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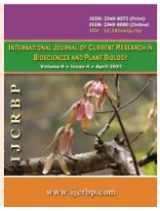

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Palmoxylon wood of *Dracaena* from Neyveli lignite formation, Tamil Nadu, India

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Abstract

The palms are a very diverse group, which mostly distributed in tropical forest, they are large ecological amplitude that extends from temperate environments to deserts and from sea level to high altitudes. The anatomy of the fossil axis shows the anomalous types of secondary growth and critical observations suggest that it belongs to the tribe *Dracaeneae* of the family *Dracaena* as well as to some extent *Cordyline*. The characterized by fossil palm wood is highly indicated the much high rainfall and a moist climates in contrast to the desert and scrub forest. The detailed anatomical study revealed with affinities of the extant genus of *Cordyline* taxa comes under the family Arecaceae. Its geographical range is also distinct, limited by tropical climatic conditions.

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Introduction

Neyveli is one of the thick lignite beds at Cuddalore district of Tamil Nadu was originally thought the Cuddalore Formation. The Neyveli Formations consists of semi consolidated sand stones and clay beds with occasional limestone intercalations followed by carbonaceous clay (fireclay and ball clay varieties) and brownish block lignite. It is overlain by the Cuddalore Formation, which is made up of ferruginous, arkosic, semi consolidated sand stone exhibiting some herring tone types cross laminations (Elayaraja and Kumarasamy, 2016). The lignite consist of well preserved palynofossils like woody and non woody tissues of angiosperm, spores and pollens, cuticles of leaves, resins, fungal spores and fungal fruiting bodies. Apart from these, taxa of ferns and fungi represented by microspores, microstructures and micro planktons also occur in the Neyveli lignite. The Neyveli Formation has indicated marine intercalations pointing to marine transgression during Miocene times (Elayaraja and Kumarasamy, 2016). Present study describes the *Palmoxylon* wood specimen identified from Neyveli, Tamil Nadu, India.

Materials and methods

Many charcoalified wood pieces look like palm collected from the field (Neyveli lignite formation Mine-1). They are dark brown in colour, the fossil axis measures 4-6 cm×1.5-2.5 cm in size. A piece of charcoalified wood was placed in Sodium hypochlorite. Sections were prepared using razor blade. The sections were immersed in sodium hypochlorite solution to get

the transparency. After cleaning, sections were immersed in a solution of 1% safranin for 3-5 minutes. Than rinsed in water, 50% alcohol and then 96% alcohol, until excess stain was removed. Dehydrated sections immersed in xylene before being mounted on glass slides in Canadabalsam. Olympus Trinocular Microscope magnification was used to observe the fossil materials and microphotographs were taken using Olympus SLR Camera attached with Microscope.

Observations

Family : Palmae
Class : Monocotyledons
Family : Agavaceae
Genus : *Dracaena* **(***Palmoxylon* wood)

Description of wood

The external and internal morphology of the *Palmoxylon* wood is depicted in Fig. 1. The vascular bundles and parenchyma are situated internally while parenchyma and fiber strands are seen externally. The meristematic tissue is made up of several layers of cells, transverse section of primary walls may exhibit different forms. Vascular bundles and parenchyma cells are added to the central cylinder. External fiber strands, parenchyma cells are added, contributing the cortex, differentiating new bundles, fiber strands bordering the meristematic evidencing their origin. Vessel element is simple with multiple perforation plate.

Epidermis: Epidermis is represented by a dark layer.

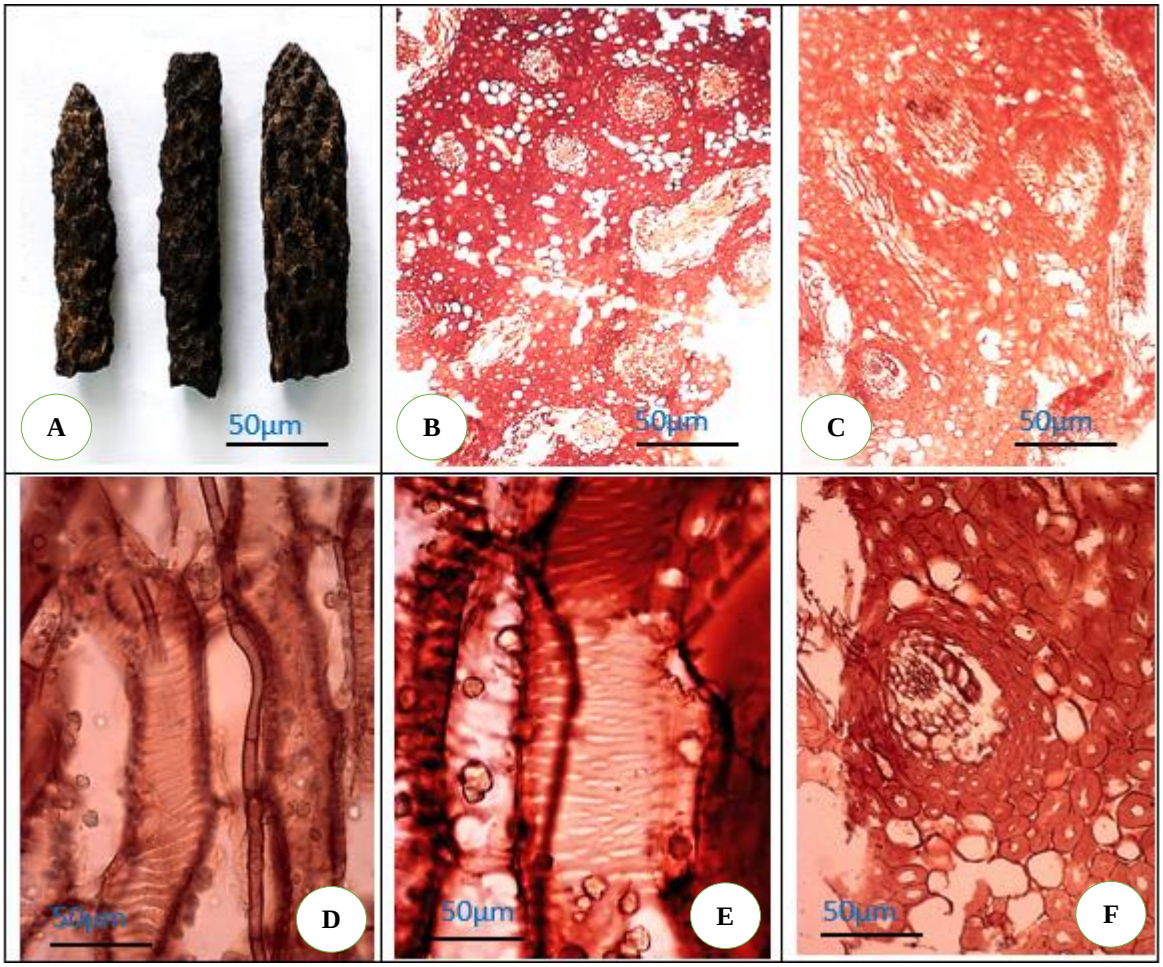

Fig. 1: A. *Dracaena* palm wood, B. *Dracaena* palm wood TS, C. *Dracaena* palm wood TS enlarged, D. *Dracaena* palm wood companion cells, E. *Dracaena* palm wood vessel elements, F. *Dracaena* palm wood vascular bundle enlarged.

Cork: Below the epidermal layer a few cells thick cork zone is present. Although this region is poorly preserved in some places cork cells are found and they are oval to circular in shape.

Cortex: The cells below the cork cells are consisting of thick walled parenchyma cells, which are poorly preserved and form the cortex.

Cambium: It is between the cortex and vascular system and has rectangular to square shaped cells arranged in tiers in transactions. This zone forms the secondary vascular system towards outside and primary vascular system towards centre of the axis.

Secondary vascular system

This region is poorly preserved but in some places it shows the details of the secondary vascular system. The vascular bundles are arranged radially. Each secondary vascular bundle is amphivessal (central phloem surrounded by xylem trachieds). The vascular bundles usually range from 90×140-140×175µm in size, phloem though not fully preserved, shows a few cells in the centre of the bundle, the ground tissue is parenchymatous with thick walled and pitted cells.

Primary vascular system

The primary vascular bundles are scattered in the central ground tissue and are similar in size to those of the secondary vascular bundles but it differs from secondary vascular bundles in having collateral bundles.

Leaf trace bundles

They are scattered in the outer portion of the central cork. The xylem consists of wide angular trachieds with indistinct end plates. They have pitted as well as scalariform thickenings. The ground tissue in the centre is compact and the cells are thick walled with simple pits.

Table 1. *Palmoxylon* wood identified during different geologic times from India.

Species	Country	Age	References
Palmoxylon anjarii	India	Palaeocene	Guleria (2005)
Palmoxylon betulensis	India	Palaeocene	Gayakwad and Patil (1989)
Palmoxylon binoriensis	India	Palaeocene	Guleria and Mehrotra (1999)
Palmoxylon biradarii	India	Upper Cretaceous	Bonde (2002)
Palmoxylon birbhumens	India	Pliocene - Early Pleistocene	Bera and Banerjee (2001)
Palmoxylon canalosum	India	Palaeocene	Guleria and Mehrotra (1999)
Palmoxylon ghoshii	India	Lower Pleistocene	Bera and Banerjee (1990)
Palmoxylon hyphaenoides	India	Eocene	Rao and Shete (1989)
Palmoxylon kamalam	India	Eocene	Datar and Patil (2002)
Palmoxylon licualaense	India	Eocene	Gayakwad and Patil (1989)
Palmoxylon lunarianum	India	Palaeocene	Guleria and Mehrotra (1999)
Palmoxylon mathuri	India	Cretaceous	Agrawal (1995)
Palmoxylon pantie	India	Late Pliocene – Early Pleistocene	Bera and Banerjee (1997)
Palmoxylon ramanujamii	India	Palaeocene	Guleria (2005)
Palmoxylon senii	India	Late Pliocene - Early Pleistocene	Bera and Banerjee (2001)
Palmoxylon sundaram	India	Upper Cretaceous	Bonde (2002)
Palmoxylon takliense	India	Palaeocene	Kapgate (1995)
Palmoxylon taroides	India	Lower Eocene - Palaeocene	Ambwani and Mehrotra (1990)
Palmoxylon trabeculosum	India	Upper Cretaceous	Bonde (2002)
Palmoxylon vaginatum	India	Palaeocene	Guleria and Mehrotra (1999)

Discussion

The palms are mostly distributed in tropical forest. Some plants grow up to 80 m in height. The fossil palm wood collected from different area the world and early period of Cretaceous (Harley, 2006). There are a number of various Tertiary lignite deposits of epochs i.e., Palana (Eocene) in Rajasthan, Neyveli (Miocene) in Tamil Nadu, and Warkalli (Miocene) and Cannanore (Upper Miocene or Pliocene) in Kerala. Many charcoalified woods, pollen and spores, cuticles described from artificially classified and identification with the modern plants, Rajendra and Lakhanpal (1970). The dominant element of the monocots comprises the

fossil palms which are represented by the *Palmoxylon* (31 species) and *Palmocarpon* (8 species) especially of *Palmocaulon, Palmophyllum, Palmostrobus* and *Rhizalmoxyl* (Lakhanpal, 1969).

Studies have been initiated on Tertiary fossils from South India particularly, Formation of Cuddalore and Formation of Neyveli. It was reported that a fossil palm wood *Palmoxylon arcotense* resembles with the living palm *Livistonia* and fossil woods resembling with the *Albizzia, Mangifera* and *Shorea* from the Formation of Cuddalore (Ramanujam, 1953). A monocot palm wood was also described to come under the genus *Palmoxylon pondicherriens* from the Cuddalore sandstones formation, by Sahni (1931). A phoenicoid fossil palm wood belongs to the family Arecaceae has been observed from the sediments of Lameta Formation, Bhisi village in Chandrapur District, Maharashtra, India. Dutta et al. (2007) described a fossil palm wood of *Palmoxylon bhisiensis* from the Bhisi area.

The secondary thickening of growth in palm woods is known as diffuse. The secondary thickening of diffuse name was given by Schoute (1912). The presence of diffuse porous palm wood in some arborescent monocotyledons and increased the thickness of stems by different forms. These cells consist of bidirectionally dividing the lateral meristem and new vascular bundles presented to the central cylinder, and new parenchyma cells formed to both cortex and the central cylinder. The secondary growth is comparable to the palms with some other arborescent monocotyledons, such as *Beaucarnea, Cordyline*, *Dracaena*, (Tomlinson, 1960; Tomlinson and Zimmermann, 1967; Waterhouse and Quinn, 1978). This could be attributed to more humidity and warm conditions during the period of Pre-Eocene, Deccan Intertrappean beds, and higher rainfall and moist climate in contrast to the desert and scrub forests of west in Rajasthan. However, it became drier and warmer after the Miocene in the northern and western India including Vastan (Prasad et al., 2013). So far, many *Palmoxylon* woods of different periods were identified from India (Table 1).

Conclusions

The anatomy of the fossil axis show the anomalous types of secondary growth and critical observations suggest that it belongs to the tribe Dracaeneae of the family *Dracaena* as well as to some extent *Cordyline*. Most of the characters of the present specimen are similar to *Dracaena* stem, so it is placed under the extent genus *Dracaena*. The abundance of the genus *Palmoxylon* known in the area of humid and warm conditions was during the Pre-Eocene Period. So it is presumed that apart from palms this region kind of plants, were also growing during the Neogene time in Neyveli lignite formation.

Conflict of interest statement

Authors declare that they have no conflict of interest.

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