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Two dicotyledonous woods from the late Neogene sediments of Jaisalmer, Rajasthan

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ABSTRACT

Shukla A, Mehrotra RC & Guleria JS 2013. Two dicotyledonous woods from the late Neogene sediments of Jaisalmer, Rajasthan. The Palaeobotanist 62(1): 11–17.

Two fossil woods collected from the late Neogene sediments of Rajasthan show best resemblance to the modern genera *Terminalia* L. and *Lagerstroemia* L. of the families Combretaceae and Lythraceae, respectively. The fossils belong to the Shumar Formation of Jaisalmer Basin considered as Plio–Pleistocene in age. The habitats of the modern counterparts of the fossils indicate the prevalence of semi–evergreen to deciduous forests with warm and humid climatic conditions in the Jaisalmer District at the time of deposition of the sediments in contrast to the present day xeric vegetation with desertic conditions in the area.

Key–words—*Terminalia*, *Lagerstroemia*, Shumar Formation, Western India, Palaeoclimate.

जैसलमेर, राजस्थान के विलंबित नियोजीन अवसादों से प्राप्त दो द्विबीजपत्री काष्ठें

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सारांश

राजस्थान के विलंबित नियोजीन अवसादों से संगृहीत दो जीवाश्म काष्ठें क्रमशः कॉम्ब्रेटेसी व लीथरेसी परिवारों के आधुनिक वंश *टर्मिनेलिया* एल. और *लेजरस्ट्रोमिया* एल. से उत्कृष्ट समरूपता दर्शाते हैं। जीवाश्म आयु में अति-अत्यंतनूतन के रूप में मानी जाने वाली जैसलमेर द्रोणी में शुमार शैलसमूह की हैं। जीवाश्मों के आधुनिक प्रतिरूपों के आवास, क्षेत्र में आज की मरू स्थितियों सहित मरूद्भिदी वनस्पति के विपरीत अवसादों के निक्षेपण के समय जिला जैसलमेर में कोष्ण एवं आर्द्र जलवायवी स्थितियों सहित अर्ध-सदाहरित से पतझड़ी वनों की व्यापकता इंगित करते हैं।

संकेत-शब्द—टर्मिनेलिया, लेजरस्ट्रोमिया, शुमार शैलसमूह, पश्चिमी भारत, पुराजलवायु।

INTRODUCTION

So far, very few plant fossils have been described from the Shumar Formation (late Neogene) of Jaisalmer Basin in western India. *Mangifera* L. of the Anacardiaceae (Guleria, 1984) and two gymnospermous woods (Guleria & Shukla, 2011) are known from this formation. In order to reconstruct the palaeoclimate of the area, a number of fossil woods were collected from the late Neogene sediments of Jaisalmer. Among these, two are being described herein. The described fossils belong to the Shumar Formation of Plio–Pleistocene age (Bhandari, 1999; Guleria & Shukla, 2011). The fossil assemblage of this formation was found similar to the wood assemblage recovered from the Kanakawati Series/Sandhan Formation (Plio–Pleistocene) of Kachchh (Biswas, 1965, 1971; Biswas & Raju, 1973; Lakhanpal *et al*., 1984). The age of the formation is uncertain due to the lack of any marker palaeontological evidence and was suggested to be post–Eocene to Quaternary or even younger (Das Gupta, 1975; Singh, 1982; Bhandari, 1999) (Fig. 1). However, in view of its close lithological and plant fossil similarities with the Sandhan Formation of Kachchh, its age is considered as Plio–Pleistocene

Era	Period		Age		Formation	Lithological Description
CENOZOIC	?Quaternary				Shumar	Alternating variegated clays, sst and gluconitic clay at the base followed by sst and variated clays, lst and calcareous sst and loose sst at the top
	TERTIARY	Neogene	Pliocene	U	Hiatus	
				L		
			Miocene	U		
				M		
				L		
		Palaeogene	Oligocene	U		
				L		
			Eocene	U		
				M	Bandah	Bentonitic clay, argillaceous and chalky limestone
				L	Khuiala	Orthoquartzite comprises coarse grained sst, greenish yellowish brown gypseous clay with animal and fragmentry leaf fossils, chalky lst, bouldery bedded lst
			Palaeocene	U	Sanu	Ochrous yellow to dark brown and reddish black, coarse to fine grained, cross–bedded sandstone
				L		

Fig. 1—Generalized stratigraphic sequence of the Tertiary sediments of Jaisalmer Basin (after Bhandari, 1999).

till more evidences are obtained (Guleria & Shukla, 2011). Although the two genera being described herein are already known from various Palaeogene and Neogene sediments of India (Prakash, 1966; Prasad, 1989; Guleria, 1990, 1991; Srivastava & Bande, 1992; Prakash *et al*., 1994; Tiwari & Mehrotra, 2000), this is their first record from this formation.

MATERIAL AND METHODS

The fossils were collected from the Habur Village (Lat. 27º10' N: Long. 70º33' E) which is situated about 40–45 km northwest of Jaisalmer. The woods were found scattered on the top of Khuiala ridge, 3–5 km east of the Habur Village near Hema Ki Dhani (Guleria & Shukla, 2011). For the study of xylotomical characters, the woods were cut into thin sections, viz. transverse, tangential and radial longitudinal and their slides were prepared by the usual method of grinding and polishing with carborundum powder. The thin sections were examined under the high power light microscope. The identification of the fossils was made after comparison with a large number of modern woods both from thin sections and published literature. The anatomical terms used in describing them are those adopted by Wheeler *et al.* (1986) and International Association of Wood Anatomists (1989). The figured slides have been deposited in the Repository of the Birbal Sahni Institute of Palaeobotany, Lucknow.

PLATE 1

Terminalioxylon varkalaensis Awasthi & Ahuja, 1982

1. Cross section of the fossil wood showing growth rings (marked by arrows) and distribution pattern of vessels.
2. Cross section of the modern counterpart of the fossil, *Terminalia travancorensis*, showing similar anatomical structures as found in the fossil.
3. Radial longitudinal section of the fossil showing bordered, alternate intervessel pits.
4. Enlarged cross section of the fossil showing vasicentric parenchyma around the vessels with short extensions.

5–6. Tangential longitudinal section of the fossil showing predominantly uniseriate rays with crystals present in the cells (marked by arrows).

7. Tangential longitudinal section of *T. travancorensis* showing similar ray pattern as in the fossil.
8. Radial longitudinal section of the fossil showing weakly heterogeneous ray tissue.

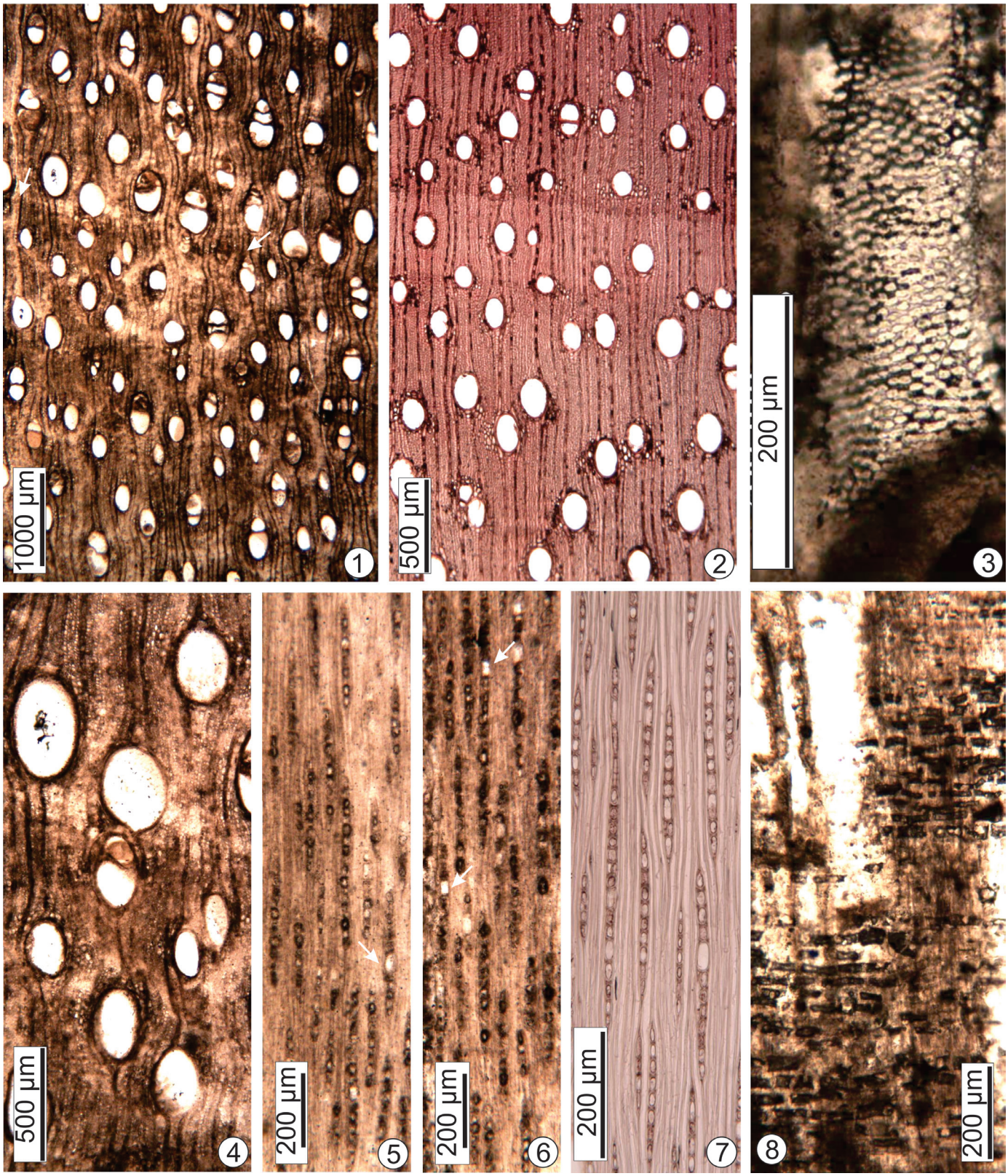

PLATE 1

SYSTEMATICS

Family—COMBRETACEAE

Genus—TERMINALIOXYLON Schönfeld, 1947

Terminalioxylon varkalaensis Awasthi & Ahuja, 1982

(Pl. 1.1, 3–6, 8)

Description—Wood diffuse porous. Growth rings indistinct, delimited by thick walled fibres (Pl. 1.1). Vessels small to large, circular to oval in shape, solitary and in radial multiples of 2–3, plugged with brownish gummy material (Pl. 1.1), evenly distributed, about 8–10 per sq mm, t.d. 60–160 µm, r.d. 60–200 µm, vessel members 420–820 µm in length, with truncate ends; perforations simple, horizontal to oblique; intervessel pits bordered, alternate, about 8–10 µm in diameter (Pl. 1.3). Axial parenchyma paratracheal, forming complete or incomplete 2–3 (sometime 4) celled sheath around the vessels (Pl. 1.4), occasionally extending sideways connecting adjacent vessels; cells 19–22 µm in diameter, thin walled. Rays exclusively fine, uniseriate (Pl. 1.5–6), biseriation present due to paired cells, homocellular to weakly heterocellular, consisting of procumbent or square cells (Pl. 1.8); procumbent cells 24–32 µm in tangential height, diameter of upright or square cells 40–45 µm; rays 8–25 cells or 135–672 µm in height and 9–13 µm wide. Fibres thick walled, radially arranged, non septate, 6–20 µm in diameter.

Figured specimen—Specimen No. BSIP 39995.

Horizon—Shumar Formation.

Locality—Hema Ki Dhani, near Habur, district Jaisalmer, Rajasthan.

Age—Plio–Pleistocene.

Affinities—The diagnostic features of the present fossil are: diffuse porous wood, simple perforation plates, vasicentric parenchyma occasionally extending sideways, predominantly uniseriate, homo–heterocellular rays and non septate fibres. All these anatomical features indicate its similarity with the modern woods of *Terminalia* of the family Combretaceae. After studying thin sections of the woods of various species of *Terminalia*, it was found that the fossil is very close to *Terminalia travancorensis* Wight & Arn. (Wood Slide No. BSIP 515) (Pl. 1.2, 1.7) and *T. tomentosa* Wight & Arn. (Pearson & Brown, 1932; Metcalfe & Chalk, 1950; Kribs, 1959; Miles, 1978; Purkayastha & Lal, 1972). However, the absence of septate fibres in the fossil separates it from *T. tomentosa*.

The organ genus *Terminalioxylon* was instituted by Schönfeld (1947) for the fossil woods showing resemblance with *Terminalia*. Since then, a number of fossil woods of the genus were described from India and abroad and enlisted by several authors from time to time (Prakash, 1966; Prasad, 1989; Guleria, 1991). After the last listing only a few new species of it, viz. *T. belericum* (Prakash *et al*., 1992) from the Tipam Sandstone of Assam, *T. bikanerense*, *T. eoolivari* and *T. vasicentricum* (Harsh *et al*., 1993) from the Tertiary of Bikaner were described from India. The present fossil was compared with all the known fossil woods of *Terminalia* and found to show best resemblance with *Terminalioxylon varkalaensis* Awasthi and Ahuja (1982) which was reported from Varkala beds, Kerala of the Mio–Pliocene age. Therefore, it has been kept under the same specific epithet.

Family—LYTHRACEAE

Genus—LAGERSTROEMIOXYLON Mädler, 1939

Lagerstroemioxylon parenchymatosum Prakash, 1965

(Pl. 2.1–5)

Description—Wood semi ring porous (Pl. 2.1). Growth rings distinct, demarcated by narrow lines of terminal parenchyma and large sized early wood vessels (Pl. 2.1–2). Vessels small to large, large ones in the inner portion of the ring and grading more or less gradually into smaller ones in the outer portion of the ring, solitary or in radial multiples of 2–3 (rarely 4–6), round to oval in shape (Pl. 2.1–2), evenly distributed, 4–9 per sq mm, open or plugged with some gummy deposits, t.d. 62–248 µm, r.d. 44–432 µm; vessel members 170–490 µm in length with truncated ends; perforations simple; intervessel pits alternate, bordered, 4–6 µm in diameter (Pl. 2.5). Axial parenchyma paratracheal and apotracheal, paratracheal parenchyma abundant, vasicentric, mostly aliform to confluent, joining 2–4 vessels (Pl. 2.2), apotracheal parenchyma sparse, solitary cells or a small group of cells scattered among fibres; cells thin walled, round, oval to polygonal in cross section, 16–48 µm in length and 28–78 µm in width. Rays fine almost uniseriate, sometimes biseriate (Pl. 2.3), 2–16 cells or 75–558 µm in height and 20–40 µm in width, closely spaced, homo to weakly heterocellular; ray tissue heterogeneous (Pl. 2.4), tangential length of procumbent cells 20–38 µm and radial length up to 100 µm, crystals not seen. Fibres round, oval

PLATE 2

Lagerstroemioxylon parenchymatosum Prakash, 1965

1. Cross section of the fossil wood showing semi–ring porosity (marked by arrows).
2. Enlarged cross section of the fossil showing distinction between early and late wood vessels and pattern of parenchyma.
3. Tangential longitudinal section of the fossil showing predominantly uniseriate rays (biseriation present and marked by an arrow).
4. Radial longitudinal section of the fossil showing weakly heterogeneous ray tissue.
5. Radial longitudinal section of the fossil showing alternate, bordered intervessel pits.

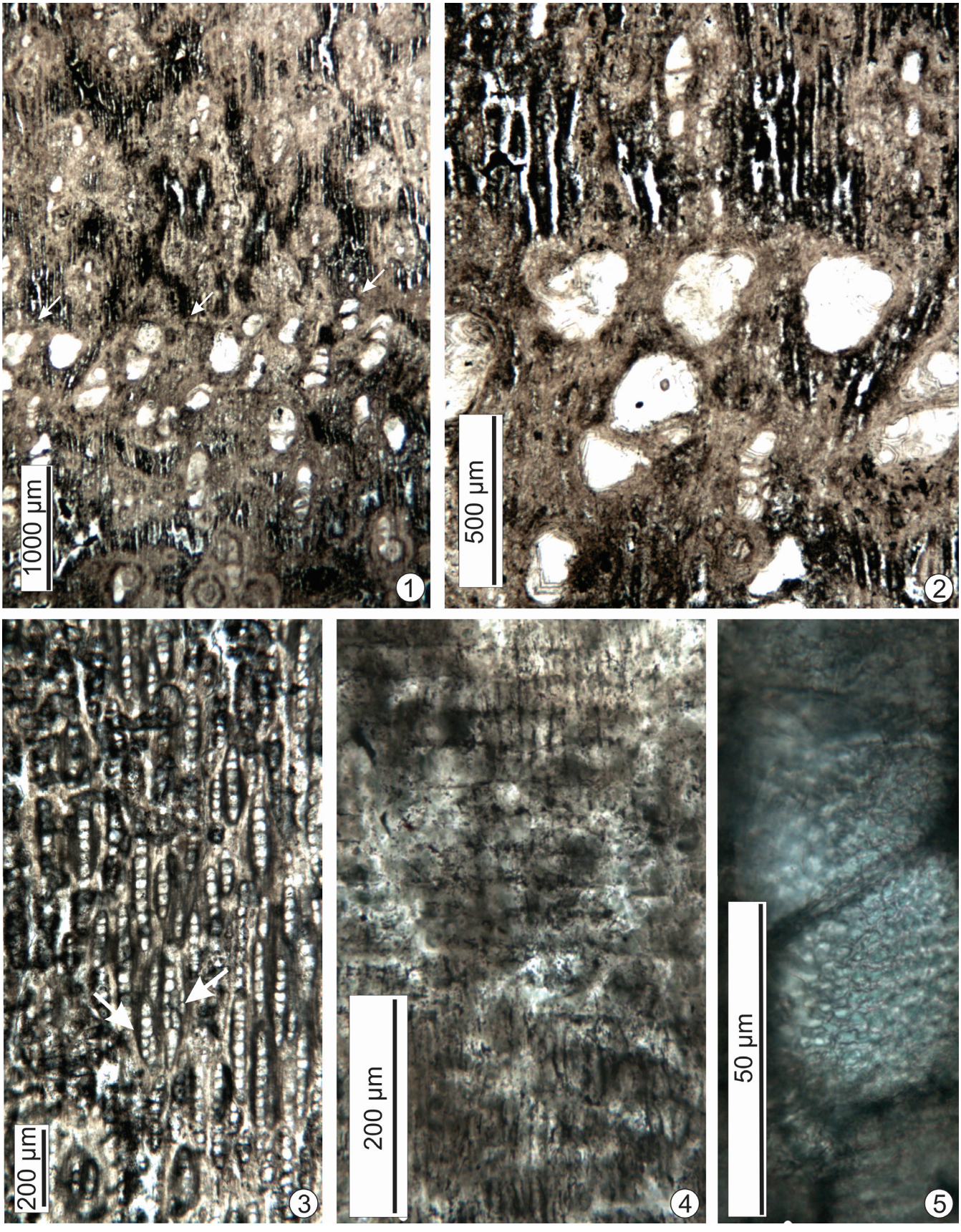

PLATE 2

S.N.	Name of the fossil wood	Modern comparable taxa	Locality	Age
1.	*Lagerstroemioxylon parenchymatosum* Prakash (Guleria, 1990; Prakash *et al*., 1994; Harsh & Sharma, 1995)	*Lagerstroemia parviiflora*	Bikaner; Northeast India	Plio–Pleistocene; Late Miocene; Tertiary
2.	*L. eoflosreginum*, Prakash & Tripathi (Lakhanpal *et al.,* 1984; Guleria, 1990; Harsh & Sharma, 1995; Tiwari & Mehrotra, 2000)	*L. flosreginae*	Hailakandi (Assam); Kachchh; Bikaner; Northeast India	Tertiary; Pliocene; Late Miocene to Early Pliocene
3.	*L. irrawadiensis* Prakash & Bande (Prakash *et al.,* 1994)	*L. venusta*; *Lagerstroemia* sp.	Northeast India	Late Miocene
4.	*L. arcotense* Awasthi (1981)	*Lagerstroemia*	Pondicherry	Mio–Pliocene
5.	*L. deomaliense* Lakhanpal *et al.* (1981)	*L. villosa*	Arunachal Pradesh	Late Mio–Pliocene
6.	*Lagerstroemioxylon* sp. cf. *parviflora* Srivastava & Bande (1992)	*L. parviflora*	Bihar	Pliocene
7.	*L. tomentosum* Prakash *et al.* (1992)	*L. tomentosum*	Northeast India	Late Miocene
8.	**L. vasicentricum* Harsh & Sharma (1995)	*Lagerstroemia*	Bikaner	Tertiary
9.	**L. obliqueporatum* Harsh & Sharma (1995)	*Lagerstroemia*	Bikaner	Tertiary
10.	**L. eohypolucum* Harsh & Sharma (1995)	*Lagerstroemia*	Bikaner	Tertiary
11.	**L. harsolavense* Harsh & Sharma (1995)	*Lagerstroemia*	Bikaner	Tertiary
12.	**L. royi* Harsh & Sharma (1995)	*Lagerstroemia*	Bikaner	Tertiary
13.	**L. floribunda* Harsh & Sharma (1995)	*L. floribunda*	Bikaner	Tertiary
14.	**L.* cf. *eoflosregium* Harsh & Sharma (1995)	*Lagerstroemia*	Bikaner	Tertiary

Fig. 2—Showing various species of *Lagerstroemioxylon* described from India.

to polygonal in shape as seen in cross section, thick walled, septate.

Figured specimen—Specimen No. BSIP 39996.

Horizon—Shumar Formation.

Locality—Hema Ki Dhani, near Habur, district Jaisalmer, Rajasthan.

Age—Plio–Pleistocene.

Affinities—The most characteristic features of the fossil such as semi ring porous wood, simple perforation plates, uniseriate rays and septate fibres show its similarity with the modern woods of the genus *Lagerstroemia* Linn. of the family Lythraceae. For further identification, the fossil was compared with a number of extant woods of *Lagerstroemia* (Pearson & Brown, 1932; Metcalfe & Chalk, 1950; Kribs, 1959; Miles, 1978) and found close to *L. flos–reginae* Retz. (BSIPw 152), *L. lanceolata* Wall. (Wood Slide No. BSIP 234) and *L. parviflora* Roxb. (Wood Slide No. BSIP 153). All these species are quite similar in their anatomical characters and can not be separated.

Mädler (1939) instituted the organ genus *Lagerstroemioxylon* for the fossil woods resembling *Lagerstroemia.* From India, a fossil wood showing resemblance to *Lagerstroemia* was first described by Prakash and Tripathi (1970) as *Lagerstroemioxylon eoflosreginum* from the Tipam Sandstone of Hailakandi (Assam). Two more species of the genus, i.e. *Lagerstroemioxylon parenchymatosum* Prakash (1965) and *L. irrawadiensis* Prakash & Bande (1980) were described from Myanmar and later on they were also reported from India. Quite a good number of fossil woods of *Lagerstroemia* are known from India and are enlisted in Fig. 2. Among these, nine fossil species of *Lagerstroemia* were described by Harsh and Sharma (1995) from the Neogene of Bikaner but the exact locality and lithological horizon of them were not mentioned. According to Guleria (1996) these species described from one locality may belong to either one or two species. The present fossil was compared with all the known species of *Lagerstroemia* but shows best resemblance with *Lagerstroemia parenchymatosum* Prakash (1965) and hence is described under the same specific epithet.

DISCUSSION

The two fossil woods described herein show resemblance with *Terminalia* and *Lagerstroemia* which are usually found to grow in the tropical forests of India (Champion & Seth, 1968). *Terminalia travancorensis*, a large tree reaching up to a height of 30 m, occurs in the evergreen forests of Kerala up to 600 m elevation (Purkayastha & Lal, 1972), whereas *Lagerstroemia lanceolata* Wall. (syn. *L. microcarpa* Wall. ex

Kurz) is a large, evergreen to deciduous tree found in the mixed forest of Western Ghats and hills of Deccan in peninsular India (Pearson & Brown, 1932). *L. parviflora* is widely distributed throughout the greater part of India and occurs in the sub–Himalayan region through Bihar, Bengal to Assam, central and south India, while *L. flos–reginae* (syn. *L. speciosa* Pers.) is found throughout Assam, Bengal, western and southern India from North Kanara through Malabar to Travancore. This tree also occurs in the Malayan Peninsula and Java. In addition, *Mangifera indica* L. (Guleria, 1984) and two gymnospermous fossil woods of *Auracaria* and *Podocarpus* of the families Auracariaceae and Podocarpaceae, respectively (Guleria & Shukla, 2011) are also known from this formation. The present distribution of all these modern counterparts of the described fossils indicates the existence of warm and humid conditions which might have supported the growth of semi–evergreen to deciduous forests in the area during the depositional time contrary to the present day harsh climate with xeric vegetation. This indicates that a drastic climate change in Rajasthan might have occurred after the Plio–Pleistocene time and became hostile for the growth of semi–evergreen to deciduous elements. The post–Pliocene changes in the climate as well as in the vegetation of the area might be due to a change in the latitudinal position of the Indian Plate and uplifting of the Himalayas (Guleria, 1984; Mehrotra, 2003).

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