

ANDIROXYLON THANOBOLENSIS SP. NOV. A NEW SPECIES OF FOSSIL WOOD OF FAMILY FABACEAE FROM MANCHAR FORMATION EXPOSED NEAR THANOBOLA KHAN, DISTRICT JAMSHORO, SINDH, PAKISTAN

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Abstract

Andiroxylon thanobolensis sp. nov., a new silicified wood has been described and identified from Tertiary Manchar formation exposed near Thanobola Khan, district Jamshoro, Sindh, Pakistan. The xylotomical features of present fossil shows close resemblance with the genus *Andira* of the Family Fabaceae. The absence of growth ring indicated that plants were growing in tropical type of climate.

Key words: *Andiroxylon thanobolensis* sp. nov, fossil wood, *Fabaceae*, Manchar Formation, Sindh, Pakistan.

Introduction

The systematic study of petrified wood play an important role in Paleobotanical studies as it indicate the type of vegetation existing in the past. It has its importance in distribution and evolution of plant through space and time. It is also helpful in improving and developing natural plant classification and tracing the origin of species. The occurrence of fossiliferous plant in the tertiary and quaternary deposit of Sindh was first time reported by Blanford in 1879, while he was working on the geology of Sindh region. Pascoe (1963) reported the presence of silicified dicot and monocot fossil woods in the upper Tertiary and Quaternary deposits of Sindh region. However large number of fossil woods have been identified and described from Sindh and other areas of Pakistan (Khan & Rehmatullah, 1968 & 1971; Khan *et al.*, 1972; Khan & Rajput, 1976; Rehmatullah *et al.*, 1984; Rajput & Khan, 1982 & 1984; Rajput *et al.*, 1985; Saeed *et al.*, 1984; Ahmed *et al.*, 1989, 1991a, 1991b, 1991c, 1993, 2007a & 2007b; Bhutto *et al.*, 1993; Shar *et al.*, 2007 and Soomro *et al.*, 2014).

Very little systematic work has been done on the present fossiliferous locality of Thano Bola khan. Present work provide information on the fossil woods of Thano Bola Khan and identified as a new species of fossil wood collected from Manchar formation of Middle miocene exposed near Thano Bola khan, district Jamshoro, Sindh, Pakistan (Lat. 25° 19' .55". N. Long. 67° 55' .26".E). A detailed systematic information is given in this contribution.

Materials and Methods

Many fossil woods were collected from the study area, which is located about 10 km east of Thano Bola Khan, town which is about 58 km south-west of Hyderabad, 111km North West of Karachi. The fossil wood used in this study, consists of one piece of silicified wood, measuring a 10 cm long and 5 cm broad, brown in color. For anatomical investigation ground thin sectioning method was employed, which was first described by Weatherhead (1938).The Anatomical features such as presence of vessels, vessel size and grouping, distribution of parenchyma, ray size and their distribution, were used in the determination to family, genus, and in some cases, species. In general for the

anatomical description of fossil woods most of the terms used are from Barefoot & Hankins, (1982), Easu, (1959), Fahn, (1969) Metcalfe & Chalk, (1950).

Systematic Positions

Division **Magnoliophyta**
Family **Fabaceae** Lindley
Genus ***Andiroxylon***
Species ***A. thanobolensis* sp. nov**

Anatomical description

Cross section: Wood diffuse porous. Growth ring absent, vessels medium to large sized, solitary as well as radial multiple of 2-3, circular to oval, flat contact wall when in group, lumen of vessels mostly empty. Radial diameter of vessels ranges from 200-268 µm; and tangential diameter ranges 185-224 µm. Length of radial multiple of 2 ranging 200-390 µm; and radial multiple of 3 ranging 240-400µm. Distribution of vessel 3-4 per sq mm. Tylosis absent. Parenchyma confluent to banded, aliform rare, both paratracheal and apotracheal type of parenchyma present. The parenchyma band bifurcating at places and joining similar band on upper and lower side's .parenchyma very variable in size, thin walled, round to oval in shape, diameter range 20-50 µm.

Xylem rays numerous, uniseriate to multiseriate forming canal like structure present after 3-5 cells of fibers. Ray cells rectangular in shape. Fibres polygonal thick walled aligned in the rows between the two consecutive xylem rays, diameter of the fibre cells is 20-26 µm (Plate 1 Fig. 2, 3 & 4. Text plate 1).

Tangential longitudinal section: Vessels composed of elongated cells having truncate ends. Vessel member length ranges from 424-1013 µm; breath 70-175 µm. Vessels irregularly distributed, perforation simple, vessel ends transverse, the intervessel pits simple and alternate. Xylem rays numerous, uniseriate to multiseriate, 5-10 rays per sq mm. Ray tissues homogenous, homocellular consisting wholly of procumbent cells; ray 6-12 cells high; 55-350 µm long; and 1-4 cells wide. Diameter of procumbent cells range 10-19 µm; Fibres libriform and septate, 5-14 µm in diameter and length of the fibres range 320 - 629 µm (Plate 2 Fig. 5 & 6. Text plate 2 & 3).

Plate 1



Fig. 1

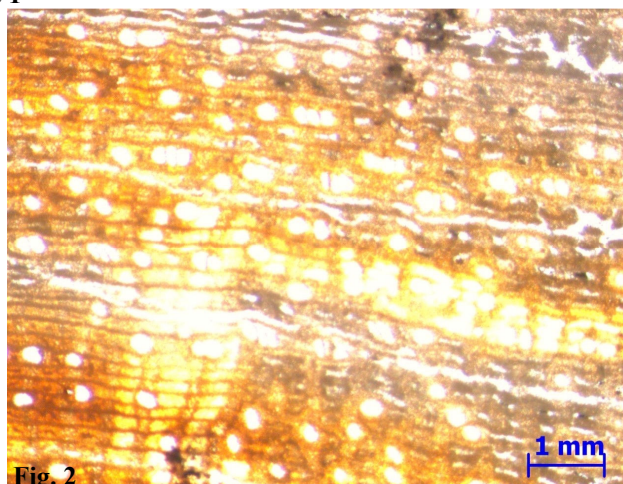


Fig. 2

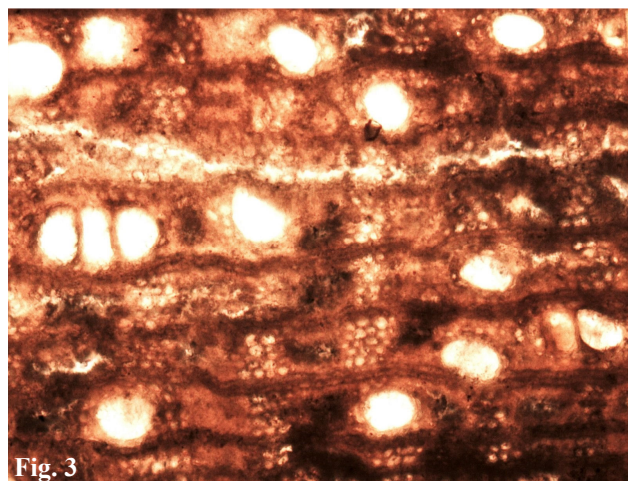


Fig. 3

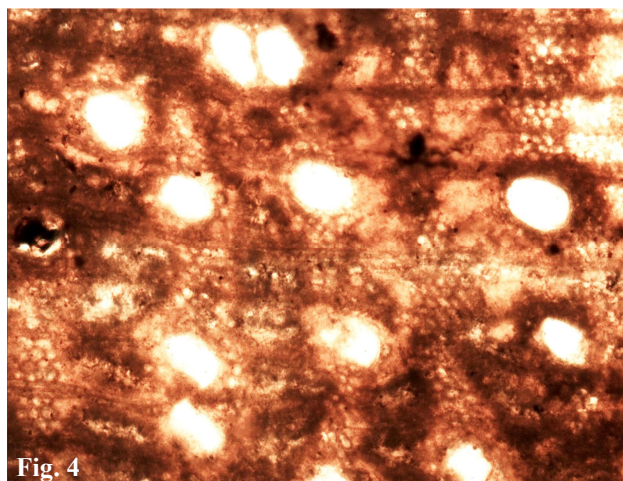


Fig. 4

Andiroxylon thanobolensis sp. nov

Fig. 1. Holotype of fossil wood.

Fig. 2. Cross section showing general distribution of vessels and parenchyma, X 30

Fig. 3. Cross section showing solitary and multiple vessels with banded parenchyma and xylem rays, X 40.

Fig. 4. Cross section showing vessels with banded to confluent parenchyma and occasionally aliform, X 40.

Radial longitudinal section: The vessels are composed of elongated cells, Length of the vessel member ranges 290–860 μm ; and breadth ranges 80–180 μm . Perforation simple, vessel ends transverse, wall of the vessels provided with simple pits. Parenchyma in 4–6 layer around the vessel, 14–25 μm wide, 23–45 μm in height. Xylem ray cells 31–45 μm long and 8–10 μm broad. Fibres libriform, septate, round to polygonal (Plate 2 Fig. 7 & 8).

Affinities: The important anatomical character of fossil wood are the diffuse type of vessels which are solitary and in radial multiple of 2 and 3, having irregular distribution and the very characteristics tangential bands of parenchyma and fibers which regularly alternate forming successive rows of almost equal width, Chowdhry & Ghosh (1946) have grouped timber having parenchyma and fibers in concentric and alternating band in to three main type.

I. Thin band of parenchyma alternate with thick band of fibers and the parenchyma band narrower, being 2–4 cells wide, where the fibers bands are broader, having 10 cells e.g. *Lophopetalium*, *Alstoinum*.

II. Parenchyma and fibers bands have equal width e.g. *Bauhinia* and *Cynometra*

III. Parenchyma bands are broader than the fibers bands e.g. *Erythrina*, *Pongamia* and *Sterculia*.

The fossil wood under investigation in view of equal width of parenchyma and fibers bands is referred to group three above. Chowdhury & Ghosh (1946) has limited timbers of 16 families with 40 genera in this group among them the wood of *Guttiferae* (*Garcinnia*, *Ravea*, *Rheedia* and *Symphonia*). Resemble to the specimen under investigation in having fiber and parenchyma bands of equal width. However, they differ distinctly in having broad and high rays. A few member of family *Urticaceae* (*Ficus*, *Malaisa*, *Aphwanthe*) are also comparable with the fossils having fibers and parenchyma bands of equal width. But the large variation in the size of vessel rays and presence of tracheids keep them apart *Terminalia belieria*. although posses' alternative bands of parenchyma and fibers yet it is differ conspicuously in having exclusively uniseriate rays and vested pits. In Leguminaceae *Bauhinia*, *Erythrina*, *Pongamia*, *Cynometra*, *Clitoria* and

Baphis are comparable with fossil wood under investigation. They genus *Erythrina* and *Pongamia* can be eliminated as they have thicker parenchyma and also *Bauhinia* can be separated due to its characteristic ripple marks. The present fossil wood does not match with *Clitoria*, as the later distinctly posses two distinct type of vessel; one larger and other smaller similarly *Baphia* can be excluded as it possesses storied arrangement of ray cells. The fossil under investigation shows close resemblance with genus *Andira* as both share most of the common character such as diffuse porous wood with medium and large size vessels. parenchyma banded to confluent, Rays are uniseriate to multiseriate. The genus *Andira* consist of 23 woody species distributed throughout tropical America and also occurs in Africa. (Willis, 1966).

Comparison with reported fossil woods: The fossil wood under investigation, show close affinity with genus *Andira*, and hence compared with known species of fossil viz *Andiroxylon biseriatum* I, Muller Stoll & Madel, (1978) and *Andiroxylon cinnamoneus*, Martinez- cabera,

cevallos-ferriz-pool ,(2006) which were reported from Kenya in 1978 and from Mexico in 2006 respectively (Table 1).

As the fossil wood under study is not having similarities with the already reported species of *Andiroxylon* in most of its anatomical attributes.

The fossil wood *Andiroxylon biseriatum* shows some similarities to the present wood in the distribution of vessels and the arrangement of parenchyma but differs in Ray cells which are uniseriate to biseriate and hetrocellular shows resemblance to the *Andiroxylon cinnamoneu* under investigation fossil in various characters such as distribution of vessels, arrangement of parenchyma ,width of ray cells ,but *Andiroxylon cinnamoneus* can be separated from *Andiroxlon thanobolensis* by having hetrocellular ray.

The anatomical character in the present wood are enough to separate it as new taxon, and hence it is described as *Andiroxylon thanobolensis* sp. nov. The specific epithet refers to the locality from where this specimen was collected.

Plate 2

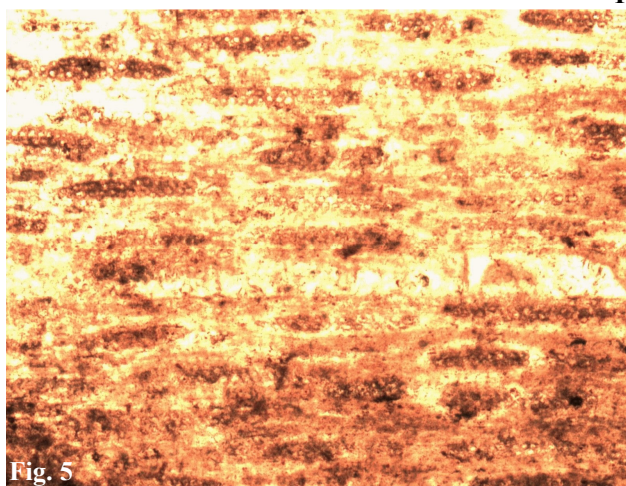


Fig. 5

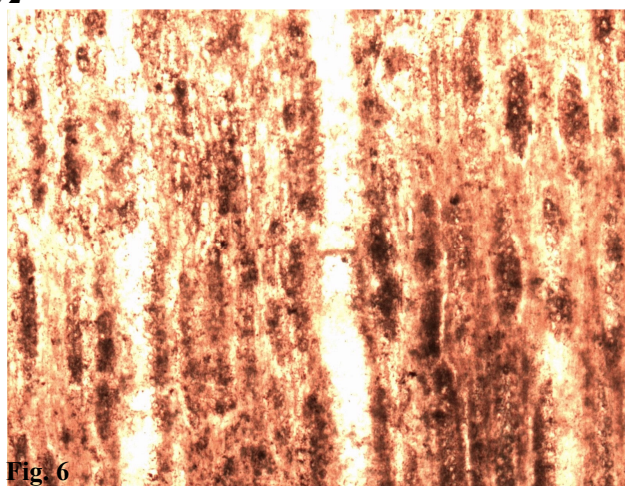


Fig. 6

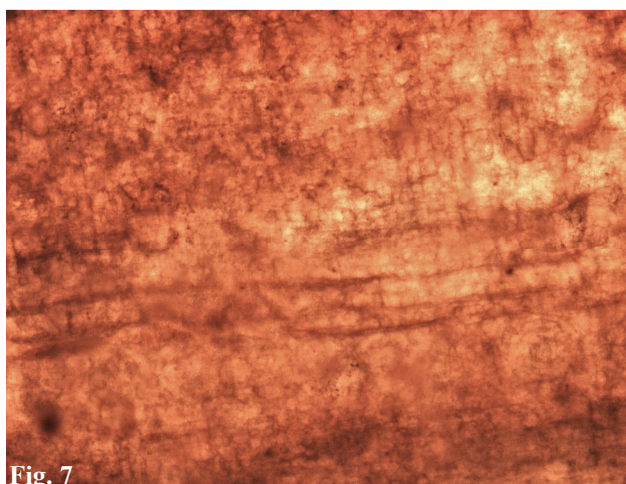


Fig. 7

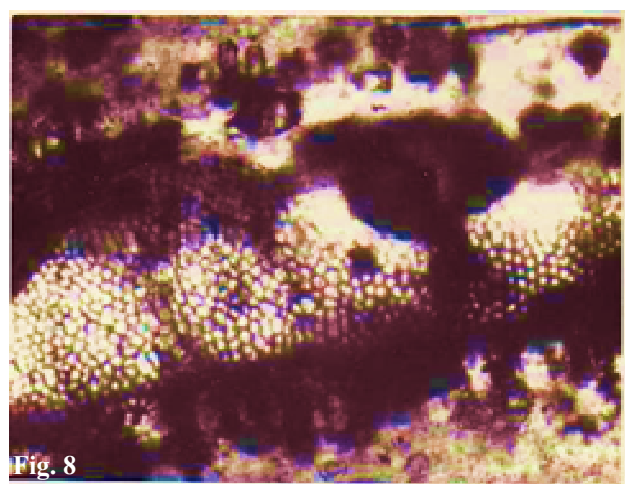


Fig. 8

Andiroxylon thanobolensis sp. nov.

Fig. 05. Tangential longitudinal section showing distribution of rays and end walls, X 40.

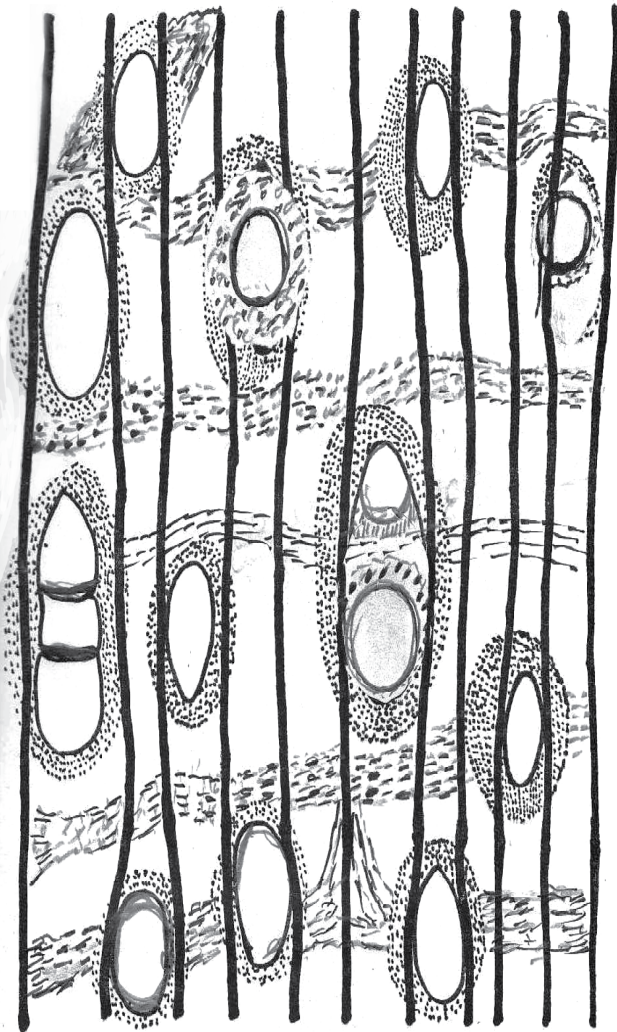
Fig. 06. Tangential longitudinal section showing nature of rays and fibers, X 40.

Fig. 07. Radial longitudinal section showing xylem rays cells, fibers and parenchyma. X 40

Fig. 08. Radial longitudinal section showing pits on the wall of the wall of the vessels, X 600.

Text Plate No. 1

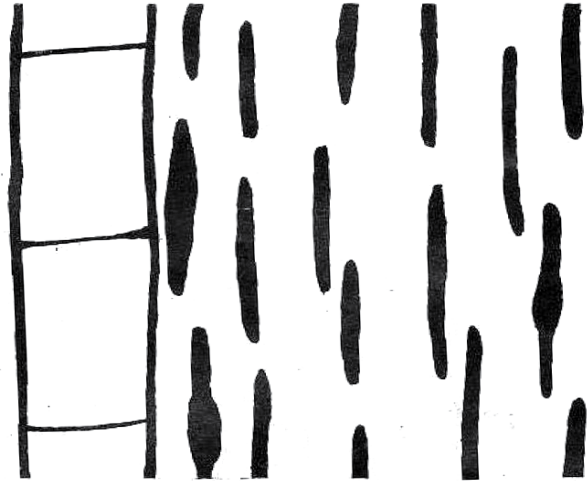
0 1 2 3 4 5
Scale: 1 = 100 μ m



Andiroxylon thanobolanesis sp. nov
Cross Section showing general distribution of vessels, rays and parenchyma.

Text Plate No. 2

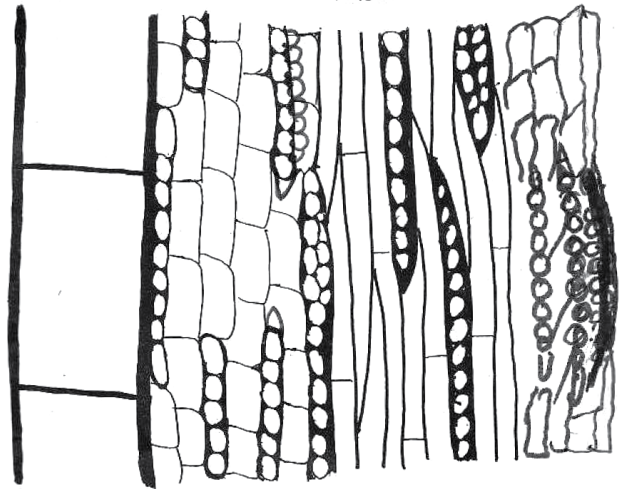
0 1 2 3 4 5
1 : 60 μ m



Tangential longitudinal section showing distribution of xylem rays and end walls.

Text Plate No. 3

0 1 2 3 4 5
1 : 40 μ m



Tangential longitudinal section showing enlarged xylem rays and fibres.

Comparison Table 1. Comparison of Fossil woods related to organ genus *Andira* along with geographical and stratigraphical information.

Name of species	Age	Locality	Wood	Vessels	Wood parenchyma	Xylem Rays	Fibers
<i>Andiroxylon biseriatum</i> , Millerstoll & Madel (1967)	Miocene	Mexico	Diffuse porous	Vessel medium to large, Solitary as well as multiple of 2 some time 3 and 4, 6-8 vessel /sq mm.	Aliform, confluent to banded	Uniseriate to biseriata 10-22 cells high Heterocellular.	Libriform, septate, round.
<i>Andiroxylon cinnamomeus</i> , Martinez- Cabrera, Cevallos-Ferriz- Pool, 2006	Early Miocene	Kenya	Diffuse porous	Vessels medium to large, Solitary as well as radial multiple of 2 and 3, 5-20 vessels/sq mm.	Aliform, confluent to banded	Uniseriate to multiseriate 9-20 Cells high Heterocellular.	Libriform, septate round to polygonal.
<i>Andiroxylon thanobolanensis</i> , sp. nov	Miocene To Pliocene	Pakistan	Diffuse porous	Vessels medium to large, Solitary as well as radial multiple of 2 and 3, 3-4 vessels/sq mm.	Confluent to banded, aliform rare	Uniseriate to multiseriate 6-12 Cells high Homocellular.	Libriform, septate round to polygonal.

Diagnosis

***Andiroxylon thanobolanensis*:** Wood diffuse porous. Growth ring absent. Vessels medium to large sized, solitary as well as radial multiple of 2-3, circular to oval, contact wall flat when in group, lumen of vessels mostly empty. r.d. 200-268 μ m; and t.d. 185-224 μ m., vessel 3-4 per sq mm. Tylosis absent. Parenchyma paratracheal and apotracheal, paratracheal parenchyma confluent to banded, rarely aliform. The parenchyma band bifurcating

at places and joining similar band on upper and lower sides. Xylem rays numerous, uniseriate to multiseriate, forming canal like structure after 3-5 cells of fibers. Ray tissues homogenous, homocellular consisting wholly of procumbent cells; ray 6-12 cells high; 55-350 μ m long; and 1-4 cells wide. Fibres libriform and septate, 5-14 μ m in diameter and length of the fibres range 320-629 μ m. Fibres polygonal thick walled aligned in the rows between the two consecutive xylem rays.

Holotype: 10 km east of Thana Bola Khan, District Jamshoro, Sindh, Pakistan. Shabab Ali; TB-2, 2006 (Paleobotany museum, Institute of Plant Sciences, university of Sindh, Jamshoro, Sindh, Pakistan). Horizon Manchar Formation Age Miocene to Pleistocene.

References

- Ahmed, B., C.R. Arain and K.M. Khan. 1993. Two new species of *Terminalioxylon* from Ranikot Fort Area, district Dadu, Sindh, Pakistan. *Sindh Uni. Res. Jour.* (Sci. Ser.), 23: 27-41.
- Ahmed, B., M.Z. Khan, M.T.M. Rajput and K.M. Khan. 1991a. *Mangiferoxylon pakistanicum* sp. nov. a new fossil species of the family Anacardiaceae from Ranikot Fort Area. *Pak. J. Bot.*, 23: 62-69.
- Ahmed, B., A.M. Abbassi, Asfraf Bano and K.M. Khan. 1991b. *Duabangoxylon pakistanicum* sp. nov. A new taxon of Sonneratiaceae from Ranikot fort area. *Pak. J. Bot.*, 23(1): 55-61.
- Ahmed, B., T. Rajput and K.M. Khan, K.M. 1991c. *Siderinium pitensis* sp. nov. A New Species of Silicified Fossil Dicot Wood from Tertiary Deposits of Sindh, Pakistan. *Pak. J. Bot.*, 23: 236-242.
- Ahmed, B., M. T. M. Rajput, and N. Soomro. 2007a. *Anogeisoxylon rehmannens* sp. nov. A New Fossil Species of Family Combretaceae from Rehman Dhoru Dist. Jamshoro, Sindh, Pakistan. *Pak. J. Bot.* 39: 2337-2344.
- Ahmed, B., M.T.M. Rajput, S. J. Nabila and N. Soomro. 2007b. *Euphorioxylon thanobolensis* sp. nov. A New Species of Fossil Wood Family Sapindaceae from Thanobolakhana Dist. Jamshoro, Sindh, Pakistan. *Pak. J. Bot.*, 39: 2317-2325.
- Ahmed, B., M. T. M. Rajput and K. M. Khan. 1989. *Laurinoxylon ellipticum* sp. nov. A New Petrified Taxon of Laraceae from the Tertiary Deposits of Sindh, Pakistan. *Sindh Uni. Res. Jour.* (Sci. Ser.), 21: 29-36.
- Barefoot, A.C. and F.W. Hankins. 1982. *Identification of modern and Tertiary woods*. Clarendon press, London.
- Bhutto, I., Ahmed, B., C.R. Arain and K.M. Khan. 1993. *Lagarstromiaxylon ranikotensis* sp. nov. A New Species of Lythraceae from the Tertiary Sequences of Sindh, Pakistan. *Sindh Uni. Res. Jour.* (Sci. Ser.), 22: 25-32.
- Blanford, W.T. 1879. On the geology of western Sindh. Ind. Geol. Survey. Mem. Volume 10, part 1, Calcuta, India. pp. 1-196.
- Chowdhuri, K.A. and S.S. Ghosh. 1946. On the anatomy of *Cynometroxylon indicum* sp. nov. A fossil dicotyledonous wood from Nailalung, Asam, proc. *Natn. Inst. Sci.*, India, 29: 435-447.
- Esau, K. 1959. Anatomy of seed plant. *John Wiley*. pp. 109-113.
- Fahn, A. 1969. Plant anatomy. *Pergaman*, pp. 320-322.
- Khan, K.M. and M.T.M. Rajput. 1976. *Laurinoxylon rehmanense* sp. nov. A New Species of Fossil Dicot. Wood from Tertiary Rocks of Sindh, Pakistan. *S. μ. Res. J.* (sci. ser.) 9: 5-13. (1975-76). *Sindh Uni. Res. Jour.* (Sci. Ser.), 9: 5-13.
- Khan, K.M. and Ch. Rehmatullah. 1968. *Sapindoxylon petaroensis* sp. nov. A New Species of Dicot Wood from the Late Tertiary Deposits of Sindh. *Sindh Uni. Res. Jour.* (Sci. Ser.), 3: 137-142.
- Khan, K.M. and Ch. Rehmatullah. 1971. *Albizioxylon dhaproense* sp. nov. A New Species of Silicified Fossil Wood from Ranikot Formation (Paleocene) near Amri, Sindh. *Sindh Uni. Res. Jour.* (Sci. Ser.), 5: 207-213.
- Khan, K.M., M. R. Ahemd and Ch. Rehmatullah. 1972. *Palmoxyylon amriense* sp. nov. A New Species of Palm from Ranikot Formation (Paleocene) near Amri Sindh. *Palaeontographica Abteilung B*, 132: 128-129.
- Khan, K.M. and M.T.M. Rajput. 1976. *Laurinoxylon rehmanense* sp. nov. A New Species of Fossil Dicot. Wood from Tertiary Rocks of Sindh, Pakistan. *Sindh Uni. Res. Jour.* (Sci. Ser.), 9: 5-13.
- Khan, K.M. and Ch. Rehmatullah. 1968. *Sapindoxylon petaroensis* sp. nov. A New Species of Dicot Wood from the Late Tertiary Deposits of Sindh. *Sindh Uni. Res. Jour.* (Sci. Ser.), 3: 137-142.
- Khan, K.M. and Ch. Rehmatullah. 1971. *Albizioxylon dhaproense* sp. nov. A New Species of Silicified Fossil Wood from Ranikot Formation (Paleocene) near Amri, Sindh. *Sindh Uni. Res. Jour.* (Sci. Ser.), 5: 207-213.
- Martinez-Cabrera, H. I., S. R. S. Cevallos-Ferriz & I. Poole. 2006. Fossil woods from Early Miocene sediments of the El Cien formation, Baja California Sur, Mexico. *Rev. Palaeobot. Palynol.* 138: 141--294.
- Metcalf, C.R. and L. Chalk. 1950. Anatomy of the Dicotyledones. Vol. I & 2, Oxford press. Oxford.
- Müller-Stoll, W.R. and E. Mädel. 1967. Die fossilen leguminosen-hölzer. Eine revision der mit leguminosen verglichenen fossilen hölzer und beschreibung älterer und neuer arten. *Palaeontographica.*, 119B: 95-174.
- Soomro, N., B. A. Arain and M. T. M. Rajput 2014. *Ougenioxylon chinjiensis* sp. nov., a New Fossil Species of the Family Leguminosae from Chinji Formation Salt Range, Punjab Pakistan. *American Journal of Plant Sciences*, 5: 3745-3751
- Pascoe, E. H. Kt. 1963. Manual of the geology of India, Pakistan & Burma. Vol.3, 3rd Ed. Govt. Press of India.
- Rajput, M.T.M. and K.M. Khan. 1982. Two new species of fossil woods from Ranikot fort area of Sindh. *Pak. J. Bot.*, 14: 75-87.
- Rajput, M.T.M. and K.M. Khan. 1984. *Araucarioxylon* sp. A Silicified Gymnosperm Wood from Manchhar Formation. *Pak. J. Bot.*, 16: 53-60.
- Rajput, M.T.M., S.T. Syeda and K.M. Khan. 1985. *Myristicoxylon ranikotensis* sp. nov. A Silicified Dicot Wood from Ranikot Fort Area, District Dadu, Sindh. *Pak. J. Bot.* 17, 247-252.
- Rehmatullah, Ch., Z.A. Nizamani, and K.M.Khan. 1984. *Palmoxyylon surangei* Lakhnupal (1955). A Petrified Wood from Dhapro Stone Beds (Lower Paleocene) of Rehman Dhoru, District Dadu, Sindh, Pakistan. *Pak. J. Bot.* 16: 61-64.
- Saeed, M., Z.A. Nizamani and N.M. Bhatti. 1984. Anatomical Studies of a Stem Fossil from Ranikot Fort Area, District Dadu, Sindh, Pakistan. *Sindh Uni. Res. Jour.* (Sci. Ser.), 16: 35-40.
- Shar, M., S.A.S. Trimizi and B.Ahmed. 2007. *Shoreoxylon ranikotensis* sp. nov. A New Species of Fossil Wood Dipterocarpiaceae from Ranikot Fort Area, District Jamshoro, Sindh, *Pak. J. Bot.*, 39: 2327- 2335.
- Weatherhead, A.V. 1938. The preparation of micro-sections of rocks. Watson Microscope record. 43.p.3 London.
- Willis, 1966. A Dictionary of flowering plant and ferns. Cambridge University Press, Cambridge.

(Received for publication 15 January 2015)