

Occurrence of *Podocarpus* and *Mesua* in the Oligocene sediments of Makum Coalfield, Assam, India

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Fossil leaves resembling those of the modern *Podocarpus neriifolius* D. Don, *Mesua ferrea* Linn. and *M. lepidota* T. Anders and a fossil fruit resembling that of *M. ferrea* are described from the Oligocene sediments of Makum Coalfield, Dibrugarh District, Assam. They have been assigned to the species *Podocarpus oligocenicus* sp. nov. and *Mesua antiqua* sp. nov. respectively. Both, *Podocarpus* and *Mesua* are inhabitants of the tropical evergreen forests of Asia and the occurrence of their allied fossils suggests that similar climatic conditions might have prevailed in northeast India during the deposition of Makum coals.

Key-words — Leaves, fruit, *Podocarpus*, *Mesua*, Oligocene, Makum Coalfield, Assam.

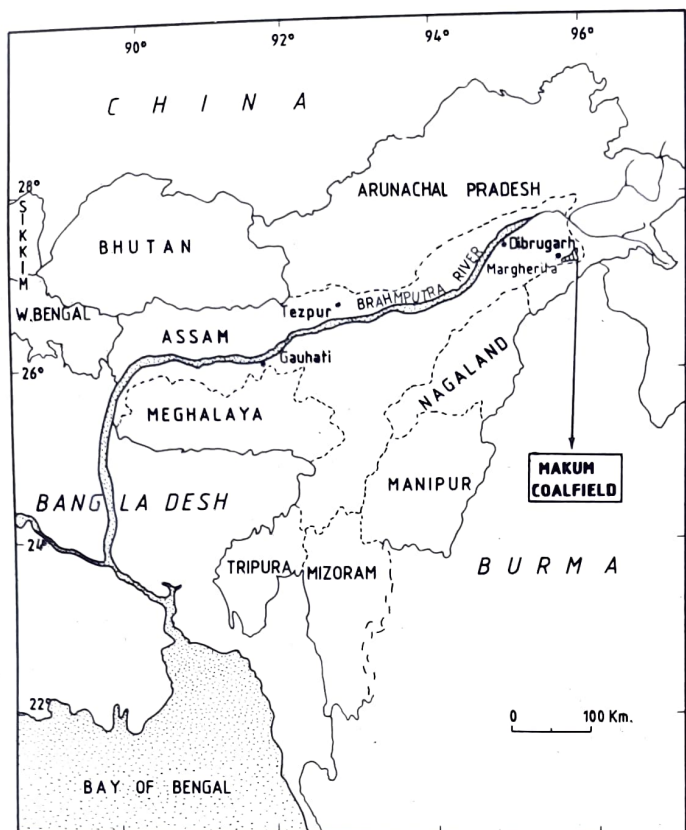
INTRODUCTION

THE Oligocene rocks of Barail Group (Tikak Parbat Formation) are well developed in northeast India all along the outermost flank of the Patkoi range in Dibrugarh District, Assam. They contain coal deposits varying in thickness from 1.5 to 18.0 m and the area is known as Makum Coalfield (27° 15' - 27° 25' N; 95° 40' - 95° 55' E). The hill ranges are traversed by the rivers Nam-

dang, Ledopani and Tirap whose courses expose sections of the coal-bearing Tikak Parbat Formation. The sediments overlying and underlying coal seams are highly fossiliferous, comprising impressions of mostly leaves and occasionally fruits and seeds. They have been found in all the four collieries of the area, viz., Baragolai, Tikak, Ledo (Tirap) and Tipong (Map 1).

According to Raja Rao (1981) the stratigraphic sequence in this area is as follows:

Age	Group	Lithology
Recent and Pleistocene		Terrace deposits and alluvium comprising siltstones, clays, gravel beds etc.
Pliocene	Dihing	Alternate coarse grained friable greyish to greenish grey felspathic sandstones and pebble beds, which are ferruginous at places and greyish to brown clays.
Oligocene	Barail	<i>Tikak Parbat Formation</i> —Well bedded at places, massive, light coloured, yellowish white to light grey, fine grained sandstone, sandy shales, shales and clays with several thick coal seams in the basal part. <i>Baragolai Formation</i> —Well bedded or at places massive tough greyish micaceous or ferruginous, shaly sandstones alternating with bluish grey, greenish yellow and reddish pink clays, sandy clays and carbonaceous shales and a number of thin coal seams. <i>Naogaon Sandstone</i> —The bedded tough compact, fine grained, dark grey to greyish quartzitic sandstone with thin partings of grey splintery shales, which are iron stained at places and sandy shales.
Eocene	Disang	Grey to dark grey splintery shales, iron stained and sandy shale with their parting of compact quartzitic sandstones.



Map 1. Showing location of Makum Coalfield.

The plant remains are found in grey carbonaceous shales and sandy shales of the Tikak Parbat Formation.

The occurrence of plant fossils in the Makum Coalfield has been known since 1912 when Seward described from here some fragmentary leaves as *Phyllites kamrupensis* and *Phyllites* sp. However, the area remained palaeobotanically unexplored until 1963-64 when one of us (RNL and party) collected a few leaf impressions from the Baragolai colliery. In order to furnish more data about the meagrely known Oligocene flora of India, preserved in this area, a detailed survey of the Makum Coalfield was

undertaken by two of us (NA & RCM) in January, 1988 and a large number of leaf impressions as well as impressions of a few fruits and seeds were collected.

The identification of these impressions was carried out by comparing them with the herbarium specimens at the Forest Research Institute Herbarium, Dehradun and the Central National Herbarium, Howrah. Out of them, the impressions showing affinities with *Podocarpus* and *Mesua* are described here in detail.

SYSTEMATIC DESCRIPTION

GYMNOSPERMS

Family-Podocarpaceae

Genus-*Podocarpus* L' Herit. ex Pers.

Podocarpus oligocenicus sp. nov.

Pl. 1, figs 1,3,5,6

The species is based on three specimens.

Description—Leaves symmetrical, linear to narrow oblong, varying from 7.00 to 13.2 cm in length and 1.00 to 2.5 cm in width; apex seemingly acute to attenuate; base symmetrical, acute to obtuse, normal; margin entire; texture coriaceous; venation pinnate, hypodromous; primary vein moderate in thickness, nearly straight to gradually curving towards apex; secondary veins absent, but numerous fine, parallel, longitudinal ridges present, more prominent on the ventral surface.

Holotype—Specimen no. BSIP 36651.

Paratype—Specimen nos BSIP 36652, 36653.

Locality—Baragolai and Tirap collieries near Margherita, Dibrugarh District, Assam.

Affinities—Linear to narrow oblong shape, coriaceous texture, absence of secondary veins and

Plate 1

(All photographs are of natural size unless otherwise mentioned)

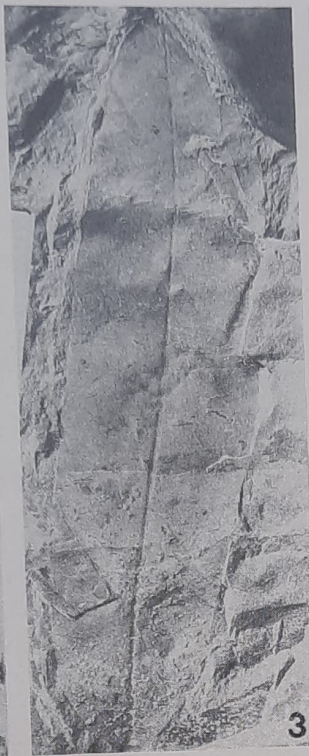
1. *Podocarpus oligocenicus* sp. nov., a fossil leaf: specimen no. BSIP 36651.
2. Leaf of *Podocarpus neriifolius*.
3. *Podocarpus oligocenicus* sp. nov., another fossil leaf, specimen no. BSIP 36652.
4. *Podocarpus neriifolius*, another leaf to show similarity with the fossil.
5. *Podocarpus oligocenicus* sp. nov., another leaf; specimen no. BSIP 36653.
6. *Podocarpus oligocenicus* sp. nov., an enlarged portion of fossil leaf showing longitudinal ridges, x 5; specimen no. BSIP 36651.
7. *Podocarpus neriifolius*, an enlarged portion of leaf showing similar ridges as in fossil, x 5.
8. *Mesua antiqua* sp. nov., a fossil leaf, specimen no. BSIP 36658.
9. A leaf of *Mesua ferrea*.
10. *Mesua antiqua* sp. nov., an enlarged portion showing details of venation pattern, x 4; specimen no. BSIP 36654.
11. *Mesua antiqua* sp. nov., a fossil fruit under reflected light showing striations on the surface, specimen no. BSIP 36792.
12. *Mesua ferrea*, a fruit showing similar striations.
13. *Mesua antiqua* sp. nov., a fossil fruit under reflected light, specimen no. BSIP 36791.
14. *Mesua ferrea*, fruit showing similar shape and size.



1



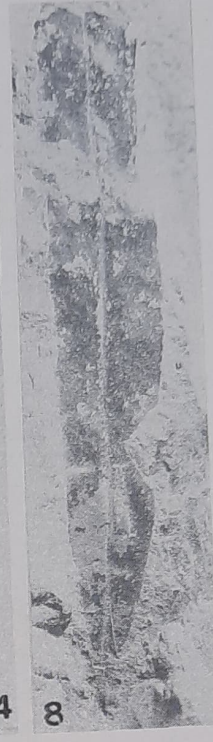
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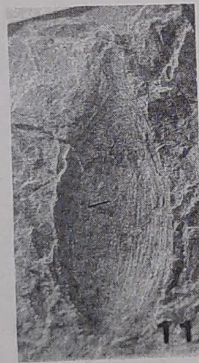
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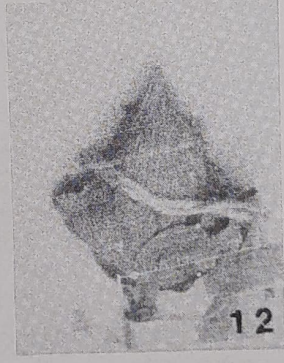
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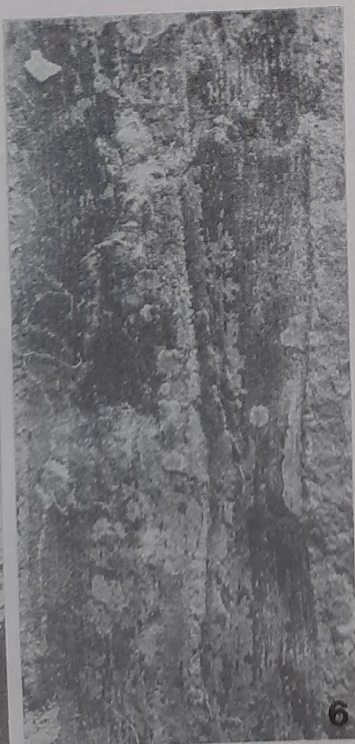
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14



5



6



7



10

Plate 1

presence of very fine numerous parallel ridges are characteristic features of the fossil leaves which show similarity with those of *Podocarpus* L. Herit ex Pers. of Podocarpaceae. In the genus *Podocarpus* leaves of *P. neriifolius* D. Don (Herb. sheet nos. FRI BW 5162, BSIP 2943) possess the same type of morphological features as exhibited by the fossil leaves (Pl. 1, figs 2, 4, 7). Further, two forms of leaves, narrow oblong as well as linear, are found in *P. neriifolius* which is also the case in the fossil specimens. This confirms the affinity of the fossil leaves with *P. neriifolius*. The other species known from India, i.e., *P. wallichianus* B. Presl., differs in having leaves of lanceolate shape and parallelodromous venation.

The fossil records of Podocarpaceae are well known from the Mesozoic and Cenozoic sediments of India and elsewhere. They include woods, leaves, ovule and pollen (Madler, 1939; Lakhanpal, *et al.* 1976). The pollen referable to Podocarpaceae are described as *Podocarpidites* and the woods are generally assigned either to *Mesembrioxylon* Seward or *Podocarpoxylon* Gothan. The only ovule known to the authors is *Podocarpoovulites chitaley* (Sheikh & Kolhe, 1982) from the Deccan Intertrappean beds of Nagpur, India.

There are a number of leaf impressions referred to *Podocarpus*, viz., *Podocarpus haeringiana* Ettingshausen, *P. taxites* Unger, *P. mucronulata* Ettingshausen, *P. eocenica* ? Unger, *P. apollinus* Ettingshausen from the Tertiary of Austria (Ettingshausen, 1853); *P. suessiorenensis* and *P. fyeensis* from the Tertiary of France (Crie, 1978); *P. campbelli* Gardner (1886) from the Palaeocene of Scotland; *P. ? stantoni* Knowlton (1919) from the Fox Hills, Colorado; *P. andiniformis* Berry, *P. engelhardti* from the Tertiary of Argentina (Berry, 1938); *P. kinkelini* Madler (1939) from the Pliocene near Frankfurt, Germany and *Podocarpus* sp. Givulescu (1973) from the Lower Pliocene of Rumania. Besides, leafy shoots resembling *Podocarpus* are also known from the Eocene of North America (Dilcher, 1969) and the Tertiary of Australia and Tasmania (Cookson & Pike, 1953). Christophel and Blackburn (1978) also mentioned the presence of *Podocarpus* in the preliminary report on the Lower-Middle Eocene flora of Maslin Bay, South Australia. From the photographs of the fossil leaves it seems that some of the determinations as *Podocarpus* are doubtful. Ferguson *et al.* (1978) re-examined and reviewed most of these species and concluded that *Podocarpus eocenica*, *P. campbelli*, *P. taxites*, *P. haeringiana* and *Podocarpus* sp. belong to *Amentotaxus* Pilger of Taxaceae. However, all the known fossil leaves described as *Podocarpus* are generally smaller in size than our fossil leaves. Therefore, we prefer to place the latter under a new species, *Podocarpus oligocenicus*.

ANGIOSPERMS

Family-Clusiaceae

Genus-*Mesua* Linn.

Mesua antiqua sp. nov.

pl. 1, figs 8, 10, 11, 13

This species is based on one incomplete leaf-impression with about Leaf 3/4 basal part and a few impressions of fruits.

Leaf

Description—Symmetrical, lorate; incomplete, preserved length 9.3 cm, maximum width 1.4 cm; apex missing; base symmetrical, acute, normal; margin entire; texture coriaceous; venation pinnate, eucamptodromous; primary veins massive, straight; secondary veins numerous, fine, closely placed, about 2-3 veins per mm, running parallel to each other, turning upward near the margin, angle of divergence 70° - 80° ; tertiary veins not discernible.

Holotype—Specimen no. BSIP 36654.

Locality—Baragolai colliery near Margherita, Dibrugarh district, Assam.

Affinities—The impression shows close resemblance with the leaves of *Mesua ferrea* Linn. (Herb. sheet no. BSIP 10055) in shape, size and texture (Pl. 1, fig. 9). In a small area near the base, where the shining organic matter is absent, there are details of venations visible clearly under a lens. In fact, it is due to these close secondaries that the identity of this leaf with dicot angiosperms is indicated. These close secondaries are also very similar to those of *Mesua ferrea*. However, a significant difference is that whereas in *M. ferrea* the secondaries are straight and running at an angle of divergence varying from 70° - 80° , in the present leaf-impression they are slightly curved near their emergence from the midrib.

After comparison with a large number of herbarium sheets of different genera and species of Clusiaceae, curved secondaries resembling those of Baragolai impression were found in *Mesua lepidota* T. Anders. Although the leaves of *M. lepidota* have the same shape and coriaceous texture as in *M. ferrea*, they are smaller in *M. lepidota* than in *M. ferrea*. It is quite possible that the fossil leaf of *Mesua* from Baragolai colliery combines the characters of *M. ferrea* and *M. lepidota*. The curved secondaries might be the ancient character which continued in *M. lepidota* and became straight in *M. ferrea*.

Fossils of *Mesua* are known in the form of woods and leaves. The fossil wood of *Mesua*, *Mesuoxydon ar-*