

Fossil wood of *Bischofia palaeojavanica* Awasthi from the Eocene of the Changchang Formation of Hainan Island, China

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ABSTRACT

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A fossil wood of *Bischofia palaeojavanica* Awasthi resembling the extant *Bischofia javanica* Blume of the family Euphorbiaceae, is described from the Eocene sediments of the Changchang Basin of Hainan Island, China. The fossil not only forms the first record of *Bischofia* from the basin, but is also the earliest from China. Its presence indicates the occurrence of humid valley forests in the region during the deposition of the sediments.

Key-words—*Bischofia javanica*, Euphorbiaceae, Fossil wood, Changchang Basin, Hainan Island, China.

चीन में हैनान द्वीपसमूह के चांगचंग शैलसमूह के ईओसीन से प्राप्त बिस्कोफिया पैलियोजावानिका अवस्थी की काष्ठ जीवाश्म

आर.सी. मेहरोत्रा, यी-फेंग याऊ एवं चेंग-सेन ली

सारांश

यूफोर्बिएसी कुल की विद्यमान बिस्कोफिया जावानिका ब्लूम से मिलती-जुलती बिस्कोफिया पैलियोजावानिका अवस्थी की एक काष्ठ जीवाश्म को चीन के हैनान द्वीपसमूह की चांगचंग द्रोणी के ईओसीन अवसदों से वर्णित की गई है। यह जीवाश्म न केवल बिस्कोफिया का प्रथम अभिलेख है परन्तु चीन से भी प्रारंभिकतम है। इसकी उपस्थिति से अवसदों के निक्षेपण के दौरान क्षेत्र में आर्द्र घाटी वनों की उपस्थिति का संकेत मिलता है।

संकेत-शब्द—बिस्कोफिया जावानिका, यूफोर्बिएसी, काष्ठ जीवाश्म, चांगचंग द्रोणी, हैनान द्वीपसमूह, चीन।

INTRODUCTION

HAINAN Island situated in the South China Sea is famous for its rich floral diversity existing in the reserved tropical forests occurring there. As far as the mega remains are concerned, Guo (1979) first reported 10 fossil leaves, namely *Cyclocarya scutellata* Guo, *Nelumbo protospeciosa* Saporta, *Cinnamomum larteti* Watelet, *Ocotea sinensis* Guo, *Citrus niger* Guo, *Sabalites szei* Guo, *Sabalites changchangensis* Guo, *Nordenskioldia borealis* Heer, *Osmunda lignitum* (Giebel.) Stur. and *Salvinia* sp. from there. Exactly after 30 years since the publication of this report, the study from the area picked the desired momentum and one more leaf, a wood and a few winged fruits have been described from there. These are *Alseodaphne changchangensis* Jin & Li of Lauraceae (Li *et al.*, 2009), *Palaeocarya* sp.

resembling *Engelhardtia* Leschen. ex Bl. of Juglandaceae, *Acer* cf. *A. miofranchetii* resembling *Acer* L. of Aceraceae (Jin, 2009), *Craigia hainanensis* resembling *Craigia* Smith & Evans of Malvaceae (Jin *et al.*, 2009) and *Paraphyllanthoxylon hainanensis* Feng *et al.* (2010) of Euphorbiaceae. The palynological study of the basin made by Yao *et al.* (2009) suggests the existence of mixed type of flora containing both temperate (*Betula* L., *Castanea* Mill., *Pinus* L., *Salix* L., *Tilia* L. and *Tsuga* Carr.) and tropical to subtropical taxa (*Carya* Nutt., *Ilex* L., *Liquidambar* L., Anacardiaceae, Arecaceae, Lauraceae, Magnoliaceae, Proteaceae and Rubiaceae, along with some aquatic forms of Nymphaeaceae and Salviniaceae). It is generally believed that pollen grains and winged fruits are generally transported to the depositional site from far off places and do not provide true picture of the palaeoclimate of the region. The mega fossils, especially

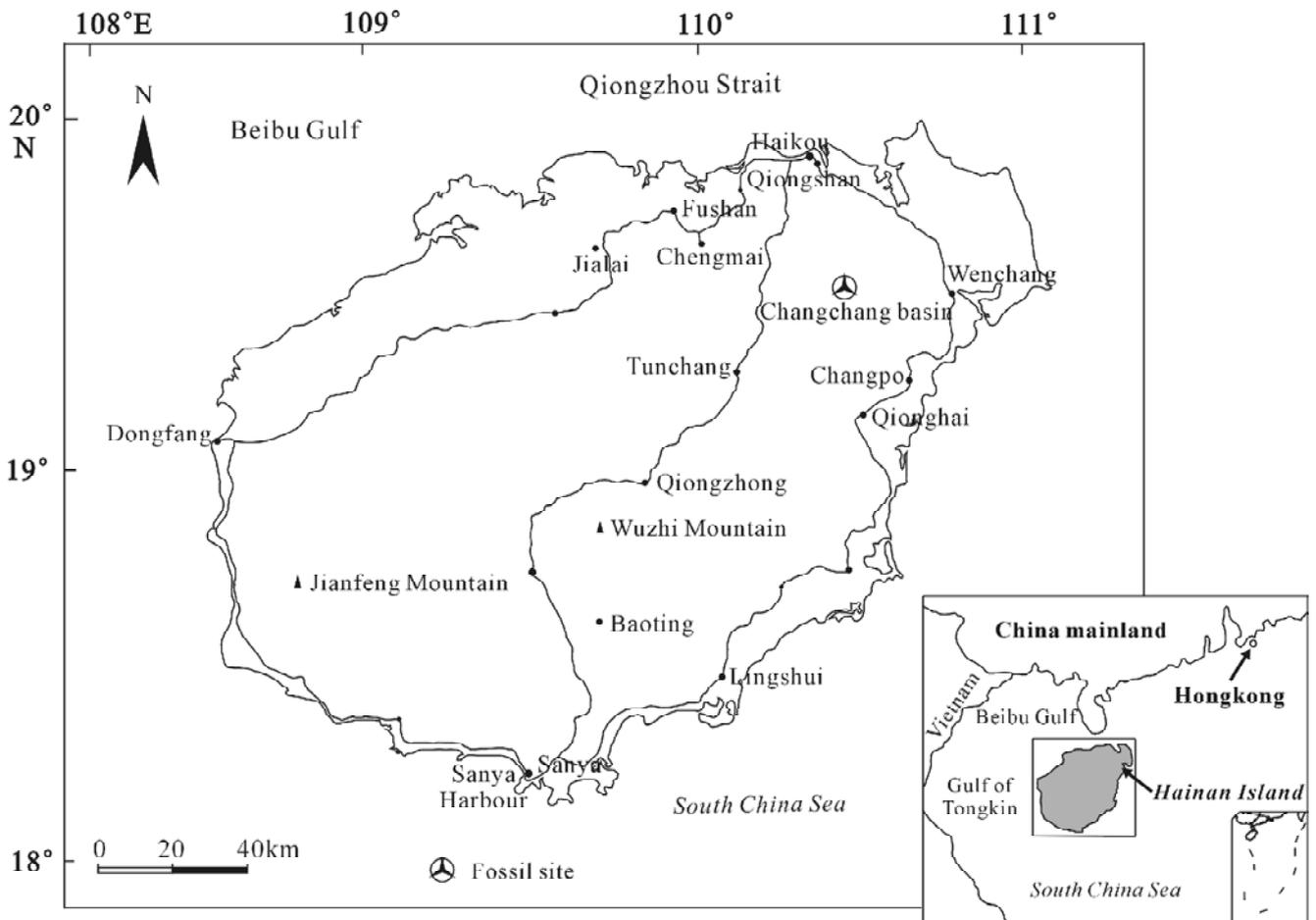


Fig. 1—Locality map (after Yao *et al.*, 2009).

fossil wood logs being heavy in weight, are deposited from the nearby areas and are true indicators of the past climate. In view of the above facts we undertook a field excursion in the region and collected many wood pieces in order to reconstruct the palaeoenvironment. They resemble *Bischofia* of the family Euphorbiaceae and are described in the present communication.

MATERIALS AND METHODS

The geology of the area has been worked out in detail by Lei *et al.* (1992) and Jin *et al.* (2002). The sediments ranging from the Palaeocene to Pliocene constitute six basins, *viz.* Fushan, Changpo, Jialai, Jiaju, Changchang and Yinggehai. The present fossil material has been collected from the Changchang Basin which is located near Jiazi Town, Qiongsan County in the northern part of the island (Fig. 1). The basin can be subdivided into three formations, namely Changtou (Palaeocene), Changchang and Wayao (Eocene). The Changchang Formation has been further divided into Lower and Upper Members on the basis of the lithological characters. According to Zhou and Chen (1988) and Lei *et al.* (1992) the fossils are preserved in the Upper Member containing a coal bearing horizon where the sediments are made up of dark grey mudstone, greyish black carbonaceous shale, brownish grey oil bearing shale, yellowish brown to greyish white muddy siltstone and sandstone. The present fossil material is from the pebbly sandstone found above the coal seams (Fig. 2).

The pieces of the fossil wood are found either in the section (Fig. 3) or scattered in the field. They are silicified and well preserved. Total five wood pieces were collected from the coal mine situated near a brick factory in the Changchang Basin (19°38'03" N, 110°27'04" E). Some leaves, fruits, seeds, etc. of the family Nymphaeaceae were also collected from the same horizon. The wood material used in the present study is fragmentary varying in size from about 10 cm to 18 cm and collected from the bigger logs after breaking them in the field. Its slides were prepared by the standard method of cutting, grinding and polishing using different grades of carborundum powder and mounted in resin. The slides as well as specimens are

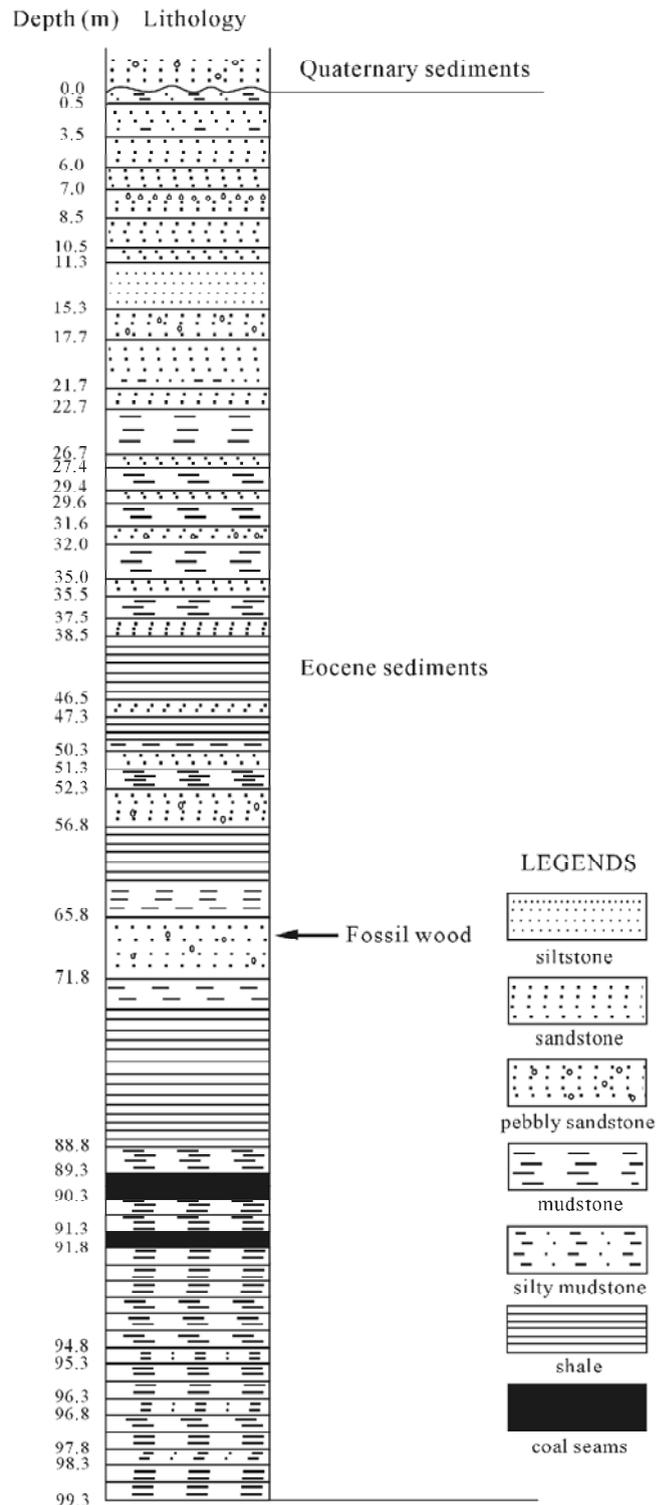


Fig. 2—Lithology of the fossil locality.

deposited in the Museum, Birbal Sahni Institute of Palaeobotany, Lucknow (India). Terminology of wood anatomical characters follows the recommendations of the IAWA list (IAWA Committee, 1989).



Fig. 3—Photograph showing a fossil wood near the hammer in the section.

SYSTEMATICS

Family—EUPHORBIACEAE

Genus—BISCHOFIA Blume

Bischofia palaeojavanica Awasthi, 1989

(Pl. 1.1-6)

Description—Out of the five specimens collected from the basin, the best preserved one has been selected for figure and description. Wood diffuse-porous (Pl. 1.1). Growth rings absent. Vessels small to medium, rarely very small, tangential diameter 66-108 μm , radial diameter 37-183 μm , solitary and in radial multiples of 2-5, rarely in clusters, round to oval, evenly distributed, 25-35 per mm^2 , heavily tylosed (Pl. 1.2); vessel members truncate, 97-166 μm in height; perforations simple; intervessel pits occasionally preserved due to profuse tyloses, bordered, alternate, 7-11 μm in

diameter, circular to oval with lenticular apertures (Pl. 1.4). Parenchyma scanty paratracheal to absent (Pl. 1.2). Xylem rays 4-8 per mm (Pl. 1.1), 1-6 seriate, ray to ray fusion observed, uniseriates made up of both procumbent and upright cells, 26-35 μm in width and 3-9 cells or 76-162 μm in height, multiseriates made up of procumbent cells with 1-3 marginal rows of upright cells, 32-224 μm in width and 16-32 cells or 484-800 μm in height (Pl. 1.3, 1.5), sheath cells also observed along the flanks in some of the rays (Pl. 1.5); ray tissue heterogeneous (Pl. 1.6); ray cells crystalliferous (Pl. 1.3, 1.5); procumbent cells 34-100 μm in radial length and 33-43 μm in tangential height; upright cells 23-41 μm in radial length and 52-73 μm in tangential height (Pl. 1.6). Fibres angular in cross section, semilibriform, septate, crystalliferous, 17-22 μm in diameter and 192-516 μm in length (Pl. 1.2, 1.5).

Figured specimen—Specimen No. BSIP 39787.

Repository—Birbal Sahni Institute of Palaeobotany, Lucknow.

Horizon and locality—Changchang Formation; near a brick factory, Jiazi Town, Qiongsan County, Hainan Island, China.

Age—Eocene.

No. of specimens studied—Five (Specimen Nos. BSIP 39787, BSIP 39788, BSIP 39789, BSIP 39790 and BSIP 39791).

Affinities—The above mentioned features of the fossil wood collectively indicate affinities with that of *Bischofia* Blume of the Euphorbiaceae (Pearson & Brown, 1932; Metcalfe & Chalk, 1950; Kribs, 1959; Ilic, 1991). The other closely allied taxa of the genus can be differentiated, in having occasionally tylosed vessels (Prakash *et al.*, 1986; Awasthi, 1989). Though *Bischofia* is represented by two species, namely *B. javanica* Bl. and *B. polycarpa* (Lévl) Airy Shaw, only the former was available for comparison. The fossil

PLATE 1

Bischofia palaeojavanica Awasthi



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| <p>1. Diffuse-porous wood showing distribution of vessels, XS, Slide No. BSIP 39787- I.</p> <p>2. Fossil wood showing shape and size of vessels plugged with tyloses, XS, Slide No. BSIP 39787- I.</p> <p>3. Pattern of xylem rays, TLS, Slide No. BSIP 39787- II.</p> | <p>4. Intervessel pits, TLS, Slide No. BSIP 39787- II.</p> <p>5. Structure of xylem rays and fibres, TLS, Slide No. BSIP 39787- II.</p> <p>6. Heterogeneous ray tissue, RLS, Slide No. BSIP 39787- III.</p> |
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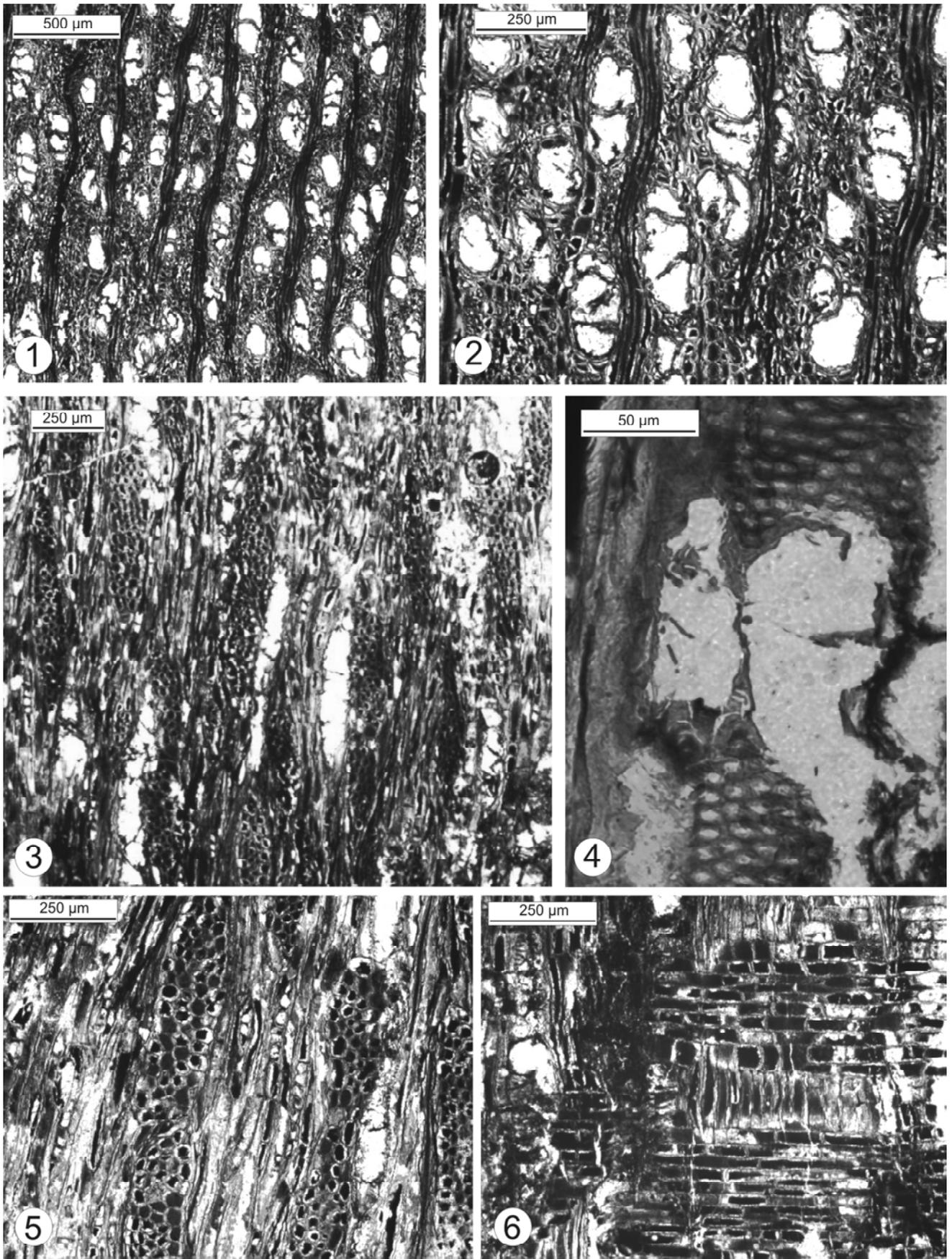


PLATE 1

shows similarities with it in almost all the characters except the frequency of the vessels which is lesser (6–13 per mm²) in the modern species (Pearson & Brown, 1932).

Ramanujam (1960) instituted the genus *Bischofiaxylon* for the fossil wood similar to that of *Bischofia* and described *Bischofiaxylon miocenicum* Ramanujam from south India. Mädler (1962) had suggested its affinities with *Bridelia* and merged it into another organ genus *Bridelioxylon* Mädler. Therefore, Bande (1974) established another genus *Bischofinium* for the fossil wood resembling *Bischofia* and described *B. deccanii* from the Deccan Intertrappean beds of India. Awasthi (1989) after the critical re-examination of the type slides of both *Bischofiaxylon miocenicum* Ramanujam and *Bischofinium deccanii* Bande found that none of them belongs to *Bischofia* or *Bridelia*. While describing a fossil wood resembling *Bischofia* from northeast India, he placed his fossil directly under the modern genus and created a new species *Bischofia palaeojavanica* Awasthi. So far the same species has been recorded from many parts of India (Awasthi & Mehrotra, 1990; Agarwal, 1994; Srivastava & Awasthi, 1996; Guleria & Srivastava, 2001; Guleria *et al.*, 2002). As far as China is concerned, there are two records of the fossil wood of *Bischofia* from there. *B. javanica* (Qi *et al.*, 1987; Cheng *et al.*, 2005) and *B. polycarpa* (Yang *et al.*, 1998) have been described from the Late Tertiary sediments of Yunnan and Hubei Provinces. Guleria *et al.* (2002) questioned the affinities of the former with *Bischofia*, while the latter species differs from our fossil in having smaller vessels (tangential diameter 45–78 µm) with higher frequency (78 per mm²). Since the present fossil specimen of China is identical to *B. palaeojavanica* Awasthi, it has been placed under the same.

Paraphyllanthoxylon hainanensis Feng *et al.* (2010) described from the same horizon though shows resemblance to our fossil in some of the characters, differs in having occasionally non-septate fibres with bordered pits on the radial walls, presence of growth rings, larger vessels (tangential diameter up to 210 µm) with lesser frequency (max. 28 per mm²), slightly narrower rays with long marginal extensions (up to 14

cells) and absence of sheath cells as well as parenchyma. Though tyloses are commonly present in *P. hainensis*, all the vessels in the present fossil are heavily tylosed.

DISCUSSION

Bischofia is a genus of evergreen or deciduous tall trees. *B. javanica*, the nearest modern counterpart of our fossil, is found in the evergreen forests, open valley woodlands below 800 m elevation in the Anhui, Fujian, Guangdong, Guangxi, Guizhou, Hainan, Henan, Hubei, Hunan, Jiangsu, Jiangxi, Shaanxi, Sichuan, Taiwan, Yunnan and Zhejiang Provinces, China. Apart from China it also occurs in Bhutan, Cambodia, India, Indonesia, Japan, Laos, Malaysia, Myanmar, Nepal, Philippines, Sri Lanka, Thailand, Vietnam, Australia and Pacific Islands (Willis, 1973; Mabberley, 1997; <http://www.efloras.org>).

Jin (2009) has suggested that the Changchang Basin was close to the mountains of mid high altitude during the Eocene and *Engelhardtia*, *Acer*, *Pinus*, *Tsuga*, *Betula*, *Tilia*, *Castanea* and *Salix* were growing in the cooler mountains. They were not in situ and were transported to the fossil site by air or water. During the period only tropical to subtropical species were growing in the lowlands and the lake was infested with aquatic plants. The present finding supports Jin's view because *Bischofia* does not grow under temperate conditions. The winged fruits and pollen grains of the temperate origin were transported to the site by air and were deposited there to become fossilized.

The present fossil not only becomes the first record of *Bischofia* from the Changchang Basin of Hainan Island, but is also the earliest from China. Its presence indicates the occurrence of humid valley forests in the region during the deposition of the sediments.

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