

LEAF IMPRESSIONS FROM THE SIWALIK SEDIMENTS OF ARUNACHAL PRADESH, INDIA

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ABSTRACT

Two leaf impressions assigned to *Zizyphus indicus* sp. nov., and *Dicotylophyllum dioscoreoides* sp. nov. are described here from the Siwalik sediments of Siang District, Arunachal Pradesh.

INTRODUCTION

During the regional geological mapping in northeastern India, a good collection of leaf impressions was made by Dr. V. C. THAKUR and Dr. A. K. JAIN of the Wadia Institute, Dehra Dun from the Siwalik sediments exposed about 5 km north of Pasighat in Siang District of Arunachal Pradesh. Unfortunately most of the impressions are ill preserved and only a few well preserved specimens could be available for study. These are preserved in the compact, hard, bluish grey to dark grey shale which occurs as thin bands (nearly 0.5 metre thick) in the coarse-grained, salt and pepper coloured sandstones of the Dafla Formation. The Upper Tertiary formations of the Arunachal foothills are often correlated with the Siwalik sediments of the western Himalaya.

Although plant fossils of the Siwalik beds of northwestern India are being worked out in detail (PRAKASH, 1975, pp. 192-193 ; 1978), the study of fossil flora of the Siwaliks in Arunachal Pradesh is still neglected. Consequently, this study forms an important contribution to our knowledge of the Siwalik flora of northeastern India. The fossil leaf of *Zizyphus* described here is another record of *Zizyphus* leaf, the only other known species from India is *Zizyphus sivalicus* by LAKHANPAL (1965, 1967) from the Lower Siwalik beds near Jawalamukhi in Himachal Pradesh. However, the other leaf resembling *Dioscorea* is probably the first record from India.

The present study of leaf impressions was carried out at the Birbal Sahni Institute of Palaeobotany, Lucknow, and the Forest Research Institute, Dehra Dun. All the specimens have been deposited in the Museum of the Wadia Institute Himalayan Geology, Dehra Dun.

SYSTEMATIC DESCRIPTION

Family RHAMNACEAE

Genus **Zizyphus** Adans.

Zizyphus indicus sp. nov.

Pl. 1, Figs. 1, 2, 3

Material—Three leaf impressions of which one is a counter part of the other preserved on bluish-grey shale have been collected. One of them is small and complete than the other two which are bigger in size and form the counter parts.

Description—Leaves symmetrical, narrowly elliptic ; apex acute, base acute, normal ; triplinerved ; petiole not preserved ; midrib prominent, almost straight ; a pair of lateral primaries coming off at the base, as prominent as midrib, arising at an angle of about 30°, curving up and running somewhat parallel to the midrib ; small secondaries arising from the midrib in its full length of which 3-4 are prominent, occurring in the apical region ; also about 8-9 secondaries are seen arising from each lateral primary towards the outer side arising at an angle of about 40°—50° and curving up towards the margin but not touching it ; tertiaries running as slender crosssties between the secondaries forming simple percurrent pattern and enclosing rectangular areas ; quite a few also arising directly from the midrib and joining those of lateral primaries ; margin appears to be faintly crenate to entire.

Dimensions	Preserved Length	Preserved Width
Holotype (Small leaf)	66 mm	25 mm
Paratype (Large leaf in counter parts) ..	86 mm	30 mm

Discussion—The typical triplinerved base and the general venation of the present fossil leaf strongly suggest its affinities with the modern leaves of *Zizyphus* Adans. Consequently, the fossil leaf was compared with the herbarium specimens of about seventeen species of *Zizyphus*, viz., *Z. mauritiana* Lam. syn. *Z. jujuba* Lam., *Z. glabrata* Heyne, *Z. nummularia* W. & A. Prodr., *Z. wynadensis* Bedd., *Z. vulgaris* Lam., *Z. oxyphylla* Edgew., *Z. aenoplia* Mill. Grad., *Z. xylopyrus* Willd., *A. napeca* Willd., *Z. lucida* Monn., *Z. linnaei* Laws., *Z. incurva* Roxb., *Z. apetala* Hook. f., *Z. horrida* Roth., *Z. calophylla* Wall., *Z. funiculosa* Ham., and *Z. rugosa* Lam., which were critically examined at the Botany Branch of the Forest Research Institute, Dehra Dun. The present fossil leaf shows near resemblance with the modern leaf of *Zizyphus mauritiana* Lam. The small leaf impression resembles so closely with a leaf picked up from a plant of *Zizyphus mauritiana* not only in the shape, size and venation pattern but also in the weakly crenate to entire margin (Pl. 1, Figs. 1, 4, 5). But the large leaf impression differs from the leaves of *Zizyphus mauritiana* in its shape and bigger size. However, there is quite a lot of variation in the shape and size of the leaves in *Zizyphus mauritiana*. Even the venation in the case of tertiaries also show some variation. The margin possesses a marked serrate to crenate and even somewhat entire surface.

As mentioned earlier, *Zizyphus sivalicus* Lakanpal (1965, 1967) is the only known record of a fossil leaf of *Zizyphus* from India. In addition to this fossil leaves resembling *Zizyphus* are also known from outside India. These are *Zizyphus elegans* Hollick, *Z. oblongus* Hollick, *Z. gronlandicus* Heer and *Z. lewisiana* Hollick from the Cretaceous of Eastern United States (Hollick, 1906), *Zizyphus ovatus* O. Web., *Z. paradisiaca* Heer, *Z. protolotus* Ung., *Z. pseudo-ungeri* Sap., *Z. raincourti* Sap., and *Z. ungeri* Heer from the Tertiary of France (FRITEL, 1903, pp. 135, 176, 224, 276, 311) and *Zizyphoides colombi* (Heer) Seward & Conway (1935) from West Greenland. All these species differ quite distinctly from the present fossil leaf. Thus, the present species compares with *Z. sivalicus* only in its general venation pattern. It is, however, symmetrical and narrowly elliptic in shape, whereas *Z. sivalicus* is broadly elliptical or elongate-ovate in shape and slightly inequilateral with a subcordate base. Small secondaries only arise from the apical region of the midrib in

Zizyphus sivalicus, while these are present all along the length of the midrib in the present fossil. Besides, 12-14 secondaries are given off from each lateral primary in *Z. sivalicus*, as compared to 8-9 secondaries in *Z. indicus*.

As the present fossil leaf is quite distinct from other known leaf impressions of *Zizyphus*, it is assigned to a new species, *Zizyphus indicus* the species name indicating its occurrence in the Indian subcontinent.

The genus *Zizyphus* includes about one hundred species widely distributed in tropical America, Africa, Mediterranean, Indo-Malaya and Australia (WILLIS, 1973, p. 1241). *Zizyphus mauritiana* with which the present fossil leaf resembles most, is a small tree growing throughout Indian region from N. W. Frontier, Sindh and base of Himalaya to Ceylon, and Malacca. It is also found in Afghanistan, tropical Africa, the Malaya Archipelago, China and Australia (HOOKER, 1872, p. 632).

Holotype—Wadia Institute Museum Specimen No. WIF/A78

Paratype—Wadia Institute Museum Specimen No. WIF/A79

Genus **Dicotylophyllum** Saporta, 1894

Dicotylophyllum dioscoreoides sp. nov.

Pl. 1, Fig. 6

Material—One incomplete specimen showing only a part of the leaf, due to which it is not possible to say anything about the shape and size of the fossil leaf.

Description—Leaf incomplete about 55 mm in length and 50 mm in width ; base, apex and the sides not preserved ; 7-8 prominent primaries preserved, appear to arise from the base and curving up and converging towards the apex ; secondaries arise at right angles from the primaries and join similar veins from the other side ; these appear to be further branched forming a reticulum.

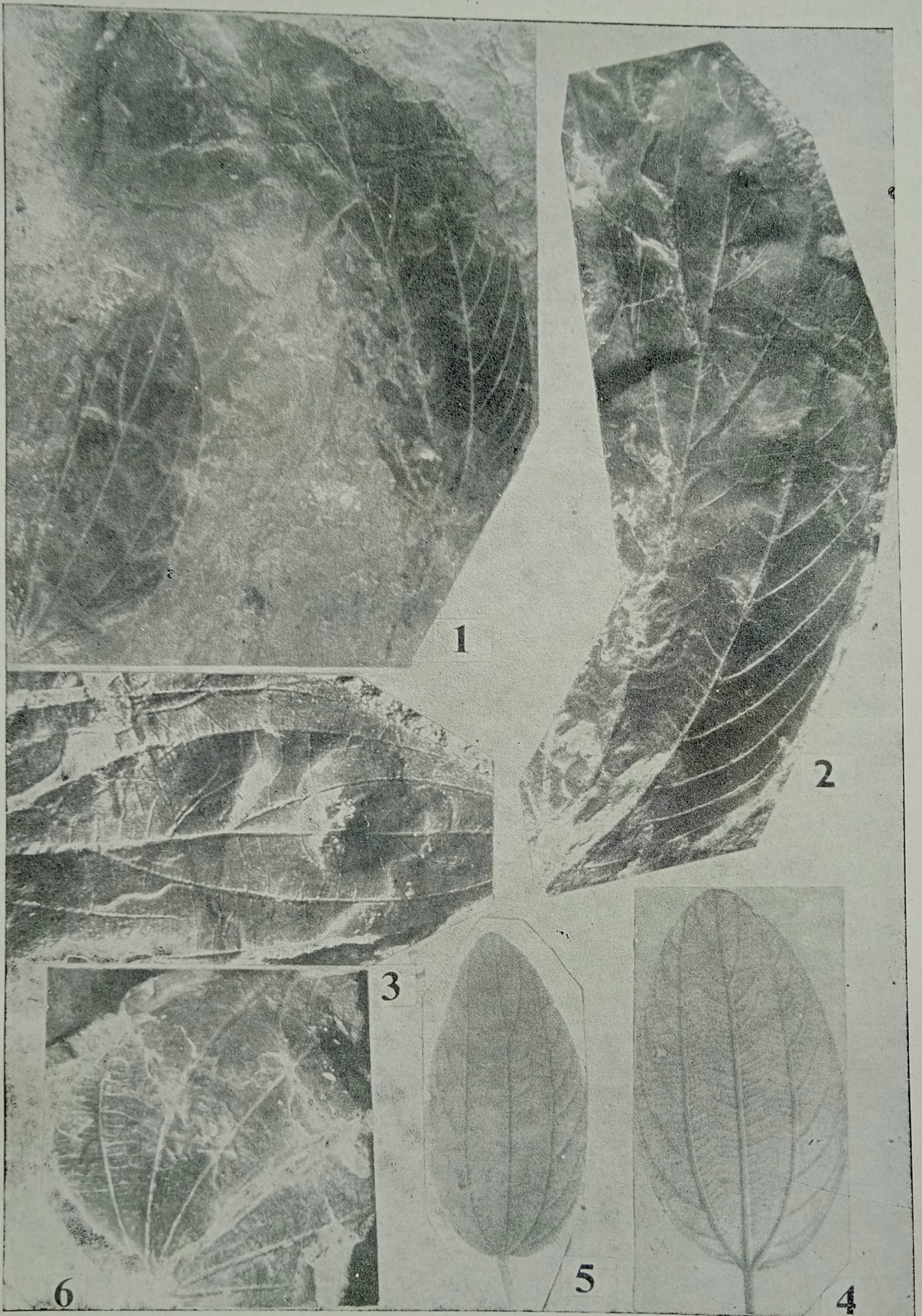
Discussion—The fossil leaf shows near resemblance to the modern leaves of *Dioscorea* Linn. in having multinerved prominent primaries arising from a single point at the base and in the arrangement of the secondaries and the tertiaries forming a reticulate pattern. In these features, it also shows a superficial resemblance to those of the *Bauhinia* leaf, except that the connecting secondaries usually form a loop between the primaries in *Bauhinia*. As the shape and size of the present leaf is not known, it has not been possible to compare it closely with the modern species of *Dioscorea*. However, the pattern of primary and secondary veins indicate it near resemblance with the leaves of *Dioscorea glabra* Roxb. and *D. oppositifolia* Linn. As the present leaf is incomplete and could not be assigned definitely to *Dioscorea*, it is described here as *Dicotylophyllum dioscoreoides* sp. nov., the specific name indicating its near resemblance with the modern leaves of *Dioscorea*. A fossil leaf belonging to Dioscoreaceae was first described by SAPORTA (1863) as *Dioscorea resurgens* from the Tertiary of France.

Dioscorea oppositifolia grows in tropical India and Bangla Desh, from Assam, Sylhet and Chittagong, southwards to Ceylon, while *D. glabra* is found in subtropical Himalaya and southwards to Bengal, Bihar, Concan, Burma and Malaya Peninsula (HOOKER, 1894, pp. 292, 294).

Holotype—Wadia Institute Museum Specimen No. WIF/A80.

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EXPLANATION OF PLATE—1

- Fig. 1. *Zizyphus indicus* sp. nov.—Two fossil leaves in natural size showing venation. Note the shape and size of smaller leaf. Wadia Institute Museum Specimen No. WIF/A78 and WIF/A79.
- Fig. 2. *Zizyphus indicus* sp. nov.—Fossil leaf magnified to show the secondaries. $\times 2$. Wadia Institute Museum Specimen No. WIF/A79.
- Fig. 3. *Zizyphus indicus* sp. nov.—Part of the fossil leaf magnified to show the tertiaries. $\times 2$. Wadia Institute Museum Specimen No. WIF/A79.
- Fig. 4, 5. *Zizyphus mauritiana*—Two modern leaves in dorsal and ventral view to show the venation pattern similar to that of the fossil leaf. $\times 1$.
- Fig. 6. *Dicotylophyllum dioscoreoides* sp. nov.—Fossil leaf in natural size. Wadia Institute Museum Specimen No. WIF/A80.