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Barringtonia Forster & Forster (Lecythidaceae) leaf from the late Oligocene of Assam, India

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ABSTRACT

Srivastava G & Mehrotra RC 2018. *Barringtonia* Forster & Forster (Lecythidaceae) leaf from the late Oligocene of Assam, India. The Palaeobotanist 67(2): 139–145.

Northeast India is considered as corridor for the plant migration from India to Southeast Asia and vice–versa after the collision of Indian Plate with the Eurasian Plate. The fossil record of the family Lecythidaceae is very sparse globally. We report a fossil leaf of *Barringtonia* (Lecythidaceae) from the late Oligocene sediments of Assam, India. The modern distribution and fossil records of the genus indicate its origin in Gondwana derived continents. After collision and complete suturing of the Indian and Eurasian plates the genus most likely migrated from India to Southeast Asia.

Key–words—Fossil leaf, Northeast India, Palaeoecology, Phytogeography.

भारत में असम के विलंबित अतिनूतन से प्राप्त *बैरिंगटोनिया* फ्यूरस्टर एवं फ्यूरस्टर (लीसीथिडेसी) पत्ती

गौरव श्रीवास्तव एवं आर.सी. मेहरोत्रा

सारांश

यूरेशियाई आधारपट्टिका से भारतीय आधारपट्टिका के संघट्ट के उपरांत भारत से दक्षिण पूर्व एशिया एवं विलोमतः पादप विस्थापन हेतु पूर्वोत्तर भारत गलियारा के रूप में माना जाता है। लीथिडेसी कुटुंब का जीवाश्म अभिलेख भू–मंडलीय रूप से अति विरल है। हम असम, भारत के विलंबित अतिनूतन अवसादों से प्राप्त *बैरिंगटोनिया* (लीसीथिएसी) की जीवाश्म पत्ती का वर्णन करते हैं। वंश के आधुनिक वितरण व जीवाश्म अभिलेख गोंडवाना व्युत्पन्न महाद्वीपों में इसकी उत्पत्ति इंगित करते हैं। भारतीय एवं यूरेशियाई आधारपट्टिकाओं के संघट्ट और पूर्ण सीवन के उपरांत सर्वाधिक संभावना भारत से दक्षिण पूर्व एशिया तक वंश विस्थापित हो गया।

सूचक शब्द—जीवाश्म पत्ती, पूर्वोत्तर भारत, पुरापारिस्थितिकी, पादपभूगोल।

INTRODUCTION

NORTHEAST India consists of eight sister states which include Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Tripura and Sikkim. This area is important for palaeobotanical studies because it acts as a corridor for the migration of flora from India to Southeast Asia and vice–versa, after collision of the Indian and Eurasian plates (Srivastava & Mehrotra, 2010; Chatterjee *et al*., 2013). The area has rich fossil records both from the Paleogene and Neogene sediments (Srivastava & Mehrotra, 2010, 2013a; Mehrotra *et al*., 2016; Mehrotra & Srivastava, 2018; Srivastava *et al*., 2018a, b, c).

The Makum Coalfield (27°15'–27°25' N), the largest coalfield of northeast India, is situated in the Tinsukia District of Assam, however, it was at a low palaeolatitude i.e. ~10°–15° N (Fig. 1) during the late Oligocene (Molnar & Stock, 2009). The coalfield envelops six collieries, namely Baragolai, Ledo, Namdang, Tikak, Tipong and Tirap which are located along the outermost flank of the Patkai range. The Makum Coalfield belongs to the Tikak Parbat Formation being considered as late Oligocene in age on the basis of regional

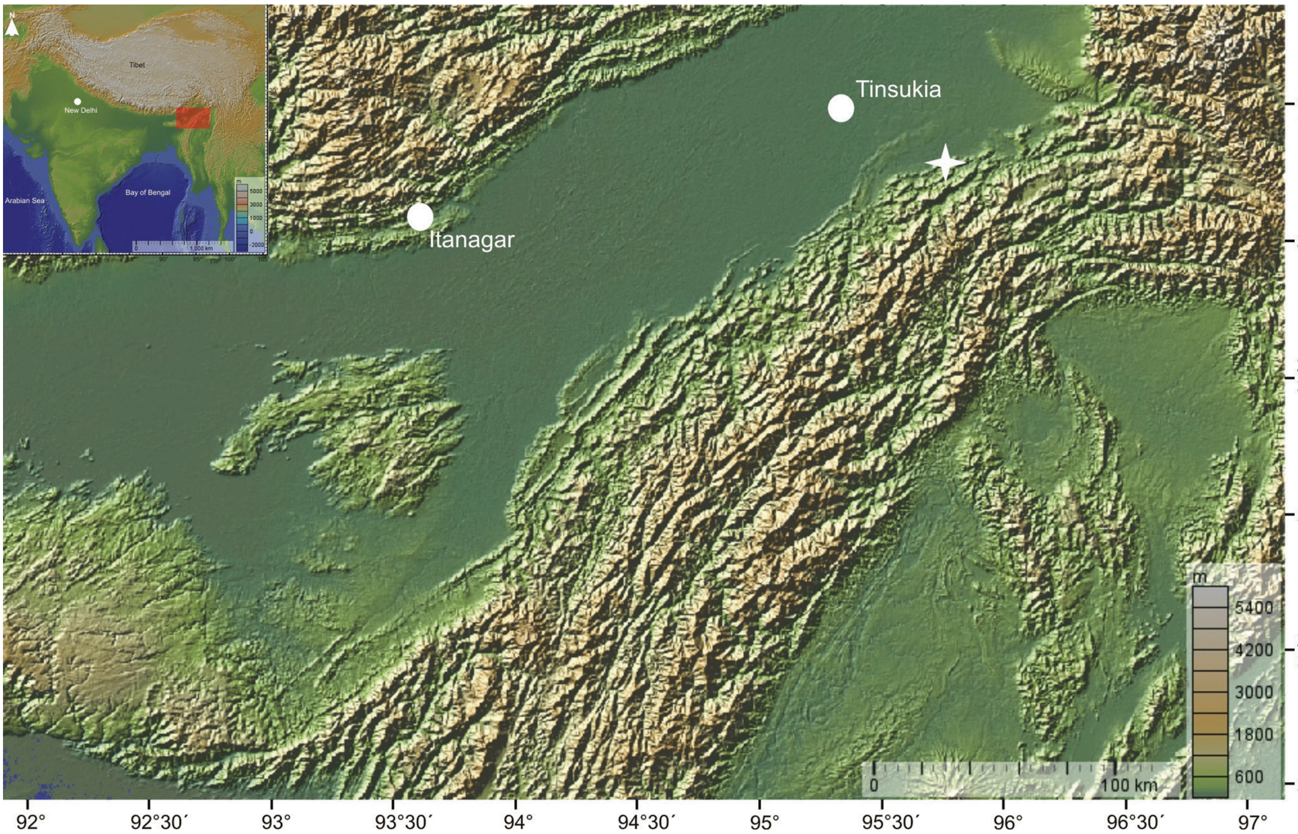

Fig. 1—A physiographic map showing the fossil locality (white asterisk).

lithostratigraphy (Pascoe, 1964), remote sensing (Ganju *et al*., 1986) and biostratigraphic controls (Kumar *et al*., 2012). The Tikak Parbat Formation envelops alternations of sandstone, siltstone, mudstone, shale, carbonaceous shale, clay and coal seams (Kumar *et al*., 2012). This formation is underlain by the Baragolai Formation which is successively underlain by the Naogaon Formation (Mishra & Ghosh, 1996). All the aforesaid formations together constitute the Barail Group (Fig. 2). This coalfield has yielded plenty of plant fossils in the form of flowers, fruits, leaves, spore–pollen, sedimentary organic matter and woods which were deposited in deltaic, mangrove or lagoonal environment (Awasthi & Mehrotra, 1995; Mehrotra *et al*., 2003; Kumar *et al*., 2012). The modern comparable taxa of the fossils reported from the Makum Coalfield are *Lannea* Rich., *Mangifera* L., *Parishia* Hk. f. and *Semecarpus* L. f. of the Anacardiaceae, *Alphonsea* Hk. f. & Thomson and *Saccopetalum* Benn. of the Annonaceae, *Alstonia* Scop. of the Apocynaceae, *Avicenia* A. St.–Hil. of the Avicenniaceae, *Santiria* Bl. of the Burseraceae, *Calophyllum* L., *Kayea* Wall. and *Mesua* L. of the Calophyllaceae, *Garcinia* Bartl. and *Poeciloneuron* Bedd. of the Cluciaceae, *Terminalia* J. St.–Hil. of the Combretaceae, *Apollonias* Ness of the Lauraceae, *Barringtonia* Forst. & Forst. and *Careya* Roxb. of the Lecythidaceae, *Firmiana* Marsili and *Pterygota* Schott & Endl. of the Malvaceae, *Heynea* Roxb. of the Meliaceae, *Memecylon* L. of the Memecylaceae, *Myristica* Gronov. of the Myristicaceae, *Bridelia* Willd. of the Phyllanthaceae, *Rhizophora* L. of the Rhizophoraceae, and *Nephelium* L., *Paranephelium* Miq. and *Sapindus* L. of the Sapindaceae (Srivastava & Mehrotra, 2013b), besides many legumes (Srivastava & Mehrotra, 2010) and palms (Mehrotra *et al*., 2003, Srivastava *et al*., 2012a). Moreover, few gymnosperms

PLATE 1

(All bar scales = 1 cm)

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1. A fossil leaf of *Barringtonia* sp. showing shape, size and venation pattern.
2. Modern leaf of *B. macrocarpa* Hassk. (Herbarium Sheet No. CNH 1018) showing shape, size and venation pattern similar to the fossil leaf.
3. Enlarged portion of the fossil leaf showing primary vein (pink arrow), secondary veins (white arrows) and eucamptodromous venation (yellow arrow).
4. Enlarged portion of the modern leaf showing similar features of the fossil such as primary vein (pink arrow), secondary veins (white arrows) and eucamptodromous venation (yellow arrows).

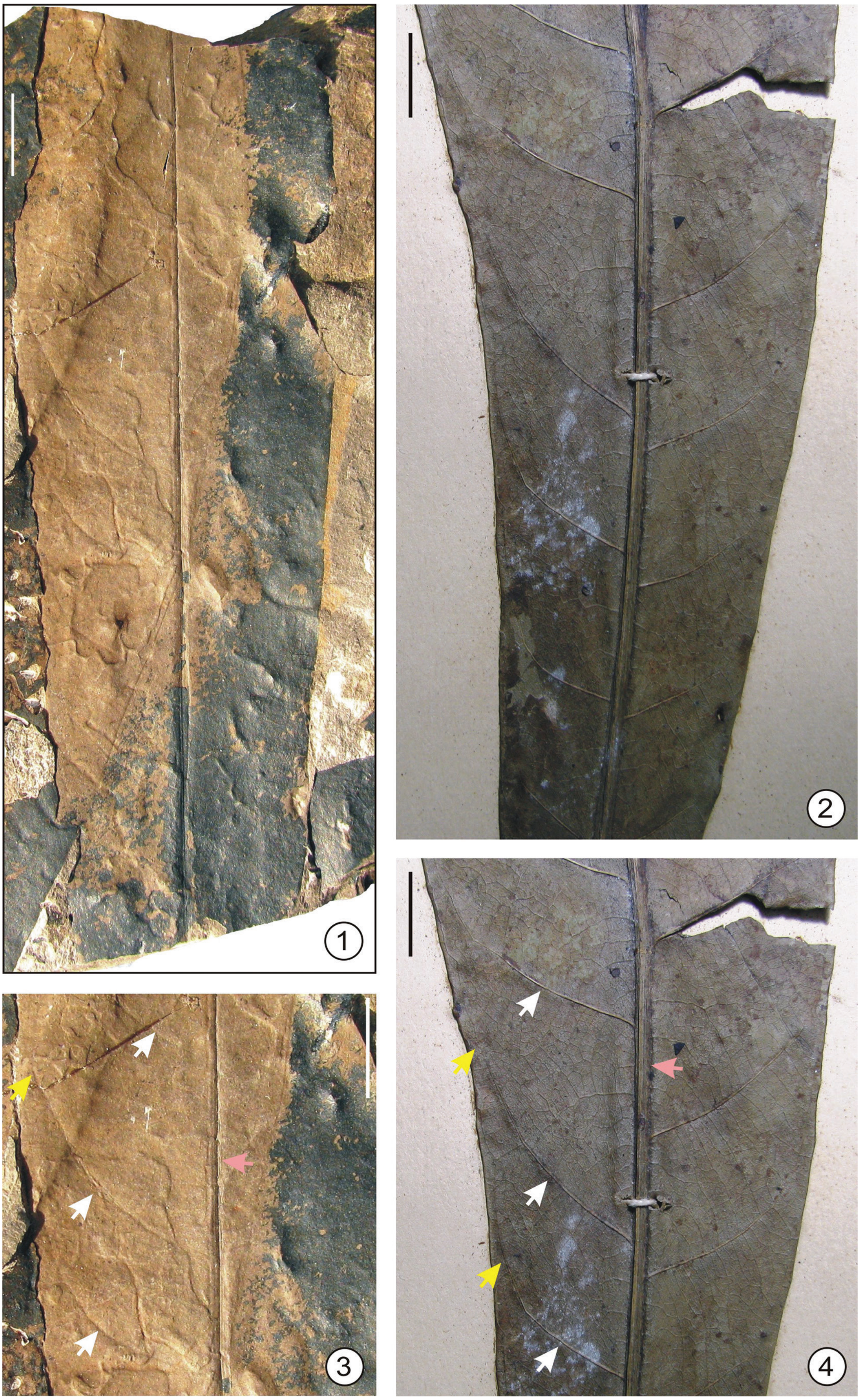

PLATE 1

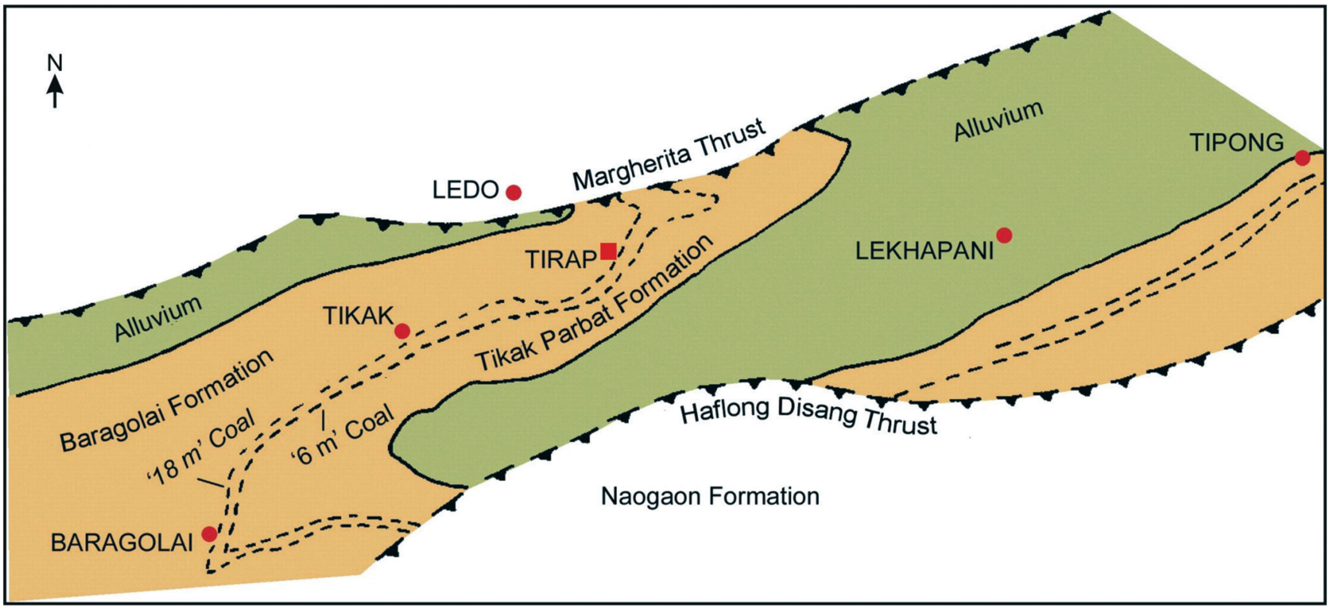

Fig. 2—Simplified geological map of the Makum Coalfield, Assam (after Ahmed, 1996).

and pteridophytes such as *Podocarpus* L'Hér. ex Pers. and *Equisetum* L. are also known from there (Awasthi *et al*., 1992; Mehrotra *et al*., 2009).

In the present communication, we describe a fossil leaf impression/compression of *Barringtonia* of the Lecythidaceae from the late Oligocene sediments of Makum Coalfield, Assam.

MATERIAL AND METHODS

The material for the present study was collected from the Tirap mine of the Makum Coalfield (27°17'20" N; 95°46'15" E). The leaf was cleared with the help of a chisel after removing dust from a soft brush. After that the leaf was photographed under low angled sunlight using 10 megapixel digital camera (Canon SX110). The terminology used in describing the fossil leaf follows Dilcher (1974) and Ellis *et al*. (2009). The fossil was identified in the herbarium of Central National Herbarium (CNH), Howrah and the website of Royal Botanic Garden (RBG), Kew after comparing it with the herbarium sheets of the modern plants. The type specimen of the fossil leaf bearing the registration number BSIP 41620 is deposited in the Museum of the Birbal Sahni Institute of Palaeosciences, Lucknow.

SYSTEMATICS

Family—Lecythidaceae

Genus—BARRINGTONIA Forster & Forster

Barringtonia sp.

(Pl. 1.1)

Description—Leaf incomplete, symmetrical, mesophyll, narrow elliptic in shape, lamina gradually becoming narrow towards the base; preserved lamina length 11.6 cm (estimated lamina length ~25 cm), maximum preserved width 4 cm; apex broken, base broken; margin seemingly entire; texture chartaceous; petiole not preserved; venation pinnate eucamptodromous; primary vein moderate in thickness, nearly straight; six pairs of secondary veins preserved, distance between two secondary veins 1.2–1.8 cm, angle of divergence moderate to wide acute (61°–70°); intersecondary veins poorly preserved; tertiary veins present, recurved and percurrent; quaternary veins not preserved; marginal ultimate venation looped.

Figured specimen—Specimen No. BSIP 41620.

PLATE 2

(All bar scales = 1 cm)

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Modern leaves of *Barringtonia* showing shape, size and venation pattern

1. *Barringtonia macrocarpa* Hassk. (Herbarium Sheet No. CNH 1018).
2. *Barringtonia papuana* Lauterb. (Herbarium Sheet No. RBG K000761594).
3. *Barringtonia calyptrocalyx* var. *boridiensis* Payens (Herbarium Sheet No. RBG K000761584).
4. *Barringtonia calyptrocalyx* Schum (Herbarium Sheet No. RBG K000761592).
5. *Barringtonia augusta* Kurz (Herbarium Sheet No. CNH 1281).

PLATE 2

Horizon & locality—Tikak Parbat Formation; Tirap colliery, Makum Coalfield, Tinsukia District, Assam.

Age—Late Oligocene.

Affinities—The characteristic features of the fossil leaf such as symmetrical lamina, mesophyll size, narrow elliptic shape, lamina gradually becoming narrow towards the base, pinnate eucamptodromous venation, moderately thick primary vein, angle of divergence of secondary veins moderate to wide acute (61°–70°), presence of intersecondary veins and recurved and percurrent tertiary veins indicate its affinity with the extant leaves of *Barringtonia* of the Lecythidaceae. Although a large number of extant leaves of the genus (Pl. 2.1–5) have been observed in the herbarium, due to the incompleteness of the specimen it is difficult to assign the fossil up to the specific level.

As far as the fossil record of *Barringtonia* is considered, the earliest specimen is known in the form of a wood, *Barringtonioxylon eopterocarpum* Prakash & Dayal (1964), from the late Maastrichian–Danian of Deccan Intertrappean beds of central India. A fossil fruit of *Barringtonia* named *B. preracemosa* Mehrotra (2000) is already known from the late Oligocene sediments of the Makum Coalfield, moreover, its pollen has been recorded from the Eocene sediments of western India (Kar, 1978). Besides, fossil wood of the genus is also known from various Neogene sediments of India (Awasthi, 1969; Prakash & Tripathi, 1972; Awasthi & Mehrotra, 1993; Prakash *et al*., 1994).

The family Lecythidaceae consists of 25 genera and 353 species which are grouped into five sub–families such as Foetidioideae, Lecythidoideae, Napoleonaeoideae, Planchonioideae and Scytopetaloideae (Stevens, 2001) distributed in tropical areas of the world, especially in South American rainforests (Mabberley, 2008).

Barringtonia belonging to the sub–family Planchonioideae is either shrub or tree and encompasses 69 species distributed mainly in the Malesian and Pacific regions but also found in south Asia, Australasia, east Africa and Madagascar (Prance, 2012). The modern distribution as well as the fossil record of the genus indicates its origin in Gondwana derived continents. The genus most likely migrated to Southeast Asia after the complete suturing of the Indian and Eurasian plates during the late Oligocene/early Miocene (Chatterjee *et al*., 2013).

A large number of plant families have been reported from the Makum Coalfield (Awasthi & Mehrotra, 1995; Mehrotra *et al*., 2003, 2009; Srivastava & Mehrotra 2010, 2012; Srivastava *et al*., 2012a) and among them Annonaceae, Burseraceae, Clusiaceae, Combretaceae, Lecythidaceae, Myristicaceae and Rhizophoraceae are typical pantropical megathermal in nature (van Steenis, 1962) suggesting a tropical climate. Similarly, Fabaceae is the most dominant family whose abundance and richness covary with the temperature (Punyasena *et al*., 2008) indicating a warm climate. The presence of families such as Avicenniaceae and Rhizophoraceae shows deltaic, mangrove or lacustrine environment of deposition of coal seams and associated sediments in the Makum Coalfield (Awasthi & Mehrotra, 1995). Moreover, the presence of abundant palms like *Nypa* (Mehrotra *et al*., 2003; Srivastava *et al*., 2012a) depicts further evidence of a coastal plain environment where both temperature and humidity remained high throughout the year (Tomlinson, 1990).

The quantitative estimation of palaeoclimate based on CLAMP (climate leaf analysis multivariate program) analysis of fossil leaves of the Makum Coalfield indicates MAT = 26.09 ± 2.7°C, WMMT = 27.85 ± 3.3°C, CMMT = 20.66 ± 4.3°C, MAP = 2460 ± 614 mm and RH = 76.6 ± 12.6% suggesting low seasonality in temperature (Srivastava *et al*., 2012b). The warm and humid climate of the fossil locality is not surprising as it was at 10°–15° N palaeolatitude, i.e. in tropics during the late Oligocene (Molnar & Stock, 2009). Nevertheless, it has been observed that not only the regional, but also the global climate was warm during the late Oligocene (Zachos *et al*., 2001; Mosbrugger *et al*., 2005).

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