

Musostrobocaulon skutchii gen. et sp. nov., a permineralized musaceous inflorescence axis from the Deccan Intertrappean beds of Mohgaonkalan, India

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ABSTRACT

Bonde SD 2008. *Musostrobocaulon skutchii* gen. et sp. nov., a permineralized musaceous inflorescence axis from the Deccan Intertrappean beds of Mohgaonkalan, India. The Palaeobotanist 57(3): 429-435.

Musostrobocaulon skutchii gen. et sp. nov., is a complete inflorescence axis attached with a part of leaf sheath embedded in a chert matrix collected from the Deccan Intertrappean beds of Mohgaonkalan, District Chhindwada, Madhya Pradesh, India. It has a cylindrical, 2.2 x 2.5 cm axis having thin cortex and wide vascular region indistinctly divisible into peripheral and central regions. Typical scitaminean or *Musa*-type of vascular bundles; large air canals bounded by uniseriate diaphragms; articulated laticifers and latex vessels suggest its affinity with *Musa* L. (Order—Zingiberales: Family—Musaceae).

Key-words—*Musostrobocaulon*, Zingiberales, Musaceae, *Musa*, Deccan Intertrappeans, Upper Cretaceous (Maastrichtian).

भारत में मोहगाँव कलाँ के दक्कन अंतःट्रेपियन संस्तरों से प्राप्त एक पर्मियनीकृत मूसेसीमय पुष्पक्रम अक्ष-मूसेस्ट्रोबोकोलॉन
स्कुची नवप्रजाति वंश

एस.डी. बोडे

सारांश

मूसेस्ट्रोबोकोलॉन स्कुची नवप्रजाति वंश, मोहगाँव कलाँ, छिंदवाड़ा जिला, मध्य प्रदेश, भारत के दक्कन अंतःट्रेपियन संस्तरों से एकत्रित चर्ट आधात्री में पत्ता आच्छद जड़ित के भाग के साथ संलग्न एक पूर्ण पुष्पक्रम अक्ष है। इसमें पतला वल्कृत व चौड़ा संवहनी क्षेत्र सहित अस्पष्ट रूप से परिधीय एवं मध्य क्षेत्रों में विभाज्य वेलनाकार 2.2 x 2.5 सेमी अक्ष है। संवहनी पूल के प्रारूपिक साइटामिनीन अथवा म्यूजा-प्रकार; एकस्तरित मध्यपटों द्वारा घिरी विशाल वायु नलिकाएं; संधित लैटेक्स एवं लैटेक्स वाहिका मूसा एल. (क्रम-ज़िन्जिबैरेलीज: कुल-मूसेसी) के संग इसकी सजातीयता सुझाती है।

मुख्य शब्द—मूसेस्ट्रोबोकोलॉन, ज़िन्जिबैरेलीज, मूसेसी, मूसा, दक्कन अन्तःट्रेपियन, ऊपरी चाकमय (मास्ट्रीक्शियन)।

INTRODUCTION

THE Deccan Intertrappean bed exposed at Mohgaonkalan, District Chhindwada, Madhya Pradesh, India, is one of the richest exposures in plant remains amongst the Deccan Intertrappean exposures in India. The fossil flora of Mohgaonkalan has been investigated by a large number of workers since its discovery by Professor K.P. Rode in 1930. Almost all major plant groups have been well documented from this locality, which is especially rich in angiosperms (Bande *et al.*, 1988). The present paper describes a permineralized monocotyledonous inflorescence axis, *Musostrobocaulon skutchii* gen. *et* sp. nov., showing its resemblance with *Musa* L. (Family—Musaceae).

MATERIAL AND METHOD

The material consists a permineralized cylindrical axis 2.2 x 2.5 cm in diameter and 7.2 cm in length embedded in a very large piece of chert. It was separated from the other chert matrix by cutting in various planes. In order to study the internal structure, the axis was sectioned in transverse and longitudinal planes on a power driven rock cutter with a diamond wafering blade. Slides for transmitted light microscopy were made thin with usual Ground Thin Section Method. Anatomical observations of the micropreparations and photography were done under Nikon-Labophot 2 microscope attached with FX 35 DX camera and Leica S6D microscope attached with Canon Power Shot S45 digital camera. The specimen and micropreparations are deposited at the Department of Geology and Palaeontology, Agharkar Research Institute, Pune, India.

Systematics

Division—Magnoliophyta

Class—Liliopsida

Order—Zingiberales

Family—Musaceae

Musostrobocaulon skutchii gen. *et* sp. nov.

(Pl. 1.1-4; Pl. 2.1-5)

The columnar axis is entire, cylindrical, 2.2 x 2.5 cm wide and 7.2 cm long attached with a part of leaf sheath. The leaf sheath is incomplete, 825 µm wide. It appears to be the middle

part of the sheath. The outer and inner epidermis are composed of thick walled radially elongated cells. A thin hypodermal layer is present below both the epidermis. The ground tissue is parenchymatous with polygonal to circular cells preserved at places. Fibre bundles and thick walled fibre cells have been observed below the hypodermis. The fibrovascular bundles are normally oriented, elliptical, 210 x 135–330 x 180 µm in size with dorsal sclerenchyma, single vessel, few phloem cells embedded in conjunctive tissue (Pl. 1.1).

The central axis is cylindrical complete in cross sectional area. It has a thin cortex and wide vascular region. Epidermis is made up of thin walled, tangentially elongated, 30 x 15 µm cells. Hypodermis is 2-3 cells wide composed of compact, thick walled, 30 x 30 µm cells. Cortex is 760-900 µm wide made up of thin walled but compactly arranged parenchymatous cells with fibre cells and few, small, 60 x 45 µm fibre bundles. The fibrovascular bundles are normally oriented; elliptical in shape and smaller in size measuring 180 x 150–225 x 180 µm. Each fibrovascular bundle has a small phloem and single metaxylem vessel embedded in the xylem parenchyma cells (Pl. 1.2). The central vascular cylinder is 2.1 x 2.4 cm in diameter. It is composed of typical scitaminean or *Musa* type (dumb-bell shaped) vascular bundles in the aerenchymatous ground tissue (Pl. 1.3). It is indistinctly divided into peripheral and central regions. The peripheral region is thin, about 5-6 mm in radius. It has small fibrovascular bundles. The central vascular region is 1.0-1.2 cm in diameter and possesses large sized, 375 x 270–450 x 375 µm fibrovascular bundles. A typical vascular bundle has both dorsal and ventral sclerenchyma enclosing a single large metaxylem vessel embedded in the xylem parenchyma cells. Phloem is preserved in places but generally represented by a cavity (Pl. 1.4). The ground tissue is parenchymatous, forming uniseriate diaphragms enclosing air canals of various shapes and dimensions. Air canals in the central vascular region are comparatively larger in size than those in the peripheral region. The vascular bundles are present at the joining regions of the neighbouring diaphragms (Pl. 2.1). Leaf-trace bundles are very few. These are the large sized, 525 x 375 µm vascular bundles and show preservation of protoxylem elements in addition to 1-2 metaxylem vessels (Pl. 2.2). Phloem is preserved in some of these vascular bundles. The ground parenchyma cells are thick walled, round to squarish, 30 x 30 – 30 x 45 µm and have simple pits in them. Some of these cells show dark deposition. These are the laticifers. Some of these cells are longitudinally fused and form articulated laticifers (Pl. 2.3). The vessels are wide and

PLATE 1

Musostrobocaulon skutchii gen. *et* sp. nov.



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| <p>1. Cross section of the axis showing part of leaf sheath-<i>s</i> and axis-<i>a</i>. x 4.</p> <p>2. Cross section of the axis showing cortical region-<i>c</i> and vascular region-<i>v</i>. x 60.</p> | <p>3. Cross section through central vascular region showing dumb-bell shaped vascular bundles. x 60.</p> <p>4. Vascular bundle showing phloem and large vessel. x 100.</p> |
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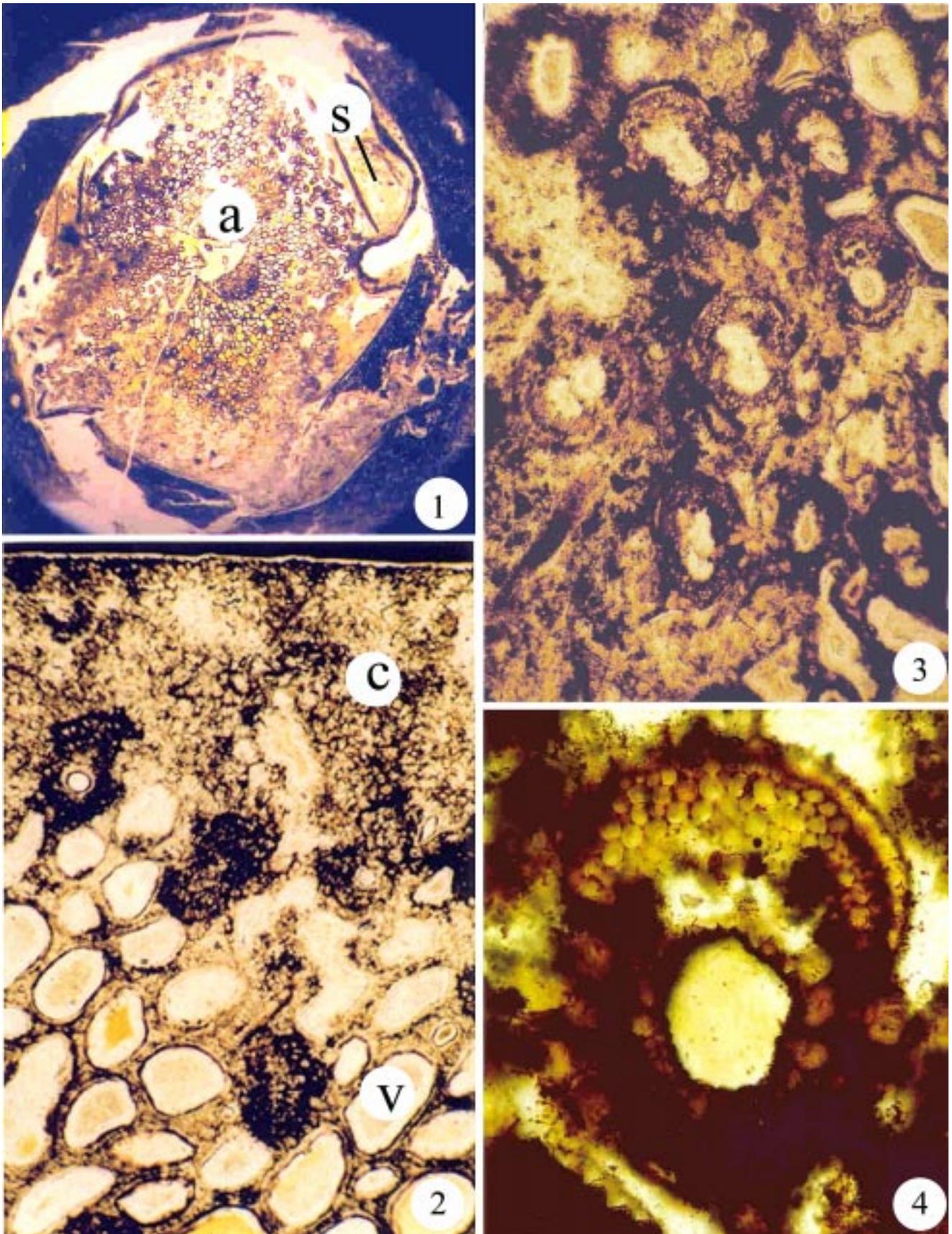


PLATE 1

short. They are 105 x 120 – 150 x 180 µm in diameter with a single circular perforation and 388–485 µm long with scalariform pittings on their radial walls (Pl. 2. 4–5). Some of the vessels show dark depositions in them. These are the latex vessels (Pl. 2.1).

DISCUSSION

The diagnostic features of the present fossil such as (i) cylindrical axis covered with a leaf sheath; (ii) thin cortex and wide vascular region; (iii) dumb-bell shaped or *Musa* type of vascular bundles with single large metaxylem vessel; (iv) arechymatous ground tissue forming large sized air canals; (v) presence of articulated laticifers and latex vessels suggest its affinity with Zingiberales, particularly with *Musa* L. of the family Musaceae (Tomlinson, 1959, 1962, 1969; Fahh *et al.*, 1963).

Fossil record of Musaceae

Musaceous plant remains are described as permineralizations of stem, pseudostem, fruit, seed and leaf impressions. *Musoxylon antracotherii* (Massalongo) Meschinelli and Squinabol (1893) is a meter long and 12–20 cm wide stem axis covered with convolutedly rolled alternate leaf sheaths (?) in distichous phyllotaxy described from the Veronensi Formation, Tertiary of Italy. However, its anatomical details are not available. *Musocaulon indicum* Jain (Jain, 1964a; Rao & Menon, 1963) is a pseudostem formed of young leaves rolled in distichous phyllotaxy. Biradar and Bonde (1990) emended it into *Cyclanthodendron sahnii* Sahnii & Surange on the basis of its organic occurrence with the later. *Musa cardiospermum* (= *Callistemonites indicus* Bande *et al.*, 1986, 1993) Jain (1964) is a seeded banana fruit. Manchester and Kress (1993) excluded it from the Musaceae due to absence of laticifers, perianth remains at the fruit apex and chalazal chamber and having seeds in a single row in each locule; but retained it in the Zingiberales. *Tricostatocarpon silvapedae* Rodriguez-De La Rosa & Cevallos-Ferriz (1994) and *Striatornata sanantoniensis* Rodriguez-De La Rosa & Cevallos-Ferriz (1994) are the two Zingiberalean tricarpeolate, trilobular fruits having axile placentation and numerous anatropous operculate small seeds described from the Upper Cretaceous (Campanian) of Coahuila, Mexico. Of them, *Tricostatocarpon silvapedae* resembles *Musa cardiospermum* Jain whereas, *Striatornata sanantoniensis* is related to *Spirematospermum* Chandler. Manchester and Kress

(1993) on re-examination of the type material of *Ensete ensetiformis* (= *Musa ensetiformis* Berry, 1925; = *Ensete berryi* Jain, 1960) Jain, (1965), a seed reported from the Oligocene of Colombia opined that the material represents the extant seed and is not a fossil! *Ensete oregonense* Manchester and Kress (1993) is the only unequivocal musaceous seed comparable to extant *Ensete* from the middle Eocene horizon of Clarno Formation, Western North America. *Spirematospermum* Chandler is a zingiberalean seed genus with spirally striate arillate seeds. *S. wetzleri* (Heer) Chandler (1925) and *S. friedrichii* Knobloch and Mai (1986) have been reported from number of European Tertiary floras (Friedrich & Koch, 1970, 1972; Koch & Friedrich, 1971) and *S. chandlerae* (Friis, 1987) from the Upper Cretaceous of eastern North America. Manchester and Kress (1993) suggested the affinity of *Spirematospermum wetzleri* with Musaceae in addition to Zingiberaceae and *S. friedrichii* Knobloch & Mai (1986) with *Musa* and *Ensete*.

Leaf impressions comparable to *Musa* are described under the genus *Musophyllum* Goepfert (Goepfert, 1854; Unger, 1861; Watelet, 1866; Ettingshausen, 1867, 1887, 1890; Lesquereux, 1878; Hollick, 1924; Pons, 1965). *Musophyllum indicum* Prakash *et al.* (1979) is reported from the Intertapean beds of Mohgaonkalan from where the present fossil is described. *Saahitia speciosa* (= *Haastia speciosa* Ettingshausen, 1887) Bonde (2007) is another leaf from the Upper Cretaceous horizon of New Zealand. Whereas, *Musopsis groenlandicum* Boyd (1992) is a leaf impression showing its resemblance with the extant taxa belonging to Heliconiaceae, Musaceae and Strelitziaceae described from the Late Palaeocene-Early Eocene horizon of Greenland. The fossil leaves assigned to Zingiberales, in general, are not well understood for their affinities with extant taxa. They have been distinguished on the characters of cuticle, epidermis and venation pattern. However, the venation pattern in the extant taxa is more or less similar in all the 8 families of Zingiberales. An indepth work on this line is required in order to decipher the fossil leaves to the natural genera.

The petiole *Heliconiaites mohgaonensis* Trivedi & Verma (1972), the pseudostem *Musocaulon indicum* Jain (Jain, 1964a; Rao & Menon, 1963) and the fruit *Tricoccites trigonum* Rode (1933) have been emended into *Cyclanthodendron sahnii* Sahnii & Surange (1953) on the basis of their organic occurrences (Biradar & Bonde, 1990; Trivedi & Verma, 1978) and the affinity of *Cyclanthodendron sahnii* has been suggested with Scitamineae as it shows

PLATE 2

Musostrobocaulon skutchii gen. et sp. nov. 

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| 1. | Cross section through central vascular region showing latex vessel- <i>lv</i> and air canals- <i>ac</i> . x 60. | 3. | L.S. showing articulated laticifer- <i>al</i> . x 60. |
| 2. | Cross section showing leaftrace bundle- <i>lb</i> and aerenchymatous ground tissue showing air canals- <i>ac</i> . x 60. | 4. | L.S. showing short and wide vessel- <i>v</i> . x 60. |
| | | 5. | L.S. showing vessel endplate- <i>ep</i> . x 60. |

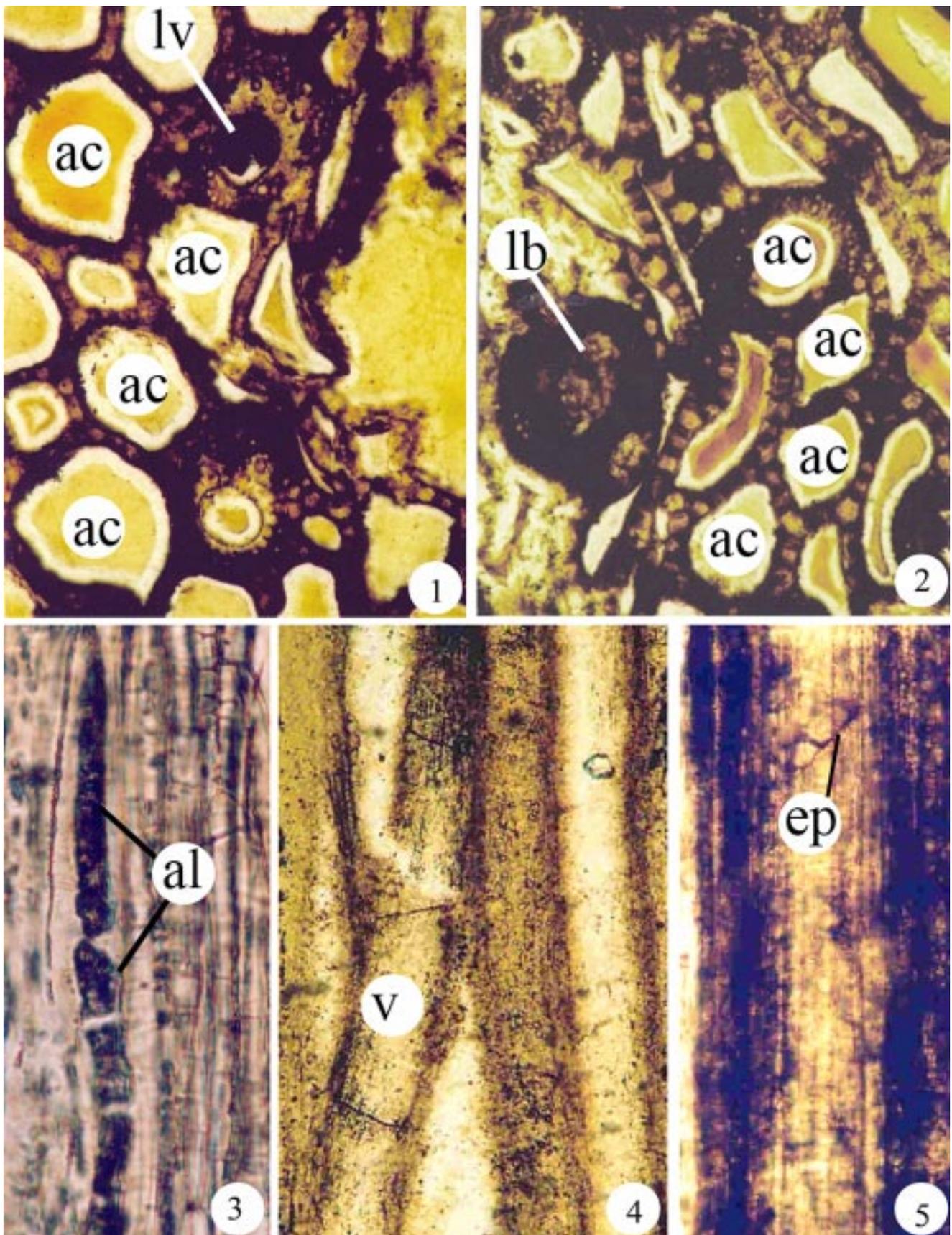


PLATE 2

combination of characters of Musaceae, Heliconiaceae and Strelitziaceae (Biradar & Bonde, 1990). The present fossil resembles the stem apex of *Cyclanthesahndron sahnii* Sahnii & Surange to certain extent in having the axis covered with a leaf sheath, vascular region divisible into thin peripheral and wide central regions. However, *Cyclanthesahndron sahnii* differs from the present fossil as *C. sahnii* possesses characteristic compound bundles and is devoid of large air canals, laticifers, latex vessels and thick walled ground tissue forming uniseriate diaphragms. A detailed morpho-anatomical analysis of *Musoxylon antracotherii* Meschinelli & Squinabol and *Cyclanthesahndron sahnii* Sahnii & Surange is required in order to ascertain their affinities with the extant members of Zingiberales.

Comparison with extant Zingiberles

Hutchinson (1959) classified Zingiberales (Scitamineae) into six families: Zingiberaceae, Marantaceae, Cannaceae, Musaceae, Strelitziaceae and Lowiaceae on the basis of morphological characters. Nakai (1941) proposed 8 families: Zingiberaceae, Costaceae, Marantaceae, Cannaceae, Musaceae, Heliconiaceae, Strelitziaceae and Lowiaceae. These were also accepted by Tomlinson (1969), Cronquist (1981), Dahlgren and Rasmussen (1983) and Dahlgren *et al.* (1985). Kress (1990) also recognized these 8 families in addition to two super families and five suborders based on the cladogram. He considers Musaceae as the basal most lineage in the phylogenetic relationships within the Zingiberales. The morpho-anatomical characters of the present fossil were compared with the inflorescence axis of *Musa*, *Ensete*, *Heliconia*, *Strelitzia*, *Ravenala*, *Phenacospermum*, *Canna*, *Zingiber*, *Maranta* and *Costus*. It shows its closest resemblance with *Musa* L. due to the presence of laticifers and latex vessels (Skutch, 1932; Fahn *et al.*, 1963; Tomlinson, 1969).

Musa L. is a palaeotropical genus with 35 species (Airy Shaw In: Willis, 1985). Santapau and Henry (1973), however, quoted about 50 species of which 14 are known from India. Chakravorti (1951) and Simmonds (1962) suggested Assam – Myanmar – Thailand region of the South East Asia as the centre of origin of ancestral stock of banana. Jain (1965) considers origin of banana in central India. Biradar and Bonde (1990) suggested the origin of ancestral stock of Scitamineae (Proto-scitamineae) in central India during the Upper Cretaceous (Maastrichtian) Period.

Genus—*Musostrobocaulon* gen. nov.

Diagnosis—Axis cylindrical; leaf sheath present. Cortex thin; vascular region wide, indistinct. Vascular bundles scitaminean or *Musa* type (dumb-bell shaped); metaxylem vessel single, large. Ground tissue thick walled,

aerenchymatous forming uniseriate diaphragms. Air canals numerous, large. Laticifers, latex vessels present.

Genotype—*Musostrobocaulon skutchii* gen. *et* sp. nov.

Species—*Musostrobocaulon skutchii* sp. nov.

Diagnosis—Leaf sheath incomplete, thin. Fibre cells and fibre bundles present. Fibrovascular bundles elliptical; vessel large, single. Inflorescence axis cylindrical, 2.2 x 2.5 cm wide. Cortex thin, compact; fibre bundles and fibre cells present; fibrovascular bundles elliptical. Vascular region wide, indistinct; Fibrovascular bundles Scitaminean or *Musa* type (dumb-bell shaped). Peripheral region thin, vascular bundles small; air canals small. Central region wide, vascular bundles large; air canals large. Leaf-trace bundles present. Ground tissue aerenchymatous; cells thick walled, round to squarish, forming uniseriate diaphragms. Vessels wide, short. Laticifers and latex vessels frequent.

Holotype—MK 32/98 (slide Nos. 1-7).

Horizon—Deccan Intertrappean beds of India.

Locality—Mohgaonkalan, District Chhindwada, Madhya Pradesh, India.

Age—Upper Cretaceous (Maastrichtian).

Repository—Department of Geology and Palaeontology, Agharkar Research Institute, Pune, India.

Etymology—The generic name is after the extant genus *Musa* and the specific epithet *skutchii* honours Dr A.F. Skutch for his anatomical work on banana plant.

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