

The oldest fossil of *Semecarpus* L.f. from the Makum Coalfield, Assam, India and comments on its origin

The Makum Coalfield (27°15'–27°25'N; 95°40'–95°55'E) lies along the outermost wing of the Patkoi range, Tinsukia District, Assam, which was once located at 10–15°N palaeolatitude¹. The coalfield carries the largest Tertiary coal deposits of Northeast India. Apart from being the most important coal resource, the area is equally important for palaeobotanical studies as these coal-bearing Oligocene successions exposed have a rich assemblage of plant remains². In fact, there is no other Oligocene sedimentary basin in India which contains such a rich and diversified assemblage of plants. The succession belongs to the Tikak Parbat Formation considered as Late Oligocene (Chattian ~28–23 Ma), which is based on regional geology and an array of biostratigraphic controls³. The formation comprises alternations of sandstone, siltstone, mudstone, carbonaceous shales and coal seams. The leaf was collected from grey-coloured shales.

Anacardiaceae Lindl., the cashew nut family, contains several fruits and seeds of economic importance, such as cashew nut (*Anacardium occidentale* L.), oriental cashew nut (*Semecarpus orientale* L.), mango (*Mangifera indica* L.) and pistachio (*Pistacia vera* L.)⁴. Owing to this, palaeobotanists are interested in the origin of this family. The family includes 73 genera and 850 species of trees, shrubs, woody vines or half shrubs⁵. Most of the species are tropical to subtropical in distribution^{6,7}, and some may be found in warm temperate regions⁷, or even in the north temperate areas of Eurasia⁸. Based on molecular and other data, the family has been placed in the clades Sapindales, rosids, core eudicots and dicots⁹. The emergence of Anacardiaceae is suggested to extend back to the Cretaceous of Argentina^{10–12}. In India, the family has been recorded from the Deccan Intertrappean sediments belonging to the Late Maestrichtian–Danian¹³.

After clearing the dust from the surface of the leaf, the fossil was photographed under low-angle sunlight using a 10 megapixel digital camera. The terminology used in describing the fossil leaf is based on Hickey^{14,15}, Dilcher¹⁶, Hickey and Wolfe¹⁷ and the Leaf Archi-

ecture Working Group¹⁸. The fossil was identified at the Central National Herbarium (CNH), Howrah and the Forest Research Institute (FRI), Dehradun after

comparing it with the herbarium sheets of the extant plants. The type specimen (holotype) bearing registration number BSIP 39905 has been deposited in the

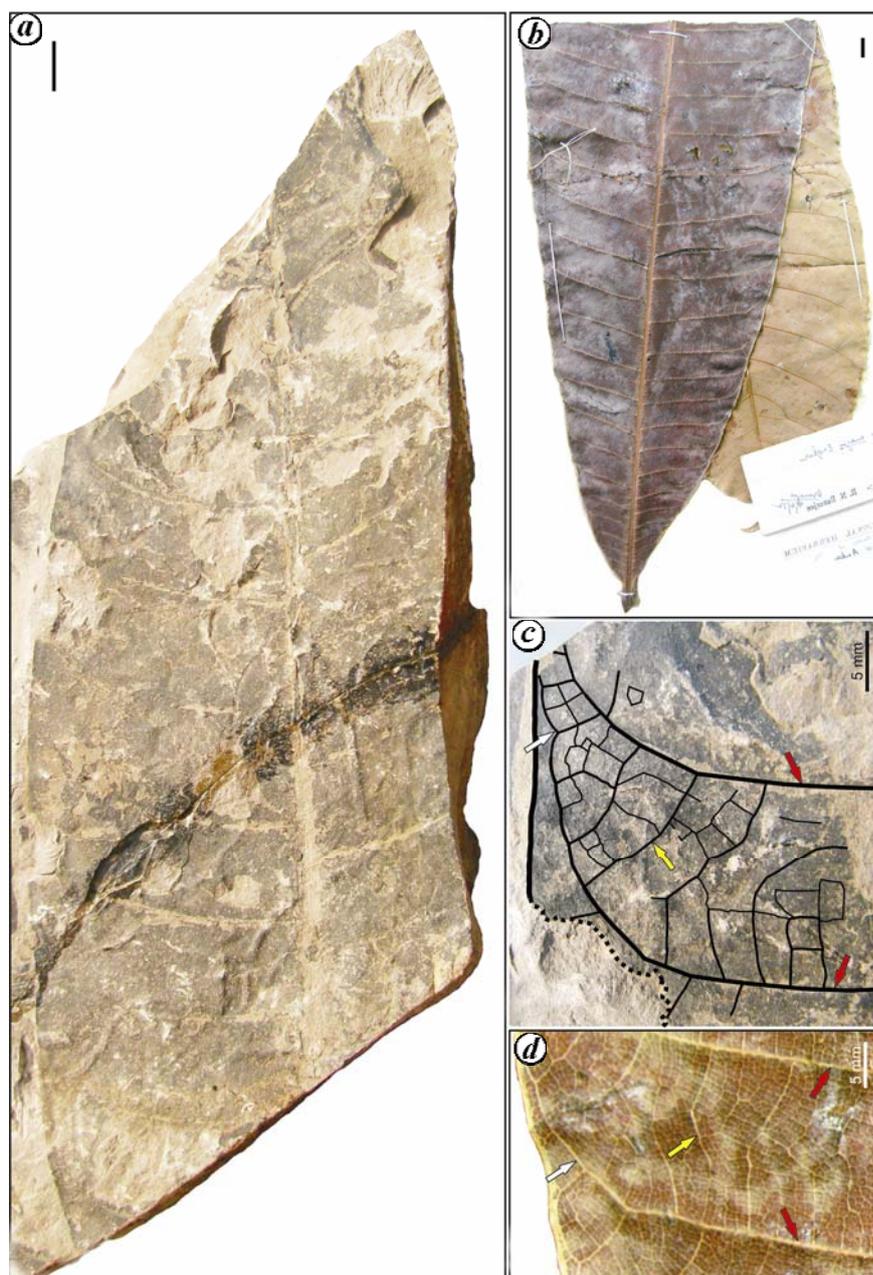


Figure 1. *a*, Fossil leaf of *Semecarpus oligocenicus* sp. nov. showing characteristic venation pattern (scale bar = 1 cm). *b*, Modern leaf of *Semecarpus kurzii* showing the same venation pattern as that of the fossil (scale bar = 1 cm). *c*, Enlarged portion of the fossil leaf showing secondary veins (red arrows), eucamptodromous venation (white arrow) and percurrent tertiary veins (yellow arrow). *d*, Enlarged portion of the modern leaf showing similar secondary veins (red arrows), eucamptodromous venation (white arrow) and percurrent tertiary veins (yellow arrow).

museum of the Birbal Sahni Institute of Palaeobotany, Lucknow.

Family – Anacardiaceae Lindl.

Genus – *Semecarpus* L.f.

Semecarpus oligocenicus, Srivastava and Mehrotra, sp. nov. (Figure 1 a and c)

Description: Leaf nearly complete, symmetrical, mesophyll, very narrow elliptic; preserved lamina length 24 cm (estimated lamina length 35 cm), maximum preserved width 8.2 cm (estimated lamina width 11 cm) near the middle position; apex broken; base broken; margin entire; texture chartaceous; venation pinnate, eucamptodromous; primary vein stout and straight; secondary veins nine pairs visible, 1.8–2.4 cm apart, alternate, angle of divergence wide acute to right angle (68°–98°), for the most part straight but turning up sharply near the margin, moderately thick; intersecondary veins present, simple; tertiary veins percurrent, forked, straight, alternate–opposite, angle of origin AA–AO; marginal ultimate venation fimbriate; areoles imperfect, random, predominantly quadrangular in shape; veinlets branched.

Holotype – Specimen No. BSIP 39905

Horizon – Tikak Parbat Formation

Locality – Tirap Colliery, Tinsukia District, Assam (27°17'20"N, 95°46'15"E)

Age – Late Oligocene (Chattian 28–23 Ma)

Number of specimens studied – One

Affinities: The characteristic features of the fossil, viz. symmetrical, very narrow elliptic and long (24 cm; estimated length 35 cm) leaf, entire margin, eucamptodromous venation, wide acute to right angle of divergence of secondary veins, simple intersecondary veins, percurrent tertiary veins and fimbriate marginal ultimate venation suggest its close affinity with the genus *Semecarpus* of the family Anacardiaceae. A large number of species of this genus, namely *Semecarpus albescens* Kurz, *S. anacardium* L.f., *S. auriculata* Bedd., *S. kurzii* Engl., *S. megabotrys* Merr., *S. obscura* Thw., *S. panduratus* Kurz, *S. prainii* King and *S. spathulata* King were examined in CNH and FRI. After detailed comparison, it has been inferred that the present fossil is similar to *S. anacardium* (herbarium sheet no. FRI 18815) and *S. kurzii* (herbarium sheet no. CNH 53) (Figure 1 b and d). In *S. albescens*,

S. panduratus and *S. prainii*, the angle of divergence of secondary veins is more acute compared to our leaf fossil. In *S. obscura*, tertiary veins are random reticulate and thus can be differentiated from those of the present fossil. In *S. spathulata* the leaf is elliptic, angle of divergence of secondary veins is more acute and the distance between the two secondary veins is less in comparison to that of the present fossil.

Fossils records of *Semecarpus* are known from the various Cenozoic successions of India and abroad. Two species, namely *S. anacardium* from the Late Tertiary sediments of Mahuadan Valley, Jharkhand¹⁹ and *S. palaeoanacardium* from the Early Miocene sediments of Himachal Pradesh²⁰ are known from India. The former is different from the present fossil in having eucamptodromous to brochidodromous venation, acute angle of divergence of secondary veins and the absence of intersecondary veins, whereas the latter can be differentiated from the absence of intersecondary veins and in having a few secondary veins bifurcated towards the margin. Recently, a fossil leaf of *S. paleocurtisioides* has also been described from the Late Oligocene to Early Miocene sediments of Thailand⁴, but it is found to be different from the present fossil in

having closely placed secondary veins. Although wood of *Semecarpus* has been described by Prakash and Dayal¹³ as *Anacardioxylon semecarpoides* from the Deccan Intertrappean sediments of Nagpur District, Maharashtra, the authors were not sure about its exact affinity. The present leaf fossil has been assigned to a new species, *Semecarpus oligocenicus* sp. nov., the specific epithet is after its age.

The genus *Semecarpus* consists of about 60 species found in tropical Asia and Australia²¹ (Figure 2). The modern distribution and degree of endemism of its various species indicate its high endemism in New Guinea (9 endemic from 11 species), i.e. east of the Wallace's line in contrast to west of the Wallace's line. The endemic species are also found in peninsular Malaysia (2 from 6), Borneo (3 from 7) and the Philippines (6 from 9)⁴.

According to Sawangchote *et al.*⁴, when indigenous genera and species density of Anacardiaceae are considered, the richest endemism is found in peninsular Malaysia and Borneo. This suggests that the evolution of *Semecarpus* should be west of the Wallace's line. The genus later migrated to east of the Wallace's line. The occurrence of *Semecarpus* in the Late Oligocene sediments of North-

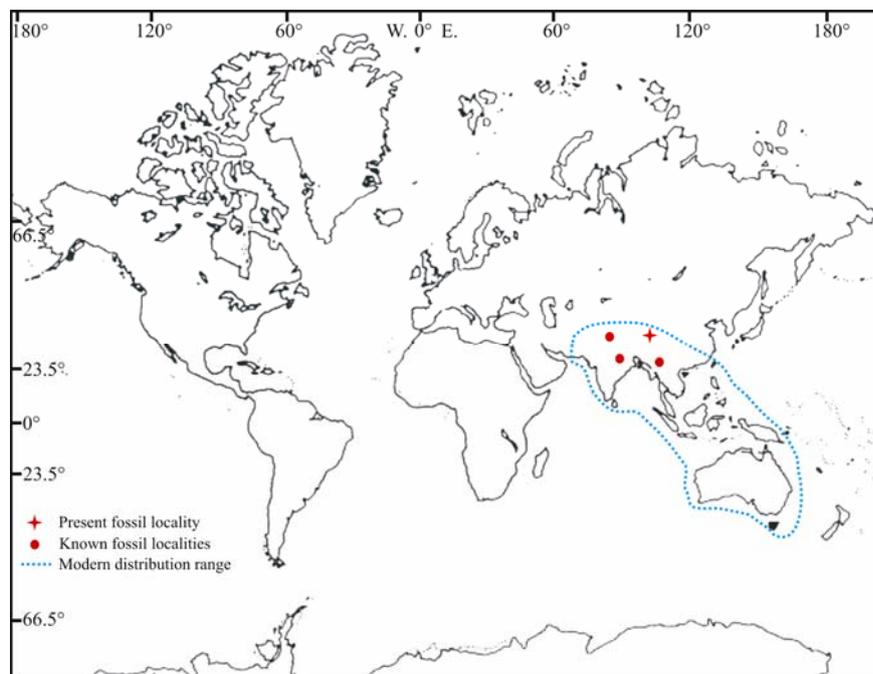


Figure 2. Fossil as well as modern distribution of the genus *Semecarpus* (blue dotted line indicates modern distribution, whereas red solid circular dots and star indicate the known fossil localities and the present fossil locality respectively).

east India appears to be its oldest fossil record, and suggests that the genus originated from Northeast India and then migrated westwards^{19,20} and southwards to Thailand via Myanmar after suturing of the Indian and Asian plates during the Early Miocene²².

S. anacardium with which our leaf fossil shows closest resemblance, is a deciduous tree found along the sub-Himalayan tract from Sutlej eastwards, ascending up to 3500 ft, extending to Chittagong²³, whereas *S. kurzii* Engler (the other comparable species) is a tree distributed throughout the forests of Andaman and Nicobar Islands²⁴.

Based on the modern distribution of *S. anacardium* and *S. kurzii* and the known fossil record from the Makum Coalfield², it may be inferred that warm and humid climate was prevailing in Northeast India during the deposition of the sediments.

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