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Anatomical Studies of Miocene Dicot Wood of Fabaceae Excavated from Ranikot (paleo-forest) Jamshoro, Sindh, Pakistan

Noorulain Soomro[1], Jamal Uddin Mangi[1], Ghulam Hussain Jatoi[2*], Farooque Ali Bhugio[1], Fahim Arshad[3] and Shahnawaz Khuhro[4]

[1]Institute of Plant Sciences, University of Sindh, Jamshoro, Sindh, Pakistan.
[2]Department of Agriculture, Mir Chakar Khan Rind University Sibi, Balochistan, Pakistan.
[3]Department of Botany, University of Okara, Punjab.
[4]Department Entomology, Shaheed. Z.A. Bhutto Agriculture Collage, Dokri, Larkana, Sindh, Pakistan.

(Corresponding author: Ghulam Hussain Jatoi)*
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ABSTRACT: An anatomically well-preserved log of mature stem from the Manchar Formation (early Miocene) at Ranikot fort area Sindh, Pakistan is described and assigned to *Isoberlinioxylon ranikotensis* sp. nov. The material was preserved by siliceous permineralization and reveals the characters of the secondary xylem of subfamily Fabaceae. The species is characterized by diffuse porous Wood, Growth rings present, Vessels small to medium in size. Solitary or in radial multiple of 2-3 (mostly Solitary). Parenchyma vasicentric, aliform to confluent. Xylem rays are uni seriate rarely 2-3 seriate, ray tissue homogenous to weakly heterogenous consisting of procumbent cells. Fibers are thick walled, probably nonseptate. The Specific epithet Ranikotensis is given to the area from where the wood specimen was taken. Taphonomy of the fossil wood indicate that the fossilized plants were transported from somewhere else, however the size of the petrified wood suggested that source area was not far away from the recent location.

Keywords: *Isoberlinia*, Fossil wood, Miocene , Manchar formation, Ranikot

I. INTRODUCTION

Fossil wood taken from the Rock strata is the most valuable tool used as an environmental indicator because of the way it has formed. The process which transforms relatively soft plant tissues to a hard rock fossil has been named as silicification, petrifaction, lithification, mineralization, fossilization, and permineralization [1]. The petrified wood discovery has often enabled palaeobotanists to identify past plant diversity and describe the depositional environment, sedimentation interruption when found in situ. Many fossil woods were discovered from the Miocene bed of Pakistan including *Atalantioxylon* [2], *Burseroxylon* [3] *Lagerstroemioxylon thanobolensis* [4],*Terminalioxylon* [5] *Terminalioxylon* [6] *Andiroxylon Thanobolensis* [7] *Dichrostachyoxylon chinjiensis* [8] *Euphorioxylon thanobolnsis* [9], *Millettioxylon Sindhiensis* [10]. *Albizzioxylon chinjiensis* [11], *Ormosioxylon* [12]. The present work deals with the anatomical description and the similarities of a fossil wood with living as well as already reported species. This research work focuses on the anatomical description and identification of Fossil wood from Manchar Formation near the Ranikot forest, Jamshoro district, Sindh (Fig.1).

A. Geological setting

Blanford (1876) [13] invented the term "Ranikot" sequence to denote the "infra-nummulitic" well-exposed rocks in the Ranikot Fort district, approximately 75 km away from Hyderabad, Sindh, Pakistan. (Lat.26 .45' - 26.00' N. Long 67 45'-68.00 E.), The area represents the western margin of the Indian subcontinent [14] and during the Pliocene to the present era, this area has highly uplifted, faulted and folded [15]. This mysterious fort is famous for animal and plant fossils.

Fig. 1. Fossileforous locality of Ranikot.

II. MATERIAL AND METHOD

The sample was collected from Rani Kot fort area district Jamshoro , Sindh Pakistan, named as (RK), The sample measures 30 cm in length, 7.5 cm in width. It is dark brown in colour and strongly silicified. Nine different thin sections were prepared by following the techniques as prescribed by Weatherhead [16]. The cross section, tangential and radial sections were prepared. For photography Microscopic Camera was used at the Paleobotany laboratory, Institute of Plant Sciences, Sindh University , Jamshoro.

The Antomical attributes such as vessel grouping and size, parenchymal distribution, size of rays and their distribution were used for identification of family, genus and in some cases, species.
For the xylotomical description of fossil woods most of the terms used are from Metcalfe & Chalk, Easu, [17] [18], Barefoot & Hankins, Fahn, [19, 20].

III. DIAGNOSIS

Wood was diffusely porous, growth rings delimited by narrow lines of parenchyma, smaller vessels and comparatively thick wall fibers. Vessels small to medium in size (mostly medium rarely large in size) were also observed. Solitary or in radial multiple of 2-3 (mostly Solitary). 5-7 per sq mm; t.d. 75-225 r.d. 90-225µm. vessels member 180-480 µm in height with truncate ends; perforation simple, inter vessel pits alternate to sub apposite. Parenchyma paratracheal and apotracheal, paratracheal parenchyma vasicentric, aliform to confluent. Xylem rays uni-seriate rarely 2-3 seriate 10-20 cells or 50-430 µm. 5-11 per mm ray tissue homogenous to weakly heterogenous consisting of procumbent cells. Fibers are thick walled, probably nonseptate.

Holotype. The specimen No.RK.20. The material (RK 20); silicified wood was collected by Noorulain Soomro from Ranikot fort area, district Jamshoro, Sindh Pakistan.
Horizon: Manchar Formation
Age: Pliestocene to Upper Miocene.

A. Morphological Description

The description of the present fossil is based on a piece of well preserved secondary wood measuring about 10 cm in length and 5 cm in diameter. The specimen enabled us to observe anatomical characters (Fig. 2A).

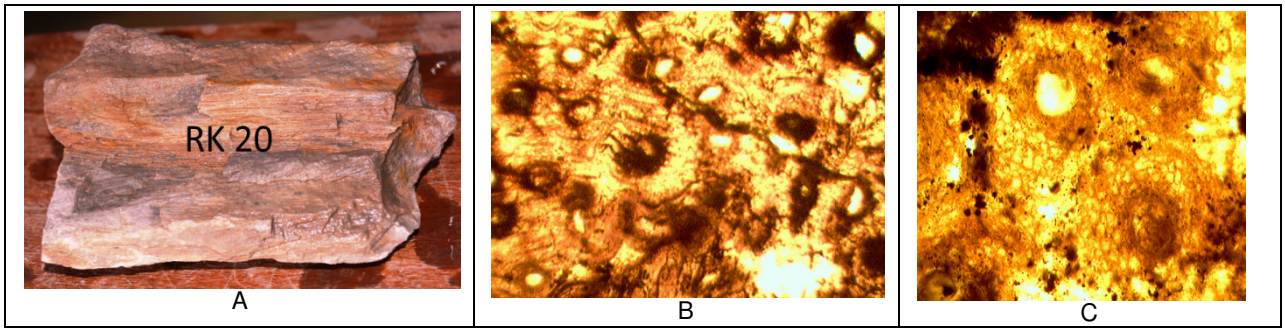

Fig. 2. A. Macrograph holotype of fossil wood RK20, B. Cross section showing general distribution of vessels andparenchyma.X40, C. Cross section showing nature of vessels and parenchyma.X100.

B. Anatomical Description

Cross section. Wood diffuse porous, Growth rings surrounded by narrow lines of parenchyma, Vessels are small to medium in size (mostly medium, rarely large size vessels were also seen), Mostly Solitary or in radial multiple of 2-3, evenly distributed 5-7 per sq. mm. Tylosis not seen, Vessels rarely filled with dark contents, round to oval in cross section. t.d. 75-225 (mostly 135-150 µm.) r.d. 90-225µm (mostly 180 µm). Walls about 3-6 µm thick, Parenchyma paratracheal and apotracheal and abundant, vasicentric, aliform (forming prominent halo around vessels with very short tangential extensions) to confluent; apotracheal parenchyma scanty, diffuse, occasionally seen shining whitish cells are forming narrow lines of 1-2 cells wide delimiting the growth ring cells round to oval in cross section. Fibers aligned in radial rows, round or oval in shape. Walls 4-6 µm thick. Probably nonseptate. Pits not seen (Fig. 2B-C).

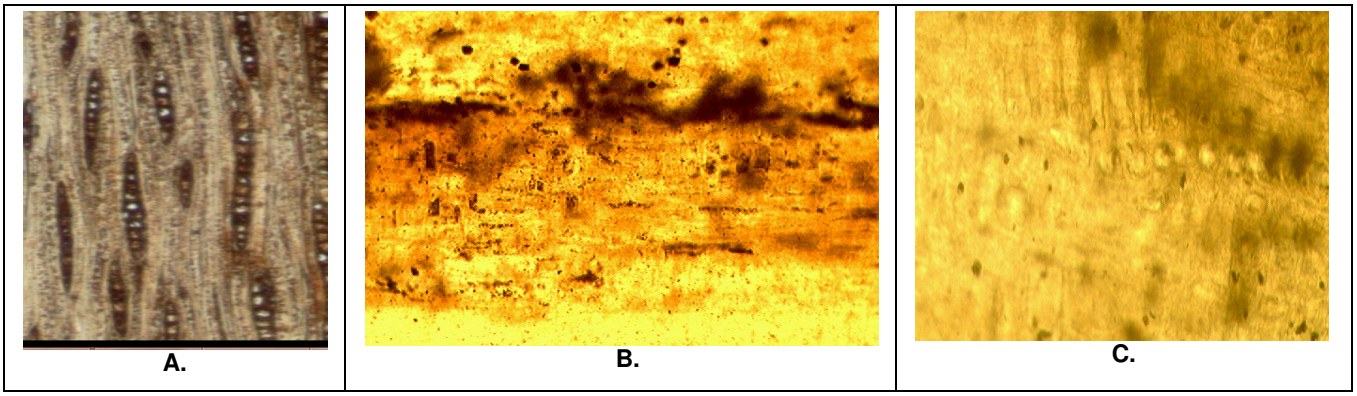

Fig. 3. A. Tengential Section showing general distribution of xylem rays and fibers of *Isoberlinia niembensis,* **B.** Tengential Section showing general distribution of xylem rays and fibers X40, **C.** Tengential Section showing Nature of xylem rays and fibers X400.

Tangential longitudinal section. Vessels are composed of elongated cells having truncate ends. Vessel members 180-480 µm (often 200-220 µm) in height. Perforation simple, inter-vessel pits alternate to sub apposite, 3-6 µm in diameter, vestured. Ray fine mostly uniseriate, 2-3 seriate also found 3 seriate rarely seen. 50-470 µm in height 07-11 per mm; Ray tissue homogenous to weakly heterogenous consisting of procumbent cells and sometimes with a single marginal row of square or upright cells at one or both ends. Fibers are non septate 4-16 µm in diameter and the length of the fibers ranges from 330-500 µm (Fig. 3. A-C).

Radial Longitudinal section. Vessels made up of elongated cells, vessel length ranges from 170-480µm. Perforation simple, vessels with transverse end, Wall of the vessels provided with vestured pits, inter-vessel pits alternate to sub apposite (Fig. 4. A-D).

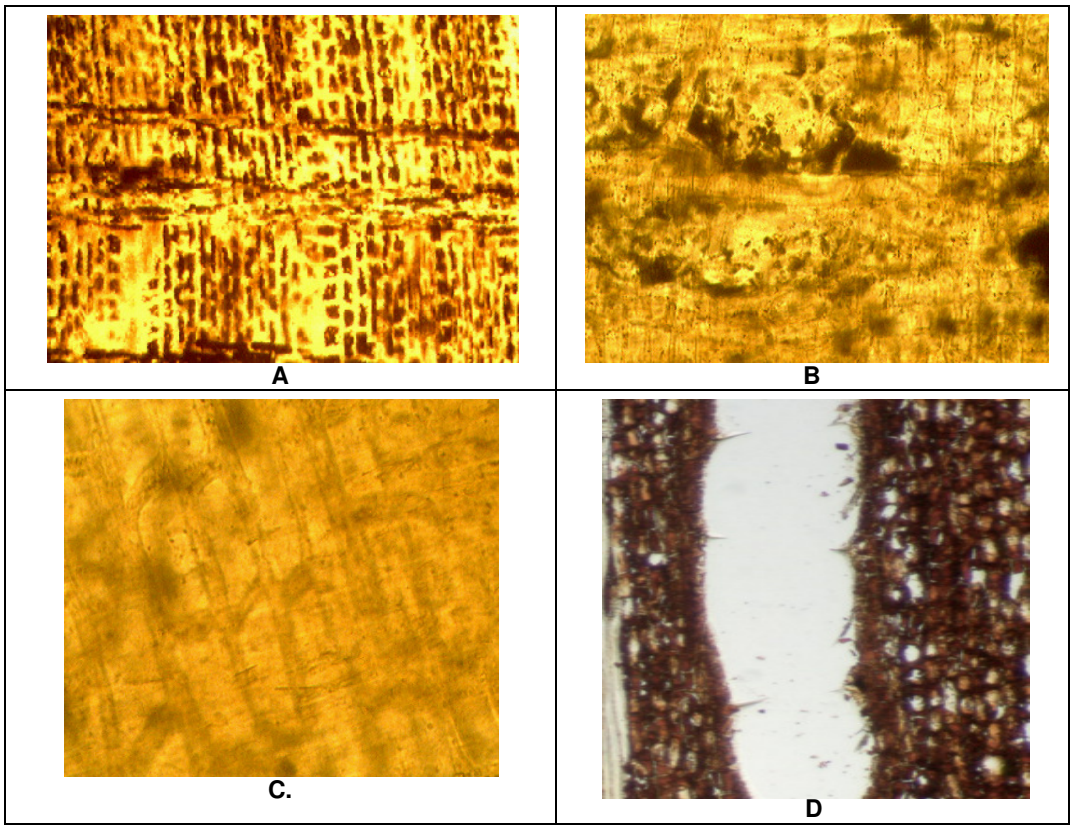

Fig. 4. A. Radial longitudinal section showing arrangements of fiber X40, **B.** Radial longitudinal section showing end wall of vessels andpits on the vessels X100, **C.** Radial longitudinal section showing arrangements of fiber X400. **D.** Radial longitudinal section of *Isoberlinia niembensis.*

IV. DISCUSSION

A. Comparison with Modern wood

The above Xylotomical features such as Vessels are mostly solitary, Vessels small to medium in size and the arrangement of parenchyma cells around the vescicentric aliform to confluent, rays uniseriate is a clear indication that fossil wood belongs to family Leguminosae. Among Legumes the wood of a few genera, such as *Bauhina*, *Crabia, Cynometra, Dalbergi Dialum, Geoffroea, Lonchocarpus, Milletia, Isoberlina Pongamia* [17]. However, taking into consideration all the xylotomical details such as the shape, size and frequency of solitary and multiple vessels, height and width of rays, the fossil shows close resemblance with the wood of *Isoberlinia* Craib. of the family Leguminosae. Detailed comparision with the thin sections of *Isoberlinia niembensis* and *I. angolensis* as well with the published description and illustration of Isoberlinia (Welw.) Hoyle & Brenan, *I. niembaensis* Duvingn and I. tomentosae (harms) Craib & staff. [21] has shown close resemblance with the fossil under investigation.

B. Comparison with reported Fossil wood

Two species of fossil wood, one of *Isoberlinioxylon congoense* [22] from the Miocene of Lake Albert, Congo and the other one from the Kuchh Dhanetti India [22] were described. Both were identical so given the same name as *isoberlininioxylon* congo. The fossil under investigation with minute differences was given the new name *Isobirilinioxylon ranikotensis,* the specific epithet refers to the area where the fossil wood belongs (Table 1).

Table 1: Comparison of fossils related to genus *Isoberlinioxylon.*

Species	Wood	Vessels	Parenchyma	Xylem	Fibres
***Isoberlinioxylon congoense* Lakhanpal & Prakash**	Diffuse	Vessels small to medium in size, solitary intervessel pits are apposite 5 vessels per sq mm	Axial Parenchyma vescicentric. aliform to confluent	Rays are mostly 1-3 seriate mostly biseriate Body ray cells procumbent with one row of upright and / or square marginal cells,4-12 per sq.mm	Non septate
Isoberlinioxylon ranikotensis Sp.Nov.	diffuse porous	Vessels small to medium in size {mostly medium rarely large in size} also observed. Solitary or in radial multiple of 2-3 (mostly Solitary). 5-7 per sq mm; t.d. 75-225 r.d. 90-225µm. vessels member 180 -480 µm in height with truncate ends; perforation simple inter vessel pits alternate to sub apposite.	Parenchyma paratracheal and apotracheal parenchyma abundant, vasicentric, aliform (forming prominent halo around vessels with very short tangential extensions)to confluent; apotracheal parenchyma scanty, diffuse, occasionally seen a shining whitish cells are forming narrow lines of 1-2 cells wide delimiting the growth rings cells round to oval in cross section.	Ray fine mostly uniseriate 2-3 seriate also found, seriate rarely seen. 50-470 µm in height 07-11 per mm; Ray tissue homogenous to weakly heterogenous consisting of procumbent cells and sometimes with a single marginal row of square or upright cells at one or both ends.	Non Septate

V. CONCLUSION

The genus Isoberlinia Craib & Stapf. consists of six species, confined to tropical Africa [23]. The characters such as diffuse porous wood and variation in Parenchyma tissue from the previous reported species indicate that the tropical type of climate was evidently found in the area of Ranikot,

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