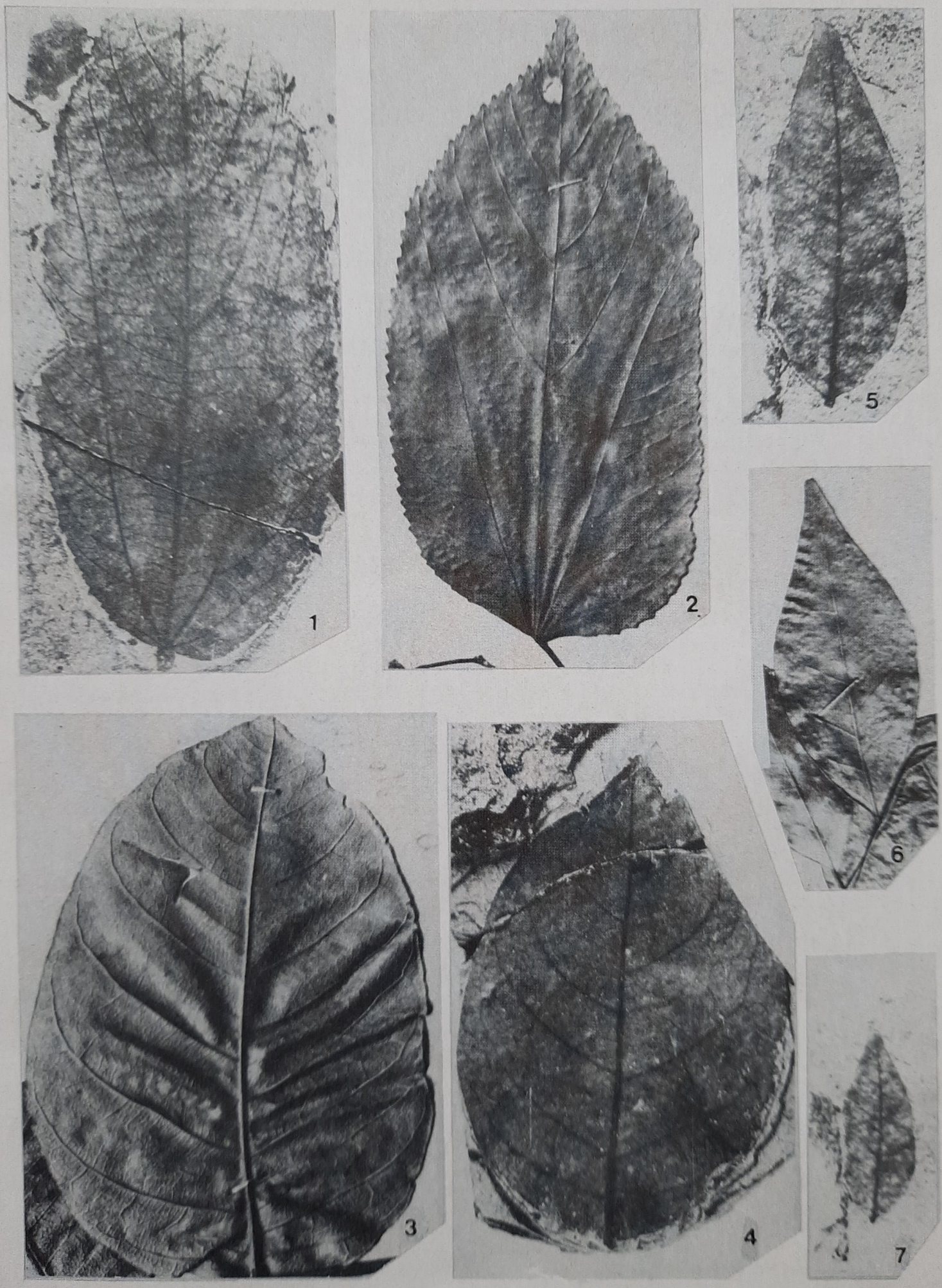


**Plate 1**

### Family — Anacardiaceae

*Mangifera indica* Linn.
Pl.2, fig 1.

*Material* - One complete leaf impression with its counterpart.

*Description* - Leaf simple, 19 cm x 5 cm. in size, lamina and base symmetrical, narrow, oblong; apex acute; base acute, margin entire; texture thick chartaceous; petiole present, length normal; venation eucamptodromous, primary vein ($1^0$) stout, straight; secondary veins ($2^0$) with acute (moderate) angle of divergence, nearly uniform, moderately thick, the secondaries upturn and gradually diminishing inside the margin, connected to superadjacent secondary by a series of cross veins, intersecondary veins present, simple; tertiary veins ($3^0$) RR, reticulate, orthogonal, highest vein order of leaf $5^0$, highest vein order of leaf showing excurrent branching $4^0$, quaternary veins thick, orthogonal, quinternary veins thick, orthogonal marginal, ultimate venation looped; areoles well developed, oriented, quadrangular to pentagonal in shape, veinlets none.

*Discussion* - The fossil leaf is characterized by narrow, oblong form, eucamptodromous venation and well developed areoles. In these important characters it shows near resemblance with the modern leaves of *Aglaia exstipulata, Nothopegia travancorica*, various species of *Mangifera* and *Alangium salvifolium*. However, a detailed comparison further indicates a close resemblance with the leaves of *Mangifera indica* (F.R.I.herb. sheet no. 86/100079; Pl.2, fig.2.).

The genus *Mangifera* is known from various Neogene localities of India represented by silicified woods and leaf-impressions. The fossil woods have been described from Cuddalore Sandstone, Tipam Sandstone, Namsang beds besides Tertiary of West Bengal and Rajasthan (Awasthi 1966; Prakash & Tripathi 1970; Roy & Ghosh, 1981; Lakhanpal *et al.* 1981; Guleria, 1984). Leaf impressions of *Mangifera someshwarica* have been described from the Siwalik sediments of India and Nepal. (Lakhanpal Awasthi, 1984; Awasthi & Prasad, 1990).

*Mangifera indica* is a medium-sized tree which grows throughout India up to 900m. It occurs wild in the Himalayas, in the hills of Eastern and Western Ghats, forests of Central India, Orissa, Bihar, Bengal and Assam (Brandis 1906).

### Family — Verbenaceae

*Vitex negundo* Linn. var. *incisa* Clarke
Pl.2, figs 3,7

*Material* - A single impression.

*Description* - Leaflet length 7.5 cm, width 3 cm, whole lamina and base appears symmetrical, narrow ovate, apex acute, base acute, normal; margin toothed, serrate axes inclined to the tangent of the margin, angle acute, apical side convex, basal side straight, sinuses nil, spacing regular, serrations limited, basal and apical part of the leaf without serrations; texture chartaceous; petiole normal; venation pinnate-craspedodromous; primary vein ($1^0$) moderate, straight unbranched; secondary veins ($2^0$) with acute (moderate) angle of divergence, angle of divergence nearly uniform, some secondaries show branching, one of the branches terminating at the tip of the serrations, intersecondary veins present, simple.

*Discussion* - Ovate form, partially toothed margin and craspedodromous venation are the important characters of the fossil leaf. In these features the fossil leaf is comparable to the leaves of *Ailanthus excelsa, Tecoma stans, Vitex negundo* and *Rhus semialata*. However, taking into consideration all other features it shows close resemblence with modern leaflets of *Vittex negundo* var. *incisa* (F.R.I. herbarium sheet no. 112465; pl.2, fig.4.).

Both, fossil woods and leaf-impressions of *Vitex* are known from India. *Vitexoxylon miocenicum* (modern comparable form *Vitex canescens*) has been described by Prakash and Tripathi (1974) from the Tipam sandstones of Assam. Prasad (1986) reported leaf impressions of two species of *Vitex* from the Siwalik beds of Koilabas near Indo-Nepal border, viz. *Vitex prenegundoides* and *V. siwalicus*.

*Vitex negundo* Linn. is a large shrub or small tree

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### Plate 2 →

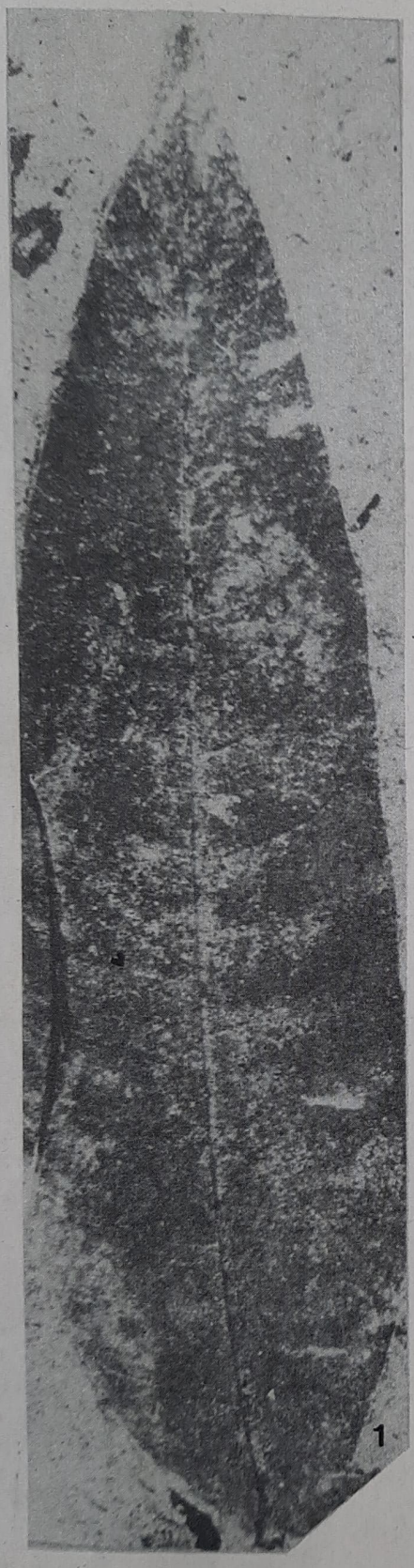
(All the figured specimens have been deposited with the repository of G.S.I. at Calcutta.
All the figures are of natural size unless otherwise mentioned)

*Mangifera indica* Linn.

1. Fossil leaf, G.S.I.Type No. 20413.
2. Modern leaf.
   *Vitex negundo* Linn. var. *incisa* Clarke
3. Fossil leaflet, G.S.I. Type No.20414.
4. Modern leaflet.
5. Dicot flower type I, G.S. I. Type No.20415.

6&8. Dicot flower type II, G.S. I.Type No. 20416.

7. Dicot flower type III, G.S. I. Type No. 20417.
9. Dicot flower type IV, G.S. I. Type No. 20418.





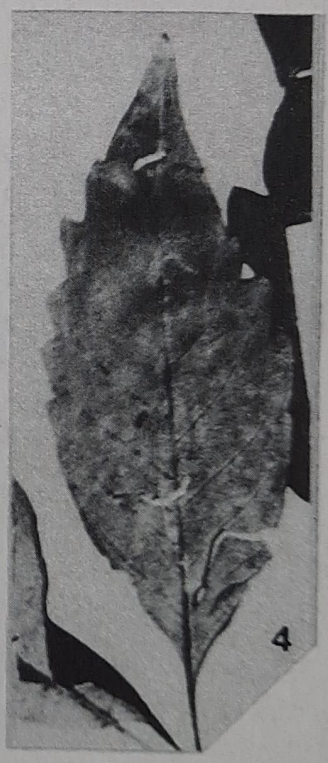









**Plate 2**

commonly occurring everywhere in the plains and hills of India, ascending to about 1700m in west Himalaya, extending west to Peshawar and Sind (Pearson & Brown, 1932; Brandis, 1906). *Vitex negundo* var. *incisa* grows in the forest of Chotanagpur region, occasionally mixed with the normal form (Haines, 1910).

## FLOWERS

The assemblage has also yielded four different types of flowers of unknown affinities. They are being described as Dicot flower types I-IV.

### Dicot flower type-I
Pl.2, fig.5

Only corolla preserved, petals five, gamopetalous, two complete and the rest partially preserved; petal 1.1cm long and 0.6cm broad; provided with prominent brochidodromous type of venation.

### Dicot flower type-II
Pl.2, figs 6&8

Flower small, 0.35 cm long, only corolla preserved; petals ten, apparently gamopetalous.

### Dicot flower type-III
Pl.2, fig.7

Only corolla preserved; petals six, free, valvate; each 1.6 cm long and 0.5cm broad.

### Dicot flower type-IV
Pl.2, fig. 9

Flower gamopetalous, 0.2 cm long; only corolla preserved; petals five, united only in the lower part.

## REMARKS

An Upper Tertiary, possibly Pliocene age was assigned to the shales in Mahuadanr area by Puri and Mishra (1982). On the basis of close similarity of the plant fossils recovered from these shales with the modern species growing in the surrounding area and the presence of *Sindora* in the underlying sandstone unit, it has been suggested that the sandstone unit in all probability is Mio-Pliocene while the overlying shales are younger (Late Cenozoic) in age. (Bande & Srivastava, 1990).

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