Angiospermous fossil woods from the Lameta Formation (Maastrichtian), Maharashtra, India

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Kar, RK, Mohabey, D.M. & Srivastava, R. 2004. Angiospermous fossil woods from the Lameta Formation (Maastrichtian), Maharashtra, India, *Geophytology* **33** (1&2) : 21-27.

Angiospermous fossil woods viz., *Euphorioxylon indicum* and *Barringtonioxyon deccanese* are described for the first time from the Lameta Formation (Maastrichtian) of Nand-Dongargaon inland basin in Nagpur district, Maharashtra. The report is probably the oldest record of structurally preserved dicot woods from India. The earliest angiospermic woods were hitherto described from Deccan Intertrappean beds of central India. The present woods are commonly found in the Deccan Intertrappeans and other Tertiary localities of India. The comparable forms e.g. *Euphoria* and *Barringtonia* of family Lecythidaceae are present in extant flora of India.

Key-words– Angiosperm, xylotomy, Lameta Formation, Maastrichtian, Maharashtra.

INTRODUCTION

THE dicotyledonous woods collected from Lameta Formation (Maastrichtian) exposed at Polgaon and Rajulwari localities of Nand- Dongargaon inland basin situated in Nagpur district, Maharashtra show satisfactorily preserved anatomical features. The reported woods are in all probability represent the oldest record of anatomically preserved dicot woods in India. Earlier Mohabey *et al.* (1993, 1996) have only listed the presence of leaf impressions of angiosperms and casts of woods.

The Lameta Formation in the Nand-Dongargaon area attains thickness up to 20m. It unconformably rests over either the Precambrian or Gondwana Supergroup and is overlain by the Deccan volcanic sequence associated with thin intertrappean sedimentaries. Based on lithofacies and biofacies analyses, Mohabey *et al.* (1993) interpreted that the dinosaur bearing Lameta sediments have been deposited in alluvial-limnic environment and assigned them a Late Cretaceous (Maastrichtian) age. They also identified various lithofacies of Lameta Formation, representing overbank, channel, palustrine and lake subenvironments. Recent work of Mohabey (2001) has helped in identifiying a diatom (*Aulacoseira*) bearing varved clay within the lake sequence. Mohabey and Samant (2003) and Samant and Mohabey (2003), recovered a rich assemblage of palynomorphs from the gray marly horizon of the Lameta Formation of Polgaon and plant bearing coprolite of type A from Pisdura areas. The assemblage includes pteridophytic spores (*Biretisporites* and *Equisetitriletes*), pollen grains of gymnosperm (*Podocarpidites, Araucariacites, Balmeisporis* and *Cycadopites*) and angiosperms (palm pollen grains).

MATERIAL

At Polgaon, the specimens of *Euphorioxylon indicum* were collected (Map) from the Lameta sequence, having a composite thickness of nearly 6 m. This sequence rests over Precambrian and comprises over-bank red and green clays associated with thin partings of lateral accretional sandstone and fossiliferous gray palustrine marls (Mohabey *et al.* 1993; Mohabey 1996).

The Lameta sediments of Rajulwari (Map) which yielded fossil woods of *Barringtonioxylon deccanense,* comprise over-bank red clays which ascend to green clays overlain by the Deccan Traps. The fossil woods are found in association with titanosaurid skeletal remains, few coprolites and pelecypod (*Unio*). So far, the plant fossils are

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concerned, Mohabey (1996) have listed charophyta, conifer, palms, woods and a few spores and pollen grains.

The fossil woods described in the present paper were collected by one of us (Mohabey) and studied at the Birbal Sahni Institute of Palaeobotany, Lucknow. All the figured slides are preserved in the museum of Birbal Sahni Institute of Palaeobotany, Lucknow.

SYSTEMATIC DESCRIPTION

Family – Sapindaceae

Genus – *Euphorioxylon* Awasthi *et al.* 1982

Euphorioxylon indicum Awasthi *et al.* 1982

Pl. 1, Figs. 1-4

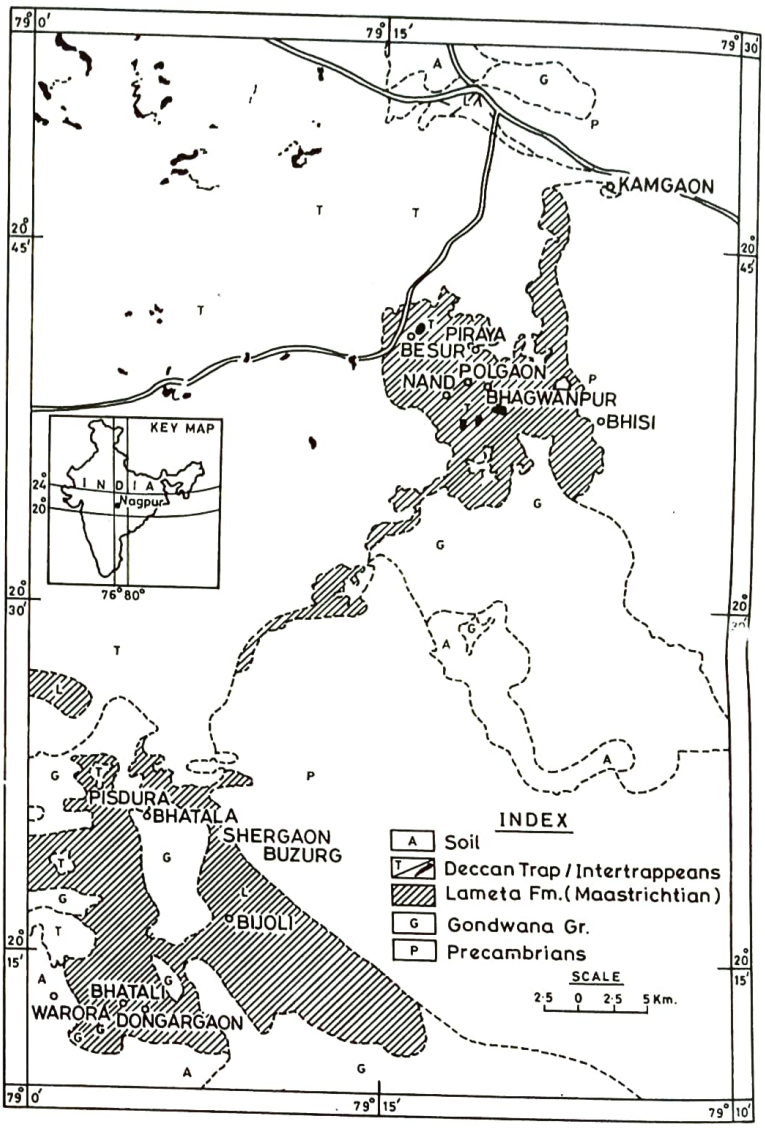
Material - Two small pieces of secondary wood, the larger one measuring about 6.0 cm in length and 3.2 cm in width.

Horizon – Lameta Formation

Locality – Polgaon, Nagpur district, Maharashtra (Map)

Specimen – BSIP Museum no. 39085

Description - *Wood* diffuse–porous. *Growth rings* not seen. *Vessels* 9-18 per sq. mm; solitary few, mostly in radial multiples and irregular clusters of 2-5 (Pl. 1 figs. 1, 2); small to medium sized, tangential diameter 33-110 µm, radial diameter 25-140 µm; oval to circular when solitary, flattened at the place of contact when in multiples; open or filled with some kind of deposit (Pl. 1, figs 1, 2); tyloses absent; perforation simple; vessel elements 140-400 µm with truncate or oblique ends (Pl. 1, figs 3, 4); inter-vessel pits alternate, bordered, hexagonal, small, 3-5 µm in diameter; vessel-ray and vessel parenchyma pits not observed. *Parenchyma* scanty, paratracheal, few cells associated with some of the vessels, occasionally vasicentric forming uni - biseriate sheath around few vessels (Pl. 1, figs 1, 2); parenchyma cells 35-40 µm in diameter, *Rays* 16-20 per mm; uniseriate, rarely bicelled due to few paired cells (Pl.1, figs 3, 4); homocellular, in one of the specimens made up of procumbent cells, while in others made up of squarish



Map - Geological map of the area showing fossil localities.

cells; 5-24 cells or 110-850 µm long; rarely prismatic crystals observed in few ray cells. *Fibres* aligned in radial rows (Pl. 1, figs 1, 2), 12-20 µm in diameter, moderately thick walled, seemingly non-septate, septa may not be observed due to poor preservation.

Affinities - The above anatomical features of the fossil woods indicate its affinity with members of the family Sapindaceae, particularly with *Euphoria,* Comm. ex. Juss. *Litchi* Sonn. and *Otonephelium* Redlk. (Metcalfe & Chalk 1950; Li Baizhong *et al.* 1995). These genera are xylotomically indistinguishable from each other (Ramesh Rao, 1963, p. 212). For naming such woods Awasthi *et al.* (1982) instituted the genus *Euphorioxylon*. So far, two species are reported from India, namely, *Euphoioxylon indicum*

Awasthi *et al.* (1982) from the Neogene sediments of Kutch, Tamil Nadu, Uttaranchal, Arunachal Pradesh, Assam and Kerala (Awasthi *et al.* 1982; Awasthi & Mehrotra 1993; Prasad 1993; Prakash *et al.* 1994 and Srivastava & Awasthi 1994). Another species *Euphorioxylon deccanensis* Mehrotra (1987) is reported from the Deccan intertrappean sediments, Neyveli Lignite deposits, Tamil Nadu and Arunachal Pradesh (Mehrotra 1987; Agarwal 1997; Mehrotra *et al.* 1999).

The present fossil wood shows gross resemblance with both the species, however, in having homocellular rays, it is closer to *Euphorioxylon indicum* Awasthi *et al.* (1987), and hence it has been assigned to the same species.

Distribution - Family Sapindaceae consists of 131 genera, mostly distributed in tropical and warm regions of the world (Mabberely 1997, p. 637). Of the three modern species showing resemblance with the fossil woods, *Euphoria longan* (Laur.) Steud. is distributed in wet evergreen forests of Western Ghats from Konkan southwards extending to Sri Lanka and ascending up to 900 m in Assam, south China, Myanmar and Malaysia. *Otonephelium stipulaceum* (Bedd.) Radlk., is also confined to Western Ghats from Nilgiris southwards and ascending up to 900 m. *Litchi chinensis* (Gaertn.) Sonn. is a native of China and cultivated in India (Ramesh Rao 1963).

Family – Lecythidaceae

Genus – *Barringtonioxylon* Shallom 1960

Barringtonioxylon deccanense Shallom 1960

Pl. 1, Figs. 5 - 10

Material - The description is based on two pieces of fossil woods, the larger one measuring 10.0 cm in length and 4.5 cm in width. The preservation is satisfactory revealing xylotomical details.

Horizon – Lameta Formation

Locality – Rajulwari, Nagpur district, Maharashtra (Map).

Specimen – BSIP Museum no. 39086

Description - *Wood* diffuse – porous. *Growth rings* not seen. *Vessels* solitary, as well as in radial multiples of 2-3 (sometimes up to 6), occasionally into small clustures (Pl.1, figs 6, 7); 12-19 per sq. mm; small to medium (mostly small) sized, tangential diameter 30-110 μm, radial diameter 30-150 μm; circular to oval when solitary, flattened at the place of contact when in multiples (Pl. 1, figs 6, 7); mostly open, few seems to be tylosed; vessel members 150-370 μm in length with oblique end walls; perforation simple; intervessel pits alternate, hexagonal, large, about 10.5-12 μm in diameter with lenticular apertures (Pl. 1, fig. 5). *Parenchyma* abundant, both apotracheal and paratracheal; paratracheal scanty, vasicentric, forming 1-2 seriate sheath round the vessels; apotracheal abundant, diffuse to diffuse-in-aggregate forming 1-2 seriate broken lines among fibres forming reticulum (Pl. 1, figs 6, 7); parenchyma lines are separated by 2-4 cells of fibres; parenchyma cells 28-40 μm in diameter. *Rays* 1-5 seriate, 8-12 rays per mm; heterocellular (Pl. 1, figs 9, 10); uniseriate few, made up of upright cells only, 8-12 cells or 275-600 μm long; multiseriate, 2-4 seriate, made, up of procumbent cells in the centre with 2-4 or more marginal row of upright cells at one or both the ends (Pl. 1, fig. 9); 10-35 cells or 275-1265 μm long; end to end ray fusion present; procumbent cells with tangential height 22-25 μm and radial length 40-60 μm; upright cells with tangential height 36-60 μm and radial length 22-36 μm. *Fibres* aligned in radial rows between two consecutive rays, angular, 24-32 μm in diameter; nonseptate.

Affinities - The characteristic features of the fossil wood are: vessels mostly in radial multiples, perforation simple, intervessel pits large; parenchyma abundant, paratracheal and apotracheal both, paratracheal vasicentric and apotracheal as diffuse-in-aggregate forming 1-2 seriate broken lines; rays 1-4 seriate, heterocellular and fibres nonseptate. These characters collectively indicate its close resemblance with the modern woods of *Barringtonia* J. R. Forster and G. Forster of the family Lecythidaceae.

Thin sections as well as published descriptions and photographs of a number of woods of modern species of *Barringtonia* were critically examined to find out nearest modern counterpart. These are: *Barringtonia*

acutangula (Linn.) Gaertn., *B. augusta* Kurz. (Syn. *B. pterocarpa* Kurz.), *B. cymosa* C.E.C. Fischer, *B. gigantostachya* Koord. *et* Valet., *B. insignis* Mig., *B. macrostachys* (Jack.) Kurz., *B. musiformis* King, *B. racemosa* (Linn.) Spreng. (syn. *Eugenia racemosa* Linn.), *B. scortechnii* King and *B. spicata* Bl. (Moll & Janssonius 1914, pp. 494-502, fig. 187; Metcalfe & Chalk 1950, pp. 633-634, figs. 142 A, B; Desch 1957, pp. 52, pl. 60, fig.1; Kribs 1959, p.57, fig. 153; Hayashi *et al.* 1973, fig. 145; Shahi & Taneja 1982, p. 20-20, pl. 98, figs. 585-588; Ilic 1991, figs. 1998-1999). The study reveals that the fossil wood shows closest resemblance with *B. acutangula*.

The genus *Barringtonioxylon* was instituted by Shallom (1960) to accommodate fossil woods showing affinities with the extant genus *Barringtonia* J. R. and G. Forst. So far, five species have been described from India and one from Ethiopia. These are: *Barringtonioxylon deccanense* Shallom (1960) from Deccan intertrappean bed of Nagpur, Maharashtra; Namsang Beds, Arunachal Pradesh (Awasthi & Mehrotra 1993), Tipam Sandstone, Assam (Prakash *et al.* 1994); *B. eopterocarpum* Prakash and Dayal (1965) from Deccan intertrappean bed of Nagpur, Maharashtra; *B. arcotense* Awasthi (1970) from Cuddalore Sandstone and Neyveli Lignite, Tamil Nadu (Reddy & Ramanujam 1985) and *B. assamicum* Prakash and Tripathi (1972) from Tipam Sandstone, Assam; *B. mandlaensis* Bande and Khatri (1980) from Deccan Intertrappean bed of Mandla (now Dindori), Madhya Pradesh and Wardha District, Maharashtra (Khare *et al.* 2000); *B. rajasthanense* Harsh *et al.* (1992) from Bikaner, Rajasthan. *Barringtonioxylon allemblack-ioides* has been reported by Lemoigne (1978) from The Tertiary of Ethiopia. Besides, *Barringtonioxylon assamicum* is also reported from Bangladesh (Agarwal *et al.* 2000).

Amongst them, *Barringtonioxylon arcotense* Awasthi (1970) and *Barringtonioxylon mandlaensis* Bande and Khatri (1980) can be differentiated in having well developed paratracheal, vasicentic, aliform to aliform-confluent parenchyma while in the present fossil wood scanty paratracheal to uniseriate vasicentric parenchyma is present in addition to diffuse to diffuse-in-aggregate apotrachaeal parenchyma. *B. arcotense* has larger vessel diameter (up to 300 µm). *Barringtonioxylon mandlaensis* reported by Khare *et al.* (2000) from Wardha District is wrongly described as their description does not tally with the slides. They described apotracheal parenchyma as diffuse to diffuse-in-aggregate, while it is totally absent. Likewise, in multiseriate rays pterospermum type of tile cells are present which they have not mentioned in their description. These characters are absent in *Barringtonia* and even in the family.

Rest of the four species, namely, *Barringtonioxylon deccanense* Shallom, *Barringtonioxylon eopterocarpum* Prakash and Dayal, *Barringtonioxylon assamicum* Prakash and Tripathi, *Barringtonioxylon rajasthanense* Harsh *et al.* exhibit resemblance with the fossil wood under consideration in having similar type of parenchyma pattern. However, *B. eopterocarpum* can be differentiated in having broader (up to 8 seriate) and taller (up to 4 mm) rays. *B. assamicum* and *B.*

PLATE 1 ⟶

Euphorioxylon indicum Awasthi *et al.*

1. Transverse section showing distribution of open vessels and scanty parenchyma x100. BSIP Slide no. 39085-I.
2. Another transverse section showing vessles filled with deposits. x 100. BSIP Slide no. 39085-II.

3,4. Tangential longitudinal sections showing uniseriate rays and simple perforation. x100. BSIP Slide no. 39085-III.

Barringtonioxylon deccanense Shallom

5. Tangential longitudinal section showing bordered, alternate, hexagonal intervessel pits. x400. BSIP Slide no. 39086-II.
6. Transverse section showing distribution of vessels and parenchyma. x40. BSIP Slide no. 39086-I.
7. Same section enlarged showing vessels and diffuse-in-aggregate parenchyma lines. x100. BSIP Slide no. 39086-I.
8. Tangential longitudinal section showing distribution of rays. x 40. BSIP Slide no. 39086-II.
9. Same section enlarged showing a multiseriate ray. x 100. BSIP Slide no. 39086-II.
10. Radial longitudinal section showing heterocellular ray cells. x 40. BSIP Slide no. 39086-III.

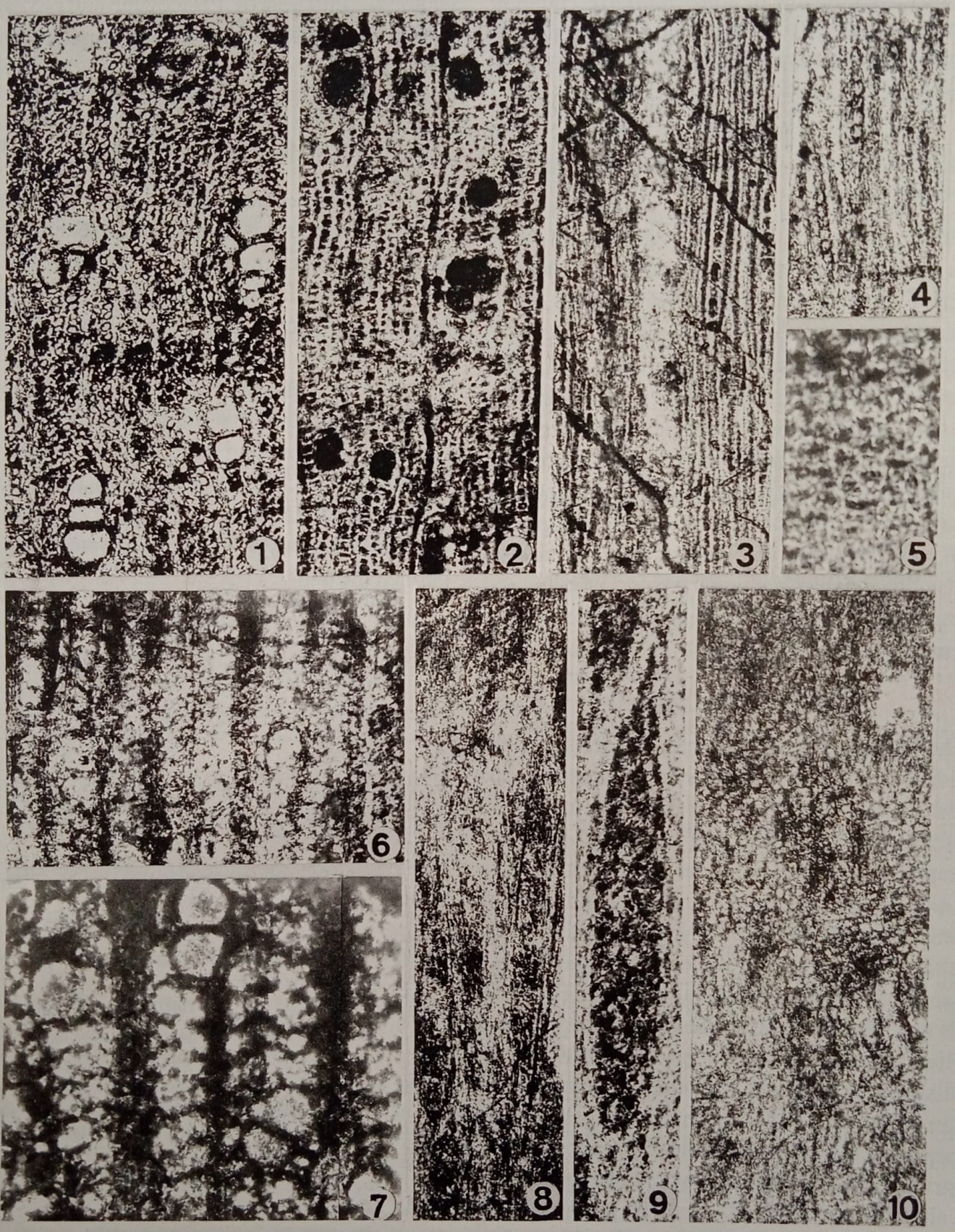


PLATE 1

rajasthanense have slightly larger vessels (diameter up to 230 μm). Besides, in *B. rajasthanense* Harsh *et al.* described homocellular rays and vessels without tyloses. *B. allamblackoides* Lemoigne differs in having larger vessels (diameter 250-300 μm). The present fossil wood shows nearest resemblance with *Barringtonioxylon deccanense* Shallom, and hence placed under it.

Distribution - The genus *Barringtonia* Forster and G. Forster consists of 39 species (Mabberley, 1997, pp. 77). Small and medium sized trees of the genus are characteristic of beach forests of Polynesia, northwest Australia, Malaysia, Myanmar, Sri Lanka, Bangladesh and India. Inland they occur along the streams and the swamps. Three species are reported to occur in India. *B. acutangula* (Linn.) Gaertn., the nearest modern counterpart is distributed in the sub-Himalayan tract from Ganga eastwards to Bengal and Assam, also in Madhya Pradesh and the coastal districts of the peninsula along the banks of rivers and on swampy land, more scarce inland in the Deccan and Karnataka (Shahi & Taneja 1980, p. 20).

DISCUSSION

The two fossil woods described here are so far the oldest anatomically preserved angiospermous woods from India. A large number of fossil angiospermous woods are recorded from the Deccan Intertrappean sediments but so far nothing was known from the underlying Lameta Formation. In this formation also there are many fossil woods around Zeerabad, Dhar District, but these are in the form of casts and hence depict no internal structure. The fossil woods described here do not belong to the primitive families. If Barremian is taken as the age of establishment of angiosperms then almost after 65 million years in the Maastrichtian we get the first angiospermic woods in Lameta Formation. In the Maastrichtian the modern characters of angiosperms were already attained and that is why there is hardly any difference between the living and fossil ones. The woods of both the families were widely spread in India during Tertiary as evidenced by the presence of number of fossil specimens from different localities of peninsular and extrapeninsular regions covering different geological horizons of Palaeogene and Neogene. The existence of both the genera in India in the present day flora speaks in volume about their adaptability and tolerance in different ecological conditions.

ACKNOWLEDGEMENT

Two of the authors (R.K.K. and R.S.) are thankful to the Department of Science and Technology, New Delhi for sponsoring a project entitled "Cretaceous megafloral and coprolitic - derived plant assemblage from the Deccan Trap associated sedimentary sequences in the Dongargaon-Pisdura area, Maharashtra" (ESS / 23/ VES / 114 / 2000) and to the Director, Birbal Sahni Institute of Palaeobotany, Lucknow for providing infrastructural facilities. One of the authors (D.M.M.) is thankful to the Director, Palaeontology Division and Deputy Director General Geological Survey of India, Nagpur, for permission to publish the paper.

REFERENCES

Acharya, SK & Lahiri, TC 1991. Cretaceous palaeogeography of the Indian subcontinent. *Cret. Res.* **12**: 3-26.

Agarwal, A. 1997. Two fossil woods from the Neyveli Lignite deposits, Tamil Nadu, India. *J. Indian bot. Soc.* **75**: 229-232.

Agarwal, A, Ambwani, K, Saha, S & Kar, RK 2000. Fossil wood of *Barringtonia* (Lecythidaceae) from Ramgarh, Chittagong Hill Tract, Bangladesh. *Phytomorphology* **50**: 33-36.

Awasthi, N 1970. On the occurrence of two new fossil woods belonging to the family Lecythidaceae in the Tertiary rocks of South India. *Palaeobotanist* **18**: 67-74.

Awasthi, N, Guleria, JS & Lakhanpal, RN 1982. Two new fossil woods of Sapindaceae from the Tertiary of India. *Palaeobotanist* **30**: 12-21.

Awasthi, N & Mehrotra, RC 1993. Further contribution to the Neogene flora of north-east India and significance of the occurrence of African elements. *Geophytology* **23**: 81-92.

Bande, MB & Khatri, SK 1980. Some more fossil woods from the Deccan Intertrappean beds of Mandla District, Madhya Pradesh, India. *Palaeontographica* **173B**: 147-165.

Chandra, SK, & Bhattacharya, A 1996. A reevaluation of stratigraphy of Lameta-Jabalpur contact around Jabalpur. M.P. *Jl. Sed. Petrol.* **37**: 425-437.

Desch, HE 1957. Manual of Malayan Timbers-1. Malay. *Forest Rec.* **15**: 1-328.

Harsh, R, Sharma, BD & Suthar, OP 1992. Anatomy of petrified woods of Lecythidaceae and Combretaceae from Bikaner (Rajasthan) India. *Phytomorphology* **42**: 87-102.

Hayashi, S, Kishima, T, Lau, LC, Wong, TC & Menon, PKB 1973. *Microscopic Atlas of Southeast Asian Timber.* Division of Wood Biology, Wood Research Institute, Kyoto University, Japan.

Ilic, J 1991. *CSIRO Atlas of Hardwoods.* Spring-Verlag.

Jain, SLY & Bandyopadhyaya, S 1997. New titanosanrid (Dinosaurian : Sauropda) from the Late Cretaceous of Central India. *J. Palaeont.* **17**: 114-136.

Khare, EG, Prasad, M & Awasthi, N 2000. Contributions to the Deccan Intertrappean flora of Nawargaon, Wardha District, Maharashtra. *Palaeobotanist* **49**: 443-460.

Kribs, DA 1959. *Commerial Foreign Woods on the American Market.* Pennsylvania.

Lemoigene, Y 1978. Flores Tertiaries de la haute vallee de L'omo (Ethiopie). *Palaeontographica* **165B**: 89-157.

Li Baizhong, Ter Welle, BJH & Klaasen, RKWM 1995. Wood anatomy of trees and shrubs from China VII. Sapindaceae, *IAWA Jour.* **16**: 191-215.

Mabberley, DJ 1997. *The Plant Book. A portable dictionary of vascular plants.* Cambridge University Press, Cambridge.

Mehrotra, RC 1987. A new fossil dicot wood from the Deccan Intertrappean beds of Mandla District, Madhya Pradesh, *Palaeobotanist* **35**: 146-149.

Mehrotra, RC, Awasthi, N & Dutta, SK 1999. Study of fossil woods from Upper Tertiary sediments (Siwalik) of Arunachal Pradesh, India and its implication in palaeoecological and phytogeographical interpretations. *Rev. Palaeobot. Palynol.* **107**: 223-247.

Metcalfe, CR & Chalk, L 1950. *Anatomy of Dicotyledons.* **1 & 2**, Clarendon Press, Oxford.

Mohabey, DM 1996. Depositional environment of Lameta Formation (Late Cretaceous) of Nand-Dongargaon inland basin, Maharashtra. The fossil and lithological evidences. *Mem. geol. Soc. India* **37**: 363-386.

Mohabey, DM 2001. Dinosour eggs and dug (faecal mass) from Late Cretaceous of Central India : Dietary implication. *Geol. Surv. India Spec. Publ.* **64**: 605-615.

Mohabey, DM & Samant, 2003. Floral remains from Late Cretaceous faecal mass of sauropod from Central India : implications to their diet and habitat. *Gond. Geol. Magz.* Spec. vol. **6**: 235-238.

Mohabey, DM, Udhoji, SG & Verma, KK 1993. Palaeontological and sedimentological observations on non-marine Lameta Formation (Upper Cretaceous) of Maharashtra, India: their palaeoecological and palaeoenvironmental significance *Palaeogeo. Palaeoclim. Palaeoecol.* **105**: 83-94.

Moll, JW & Janssonius, HH 1914. *Micrographie des Holzes der auf Java vorkommenden Baumarten.***3**.

Prakash, U & Dayal, R 1965. *Barringtonioxylon eopterocarpum* sp. nov., a fossil wood of Lecythidaceae from the Deccan Intertrappean beds of Mahurzari. *Palaeobotanist* **13**: 25-29.

Prakash, U & Tripathi, PP 1972. Fossil woods of *Careya* and *Barringtonia* from the Tertiary of Assam. *Palaeobotanist* **19:** 155-160.

Prakash, U, Vaidyanathan, Lalitha & Tripathi, PP 1994. Plant remains from the Tipam Sandstones of northeast India with remarks on the palaeoecology of the region during the Miocene. *Palaeontographica* **231B**: 113-146.

Prasad, M 1993. Siwalik (Middle Miocene) woods from the Kalagarh area in the Himalayan foothills and their bearing on palaeoclimate and phytogeography. *Rev. Palaeobot. Palynol.* **76**: 49-82.

Ramesh Rao, K 1963. Family Sapindaceae, In: Indian Woods, **II** pp. 207-239 Manager, Govt. of India Press, Controller of Publications, Delhi.

Reddy, PR & Ramanujam, CGK 1985. Some frequently encountered carbonised woods from the first mine area of Neyveli Lignite, Tamil Nadu, pp. 59 *Sixth Geophytol. Conf. Pune.*

Samant, B. & Mohabey, DM 2003. Palynofloral study of Late Cretaceous (Maastrichtian) sediments of Nand-Dongargaon area : palaeoclimate and palaeoenvironment. *XIX Indian Collq. Micropalaeont. Strat.*, Varanasi, pp. 63-64.

Shahi, R & Taneja, Kamlesh 1982. Family Lecythidaceae, pp. 19-25 In: *Indian Woods*, **IV** Purkayastha SK. (ed.) Manager, Govt. of India Press, Controller of Publications, Delhi.

Shallom, LJ 1960. Fossil dicotyledonous wood of Lecythidaceae from the Deccan Intertrappean beds of Mahurzari. *J. Indian bot Soc.* **39**: 198-203.

Srivastava, Rashmi & Awasthi, N 19994. Carbonised woods of Sterculiaceae and Sapindaceae from Middle Miocene sediments of Kerala coast. *Palaeobotanist* **42** : 178-182.