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# Occurrence of *Bischofia* and *Antiaris* in Namsang beds (Miocene-Pliocene) near Deomali, Arunachal Pradesh, with remarks on the identification of fossil woods referred to *Bischofia*

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Two fossil woods resembling those of *Bischofia* and *Antiaris* belonging to the family Bischofiaceae and Moraceae, respectively, are described from the Namsang beds near Deomali, Arunachal Pradesh. A critical assessment of the structural details of the fossil woods referred earlier to *Bischofia* has revealed that they are quite different from that of *Bischofia*.

**Key-words**—Xylotomy, *Bischofia*, *Antiaris*, Namsang beds, Miocene-Pliocene (India).

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## सारांश

अरुणाचल प्रदेश में देवमाली के समीपस्थ नामसांग संस्तरो (मध्यनूतन-अतिनूतन) में बिस्कोफिया एवं एन्टीएरिस की उपस्थिति तथा बिस्कोफिया के काष्ठशर्मों के अभिनिर्धारण पर टिप्पणियाँ

नीलाम्बर अवस्थी

अरुणाचल प्रदेश में देवमाली के समीपस्थ नामसांग संस्तरो में क्रमशः बिस्कोफिया एवं मोरेसी कुलों के बिस्कोफिया एवं एन्टीएरिस से समानता प्रदर्शित करने वाले दो काष्ठशर्मों का वर्णन किया गया है। पहले से वर्णित बिस्कोफिया की अशमत काष्ठों की शारीरिक संरचना के विशिष्ट विश्लेषण से व्यक्त होता है कि ये अशमत काष्ठें बिस्कोफिया से बिल्कुल भिन्न हैं।

THE Namsang beds (Miocene-Pliocene) consisting of mottled clays, sandstones, conglomerates and grits resting on the Tipam sandstones are exposed along the Namsang River near Deomali in Arunachal Pradesh. Petrified woods, ranging in size from small pieces to big logs, strewn along with pebbles and boulders in the river beds of Namsang and Buri-Dihing are known to have been derived from these beds. The taxa recovered so far from the Namsang beds belong to the dicotyledonous families, viz., Clusiaceae, Dipterocarpaceae, Sterculiaceae, Burseraceae, Anacardiaceae, Fabaceae, Combretaceae, Lythraceae, Sonneratiaceae, Sapotaceae and Lauraceae (Prakash, 1965, 1966; Prakash & Awasthi, 1970, 1971; Lakhanpal *et al.*, 1981; Awasthi & Prakash, 1987). Further investigation of the petrified woods from the same locality has revealed the presence of *Bischofia* (Bischofiaceae) and *Antiaris* (Moraceae).

## SYSTEMATIC DESCRIPTION

### Family—Bischofiaceae

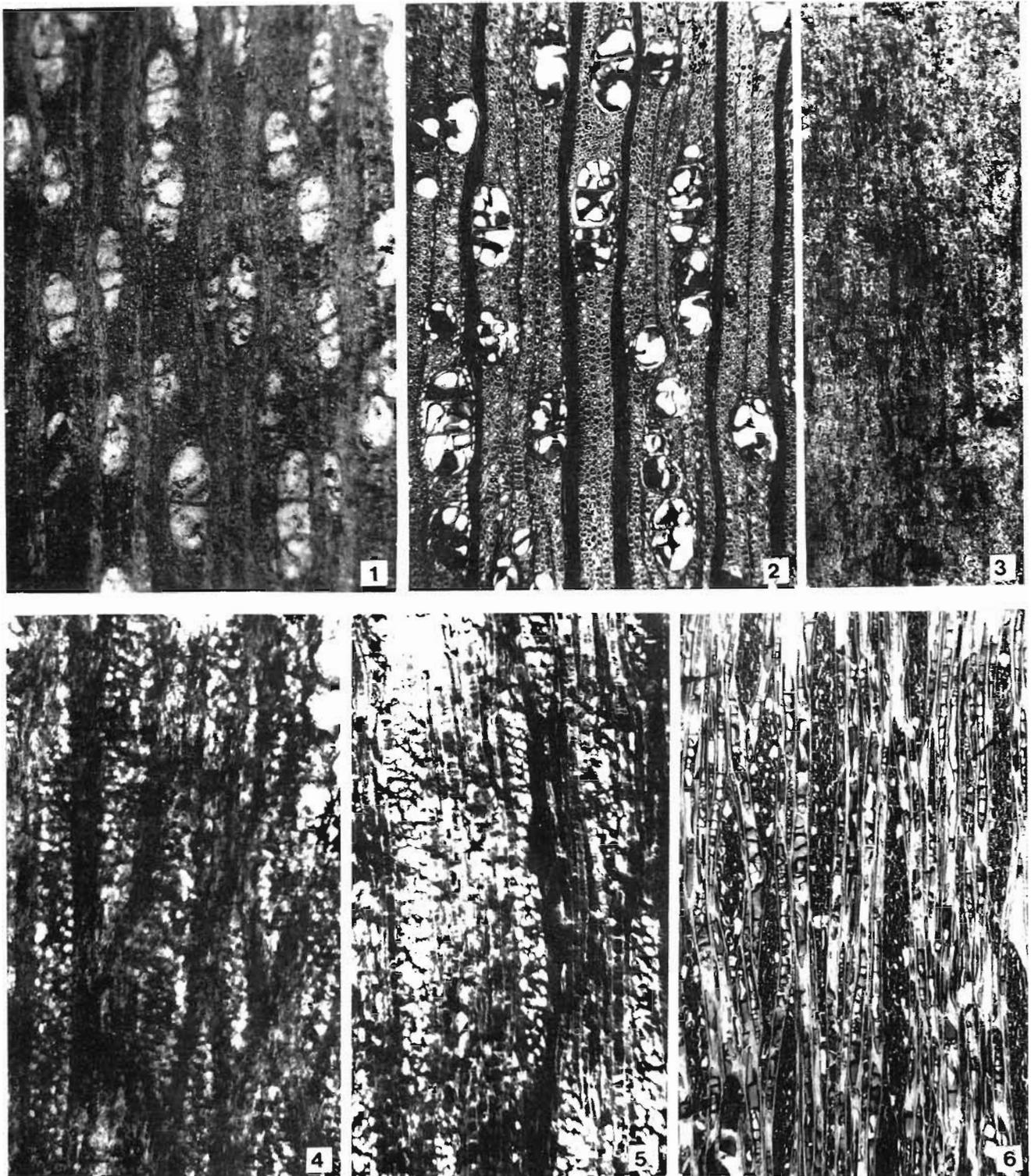
#### Genus—*Bischofia* Bl.

*Bischofia palaeojavanica* sp. nov.

Pl. 1, figs 1, 3, 4, 5

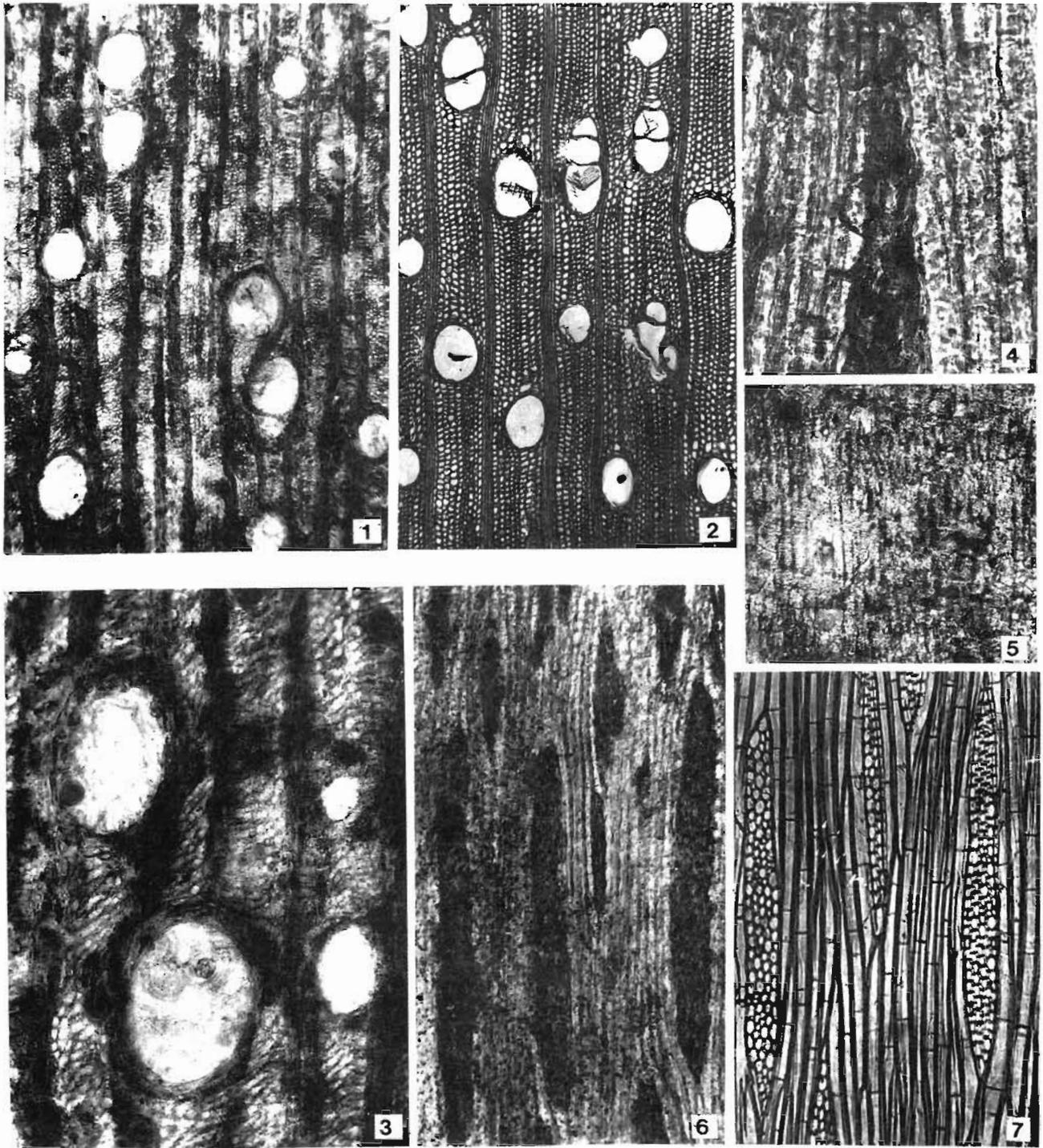
*Material*—Three pieces of fairly well-preserved petrified woods.

*Description*—Wood diffuse-porous. *Growth rings* not seen. *Vessels* visible to the naked eye, medium to large (Pl. 1, fig. 1), solitary and mostly in radial multiples of 2-4, sometimes up to 6, tangential diameter of solitary vessels up to 300  $\mu$ m and radial diameter up to 340  $\mu$ m, solitary vessels circular to mostly oval (Pl. 1, fig. 1), uniformly distributed, about 12-25 per sq mm; perforations simple; vessel-members with truncate or slightly oblique ends; intervessel pits large, 16-20  $\mu$ m in diameter,



## PLATE 1

- 1 *Bischofia palaeojavanica* sp. nov. Cross section showing both solitary and multiple vessels with tyloses  $\times 35$ . Slide no. BSIP 35887 I
- 2 *Bischofia javanica* Roxb. : Cross-section showing vessels similar in type and distribution and with full of tyloses as in fossil wood shown in fig. 1  $\times 35$ .
- 3 *Bischofia palaeojavanica* sp. nov. : Radial longitudinal section showing heterocellular ray.  $\times 90$ . Slide no. BSIP 35887 III
- 4 *Bischofia palaeojavanica* sp. nov. : Tangential longitudinal section showing rays with sheath cells.  $\times 85$ . Slide no. BSIP 35887 II.
- 5 Another tangential longitudinal section showing rays  $\times 70$ . Slide no. BSIP 35887 II
- 6 *Bischofia javanica* showing similar type of rays as in fossil  $\times 70$ .



## PLATE 2

1. *Antiaris deomaliensis* sp. nov. : Cross-section showing nature and distribution of vessels and parenchyma.  $\times 35$ ; Slide no. BSIP 35888-I.
2. *Antiaris toxicaria* Lesch. : Cross-section showing vessels and parenchyma similar in nature and distribution as in the fossil shown in fig. 7.  $\times 35$ .
3. *Antiaris deomaliensis* sp. nov. : Cross-section magnified showing vessels and vascentric to aliform and confluent parenchyma.  $\times 90$ ; Slide no. BSIP 35888-I
4. Magnified tangential longitudinal section showing septate fibres.  $\times 90$ , Slide no. BSIP 35888 II
5. Radial longitudinal section showing heterocellular rays.  $\times 90$ ; Slide no. BSIP 35888-III
6. Tangential longitudinal section showing rays.  $\times 70$ , Slide no. BSIP 35880 II.
7. *Antiaris toxicaria* : Tangential longitudinal section showing similar rays as in the fossil shown in fig. 12.  $\times 70$ .

alternate, bordered, apertures lenticular; tyloses abundant, often completely occluding the vessels. *Parenchyma* typically absent or 1-2 cells may be rarely present contiguous to the tangential walls of vessels. *Rays* 1-7 seriate, 5-7 per mm, about 70 cells high; ray tissue heterogeneous; uniseriate rays frequent, often moderately low, homocellular to heterocellular; multiseriate rays heterocellular, consisting of 1 to several uniseriate marginal rows of upright cells at one or both the ends (Pl. 1, figs 4, 5) and procumbent cells in the central part; sheath cells often present (Pl. 1, fig. 4); tangential height of upright or square cells about 40-80  $\mu\text{m}$ , radial length 30-50  $\mu\text{m}$ ; tangential height of procumbent cells 20-30  $\mu\text{m}$ , radial length 60-130  $\mu\text{m}$ . *Fibres* aligned in radial rows, large, 20-40  $\mu\text{m}$  in diameter, rectangular, thick-walled, walls 6-10  $\mu\text{m}$  in thickness, septate.

*Affinities*—A combination of the important xylotomical characters of the fossil, such as medium to large vessels, solitary or mostly in radial multiples of up to 6 cells, heavily tylosed; *parenchyma* typically absent or rarely 1-2 cells present contiguous to tangential walls of the vessels; moderately broad rays up to 70 cells in height, heterocellular with sheath cells and the fibres bigger in size, thick-walled and septate, is met with in the woods of Phyllanthoideae of the family Euphorbiaceae (including Bischofiaceae). However, in all other structural details, e.g., shape, size, frequency of vessels; amount of tyloses; length and width of rays, bigger size of fibres and intervessel pits, the fossil wood shows close similarity with that of *Bischofia javanica* Bl. of Bischofiaceae.

#### Remarks on fossil woods referred to *Bischofia* Bl.

Ramanujam (1960) instituted the genus *Bischofioxylon* to accommodate a fossil wood from the Cuddalore Sandstone near Pondicherry showing near resemblance with that of *Bischofia*. Mädel (1962) opined that *Bischofioxylon miocenicum* as well as *Euphorbioxylon kraeuselii* Prakash 1957 possess the xylotomical characters of *Bridelia* and not of *Bischofia*. She, therefore, transferred both the species to *Bridelioxylon* Ramanujam 1956. Awasthi (1974) pointed out that *Bridelioxylon miocenicum* and *Bridelioxylon cuddaloreense* Ramanujam 1958 are identical, therefore, he merged the former with the latter.

However, on critical re-examination of the type slides of all these fossils it was found that these fossil woods are quite different from those of *Bischofia* and *Bridelia*. One of the important differences is that the vessels in these fossils are mostly in several radial multiples, often reaching up

to 25 vessels and appearing as short chains; whereas in *Bridelia* and *Bischofia* they are in radial multiples of mostly 2-5 and occasionally up to 8. Moreover, in *Bischofia* the *parenchyma* is absent or rarely a few cells may be associated with vessels, and the rays have sheath cells; while in *Bridelia* the apotracheal *parenchyma* is often present in addition to paratracheal, as widely spaced narrow bands, and the sheath cells in rays are absent. To which extant genus of Euphorbiaceae or other than Euphorbiaceae, these woods belong is yet to be ascertained.

Bande (1974) described a fossil wood from the Deccan Intertrappean beds of Parapani in Mandla District, Madhya Pradesh showing resemblance with that of *Bischofia javanica*. A critical examination of the type slides has revealed that the fossil is quite different from *Bischofia javanica*. In *Bischofia javanica* the *parenchyma* is typically absent or sometimes one or two cells may be present associated with the vessels that are mostly large. On the contrary, in *Bischofinium deccanii* the *parenchyma* is paratracheal, vasicentric, completely sheathing the vessels and sometimes aliform and the vessels are mostly medium-sized (Bande, 1974, pl. 2, figs 6, 7). In view of these major anatomical differences, *Bischofinium deccanii* cannot be considered as a fossil wood of *Bischofia javanica*.

Since the present fossil wood shows close similarity with that of *Bischofia*, in accordance with the suggestions of Prakash and Lakhanpal (1980) and Wheeler, Scott and Barghoorn (1977) it is being placed under the same genus and named as *Bischofia palaeojavanica* sp. nov.

*Holotype*—Specimen no. BSIP 35887; Namsang River beds, Deomali, Arunachal Pradesh; Miocene.

#### Family—Moraceae

##### Genus—*Antiaris* Lesch.

*Antiaris deomaliensis* sp. nov.

Pl. 2, figs 1, 3-6

*Material*—One piece of fairly well-preserved petrified wood.

*Description*—Wood diffuse-porous. Growth rings not seen. Vessels medium to large, mostly large, sometimes small, solitary and in radial multiples of 2-4 (Pl. 2, fig. 1), sometimes small vessels present in groups associated with bigger vessels, solitary vessels up to 320  $\mu\text{m}$  in tangential diameter and up to 340  $\mu\text{m}$  in radial diameter, thick-walled, common walls up to 16  $\mu\text{m}$ , evenly distributed, about 3-4 vessels per sq mm; perforations simple; vessel-members truncate, very short, about 100-400  $\mu\text{m}$  in length; intervessel pits

medium to large, 6-8  $\mu\text{m}$  in diameter, bordered, alternate with lenticular apertures; tyloses present. *Parenchyma* paratracheal, vasicentric to aliform, sometimes narrow aliform extension seen meeting with those of adjacent vessels (Pl. 2, fig. 3), cells about 16-24  $\mu\text{m}$  in diameter, filled with dark contents. *Rays* 1-4 seriate (Pl. 2, fig. 6), 7-10 per mm in cross section, about 10-30 cells in height, ray tissue heterogeneous; rays heterocellular, consisting of procumbent cells and 1-2 uniseriated marginal rows of upright or square cells (Pl. 2, fig. 5); crystals present in upright or square cells. *Fibres* aligned in radial rows between two consecutive rays, small, 8-24  $\mu\text{m}$  in diameter, mostly thick-walled (Pl. 2, fig. 3), walls about 3-5  $\mu\text{m}$  in thickness, septate (Pl. 2, fig. 4).

*Affinities*—The above anatomical features of the fossil indicate that it belongs to the family Moraceae and is comparable to the woods of *Artocarpus* and *Antiaris*. In shape, size and distribution of parenchyma, length and width of rays the fossil wood is very similar to *Antiaris* and differs from that of *Artocarpus* in having vessels relatively smaller in size and the rays narrower and shorter. Among the modern woods of *Antiaris*, *A. toxicaria* Lesch. shows closest resemblance with the present fossil wood. As far as the author is aware this is the first record of the fossil wood of *Antiaris* Lesch. It is being described under this genus and assigned to a new species, *A. deomaliensis* indicating its occurrence in the Namsang beds at Deomali.

*Holotype*—Specimen no. BSIP 35888; Namsang River beds, Deomali, Arunachal Pradesh; Miocene.

## DISCUSSION

The genus *Bischofia* Bl. is represented by a single species, *B. javanica* Bl. (Willis, 1973, p. 141) which is a large deciduous tree widely distributed in the Indo-Malayan region ranging from the western Peninsula eastward through Burma and Thailand to Cochin China (South Vietnam), the Philippines, Formosa and Polynesia and southward into Malaya. In India, it occurs in Lower Himalaya up to 300 m and sub-Himalayan tract from Jamuna River eastwards, through Uttar Pradesh to Bengal and Assam; southward to Bihar and Orissa, Tirunelveli and Madurai, and on the West Coast from Konkan to the Nilgiris; throughout upper and lower Burma in hills and plains forest; scarce in Andaman Islands (Pearson & Brown, 1932, p. 881). *Antiaris toxicaria* Lesch. which is closely comparable to the fossils, is

found in the evergreen forest of Western Ghats, Sri Lanka and Burma (Gamble, 1972, p. 651).

It is important to mention here that out of several taxa recovered from the Namsang sediments near Deomali, *Holigarna*, *Gluta*, *Kingiodendron* and *Antiaris* no longer exist in north-east India, though some of their species are known to occur in the evergreen forest of Bangladesh and Burma. Extinction of these elements from this region might have been caused due to considerable change in the environmental conditions in the region since the time of their deposition.

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