

---

# Angiospermous fossil leaves from the Siwalik sediments (Middle Miocene) of Darjeeling District, West Bengal

J.S. Antal & M. Prasad

---

Antal JS & Prasad M 1997. Angiospermous fossil leaves from the Siwalik sediments (Middle Miocene) of Darjeeling District, West Bengal. *Palaeobotanist* 46(3) : 95-104.

In the present paper some more angiospermous leaf-impressions recovered from Ghish River, Lish River and Sevok Road section in Darjeeling District, West Bengal have been described. These are—*Flacourtia tertiarra* Prasad & Awasthi 1996, *Alsodeia palaeoracemosa* sp. nov. (Flacourtiaceae), *Shorea bengalensis* sp. nov. (Dipterocarpaceae), *Zizyphus palaeopetalala* sp. nov., *Ventilago tistaensis* sp. nov. (Rhamnaceae), *Syzygium palaeocuminii* Prasad & Awasthi 1996 (Myrtaceae) and *Homonoia mioriparia* sp. nov. (Euphorbiaceae). Out of these seven taxa, five are new records to the Siwalik flora. The dominance of evergreen and moist deciduous elements in the assemblage further confirms the prevalence of warm and humid climate during the deposition of the Himalayan foreland sediments.

**Key-words**—Angiosperms, Leaf-impressions, *Flacourtia*, *Alsodeia*, *Shorea*, *Zizyphus*, *Ventilago*, *Syzygium*, *Homonoia*, Middle Miocene, West Bengal (India).

J.S. Antal & M. Prasad, Birbal Sahni Institute of Palaeobotany, 53 University Road, Lucknow 226 007, India.

## सारांश

पश्चिम बंगाल में दार्जिलिंग जनपद के शिवालिक अवसादों से प्राप्त आवृत्तबीजी अश्मित पत्तियाँ

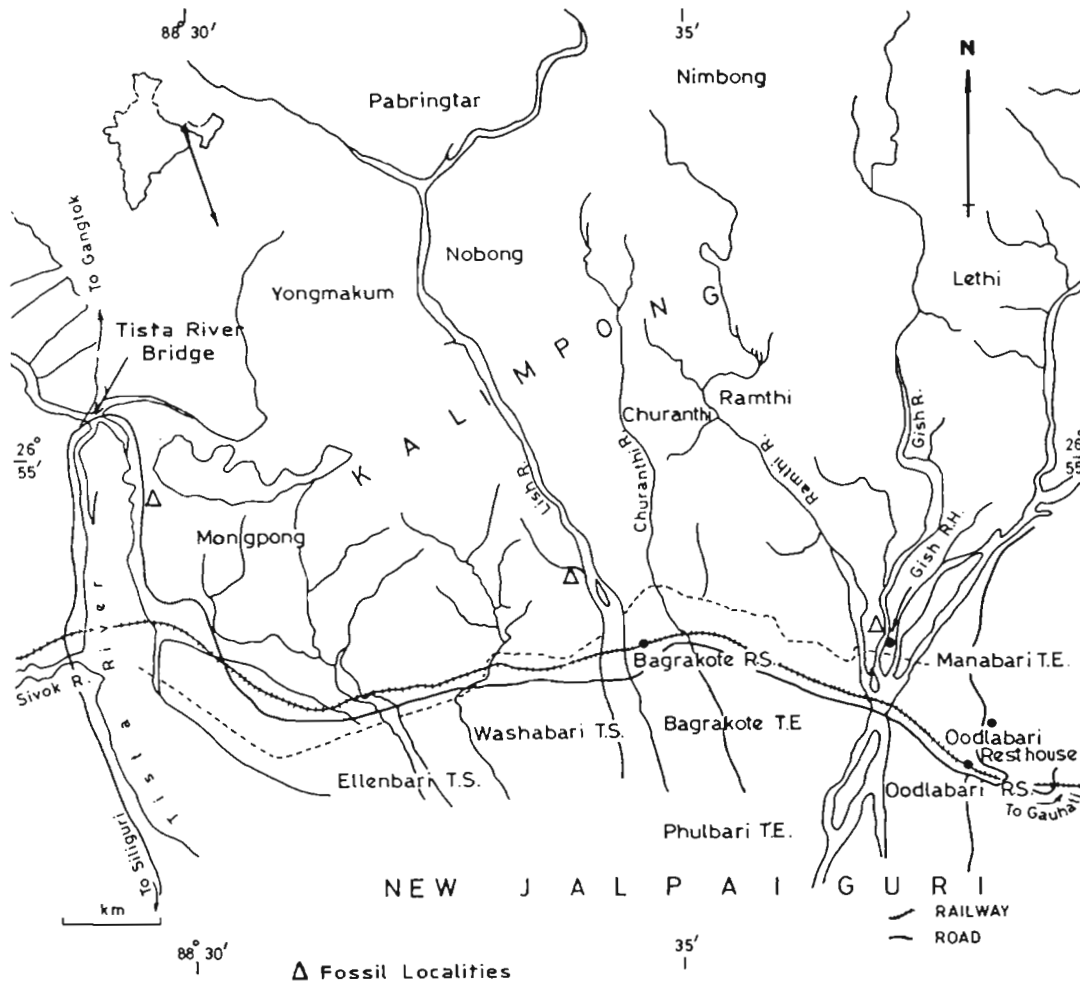
जसवन्तसिंह अन्तल एवं महेश प्रसाद

इस शोध-पत्र में पश्चिम बंगाल में दार्जिलिंग जनपद में घिश नदी, लिश नदी एवं सिवक रोड खंड से उपलब्ध कुछ और आवृत्तबीजी पर्ण-छापों का वर्णन किया गया है। ये अश्मित पत्तियाँ पाँच कुलों के सात वर्गकों फ्लेकोर्शिया टर्शियरा प्रसाद व अवस्थी 1996, आल्सोडिआ पेलियोरेसीमोसा नव जाति (फ्लेकोर्शियासी), शौरिया बंगालेन्सिस नव जाति (डिप्टेरोकार्पेसी), जिजीफस पेलियोएपेटेला नव जाति, वेन्टीलागो तिस्तायेन्सिस नव जाति (रहमनेसी), सिजीजियम पेलियोक्युमिनाई प्रसाद व अवस्थी 1996 (मिर्टेसी) एवं होमोनोइया मायोराइपेरिया नव जाति (यूफोर्बिआसी) से सम्बद्ध हैं। इन सात वर्गकों में से पाँच वर्गक शिवालिक वनस्पतिजात के लिये नये हैं। इस समुच्चय में सदाहरित एवं नम पर्णपाती अवयवों की बाहुल्यता से हिमालयी गिरि-पादों के अवसादों के निक्षेपण के समय इस क्षेत्र में उष्ण और आर्द्र जलवायु होने की पुष्टी होती है।

THE Siwalik sequence of West Bengal has been broadly subdivided into three units—(i) upper pebbly sandstone and conglomerate unit, (ii) middle sandstone unit, and (iii) lower claystone unit (Acharyya, 1972, 1975). The lower claystone unit is best exposed in Ramthi River, Ghish River and along Tista River on the Sevok Road. They consist of claystone, siltstone and fine-grained sandstone. The middle sandstone unit is well exposed in Lish and Ghish Rivers and also in some tributaries of Tista River

The material for the present investigation was collected from both lower and middle units exposed

in Ghish River, Lish River and Sevok Road section about 2 km from Tista River Bridge towards Oodlabari (Map 1). Earlier a number of leaf-impressions, some fruits and fossil woods have been described from this area (Antal & Awasthi, 1993; Antal & Prasad, 1995, 1996a, 1996b, 1996c; Antal *et al.*, 1996). Recently, a large number of well preserved impressions of leaves, fruits and seeds were collected from these sections. The study on these impressions reveals the presence of some more new taxa which have been described and discussed in this paper. For description of these leaf-impressions the terminology given by Hickey (1973) and Dilcher (1974) has been followed.



Map 1 — Showing the fossil localities in the area.

All the figured specimens have been deposited in the Museum of Birbal Sahni Institute of Palaeobotany, Lucknow.

#### SYSTEMATIC DESCRIPTION

Family—*Flacourtiaceae*

Genus—*Flacourtia* Comm. ex L'Herit

*Flacourtia tertara* Prasad & Awasthi 1996  
Pl. 1, fig. 1

*Material*—One specimen with counterpart.

*Description*—Leaf simple, symmetrical, elliptic, preserved size 9.0 x 3.8 cm; apex slightly broken; base acute, normal; margin serrate, serration con-

#### PLATE 1

(All specimens are in Natural size)

1. *Flacourtia tertara* Prasad & Awasthi 1996, fossil leaf showing shape, size, venation pattern and serrate margin; Specimen no. BSIP 38020.
2. *Alsodeia palaeoracemosa* sp. nov., fossil leaves showing shape, size and venation pattern; Specimen no. BSIP 38021.
3. *Alsodeia palaeoracemosa* sp. nov., another fossil leaf showing details of venation; Specimen no. BSIP 38022.
4. *Shorea bengalensis* sp. nov., fossil leaf showing shape, size and venation pattern; Specimen no. BSIP 38023.
5. *Shorea bengalensis* sp. nov., apical part of the fossil leaf showing nature of apex; Specimen no. BSIP 38024.
- 6, 7. *Shorea bengalensis* sp. nov., another fossil leaves showing some variation; Specimen nos. BSIP 38025 and 38026.

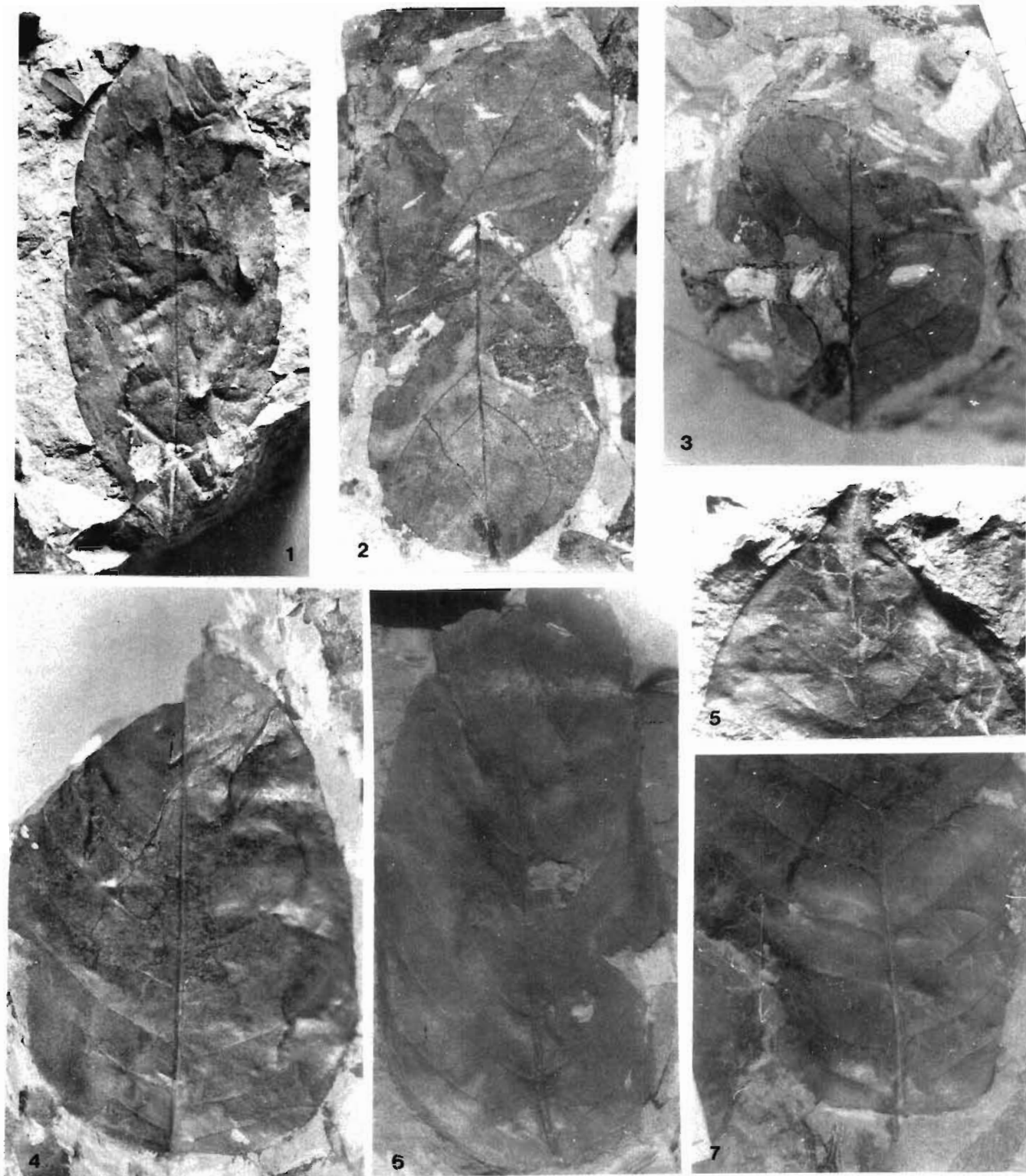


PLATE 1

vex from basal as well as apical side; texture thick, chartaceous; petiole broken; venation pinnate, simple craspedodromous; primary vein (1°) single, prominent, almost straight, stout; secondary veins (2°) five pairs preserved, alternate to subopposite, distance between secondary veins 1.3 to 3.0 cm, curving up toward margin and run toward apex to a greater length before terminating at the margin, angle of divergence about 50°, acute, sometimes branched; tertiary veins (3°) fine, angle of origin R-R, percurrent, branched, almost straight and right angle in relation to midvein, close; further details not clearly visible.

*Spectmen* — No. BSIP 38020.

*Locality*—Sevok Road section about 2 km from Tista River Bridge towards Oodlabari, Darjeeling District, West Bengal.

*Horizon & age*—Lower Siwalik, Middle Miocene.

*Comparison*—The important distinguishing characters of the fossil leaf are elliptic shape, acute base, serrate margin, simple craspedodromous venation and percurrent tertiaries with right angle in relation to midvein. Besides, the secondary veins arising from midvein run towards apex up to a greater length. These features indubitably indicate that the fossil leaf belongs to the family Flacourtiaceae. Among this family nearly resembling modern genera *Scoloptia*, *Xylosmia*, *Maesa* and *Flacourtia* were studied in detail in order to identify this fossil leaf and found that the genus *Flacourtia* shows closest resemblance with the fossil. To identify it up to specific level, a number of herbarium sheets of various species of this genus were consulted and observed that the leaves of extant *Flacourtia inermis* Roxb. comes closest with the fossil leaf.

So far only two fossil leaves resembling the genus *Flacourtia* have been recorded under *F. nepalensis* Awasthi & Prasad 1990 and *F. tertara* Prasad & Awasthi 1996 from The Siwalik sediments of Surai Khola, western Nepal. On comparison of the present fossil leaf with those already known fossil leaves of *Flacourtia*, it has been observed that *F. tertara* which has also been compared with *F. inermis* Roxb., shows closest similarity in all morphological features. Therefore, it has been de-

scribed under *F. tertara* Prasad & Awasthi 1996; though it is the first record from India.

The genus *Flacourtia* Comm. ex L'Herit consists of about 15 species of trees and shrubs distributed in tropical Asia and Africa. The extant taxon *F. inermis* Roxb. is an evergreen tree and native of Malayan Archipelago. It is also cultivated in India on account of its edible fruits (Brandis, 1971).

**Genus—*Alsodeta* Thours**

*Alsodeta palaeoracemosa* sp. nov.  
Pl. 1, figs 2, 3

*Material*—This species is based on three specimens.

*Description*—Leaf simple, symmetrical, wide ovate, preserved size 7.5 x 5.0 cm; apex seemingly bluntly acute; base narrow acute, normal; margin entire; texture chartaceous; venation pinnate, eucamptodromous; primary vein (1°) single, prominent, thicker at the basal region, massive; secondary veins (2°) 5 to 6 pairs preserved, less than 1.00 to 2.5 cm apart, alternate to subopposite, angle of divergence 45°, seemingly unbranched, intersecondary veins present, simple; tertiary veins (3°) very fine, angle of origin usually RR, percurrent, sometime branched, predominantly alternate, right angle in relation to midvein, close to slightly distantly placed; quaternary veins (4°) still fine with angle of origin RR, branched forming orthogonal to polygonal meshes.

*Holotype*—Specimen no. BSIP 38021.

*Paratype*—Specimen no. BSIP 38022.

*Locality*—Sevok Road section about 2 km from Tista River Bridge towards Oodlabari, Darjeeling District, West Bengal.

*Horizon & age*—Lower Siwalik, Middle Miocene.

*Comparison*—The distinguishing features of the fossil leaves such as wide ovate shape, acute base and apex, entire margin, chartaceous texture, eucamptodromous venation and percurrent tertiary with RR angle of origin and closely to distantly placed tertiary veins collectively indicate their resemblance with the modern leaves of *Alsodeta racemosa* H.f. & Th. (CN Herbarium Sheet no. 32274) of the family Flacourtiaceae.

As far as we are aware there is only one record of the fossil leaves of *Alsodeta palaeozeylantica* Antal & Awasthi 1993 described from Ghish River Section near Oodlabari, Darjeeling District, West Bengal. This fossil leaf was compared with another modern species—*Alsodeta zeylantica* Thw. and thus obviously differs from the present specimens in being small size and possessing very closely placed percurrent fine tertiary veins. Therefore the present fossil leaves have been assigned to a new species—*Alsodeta palaeoracemosa*.

Genus *Alsodeta* Thours. includes 50 species distributed in the tropics of both hemispheres. The comparable extant species *A. racemosa* H.f. & Th. is a small tree of the tropical forests and upper mixed forest of Martaban and Tenasserim up to 500 m. In India, it is also distributed in Assam (Gamble, 1972; Brandis, 1971).

### Family—Dipterocarpaceae

Genus—*Shorea* Roxb.

*Shorea bengalensis* sp. nov.

Pl. 1, figs 4-7

*Material*—There are 12 specimens in the collection.

*Description*—Leaf simple, symmetrical, ovate to elliptic, preserved size 9.0 x 6.0 cm, 11.0 x 6.0 cm, 9.0 x 6.0 cm; apex acute; base cordate to rounded, normal; margin entire; texture coriaceous; petiole present, 0.5 cm preserved, normal; venation pinnate, simple craspedodromous to eucamptodromous; primary vein (1°) single, prominent, almost straight, sometime slightly curved, thicker at the basal region; secondary vein (2°) about 10 pairs visible, 0.5 to 1.2 cm apart, curved up, angle of divergence acute to nearly right angle (65°-85°), usually alternate; tertiary veins (3°) fine, angle of origin usually RR, percurrent, sometime branched, straight, oblique in relation to midvein, predominantly alternate and close, further details could not be seen.

*Holotype*—Specimen no. BSIP 38023.

*Paratype*—Specimen nos. BSIP 38024, 38025 and 38026.

*Locality*—Sevok Road section about 2 km from Tista River Bridge towards Oodlabari, Darjeeling District, West Bengal.

*Horizon & age*—Lower Siwalik, Middle Miocene.

*Comparison*—The characteristic features of the present fossil leaves are ovate to elliptic shape, cordate to rounded base, entire margin, usually eucamptodromous venation, arrangement of lowest pair of secondary veins and percurrent tertiaries having right angle origin. These features indicate that the fossil leaves belong to the genus *Shorea* Roxb. of the family Dipterocarpaceae. In order to find out its nearest comparable species a large number of available Herbarium sheets of different species of *Shorea* were consulted. After critically examination it has been found that the fossil leaves show closest affinity with the extant species *Shorea roxburghii* (*S. talura* Roxb.) (CN Herbarium Sheet no. 82236).

The fossil leaves resembling the genus *Shorea* are known both from India and abroad (Merill, 1923; Seward, 1935; Antal & Prasad, 1996c, p. 76). Of them, three fossil species have been reported from the Siwalik sediments of India. These are *Shorea siwalica* Antal & Awasthi 1993 from Lower Siwalik sediments, Ramthi River, Darjeeling District, West Bengal; *S. neoassamica* Prasad 1994 from the Lower Siwalik sediments of Kathgodam, Uttar Pradesh, India and *S. miocenica* Antal & Prasad 1996c from the Middle Siwalik sediments of Ghish River Section near Oodlabari, Darjeeling District, West Bengal. The comparison of present fossil leaves with those already known fossil leaves of *Shorea* was done and found that none of them is comparable to the present leaves. Thus they have been described as a new species *Shorea bengalensis*.

The genus *Shorea* Roxb. consists of about 167 species distributed all over the world. Out of these, nearly 100 species of trees grow throughout the tropical parts of Indo-Malayan region (Pearson & Brown, 1932). The extant taxon *Shorea roxburghii*, with which the fossils show closest resemblance, is a large handsome tree found in the evergreen forests of North Kanara southwards and the hills of southern Deccan. It is also found in the Malayan Peninsula (Desch, 1957; Brandis, 1971).

### Family—Rhamnaceae

Genus—*Zizyphus* Juss

*Zizyphus palaeoapetala* sp. nov.

Pl. 2, figs 1, 2

*Material*—This species is represented by four specimens.

*Description*—Leaf simple, slightly asymmetrical at base, narrow elliptic, preserved size 11.0 x 4.0 cm and 7.0 x 4.2 cm; apex acute; base acute, oblique; margin almost entire; texture thick chartaceous; petiole not preserved; venation acrodromous, basal, perfect; primary veins (1°) three, one midvein and two strongly developed secondary veins; secondary veins (2°) 4-5 pairs arising from mid-primary vein, up to 10 secondary veins radiating towards margin, distance between secondaries at mid-primary 2.5 to 3.5 cm and at lateral primary about 1.00 cm, alternate, angle of divergence acute, about 35°, curved up running towards apex up to a greater length joining to their supradjacent secondaries; tertiary veins (3°) fine, angle of origin AR to RO, percurrent, straight as well as retroflex, angle in relation to midvein almost right angle, predominantly alternate and close, further details not clearly visible.

*Holotype*—Specimen no. BSIP 38027.

*Paratype*—Specimen no. BSIP 38028.

*Locality*—Lish River, near Bagrakot and Sevok Road Section about 2 km from Tista River Bridge towards Oodlabari, Darjeeling District, West Bengal.

*Horizon & age*—Lower Siwalik, Middle Miocene.

*Comparison*—The narrow elliptic shape with slightly asymmetrical acute base, acute apex, almost entire margin, basal perfect acrodromous venation, prominent secondaries arising both from mid- and lateral primary veins and straight to retroflexed tertiaries with almost right angle in relation to mid-primary vein indubitably indicate their resemblance with the genus *Zizyphus* Juss. of the family Rhamnaceae. In order to identify them up to

specific level the herbarium sheets of a number of species of this genus have been examined and observed that the present fossil specimens closely resemble the leaf of *Zizyphus apetala* Hook.f. (CN Herbarium Sheet no. 80636) in shape, size and venation pattern.

As far as we are aware there are about 16 fossil records of *Zizyphus* leaves from India and abroad (Prasad, 1994, p. 134). Of them, six fossil leaves have been reported from the Siwalik sediments. They are: *Z. stwalticus* Lakhanpal (1965, 1966) from Jawalamukhi, Himachal Pradesh; *Z. indicus* Singh & Prakash 1980 from Arunachal Pradesh; *Z. champaran* Lakhanpal & Awasthi 1984 from Bhikhnathoree, Bihar; *Z. cf. Z. rugosa* Prasad 1994a from Haridwar, Uttar Pradesh and *Z. mtocentica* Prasad 1994b from Kathgodam, Uttar Pradesh and Koilabas, western Nepal.

All the known fossil leaves were critically compared with the present fossil leaves and found that these are entirely different from them either in size or nature and arrangement of secondary and tertiary veins. Thus they have been described as *Zizyphus palaeoapetala* sp. nov.

The genus *Zizyphus* Juss. consists of about 40 species of shrubs or trees, mostly Indo-Malayan. The extant species *Z. apetala* Hook.f., with which our fossil leaves resemble, is a large struggling shrub or small tree distributed in Sikkim (Brandis, 1971).

**Genus—*Ventilago* Gaertn.**

*Ventilago tistaensis* sp. nov.

Pl. 2, fig. 3

*Material*—Three specimens, one with counterpart, are in the collection.

*Description*—Leaf simple, almost symmetrical, narrow ovate, preserved size 9.6 x 4.6 cm; apex seemingly acute; base nearly obtuse, somewhat

## PLATE 2

(All specimens are in Natural size)

1. *Zizyphus palaeoapetala* sp. nov., a fossil leaf showing shape, size and venation pattern; Specimen no. BSIP 38027.
2. *Zizyphus palaeoapetala* sp. nov., another fossil leaf showing details of venation; Specimen no. BSIP 38028.
3. *Ventilago tistaensis* sp. nov., a fossil leaf showing shape, size and venation pattern; Specimen no. BSIP 38029.
4. *Syzygium palaeocuminii* Prasad & Awasthi 1996, a fossil leaf showing shape, size and venation pattern; Specimen no. BSIP 38030.
5. *Homonoia mioriparia* sp. nov., a fossil leaf showing shape, size and venation pattern; Specimen no. BSIP 38031.
6. *H. mioriparia* sp. nov., another fossil leaf variation in size; Specimen no. BSIP 38032.

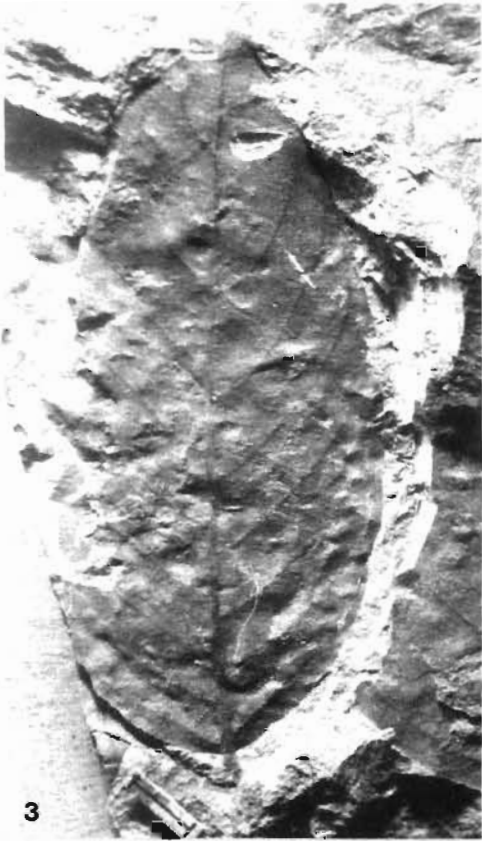


PLATE 2

oblique; margin entire; texture chartaceous; petiole 0.4 cm preserved, normal; venation pinnate, craspedodromous to eucamptodromous; primary vein (1°) single, prominent, stout, thicker at basal half part, almost straight; secondary veins (2°) about 9 pairs visible, 0.6 to 1.5 cm apart, alternate to subopposite, angle of divergence acute, about 55°, uniformly curved up, unbranched; tertiary veins (3°) very fine, angle of origin usually RR, percurrent, branched, almost straight, oblique to right angle in relation to midvein, alternate to opposite, close; quaternary veins not visible.

*Holotype*—Specimen no. BSIP 38029.

*Locality*—Sevok Road section about 2 km from Tista River Bridge towards Oodlabari, Darjeeling District, West Bengal.

*Horizon & age*—Lower Siwalik, Middle Miocene.

*Comparison*—The most characteristic features of the present fossil leaves are narrow ovate shape, nearly oblique obtuse base, entire margin, chartaceous texture, craspedodromous to eucamptodromous venation, very fine and somewhat closely placed percurrent tertiary veins having right angle origin. These features obviously indicate their resemblance with the leaves of genus *Venttлаго* Benth. of Rhamnaceae. In order to reach up to specific level the herbarium sheets of all available species of *Venttлаго* were examined and observed that the present leaves closely resemble those of *V. calyculata* (CN Herbarium Sheet no. 168) in all morphological features.

As far as the authors are aware, so far there is no fossil record of the genus *Venttлаго* and hence this has been described as a new species *Venttлаго tistaensis*. The specific name is after Tista River flowing along the road section, from where the Holotype was collected.

The genus *Venttлаго* Gaertn. consists of about five species of large climbing shrubs. *V. calyculata*, which closely resembles with the fossil leaves is a very conspicuous forest climber distributed throughout the plains of India, chiefly in the drier forests, also in Myanmar and Sri Lanka (Gamble, 1972).

## Family—Myrtaceae

Genus—*Syzygium* Gaertn.

*Syzygium palaeocumtnti* Prasad & Awasthi 1996  
Pl. 2, fig. 4

*Material*—This species is represented by only one specimen.

*Description*—Leaf simple, symmetrical, wide elliptic, preserved length 7.5 cm and width 2.0 cm (one side of midrib; apex acute; base acute; margin entire; texture chartaceous; petiole not preserved; venation pinnate, eucamptodromous; primary vein (1°) prominent, straight, stout; secondary veins (2°) about 28 pairs visible, alternate to opposite, branched, angle of divergence widely acute, 60°-75°, uniformly curved up, closely placed, joining their supradjacent veins forming intramarginal vein, intersecondary veins frequent, simple, 3-4 intersecondary veins in between secondaries; tertiary veins (3°) fine with angle of origin AO, exmedially ramified, oblique in relation to midvein and close.

*Specimen*—No. BSIP 38030.

*Locality*—Sevok Road section about 2 km from Tista River Bridge towards Oodlabari, Darjeeling District, West Bengal.

*Horizon & age*—Lower Siwalik, Middle Miocene.

*Comparison*—Wide elliptic shape, acute apex and base, entire margin, eucamptodromous venation, closely placed secondary veins with wide acute angle of divergence, presence of intramarginal vein and exmedially ramified tertiary veins indubitably indicate its resemblance with the genus *Syzygium* Gaertn. of the family Myrtaceae. After detail examination of the extant species of this genus it has been found that the present fossil leaf closely resembles the leaves of *Syzygium cumtnti* Roxb. However, during the examination of leaves of extant species it has been observed that the nature of venation pattern in most of the species looks somewhat similar due to which it becomes practically difficult to distinguish them from one another.



So far, six fossil species of *Syzygium* are known from different parts of world. These are *S. floribundoides* Engelhardt from the Middle Miocene of West Germany (Miller, 1934), *S. chaneyi* Huzioka & Takahashi 1970 from the Eocene of Japan, *S. kachchhense* Lakhanpal & Guleria 1981 from the Eocene of Kachchh, *S. miocenticum* Prasad & Prakash 1984 from the Siwalik sediments of Koilabas, Nepal; *S. palaeobracteatum* Awasthi & Lakhanpal 1990 from the Siwalik sediments of Bhikhnathoree, Bihar and *S. palaeocuminii* Prasad & Awasthi 1996 from the Siwalik sediments of Surai Khola, Nepal.

The present fossil leaf was critically compared with all the known species and found that it shows close resemblance with *S. palaeocuminii* Prasad & Awasthi 1996 in all morphological features and thus has been described under it.

The genus *Syzygium* (= *Eugenia*) Gaertn. includes about 650 species distributed in the tropical and subtropical region of Asia, tropical America and few of them in tropical Africa and Australia. About 110 species are found in India and Myanmar. The modern comparable species *S. cumini* Roxb. is an evergreen tree occurring throughout India, Myanmar and Sri Lanka. It is chiefly found along river banks and in the forests of moist localities (Brandis, 1971; Gamble, 1972).

### Family—Euphorbiaceae

Genus—*Homonota* Lour.

*Homonota mitoriparia* sp. nov.

Pl. 2, figs 5, 6

*Material*—This species is represented by two specimens, one specimen with counterpart.

*Description*—Leaf simple, symmetrical, narrow elliptic, preserved size 8.0 x 2.1 cm; apex seemingly acute; base seemingly acute, normal; margin entire to slightly wavy; texture thick, chartaceous; petiole not visible; venation pinnate, eucamptodromous; primary vein (1°) single, prominent, straight, massive; secondary veins (2°) 6-7 pairs visible, usually alternate, 1.5 to 2.2 cm apart, angle of divergence 50° to 65°, acute, unbranched, uniformly curved up;

tertiary veins (3°) fine, poorly visible, angle of origin RR, percurrent, seemingly unbranched, almost straight, predominantly alternate; close; further details not visible.

*Holotype*—Specimen no. BSIP 38031.

*Paratype*—Specimen no. BSIP 38032.

*Locality*—Sevok Road section about 2 km from Tista River Bridge towards Oodlabari, Darjeeling District, West Bengal.

*Horizon & age*—Lower Siwalik, Middle Miocene.

*Comparison*—The distinguishing features of the present fossil leaf are narrow elliptic shape, seemingly acute apex and base, slightly wavy margin, eucamptodromous venation, distantly placed secondary veins with acute angle of divergence having characteristic curvature which collectively indicate its resemblance with extant taxon *Homonota riparia* Lour. of the family Euphorbiaceae (CN Herbarium Sheet no. 417075).

As far as we are aware there is only one record of the fossil leaf resembling *H. riparia* from the Siwalik sediments of Haridwar, Uttar Pradesh. This specimen was described as *Homonota* cf. *H. riparia* Lour. by Prasad (1994, p. 90) without establishing a form species. Since this leaf as well as the present fossil leaf both possess same morphological characters and also have been compared with the same extant species, these are being named as *Homonota mitoriparia* sp. nov.

Genus *Homonota* Lour. consists of about 3 or 4 Indo-Malayan species. *Homonota riparia* Lour., with which the present fossil species closely resembles, is an evergreen shrub distributed in Myanmar, Sri Lanka, Malaya Peninsula, China and throughout India, except in the north-west (Brandis, 1971; Gamble, 1972).

### DISCUSSION

The investigation of the present plant megafossils recovered from Ghish River near Oodlabari, Lish River near Bagrakot and Sevok Road Section near

Tista River Bridge in Darjeeling District, West Bengal reveals the presence of some more elements belonging to five dicotyledonous families and seven taxa. Of them, *Ventilago tistaensis*, *Zizyphus palaeopetala*, *Alsodeia palaeoracemosa*, *Shorea bengalensis* and *Homonota mitoriparia* are new to the angiospermous fossil leaf records from the Tertiary sediments of Indian Subcontinent. The remaining two taxa, viz., *Sygygium palaeocumini* and *Flacourtia tertiana* are already known from the Siwalik sediments of Surai Khola, western Nepal. It is interesting that the present assemblage represents trees, shrubs and climbers distributed mostly in evergreen forests either in north east India, Myanmar or Malayan region. The habit and habitat as well as physiognomic characters of the fossil floral assemblage infer that an evergreen forest was flourishing under tropical climate with excessive rainfall in and around the area.

#### ACKNOWLEDGEMENTS

The authors are thankful to Professor Anshu K. Sinha, Director, BSIP for constant encouragement and facilities. We also express our sincere thanks to the authorities of the Central National Herbarium, Howrah for permitting to consult the Herbarium. Thanks are also due to Shri M.R. Baloch, Divisional Forest Officer, Baikunthpur Division, Siliguri for his valuable help during the collection of plant megafossils and Shri Rattan Lal Mehra, BSIP, for processing the manuscript in Computer.

#### REFERENCES

- Acharyya SK 1972. Geology of the Darjeeling Coalfield with a reference to its intrusives. *Rec. geol. Surv. India* **99**(2) : 75-101.
- Acharyya SK 1975. Structure and stratigraphy of the Darjeeling frontal zone, eastern Himalaya. *Rec. geol. studies in Himalaya, geol. Surv. India Misc. publ.* **24**(1) : 71-90.
- Antal JS & Awasthi N 1993. Fossil flora from the Himalayan foot-hills of Darjeeling District, West Bengal and its palaeoecological and phytogeographical significance. *Palaeobotanist* **42**(1) : 14-60.
- Antal JS & Prasad M 1995. Fossil leaf of *Clinogyne* Salisb. from the Siwalik sediments of Darjeeling District, West Bengal. *Geophytology* **24**(2) : 241-243.
- Antal JS & Prasad M 1996a. Some more leaf-impressions from the Himalayan foot-hills of Darjeeling District, West Bengal, India. *Palaeobotanist* **43**(2) : 1-9.
- Antal JS & Prasad M 1996b. Leaf-impressions of *Polyalthia* Bl. in the Siwalik sediments of Darjeeling District, West Bengal. *Geophytology* **26**(1) : 125-127.
- Antal JS & Prasad M 1996c. Dipterocarpaceous fossil leaves from Ghish River section in Himalayan foot-hills near Oodlabari, Darjeeling District, West Bengal. *Palaeobotanist* **43**(3) : 73-77.
- Antal JS, Prasad M & Khare EG 1996. Fossil woods from the Siwalik sediments of Darjeeling District, West Bengal, India. *Palaeobotanist* **43**(2) : 98-105.
- Awasthi N & Lakhanpal RN 1990. Additions to the Neogene florule from near Bhikhathoree, West Champaran District, Bihar. *Palaeobotanist* **37** : 278-283.
- Awasthi N & Prasad M 1990. Siwalik plant fossils from Surai Khola area, western Nepal. *Palaeobotanist* **38** : 298-318.
- Brandis D 1971. *Indian trees*. Bishen Singh Mahendra Pal Singh, Dehradun.
- Desch HE 1957. Manual of Malayan timbers. *Malaya For. Rec.* **15** : 1-328.
- Dilcher DL 1974. Approaches to the identification of angiosperm leaf remains. *Bot. Rev.* **40**(1) : 1-157.
- Gamble JS 1972. *A manual of Indian timbers*. Bishen Singh Mahendra Pal Singh, Dehradun.
- Hickey LJ 1973. Classification of the architecture of dicotyledonous leaves. *Am. J. Bot.* **60** : 17-33.
- Huzioka K & Takahashi E 1970. The Eocene flora of the Ube Coalfield, southwest Honshu, Japan. *J. Min. Coll. Akita Univ., ser. A* **4**(5) : 1-88.
- Lakhanpal RN 1965. Occurrence of *Zizyphus* in the Lower Siwalik beds near Jawalamukhi. *Curr. Sci.* **34**(23) : 666-667.
- Lakhanpal RN 1966. Fossil Rhamnaceae from the Lower Siwalik beds near Jawalamukhi (Himachal Pradesh). *Publ. Centre Adv. Study Geol. Punjab Univ.* **3** : 23-26.
- Lakhanpal RN & Guleria JS 1981. Leaf-impressions from the Eocene of Kachchh, western India. *Palaeobotanist* **28-29** : 353-373.
- Lakhanpal RN & Awasthi N 1984. A Late Tertiary florule from near Bhikhathoree in West Champaran District, Bihar. *Proc. Symp. Evol. Bot. Biostratigr., Calcutta 1979 (A.K. Ghosh Comm. Vol.)* **10** : 587-596.
- Merill ED 1923. Distribution of the Dipterocarpaceae. *Philipp. J. Sci.* **23** : 1-32.
- Muller WR 1934. Die Pflanzen des Neozoikums. *Oberre in Fossil Katalog* **3**(10) : 1-153.
- Pearson RS & Brown HP 1932. *Commercial timbers of India -1 & 2*. Manager of Publications, Calcutta.
- Prasad M 1994a. Investigation on the Siwalik (Middle Miocene) leaf-impressions from the foot-hills of the Himalaya, India. *Tertiary Res.* **15**(2) : 53-90.
- Prasad M 1994b. Plant megafossils from the Siwalik sediments of Koilabas, central Himalaya, Nepal and their impact on palaeoenvironment. *Palaeobotanist* **42**(2) : 126-156.
- Prasad M & Awasthi N 1996. Contribution to the Siwalik flora from Surai Khola sequence, western Nepal and its palaeoecological and phytogeographical implications. *Palaeobotanist* **43**(3) : 1-42.
- Prasad M & Prakash U 1984. Leaf-impressions from the Lower Siwalik beds of Koilabas, Nepal. *Proc. V Indian geophytol. Conf. (1983), Spl. publ.* : 246-256.
- Seward AC 1935. Leaves of dicotyledons from the Nubian sandstone of Egypt. *Min. of Finance Surv. Dept., Egypt* : 1-21.
- Singh T & Prakash U 1980. Leaf-impressions from the Siwalik sediments of Arunachal Pradesh, India. *Geophytology* **10**(1) : 104-107.