

## CENOZOIC WOODS FROM BIKANER, INDIA- ANATOMY OF FOUR SPECIES OF *DRYOXYLON* SCHLEIDEN

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### ABSTRACT

Anatomy is described of petrified woods of *Dryoxylon* Schleiden collected from the Neogene rocks of Bikaner. These are grouped into four species on the basis of distribution of vessels, parenchyma and nature of wood rays. Comparison is made with the allied extant taxa of angiosperms.

**Keywords :** Neogene, Angiospermous woods, Western Rajasthan.

### Introduction

Cenozoic rocks of western Rajasthan are divided into four basins i.e. Bikaner-Nagaur, Jaisalmer, Barmer and Sanchor (Bhatia 1977, Das Gupta 1975, 1977). Bikaner- Nagaur Basin is further divided into three formation i.e. Jogira formation, Palana formation, and Kolayat formation. The present material of petrified woods comes from Jogira formation. Anatomy of a number woods have been described from The Neogene rocks of Western Rajasthan assigned to the family Anacardiaceae, Lythraceae, Lacythidaceae, Combrataceae, Sonneratiaceae, Meliaceae etc. (Guleria 1983, 1984, 1990, Harsh 1990, Harsh & Sharma 1990, Harsh et al 1992, Sharma & Harsh 1997). The fossil wood taxa described are *Glutoxylon burmense*, *Mengiferoxylon assamicus*, *Lagerstoemioxylon eo-flosreginum*, *L. ef. Eoflosreginum*, *L. parenchymatosum*, *L. vesicentricum*, *L. obliqueporatum*, *L. eohypolucum*, *L. harsolavense*, *L. royi*, *L. florebunda*, *Barringtonioxylon rajasthanensis*, *Carioxylon awasthi*,

*Terminalioxylon bikaneriense*, *T. eo-olivera*, *T. vescicentricum*, *Anogeissusoxylon guptai*, *A. harsolavense*, *Duabungoxylon krishnii*, *Dysoxylumoxylon* sp. and four species of *Droxyylon* described in this paper. In addition to petrified woods, other Neogene plant remains occur in form of impression of leaves either on sand or on fullers earth (Bose 1949, 1952, Deshmukh & Sharma 1978, Lakhanpal 1964, Lakhanpal & Bose 1951) or the lignite in form of cuticle, spores and pollen grains etc. (Rao & Vimal 1950, 1951, 1952, Tripathi & Sharma (1996, 2000, 2000a, 2000b, Tripathi et al 1998, 1999). The generic name *Dryoxylon* is used when exact relationship is untraceable of the fossil angiospermous wood. Description of four such woods has been included in this paper.

### Material and Method

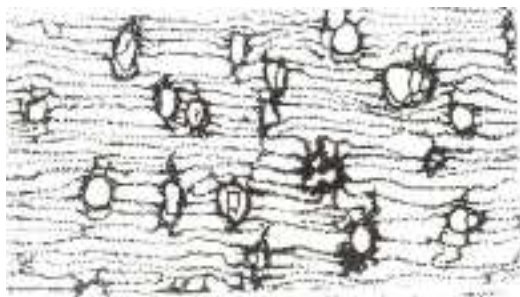
The material has collected from different sites surrounding Bikaner city either scattered on surface or embedded in subsurface approximately at depth of two meter or more. Some of the larger loggs

are horizontally embedded while smaller ones are in different directions. The woods are silicified and without preservation of cortex. Sections were cut with the help of a diamond edge wheel and slides were prepared by the usual method of cutting, grinding and polishing techniques. These were mounted in Canada balsam. The type slides were deposited at the conservatory of Birbal Sahni Institute of Palaeobotany - Lucknow (U.P). India.

### Description

#### (1) *Dryoxylon cazmii* sp. nov.

(Plate Fig 1)



T. S. Wood, diffuse porous, tangentially flattened, solitary and multiple of 2-3 cells vessels, single layered thick walled fibers demarcating growth ring,  $\times 40$ .

**Diagnosis** – Wood diffuse porous, growth rings demarcated by a single layer of thick walled fibers, Vessels small to moderately large, oval to tangentially flattened, solitary and in multiple (3-4), evenly distributed (5-7 / mm<sup>2</sup>), diameter 110-200  $\mu$ m and 66-140 $\mu$ m, length 260-280  $\mu$ m ; end walls little oblique, tylosis present ; parenchyma paratracheal, vasicentric (2-3 cells wide ) or aliform, apotracheal sparse and diffuse ; xylem rays exclusively uniseriate, frequency 11-13 / mm<sup>2</sup>, 4-25 cells high, 142-830  $\mu$ m in length, homogenous ; fibers mostly septate, lumen absent.

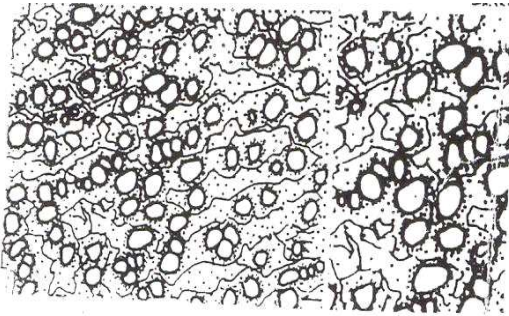
Holotype – BKN 77, slide no. 77 / 1-5  
Locality & Horizon – Harsolav, Eocene  
Collection present – BSIP, Lucknow,

This type specimen is whitish yellow silicified of wood measuring 11  $\times$  6  $\times$  4 cm in size wood diffuse porous, growth rings demarcated by a single layer of thick walled fibers. Vessels small to moderately large, oval to tangentially flattened, approximately 50 % vessel solitary remaining ones are in radial multiple of 3-4 vessel evenly distributed, frequency 5-7 /mm<sup>2</sup>, diameter 110-200 $\mu$ m and 66-140 $\mu$ m terminal pores transverse to little oblique; tylosis present frequently. Paratracheal parenchyma distinct, vesicentric 2-3 layers surrounds a vessel or a group of vessel. Sometimes aliform, apotracheal parenchyma diffuse and septate. Parenchyma cells circular to oval in cross section. Fibers not very distinct aligned in radial, 2-3 rows between consecutive rays, angular in cross section, average diameter 17  $\mu$ m, at growth rings lumen is absent

Xylem rays narrow, uniseriate, homocellular, 4-25 cells in height and measure 140-830  $\mu$ m in length, procumbent cells measure 30-32  $\times$  32-35  $\mu$ m. Radial longisection does not show pittings on tracheid and vessel

**Comparison** - In presence of diffuse porous wood, indisnt growth rings, solitary and multiple vessels and uniseriate rays, this wood shows resemblance with the taxa of Combretaceae and Sonneratiaceae. But want of good preservation of rays, pitting on tracheary elements and the parenchyma in the present material, tentatively it is described as *Dryoxylon cazmii* sp. nov. Specific name is given in honour of an eminent wood anatomist Dr. M.A.H. Cazmi of Forest Research Institute, Dehradun (India).

(2) *Dryoxylon lineariporatum* sp. nov.  
(Plate Fig 2)



T. S. Wood, diffuse porous, vessel extremely small, solitary and multiple of 2-3 cells and radially arranged vessels,  $\times 40$

**Diagnosis** – Diffuse porous, growth rings indistinct, vessels extremely small, circular, mostly solitary or radial multiples 2-4, evenly distributed in radial rows, diameter 30-84  $\mu\text{m}$  and 33-105  $\mu\text{m}$ , frequency 27-30/mm<sup>2</sup>, length of vessel 85-280  $\mu\text{m}$ , crystals and tylosis abundant. Xylem rays multiseriate (2-5 cells), short 7-20 cells in height and measure 175-490  $\mu\text{m}$  in length, homogeneous, 8-11/mm<sup>2</sup>. Fibers circular to angular, 3-5  $\mu\text{m}$  thick, separate with crystal.

Holotype - BKN 87, Slide no. 87 / 1-6  
Locality & Horizon - Karmisar, Eocene.  
Collection present - BSIP, Lucknow

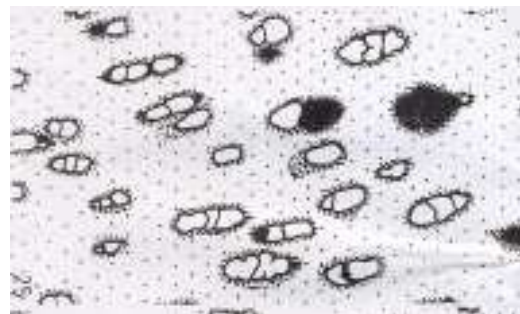
A triangular, blackish-brown petrified piece of wood measuring 25  $\times$  12  $\times$  6.5 cm. Surface white-yellow. Wood diffuse porous with no variation in size of pores between early and late woods. Growth rings indistinct, vessels narrow, 80 % solitary remaining ones radial multiple of 2-4 vessel. Vessels arranged in radial rows between straight broad rays. Frequency of vessels 17-29/mm<sup>2</sup>, size 30-84  $\mu\text{m}$  in radial thickness. Perforation plate simple. Tylosis and crystal abundant in vessel. Parenchyma is paratracheal vesicentric to paratracheal zone. Fibers

aligned to radial rows in between broad rays, circular to angular in cross section with average diameter 23  $\mu\text{m}$ , commonly septate, crystals present.

Xylem rays short in length, multiseriate (2-5), 7-20 cells high measuring 175-490  $\mu\text{m}$  in length, homocellular, frequency 8-11 / mm<sup>2</sup>, procumbent cells measure 23-26  $\mu\text{m} \times$  22-25  $\mu\text{m}$ .

**Comparison** - The present material is peculiar in frequency and arrangement of vessel and multiseriate short rays. Comparison is made with the taxa of the family Dipterocarpaceae, Meliaceae, Bignoniaceae, and Flacourtiaceae etc. both at the Forest Research Institute, Dehradun and Birbal Sahni Institute of Palaeobotany, Lucknow. The expert anatomist consider the material a new one and as such it is named as *Dryoxylon lineariporatum* sp. nov.

(3) *Dryoxylon bikaneriense* sp. nov.  
(Plate Fig. 3)



T. S. Wood, semi ring porous, vessel oval to flattened or elongated, solitary and multiple of 2-5 cells,  $\times 40$

**Diagnosis** – Wood semi-ring porous, growth rings demarcated by little larger vessels, thin layer of terminal parenchyma and thick walled fibers; vessel small to moderately large, oval majority are in multiple of 2-4, solitary vessels also exist, evenly distributed,

8-11 / mm<sup>2</sup>, arranged in radial lines, diameter 50-165 and 85-210 µm, length 150-1050 µm, some vessels are plugged with dark contents, parenchyma also paratracheal vascentric (1-2 cells thick) to aliform, apotracheal parenchyma diffuse. Xylem rays uniseriate, homogenous.

Holotype - BKN 93, Slide no. 93/1-6  
 Locality & Horizon - Harsolav, Eocene.  
 Collection present - BSIP, Lucknow

Well preserved small piece of petrified wood measuring 12 × 3.5 × 2.5 cm, brownish in colour, wood semi-ring porous, early and late wood vessels not very distinct and show a tendency towards diffuse porosity. Growth rings present demarcated by little larger pores, thin layer of terminal parenchyma and thick walled fibers. Vessels small to moderate large, majority in multiple of 2-4, solitary vessel also present frequently 8-11/mm<sup>2</sup>, diameter ranges 50-165 × 83-230 µm, length varies from 50-1050 µm, perforation plate simple and transverse.

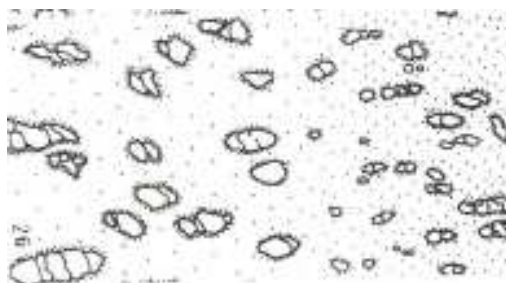
Parenchyma both paratracheal and apotracheal, paratracheal vascentric to aliform; apotracheal diffuse, solitary cells are seen scattered in ground tissue. Parenchymatous cells are seen circular in cross section, 28-30 µm in diameter. Fiber aligned in radial 1-4 (mostly 2) rows consecutive rays, angular or little circular in cross section, 13-14 µm in diameter. Xylem rays poorly preserved, uniseriate, homogenous, other details not available.

**Comparison** - The present wood resembles in gross morphology with the taxa like *Terminalia*, *Sonneratia* and *Duabunga* but differs in anatomical details. For want of better preserved material details of xylem rays and pittings on radial walls of tracheary

elements are unknown and as such the comparison remains incomplete. Tentatively it is identified as a new species of *Dryoxylon*, *D.bikaneriense*.

**(4) *Dryoxylon jasodai* sp. nov.**

(Plate Fig 4)

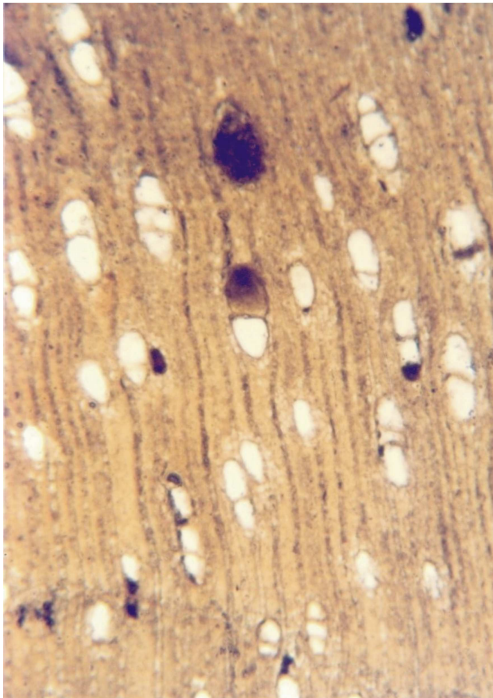


T. S. Wood, semi ring porous, vessel oval to flattened, solitary and multiple of 2-5 cells, vessels which grade gradually into smaller vessels, wavy, radial apotracheal bands forms reticulations with rays. ×40.

**Diagnosis** - Wood semi-ring porous, growth rings present demarcated by little larger vessels which reduce gradually to smaller vessels, small to moderately large, oval to tangentially flattened, in radial multiple 2-5 (generally 3), evenly distributed 13-15/mm<sup>2</sup> in early wood and 20-23/mm<sup>2</sup> in late wood, diameters 150-200 µm and 170-180 µm in early wood whereas 33-41 µm and 42-43 µm in late wood, length 33-490 µm, intervessel pits angular, paratracheal parenchyma absent, apotracheal parenchyma is terminal and in radial bands forming network with rays. Xylem rays short, uni to triseriate (mostly biseriate), exclusively homogeneous, 7-37 cells high measuring 165-915 µm in length; fibers fine, septate, angular with diameter 25 µm.

Holotype - BKN 97, Slide no. 97 / 1-6  
 Locality & Horizon - Sansolav, Eocene.  
 Collection present - BSIP, Lucknow





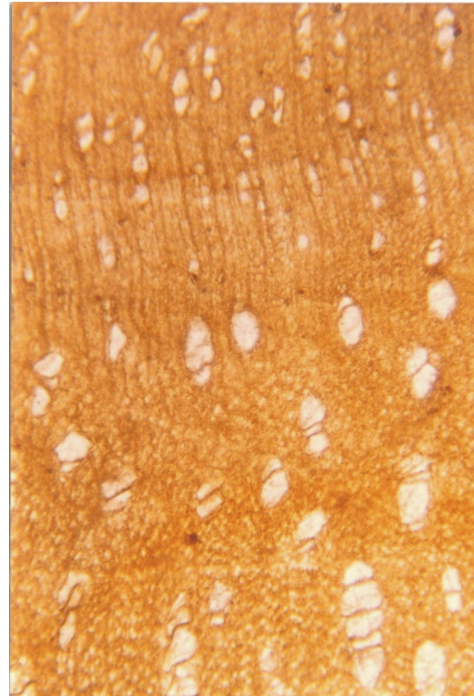
**A**



**B**



**C**



**D**

A well preserved petrified piece measuring 6 × 4 × 3 cm in size and light brown in colour. Wood semi-ring porous, early and late wood pores distinct; growth rings present demarcated by larger vessel at the beginning of rings and which reduce gradually into smaller pores towards the end of the rings, growth rings is also demarcated by thick walled fibers zone at the end of ring; terminal parenchyma present.

Vessels very small to moderately large, tangentially flattened in shape, mostly in radial multiple of 2-5 (generally 3), evenly distributed, 13-23/mm<sup>2</sup>; tylosis abundant. Vessel range in diameter 150-200 μm tangentially and 170-180 μm radially in early wood, whereas 33-41 μm tangentially and 42-43 μm radially, vessel members long 33-498 μm long, perforation plate simple and transverse, inter vessel pits angular.

Parenchyma – paratracheal absent, apotracheal terminal as well as in radial bands forming network with the rays, Fibers aligned in 3-6 wavy radial rows between two consecutive rays, circular angular in cross section, diameter (25μm), septate, interfiber pits distinct. Xylem rays fine, short, uni to triseriate (majority are biseriate), exclusively homogeneous, 7-27 cells high, measuring 165-915 μm in length separated by 3-6 rows of fibers.

**Comparison** – Interesting feature of the present wood is absence of paratracheal parenchyma, apotracheal parenchyma arranged in tangential line forming network with the rays; semi-ring porous, bi to triseriate rays, thick walled fibers, vessels in multiple of 2-5 and abundant tylosis. Considering these characters it is compared with the taxa of Rubiaceae, Euphorbiaceae, Sapotaceae, Lacythidiaceae, Abenaceae, Malvaceae, Bombacaceae, and Tiliaceae (Metcalfe & Chalk 1950, Purkayastha 1982, Purkayastha & Kishanlal 1982).

## Discussion

The occurrence of fossil wood on surface and sub-surface at a depth of two meters or more in the gravel soil suggest that these plants did not grow at the site of occurrence but migrate from distant place and deposited near Bikaner area and became fossilized. The placement of fossil woods in different direction (horizontal, vertical and oblique) also favors migration through water (river) and deposition in the area during Eocene period.

During Eocene in addition to depositions in fresh water i.e. silicified woods, leaf impressions on sand stones and the lignite, marine rocks bearing plants and animals on fullers earth also exist at several places e.g. Kolayat (Bikaner), Kapurdi (Barmer) etc. Fossil woods from Jogira formation Bikaner include plants of Tropical and humid climate say *Mangiferoxylon*, *Gluttoxylon*, *Lagerstroemioxylon*, *Terminalioxylon* etc. The four species of *Dryoxylon* described in this paper also show typical anatomical character of Tropical humid climate plants.

*Dryoxylon cazmii* resembles *Terminalioxylon* in vessel distribution and uniseriate rays but it has neither upright cells nor parenchyma like *Terminalioxylon*. *D. lineariporatum* is peculiar in having very small sized pores in close arrangement and multiseriate rays. It has been compared with *Hardwickia* of Leguminosae. *D. bikaneriense* has semi-ring porous wood with both paratracheal (vasicentric), and apotracheal parenchyma. It could not be compared with any known extinct or extant plant. *D. jasodai* has semi-ring porous wood with only apotracheal parenchyma in bands and multiseriate rays It may be compared with *Caryoxylon* in presence of apotracheal parenchyma bands but differs in other anatomical characters.

## Description of plates

***Dryoxylon bikaneriense*** sp. nov.

T. S. Wood, semi ring porous, vessel oval to flattened or elongated, solitary and multiple of 2-5 cells, X40.

***Dryoxylon cazmii*** sp. nov.

T. S. Wood, diffuse porous, tangentially flattened, solitary and multiple of 2-3 cells vessels, single layered thick walled fibers demarcating growth ring, X40.

***Dryoxylon lineariporatum*** sp. nov.

T. S. Wood, diffuse porous, vessel extremely small, solitary and multiple of 2-3 cells and radially arranged vessels, X40.

***Dryoxylon jasodai*** sp. nov.

T. S. Wood, semi ring porous, vessel oval to flattened, solitary and multiple of 2-5 cells, vessels which grade gradually into smaller vessels, wavy, radial apotracheal bands forms reticulations with rays. X40.

## REFERENCES

- Bhatia, S. B. (1977). Palaeontology of Rajasthan- a review. In ML Roonwal (Ed) The natural resource of Rajasthan, **2**: 885-906.
- Bose, M.N. (1949). Angiospermic remains from Barmer sand stone. *Rec Geol Surv India*, **18 (7)**: 246-247.
- Bose, M.N. (1952). Plants remain from Barmer district, Rajasthan. *J Sci Ind Res II B*, **(5)**: 18b-19c.
- Das Gupta, S.K. (1975). A revision of the Mesozoic Tertiary stratigraphy of the Jaisalmer Basin, Rajasthan. *Indian J Earth Sci*, **2 (1)**: 77-99.
- Das Gupta, S.K. (1977). The stratigraphy of west Rajasthan shelf. *Proc 4<sup>th</sup> Colloq Indian Pliocopalaeontol & Strat ONGC Dehradun*: 219-233.
- Desmukh, G.P. & Sharma, B.D. (1978). Fossil plante from The Eocene of Barmer, Rajasthan (India). *Trans Isdt and UCDS, Jodhpur*, **3(2)**: 88-90.
- Gularia, J.S. (1983). Some fossil woods from the Tertiary of district Kuchchh, Western India. *Palaeobotanist*, **31**: 109-128.
- Gularia, J.S. (1984). Occurrence of Anacardiaceous wood in Tertiary of Western India. *Palaeobotanist*, **32**: 35-43.
- Gularia, J.S. (1990). Fossil dicotyledonous wood from Bikaner, Rajasthan India. *Geophytology*, **19**: 182-188.
- Harsh, R. (1990). Studies on the prtrified woods from the Tertiary of Bikaner (Rajasthan) and palaeoecology of the area. Ph.D. (unpublished) JNV Univ. Jodhpur, India.
- Harsh, R. and Sharma, B.D. (1990). A note on a new locality of petrified woods from the Eocene of Rajasthan, India. *Indian J Earth Sci*, **17**: 157-158.
- Harsh, R. & Sharma, B.D. (1995). Petrified Tertiary woods from Bikaner (Rajasthan). *Indian J Earth Sci*, **22 (3)**: 104-109.
- Harsh, R., Sharma, B.D. & Suthar, O.P. (1992). Anatomy of petrified woods of Lecythidaceae and Combretaceae from Bikaner, (Rajasthan) India. *Phytomorphology*, **42**: 87-102.
- Lakhanpal, R.N. (1964). Specific identification of the Guttiferous leaves from the Tertiary of Rajasthan. *Palaeobotanist*, **12**: 265-266.
- Rao, A.R. & Vimal, K.P. (1950). Plant micro fossil from Palana lignite (Eocene) Bikaner. *Curr Sci*, **19**: 82-84.
- Rao, A.R. & Vimal, K.P. (1951). Tertiary pollen from Palana lignite (Eocene) Bikaner. *Proc Indian Sci Congr Banglore*, **P3**.
- Rao, A.R. & Vimal, K.P. (1952). Tertiary pollen from Lignites from Palana (Eocene) Bikaner. *Proc Nat Insti Sci India*, **18**: 596-601.
- Sharma, B.D. & Harsh, R. (1997). Petrified woods from the Tertiary of Rajasthan and Palaeoecology of the area. In *Plant diversification and human welfare*: 129-143 (Eds) AK Roy, JVV Dogra & SK Varma. M D Publication Pvt Ltd, New Delhi.
- Tripathi, R.P. & Sharma, B.D. (1996). Pteridophytic micro fossils from Eocene lignite deposits of Rajasthan. *Indian Fern J*, **13**: 36-39.
- Tripathi, R.P. & Sharma, B.D. (2000). Tracheary elements from lignite (Eocene) of Rajasthan. *Phytomorphology*, **50**: 87-89.
- Tripathi, R.P. & Sharma, B.D. (2000A). Fossil sed cuticles from Eocene lignite deposits of Rajasthan. *Phytomorphology*, **50** : 180-183.
- Tripathi, R.P. & Sharma, B.D. (2000B). Plant diversity during Eocene in Western Rajasthan. Recent Trends in Botanical Research (D D Nautiyal comm. vol.) (Ed) D K Chouhan: 181-188 Deptt. Of Botany, Allahabad Univ. Allahabad (India).
- Tripathi, R.P., Srivastava, K.L. AND Sharma, B.D. (1998). Plant micro fossil from the lignite deposit (Eocene) of Barsinghsar in Bikaner district, Rajasthan, India. *Palaeobotanist*, **47**: 110-115.
- Tripathi, R.P., Sissodia, M.S., Srivastava, K.L. & Sharma, B.D. (1999). Micropalaeontological studies of lignite from Rajasthan. In Geological evolution of North Western India. (Ed) B S Paliwal: 118-128. Scientific Publishers, Jodhpur, India.