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Xylotomical Comparision of Fossil Wood with Living Wood of the Sapotaceae Family, from Manchar Formation Exposed at Thano Bula Khan, Jamshoro, Sindh, Pakistan..

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Abstract

A new silicated wood fossil related to the Sapotaceae family was identified from Quaternary Manchar beds of Thano Bula Khan (Paleoforest), Jamshoro, Pakistan. The xylotomic characteristics of the present fossil wood, i.e., diffuse porous wood, parenchyma tissue structure, rays and pits indicated close attributes with the genus *Sapota* belonging to family Sapotaceaee. The taphonomic evidence of the fossilized remains inferred that the tree from possessing fossilized wood was developed *in situ*, but was carried into the current location from another region.

Key words: Petrified wood, *Sapotoxylon thanobulansis*, Manchar Formation.

Introduction

Since the early Blanford study (1879), the existence of the fossil dicot and monocot forests in the upper Tertiary and Quaternary deposits of Pakistan has been identified. Many authors have described and documented species of petrified wood from various locations in Sindh. The most recent are from Bara Formation of Ranikot was identified by Mangi *et al.* (2020) and from Manchar formation of Thano Bula khan by Soomro *et al* . 2021 Further, Manchar formation Some of the existing publications on fossil plants provides special aid for the identification of remains of fossil wood included Soomro *et al.,* (2017); Khan *et al*. (2016); Ahmed *et al*., (1991a,b,c, 1993; 2001, 2007a,b) and Shar *et al*. (2007). In addition, three new species were also identified from Punjab, Pakistan (Soomro *et al*., 2014, Soomro *et al.,* 2016 a & b). Present research focuses on the anatomical description and fossil wood comperission with living wood and already reported wood collected from Manchar Formation near the Thano Bula khan, Jamshoro district, Sindh **(Fig.1).**

Fig.1: Fossileforous locality of Thano Bula khan

Material Method

Three-dimensional sections of the fossil wood were prepared as described by Weatherhead (1938). Most of the studies were done with a simple light microscope and images were photographed through German Ortholux Microscope.

Fossil Description

Morphological Description

The preserved wood was consisted of one piece of wood deposition of silicates, measuring about 0.13 cm. long and 7 cm broad. The colour is light brown and shiny

Anatomical Description

Genus –*Sapotoxylon* Felix, 1882

Sapotoxylon thanobulansis sp. nov.

Topography:- Wood diffuse porous. Growth rings not clearly seen. *Vessels* small to medium –sized, mostly medium, solitary and mostly in radial multiples of 2-5, **(Plate 1; Figs. 2-6)** occasionally up to 8, exhibiting short chain-like structure, characteristically grouped together in oblique radial line forming zig zag flame-like pattern, about 30-60 vessels per sq mm; tyloses present, thick-walled, vessels also filled with whitish crystalliferous contents. Vasicentric tracheids occurring in the immediate vicinity of vessels and vessel groups. Parenchyma paratracheal and apotracheal, the former vasicentric, only a few row of cells associated with the vessels, intermingled with vasicentric tracheids, while the latter forming more or less loose, wavy as well as straight, regular lines, 1-5 (mostly 2-4) seriate in width, about 4-9 lines per mm. Xylem rays fine, 1-4 seriate, mostly 3, and occasionaly 4, 7-22 cells in height and 8-19 rays per mm; ray tissue heterogeneous, rays heterocellular, consisting of procumbent cells through the median portion and one-seral uniseriate marginal rows of upright cells at both the ends. Fibres aligned in radial rows between two consecutive rays **(Plate 2; Figs. 7-10).**

Elements – Vessels circular to oval, those in multiples flattened at places of contact, t.d. 90-190 µm, r.d. 74-170 µm; perforations simple; vessel members truncate or atenuately tailed, usually short, 90-320 µm in length; intervessel pits small medium, **(Plate No. 3; Figs. 11-12)** 4-6 µm in diameter, crowded, alternate with small, circular apertures; pits leading to contiguous vasicentric tracheids almost similar to intervessel pits; pit leading to ray cells slightly bigger than intervessel pits. Vasicentric tracheids slightly bigger than fibres, usually with 2 rows of bordered pits. Parenchyma cells angular or rounded in cross section, 18-34 µm in diameter, infiltration dark. Ray cells upright and procumbent; upright cells 58-115 µm in tangential height, 20-30 µm in, 40-130 µm in radial length. Fibres libriform, thick-walled, nonseptate, angular in cross section, small with narrow constricted lumen, about 8-12 in diameter.

Comparison with living counterparts

The above features of the fossil clearly show that it is a sapotaceous wood. The family Sapotaceae, on the whole, is quite homogenous in wood structure. There is hardly any characteristic feature in the woods having diagnostic value in the generic distinction. However, they can be distinguished only in certain cases when all the characters of the woods are taken into consideration collectively. After examining the available thin sections of modern woods as well as published description and illustrations of quite a number of woods of the described family (Desch, 1954; Kribs, 1959; Lecomte and Guibier, 1926; Metcalf & Chalk, 1950; Normand, 1960 and Pearson & Brown, 1932), it was found that the fossil shows general resemblance with some species of *Mimusops, Manilkara, Payena, Bequaerrtiodendron* (*Neoboivinella*) and *Pachystela*.

Manilkara and *Mimusops* exhibited some significant variations with regards to the size and arrangement of the vessels, the type of parenchyma and rays. The size of vessels varies from small to large, arranged in loose to compact groups arranged in loose to compact groups along oblique radial lines; the parenchyma lines are 1-3 serate, close or slightly widely spaced; the rays are 1-2 or up to 4-seriate. In the present fossil the vessels are mostly medium, with majority of vessels being more than 100 µm in diameter, arranged in groups as well as along oblique radial lines; the parenchyma lines are 1-5 seriate and closely spaced, and the rays are only 1-4 seriate. It is evident that the possibility of being either *Manilkara* or *Mimusops* as its modern equivalent can not be ruled out. In the nature and distribution of vessels and parenchyma and in the width of rays, it is also somewhat similar to those of *Payena*. However, the vessels in Payena are slightly bigger than those of the fossil. In the type and distribution of vessels and parenchyma, the fossil also shows resemblance with *Bequaerrtiodendron glomeruliflora* Aubr. and *Pachystela brevipe*s Baill. (Normand, 1960). However, the former differs from the fossil in having slightly smaller vessels (i.e. the diameter being less than 100 µm), while the latter differs in having rays up to 4-seiate. Since the fossil exhibits all the anatomical characters of the family Sapotaceae, it is assigned to the genus *Sapotoxylon* Felix (1882).

Comparison with already reported fossil wood species

So far with species of fossil woods of the family Sapotaceae are known. These are *Sapotoxylon taeniatum* (Felix, 1882) from Bavaria in south-east Germany. *Manilkaroxylon diluviale* (Hofmann, 1944) from the Quaternary deposits of South America, *Manilkaroxylon crystallophora* and *Palaeosideroxylon flammula* (Grambast-Fessard, 1968) from the Upper Miocene of Castel-lane in south-east France, *Siderinium*

deomatliense Prakash & Awasthi (1970) from the Mio-Pliocene of Deomali, Arunachal Pradesh. *Manilkaroxylon bohemicum* and *Sapotoxylon pacltovae* (Prakash *et al.,* 1974) from the Tertiary of South Bohemia, Czechoslovakia, *Chrysophyllxylon indicum* Awasthi (1977) from the Mio-Pliocene beds, near Pondicherry, India and *Madhucoxylon cacharense* Prakash & Tripathi (1976) from the Tipam Seiresm, near Hailandandi, Assam. All these species are quite different from the present fossil wood.

In *Sapotoxylon taeniatum* the vessels are slightly bigger (diameter 180 µm), rays 2-3 seriate and parenchyma line 3-celled or even broader. The vessels in *Palaeosideroxylon flammula* are very much crowded and grouped forming dendritic patterns and the parenchyma lines are 2-3 seriate and widely space. In *Aamnikara crystallophora* the rays are 1-4 seriate with swollen and crystalliferous upright cells, and the vessels are arranged in distinct radial lines without forming zig-zag or flame-like pattern. Similarly, in *Siderinium deomatliense* and *Madhucoxylon cacharense*, the vessels are in derail line without forming zig-zag pattern and the parenchyma is diffuse or in uniseriate lines. In *Manil-karoxylon bohemicum* the vessels are mostly large (t.d. 50-290 µm, r.d. 50-310 µm) and the rays are 1-3 seriate. The frequency of the vessels in *Sapotoxylon pacltovae* is very less (2-4 vessels per sq mm) and their size ranges between 75 to 200 µm in diameter, and the apotracheal parenchyma lines are uniseriate only. In *Chyropyloxylon indicum* the vessels are large and the xylem rays are 1-4 seriate, whereas in the present Ethipian fossil wood the vessels are mostly smaller (t.d. 48-100 µm, r.d. 32-120 µm), arranged in long radial multiples forming zig-zag patterns, the xylem rays are 1-2 seriate and the parenchyma is scanty paratracheal and in regular lines from 1-3 mostly 1-2 cells in width. Detailed comparision of reported fossil wood with fossil under invetigation with in same genus of sapota given in **(Table 1)**.

It is seen that the present fossil is quite different from all the above species. It is, therefore, described as a new species of *Sapotoxylon felix*, *Sapotoxylon thanobulansis* sp.nov.

Diagnosis of the Species

***Sapotoxylon thanobulansis* sp. nov.**

Wood diffuse-porous *Growth rings* not seen. Vessels small to medium, mostly medium, t.d.. 90-190 µm, r.d. 74-170 µm solitary and mostly in radial multiples of 2-5, occasionally up to 8, characteristically grouped in oblique radial lines, 30-60 vessels per sq mm; perforations simple; intervessel pits alternate, crowded, small to medium, 4-6 µm in diameter, with circular apertures; tyloses present, thick walled. Vasicentric tracheids few, associated with vessels. Parenchyma paratracheal and aportracheal; paratracheal parenchyma having only a few cells associated with vessels; apotracheal parenchyma forming 1-5 (mostly 2-4) seriate, almost regular, straight or wavy lines, about 4-9 lines per mm. Xylem rays fine, 1-4 seriate, mostly 3, occasionaly 4 also been found, about 7-22 cells in height and 8-19 per mm; ray tissue heterogeneous, rays teterocellular, consisting of procumbent cells through the median portion and one to several marginal rows of upright cells at both the ends. Fibres libriform, thick-walled with narrow constricted lumen, non-septate, angular, small, 8-17 µm in diameter.

Conclusions

Anatomical analyses of the fossil wood with the present wood have shown that the fossil wood is more comparable with the living wood of the Sapota genus and hence has given the name *Sapotoxylon thanobulansis* Sp Nov. further, the occurance of diffuse porous fossil wood and other anatomical features indicated the prevalence of tropical climate during the deposition phase of sedimentation. Fossil samples indicated that the tree from which the fossil wood had been developed was not growing *in situ* but transported from some other areas, into the present location.

PLATE NO. 1

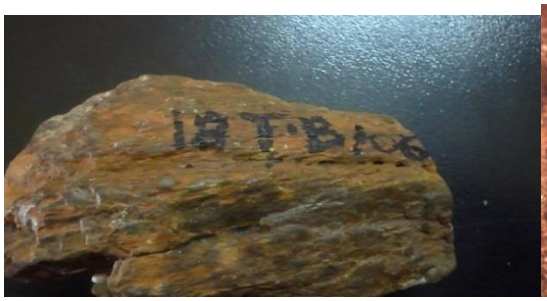


Figure 01

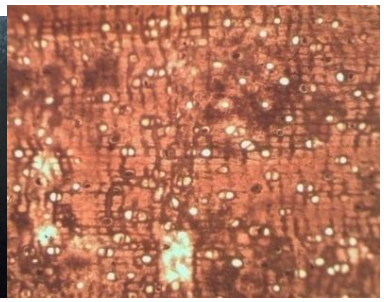


Figure 02

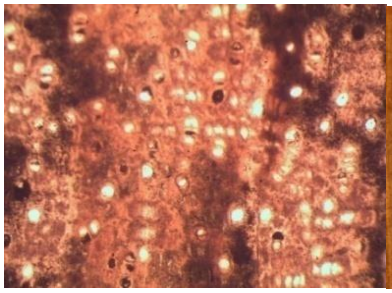


Figure03

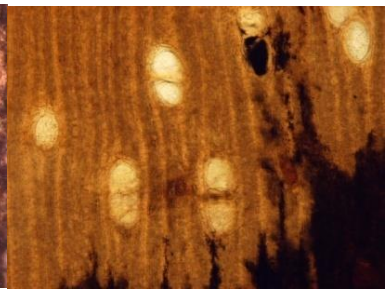


Figure 04

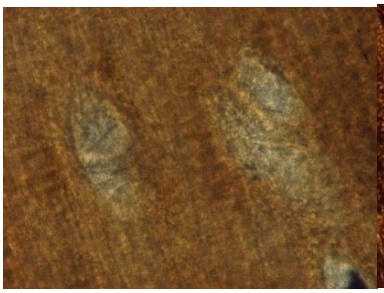


Figure05

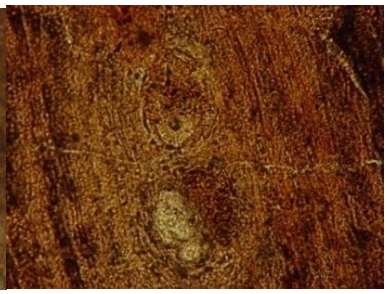


Figure 06

***Sapotoxylon thanobolansis* sp. nov.**

Fig: 20 showing microphotograph of the Holotype fossil wood T-B-W-6.

Fig: 02, 03 General distribution of vessels and parenchyma in cross section.

Fig: 04 Showing mostly vessels multiple of two.

Fig: 05 Another view of vessels and parenchyma.

PLATE NO.02

***Sapotoxylon thanobolensis* sp. nov.**

Fig: 06- 09 Showing xylem rays in tangential section.

Figure 10

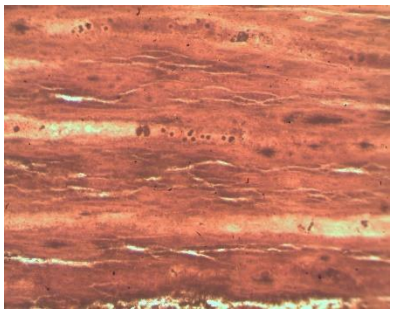


Figure 11

PLATE NO. 03

***Sapotoxylon thanobolensis* sp. nov.**

Fig: 10 Showing intervessel pits radial section.

Fig: 11 Another view of intervessel pits.

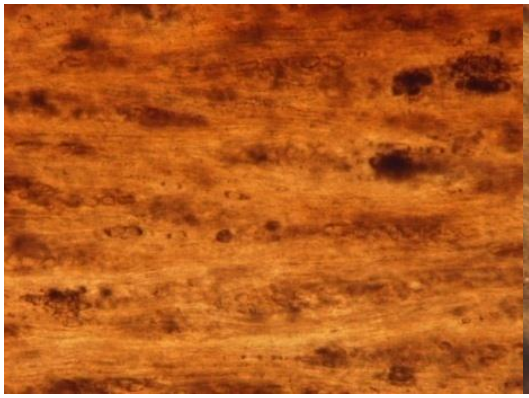
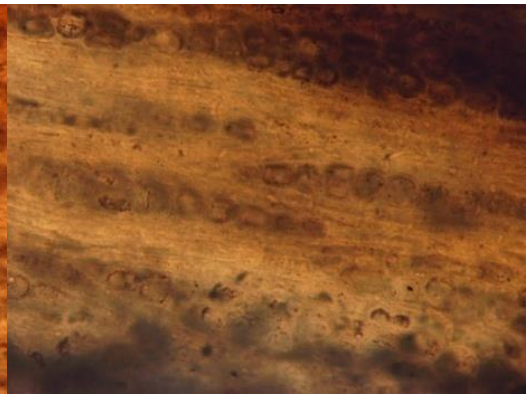


Figure06



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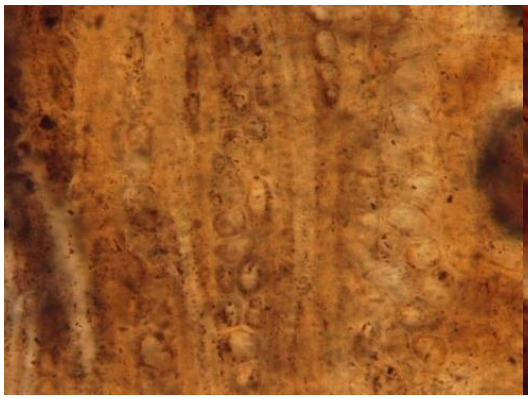

Figure08

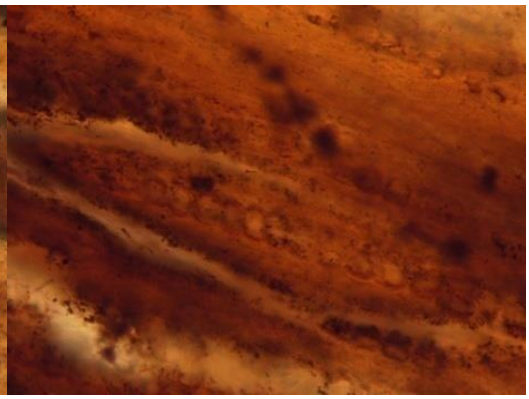

Figure 09

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Table 1 Comparison of fossil woods related to the genus *Sapatoxylon, age and Geological distribution*

Fossil Species	Growth Ring	Vessels	Parenchyma	Xylem Rays	Fibers	Age	Geological distribution
Sapotaceoxyln multiporosum Prakash, Awasthi & Lemoigne	I/A	Dendritic pattern ,Small in sized, 50 - 100 µm	Axial parenchyma scanty paratracheal	Hetero-Cellular, 1 to 3 Cells Wide	Simple to Minutely Bordered Pits	Miocene	Tropical mainland Africa and adjacent islands
Sapotaceoxylon prepayena Awasthi & Srivastava	I/A	Wood diffuse and Porous 50-100 µm. occasionally large sized vessels also found	Axial parenchyma scanty paratracheal, Axial parenchyma vasicentric	Heterogeneous Rays 2-3 seriate	Simple to Minutely Bordered Pits	Miocene Pliocene	Central South Asia
Sapotaceoxylon sp. 1 – Fejej Wheeler et al.	A	Diagonal and /or Radial Pattern; In radial multiples of 4 or more common 100 - 200 µm.	Axial parenchyma diffuse-in-aggregate. Axial parenchyma scanty paratracheal	1 to 3 cells wide mostly 2 seriate	Simple to Minutely/ Distinctly Bordered Pits	Miocene	Ethiopia
Sapotoxylon taeniatum Felix, 1882 Germany Tertiary	A	Slightly bigger (diameter 180 µm)	Parenchyma line 3-celled or even broader.	Rays 2-3 seriate	Minute Pit and Non Septate	Miocene	Germany
Sapotoxylon aethiopicum Lemoigne, Beauchamp, & Samuel	A	Wood diffuse-porous Vessels small to medium, mostly medium. 100 - 200 µm.	Axial parenchyma diffuse-in-aggregates Axial parenchyma scanty paratracheal Banded	Hetero-Cellular, 1 to 3 Cells Wide	Simple to Minutely Bordered Pits	Miocene	Ethiopia
Sapotoxylon lecomtedoxoides Lemoigne	A	Heterogeneous Rays fine, 1-4 seriate, mostly 3 seriate occasionally 4. about 7-22 cells in height and 8-19 per mm	Axial parenchyma bands more than three cells wide Axial parenchyma in narrow bands or lines up to three cells width	Ray width 1 to 3 cells Rays Hetero-cellular	Non septate	Miocene	Omo Valley, Ethiopia
Sapotoxylon thanobulansiss sp. Nov.	A	Small to Medium, Wood diffuse-porous t.d.. 90-190 µm, r.d. 74-170 µm solitary and mostly in radial multiples of 2-5, occasionally up to 8, tyloses present.	Parenchyma paratracheal; vasicentric and aportracheal; forming 1-5 (mostly 2-4) seriate	Rays fine, 1-4 seriate, mostly 3 seriate occasionally 4. about 7-22 cells in height and 8-19 per mm; ray tissue heterogeneous.	Xylem Fibres libriform, thick-walled, non-septate	Miocene	ThanoBula khan Pakistan

Legend: I= Indistinct ; A= Absent ;