Rhodospathodendron tomlinsonii gen. et sp. nov., an araceous viny axis from the Nawargaon intertrappean beds of India

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ABSTRACT


Rhodospathodendron tomlinsonii gen. et sp. nov., a monocotyledonous viny axis has been described from the Deccan intertrappean beds exposed at Nawargaon, Wardha District, Maharashtra, India. The fossil represents a thin aerial stem, endogenous roots and leaf sheaths. Externally it shows scars of roots. Broad and well differentiated cortex of the stem with a distinct vascular system and trichosclereids; vascular region with compact arrangement of amphivasal, compound and trace bundles and angular vessels suggest its close resemblance with Rhodospatha (Subfamily - Monsteroideae) of Araceae.

Key-words— Rhodospathodendron, Araceae, Petrifications, Deccan Intertrappeans (India).

भारत के नवरागोब अन्तर्ग्रीषय संस्त्रों से प्राप्त रोडोस्पाथोडेंड्रॉन टोम्लिन्सनियाई नव वंश व नव प्रजाति की एक एरेशियस द्वारा पहुँची
एस.डी. बोंडे

सारांश

भारत के महाराष्ट्र प्रात्त के वर्षा जनपद नवरागोब से अनावरित दक्षिण अन्तर्ग्रीषय संस्त्रों से रोडोस्पाथोडेंड्रॉन टोम्लिन्सनियाई नव प्रजाति/एवं नव वंश की एक एकीकृत विकसित अभिलक्षणता की गई है। इसका पादप एक फलिक वायुस्वरूप शक्ति, अन्तर्गत जड़ें तथा पर्यावरण प्रभाव प्रदर्शित करता है। बाहर से यह जड़ों के भिन्न प्रदर्शित करता है। तृणस्तंबर तल पर एवं बिजवायु दृष्टिकोण एवं सुविरोधित तल (रोटेशन), फलोप्प और स्रोत मिश्रण एवं केरवृक्षों के विशिष्ट कुलदाता नव वंश के एरेशियस (उपकुल - मोनस्थीडियाइड) के साथ नियंत्रण समस्तता प्रस्तावित करती है।

संक्षेप शब्द—रोडोस्पाथोडेंड्रॉन, एरेशियस, अध्ययन, दक्षिण अन्तर्ग्रीषय (भारत).
INTRODUCTION

ALTHOUGH majority of pcrmineralized monocotyledonous have been assigned to family Arecaceae (*Palmoxyylon* Schenk, 1882; *Rhizopalmoxylon* Felix, 1883; *Palnostroxyylon* Biradar & Bonde, 1979; *Parapalmoxylon* Bonde, 1987), quite a few of the specimens are identified as members of the Gramineae, Cyperaceae, Scitamineae, Agavaceae and Liliaceae. They have been attributed to *Culmis* (Brongniart, 1822: Paradkar, 1975; Bonde, 1986), *Rhodoculol* (Sapona In: Heel, 1861), *Glycerioxyylon* (Trivedi & Bajpai, 1982), *Elymus* (Pati & Singh, 1984), *Toxilandia* (Nambudiri et al., 1978: Tidwell & Nambudiri, 1989, 1990), *Cyperoxylon* (Chitaley & Patel, 1970), *Scirpusoxylon* (Shete, 1989), *Crellacladodon* (Sahni & Surange, 1953; Biradar & Bonde, 1990), *Dracaena* (Ambwani, 1982), and *Protovucca* (Tidwell & Parker, 1990). *Viracarpus* fruits were shown to have affinities with modern genera of Araceae (Chitaley, 1954; Prakash & Jain, 1963; Nambudiri et al., 1978; Mahabale, 1979). The present paper describes *Rhodospatherodendron tomlinsonii* gen. et sp. nov., an araceous stem from the Deccan intertrappean beds which constitute the first record from intertrappean beds.

MATERIAL AND METHODS

A silicified piece of stem about 8.5 cm in length and 1.5 cm in diameter was collected from the Deccan intertrappean beds exposed at Nawargaon (21°0' North and 78°35' East), Wardha District, Maharashtra, India. Several transverse and longitudinal sections of the wood were prepared by the usual thin section method to study the excellently preserved material. The sections were studied and photographed under the Nikon-LABOPHOT-2 microscope. Specimens are deposited in the repository of Botany Department, Agharkar Research Institute, G.G. Agarkar Road, Pune.

SYSTEMATICS

Family—ARACEAE

Subfamily—MONOSTEROIDEAE

Genus—RHODOSPATHODENDRON gen. nov.

**RHODOSPATHODENDRON TOMLINSONII** gen. et sp. nov.

Pl. 1-A, 1-6; Pl. 2-1-6.

**Description**—The present genus and species is based on a permineralized thin axis. It is entire, round, 8.5 cm long and 1.5 cm in diameter. Externally it shows a number of scars of detached roots and part of leaf sheaths (Pl. 1-A). Internally the axis exhibits three distinct regions: periderm, cortex and the vascular region. Number of endogenous root traces are also present in the cortical region. Leaf sheaths attached to the axis are also present (Pl. 1-1-2).

**Stem axis**—Periderm is thin, 62-125 μm. The cells are thick-walled and compact. Cortex is 1.9-2.5 mm wide with well developed vascular system. The vascular bundles are both large and small, amphivasal, circular, with a single layered bundle sheath, and arranged in 3-6 series. Large vascular bundles are 234 x 234-306 x 270 μm and small vascular bundles are 36 x 36 - 126 x 172 μm in size. Phloem is not preserved and is generally represented by a cavity. Xylem is reduced, consisting 1 or 2 angular vessels, 6.8 x 6.8 - 13.6 x 17.0 μm and xylem parenchyma enclosing the phloem. The bundle sheath is a single cell layer, encircling the vascular elements. The cells are sclerenchymatous and polygonal in cross section. The ground tissue is parenchymatous with thin-walled, 34 x 30.6 μm cells. Some of the cells are occluded with dark deposit. Brachysclereids are abundant measuring 45.3 x 30.2 - 75.5 x 60.4 μm (Pl. 1-3-4).

**Vascular region**—It is 9-4-10.6 mm in diameter. The vascular bundles are compactly arranged throughout the region. However, they are more crowded at the periphery, forming a thin vascular cylinder. The bundles are collateral, amphivasal and compound but mostly collateral and amphivasal at the periphery. The frequency of compound bundles is higher near the centre (Pl. 1-1-2). The collateral bundles are round to elongated, 234 x 193 - 268 x 252 μm. The amphivasal bundles are 180 x 162 - 366 x 268 μm. The compound bundles are irregular in shape depending upon the number and orientation of the fusing bundles. Each vascular bundle has a tangentially elongated phloem and 6-12 angular xylem vessels. Vessels are 63 x 55 - 71 x 34 μm in diameter and show an oblique endplate with a large number (8-14) of cross bars. The encircling bundle sheath is single layered. The ground tissue is

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PLATE 1

A & 1-6, petrified araceous stem - *Rhodospatherodendron*.

1. Petrified axis showing root scars - 1 x 1
2. Cross section of the stem showing periderm, cortex and vascular region x 6.
3. Cross section enlarged, showing compact arrangement of vascular bundles x 10.
4. Cortical region showing amphivasal vascular bundles and brachysclereids x 45.
5. The same showing cortical bundles with single layered bundle sheath, compact ground tissue and brachysclereids x 140.
6. Vascular region showing compact arrangement of vascular bundles x 60.
7. The same enlarged, showing amphivasal bundles with angular vessels x 140.
parenchymatous. The cells measure 20-4 x 30-6 - 40-8 x 51-2 μm (Pl. 1-5; 6; Pl. 2-1; 3).

In the cortex, a number of branch initiations originating from the vascular region and supplying the branch proper at a higher level are present. Each branch initiation is formed of a group of compactly arranged vascular bundles (Pl. 2-2).

**Root**—Number of small, endogenous root traces have been observed in the cortical region. They are roughly circular in outline and range 850 x 935 - 1090 x 935 μm in size. Further they exhibit various developmental stages. The root trace bundle has a central vascular cylinder enclosing a small pith and has a wide cortex pierced by radiating air spaces. Epiblema and hypodermis could not be observed clearly but a thin dark strip of cells outlined the bundles. The cortex is differentiated into three distinct regions. Outer region is 3-5 celled in thickness having compactly arranged parenchyma cells. Inner zone is 2-5 cells thick with a characteristic endoderm as the innermost layer. In between them, middle cortex is characterised by radially stretched, thin-walled parenchyma enclosing radially elongated air chambers. Pericycle is not distinctly observed. The vascular cylinder consists of 18-26 xylem bundles alternating with phloem bundles and embedded in the small sized parenchymatous ground tissue. The xylem consists of a large, round metaxylem vessel, 170-234 μm in diameter and 1-2 small vessels in radial rows. The pith is composed of homogeneous, thin-walled parenchymatous tissue and devoid of medullary bundles (Pl. 2-4-5).

**Leaf sheath**—Leaf sheaths are triangular in shape and are adnate to the stem axis. Epidermis is seen only on the outer side, whereas the inner side is seen in continuation with the cortex. Epidermal cells are thin-walled, rectangular and measure 45 x 15 μm in size. Hypodermis is compact, 2-3 layered, with thick-walled cells, followed by inner aerenchymatous ground tissue. The aerenchyma cells are 19-4 x 12-6 μm in size and enclose elongated air spaces. The vascular bundles are few, randomly placed and 364 x 260 - 1169 x 418 μm in size. The vascular elements are highly reduced and represented only by 1-2 small xylem vessels and an indistinguishable phloem group surrounded by a single celled thick bundle sheath. No fibre bundles, secretory cells or secretory canals were observed (Pl. 2-6).

**COMPARISON AND DISCUSSION**

Diagnostic features of the present stem are (i) thin, viny axis with aerial roots and spirally arranged leaves, (ii) triangular petiole with aerenchyma and reduced vascular elements, (iii) polystelic root trace bundles without medullary bundles, (iv) broad cortex differentiable into three zones, (v) amphivasal vascular bundles with reduced vascular elements, (vi) well developed vascular system composed of amphivasal, collateral and compound bundles, (vii) vessels angular, and (viii) occurrence of brachysclereids in the cortex. These characters suggest its affinity with the family Araceae.

**Fossil history of Araceae**

Araceous fossil remains have been described as leaves, spadices, infructescence and seeds. Araceophyllum sp. Kräusel (1929), Anthurium sp. Weyland (1957), Philodendron limnestis Dilcher and Daghiian (1977) and Peltandra Hickey (1977) are the leaves. Acorites sp. Crepet (1978), Araceaeites Fritel (1910) and Acoropsis exilis (Goeppert et Menge) Bogner (1976) are the spadices and Aracrostrobos sp. (Nikitin) Gregor and Bogner (1989) is the infructescence. Isolated araceous seeds have been referred to a number of extinct and extant genera such as Acorus, Arapeites, Aracisperma, Arisaema, Caladiosoma, Cala, Cyrtospermae, Epipremnites, Epipremnum, Lysichiton, Orontium, Pista, Scindapsites, Scindapsus, Stenospermae, Urospathes, etc. (Gregor & Bogner 1984, 1989; Madison & Tiffney, 1976; van der Burgh, 1978).

Sahnipushpam shuklae Verma (1956) is a small flower from the Deccan intertrappean beds with uncertain affinities. Prakash and Jain (1963) have suggested its affinity with Araceae on the structure of anther wall and anisopolar monocolpate boat shaped pollen grains. However, Thanikaimoni (in: Gregor & Bogner, 1989). Daghiian (1981) and Bogner (personal communication) have doubted its affinity with Araceae and emphasised the need of further work on anatomy and pollen studies of Sahnipushpam shuklae.

**Comparison with extant Araceae**

Araceae is one of the large tropical families having about 2000 species belonging to 105 genera and 9 subfamilies. They show considerable morphological diversity as climbers, vines, erect subarborescent forms, or cormous geophytes. The nine...
subfamilies are Gymnostachydoideae, Pothoideae, Monsteroideae, Callidioideae, Lasióideae, Philodendroideae, Colocasioideae. Aroidcae, and Pitioideae (Bogner, 1979; Bogner & Nicolson, 1991). The viny forms, however, occur only in Pothoideae, Monsteroideae, Lasióideae, Philodendroideae, and Colocasioideae.

Araceae is one of the monocotyledonous families which has comprehensively been investigated anatomically (Doshi, 1985; French, 1986; French & Tomlinson, 1980, 1981, 1983, 1984; Nicolson, 1960; Rao, 1977). Occurrence of amphivasal bundles in the present fossil suggests its resemblance with Pothos, Pothoidium, Rhodospatha, Epipremnum, Rhapidophora, Amygdrium, Scindapsus, Monstera, Alloschemone, Zamioculcas, Montrichardia, Philodendron and Dieffenbachia. However, occurrence of compound bundles along with amphivasal bundles in the present fossil shows its resemblance with Cercestis, Stenospermation, Montrichardia, Philodendron, Dieffenbachia, Zamioculcas and Rhodospatha (French & Tomlinson, 1986).

Stenospermation is an epiphyte with short erect stem. It differs from the fossil in having a single series of vascular bundles in a narrow cortex and a sclerotic region in between the cortex and vascular cylinder. Zamioculcas has a rhizomatous underground stem. Having a narrow cortex, uniform distribution of vascular bundles in both cortex and vascular regions, and poorly developed vascular elements, it is not comparable. Moreover, there is no bundle sheath in Zamioculcas. Cercestis, having a single series of vascular bundles, secretory canals and laticifers in the cortex and a single metaxylem vessel in the vascular bundles, is also taken out. Montrichardia is an aquatic genus with sympodial rhizome, characterized by a single series of vascular bundles in the cortex, aerenchymatous ground tissue with idioblast cells, and bi- or tetra-polar vascular bundles differs from the present fossil. Philodendron is a very large genus having about 350 species, which are generally scandant or arborecent forms. However, P. maxicanum, P. seguine, and few others are the root climbers. These species differ from the fossil by having a single series of collateral vascular bundles and resin and mucilage canals in the cortex. Dieffenbachia is an erect herb. It contrasts from the fossil in having bi-tri or tetra-polar compound bundles. Moreover, there is no bundle sheath in Dieffenbachia. Rhodospatha having a wide cortex with 3-4 series of vascular bundles, well developed bundle sheath, reduced vascular tissue, small angular vessels and trichosclereids, shows affinities with our specimen. This fossil has further similarity with Rhodospatha in having a central vascular cylinder with compact arrangement of collateral, amphivasal, and compound bundles and a large number of angular metaxylem vessels.

The present fossil thus matches best with Rhodospatha. It is a root climber flourishing well in the humid climate of Central and tropical South America. It has a shoot system developed as a polyphyllus symposium having roots restricted at the nodes. The present fossil form has been named as Rhodospathodendron tomlinsonii gen. et sp. nov. in honour of Dr. P.A. Tomlinson, who is known for his work on the anatomy of monocotyledons.

**GENERIC DIAGNOSIS**

**RHODOSPATHODENDRON** gen. nov.

*Stem—viny with spiral phyllostaxy and aerial roots.*

*Cortex—broad; vascular system well developed. Vascular bundles in 3-6 series, vascular elements reduced, trichosclereids abundant.*

*Vascular region—compact arrangement of amphivasal, collateral and compound bundles. Vessels many, angular.*

*Type species—RHODOSPATHODENDRON TOMLINSONII* gen. et sp. nov.

**Specific Diagnosis**

*Stem—thin, viny; nodes and internodes indistinct, leaf and root arrangement spiral.*

*Periderm—thin, 62-125 μm.*

*Cortex—broad; vascular bundles in 3-6 series; Vascular bundles variable in size; small bundles 36 x 36-126 x 172 μm; large bundles 234 x 234 - 306 x 270 μm; bundle sheath single layered; vascular elements reduced.*

*Vessels—small, angular, 6-8 x 6-8 - 13-6 x 10 2 μm; phloem band elongated. Brachysclereids abundant.*

*Vascular region—wide; vascular bundles amphivasal, collateral and compound; compact arrangement at the periphery. Compound bundles variable in size and shape, uniformly distributed.*

*Vessels—many, large, angular, 63 x 55 - 71 x 34 μm.*

*Holotype—N/105, Botany Department, Agharkar Research Institute, G.G. Agarkar Road, Pune.*

*Locality—Nawargaon, Wardha District, Maharashtra, India.*

*Horizon—Deccan Intertrappeans.*

*Age—Uppermost Cretaceous (Late Maastrichtian).*

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