Pterospermumocarpon, a new malvalean fruit from the Sindhudurg Formation (Miocene) of Maharashtra, India, and its phytogeographical significance

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Pterospermumocarpon (Type: *P. kalviwadiensis*), a new morphogenus of fossil fruits showing resemblance with fruits of extant *Pterospermum* Schreb. (Malvaceae *s.l.*), is described from the Sindhudurg Formation (Miocene) at the Kalviwadi Village, Sindhudurg District, Maharashtra, India. Diagnostic feature of the fossil taxon is the dehiscent pentalocular capsule with five distinct sutures and imprints of winged seed-like structures in the locules. Recent modifications in the systematics of the Malvales, their fossil record, and the distribution and migration of *Pterospermum* and other malvalean taxa in the context of the Indian subcontinent are discussed.

1. Introduction

The tropical Asian genus *Pterospermum* Schreb. is distributed from the Eastern Himalayas to South China and throughout Southeast Asia to the Moluccas (Ramesh Rao 1958; Mabberly 1997; Wilkie 2007). The name *Pterospermum* is of Greek origin, meaning 'winged seed'. Previously, the genus was included in the Sterculiaceae, however, it is now placed in the expanded Malvaceae (Bayer *et al* 1999; Bayer and Kubitzki 2003; Soltis *et al* 2005).

For the first time, Wilkinson (1871) reported deposits of obscure age and origin underlying the laterite in various quarry and well sections near Ratnagiri, Maharashtra. Saxena *et al* (1992) published the respective succession as developed in the Ratnagiri and Sindhudurg districts of Maharashtra, which was later described as Sindhudurg Formation. This formation rests unconformably on Precambrian rocks or Deccan Traps and is overlain by laterites. The lithostratigraphic unit 'Sindhudurg Formation' was proposed by Saxena (1995) for a sequence of clays with carbonaceous and lignitic beds developed in a large area along the Konkan Coast of Maharashtra, India. Plant remains are known from the lignite and carbonaceous clays of this formation (figure 1). The stratigraphic section studied here consists of grey clay (1.0 m) at the base followed by lignite (1.0 m), an ironstone band (0.1 m), grey clay (0.5 m) and laterite (>4.0 m) (figure 1b). The lignite contains well-preserved carbonized woods, fruits and seeds.

Plant megafossils recorded from the Sindhudurg Formation of the Konkan Coast, Maharashtra are given in table 1. In addition, a diversity of fungal remains (Saxena and Misra 1990; Saxena 2000; Tewari and Agarwal 2001; Tewari 2002; Rao 2003, 2004), wood fragments, leaves, cuticles with stomata and terrestrial organic matter has been described along with palynofossils (Phadtare and Kulkarni 1980a, 1980b, 1984a, 1984b; Kulkarni and

Keywords. *Pterospermumocarpon* gen. nov.; *Pterospermum*; Malvaceae; phytogeography; Miocene; India; fossil fruit; Sindhudurg Formation; Maharashtra.

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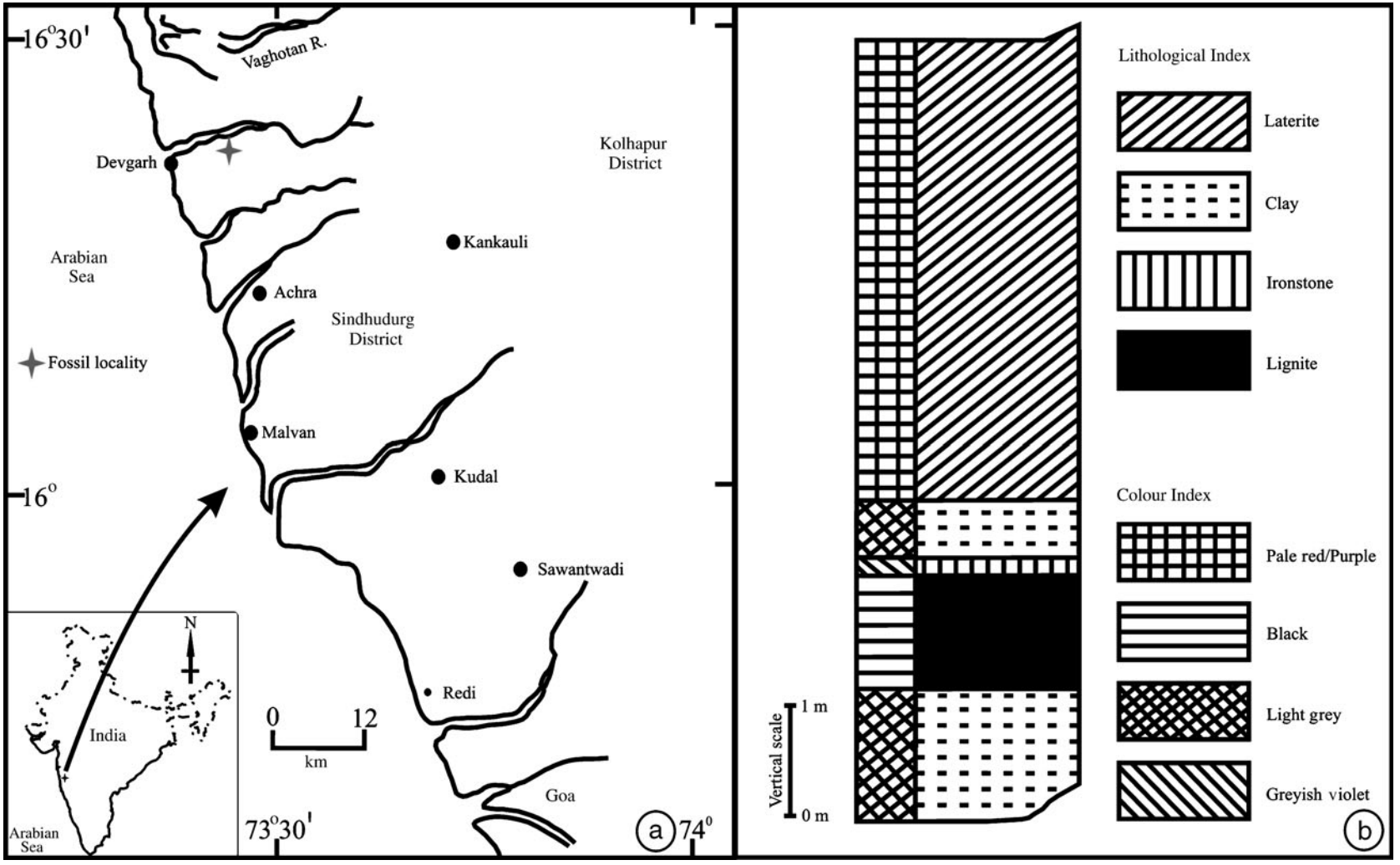

Figure 1. (**a**) Map showing the Kalviwadi Village in the Sindhudurg District, Maharashtra, India, star indicates fossil locality; and (**b**) litholog of the Kalviwadi Section.

Table 1. *Plant megafossils recorded from Konkan Coast of Maharashtra, India.*

Family	Fossil species/plant part	Reference
Alangiaceae	*Alangium*, cuticle	Dalvi and Kulkarni (1982)
Anacardiaceae	*Anacardioxylon ratnagiriense*, wood	Phadtare and Kulkarni (1984c)
	Dracontomelumoxylon mangiferumoides, wood	
	Bouea rediensis, wood	Srivastava and Saxena (1999)
	Nothopegia, cuticle	Dalvi and Kulkarni (1982)
Arecaceae	*Eugeissonocarpon indicum*, fruit	Shinde and Kulkarni (1989)
	Nypa, cuticle	Kulkarni and Phadtare (1980)
Burseraceae	*Canariocarpon ratnagiriensis*, fruit	Agarwal and Ambwani (2000)
Clusiaceae	*Garcinia*, cuticle	Dalvi and Kulkarni (1982)
Combretaceae	*Terminalia praechebula*, seed	Agarwal (2005)
Dipterocarpaceae	*Shoreoxylon vayganiensis*, wood	Srivastava and Saxena (1999)
Ebenaceae	*Diospyros*, cuticle	Dalvi and Kulkarni (1982)
Fabaceae	*Entada palaeoscandens*, seed	Agarwal (2003)
Nyssaceae	*Nyssa brandoniana*, fruit	Shinde and Kulkarni (1989)
Rubiaceae	*Amberiwadiacarpon devgarhensis*, fruit	Agarwal and Ambwani (2002)
Incertae sedis	*Lusaticutis miocenica*, *L. ratnagiriensis*,	Agarwal *et al* (2002)
	L. sindhudurgensis, dispersed cuticle	

Phadtare 1983; Kulkarni *et al* 1985; Saxena and Misra 1990; Saxena *et al* 1992; Saxena 2000; Tewari and Agarwal 2001; Rao 2004). Malvalean pollen, known as *Malvacearumpollis*, has been recorded by Saxena and Misra (1990) and Rao (2004).

2. Methodology

A number of carbonized fruits, described here as *Pterospermumocarpon kalviwadiensis* gen. et sp. nov., were collected from a lignite bed of the Sindhudurg Formation exposed at the Kalviwadi Village (lat. 16°24′30″N: long. 73°26′10″E). This exposure is located about 0.6 km east of the Mondtar Bus-stop in the Devgarh Subdivision, Sindhudurg District, Maharashtra, India (figure 1a). For anatomical details, the fruits were studied under Scanning Electron Microscopic (SEM). For SEM study, the specimens were mounted on aluminum stubs with the help of double-sided adhesive tape and then coated with gold–palladium alloy on a Polaron Sputter Coater. The coated samples were studied under SEM LEO-430 and photographs were taken in desired magnifications. The type material is deposited in the collections of the Birbal Sahni Institute of Palaeobotany, Lucknow, India.

3. Systematic description

Order: Malvales

Family: Malvaceae *s.l.*

Subfamily: Dombeyoideae

Genus: Pterospermumocarpon R Srivast., R K Saxena and Gaurav Srivast., gen. nov.

Type species: Pterospermumocarpon kalviwadiensis R Srivast., R K Saxena and Gaurav Srivast., sp. nov.

Generic diagnosis: Fruit capsule, loculicidal, dehiscent, symmetrical, elliptic to lanceolate in shape, apex acute, base obtuse, pentalocular, five distinct sutures seen on the surface separating each locule, capsule wall thick, seed wings represented by imprint on the inner surface.

Etymology: The generic name indicates the resemblance of the fossil fruit with the fruits of modern *Pterospermum* Schreb.

Pterospermumocarpon kalviwadiensis R Srivast., R K Saxena and Gaurav Srivast., sp. nov.

Description: Fruit capsule, loculicidal, dehiscent, symmetrical, elliptic to lanceolate in shape, length 3.0 cm, diameter 1.5 cm, apex acute, base obtuse, stalk broken; pentalocular, five distinct sutures present (figure 2a); pericarp 2.7-mm thick, epicarp 0.6 mm, mesocarp 2.0 mm, endocarp not distinct. Under higher magnification, venation-like pattern representing imprints of seed wings, may be observed on the inner surface of the locules in few capsules (figure 2d, e). Seeds not preserved.

Epicarp cells predominantly rectangular and moderately thick-walled with striated ornamentation (figure 3b); mesocarp cells oval to circular

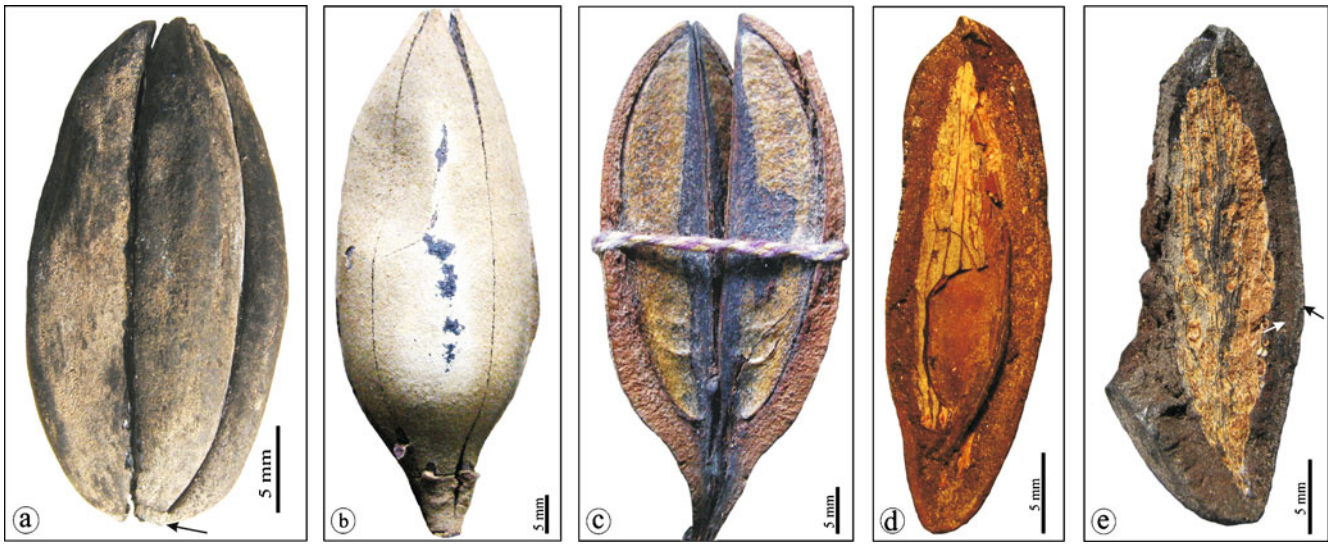

Figure 2. (**a**) Carbonized fruit of *Pterospermumocarpon kalviwadiensis*, Holotype specimen no. BSIP 39896; (**b**, **c**) Fruit of extant *Pterospermum subrifolium* CNH No. 17177 (**d**, **e**) Another specimen of a dehisced carbonized fruit of *Pterospermumocarpon kalviwadiensis*, specimen no. BSIP 39897.

with few polygonal ones, cell wall thicker than that of epicarp cells, frequently perforated, spongy-papillate bodies protrude into the cell lumen from perforations in the cell wall (figure 3c, d); endocarp not very distinct, cells of the inner layer very thick-walled, hexagonal stone cells with very small lumen (figure 3f); frequently pitted vascular strands present (figure 3g, h).

Holotype: Specimen no. BSIP 39896.

Additional Specimen: BSIP 39897.

Type locality: Kalviwadi Village, Sindhudurg District, Maharashtra, India.

Type horizon: Sindhudurg Formation.

Age: Miocene.

3.1 *Affinities and comparison*

Diagnostic feature of the present fossil taxon is the dehiscent pentalocular capsule with five distinct sutures and imprints of wing-like structures in the locules, indicating its affinity with the genus *Pterospermum* Schreb. of the Malvaceae. In external morphology and size, the carbonized fruits also show some resemblance with the fruits of *Alseodaphne andersonii* (King ex Hook. f) Koestrum. of the Lauraceae and *Canarium strictum* Roxb. of the Burseraceae. However, the fruits of *Alseodaphne* are indehiscent with a single seed and the *Canarium* fruits are also indehiscent but trilocular with small seeds without wings.

In order to find the nearest modern equivalent of the present fossil taxon, a large number of *Pterospermum* fruits and other malvalean fruits with a dehiscent capsule and membranaceous winged seeds were studied at the Central National Herbarium, Howrah, Forest Research Institute, Dehradun, and Birbal Sahni Institute of Palaeobotany, Lucknow, India. Amongst them, *Pterospermum suberifolium* Lam. (Hebarium Sheet no. 17177; figure 2b, c), *P. acerifolium* Wild, and *P. lancaefolium* Roxb. show closest resemblance with the fruit under consideration. However, in modern *Pterospermum* species, mature fruits are woody capsules and much bigger in size than the fossil fruits under consideration. Therefore, a new morphogenus *Pterospermumocarpon* is proposed herewith.

Two other genera of fossil fruits, namely, *Canariocarpon ratnagiriensis* (Agarwal and Ambwani 2000) and *Amberiwadiacarpon devgarhensis* (Agarwal and Ambwani 2002) have earlier been described from the same locality. *Canariocarpon ratnagiriensis* (Burseraceae) is a trilocular, faintly triangled, indehiscent fruit with many seeds in each locule quite different from the present fruit. *Amberiwadiacarpon devgarhensis* differs markedly in having prominent ridges and furrows on the outer surface and being larger in size (7.5 × 5.5 cm). The latter fruit is provisionally placed in the Rubiaceae without reference to any of its extant taxa. Since these two, as well as other fruits described so far from Late Cretaceous to Tertiary sediments, are quite different from the fruit under consideration, it is assigned to *Pterospermumocarpon kalviwadiensis* R Srivast., R K Saxena and Gaurav Srivast., gen. et sp. nov.

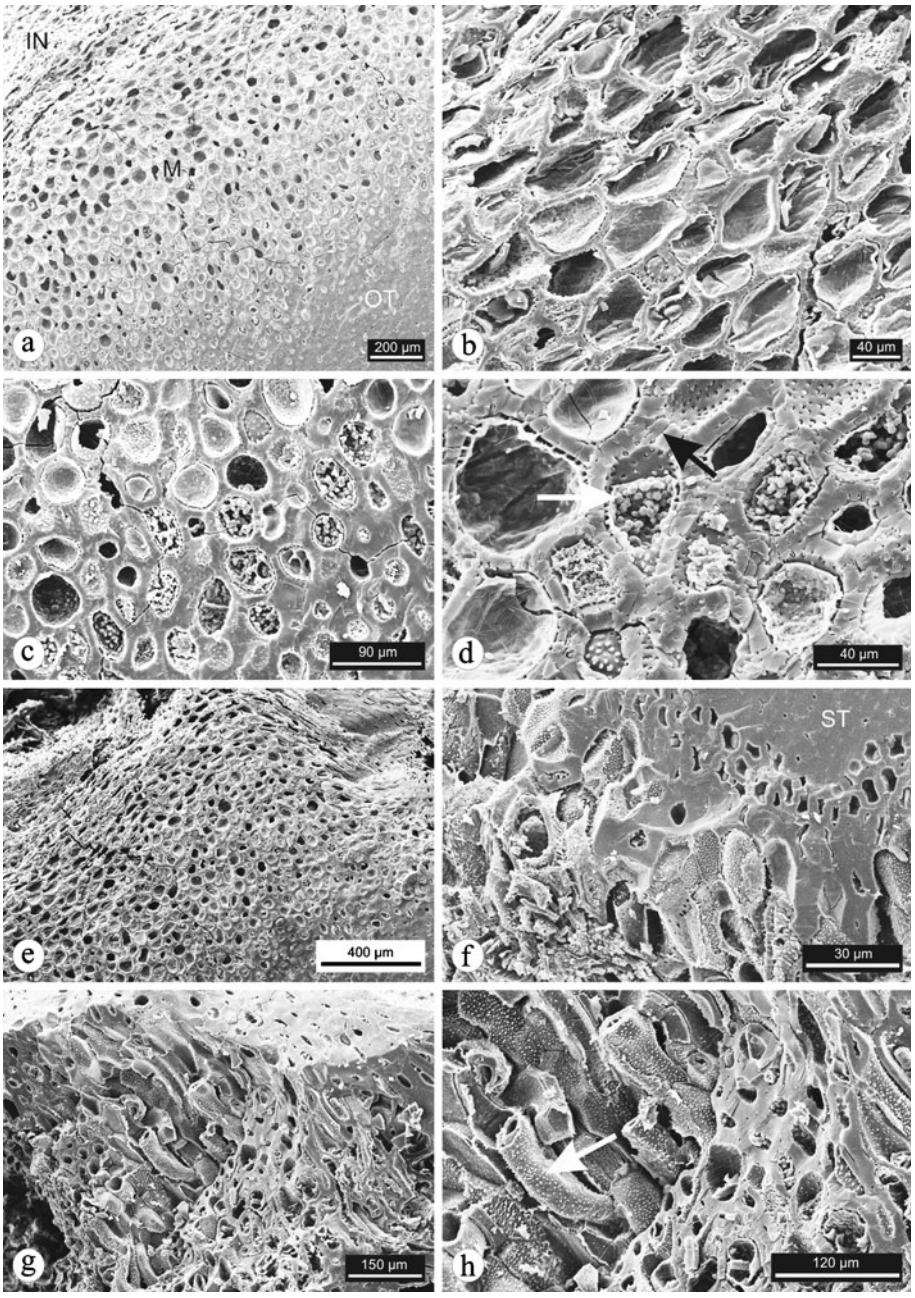

Figure 3. (**a**) Details showing epicarp – outer (OT), mesocarp – middle (M) and endocarp – inner (IN) layers of fruit wall; (**b**) outer layer having rectangular and moderately thick walled with striated ornamentation; (**c**) the cells of middle layer oval to circular in shape with few polygonal ones; (**d**) details of (**c**) showing frequently perforated cell walls (marked with black arrow) and spongy-papillate bodies protruding into the cell lumen (marked with white arrow); (**e**) inner and middle layer cells at low magnification; (**f**) thick-walled stone cells (ST) of inner layer with vascular strands; (**g**, **h**) inner layer showing frequently pitted vascular strands (marked with arrow), inter-vascular pits small, alternate and bordered (**f**–**h**).

Etymology: The specific epithet refers to the Kalviwadi village, where the fossils were collected.

The genus *Pterospermum* Schreb. consists of approximately 25 to 30 species (Mabberly 1997; Wilkie 2007). It is a tropical Asiatic genus widely distributed in the evergreen to semi-evergreen forests of India, Indonesia, Malaysia, the Philippines and southern China. It is mostly found growing naturally along forested stream banks. The best growing conditions are met in a moist climate with access to full sunlight. In India, about 10 species are distributed in Western Ghats, the Andaman Islands and Kutch. The nearest modern counterparts of the fossil fruits, *viz.*, *P. lancaefolium* Roxb., a medium-sized tree of eastern India (Khasi Hills, Manipur) and Bangladesh, and *P. subrifolium* Lam., a small to medium-sized tree found in Deccan on the east coast inland hills of

Orissa, and Cuddapah, and also in the drier regions of Sri Lanka (Ramesh Rao 1958).

4. Discussion

The genus *Pterospermum*, earlier placed in the Sterculiaceae, is now merged into the Dombeyoideae of the Malvaceae *s.l.* The circumscription of Malvaceae is controversial. In the Cronquist system, Sterculiaceae, Malvaceae, Bombacaceae and Tiliaceae constitute the 'Core Malvales' because of the close relationship among these families. However, systematic position of the Malvales Juss. has recently undergone significant modification on the basis of cladistic or phylogenetic analysis (Judd and Manchester 1997) and molecular studies (Alverson *et al* 1999; Worberg *et al* 2009). They excluded Elaeocarpaceae from the Malvales and placed the rest of the families in a single family Malvaceae Juss. The families clustered under Malvaceae *s.l.* were treated as nine subfamilies (Bayer *et al* 1999; Bayer and Kubitzki 2003; Soltis *et al* 2005). However, Baum *et al* (1998); Cheek (2006) and Heywood *et al* (2007) favour a restricted concept of 10 families, viz., Bombacaceae Kunth, Brownlowiaceae Cheek, Byttneriaceae R Br., Durionaceae Cheek, Helicteraceae J Agardh, Malvaceae Juss. *s.s.*, Pentapetaceae Berch and J. Presl, Sparmanniaceae J Agardh, Sterculiaceae (DC) Bartl. and Tiliaceae Juss. Recently, Kvaček and Wilde (2010) opted for Malvaceae *s.l.* while describing fossil malvalean leaves and seeds from Europe because this appears more convenient for palaeobotanical studies. We are following the same concept as it is widely practised by a majority of modern taxonomists.

From India, the Malvaceae *s.l.* are well-documented by megafossils (Srivastava 1991; Srivastava and Guleria 2006) as well as by pollen records (Saxena 1991; Saxena and Trivedi 2006). These are listed in table 2. Fossil woods (*Pterospermoxylon kutchensis* Awasthi *et al* 1980, *P. bengalensis* Roy and Mukhopadhyay 2005) and leaves (*Pterospermum palaeoheyneanum* Antal and Awasthi 1994, *P. siwalicum* Antal and Prasad 1996), showing affinities with the genus *Pterospermum,* are recorded from the Neogene sediments of India.

4.1 *Phytogeographical aspect*

During the Early Cretaceous, India separated from Gondwanaland and moved northwards until it collided with the Asian landmass during the Early Tertiary. Following collision of the two plates, land connections were established between the Indian subcontinent and Southeast Asia during the Neogene (Smith *et al* 1994). As a result, vis-à-vis migration of a number of taxa took place, in both plants and animals, ultimately resulting in the evolution of modern floras and ecosystems (Rao 1974; Awasthi and Srivastava 2005; Srivastava and Mehrotra 2010). During the Neogene, the Dipterocarpaceae, which are considered to be of Malaysian origin (Lakhanpal 1974), entered India from Southeast Asia via Myanmar, along with a number of fabaceous, ebenaceous, sapotaceous and malvalean genera. Bande and Prakash (1986) traced the migration of various taxa between the two landmasses.

The Malvaceae are an interesting example indicating vis-à-vis migration of a number of taxa. Of these, the genus *Pterospermum* is recorded from the Palaeogene of Borneo as *Phyllites* (*Pterospermum*) *gracilis* Geyler (1875). In India, *Pterospermum* makes its first appearance in the Neogene (Awasthi *et al* 1980; Antal and Awasthi 1994; Antal and Prasad 1996; Roy and Mukhopadhyay 2005). Another malvalean genus, *Grewia*, which is well-documented from the Deccan Intertrappean bed (Maastrichtian–Danian) of India (table 2), has been recorded from the Neogene sediments of South Vietnam as *Grewinium fontansii* Serra (1981) and from the Miocene sediments of Chindwin, Myanmar as *Grewioxylon burmense* and *G. macroporosum* (Gottwald 1994). Likewise, *Sterculia* is recorded from the Maastrichtian–Palaeogene sediments of India (table 2) and from the Neogene sediments of Myanmar as *Sterculinium foetidense* (Prakash 1973; Guleria 1983). A leaf of the genus *Bombax* (*Bombacites orientalis*) has also been recorded from the Late Palaeocene sediments of Garo Hills, Meghalaya, India (table 2), whereas its wood (*Bombacoxylon*) has been recorded from the Neogene sediments of Myanmar (Gottwald 1969), further providing evidence for vis-à-vis migration of malvalean taxa from both regions. The occurrence of *Bombacoxylon owenii* (=*Dombeyoxylon oweni* Kräusel) in the Eocene and Oligocene sediments of Libya and Algeria and the Late Cretaceous or Eocene sediments of Ethiopia (Beauchamp and Lemoigne 1973) and *Dombeyoxylon monodii* (Boureau 1949) in the Tertiary sediments of Algeria and West Africa further supports a palaeotropical origin of the Dombeyoideae and a Gondwanan origin of the Malvaceae.

The present day distribution of Malvaceae suggests that, except Tilioideae, it originated in Gondwanaland (Southern Hemisphere). However, the modern distribution is not significant unless the fossil record is taken into consideration. The fossil record of the family extends back into the Late Cretaceous. The subfamily Dombeyoideae is palaeotropical, with centres of diversity in

Table 2. *Plant megafossils of Malvales (Malvaceae s.l.) from Late Cretaceous and Tertiary sediments of India.*

Family	Fossil species	Modern comparable taxa/plant part	Horizon and age; locality	Reference
Bombacaceae	*Bombacites orientalis*	*Bombax insigne*, leaf	Tura Formation (palaeocene); Garo Hills, Meghalaya	Lakhanpal (1955)
	Pachira palaeomalaberica	*Pachira malaberica*, leaf	Lower Siwalik (Middle Miocene); Nainital, Uttarakhand	Prasad *et al* (2004)
Malvaceae	*Daberocarpon gerhardii*	Fruit	Deccan Intertrappean Beds (Maastrichtian–Danian); Mohgaon Kalan, Chhindwara, Madhya Pradesh	Chitaley and Sheikh (1973)
	Harrisocarpon sahnii	Fruit	Deccan Intertrappean Beds (Maastrichtian–Danian); Mohgaon Kalan, Chhindwara, Madhya Pradesh	Chitaley and Nambudiri (1973)
	Hibiscoxylon intertrappeum	?*Hibiscus*, wood	Deccan Intertrappean Beds (Maastrichtian–Danian); Mahurzari, Nagpur, Maharashtra	Trivedi and Ambwani (1971)
Sterculiaceae	*Dombeyoxylon mahabalei*	*Dombeya*, wood	Deccan Intertrappean Beds (Maastrichtian–Danian); Mohgaon Kalan, Chhindwara, Madhya Pradesh	Biradar (1975)
	Heritieroxylon arunachalensis	*Heritiera*, wood	Miocene–Pliocene; Deomali, Arunachal Pradesh	Lakhanpal *et al* (1981)
	Heritieroxylon keralaensis	*Heritiera*, wood	Warkalli Formation (Middle Miocene); Meenkunnu, Kannur, Kerala	Srivastava and Awasthi (1994)
	Pterospermoxylon bengalensis	*Pterospermum*, wood	Tipam Series (Miocene); Burdwan, West Bengal	Roy and Mukhopadhyay (2005)
	Pterospermoxylon kutchensis	*Pterospermum reticulatum*, wood	Kankawati Series (Pliocene); Kutch, Gujarat	Awasthi *et al* (1980)
	Pterospermum palaeoheyneanum	*Pterospermum heyneanum*, leaf	Lower Siwalik (Middle Miocene); Darjeeling, West Bengal	Antal and Awasthi (1994)
	Pterospermum siwalicum	*Pterospermum*, leaf	Lower Siwalik (Middle Miocene); Darjeeling, West Bengal	Antal and Prasad (1996)
	Pterygota alata	*Pterygota alata*, leaf	Late Cenozoic, Mahuadanr, Palamu, Jharkhand	Bande and Srivastava (1990)
	Pterygota cordata	*Pterygota cordata*, leaf	Oligocene; Makum Coalfield, Tinsukia, Assam	Awasthi and Mehrotra (1995)
	Pterygota sp.	*Pterygota*, leaf	Mar Formation (Neogene); Bikaner, Rajasthan	Mathur and Mathur (1998)
	Sterculia kathgodamense	*Sterculia*, leaf	Lower Siwalik (Middle Miocene); Nainital, Uttarakhand	Prasad (1994)
	Sterculia palaeovilosa	*Sterculia villosa*, fruit	Oligocene; Makum Coalfield, Tinsukia, Assam	Mehrotra (2000)

Table 2. *(Continued).*

Family	Fossil species	Modern comparable taxa/plant part	Horizon and age; locality	Reference
	Sterculia sp.	*Sterculia*, leaf	Mar Formation (Neogene); Bikaner, Rajasthan	Mathur and Mathur (1998)
	Sterculinium dattae	*Sterculia*, wood	Late Miocene; Hailakandi, Cachar, Assam	Prakash and Tripathi (1974), Guleria (1983)
	Sterculinium deccenensis	*Sterculia*, wood	Deccan Intertrappean Beds (Maastrichtian–Danian); Mohgaon Kalan, Chhindwara, Madhya Pradesh	Lakhanpal *et al* (1978), Guleria (1983)
	Sterculinium foetidense	*Sterculia*, wood	Lower Siwalik (Middle Miocene); Kalagarh, Pauri Garhwal, Uttarakhand	Prasad (1993)
	Sterculinium jairampurense	*Sterculia*, wood	Tipam Group (Late Miocene), Jairampur, Tirap, Arunachal Pradesh	Awasthi and Mehrotra (1997)
	Sterculinium kalagarhense	*Sterculia*, wood	Lower Siwalik (Middle Miocene); Kalagarh, Pauri Garhwal, Uttarakhand	Prasad (1993)
	Sterculinium pondicherriensis	*Sterculia*, wood	Miocene–Pliocene; Murattandichavadi, near Puducherry	Awasthi (1981), Guleria (1983)
	Sterculinium shahpurensis	*Sterculia*, wood	Deccan Intertrappean Beds (Maastrichtian–Danian); Shahpura, Dindori, Madhya Pradesh	Bande and Prakash (1983), Guleria (1983)
	Sterculinium sp. cf. *S. shahpurensis*	*Sterculia*, wood	Deccan Intertrappean Beds (Maastrichtian–Danian); Shahpura, Dindori M.P.	Bande and Prakash (1983), Guleria (1983)
	Sterculinium vermahii	*Sterculia*, wood	Namsang Beds (Miocene–Pliocene; Deomali, Arunachal Pradesh	Lakhanpal *et al* (1981), Guleria (1983)
	Sterculioxylon baradense	?*Sterculia*, wood	Deccan Intertrappean Beds (Maastrichtian–Danian); Mahurzari, Nagpur, Maharashtra	Sheikh and Kolhe (1980)
Tiliaceae	*Grewia mohgaoensis*	*Grewia*, fruit	Deccan Intertrappean Beds (Maastrichtian–Danian); Mohgaon Kalan, Chhindwara, Madhya Pradesh	Paradkar and Dixit (1984)
	Grewinium canalisum	*Grewia*, wood	Deccan Intertrappean Beds (Maastrichtian–Danian); Mohgaon Kalan, Chhindwara, Madhya Pradesh and Nawargaon, Wardha, Maharashtra	Bande and Srivastava (1995), Srivastava and Guleria (2000)
	Grewinium intertrappeum	*Grewia*, wood	Deccan Intertrappean Beds (Maastrichtian–Danian); Mahurzari, Nagpur, Maharashtra	Shallom (1963b), Srivastava and Guleria (2000)
	Grewinium mahurzariense	*Grewia*, wood	Deccan Intertrappean Beds (Maastrichtian–Danian); Mahurzari, Nagpur, Maharashtra	Srivastava and Guleria (2000)
	Grewioxylon indicum	*Grewia*, wood	Deccan Intertrappean Beds (Maastrichtian–Danian); Mahurzari, Nagpur and Nawargaon, Wardha, Maharashtra	Prakash and Dayal (1965), Khare *et al* (2000)

Madagascar and Southeast Asia and seems to be of East Gondwanan origin. However, fossils have also been reported from the Eocene sediments of North America (*Chattawaya paliformis* Manchester 1980) and Europe (*Dombeyoxylon sturanii* Charrier 1967, *Saportaspermum kovacsiae* Kvaček and Wilde 2010) comparable with the seeds of *Pterospermum*).

5. Conclusion

The occurrence of *Pterospermumocarpon* and the fossil woods and leaves showing affinity to *Pterospermum* in the Neogene sediments along with a number of other malvalean taxa in the Maastrichtian–Danian of India (table 2) clearly indicates vis-à-vis migration of Malvaceae from India to Southeast Asia. On the basis of the fossil record, the Malvaceae probably have a palaeotropical origin in the Southern Hemisphere. After land connection between the Indian subcontinent and Southeast Asia was established during the Neogene, new routes were opened for vis-à-vis migration of a number of taxa which ultimately resulted in the evolution of the modern flora of both regions.

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