FOSSIL WOODS OF *GREWIA* FROM THE DECCAN INTERTRAPPEAN SERIES, INDIA

U. PRAKASH & R. DAYAL
Birbal Sahni Institute of Palaeobotany, Lucknow

ABSTRACT

The present paper describes in detail the anatomy of two fossil dicotyledonous woods, viz., *Grewioxylon mahurzariense* Prakash aud Dayal (1963a) and *Grewioxylon indicum* sp. nov. from the Deccan Intertrappean beds of Mahurzari (21° 13′ N; 79° 1′ E), district Nagpur, Maharashtra. This is the first authentic record of the genus *Grewia* Linn. as petrified wood from India and abroad.

INTRODUCTION

THE silicified woods thus far described from the Deccan Intertrappean beds represent a small fraction of an extensive collection made by us. The present investigation is a continuation of the systematic study of this collection. In the present paper we are concerned with the identification and description of two species of petrified woods collected from the fossiliferous locality of Mahurzari (21° 13′ N; 79° 1′ E), about 8 miles northwest of Nagpur in Maharashtra. These woods resemble the wood structure of the modern genus *Grewia* Linn. of Tiliaceae.

Although petrified woods occur in great abundance in this locality, the number of dicotyledonous woods, so far described in detail is comparatively less (PRAKASH, 1958, 1962; SHALLOM, 1958, 1959, 1960). Quite recently fossil woods resembling the modern genera *Elaeocarpus* Linn. and *Leea* Linn. (PRAKASH & DAYAL, 1963b) and *Grewia* (SHALLOM, 1963) have also been identified. The present investigation adds further to our knowledge of the fossil flora of this locality.

DESCRIPTION

FAMILY — TILIACEAE

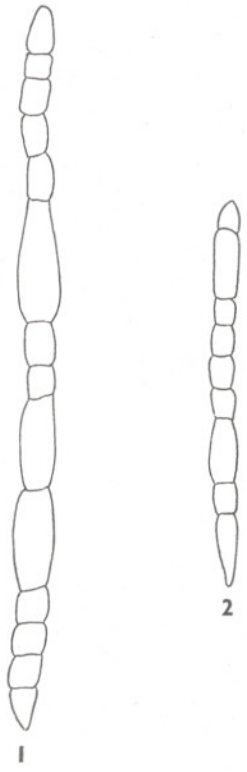
Genus — *Grewioxylon* (Schuster) Emended

1. *Grewioxylon mahurzariense* Prakash and Dayal (1963a)

(Pl. 1, Figs. 1-5; Text-fig. 1)

The present species is based on a piece of petrified secondary xylem measuring about 5 cm. in length and 3 cm. in diameter. The general appearance of the fossil suggests that it is neither close to the pith nor to the periphery. The preservation of the fossil is excellent.

TOPOGRAPHY: *Wood* diffuse-porous (PL. 1, FIG. 1). *Growth rings* present, delimited by narrow lines of terminal parenchyma (PL. 1, FIG. 1). *Vessels* appearing as dots with the naked eye, their orifices clearly visible with a hand lens, small to medium-sized, solitary and in radial multiples of 2-4 or sometimes more cells, occasionally in short double rows and tangential groups or clusters of 3-5 or more (PL. 1, FIGS. 1, 2), somewhat unevenly distributed, with the smaller vessels more numerous and somewhat crowded near the growth ring while the bigger vessels slightly apart in the median portion of the ring (PL. 1, FIG. 1), 5-15 per sq. mm.; tyloses wanting. *Parenchyma* paratracheal and terminal; paratracheal parenchyma occurring as narrow, 1-2 or 3 cells thick vasicentric sheath round the pores (PL. 1, FIG. 2); terminal parenchyma forming well-defined narrow lines delimiting the growth rings (PL. 1, FIG. 1); parenchyma irregularly storied. *Xylem rays* visible with the naked eye on the cross and tangential longitudinal sections of the wood, fine to broad, normally 1-12 cells and 30-360 μ wide, 4-7 per mm.; ray tissue markedly heterogeneous (PL. 1, FIGS. 3, 4); rays divisible on the basis of size and composition into two types, (a) narrow rays 1-2 seriate, 30-45 μ wide and 150-750 μ high, heterocellular, consisting of both procumbent and upright cells (PL. 1, FIG. 4; TEXT-FIG. 1), showing at some places a tendency towards storied arrangement; (b) broader rays 3-12 seriate, 90-360 μ broad and up to 4 mm. high, heterocellular, consisting of large (colourless) tile-cells of the *Pterospermum* type, interspersed with clusters of smaller procumbent cells with dark contents (PL. 1, FIGS. 3, 4); rays often showing various stages of dissection into smaller units (PL. 1, FIG. 4); some of the rays with vascular strands very broad. *Fibres* aligned



TEXT-FIGS. 1-2 — 1. *Grewioxylon mahurzariense* Prakash and Dayal. Uniseriate xylem ray consisting of both procumbent and upright cells. × 215. 2. *Grewioxylon indicum* sp. nov., uniseriate xylem ray consisting of both procumbent and upright cells. × 215.

in radial rows between the two consecutive rays (PL. 1, FIGS. 1, 2); median portion irregularly storied. *Ripple* marks present, indistinct.

ELEMENTS — *Vessels* thin-walled, t.d. 60-180 μ, r.d. 60-150 μ, often circular when solitary, those in radial multiples flattened at the places of contact; vessel-members usually short, 285-450 μ long with tapered ends (PL. 1, FIG. 4); perforations simple; intervessel pit-pairs small to medium-sized, 5-6 μ in diameter, alternate, bordered with lenticular, sometimes coalescent apertures (PL. 1, FIG. 5); vessel-ray and vessel-parenchyma pitting not observed. *Parenchyma cells* thin-walled, t.d. 24-52 μ, height 32 to 68 μ, strands of upto 7 cells. *Ray cells* thin-walled; procumbent cells circular to oval as seen in tangential longitudinal sections, distinct due to their dark contents, small in size, t.d. 12-18 μ, vertical height 14-32 μ, radial length 24-104 μ; tile-cells larger than the procumbent cells, polygonal as seen in tangential longitudinal sections, without any dark infiltration, vertical height 40-70 μ, radial length 16-38 μ; marginal upright cells t.d. 20-32 μ, r.d. 20-48 μ. *Fibres* thin to moderately thick-walled, non-septate, polygonal in cross-section, t.d. 16-28 μ, r.d. 16-32 μ; interfibre pits not observed.

AFFINITIES AND DISCUSSION

Of all the anatomical features exhibited by the present Intertrappean fossil wood, the presence of tile-cells in the xylem rays is of considerable diagnostic value. Chattaway (1933), as a result of her extensive studies on the woods of a large number of genera, came to the conclusion that this type of ray cells are confined only to some genera of the Bombacaceae, Sterculiaceae and Tiliaceae. She distinguished two extreme forms of tile-cells, viz., the *Durio* and the *Pterospermum* types. In the *Durio* type, " the tile-cells are a conspicuous feature of the transverse and radial sections of the wood, but they are not always distinguishable on the tangential section. The tile-cells are no wider tangentially than the procumbent cells, but are much narrower radially, and about 10-14 correspond to one procumbent cell. On the radial section the narrower diameter of the cells is very clearly marked". On the other hand in the *Pterospermum* type the tile-cells " can be recognised on all sections, but on the transverse section the tile-cells do not form a conspicuous feature of the wood, and they might pass for ordinary marginal ray cells if only that section were considered. On the tangential section the rays are seen to consist of large angular cells which are devoid of contents, interspersed with clusters of smaller cells with dark contents. The large cells are the tile-cells and the small cells are the procumbent cells of the ray. This is more clearly seen on the radial section, where the proportions of the cells can be made out. The procumbent cells are usually about half as high vertically as the tile-cells and about four to six times as long. The absence of contents, a characteristic feature of all tile-cells, adds to their distinctness, and they stand out sharply from the darker procumbent cells".

Following is the list of genera which Chattaway (1933) placed in the *Durio* and *Pterospermum* types:

Durio Type

Bombacaceae — *Durio, Cullenia, Neesia, Boschia* and *Coelostegia.*
Sterculiaceae — *Guazuma, Kleinhovia, Leptonychia, Reevesia, Scaphopetalum* and *Triplochiton.*
Tiliaceae — *Columbia, Luehea* and *Grewia* (in part).

Pterospermum Type

Bombacaceae — *Hampea* and *Ochroma.*
Sterculiaceae — *Pterospermum.*
Tiliaceae — *Belotia, Duboscia* and *Grewia* (in part).

According to her (CHATTAWAY, loc. cit.) the division of these two types is only an arbitrary one. There is a complete sequence of intermediate forms and both the *Durio* and the *Pterospermum* types may be found in the same genus. For example, in *Grewia microcos* Linn. (*Microcos paniculata* Linn.) the tile-cells are of *Durio* type; in *G. rolfei* Merrill, *G. populifolia* (WARB.) Vahl and *G. multiflora* Juss. they are like *Pterospermum* type; while *G. stylocarpa* Warb. (*Microcos stylocarpa* (Warb.) Burret) is a borderline type, and might be included in either. Also *Guazuma* and *Reevesia* are two intermediate forms, in both of which the tile-cells are like those in *Pterospermum* type when seen on the tangential section.

It is appropriate to mention here that Chattaway (1934) on the basis of her anatomical investigation supported Burret's observations that the two genera, *Grewia* Linn. and *Microcos* Linn. are distinct and can also be distinguished from each other anatomically.

A survey of all the modern woody genera characterized by the presence of tile-cells, indicates that the closest resemblance of the present fossil wood is with that of the modern wood of *Grewia* Linn. Detailed microscopic examination of the various species of *Grewia* was made in order to find out the nearest living representative of the present Intertrappean wood. Consequently thin sections of a number of species of *Grewia*, such as *Grewia microcos* Linn. (*Microcos paniculata* Linn.), *G. pilosa* Lam. (*G. flavescens* Juss.), *G. populifolia* Vahl (*G. tenax* (Forsk.) Asch. & Schwf.), *G. orbiculata* Rottler, *G. elastica* Royle, *G. laevigata* Vahl (*G. glabra* Bl.), *G. oppositifolia* Roxb. (*G. optiva* Drumm), and *G. tiliaefolia* Vahl were examined. In addition published descriptions and figures of *G. piscatorum* Hance (KANEHIRA, 1921, p. 50), *G. stylocarpa* Warb. (KANEHIRA, 1924, p. 14, PL. 1, FIG. 4), *G. mollis* Juss. (METCALFE & CHALK, 1950, p. 256, FIG. 63 E), *G. celtidifolia* Juss., *G. excelsa* Vahl, *G. eriocarpa* Juss., *G. laevigata* Vahl var. *oblongifolia* Koord. et Valet. (MOLL & JANSSONIUS, 1906, pp. 497-517, FIG. 66) and *G. rolfei* Merrill (REYES, 1938, p. 233, PL. 40, FIG. 1) were also available for comparison. An examination of all the available data reveals that there is a close agreement in almost all the anatomical details of the fossil wood with that of *Grewia laevigata* Vahl.

The present fossil wood resembles the modern wood of *G. laevigata* in shape, size and distributional pattern of the vessels, in the type of perforation plates, in the nature of intervascular pitting, in parenchyma distribution and the fibre and ray structure with similar type of tile-cells. However, *G. laevigata* differs from the fossil in having less broad rays and in somewhat bigger size of the fibres as seen in the cross-section. Besides this the fibres in *G. laevigata* are not graded like those of the present fossil wood but form small patches of smaller fibres in the early wood.

The present wood is the first authentic record of the fossil wood of *Grewia* from India and abroad. Although in 1910, Schuster described a fossil, indicating its resemblance with the modern wood of *Grewia laevigata* Vahl; it was subsequently shown to belong to Dipterocarpaceae and was transferred to *Dipterocarpoxylon* as *Dipterocarpoxylon swedenborgii* by Kräusel (1922). On further examination Schweitzer (1958) changed it to *Shoreoxylon swedenborgii.* As the description given by Schuster (1910) does not properly diagnose the fossil wood of *Grewia*, an emended diagnosis for the genus *Grewioxylon* Schuster is being given in the following pages. The present fossil wood has been described as *Grewioxylon mahurzariense.* The specific epithet is after the name of its locality.

Recently Shallom (1963) has described a fossil wood resembling that of *Grewia* from the Deccan Intertrappean beds of Mahurzari. She has assigned it to a new genus, *Grewioxylon* Shallom. This is incorrect since the name *Grewioxylon* was already instituted by Schuster (1910) for a fossil wood resembling that of *Grewia laevigata.* It seems that Shallom

was unaware of Schuster's publication, since there is no mention of this in her paper. On grounds of priority Shallom has no claim to the genus *Grewioxylon* and therefore the wood described by her (SHALLOM, loc. cit.) is merely a new species of *Grewioxylon*, viz. *Grewioxylon intertrappeaum*.* As described by Shallom it differs from the present fossil wood in the absence of terminal parenchyma and in having diffuse parenchyma in addition to the vasicentric type, otherwise her fossil wood appears to be almost similar to that of *Grewioxylon mahurzariense* described and published earlier.

Two more fossil woods of Tiliaceae are known under the genus *Tilioxylon* Hofmann (1929). These are *Tilioxylon* sp. Hofmann (1929) from the Pliocene (or Pleistocene) of Hungary (Csadberge) and *Tilioxylon* sp. Hofmann (1952) from the Oligocene of Austria. These fossil woods have been attributed to the modern genus *Tilia* (Tourn.) Linn. and thus differ markedly from the present fossil wood. Besides the present fossil wood, fossil leaves resembling those of *Grewia* have been described by Lakhanpal (1954) from the Tertiary of Assam.

The genus *Grewia* is confined to the tropical and sub-tropical regions of the Old World, namely tropical Africa, Madagascar, Arabia, India, Burma, Ceylon, Andamans and Nicobars, Malayan Peninsula and East Indies (Java, Sumatra, Borneo, Philippine islands and Formosa), Siam, Indo- and Chochin-China, Pacific islands and north Australia. It is absent from the New World. At present, of all the countries, Africa has the largest number of living species of *Grewia*. About 42 species are represented in the modern flora of India (NARAYANASWAMI & SESHAGIRI RAO, 1950).

The species *Grewia laevigata* Vahl, with which the fossil shows its nearest resemblance, is a small to medium-sized tree upto 14 m. in height and about a metre in girth. It is found in the outer Himalayas from the Jumna eastwards to Bengal, in Chittagong, Assam, central and southern India, the Andamans and Burma, ascending up to 900 m. (CHOWDHURY & GHOSH, 1958, p. 232). It is also common in the vicinity of streams in the Santal Parganas and along seashores in the Andamans (PEARSON & BROWN, 1932, p. 178).

*Originally spelt as *Grewioxylon intertrappea* by Shallom (1963).

EMENDED GENERIC DIAGNOSIS

Grewioxylon (Schuster) Prakash and Dayal

Growth rings present, delimited by terminal parenchyma. *Vessels* small to medium-sized, solitary and in radial multiples of 2-4 or sometimes more cells, somewhat unevenly distributed; vessel-members short; perforations simple; intervessel pit-pairs bordered, alternate. *Parenchyma* paratracheal and terminal. *Xylem rays* fine to broad, generally divisible on the basis of size and composition into two types; the narrow rays storied with other longitudinal elements; multiseriate rays consisting of tile-cel's; ray tissue markedly heterogeneous. *Fibres* forming extensive tracts between vessels and rays, thin to moderately thick-walled, the median portion storied with other elements.

Genotype — *Grewioxylon mahurzariense* Prakash and Dayal.

SPECIFIC DIAGNOSIS

Grewioxylon mahurzariense Prakash and Dayal

Wood diffuse-porous. *Growth rings* distinct, delimited by narrow lines of terminal parenchyma. *Vessels* small to medium-sized, t.d. 60-180 μ, r.d. 60-150 μ, solitary and in radial multiples of 2-4 or sometimes more cells, occasionally in short double rows and tangential groups or clusters of 3-5 or more, 5-15 per sq. mm.; vessel-members short, with tapered ends; perforations simple; intervessel pit-pairs small to medium-sized, 5-6 μ in diameter, bordered, alternate with lenticular, sometimes coalescent apertures. *Parenchyma* paratracheal and terminal; paratracheal parenchyma as narrow 1-2 or 3 cells thick vasicentric sheath round the vessels; terminal parenchyma forming a well-defined narrow line at the growth rings; parenchyma irregularly storied. *Xylem rays* 1-12 cells broad and up to 4 mm. high; narrow rays heterocc'lu'ar, consisting of both procumbent and upright cells, showing a tendency towards storied arrangement; broader rays consisting of large (colourless) tile-cells of the *Pterospermum* type, interspersed with clusters of smaller procumbent cells (with dark contents). *Fibres* thin to moderately thick-walled, nonseptate; median portion

irregularly storied. *Ripple marks* present, indistinct.

Holotype — B.S.I.P. Museum No. 32777.

Locality — Mahurzari, Nagpur district, Maharashtra.

Horizon — Deccan Intertrappean Series.

Age — Early Tertiary (probably Eocene).

2. *Grewioxylon indicum* sp. nov.

(Pls. 1, 2, Figs. 6-13; Text-fig. 2)

The following description is based on a fairly well preserved petrified wood consisting of primary and secondary xylem. Before cutting, it measured about 12 cm. in length and 8-8·5 cm. in diameter. It appears to be a portion from a small branch of a tree or the main stem of a large shrub. It is light brown on the outside and black with greyish patches on the cut surface.

The present fossil, although a small piece of wood, shows a good deal of variation in its anatomical characters from the centre to the periphery. This forms one of the important aspects of wood identification, a knowledge of which would help us to understand the variable characters met with in the wood of a plant. It would also check us from making new species of fossil woods from the petrified pieces derived from the same species or even from different portions of a single tree.

TOPOGRAPHY — *Wood* diffuse-porous (PL. 2, FIG. 8). *Pith* not preserved. *Primary xylem* present, number of primary xylem groups not very clear. *Growth rings* present, not discernible in the block but visible in cross-section, delimited by terminal parenchyma and often also by somewhat smaller fibre elements (PL. 1, FIG. 7). *Vessels* indistinct to the naked eye, their orifices easily distinguished with a hand lens, showing variation in size and distribution from the centre to the periphery, being small to very small and few near the pith region (PL. 2, FIG. 9) and small to medium-sized and comparatively more towards the periphery (PL. 2, FIG. 8), 4-12 per sq. mm., with or without infiltration, usually contiguous to xylem rays on one or both the sides; tyloses wanting. *Parenchyma* paratracheal, terminal and diffuse; paratracheal parenchyma forming a narrow sheath round the vessels and appearing as darker tissue in the cross-section (PL. 2, FIGS. 8-9), occasionally with short lateral extensions; terminal parenchyma in narrow, mostly continuous, 2-3 seriate lines (PL. 1, FIG. 7); diffuse parenparenchyma occurs as single cells or short uniseriate lines joining two adjacent rays; parenchyma occasionally with a tendency towards storied arrangement. *Xylem rays* visible with the naked eye or a hand lens on the cross-surface of the wood, fine to broad, 1-7 seriate, showing variation from near the pith to the periphery, being fine, 1-2 seriate near the pith region and both fine and broad, upto 7-seriate towards the periphery (PL. 2, FIGS. 8, 9, 11, 12), 7-12 per mm.; ray tissue markedly heterogeneous (PL. 2, FIGS. 10, 13); rays divisible on the basis of size and composition into two types, (a) uniseriate rays 12-24 μ wide, 5-12 or more cells and 132-320 μ high, heterocellular, consisting of both procumbent and upright cells (PL. 2, FIG. 11; TEXT-FIG. 2); (b) multiseriate rays 2-7 (mostly 3-5) seriate, heterocellular, with upto 4 or 5 marginal rows of upright cells at one or both the ends, upto 2 mm. high, median portion 45-150 μ wide, consisting of large tile-cells of the *Pterospermum* type (PL. 2, FIG. 13), interspersed among the smaller procumbent cells (PL. 2, FIG. 13); rays commonly showing various stages of dissection into smaller units; end to end ray fusion rare. *Fibres* forming an appreciable part of the wood, aligned in distinct radial rows (PL. 2, FIG. 8), nicely preserved only at some places where the secondary walls can be seen; irregularly storied.

ELEMENTS — *Vessels* thin-walled, t.d. 45-105 μ, r.d. 60-90 μ towards the periphery; t.d. 45-60 μ, r.d. 45-75 μ near the pith region; circular to oval when solitary, those in radial multiples flattened at the places of contact; vessel-members usually short, 225-405 μ long with truncate or sometimes with tapered ends; perforations simple; intervessel pit-pairs small to medium-sized, 4-6 μ in diameter, alternate, bordered with usually linear, often coalescent apertures and inconspicuous borders (PL. 1, FIG. 6); vessel-ray and vessel-parenchyma pits not observed. *Parenchyma strands* 2-8 (usually 4-8) celled, cells thin-walled, t.d. 28 μ, height 64-96 μ. *Ray cells* thin-walled; procumbent cells circular or sometimes slightly angular in the tangential longitudinal sections, distinct due to their dark contents, small in size, t.d., 8-16 μ, vertical height 16-28 μ, radial length 28-100 μ; tile-cells larger than the procumbent cells, angular in the tangential longitudinal sections, without contents, vertical

height 40-60 μ, radial length 16-36 μ; marginal upright cells t.d. 16-28 μ, r.d. 24-52 μ. *Fibres* thin to moderately thick-walled with large lumina, the walls about 8 μ thick, non-septate, polygonal in the cross-section, t.d. 32-40 μ, r.d. 20-32 μ, without any infiltration; interfibre pits not observed.

SPECIFIC DIAGNOSIS

Grewioxylon indicum sp. nov.

Wood diffuse-porous. *Growth rings* present, delimited by terminal parenchyma and often also by somewhat smaller fibre elements. *Vessels* small to very small and medium-sized, solitary and in radial multiples of 2-3 or 4 cells, t.d. 45-105 μ, r.d. 45-90 μ; vessel-members usually short; perforations simple; intervessel pit-pairs small to medium-sized, 4-6 μ in diameter, alternate, bordered with usually linear, often coalescent apertures and inconspicuous borders. *Parenchyma* paratracheal, terminal and diffuse; parenchyma strands usually 4-8 celled, occasional tendency towards storied arrangement. *Xylem rays* fine to broad, 1-7 cells or 12-150 μ wide, divisible on the basis of size and composition into two types, (a) the uniseriates heterocellular, consisting of procumbent and upright cells; (b) the multiseriates 2-7 (mostly 3-5) seriate, heterocellular, 45-150 μ wide and upto 2 mm. high, consisting of large tile-cells of the *Pterospermum* type and clusters of smaller procumbent cells; ray tissue markedly heterogeneous; rays showing various stages of dissection into smaller units. *Fibres* thin to moderately thick-walled, non-septate, irregularly storied.

Holotype — B.S.I.P. Museum No. 32789.

Locality — Mahurzari, Nagpur district, Maharashtra.

Horizon — Deccan Intertrappean Series.

Age — Early Tertiary (probably Eocene).

AFFINITIES AND DISCUSSION

The most important anatomical features exhibited by the fossil wood are (1) vessels usually moderately small, solitary and in radial multiples of 2-4 cells, (2) simple perforations, (3) paratracheal, terminal and diffuse parenchyma, (4) 1-7 seriate xylem rays with *Pterospermum* type of tile-cells, and (5) moderately thick-walled, non-septate and irregularly storied fibres. Considering all these features collectively, the present fossil shows striking similarities with the woods of the modern genus *Grewia*. Hence, it is also placed under the genus *Grewioxylon* (Schuster) Prakash and Dayal.

Of the various species of *Grewia* studied, the nearest affinity of the present fossil wood is with that of the modern *Grewia tiliaefolia* Vahl, although they are not identical. In the modern wood of *G. tiliaefolia* the fibres in the outer portion of the ring (late wood) are thicker-walled and form darker and denser bands, whereas in the early wood they are thin-walled. This feature has not been observed in the fossil wood. Secondly the range in size of the vessels is also less in the present fossil wood. This can be explained because of the small size of the specimen which might have come from a small branch of a tree. In other structural features the Intertrappean wood shows quite a close resemblance with the wood structure of the species *Grewia tiliaefolia*.

Grewioxylon mahurzariense (Prakash & Dayal, 1963a) now described in detail in the preceding pages, differs from the present fossil wood in having medium-sized to moderately small vessels (t.d. 60-180 μ), in the nature of the parenchyma which is vasicentric without short lateral extensions, and in possessing broad, 1-12 seriate xylem rays, whereas in the present fossil wood the vessels are small (t.d. 45-105 μ), the paratracheal parenchyma occasionally shows short lateral extensions with diffuse parenchyma in addition and the xylem rays are only 1-7 cells wide. Similarly *G. intertrappeaum* (Shallom, 1963) also differs from the present fossil wood in the absence of terminal parenchyma and in having up to 14 or more cells wide xylem rays. Therefore, the present fossil has been described as a new species of *Grewioxylon*, *G. indicum*.

Grewia tiliaefolia Vahl, which is nearest in wood structure to the present fossil wood, is usually a medium-sized tree. It is found in the sub-Himalayan tracts from the Jumna to Nepal, throughout central and southern India ascending upto 1,200 m. It is rather common in the Central Provinces (now called the Madhya Pradesh), and the Western Ghats particularly in Coorg and Wynaad where it reaches its best development (Pearson & Brown, 1932, p. 172; Chowdhury & Ghosh, 1958, pp. 234-235).

It is important to realize that the correct identification and interpretation of fossil dicotyledonous woods largely depends on the state of our knowledge of the woody structures of the modern plants and hence those working on fossil woods are advised to concentrate more on this before placing an isolated specimen of fossil wood in its natural place. At this place it is appropriate to emphasize that there is a considerable range of variation in anatomical characters in different portions of the same tree or trees growing under different environmental conditions and this has to be borne in mind before giving a name whether generic or specific to a fossil wood. The basic problem before us is to determine as correctly as possible the affinities of the remains, and their naming is of secondary importance. The value of a name can be no greater than the accuracy with which the plant is determined.

It is interesting to note that the present fossil, although a small piece of wood, about 12 cm. in length and 8-8·5 cm. in diameter, shows quite a good deal of variation primarily in vessel size and their distribution and the ray structure. Near the pith the vessels are small to very small, few in number and mostly solitary (Pl. 2, Fig. 9), whereas they are small to medium-sized and comparatively more towards the periphery (Pl. 2, Fig. 8), where the vessel multiples are also common. Also the rays are 1-2 seriate near the pith (Pl. 2, Fig. 12), whereas both fine and broad, up to 7-seriate, rays are seen towards the periphery (Pl. 2, Fig. 11). There is also some variation in the amount of parenchyma in both the regions of this wood, but that is not very marked (Pl. 2, Figs. 8, 9).

This would show the variability of anatomical characters found even in the small piece of wood of a plant. If by chance the above piece of fossil wood was broken in such a way as to separate the two parts, one near the pith and the other near the periphery, many workers, unfamiliar to such structural variability, would have described them as two different "species". In this connection it is not an improbable inference to draw that many of the supposedly distinct "species" of fossil woods might have been derived from the same species growing in different environmental conditions or from different portions of a single tree. However, a careful study of the authentic material and vast literature on wood anatomy which has accumulated in the recent years, would help us to identify a fossil wood more precisely giving due regard to the structural variations. In this way we would also be in a sound position to resolve many of the supposedly distinct "species" of fossil woods.

ACKNOWLEDGEMENTS

We are thankful to Shri K. Ramesh Rao, Officer-in-Charge, Wood Anatomy Branch, Forest Research Institute, Dehra Dun, for facilities given to consult the extensive collection of slides and samples of modern woods and for sending us wood samples of a number of species of *Grewia*.

REFERENCES

Chattaway, M. M. (1933). Tile-cells in the rays of the Malvales. *New Phytol.* **32**: 261-273.

Idem (1934). Anatomical evidence that *Grewia* and *Microcos* are distinct genera. *Trop. Woods* **38**: 9-11.

Chowdhury, K. A. & Ghosh, S. S. (1958). Indian woods **1**. *Dehra Dun.*

Hofmann, E. (1929). Verkieselte Hölzer von der Vashegy (Eisenberg) — Gruppe. *Ann. Sabariensis* **3**: 81-87.

Idem (1952). Pflanzenreste aus dem phosphoritvorkommen von Prambachkirchen in Oberösterreich. *Palaeontographica* **92** B: 158-159.

Kanehira, R. (1921). Anatomical characters and identification of Formosan woods. *Taihoku.*

Idem (1924). Identification of Philippine woods by anatomical characters. *Taihoku.*

Kräusel, R. (1922). Fossile Hölzer aus dem Tertiär von Süd-Sumatra. *Verh. Geol. Mijnb. Gen. Nederland en Kol.* **5**: 231-287.

Lakhanpal, R. N. (1954). Recognizable species of Tertiary plants from Damalgiri in the Garo Hills, Assam. *Palaeobotanist* **3**: 27-31.

Metcalfe, C. R. & Chalk, L. (1950). Anatomy of the dicotyledons. **1** & **2**. *Oxford.*

Moll, J. W. & Janssonius, H. H. (1906). Mikrographie des holzes der auf Java vorkommenden Baumarten. **1**. *Leiden.*

Narayanaswami, V. & Seshagiri Rao, R. (1950). A preliminary note on the Indo-Burmese species of *Grewia* Linn. *J. Indian bot. Soc.* **29** (4): 177-190.

Pearson, R. S. & Brown, H. P. (1958). Commercial timbers of India. **1** & **2**. *Calcutta.*

PRAKASH, U. (1958). Studies in the Deccan Intertrappearn Flora-4. Two silicified woods from Madhya Pradesh. *Palaeobotanist* **7** (1): 12-20.

Idem (1962). *Aeschynomene tertiara*, a new fossil wood from the Deccan Intertrappean beds at Mahurzari near Nagpur, India. *Ibid.* **11** (1-2): 1-6.

PRAKASH, U. & DAYAL, R. (1963a). Fossil wood resembling *Grewia* from the Deccan Intertrappean beds of Mahurzari near Nagpur, India. *Curr. Sci.* **32**: 315-316. (Issued Jan. 1963).

Idem (1963b). Fossil woods resembling *Elaeocarpus* and *Leea* from the Deccan Intertrappean beds of Mahurzari, near Nagpur. *Palaeobotanist* **12** (2): 121-127.

REYES, L. J. (1938). Philippine woods. *Tech. Bull. Dep. Agric. Phil. Is.* **7**.

SCHWEITZER, H. J. (1958). Die fossilen Dipterocarpaceen — Hölzer. *Palaeontographica* **105B**: 1-166.

SCHUSTER, J. (1910). Über Nicolien und Nicolien ähnliche Hölzer. *K. svenska Vetensk Akad Handl.* **45** (6): 1-18.

SHALLOM, L. J. (1958). A fossil dicotyledonous wood from the Deccan Intertrappean beds of Mahurzari. *J. Indian bot. Soc.* **37** (2): 492-498.

Idem (1959). *Ailanthoxylon mahurzarii* sp. nov.—new fossil dicotyledonous wood from the Deccan Intertrappean beds of Mahurzari. *Palaeobotanist* **8** (1): 65-68.

Idem (1960). Fossil dicotyledonous wood of Lecythidaceae from the Deccan Intertrappean beds of Mahurzari. *J. Indian bot. Soc.* **39** (2): 198-203.

Idem (1963). A fossil dicotyledonous wood with tile-cells, from the Deccan Intertrappean beds of Mahurzari. *Ibid.* **42** (2): 170-176. (Issued Jan. 1964).

TROUP, R. S. (1921). The silviculture of Indian trees. **2**. *Oxford.*

WILLIS, J. C. (1957). A dictionary of the flowering plants and ferns. *Cambridge.*

EXPLANATION OF PLATES

PLATE 1

Grewioxylon mahurzariense Prakash and Dayal

1. Cross-section showing the shape, size and distribution of the vessels. Note the terminal parenchyma. × 30.

2. Cross-section to show the vasicentric parenchyma round the pores. × 68.

3. Radial longitudinal section showing the tile-cells and the procumbent cells. × 125.

4. Tangential longitudinal section showing the xylem rays. Note the dissection of the rays and the tile-cells. × 30.

5. Intervessel pit-pairs. × 520.

Grewioxylon indicum sp. nov.

6. Intervessel pit-pairs. × 550.

7. A portion of the cross-section showing the terminal parenchyma. × 75.

PLATE 2

Grewioxylon indicum sp. nov.

8. Cross-section showing the shape, size and distribution of the vessels and the paratracheal parenchyma near the periphery of the wood. × 35.

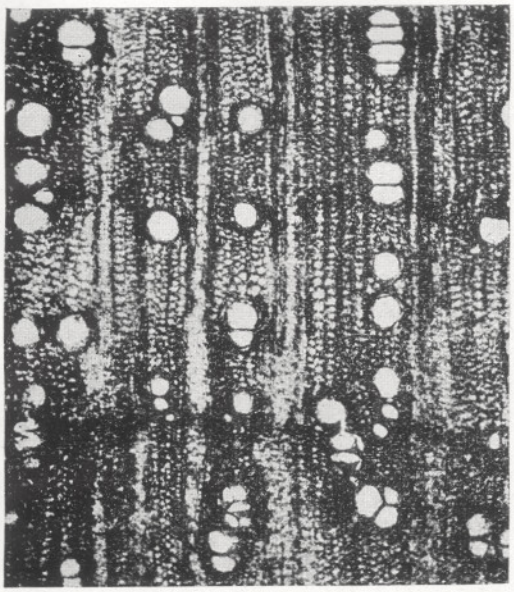
9. Cross-section showing the shape, size and distribution of the vessels near the pith region. × 35.

10. Radial longitudinal section showing the tile-cells and the procumbent cells. × 120.

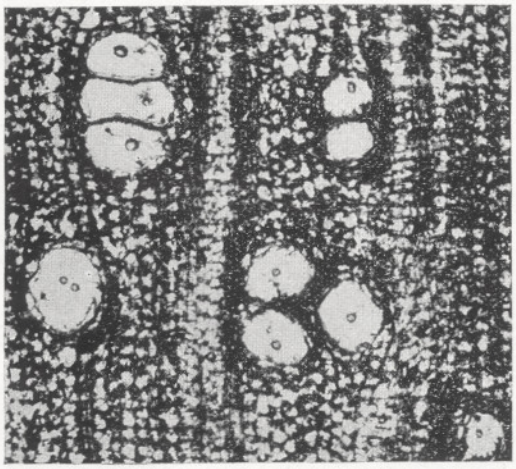
11. Tangential longitudinal section showing fine to broad rays towards the periphery. × 35.

12. Tangential longitudinal section showing fine, 1-2 seriate xylem rays near the pith. × 85.

13. A portion of the xylem ray magnified to show the distribution of tile-cells. × 100.

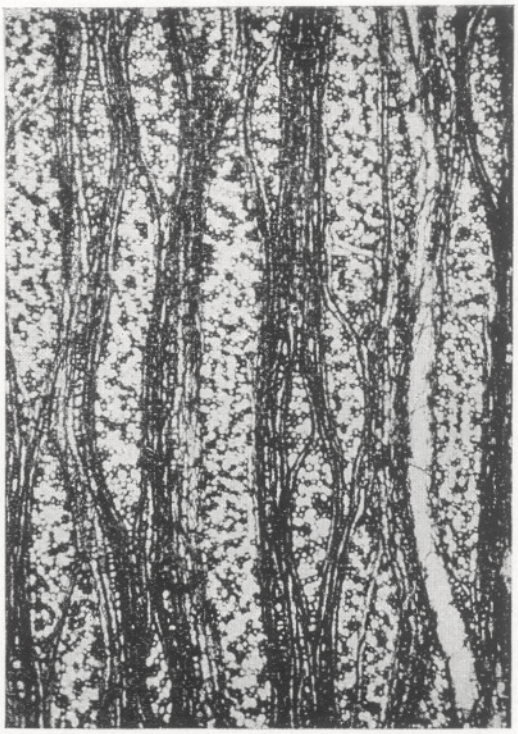


1

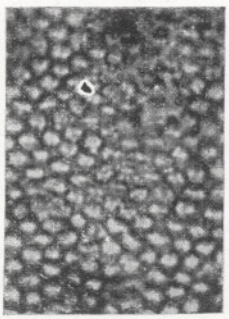


2

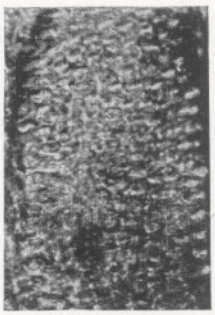
3



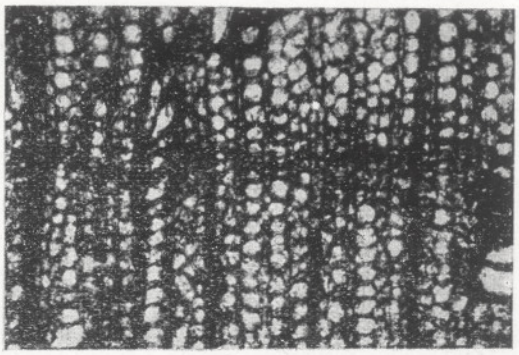
4



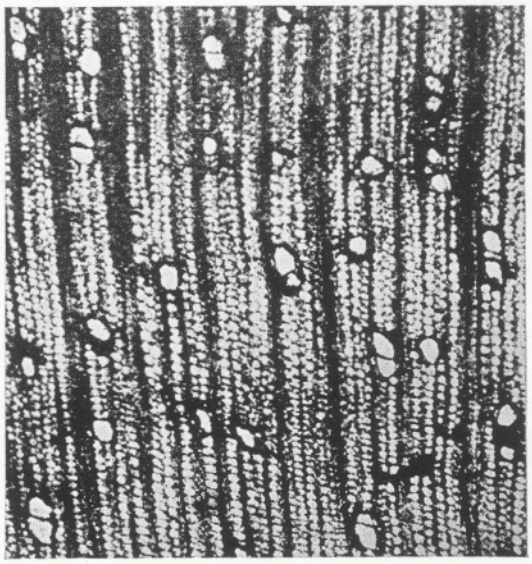
5



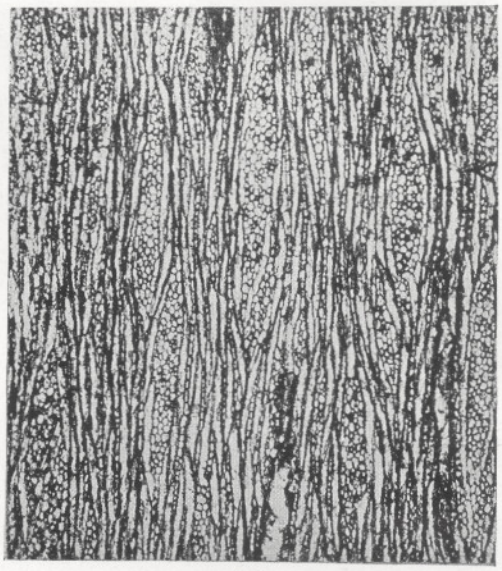
6



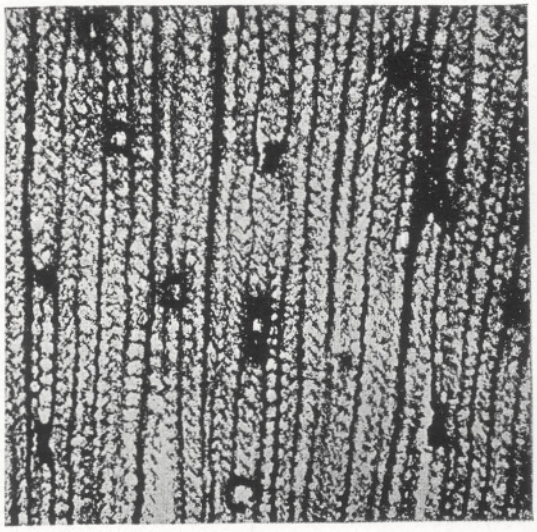
7



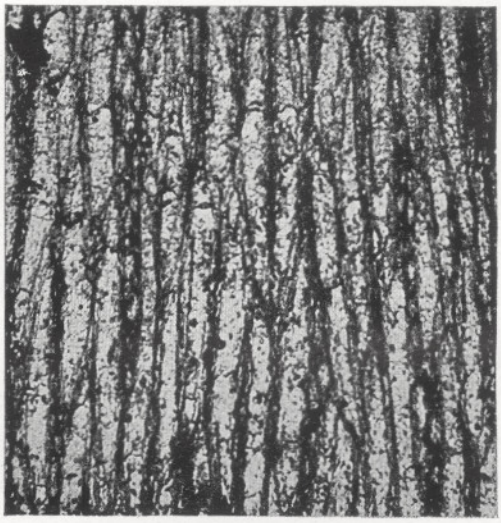
8



11

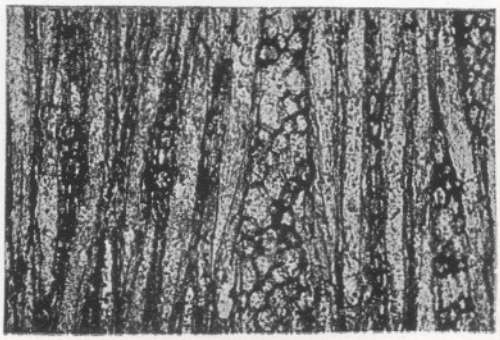


9



12

10



13