Carbonised woods from the Sindhudurg Formation (Miocene) in Ratnagiri and Sindhudurg districts, Maharashtra, India

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Two carbonised woods are described from the Sindhudurg Formation (Miocene) developed in the Konkan area of Maharashtra, India. One of these, *Shoreoxylon vayganiensis* sp. nov. (Dipterocarpaceae), was collected from a dug well at Vaygani village in Ratnagiri District whereas the other, *Bouea rediensis* sp. nov. (Anacardiaceae), was collected from a mine cutting at Redi village in Sindhudurg District, Maharashtra. The extant equivalents of the carbonised woods are presently growing in tropical moist deciduous to wet evergreen forests of Malaysia and Myanmar, indicating more humid climate during the sedimentation of the Sindhudurg Formation.

Key-words–Carbonised woods, *Shoreoxylon* (Dipterocarpaceae), *Bouea* (Anacardiaceae), Sindhudurg Formation, Miocene, Maharashtra, India.

INTRODUCTION

THE Sindhudurg Formation was proposed by Saxena (1995) for a sequence of clays with carbonaceous and lignitic beds developed in a large area along Konkan Coast of Maharashtra. Wilkinson (1871) reported these beds as deposits of obscure date and origin lying beneath the laterite from various quarry and well sections near Ratnagiri. Saxena *et al.* (1992) published the lithostratigraphic succession developed in Ratnagiri and Sindhudurg Districts of Maharashtra which was later named as Sindhudurg Formation. This formation rests unconformably over Precambrians/Deccan Traps and is overlain by laterites. Plant remains described from the lignite and carbonaceous clays of this formation are mentioned below:

Woods - *Dracontomelumoxylon* and *Anacardioxylon* belonging to Anacardiaceae (Phadtare & Kulkarni 1984c).

Fruits - *Nyssa* (Nyssaceae) and *Eugeissona* (Arecaceae) (Shinde & Kulkarni 1989).

Leaf cuticles -*Nypa* (Arecaceae) (Kulkarni & Phadtare 1980): *Nothopegia* (Anacardiaceae), *Garcinia* (Cluciaceae), *Alangium* (Alangiaceae), *Diospyros* (Ebenaceae) (Dalvi & Kulkarni 1982).

Palynofossils - Fungal remains (fruiting bodies, spores and hyphae), pteridophytic spores and angiospermous pollen (Phadtare & Kulkarni 1980a, b, 1984a, b; Kulkarni & Phadtare 1983; Kulkarni *et al.* 1985; Saxena & Misra 1990; Saxena *et al.* 1992).

MATERIAL

The carbonised woods were collected from the lignite bed of the Sindhudurg Formation. The wood described as *Shoreoxylon vayganiensis* sp. nov. (specimen no. BSIP 37746) was collected from a well dug at Vaygani village in Ratnagiri District whereas that described as *Bouea rediensis* sp. nov. (specimen no. BSIP 37747) was collected from the Mavli Mine of the New India Mineral Corporation Private Limited at Redi (Lat. 15°46' N: Long. 73°40' E) in Sindhudurg District, Maharashtra (Text-figs 1, 2). The type material is stored in the museum of the Birbal Sahni Institute of Palaeobotany, Lucknow.

SYSTEMATIC DESCRIPTION

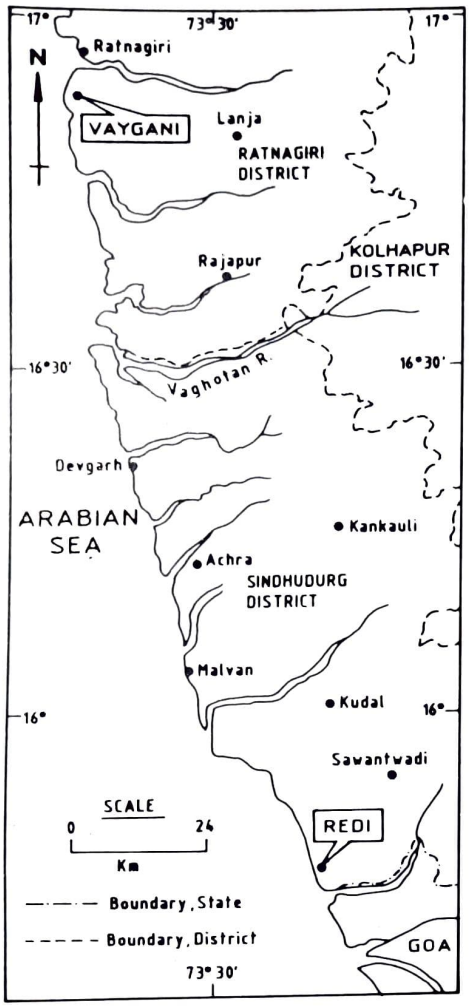
Family - Dipterocarpaceae

Genus - ***Shoreoxylon* Den Berger 1923**

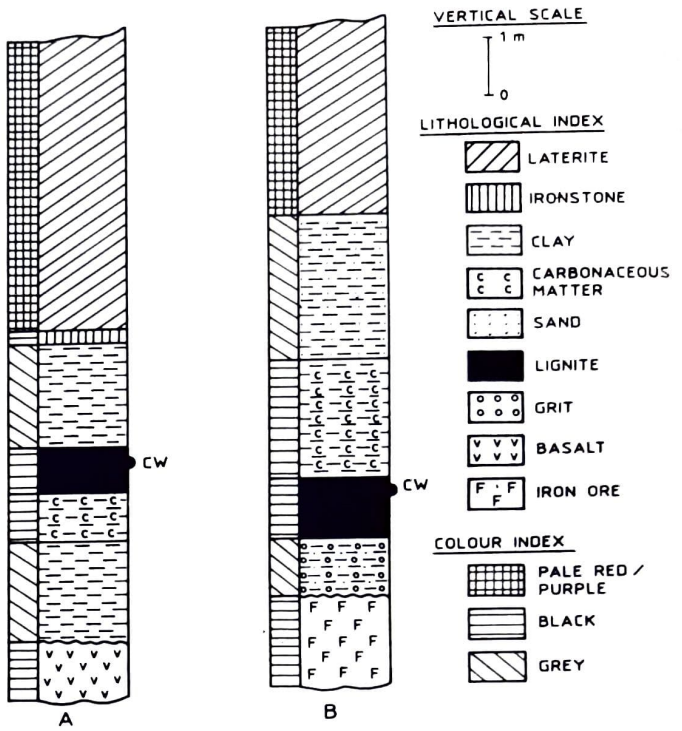
***Shoreoxylon vayganiensis* sp. nov.**

Pl. 1, figs 1-2, 4-6

The species is based on a single specimen of decorticated wood measuring about 9 cm in length and 3.5 cm in width. The wood is twisted due to compression during fossilization. However, it shows satisfactory anatomical details under polarised light microscope (MPV-1).



Text-fig. 1. Map of Ratnagiri and Sindhudurg Districts, Maharashtra showing locations of Vaygani village and Mavli Mine, Redi.



Text-fig. 2. A. Litholog of the Vaygani well in Ratnagiri District, Maharashtra; B. Litholog of the Mavli Mine Section, Redi in Sindhudurg District, Maharashtra. CW-carbonised wood horizon.

Description - *Wood* diffuse - porous. *Growth rings* indistinct. *Vessels* mostly solitary, occasionally in multiples of 2-3; small to medium sized, t.d. 80-220 µm, r.d. 80-230 µm; circular to oval, heavily tylosed (Pl. 1, fig. 1); perforations simple; vessel members 200-450 µm long with truncate ends; inter-vessel pit pairs not seen. *Parenchyma* both paratracheal and apotracheal; paratracheal aliform, confluent (Pl. 1. fig. 1), at places forming 2-3 seriate short bands (Pl. 1, fig. 4); apotracheal associated with vertical gum canals (Pl. 1, fig. 5); parenchyma cells 80-100 µm in length and 24-38 µm in width. *Vasicentric tracheids* present, intermingled with paratracheal parenchyma forming sheath around vessels. *Xylem rays* 1-4 seriate; uniseriate few. short, homocellular to heterocellular, either made up of wholly upright cells or both upright and procumbent cells; multiseriate weakly heterocellular consisting of procumbent cells in the centre with extensions of 1-4 upright cells at one or both the ends (Pl. 1, fig. 2); 3-50 cells or 80-900 µm long; ray cells small, procumbent cells 35-80 µm in radial length and 20-36 µm in tangential height (Pl. 1, fig. 6); upright cells 24-36 µm in radial length and 32-44 µm in tangential height; sheath cells absent. *Fibres* aligned in radial rows between two consecutive rays, semilibriform, nonseptate (Pl. 1, figs. 1, 2), 8-20 µm in diameter. *Gum canals* vertical, present in tangential rows; small, 40-80 µm in tangential diameter; deformed due to compression; embedded in parenchymatous tissue (Pl. 1, fig. 5).

Affinities - The above anatomical details bring out certain diagnostic features which help in identification of the carbonised wood. These are : heavily tylosed, small to medium sized vessels; paratracheal, aliform, confluent parenchyma; vasicentric tracheids; heterocellular xylem rays and vertical gum canals in tangential rows. These characters collectively indicate affinity of the carbonised

wood with *Shorea* Roxburgh ex Gaertner, *Parashorea* Kurz and *Pentacme* A. de Candolle of the family Dipterocarpaceae (Metcalfe & Chalk 1950). The woods of these genera are anatomically indistinguishable and are referred to *Shoreoxylon.* Thin sections and published descriptions and photographs of different species of these genera (Pearson & Brown 1932; Metcalfe & Chalk 1950; Desch 1957; Chowdhury & Ghosh 1958; Kribs 1959; Hayashi *et al.* 1973; Ilic 1991) were carefully examined and it was inferred that the present carbonised wood shows resemblance with many species of *Shorea,* viz., *Shorea kunstleri* King, S. *laevis* Ridl. and *S. maxwelliana* King. However, S. *kunstleri* has bigger gum canals and longer rays. *Shorea laevis* and *S. maxwelliana* show resemblance in having heavily tylosed vessels, nature of parenchyma and dimension of gum canals but in *S. maxwelliana* rays are longer. The carbonised wood, therefore, shows close resemblance with *S. laevis.*

Comparison with fossil species - So far nine fossil wood species have been described under *Shoreoxylon* Den Berger (1923) from the Tertiary sediments of India. These are: *Shoreoxylon evidens* Eyde (1963), *S. kraeuselii* Ramanujam & Rao (1967), *S. tipamense* Prakash & Awasthi (1970), *S. deomaliense* Prakash & Awasthi (1971), *S. arcotense* Awasthi (1974), *S. indicum* Awasthi (1974), *S. ornatum* (Trivedi & Ahuja) comb. nov. (Basionym: *Pentacmeoxylon ornatum* Trivedi & Ahuja, 1979, *Curr. Sci.* **48** (14) : 646-647, figs. 1-5), *S. robustoides* Roy & Ghosh (1981), *S. siwalicus* Prasad & Prakash (1988). The anatomical features and other details of these species are given in Table-1. *Shoreoxylon holdenii* Ramanujam (1956), *S. megaporosum* Ramanujam (1960) and *S. mortandranse* Ramanujam (1956) have been transferred to *Dryobalanoxylon holdenii* (Ramanujam) Awasthi (Awasthi 1971).

From South-east Asia, 13 species of *Shoreoxylon* have been reported from Sumatra, Java, Myanmar and East Indies. Five species, viz., *Shoreoxylon djambiense* Den Berger (1923), *S. palembangense* (Kraeusel) Den Berger (1923), *S. asiaticum* Schweitzer (1958), *S. maximum* Schweitzer (1958) and *Shoreoxylon* cf. *posthumi* Schweitzer (1958) have been reported from the Tertiary sediments of Sumatra whereas three species, viz., S. *multiporosum* Schweitzer (1958), *S. pulchrum* Schweitzer (1958) and *S. posthumi* Schweitzer (1958) have been recorded from the Quaternary sediments of Sumatra. *Shoreoxylon moroides* Den Berger (1927), *S. djambiense* Den Berger in Schweitzer (1958) and *S. parvum* Schweitzer (1958) have been reported from the Tertiary sediments of Java. One species, viz., *S. swedenborgi* (Schuster) Schweitzer (1958) has been reported from the Pliocene sediments of East Indies. Two species, viz., *S. burmense* Prakash (1965) and *S. irrawaddiensis* Prakash & Bande (1980) have been reported from the Tertiary sediments of Myanmar. It has been found that the carbonised wood under consideration is different from all the above species in either dimensions of gum canals and vessels or nature and amount of parenchyma or length and width of xylem rays and is, therefore, being proposed as a new species, namely *Shoreoxylon vayganiensis.* The species is named after Vaygani village from where the carbonised wood was collected.

Holotype- Specimen No. BSIP 37746.

Locality - A well at Vaygani village, Ratnagiri District, Maharashtra (Text-fig. 1).

Family - Anacardiaceae

Genus - ***Bouea* Meisner**

***Bouea rediensis* sp. nov.**

Pl. 1, figs 3, 7-9

The species is based on a single specimen of secondary wood measuring 8.5 cm in length and 6 cm in width. Although the preservation is not good, the anatomical details could be studied from a large number of sections prepared by sliding microtome.

Description - *Wood* diffuse-porous. *Growth rings* present, delimited by terminal parenchyma bands. *Vessels* small to medium sized, t.d. 64-112 µm, r.d. 64-96 µm; usually solitary, rarely in multiples of 2-3; open or plugged with tyloses (P1 . 1, figs 7-8); 2-8 vessels per sq mm; vessel members 240-250 µm long with oblique or tailed ends; perforations simple; inter-vessel pits alternate, hexagonal with

ANATOMICAL FEATURES OF DIFFERENT SPECIES OF THE GENUS *Shoreoxylon* Den Berger 1927 FROM INDIA

Name of fossil species	Modern comparable species	Vessels	Parenchyma	Xylem Rays	Fibre	Gum Canals	Horizon & Locality
Shoreoxylon arcotense Awasthi, 1974; Awasthi & Srivastava, 1990	*Shorea acuminata*	Mostly solitary and rarely in multiples of 2; small-medium sized, t.d. 45-165 µm; r.d. 45-195 µm; tylosed; 12-20 per sq mm.	Paratracheal and apotracheal both, paratracheal scanty; forming 1-2 seriate sheath round the vessels, intermingled with tracheids, apotracheal forming 3-5 seriate bands associated with gum canals.	1-4 (mostly 2-3) seriate or 12-60 µm wide, heterocellular uniseriate composed wholely of upright cells or both upright and procumbent cells; multiseriate with procumbent cells in the centre and 1-6 upright cells at one or both the ends; 12-45 cells or upto 800 µm in length.	Aligned in radial rows, 12-24 µm in diameter, nonseptate; thin walled	Vertical, in concentric rings; t.d. 40-140 µm, r.d. 100-160 µm.	Cuddalore Sandstone; Murtandichavadi near Pondicherry; Warkalli Beds, Payangadi Super Clay Mine, Kannur District, Kerala.
Shoreoxylon burmense Prakash, 1965; Prakash, Vaidyanathan & Tripathi, 1994	*Shorea*	Mostly solitary and often in multiples of 2-3; small-large sized; t.d. 60-190 µm, r.d. 150-275 µm; tylosed; 6-7 per sq mm.	Paratracheal and apotracheal both; mostly vasicentric aliform; apotracheal diffuse to diffuse-in-aggregate, also in the form of 7-12 seriate bands associated with gum canals.	1-5(6) seriate or 16-120 µm wide, weakly heterocellular, rays mostly composed of procombent cells, 3-47 cells or 70-840 µm long.	Radially aligned; nonseptate, non-semilibriform, 12-18 µm in diameter.	Vertical, in concentric rings; 30-120 µm in diameter.	Tipam Sandstone; Kartikcherra near Hailakandi, Cachar District, Assam.
Shorexoylon deomaliense Prakash & Awasthi, 1971	*Shorea*	Solitary, rarely in multiples of 2; small-large (mostly large), t.d. 64-256 µm; r.d. 64-320 µm tylosed, 8-16 per sq mm.	Paratracheal and apotracheal both, paratracheal vasicentric, occasionally aliform to confluent; apotracheal	1-7 seriate, heterocellular, consists of procumbent cells in median portion with 1-8 marginal upright cells at one	Aligned in radial rows; nonseptate, thick walled;	Vertical, in concentric rings; 35-240 µm in diameter.	Deomali Series; Namsang beds, Arunachal Pradesh.

			associated with gum canals , occasionally diffuse.	or both the ends.			
Shoreoxylon evidens Eyde, 1963	*Shorea*	Mostly solitary, also in multiples of 2-3; t.d. 105-285 µm; r.d. 135-345 µm; rarely tylosed, 2 per sq mm.	Paratracheal and apotracheal both; paratracheal aliform; apotracheal bands associated with gum canals.	1-5 seriate, weakly heterocellular, made up of procumbent cells with single row of marginal upright cells at both the ends.	Nonseptate, libriform	Vertical, in concentric rings; t.d. 120-195 µm; r.d. 165-270 µm	Garo Hills, Meghalaya.
Shorexylon indicum Awashti, 1974	*Shorea obtusa, Parashorea stellata, Pentacme suavis*	Mostly solitary, also in multiples of 2-4; medium to large; t.d. 45-420 µm;, r.d. 45-300 µm; 5-10 vessels per sq mm.	Paratracheal and apotracheal both; paratracheal vasicentric, aliform to confluent, often fine to broad confluent bands; apotracheal diffuse to diffuse-in-aggregate, forming 1-2 seriate irregular lines.	1-6 seriate, heterocellular, multiseriate made up of procumbent cells in the centre with 1-2 upright cells at one or both the ends, upto 60 cells long.	Aligned in radial rows, nonseptate, thick walled	Vertical, in concentric rings; 40-120 µm in diameter.	Cuddalore Sandstone; Murtandichavadi , near Pondicherry.
Shoreoxylon kraeuselii Ramanujam & Rao, 1967, 1969	*Shorea talura S. tunbuggaia*	Mostly solitary, often in radial group of 2-3; t.d. 150-200 µm; 2-8 vessels per sq mm.	Paratracheal scanty and vasicentric; apotracheal diffuse to 1-3 seriate bands at close intervals, also associated with gum canals.	2-5 (mostly 3-4) seriate, 5-60 cells high, unseriate very short and rare; ray tissue predominantly homocellular	Not aligned in radial rows; nonseptate, libriform.	Vertical, in concentric rings; 75-95 µm diameter	Cuddalore Sandstone; near Pondicherry.

Shoreoxylon ornatum (Trivedi & Ahuja) comb. nov.	*Pentacme suavis, P.mindamensis*	Solitary, medium to large; t.d. 135-399 µm; r.d. 200-230 µm; tylosed; 5-9 per sq mm.	Paratracheal and apotracheal; paratracheal scanty, apotracheal diffuse, scattered or aggregate.	1-5 (mostly 3-4) seriate, heterocellular, uniseriate 7-20 cells high, multiseriate 484-1870 µm high, sheath cells on one or both the flanks.	Nonseptate; semilibriform,	Vertical, in concentric rings.	Siwalik Group, Kalagarh, Pauri Garhwal District, Uttar Pradesh.
Shoreoxylon robustoides Roy & Ghosh, 1981	*Shorea robusta*	Mostly solitary, also in multiples of 2-4; small to large; t.d. 133-399 µm; r.d. 166-266 µm.	Paratracheal vasicentric; apotracheal associated with gum canals.	1-4(3-4) seriate or 52 -104 µm broad, multiseriate 8-22 cells or 199-665 µm long, heterocellular.	Aligned in radial rows, thick walled; septate;	Vertical, arranged in concentric rings; 66-165 µm in diameter.	Birbhum District, West Bengal
Shoreoxylon siwalicus Prasad & Prakash, 1988	*Shorea minor*	Usually solitary, rarely in multiples; medium to large; t.d. 100-264 µm; r.d. 105-284 µm; tylosed.	Paratracheal and apotracheal both; paratracheal vasicentric, scanty tool-4 seriate thick sheath round the vessels; apotracheal abundant, diffuse to diffuse-in-aggregate lines.	1-7 (mostly 5-6) seriate uniseriate homo and heterocellular both; multiseriate heterocellular having procumbent cells in median portion with 1-6 rows of upright cells at one or both the ends, sheath cells at both flanks; 3-65 cells or 178-1440 µm long.	Nonseptate; semilibri-form.	Vertical, found in concentric rings; 88-179 µm in diameter.	Siwalik Group, Kalagarh, Pauri Garhwal District, Uttar Pradesh.
Shoreoxylon tipamense Prakash & Awasthi, 1970	*Shorea assamica*	Mostly solitary, rarely in multiples of 2-3; t.d. 112-352 µm; r.d. 122-332 µm; thin walled tylosed.	Paratracheal and apotracheal both, paratracheal vasicentric aliform to occasionally aliform-confluent; apotracheal diffuse to aggregate	1-5 seriate, heterocellular, uniseriate homo-heterocellular; multiseriate heterocellular, made of procumbent cells with 1-12 marginal	Aligned in radial rows; nonseptate; thin walled.	Vertical, in concentric ringe; 80-160 µm in diameter.	Tipam Sandstone; Namsang river bed at Deomali, Arunachal Pradesh; Bolpur District, West Bengal.

				rows of upright cells, sheath cells occasionally present; 3-66 cells in height .			
Shoreoxylon vayganiensis sp. nov.	*Shorea laevis*	Mostly solitary, rarely in multiples of 2-3; t. d. 80-220 µm, r.d. 80-230 µm, thin walled; 5-8 vessels per sq mm heavily tylosed.	Paratracheal and apotracheal both; paratracheal aliform confluent to 2-3 seriate bands; apotracheal associated with gum canals	1-4 seriate, heterocellular, made up of procumabant cells in the centre with extensions of 1-4 upright cells at one or both the ends; 3-50 cells or 80-900 µm long	Aligned in radial rows; nonseptate; semilibri-form.	Vertical, in concentric rings; 40-80 µm in tangential diameter.	Sindhudurg Formation; Ratnagiri District, Maharashtra.

lenticular apertures, 8-10 µm in diameter. *Parenchyma* fairly abundant, both apotracheal and paratracheal; apotracheal in long tangential bands of irregular distribution, ending abruptly (Pl. 1, figs 7-8); paratracheal vasicentric as thin sheath round the vessels (Pl. 1, fig. 8). *Xylem rays* fine, 1-2 (mostly 2) seriate, closely spaced (Pl. 1, fig 9); ray tissue heterocellular, made up of both upright and procumbent cells, 4-25 cells or 150-750 µm long; procumbent cells 48-96 µm in radial length and 20-24 µm in tangential height; upright cells 24-32 µm in radial length and 48-64 µm in tangential height (Pl. 1, fig. 3); radial gum canals absent. *Fibres* aligned in radial rows; nonseptate; 16-20 µm in diameter (Pl. 1, figs 7, 8).

Affinities - The important anatomical characters of the fossil wood, viz., mostly small to medium sized vessels, presence of apotracheal parenchyma lines, vasicentric paratracheal parenchyma and 1-2 seriate, closely placed, heterocellular xylem rays without radial gum canals indicate affinity of the carbonsied wood with the genus *Bouea* Meisner of the family Anacardiaceae (Metcalfe & Chalk 1950; Ghosh & Purkayastha 1963; Hayashi *et al.* 1973; Ilic 1991). Thin sections and published descriptions and photographs of *Bouea microphylla* Hooker F., *B. macrophylla* Griff. and *B. oppositifolia* (Roxburgh) Meisner (=*B. burmanica* Griff.) were critically examined. The carbonised wood under consideration shows gross resemblance with all the above species except for having smaller vessels. It has been observed that *Bouea oppositifolia* differs in having almost uniseriate xylem rays whereas *B. macrophylla* and *B. microphylla* have 1-2 (mostly 2) seriate xylem rays as in the case of present carbonised wood.

Comparison with fossil species - The only Indian record of *Bouea* wood *(Bouea neyveliense* Agarwal 1989) from the Neyveli lignite depostis of South Arcot District, Tamil Nadu, shows resemblance with *B. oppositifolia.* Since this wood differs from the present wood specimen in having mostly uniseriate xylem rays, the latter is being described as a new species, viz., *Bouea rediensis* sp. nov. The specific epithet indicates the locality from where the carbonised wood was collected. Fossil leaves of *Bouea*, viz., *Bouea koilabasensis* Prasad (1994) showing affinities with *B. oppositifolia* have been reported from the Siwalik sediments of Koilabas, Nepal whereas *Bouea premacrophylla* Antal & Awasthi (1993) showing affinities with *B. macrophylla* has been recorded from the Siwalik sediments of Darjeeling District, West Bengal.

Holotype - Specimen No. BSIP 37747.

Locality–Mavli Mine of the New India Mineral Corporation Private Limited at Redi, Sindhudurg District, Maharashtra, India (Text- fig. 1).

DISCUSSION

The carbonised woods assigned to *Shorea* (Dipterocarpaceae) and *Bouea* (Anacardiaceae) are important for interpreting palaeoclimate and palaeophytogeography of Konkan area during deposition of the Sindhudurg Formation.

The genus *Shorea* Roxb. ex Gaertn. consists of 180 species distributed in the tropical region of Sri Lanka, India, South China, Myanmar, West Malaysia, Indonesia, Moluccas and other south east Asian

PLATE 1

***Shoreoxylon vayganiensis* sp. nov.**

1. Transversely sectioned surface showing heavily tylosed vessels and parenchyma. x 120. Polished Block no. BSIP 37746.
2. Tangential longitudinaly sectioned surface showing xylem rays. x 120. Polished Block no. BSIP 37746.
3. Radial longitudinal section showing heterocellular xylem rays. x 10. Slide no. BSIP 37747-III.
4. Transversly sectioned surface showing paratracheal bands. x 120. Polished Block no. BSIP 37746.
5. Same surface showing vertical gum canals in concentric rings. x 120.
6. Radial longitudinally sectioned surface showing weakly heterocellular rays. x 120. Polished Block no. BSIP 37746.

***Bouea rediensis* sp. nov.**

7. Transverse section showing distribution of vessels and parenchyma. x 40. Slide no. BSIP 37747-I.
8. Same section as Fig. 7 to show distribution of parenchyma. x 100.
9. Tangential longitudinal section showing closely placed xylem rays. x 100. Slide no. BSIP 37747-II.

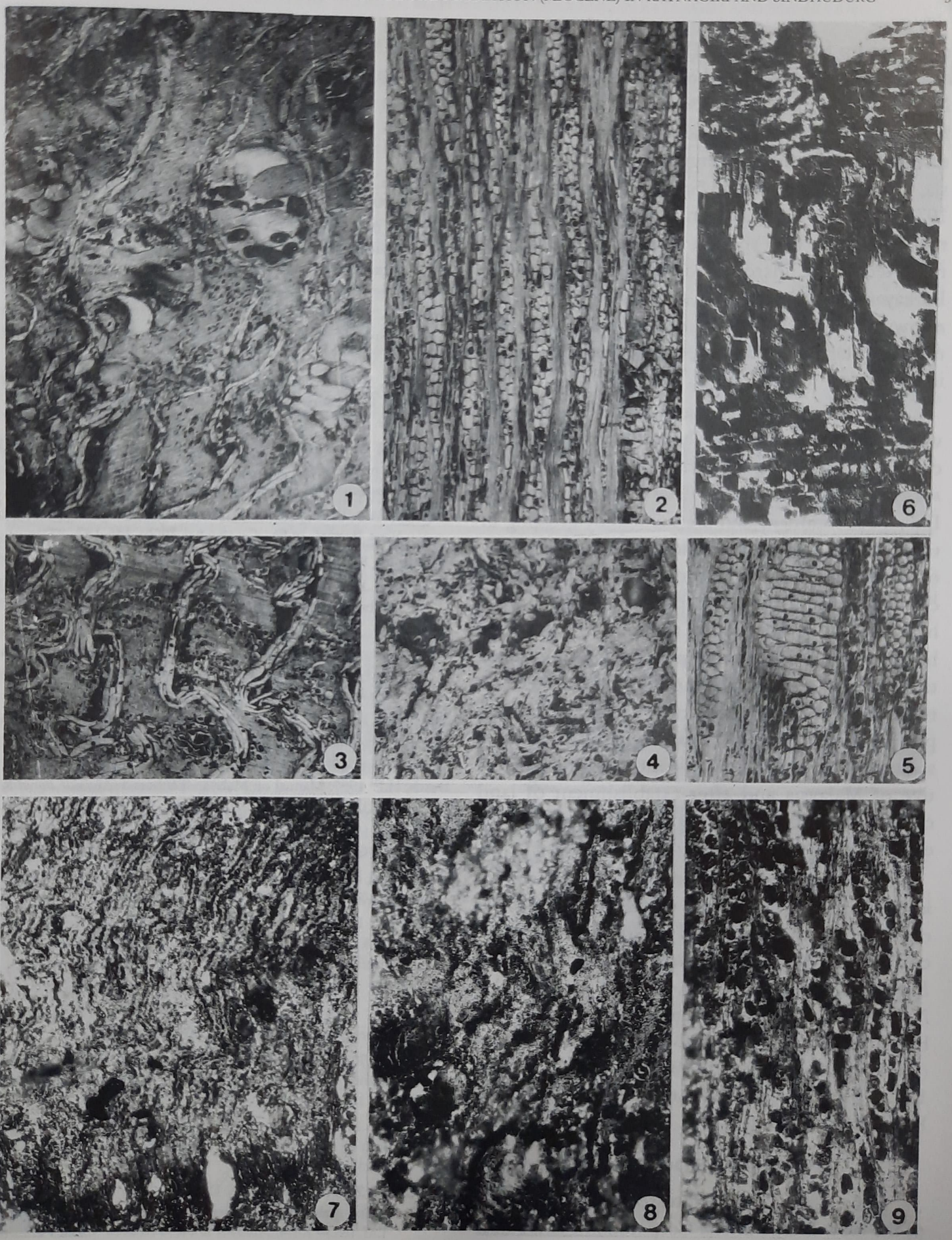


PLATE 1

countries up to Philippines (Willis 1973). Of these, nearly 100 species grow in the tropical parts of Indo-Malaysian region (Pearson & Brown 1932). *Shorea laevis* Ridl., with which the carbonised wood closely resembles, is found in evergreen forests of Malaysia, Indonesia, Sabah and Sarawak (Hayashi *et al.* 1973). *Bouea* Meisner, a genus of Indo-Malaysian region, consists of 5 species, of which 3 species are reported to be introduced in India (Ghosh & Purkayastha 1963; Santapau & Henry 1973). *Bouea macrophylla* Griff. and *B. microphylla* Hooker F., the nearest extant counterparts, are presently growing in Malaysia.

The modern comparable forms of carbonised woods are palaeoecologically and phytogeographically significant. At present, *Shorea laevis, Bouea microphylla* and *B. macrophylla* are absent from the Indian subcontinent and are luxuriantly growing in tropical wet evergreen to moist deciduous forests of Myanmar, Malaysia and other south-east Asian countries where the atmospheric precipitation is high. It may be interpreted that due to considerable decrease in the annual precipitation and duration of rainy season, moisture loving taxa failed to regenerate and became extinct from the area of present study. From their absence in the Palaeogene sediments of India, it is evident that they are native of Malaysia and after establishment of land connections between India and south east Asia, they entered India via Myanmar during Neogene.

Other megafossils reported from this area are in the form of carbonised woods, fruits and leaf cuticles. In terms of modern genera, the assemblage consists of *Alangium, Diospyros, Dracontomelum, Eugeissona, Garcinia, ?Gluta, Nothopegia, Nypa* and *Nyssa*. The overall assemblage indicates a warm and humid climate and Indo-Malaysian distribution (Kulkarni & Phadtare 1980; Dalvi & Kulkarni 1982; Phadtare & Kulkarni 1984c; Shinde & Kulkarni 1989).

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