Grewia-type of fossil woods from the Deccan Intertrappean beds of India

M.B. Bande and Rashmi Srivastava

Birbal Sahni Institute of Palaeobotany, 53 University Road, Lucknow 226007

Bande, M.B. & Srivastava, Rashmi 1995. *Grewia*-type of fossil woods from the Deccan Intertrappean beds of India. *Geophytology* **24**(2):131-135.

Two silicified dicotyledonous woods closely comparable with the woods of *Grewia* (Tiliaceae) are described from the Deccan Intertrappean beds of India. The fossil woods are characterized by the presence of tile cells and radial canals in the xylem rays. Since these two characters are never reported to occur together in the woods of extant genera or families of the dicotyledons, their simultaneous occurrence in the present fossil woods is phylogentically significant.

Key-words- Fossil wood, *Grewia*, Deccan Intertrappean.

INTRODUCTION

THE Deccan Intertrappean flora, the earliest well explored Cenophytic flora of the Indian subcontinent, is well known for its well preserved fossils and the variety of plant taxa represented. Although, all the major groups of the plant kingdom are represented in this flora, it is mainly angiospremous in nature. A majority of angiospermous fossils recovered from the Deccan Intertrappean sediments exposed at various localities have successfully been assigned to the extant angiospermous genera or families. However, a number of fossil fruit and flower taxa, e.g. *Viracarpon*, *Tricoccites*, *Sahnipushpam*, *Monocotylostrobus* etc. and some dicotyledonous woods still elude their identification with the modern genera or families. In most of such cases this is because of our lack of knowledge regarding the structures of the comparable forms. At the same time, atleast in some cases, this is because of the fact that these fossil taxa exhibit characters of more than one extant genus or even family. Such fossil taxa are of special interest in the sense that they throw a new light on the phylogeny of various morphological or anatomical characters and also on the interrelationship of different modern genera and families. In this category of fossils, two silicified woods showing tile cells as well as radial gum canals in the xylem rays have been described from the Deccan Intertrappean beds exposed near Nawargaon, Wardha District, Maharashtra and Mohgaon Kalan, Chhindwara District, Madhya Pradesh. The significance of the occurrence of these two characteristic features in the same wood has also been discussed.

SYSTEMATIC DESCRIPTION

Order - Malvales

Family - Tiliaceae

Genus - *Grewioxylon* (Schuster) Prakash & Dayal, 1965

Grewioxylon canalisum **sp. nov.**
Pl. 1, Figs 1-7

Two pieces of mature secondary woods were collected from two different exposures of Deccan Intertrappean Beds. The first one is of 10 cms in length and 8 cms in diameter, collected from the locality of Nawargaon (21° 1′ North and 78° 1′ East), Wardha district, Maharashtra. The other one is of 7 cms in length and 3.5 cms in diameter collected from Mohgaon Kalan (22° 1" North and 79° 11′30" East), District Chhindwara, Madhya Pradesh. The description is based on a combined study of both the specimens.

Description - Wood diffuse porous. *Growth rings* absent. *Vessels* small to medium, rarely large, t.d. 40-150 µm, r.d. 45-225 µm, solitary and in radial multiples of 2-5, tangential pairs and small groups, showing variation in the distribution pattern at different places in the same slide, 5-14 per mm, circular to orbicular when solitary, with flat contact walls when in multiples; perforations simple, oblique; intervessel pit pairs alternate to opposite, polygonal in shape, with linear apertures, 6-8 µm in diameter. *Parenchyma* paratracheal,

vasicentric, forming 2-3 seriate sheath around the vessels or vessel multiples, sometimes with lateral extensions of aliform to aliform confluent parenchyma. *Xylem rays* fine to broad, broad multiseriate rays separated by a number of uniseriate rays, closely spaced, 12-15 per mm, heterogeneous made up of dark coloured procumbent cells and empty large, brick shaped *Pterospermum* type of tile cells; uniseriate rays 2-20 cells or 60-675 µm in height, multiseriates up to 20 seriate or 450 µm in width and upto 3 mm in height. Radial canals present in broad multiseriate rays, mostly one, rarely two per ray. *Fibres* arranged in regular radial rows in between the xylem rays, nonlibriform to semi-libriform, rectangular to polygonal in shape, 12-20 µm in diameter, non septate.

Affinities - Important characters of the fossil woods such as mostly small to medium sized vessels, paratracheal vasicentric to aliform parenchyma, broad multiseriate rays separated by uniseriate rays and made up of procumbent cells and pterospermum type of tile cells, and non-libriform to semi-libriform non septate fibres clearly indicate their affinities with the woods of the modern genus *Grewia* L. of Tiliaceae. However, occurrence of radial canals in the rays, a character so far not recorded in the woods of *Grewia* prevents their assignment under modern genus.

Comparison - So far nine woods showing affinities with *Grewia* are known from India and abroad. From abroad, three species are reported from Neogene sediments of Europe and one from South-East Asia. These are *Grewioxylon neumaieri* Selmeier (1985), *S. ortenburgense* Selmeier (1985), *Grewioxylon* sp. Selmeier (1985) from Germany and *Grewioxylon fontanesii* Vozenin-Serra (1981) from Vietnam.

From India, four fossil woods have been described from Palaeogene deposits of Deccan Intertrappean Series and one from Neogene deposits of Neyveli lignite. These are *Grewioxylon intertrappea* Shallom (1964), *G. mahurzariense* Prakash & Dayal (1965) and *G. indicum* Prakash & Dayal (1965), all from Mahurzari near Nagpur district; *Grewioxylon* sp. cf. *G. mahurzariense* Prakash & Dayal from near Mohgaon in Mandla district (Lakhanpal *et al.*, 1978) and *G. microcoides* Agarwal (1991) from Neyveli lignite deposits of South Arcot district, Tamil Nadu. Amongst them, *G. microcoides* comparable with *Microcos paniculata* L. (- *Grewia microcos* L.) having durio type of tile cells does not show the character of *Grewia*. The genus *Microcos* is separated from *Grewia* (Chattaway, 1934; Chowdhury & Ghosh, 1958; Metcalfe & Chalk, 1950).

In none of these woods, the xylem rays possess radial canals, the characteristic feature observed in the present fossil woods from Deccan. They have, therefore, been described under new species of *Grewioxylon*, viz. *Grewioxylon canalisum*, the specific epithet indicating the occurrence of radial canals in xylem rays.

Holotype - B.S.I.P. Museum no 36795; Nawargaon, Wardha District, Maharashtra.

Specimen II - B.S.I.P. Museum no. 36796; Mohgaon Kalan, Chhindwara District, Madhya Pradesh.

Horizon - Deccan Intertrappean beds.

Age - Early Tertiary.

DISCUSSION

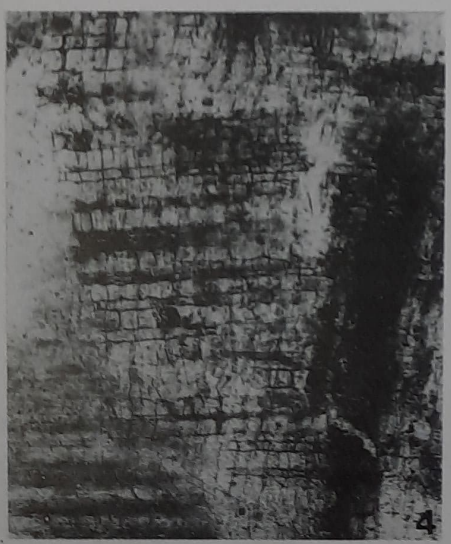
Amongst dicotyledons, certain wood anatomical characters which are restricted only to a limited number of genera or families have been considered to be of special significance. They not only help in the identification of these taxa on the basis of wood anatomy but are also useful in understanding the interrelationship between the taxa possessing them. Tile cells and radial secretary canals in the xylem rays are two such features. Tile cells, as defined by Chattaway (1933), Carlquist (1988) has listed the genera of four families of Malvales (Bombacaceae, Malvaceae, Sterculiaceae and Tiliaceae) which possess tile cells either of *Durio*, *Pterospermum* or intermediate type as follows:

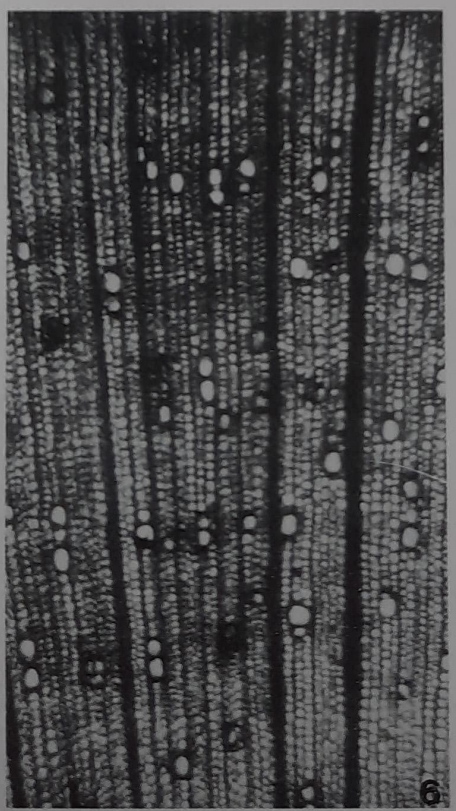
1. Durio type: Bombacaceae *Boschia, Coelostegia, Culllenia, Durio, Neesia);* Malvaceae (*Kydia*); Sterculiaceae (*Guazuma, Kleinhovia, Leptonychia, Scaphopetalum*); Tiliaceae (*Columbia, Luehea, Lueheopsis, Microcos, Mollia, Mortaniodendron p.p., Vasivoea, Vinticena*).

Plate 1

Grewioxylon canalisum sp. nov.

1. Cross section showing type and distribution of vessels and parenchyma x 40; B.S.I.P. Slide no. 36795-I.
2. Cross section of the same wood from different portion showing distribution of vessels and parenchyma x 40; B.S.I.P. Slide no. 36795-II.
3. Tangential longitudinal section showing heterocellular xylem rays with *Pterospermum* type of tile cells and radial gum canals x 40; B.S.I.P. Slide no. 36795-III.
4. Radial longitudinal section showing heterocellular xylem rays with *Pterospermum* type of tile cells x 60; B.S.I.P. Slide no. 36795-IV.
5. Tangential longitudinal section showing intervascular pit-pairs x 400; B.S.I.P. Slide no. 36795-V.
6. Cross section of another wood from Mohgaon Kalan showing type and distribution of vessels and parenchyma x 20; B.S.I.P. Slide no. 36796-I.
7. Tangential longitudinal section showing xylem rays with *Pterospermum* type of tile cells with radial gum canals x 37; B.S.I.P. Slide no. 36796-II.





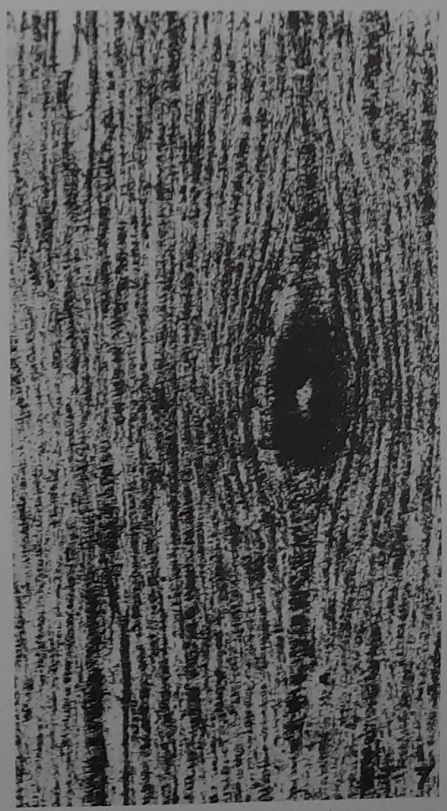


PLATE 1

2. *Pterospermum type*: Bombacaceae, (*Montezuma, Ochroma*); Malvaceae (*Malvaviscus, Pavonia, Urena,* probably also *Hibiscus mutabilis*); Sterculiaceae (*Pterospermum, Melochia* p.p.); Tiliaceae (*Belotia, Duboscia, Grewia, Mortoniodendron p.p., Trichospermum*, possibly also *Sparmannia* and *Triumfetta*).

3. *Intermediate type: Reevesia* and *Triplochiton* of Sterculiaceae according to Metcalfe and Chalk (1950) and *Guazuma* (Manchester & Miller, 1978).

Similar to tile cells, the radial canals also occur in only a limited number of dicotyledonous families and have been defined as "secretary canals running radially in ray tissue" (Carlquist, 1988). They are usually borne singly within rays and occur in the widest portions of multiseriate rays.

Combining and modifying the listings of Record (1925, 1944) and Metcalfe and Chalk (1983), Carlquist (1988) has given following list of families possessing radial canals in their rays:

Anacardiaceae : 33 genera
Apiaceae : *Eryngium, Peucedanum, Steganotaenia*
Apocynaceae : 23 gerera
Araliaceae : *Arthrophyllum, Cheirodendron, Didymopanax, Heptapleura, Sciadodendron*
Asteraceae : *Artemisia, Chrysothamnus, Hymenoclea*
Burseraceae : *Boswellia, Bursera, Canarium* and many other genera.
Cactaceae : Several genera (Record & Hess, 1943).
Clusiaceae: *Mammea, Ochrocarpus, Rheedia.*
Cochlospermaceae : *Cochlospermum.*
Crypteroniaceae : *Crypteronia.*
Dipterocarpaceae : *Shorea.*
Euphorbiaceae : *Alchornea, Croton, Mabea, Pera, Sapium.*
Fabaceae : *Hardwickia, Herminiera.*
Hammamelidaceae : *Altingia, Liquidamber.*
Julianiaceae : *Amphyterygium, Juliania.*
Loganiaceae : *Anthocleista.*
Myrtaceae : *Eugenia, Leptospermum.*
Rosaceae : *Pygeum.*
Rubiaceae : *Hymenodictyon.*
Sapindaceae : *Deinbollia*
Ulmaceae : *Gironniera*

From a comparison of the above two lists it becomes evident that the families with tile cells in their rays do not appear in the list of dicotyledonous families with xylem rays possessing radial secretary canals and vice-versa. However, Mouton and Jacquet (1981) have recorded sporadic occurrence of radial canals in the rays of *Apeiba glabra* and *Luehea paniculata* of the family Tiliaceae from French Guyana. Genus *Luehea* possess Durio-type of tile cells. Thus, the occurrence of these two characters together in the fossil woods described in this communication brings out some interesting phylogenetic points. It may be noted here that as the tile cells are restricted only to the families belonging to the order *Malvales* (Malvaceae, Bombacaceae, Sterculiaceae, Tiliaceae). The radial secretary canals are present in many families of the order *Sapindales* (Anacardiaceae, Burseraceae, Julianiaceae, Sapindaceae). Thus, these two characters appear to indicate some taxonomic relationships between the familes possessing them. It has also been observed that while origin of the tile cells is usually considered as a unique, isolated phenomenon, the radial canals are believed to have evolved polyphyletically in woods of dicotyledons but only few times (Carlquist, 1988). The present evidence of the fossil woods from the Deccan Intertrappean sediments and some species of modern woods of *Apeiba* and *Luehea* thus, indicates one more instance of an independent origin of radial canals in at least some members of Tiliaceae. If this view is accepted then what could be the probable reason for their loss in the woods of this family in the due course of time? The radial canals have been said to contain secondary plant products that function as defense mechanisms against herbivorous vertebrates and insects. The tile cells too have been said to carry the function of conduction or for accumulation of some kind of crystals or other compounds probably active in herbivore deterrence (Carlquist, 1988). Thus, it is plausible that the radial canals in Tiliaceae evolved independently before the origin of tile cells in this family. With the evolution of the later, the function of the radial canals was taken over by the tile cells which resulted in the consequent loss of radial canals from the xylem rays. The present finding of fossil woods similar to *Grewia* and possessing both tile cells and radial canals in the xylem rays from the Early Tertiary Deccan Intertrappean sediments of India, seems to provide an evidence in this direction.

REFERENCES

Agarwal, A. 1991. Fossils wood of *Grewia* from Neyveli lignite deposit, India. *Vegetos* 4 ((1&2) : 5-7.

Carlquist, S. 1988. *Comparative Wood Anatomy*. Springer- Verlag, Berlin Heidelberg.

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

Chattaway, M.M. 1934. Anatomical evidence that *Grewia* and *Microcos* are distinct genera. *Trop. woods* **30**: 9-11.

Chowdhury, K.A. & Ghosh, S.S. 1958. *Indian woods, their identifications, properties and uses*. Dehradun.

Krausel, R. 1922. Fossile Holzer aus dem Tertiar von Sud Sumatra. *Verh. Geol Mijnb. Gen. Nederland en kol* **5**: 231-287.

Lakhanpal, R. N., Prakash, U. & Bande, M. B. 1978. Fossil dicotyledonous woods from the Deccan Intertrappean beds of Mandla district in Madhya Pradesh. *Palaeobotanist* **25**: 190- 204.

Manchester, S.R. & Miller, R.B. 1978. Tile cells and their occurrence in Malvalean fossil woods. *IAWA Bull* 2-3: 23- 28.

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

Metcalfe, C.R. & Chalk. L. 1983. *Anatomy of Dicotyledons: Wood Structures and Conclusions of the general introduction.* Clarendon Press, Oxford. **2** (2nd Edition).

Mouton, J. & Jacquet, P. 1981. Contribution A L' Inventaire floristique et xylologique de la Guyane Francaise-7- *Apeiba, Luehea, Luehopsis* (Tiliaceae). *106th Congress national des Societe's savantes, Perpignan,* Sciences, Fasc. **II**: 245- 259.

Prakash, U. & Dayal, R. 1965. Fossil woods of *Grewia* from the Deccan Intertrappean Series, India. *Palaeobotanist* **13**:(1): 17-24.

Record, S.J. 1925. Occurrence of intercellular canals in dicotyledonous woods. *Trop. Woods* **4**:17-20.

Record, S.J. 1944. Keys to American woods XI woods with resin or gum ducts. *Trop. Woods* **77**:20-26.

Selmeier, A. 1985. Jungtertiare Kieselholzer (Fam. Bombacaceae, Tiliaceae, Meliaceae) aus dem Ortenburger Schotter Von Rauscherod, Niederbern. *Munchner Geoniss. Abh (A)* **6**: 89-140.

Shallom, L.J. 1964. A fossil dicotyledonous wood with tile cells from the Deccan Intertrappean beds of Mahurzari. *J. Indian bot. Soc.* **42**(2): 170-176.

Vozenin-Serra, C. 1981. Les structures ligneuses neogenes du plateau de Di Linh (Sud-Vietnam). *Palaeontographica* B**177**: 136-161.