

ON TWO NEW FOSSIL WOODS RESEMBLING *CHRYSOPHYLLUM* AND *HOLOPTELEA* FROM THE CUDDALORE SERIES NEAR PONDICHERRY

N. AWASTHI

Birbal Sahni Institute of Palaeobotany, Lucknow-226007

ABSTRACT

Two new fossil woods have been described from the Cuddalore Series near Pondicherry. One of these shows closest resemblance with the woods of *Chrysophyllum* L. of Sapotaceae and the other with that of *Holoptelea* of Ulmaceae. These have been named as *Chrysophylloxylon pondicherricense* gen. et sp. nov. and *Holopteleoxylon indicum* gen. et sp. nov. respectively.

INTRODUCTION

STUDIES on the petrified dicot woods from the Cuddalore Series near Pondicherry, carried out for the last two decades, have yielded large number of genera and species belonging to diverse families. A classified list of these has already been given by Awasthi (1974). There are still a few woods in our collection which appear to be new for the area. Two of them show striking resemblance with those of *Chrysophyllum* and *Holoptelea* respectively, and are described here in detail.

SYSTEMATIC DESCRIPTION

FAMILY — SAPOTACEAE

Chrysophylloxylon gen. nov.

Chrysophylloxylon pondicherricense sp. nov.

Pl. 1, figs. 1-3, 6; Pl. 2, figs. 7, 8

Material — The material consists of a single piece of petrified wood measuring about 20×10 cm and shows fairly good preservation.

Topography — Wood diffuse-porous. *Growth rings* occasionally seen, delimited by somewhat darker zone of thick-walled fibres with less parenchyma (Pl. 1, fig. 2). *Vessels* visible to the naked eye, small to

large, solitary, majority in radial multiples of 2-8, rarely up to 18, characteristically arranged somewhat in oblique radial lines, sometimes crowded at the beginning of growth rings (Pl. 1, figs. 1, 2), about 10-15 vessels per sq mm; perforations simple, nearly horizontal to oblique; tyloses present, sometimes thick-walled, or sclerotic in a few vessels with characteristic flat walls across the lumina at right angle to the longitudinal vessel walls. *Vasicentric tracheids* forming 1-2 seriate sheath around the vessels. *Parenchyma* typically apotracheal, occurring in numerous tangential lines, mostly uniseriate, regular, occasionally with some scattered or diffuse cells (Pl. 1, figs. 1, 2, 6), 10-16 lines per mm. *Xylem rays* 1-3 seriate, occasionally 4-seriate; ray tissue heterogeneous; uniseriate rays mostly composed of square or upright cells, or both procumbent as well as upright cells; multiseriate rays 2-3, occasionally 4-seriate; rays heterocellular, consisting of procumbent cells through the median thickened portion and 1-several marginal rows of upright or square cells (Pl. 1, fig. 3; Pl. 2, fig. 7) at both the ends, rays about 50 cells in height, 10-16 per mm. *Fibres* aligned in radial rows between two consecutive xylem rays.

Elements — *Vessels* round to oval, those in radial multiples flattened at places of contact, t.d. 32-200 μ , r.d. 40-300 μ , walls 8-12 μ in thickness; vessel-members with truncate or slightly tapered ends, up to 900 μ in length; intervessel pits medium to large, 8-10 μ in diameter, alternate, with small circular apertures, pits leading to tracheids and parenchyma similar to intervessel pits. *Vasicentric tracheids* not easily recognizable in cross section, clearly seen in tangential section with vertical rows of bordered pits, length of tracheids almost same as of fibres, diameter slightly more than the diameter of fibres. *Parenchyma cells* 24-36 μ in diameter, mostly filled with dark contents. *Ray cells* upright or square

and procumbent; upright or square cells 48-60 μ in vertical height, 20-140 μ in radial length. *Fibres* angular, sometimes tangentially flattened, semi-libriform to libriform, 16-24 μ in diameter, thick-walled, common wall 4-8 μ in thickness, nonseptate, pits not seen.

Affinities — In having characteristic features such as vessels mostly in radial multiples, arranged somewhat in oblique radial lines, vasicentric tracheids, apotracheal parenchyma occurring in almost regular, closely spaced uniseriate lines, and 1-3 seriate heterocellular rays, it resembles the woods of the family Sapotaceae.

In order to find out the nearest modern equivalent, the fossil was compared with the woods of the family Sapotaceae at the Xylarium, Forest Research Institute, Dehradun. Besides, it was also compared with the anatomical description and figures of the woods of Sapotaceae described by Metcalfe and Chalk (1950, p. 883, fig. 204), Moll and Janssonius (1920, pp. 353-412, fig. 258), Normand (1960, vol. 3, pp. 305-320, pls. 131-142), Pearson and Brown (1932, vol. 2, pp. 663-668, figs. 217-223), Desch (1954, pp. 540-541, pl. 108, fig. 2), Henderson (1953, figs. 348-356), Kribs (1959, pp. 146-151, figs. 309-314, 457-464). From this it was found that the fossil wood is quite similar to those of the genus *Chrysophyllum*.

Among the woods of *Chrysophyllum* further detailed comparison of the present fossil wood was made with *Chrysophylloxylon roxburghii* L., *C. africanum* ADC., *C. cainito* L., *C. oliviforme* L., *C. sericeum* ADC. (Kribs, 1959, p. 147, fig. 312), *C. africanum* ADC. var. *aubrevillei* Pellegr. *C. perpulchrum* Mildbr. ex Hutch. & Dalz., *C. giganteum* A. Chev., *C. subnudum* Bak., *C. laurentei* De Wild., *C. pruniforme* Engl., *C. albidum* G. Don., *C. begulei* Auber. & Pellegr. and *Chrysophyllum* sp. (Normand, 1960). Of these, *Chrysophyllum roxburghii* shows closest resemblance with the present fossil wood. The only difference between the fossil and *Chrysophyllum roxburghii* is that the vessels in the latter are slightly smaller than those of the former.

In view of its closest resemblance with the modern woods of *Chrysophyllum* the present fossil is designated as *Chrysophylloxylon* gen. nov. and named *Chrysophylloxylon pondicherriense* sp. nov.

GENERIC DIAGNOSIS

Chrysophylloxylon gen. nov.

Wood diffuse-porous. *Growth rings* delimited by somewhat darker zone of thick-walled fibres and with less parenchyma. *Vessels* small to large, solitary as well as in radial multiples of 2-8 or more, characteristically arranged more or less in oblique radial lines; perforations simple; tylosed; intervessel pits medium to large, alternate, vested. *Vasicentric tracheids* occurring in the immediate vicinity of vessels, with rows of bordered pits. *Parenchyma* typically apotracheal, forming closely spaced uniseriate lines, occasionally biseriate or with scattered cells. *Xylem rays* 1-4 seriate, heterocellular, consisting of upright or square cells and procumbent cells through median portion. *Fibres* angular, nonseptate, thick-walled.

Genotype — *Chrysophylloxylon pondicherriense* sp. nov.

SPECIFIC DIAGNOSIS

Chrysophylloxylon pondicherriense sp. nov.

Vessels small to large, solitary as well as in radial multiples of 2-8, rarely up to 18, characteristically arranged in oblique radial lines, crowded at the beginning of annual rings, t.d. 32-200 μ , r.d. 40-300 μ ; perforations simple; intervessel pits 8-10 μ in diameter, alternate, with nearly circular apertures; tyloses thick-walled or sclerotic in some vessels. *Vasicentric tracheids* forming 1-2 seriate sheath around the vessels, with two vertical rows of bordered pits. *Parenchyma* apotracheal, forming almost uniseriate, closely spaced lines, 19-16 lines per mm, sometimes cells irregularly arranged or scattered. *Xylem rays* 1-4 (mostly 1-3) seriate, uniseriate rays common; ray tissue heterogeneous; rays heterocellular, consisting of 1-several rows of upright or square cells at both the ends and procumbent cells through median portion; rays up to 50 cells in height. *Fibres* semi-libriform to libriform, thick-walled, nonseptate.

Holotype — B.S.I.P. Museum no. 35226.

Locality — Murattandichavadi, near Pondicherry.

Horizon — Cuddalore Series.

Age — Miocene-Pliocene.

FAMILY — *ULMACEAE**Holopteleoxylon* gen. nov.*Holopteleoxylon indicum* sp. nov.

Pl. 2, figs. 9, 11-13

Material — Several pieces of petrified wood varying in size from small to big. On the whole their preservation is fairly good.

Topography — Wood diffuse-porous. *Growth rings* present, inconspicuous, delimited by fibres comparatively darker zone of thick-walled and narrow lines of apotracheal parenchyma (Pl. 2, fig. 13). *Vessels* small to large, mostly medium-sized, solitary and in radial multiples of 2-4 (mostly 2-3), occasionally up to 7 vessels, evenly distributed, about 8-16 vessels per sq mm; perforations simple, nearly horizontal to oblique; tyloses not seen. *Parenchyma* sometimes unilaterally paratracheal, mostly vasicentric to aliform or aliform-confluent, vasicentric sheath consisting of 1-3 or up to 5 cells wide (Pl. 2, fig. 12), sometimes incomplete, or unequal in width, frequently interrupted by xylem rays; aliform extensions ending blindly as well as joining those of others, sometimes 1-3 parenchyma lines coming out independently from the vasicentric sheath or sheath enclosing vessels or vessel groups and extending beyond several rays as seen in cross section (Pl. 2, fig. 12), thin or narrow parenchyma lines often present towards outer margin of annual rings, frequently stimulating the terminal parenchyma (Pl. 2, fig. 13). *Xylem rays* 1-3 (mostly 3) seriate (Pl. 2, fig. 9), rarely up to 4-seriate, 7-10 rays per mm; ray tissue homogeneous to rarely weakly heterogeneous; rays homocellular to rarely weakly heterocellular, consisting of procumbent cells and rarely single marginal row of square cells; rays mostly 12-14 cells in height, storied (Pl. 2, fig. 9). *Fibres* aligned in radial rows between two consecutive xylem rays. *Ripple marks* present due to storied arrangement of vessel segments, parenchyma strands and xylem rays.

Elements — *Vessels* circular to oval or orbicular, those in radial multiples flattened at places of contact, t.d. 80-260 μ , r.d. 40-220 μ , moderately thick-walled, walls 6-10 μ in thickness, vessel-members truncate,

short, about 180-375 μ in length, storied; intervessel pits large, 8-12 μ in diameter, alternate, angular, with distinct lenticular apertures; pits leading to parenchyma and ray cells almost similar to intervessel pits. *Parenchyma strands* fusiform, about 3-5 cells per strand, storied with other elements; cells about 24-48 μ in diameter, those occurring in the immediate vicinity of vessels up to 80 μ in diameter; infiltration dark. *Ray cells* procumbent, about 16-24 μ in vertical length, 24-180 μ in radial length, upright or square cells slightly more in vertical height and less in radial length than procumbent cells; infiltration dark. *Fibres* semi-libriform to libriform, angular, 12-40 μ in diameter, moderately thick-walled, common walls 4-8 μ in thickness, non-septate.

Affinities — The most characteristic feature of the present fossil is the presence of ripple marks in the tangential longitudinal section due to storied arrangement of vessel-members, parenchyma strands and xylem rays. This is one of the important features of quite a number of woods of the family Leguminosae. Besides legumes, *Holoptelea* of *Ulmaceae* is also one of the other woods which possesses ripple marks due to storied arrangement of all the elements. Taking into consideration all the important characters, the fossil wood was compared with the leguminous woods from their thin sections and published literature. However, none of them was found similar to our fossil wood. Apart from the ripple marks the leguminous woods generally possess typical aliform or aliform-confluent parenchyma, as in *Ougeinia*, or banded parenchyma, bands varying from thin to thick, e.g. *Erythrina*, *Butea*, *Milletia*, *Pongamia*, *Dialium* etc. which may be apotracheal, and sometimes in uniseriate to biseriate lines, e.g. *Pterocarpus*, *Dalbergia*, etc. But in the present fossil wood the paratracheal parenchyma is unilaterally vasicentric, as well as completely surrounding the vessels, which extends beyond several rays into fine lines ending abruptly. Moreover, in most of the leguminous woods the vested pits are present, whereas in the present fossil the pits are nonvested.

Among the other dicotyledonous woods these features are found only in *Holoptelea* of the family *Ulmaceae*. So, further comparison of the fossil wood was made with

the thin sections of the woods of *Holoptelea*, viz., *Holoptelea integrifolia* Planch. and *H. grandis* Milbr. Of these, the former is more closer to the present fossil wood than the latter. However, *H. grandis* slightly differs in having paratracheal parenchyma less abundant.

As far as the author is aware this is the first record of the fossil wood resembling *Holoptelea*, hence, it is placed under a new genus *Holopteleoxylon* and named *Holopteleoxylon indicum* sp. nov.

GENERIC DIAGNOSIS

Holopteleoxylon gen. nov.

Wood diffuse-porous. Growth rings present, delimited by narrow and darker zone of thick-walled fibres and terminal parenchyma. Vessels small to large, solitary and in radial multiples of 2-4; perforations simple; vessel-members storied, intervessel pits large, alternate. Parenchyma paratracheal, unilaterally vascentric to aliform, aliform-confluent or in confluent lines or thin bands; thin narrow lines often occurring towards outer margin of rings; strands storied. Xylem rays 1-4 seriate, homocellular to weakly heterocellular, consisting of procumbent cells and occasionally single marginal row of square cells, medium in height, storied. Fibres moderately thick-walled, nonseptate. Ripple marks present due to storied arrangement of all elements.

Genotype — *Holopteleoxylon indicum* sp. nov.

SPECIFIC DIAGNOSIS

Holopteleoxylon indicum sp. nov.

Vessels small to large, mostly medium, t.d. 80-260 μ , r.d. 40-220 μ , solitary and in radial multiples of 2-4, mostly 2-3, rarely up to 7, evenly distributed, perforations simple, vessel-members nearly truncate, short, 180-375 μ in length, storied; intervessel pits large, 8-12 μ in diameter, alternate, bordered, with circular aperture. Parenchyma paratracheal, vascentric, mostly vascentric, aliform to fine aliform-confluent lines or bands, sometimes unilaterally paratracheal, forming incomplete sheath

around the vessels, thin or narrow parenchyma lines often present towards the outer margin of rings; strands storied. Xylem rays 1-4 (mostly 3) seriate, mostly 12-14 cells in height, rays homocellular to weakly heterocellular, consisting of procumbent cells and rarely single marginal row of square cells, storied. Fibres moderately thick-walled, nonseptate. Ripple marks present due to storied arrangement of vessel-members, parenchyma strands and xylem rays.

Holotype — B.S.I.P. Museum no. 35227.

Locality — Murattandichavadi, near Pondicherry.

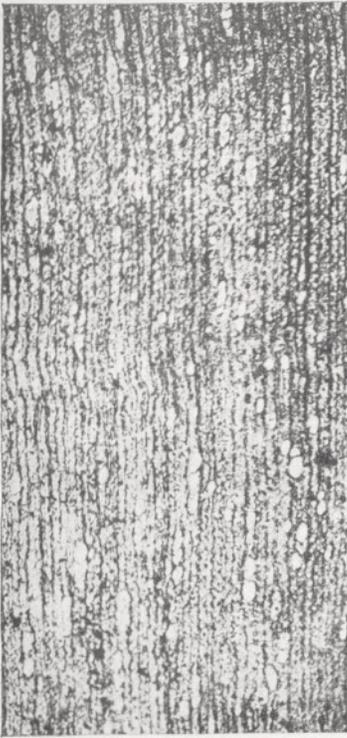
Horizon — Cuddalore Series.

Age — Miocene-Pliocene.

DISCUSSION

The genus *Chrysophyllum* consists of about 150 species (Willis, 1973, p. 251), distributed throughout the tropical parts of the world especially in America. *Chrysophyllum roxburghii* G. Don, the nearest modern equivalent of the present fossil wood, is a large evergreen tree, found in the evergreen forests of Assam, the Khasi Hills, Sylhet, the Western Ghats and Sri Lanka (Gamble, 1902, p. 443). In the West coast tropical evergreen forests, it is found in the Eastern Kanara, Mysore in association with *Dipterocarpus indicus*, *Calophyllum elatum*, *C. wightianum*, *Hopea wightiana*, *Holigarna arnottiana*, *H. grahmii*, *Olea dioica*, *Lophopetalum wightianum*, *Polyalthia coffeoides*, *Machilus macrantha*, *Mangifera indica*, *Aglaia roxburghiana*, *Euphorbia longana*, *Aprosa lindleyana*, *Lansium anamalayanum*, *Nothopogia colebrookiana*, *Litsea* spp., *Pouteria tomentosa*, *Flacourtea montana*, *Caryota urens* and *Areca* (Champion & Seth, 1968, p. 68).

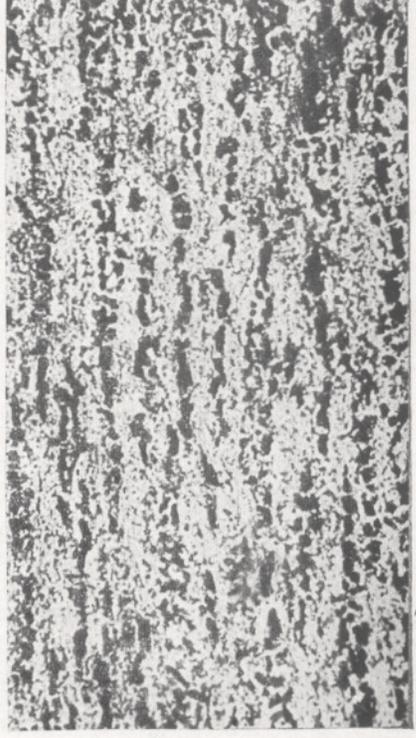
The genus *Holoptelea* consists of only 2 species (Willis, l.c., p. 565), occurring in tropical Africa and Indo-Malayan region. *Holoptelea integrifolia* Planch. is found throughout the greater part of India, except in the higher hills, Eastern Himalaya and Assam, usually in deciduous forests. In South India it grows in West coast semi-evergreen forests of Wynaad, Palghat and Trivandrum, Kerala in different associations. The chief or the common elements of the associations are *Artocarpus hirsuta*, *Hopea parviflora*, *Vitex altissima*, *Tetrameles nudiflora*, *Mesua ferrea*, *Terminalia tomentosa*,



1



2



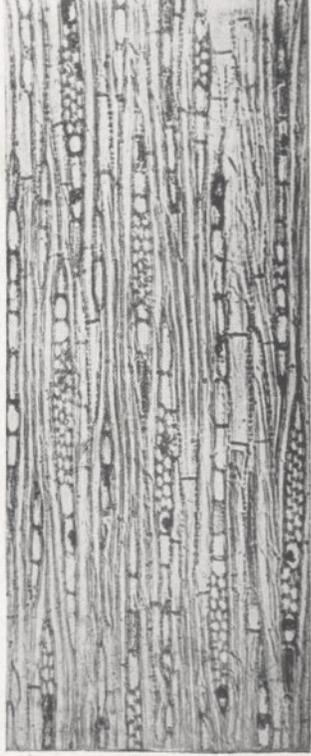
3



6



5



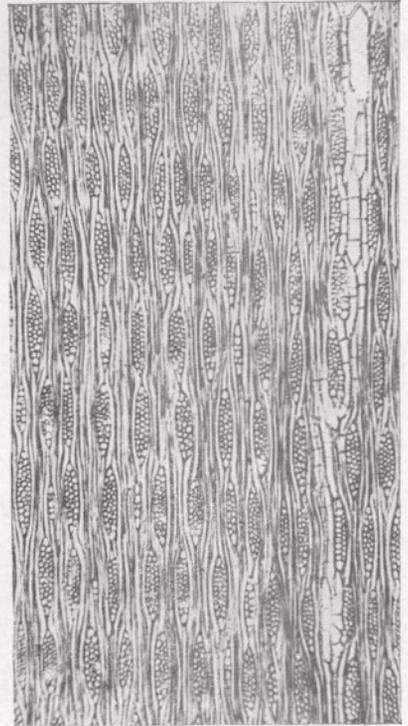
4



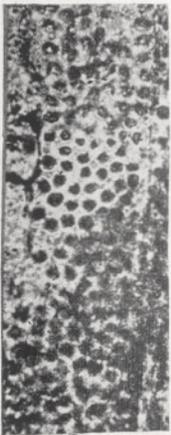
7



9



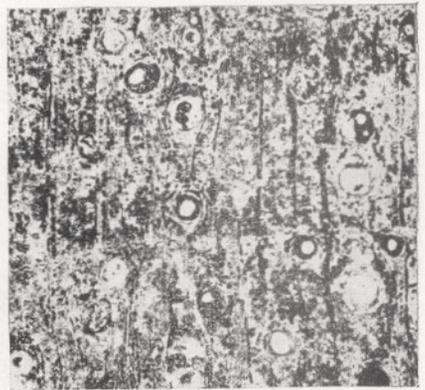
10



8



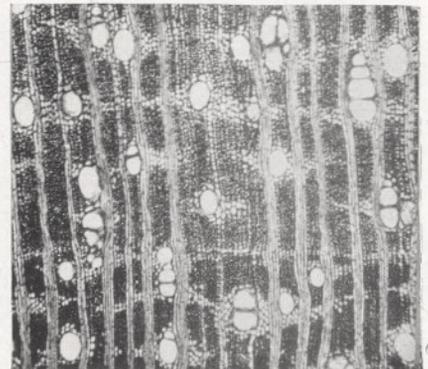
12



13



11



14

Sterculia guttata, *Vateria indica*, *Calophyllum elatum*, *Lagerstroemia lanceolata*, *Mallotus philippinensis*, *Grewia tiliaefolia*, *Pterocarpus marsupium* (Champion & Seth, 1968, p. 86).

A number of genera representing the above associations in which *Chrysophyllum roxburghii* and *Holoptelea integrifolia* are also present, have been found in the Cuddalore Sandstones near Pondicherry, viz., *Dipterocarpus*, *Calophyllum*, *Mangifera*, *Terminalia*, *Mesua*, (Awasthi, 1973), *Hopea* and *Sterculia* (Awasthi, unpublished). This obviously suggests that during the Miocene-Pliocene epoch similar associations of plants

might have also existed along the Eastern coast of South India, under somewhat similar climatic conditions prevailing today in Eastern Kanara, Wynaad, Palghat and Trivandrum, in the Western coast of South India.

ACKNOWLEDGEMENT

The author is grateful to the authorities of the Forest Research Institute, Dehra Dun for facilities to consult the xylarium of their Institute.

REFERENCES

- AWASTHI, N. (1974). Neogene Angiospermous woods: pp. 341-358 in Surange, K. R., Lakhanpal, R. N. & Bharadwaj, D. C. (editors). *Aspects and Appraisal of Indian Palaeobotany*, Lucknow.
- CHAMPION, H. G. & SETH, S. K. (1968). *A revised survey of the forest types of India*. Delhi.
- DESCH, H. E. (1954). *Manual of Malayan timbers*. II. *Malay Forest Rec.* 15: 1-388.
- GAMBLE, J. S. (1902). *Manual of Indian timbers*. Sampson Low Marston & Company, London.
- HENDERSON, F. Y. (1953). An atlas of end-grain photomicrographs for the identification of hard woods. *Bull. For. Prod. Rec. Lond.* 26: 1-87.
- KRIBS, D. A. (1959). *Commercial foreign woods on the American market*. Pennsylvania.
- METCALFE, C. R. & CHALK, L. (1950). *Anatomy of the dicotyledons*. 1 & 2. Oxford.
- MOLL, J. W. & JANSSONIUS, H. H. (1920). *Mikrographie des holzes der auf Java Vorkommenden Baumarten*. 4. Leiden.
- NORMAND, D. (1960). *Atlas des bois de la Cote d'Ivoire*. 3. Nogent-sur-Marne.
- PEARSON, R. S. & BROWN, H. P. (1932). *Commercial timbers of India*. 1 & 2. Oxford.
- WILLIS, J. C. (1973). *A dictionary of the flowering plants and ferns*. Cambridge.

EXPLANATION OF PLATES

PLATE 1

Chrysophylloxylon pondicherriense gen. et sp. nov.

1. Cross section through the central region showing type and distribution of vessels. $\times 12$. (Note the vessels are smaller in size). B.S.I.P. Museum slide no. 5002.

2. Cross section through the peripheral region showing vessels bigger in size than those of central region shown in fig. 1. $\times 12$. B.S.I.P. Museum slide no. 5002.

3. Tangential longitudinal section showing xylem rays. $\times 80$. B.S.I.P. Museum slide no. 5003.

L. Chrysophyllum roxburghii

4. Tangential longitudinal section showing similar type of rays as in fossil shown in fig. 3. $\times 80$.

5. Cross section magnified to show multiple vessels and uniseriate lines of parenchyma. $\times 45$.

Chrysophylloxylon pondicherriense gen. et sp. nov.

6. Cross section showing vessels and parenchyma similar in nature and distribution to those of living shown in fig. 5. $\times 45$. B.S.I.P. Museum slide no. 5004.

PLATE 2

Chrysophylloxylon pondicherriense gen. et sp. nov.

7. Radial longitudinal section showing xylem rays. $\times 100$. B.S.I.P. Museum slide no. 5005.

8. Intervessel pits. $\times 400$. B.S.I.P. Museum slide no. 5006.

Holopteleoxylon indicum gen. et sp. nov.

9. Tangential longitudinal section showing storied xylem rays. $\times 45$. B.S.I.P. Museum slide no. 5007.

Holoptelea integrifolia Planch.

10. Tangential longitudinal section showing similar storied xylem rays as in fossil shown in fig. 9. $\times 45$. B.S.I.P. Xylarium no. 449.

Holopteleoxylon indicum gen. et sp. nov.

11. Intervessel pits. $\times 220$. B.S.I.P. Museum slide no. 5007.

12. Cross section showing nature and distribution of vessels, parenchyma and growth ring. $\times 30$. B.S.I.P. Museum slide no. 5008.

13. Another cross-section showing growth ring. $\times 30$. B.S.I.P. Museum slide no. 5009.

Holoptelea integrifolia Planch.

14. Cross section showing similar nature and distribution of vessels parenchyma and the growth ring as present in fossil. $\times 30$. B.S.I.P. Xylarium no. 449.