



***Dichrostachyoxylon chinjiensis* sp. nov., A New Fossil Species of the Family Fabaceae from Chinji Formation, Salt Range, Punjab, Pakistan**

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Abstract: Xylotomical studies of fossil wood is often view as a source of independent data that may be used to asses evolutionary relationship among angiosperm. Here we did the systematics of fossil wood from the anatomical characters of petrified wood collected from Chinji formation of Miocene age exposed at Chinji National Reserve. Three dimensional sections (transverse, tangential and radial) were prepared by ground thin section technique. Microscopic characters of the fossil wood were compared with the modern and already reported fossil woods. The xylotomical characters were comparable with the family Leguminosae (Fabaceae). The fossil wood shows close resemblance with the wood of *Dichrostachy* in respect of size and arrangement of parenchyma, vessels, xylem rays and fibers. Therefore it is considered as a new species and is named *Dichrostachyoxylon chinjiensis* sp. nov. The epithet *chijiensis* refers to area from which the fossil wood belongs.

Keywords: *Dichrostachyoxylon Chinjiensis*, Petrified Wood, Chinji Formation, Pakistan

1. INTRODUCTION

Petrified wood is ubiquitous in Pakistan and found almost in every continent and contain fruitful information of past plant. Blandford in 1879 reported petrified wood from the tertiary and Quaternary sequence of Pakistan after that many scholars identified and published reports from different fossiliferous localities exposed in Pakistan. Khan and Rehmatullah (1968, 1971) Khan *et al.* (1972); Khan and Rajput (1976) Rehmatullah *et al.* (1984); Ahmed *et al.* (1989) Ahmed *et al.* (1991a) Ahmed *et al.* (1991b), Bhutto *et al.* (1992); Ahmed *et al.* (2001) Ahmed *et al.* (2003) Ahmed *et al.* (2007a) Ahmed *et al.* (2007b) and Shar *et al.* (2007); Khan *et al.* (2016). de Franceschi *et al.* (2008) were reported from the lower parts of the Chitarwal Formation (Zinda Pir Dome, Sulaiman Range, Eastern Baluchistan) and three from Punjab province *Ougenioxylon chinjiensis* Soomro *et al.* (2014), *Albizzioxylon chinjiensis* Soomro *et al.* (2016) *Ormosioxylon chinjiensis* Soomro *et al.* (2016)

Fossil wood abundantly found in the study area of Chinji formation belonging to Siwalik group of Pakistan. Wood samples were collected from the fossiliferous locality of Chinji National Reserve, district Khushab, (72°22' E, 32° 41' N) which falls in the heart of the Salt Range and is 50 km away from Khushab city. Fossil wood were buried on the slopes of sedimentary rocks. Some of these fossils are in complete log of 4-6m. The present work deals with the anatomical description and the affinities of a fossil wood.

2. MATERIAL AND METHODS

The fossil wood specimen was collected from Chinji National Reserve, district Khushab, Punjab, Pakistan. The mature secondary xylem fossil wood is about 18 cm. in length and 11.5 cm. in diameter, dark brown in color. Transverse, tangential and radial sections were prepared with the help of petrotome as described by Weatherhead (1938) detail anatomical analysis was done with help of stereozoom microscope and light microscope. Photographs were taken of all three sections with Microscopic camera in the Paleobotany laboratory, Institute of Plant Sciences,, University of Sindh, Jamshoro.



Fig. Fossiliferous locality of chinji formation. Huge log of fossil wood lying on ground

SYSTEMATICS

Phylum **MAGNOLIOPHYTA** CRONQUIST, TAKHT. AND ZIMERM. L
Family **FABACEAE** LIND.
PLATE 1-3

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Diagnosis: Wood diffuse-porous, growth rings slightly distinct, vessels are small to medium in size rarely large; mostly vessels are solitary in or in radial multiples of 3-4, the tangential diameter varies from 40-153 μm radial diameter ranges from 80-200 μm , 6-18 per sq mm. The intervessel pits are bordered, quite dense and alternate, the axial parenchyma in marginal are in seemingly marginal bands, apotracheal parenchyma forming the tangential bands paratracheal parenchyma mostly vasicentric, aliform aliform to confluent. Xylem rays seem to be mostly homogenous or slightly heterogeneous, 1-5seriate, mostly tri-seriate. Fibres form radial lines of two to six between two rays.

Holotype

Collected from Thati Rest House, Chinji National Park, District Khushab, Punjab, by Author, TR-17 2011 (Paleobotany museum, Insititute of Plant sciences, University of Sindh, Jamshoro, Sindh Pakistan).

Horizon: Chinji Formation

Age: Late Miocene.

Morphological description

Fossil wood consist of one piece of silicified wood which is ca. 18 cm long and 11.5 cm broad. The color of fossilized wood is dark brown in colour.

Anatomical Description

Cross section

Wood diffuse porous with slightly distinct growth rings. Vessels are mostly small to medium in size, Solitary and in radial multiple of 2-4, 6-18 per sq mm, round, oval and some vessels due to pressure exhibit elliptical in sections the tangential diameter varies from 40-153 μm radial diameter ranges from 80-200 μm , the wall thickness varies from 6-10 μm , axile parenchyma apotracheal and paratracheal, apotracheal parenchyma, forming tangential bands and paratracheal parenchyma consist of vasicentric, aliform, aliform to confluent, The sheath of parenchyma cells around the vessels are 3-8 cells thick, round to oval in shape. The cell tangential diameter ranges from 7-25 μm , and the radial diameter are 8-44 μm .

Xylem rays canal like and present on both sides of xylem, distributed evenly in the ground mass, Fibres form radial lines of two to six fibers between two rays their tangential and radial mean vary from 5-13 μm .

Tangential Longitudinal Section

The vessel elements are 232-341 μm long, having truncated ends, and are irregularly distributed, vessel ends are transverse, thickness of the wall of the vessels is 6-10 μm . Perforation plates are simple, the intervessel pits are alternate, bordered, and quite intense, with average diameter of 2.6 μm .

Xylem rays seem to be homogenous or to some extent heterogenous cells. They are mostly multiseriated rarely 1-3 seriate, mostly triseriate 5

seriate rarely found, 12-19 per sq mm. the uniseriate rays are composed of vertically 3-8 elongated cells high, or 45-237 μm high, while multiseriate rays are usually flattened and their width varies from 16-41 μm , their height ranges from 7-20 cells 56-332 μm high. Fibres are long, septate, libriform mean tangential diameter ranges from 5-13 μm in diameter 300-523 μm long.

Radial Longitudinal section

Vessels segments are elongated, having truncate ends. Length of the vessel member ranges from 232-341 μm 138-276 μm broad, vessel ends are transverse with simple perforation. Wall thickness of vessels ranges 6-10 μm . intervessel pits alternately arranged with average diameter 2.6- 3 μm .

Parenchyma cells are found around the vessels were arranged in 2-5 layers of cell 24-130 μm long 8-24 broad μm ,

Xylem rays cells ranges from 9-25 cells 56-339 μm and 4-7 μm broad. Fibers are elongated, two slightly different (Thick 4 μm walls thick and thin 2 μm walls thin) fibers have been observed, Septate libriform, 8-15 μm in diameter.

Comparison with modern wood

The most important anatomical features exhibited by the fossil wood are the following: wood diffuse porous vessels mostly solitary or in radial multiple of 2, 4 made up of very short elements, vessel pits are small which look vestured; Axile parenchyma vasicentric, aliform rarely aliform to confluent or in tangential bands: rays 1-3 seriate homogenous, slightly heterogeneous. Taking into consideration the above mentioned xybotomical characters show its affinity with the wood of leguminosae and specially to the family mimosaceae caesalpiniaceae(Louvet 1976). But further can be distinguished by the storied rays which have placed the fossil wood under investigation nearer to the family Fabaceae (Metcalf and Chalk 1950). In leguminosae family *Bauhinia*, *Pongamia*, *Acacia*, *Erythrina*, *Dichrostachy Clitoria* and *Baphis* are comparable with fossil wood under investigation, The genus *Acacia* can be eliminated by having boarded rays and non septate fibers, The genera *Pongamia* and *Erythrina* can be eliminated as they have thicker parenchyma bands (Chowdhury and Ghosh 1946), *Bauhinia* can also be separated due to its characteristic of medium to large vessels and of ripple marks considering the remaining three genera namely *Clitoria*, *Dichrostachys* and *Baphis*, *Baphis* can be excluded as it posses completely homogenous rays, the present fossil wood do not match with clitoris as it posses large and small vessels distinctly. The fossil under investigation shows similarities in most of the anatomical detail with *Dichrostachys* viz, the present fossil wood referred to the genus *Dichrostachys*

A genus with about 7 species, distributed in Tropical and South Africa, Madagascar, Tropical Asia, Australia, with some cultivated in Lahore and Karachi (Nasir *et al.* 1973)

Comparison with recorded fossil Species

So far only 5 species of fossil woods are showing resemblance with the *Dichrostachys* have been described from different parts of the world. All of these reported fossil woods have been compared with fossil wood under discussion and a detail of compared character is given in table. The comparison in table

indicates that the fossil wood in genus is different from all 5 reported species Hence it is identified as new species *Dichrostachyoxylon chinjiensis* sp. Nov. The specific epithet refers to the locality from where the fossil wood collected.

3, CONCLUSION

The Xylotomical attribute of the petrified wood such as diffuse porous wood and the growth rings indicated by terminal parenchyma are the evidence of the existence of tropical type of climate of that time.

Plate.1



Fig: 01

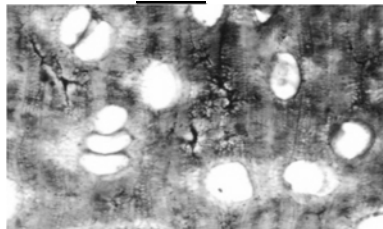


Fig: 02

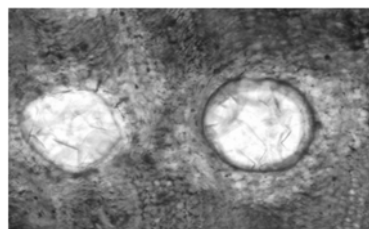


Fig: 03

***Dichrostachyoxylon chinjiensis* sp. Nov.**

Fig. 01 Macrograph of the fossil wood TR 17

Fig. 02: Cross section showing general distribution of vessels and parenchyma. X 100

Fig. 03: Another view of cross section showing aliform to confluent Parenchyma X200

Plate.2

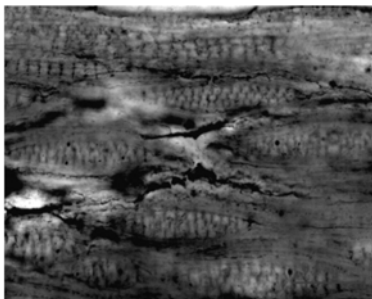


Fig.04

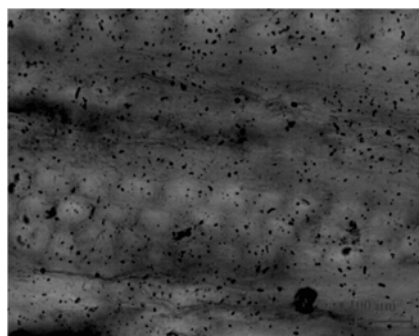


Fig.05

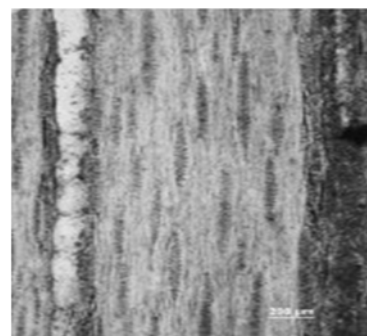


Fig.06

***Dichrostachyoxylon chinjiensis* sp. Nov.**

Fig.04: Tangential longitudinal section showing general distribution of xylem rays X100

Fig.05 Tangential longitudinal section showing distribution of multiseriate rays X200.

Fig.06: *Dichrostachyoxylon herenddeenii* Tangential longitudinal section of fossil wood showing rays similar to fossil wood which is under investigation. (Inside wood)

Fig.07: Another view of Tangential longitudinal section showing distribution of xylem rays X100

Plate. 03

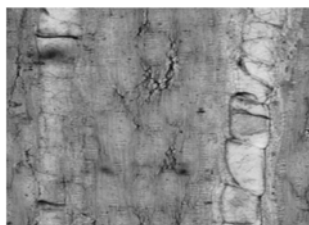


Fig 07

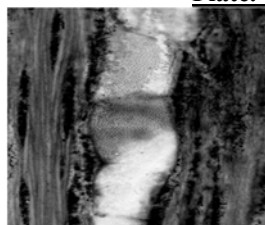


Fig :08

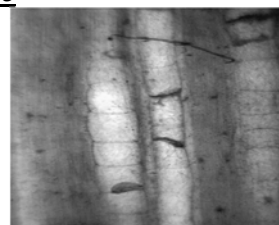


Fig:9

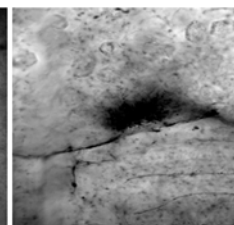


Fig 10

***Dichrostachyoxylon chinjiensis* sp. Nov.**

Fig. 07: Radial longitudinal section showing the nature of xylem rays and pits on the walls of the Vessels. X100.

Fig.08 : *Dichrostachyoxylon herenddeenii* Radial longitudinal section of fossil wood showing the nature of xylem rays similar to fossil wood which is under investigation. (Inside wood)

Fig. 9 : Another view of Radial longitudinal section showing the end wall of the Xylem rays

Fig. 10: Pits on the wall of vessels X400.

Table. Comparison of fossils related to *Dichrostachyoxydon chinjiensis* Sp.Nov.

Species	Wood	Vessels	Parenchyma	Xylem	Fibres
<i>Dichrostachyoxydon occidentale</i> Prakash and Barghoorn 1961	Diffuse porous	Small to medium, 40-130µm. in diameter, 3-7 vessels / sq.mm, mostly solitary as well as in radial multiples of 2, intervessel pits are alternate circular, oval to elliptical.	Paratracheal and apotracheal; Mostly Vasicentric, aliform to confluent; apotracheal Parenchyma form thick lines of terminal parenchyma; parenchyma strands storied	Mostly biseriate, occasionally 3 seriate 10-20 cells high, 10-19 rays/mm. homogenous, homocellular procumbent	Septate
<i>Dichrostachyoxydon atridiatum</i> Muller Stoll and Madel 1967)	Diffuse porous	Vessels are small 50-100 µm, simple perforation plates, Intervessel pits alternate,	Paratracheal and apotracheal; Vasicentric, aliform to confluent; apotracheal Parenchyma diffuse as scattered cells and terminal; parenchyma strands storied and crytalliferous.	Rays 1-4 (mostly 2-3) seriate procumbent 3-20 ccells high, 8-10 rays / mm. homogeneus. and homocellular	Septate
<i>Dichrostachyoxydon acaciaeforme</i> Muller Stoll and Madel 1967	Diffuse Porous	Small to medium in size 100-200µm, 5 vessels/sq.mm, mostly solitary as well as in radial multiple of 2-5, Intervessel pits alternate	Paratracheal and apotracheal parenchyma, Mostly Vasicentric, aliform, Axial parenchyma in marginal or in seemingly marginal bands,	Rays are homogenous made up of procumbent cells, 4-10 seriate, Prismatic crystals present	Septate
<i>Dichrostachyoxydon palaeonyassanum</i> Lakhnappa I and Prakash 1970	Diffuse Porous	Vessels are mostly solitary, multiple of 2-3, Vessels size are small to medium occasional large size vessels are also found Inter vessel pits are scalariform	Axial Prenchyma vesicentric , aliform, Axial parenchyma in marginal or in seemingly marginal bands	Rays are mostly 4-8 seriate , All rays cell are made up of procumbent cells 15-18 sq per mm.	Septate
<i>Dichrostachyoxydon aff. zirkelii</i> (Felix) Muller-Stoll and Madel , Sakala, J. 2000	Diffuse Porous	Mostly Solitary , Multiples of 2-4, 13-14 per sq mm. Small to medium in size Round to elliptical in in shape	The axial parenchyma is apotracheal, forming tangential circum-medullar bands and paratracheal (vasicentric, slightly aliform, very rarely confluent)	Rays are 1-4seriate, homogenous or slightly heterogenous 12-19 per sq. per mm.	Septate
<i>Dichrostachyoxydon herendeeni</i> Wheeler, E.A. and S.R. Manchester. 2002.	Wood Diffuse porous	Small to medium in size, Vessels are solitary as well as in multiple of 2-5 100-200µm. 5-20 per sq.mm, Round and elliptical in shape.	Axial Parenchyma vasicentric aliform to confluent .	Rays are 4-10 seriate, Rays hetrocellular, Body ray cells procumbent with one row of upright and / or square marginal cells. 4-12 per mm.	Septate
<i>Dichrostachyoxydon chinjiensis</i> sp. nov.	Wood diffuse porous	Vessels are small to medium in size Solitary as well as in radial multiples of 3-4, Inter vessel pits are alternate and dense, 6-18 per sq mm.	Axial Parenchyma are forming a marginal bands apotracheal parenchyma forming Vasicentric aliform, aliform to confluent	Rays are 1-3 seriate triseriate are common while 5 seriate also found homogenous or slightly heterogenous made up of procumbent cells	Septate

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