PALMOCAULON COSTAPALMATUM, A PETRIFIED PALM LEAF AXIS FROM THE DECCAN INTERTRAPPEAN BEDS OF WARDHA DISTRICT, MAHARASHTRA*

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ABSTRACT

A petrified palm leaf axis, *Palmocaulon costapalmatum* has been described from the Deccan Intertrappean exposures of a forest village Maragsur belonging to Arvi Tahsil of Wardha District. The morphological and the anatomical details presented by it suggest its close resemblance to the petiole-rachis portion of a costapalmate palm.

INTRODUCTION

Deccan Intertrappean exposures of Wardha District have received meagre attention. So far, only three fossil palm woods, viz. *Palmoxylon sclerodermum* Sahni (SHUKLA, 1946), *P. deccanense* Sahni (1964) and *P. nawargaoensis* Shukla (1941) have been described from these exposures. Of these, the last mentioned species is imperfectly known and the details of it are not available and hence detailed investigations on the Intertrappean fossils of Nawargaon, Maragsur and Sindhivihira belonging to Arvi Tahsil of Wardha District were undertaken. These localities are located at about 36 to 43 km north-west of Wardha (21° 1′ : 78° 35′). The present paper is a part of these investigations and deals with *Palmocaulon costapalmatum* sp. nov., a petrified palm leaf axis collected from Maragsur.

SYSTEMATIC DESCRIPTION

Family—ARECACEAE

Genus—**Palmocaulon** Menon, 1964

Palmocaulon costapalmatum sp. nov.

(Pl. 1, Figs. 1-6; Text-figs. 1-9).

Leaf axis of 5 cm height is embedded in a black chert of 6×5×5 cm size (Text-fig. 1). At its basal surface it shows a typical lunate outline of the petiole, 1.5 cm high and 4 cm broad (Pl. 1, Fig. 1); at the upper surface it has more or less triangular outline of the rachis with 1.5 cm height and 2 cm breadth in the broadest part (Pl. 1, Fig. 2). Of its three angles, two have short diverging arms. Peels of upper and lower surfaces and along the length of the axis were taken to study the internal details. The preservations of the internal tissues are not very satisfactory though the major characters could be studied.

Epidermis, hypodermis and cortical tissues could not be recognized. The entire tissues preserved belong to the vascular region only. The vascular region consists of fibrovascular bundles distributed in ground parenchyma. On both basal as well as upper surfaces, majority of the fibrovascular bundles in the outermost layer are oriented with their vascu-

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lar tissues directed towards centre of the axis. Though they are somewhat closely arranged than the inner bundles, they are neither congested nor are they marginally fused (Text-figs. 8, 9). The inner fibrovascular bundles are oriented in various ways (Text-figs. 8, 9; Pl. 1, Figs. 5, 6). They are more or less evenly distributed on both the surfaces (Text-fig. 1). On an average 42-50 fibrovascular bundles are found per sq. cm. At the angles of the lower surface however the density of vascular bundles appears to be slighly higher ranging to 68 bundles per sq. cm.

Two types of fibrovascular bundles are found. These are, typical fibrovascular bundles and the so-called leaf-trace bundles. The latter are larger and far fewer than the typical bundles. Both the types of bundles have only dorsal fibrous cap, the ventral cap is either very poorly developed or is completely lacking.

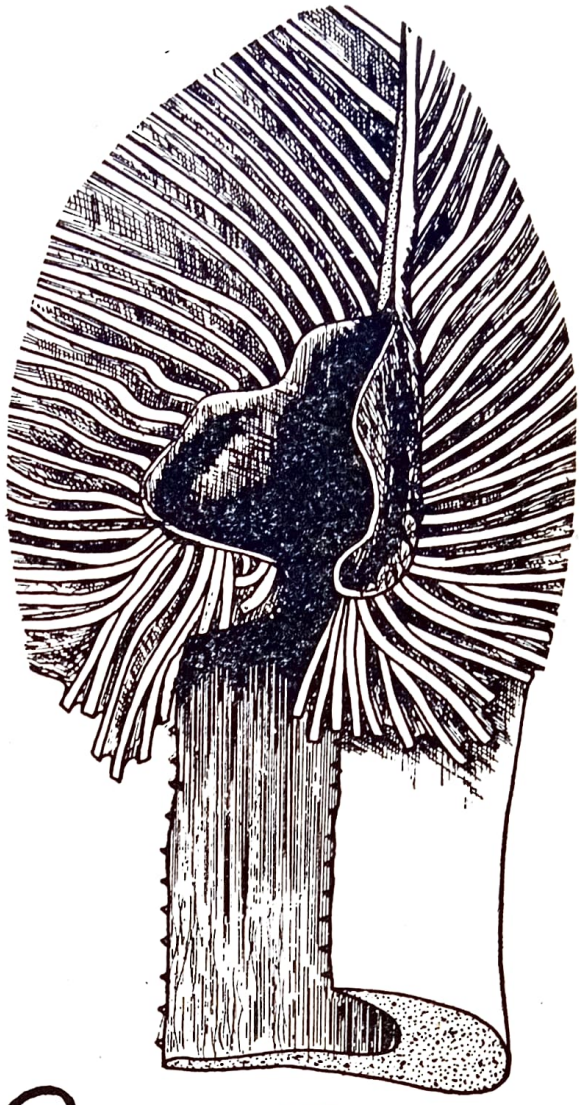
Typical fibrovascular bundle (Text-fig. 7; Pl. 1, Fig. 3) is 990×850 μ in size and is almost oval to circular in cross section. The dorsal fibre cap in majority of the bundles is lunate. However, a few bundles show reniform to cordate dorsal cap also. The dorsal cap is 630×850 μ in size, being broader than high. The fibres are polygonal in cross section, thin walled with conspicuous oval to angular lumen (Text-fig. 6). The vascular tissue has mostly two, round, extruded metaxylem elements each of 162 μ diameter placed side by side in the conjunctive parenchyma. The end plates of the metaxylem vessels appear to be remarkably slanting with more than seven transverse bars (Text-fig. 3). Even in transversely cut vessels, 3-4 bars on the end plate are clearly seen at several places (Text-fig. 4). The lateral wall pitting on the vessels is not preserved. The lunate phloem included in the median sinus is not preserved. It is mostly an undivided patch though in rare cases (Text-fig. 7) it appears to be partially divided due to intrusion of dorsal cap fibres. The F/V ratio is 3/1 except for the bundles of the outermost layer which have 10-15 times greater fibrous tissue than the vascular.

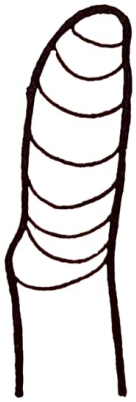
The leaf-trace bundles (Text-fig. 5; Pl. 1, Fig.4) are 1800×1260 μ in size and have a patch of angular to circular protoxylem elements arranged in the conjunctive parenchyma. Their dosal cap, 720×1260 μ in size, is better developed than that of the typical bundles. The F/V ratio of these bundles is 9/1.

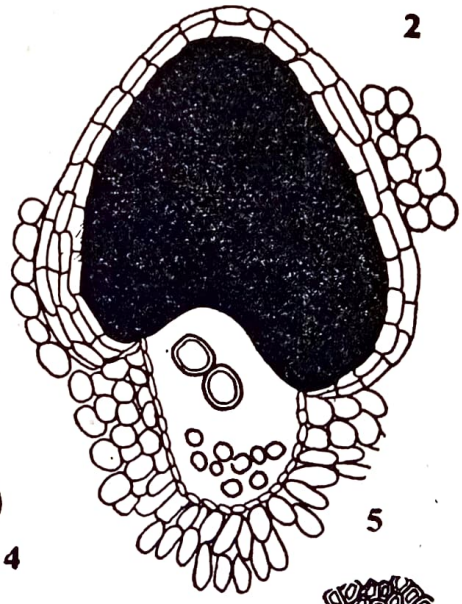
The diminutive vascular bundles, the fused vascular bundles and the fibre bundles are entirely lacking. Ground parenchyma (Text-figs. 5, 7; Pl. 1, Figs. 3-6) is preserved only at places. The dorsal cap of each vascular bundle is surrounded by 2-3 layers of tabular parenchyma. The cells of the tabular parenchyma are oval to rectangular. The radiate parenchyma is found only on the ventral side of the leaf-trace bundles. The general parenchyma cells are oval to circular, 135×108 μ in size and very loosely arranged with conspicuous intercellular spaces.

AFFINITIES

Diagnostic features exhibited by this axis are : (1) The axis has concavo-convex lower surface which tapers to triangular surface above, within a height of five cm, (2) The vascular region is not sharply distinguished into peripheral and central zones. Instead, except for the outermost row of bundles others are more or less evenly distributed in the ground parenchyma with variously orientated vascular tissues, (3) The phloem in most of the fibrovascular bundles is undivided, (4) There are but two metaxylem elements for each vascular bundle, (5) Fused fibrovascular bundles are entirely lacking even in the outermost row, (6) The performation plates of the metaxylem vessel elements are markedly slanting with varying numbers of bar on them, (7) The ground parenchyma is of thin walled, loosely arranged cells. The stretching of ground parenchyma appears to be absent.







1 2 3 4 5 6 7 8 9

The typical structure of fibrovascular bundles of the fossil undoubtedly suggests its affinity with palms.

The slanting nature of the vessel end-plate with number of bars on it and the unstretched ground parenchyma clearly show that the axis belongs to the tender organ of a palm-like younger part of the stem, peduncle or the leaf axis. In the former two organs of a palm, the vascular region is always differentiated into at least peripheral and central vascular zones. In addition, in both, specially in the peduncles, the fusion bundles are very common and their frequency increases from base to the apex of the organ. The absence of clear zonation in the vascular region and the fusion bundles precludes the possibility of this fossil to be a peduncle or a young stem.

The general size and shape of the axis, the absence of fusion bundles and the thin-walled unstretched parenchyma, all these features indicate that this fossil is a leaf axis of a palm.

The leaf axis of a palm is distinguished into a basal leaf-sheath, the usual canal-shaped petiole and the rachis bearing lamina. The rachis changes its shape from a broadly quadrangular basal part to a narrowly triangular apical part. The shape of basal surface of the fossil is typical of the petiole and broadly triangular shape at the upper surface is typcial of the rachis. The fossil axis thus represents the transition zone from petiole to rachis. This transition in shape of the rachis is very gradual in pinnate palms involving several centimetres of length, whilst in number of costapalmate palms (Text-fig. 2) this transition is abrupt, though often involving a prominent development of adaxial hastula at the junction of the petiole and the rachis. The rachis in these costapalmate palms is very much abbreviated. In typical palmate palms, on the contrary, the petiole ends more or less abruptly at the insertion of the lamina so that it is not prolonged into the rachis at all.

Since in the fossil axis this transition from petiole to rachis takes place within a distance of 5 cm only, it can be deduced that it must have belonged to the costapalmate palm. This conclusion is further indirectly borne out by the fact that 'V' shaped arcs of vascular bundles often found in the central tissues of the upper level of the petiole and the rachis of Arecoid, Bactroid, Caryotoid, Chamaedoroid, Iriartoid and Lepidocaryoid palms are lacking in the present fossil. The tissues in it are more or less homogeneous with scattered central vascular bundles typical of fan palms of Borassoid and Sabaloid groups (Tomlinson, 1961, pp. 42, 43). Like the petioles of the latter groups, in the present fossil also the peripheral vascular bundles, though somewhat closely arranged than the central ones, are not irregularly and incompletely fused to form an almost continuous peripheral sclerotic cylinder. Further, the phloem in most of the fibrovascular bundles of the fossil is an undivided patch like those of Borassoid and some Sabaloid palms. All these considerations jointly strengthen the conclusion that the fossil represents the leaf-axis of costapalmate genera of Borassoid and Sabaloid palms. While in majority of Sabaloid palm petioles

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EXPLANATION OF TEXT-FIGURES

Text-figs. 1-9. *Palmocaulon costapalmatum* sp. nov., 1. The original specimen showing outlines of leaf axis in cross section at basal and upper levels ×1.75, 2. Petiole-rachis part of a typical costapalmate palm leaf axis ×half n.s. Note the abbreviated rachis, 3. Slanting perforation plate of the metaxylem elements with number of bars on it ×50, 4. Vessel element in T.S. showing bars on the perforation plate ×50, 5. Leaf trace bundle in T. S. showing tabular and radiating parenchyma ×25, 6. Fibres of the dorsal fibre cap of the fibrovascular bundle in T.S. ×50, 7. A typical fibrovascular bundle in T.S. with associated parenchyma ×50, 8. Distribution of fibrovascular bundles in T.S. from abaxial side of the petiole ×5. Note almost regular orientation of the bundles in the peripheralmost row, 9. Distribution of fibrovascular bundles in T. S from the abaxial part of rachis ×5.

there are two metaxylem elements for each fibrovascular bundle, in some Borassoid palms there is but one metaxylem element. This, therefore, further suggests that there are more possibilities of the affinity of this fossil axis with Sabaloid genera than with Borassoid group.

The sections of the corresponding regions of the leaf-axis of following costapalmate palms were, therefore, examined—*Hyphaene indica*, *Livistona chinensis*, *Nannorhops ritchieana*, *Pritcardia* sp., *Sabal major* and *Corypha umbraculifera*.

Amongst these, *Sabal major* shows number of features of the fossil palm, e.g. (1) all central vascular bundles more or less of the same size, (2) each with only dorsal fibrous cap, (3) majority of the bundles have 2 metaxylem elements placed side by side, (4) each vascular bundle is ensheathed by 1-3 layered tabular parenchyma and (5) ground parenchyma homogeneous, consisting of loosely arranged circular cells. However, the large leaf trace bundles with radiating parenchyma found in this fossil are not seen in *Sabal major*. Secondly, in *S. major* majority of the fibrovascular bundles possess protoxylem elements in addition to 2 metaxylem elements. The protoxylem elements are not found in most of the fibro-vascular bundles of the fossil. There are two additional small phloem patches, one on either side of the central phloem patch in some bundles of *Sabal major*. These additional patches are not seen in the fibrovascular bundles of the fossil.

It is very clear that examination of the petiole-rachis region of many more species of costapalmate palms is necessary to assign the present fossil to the living palm genus.

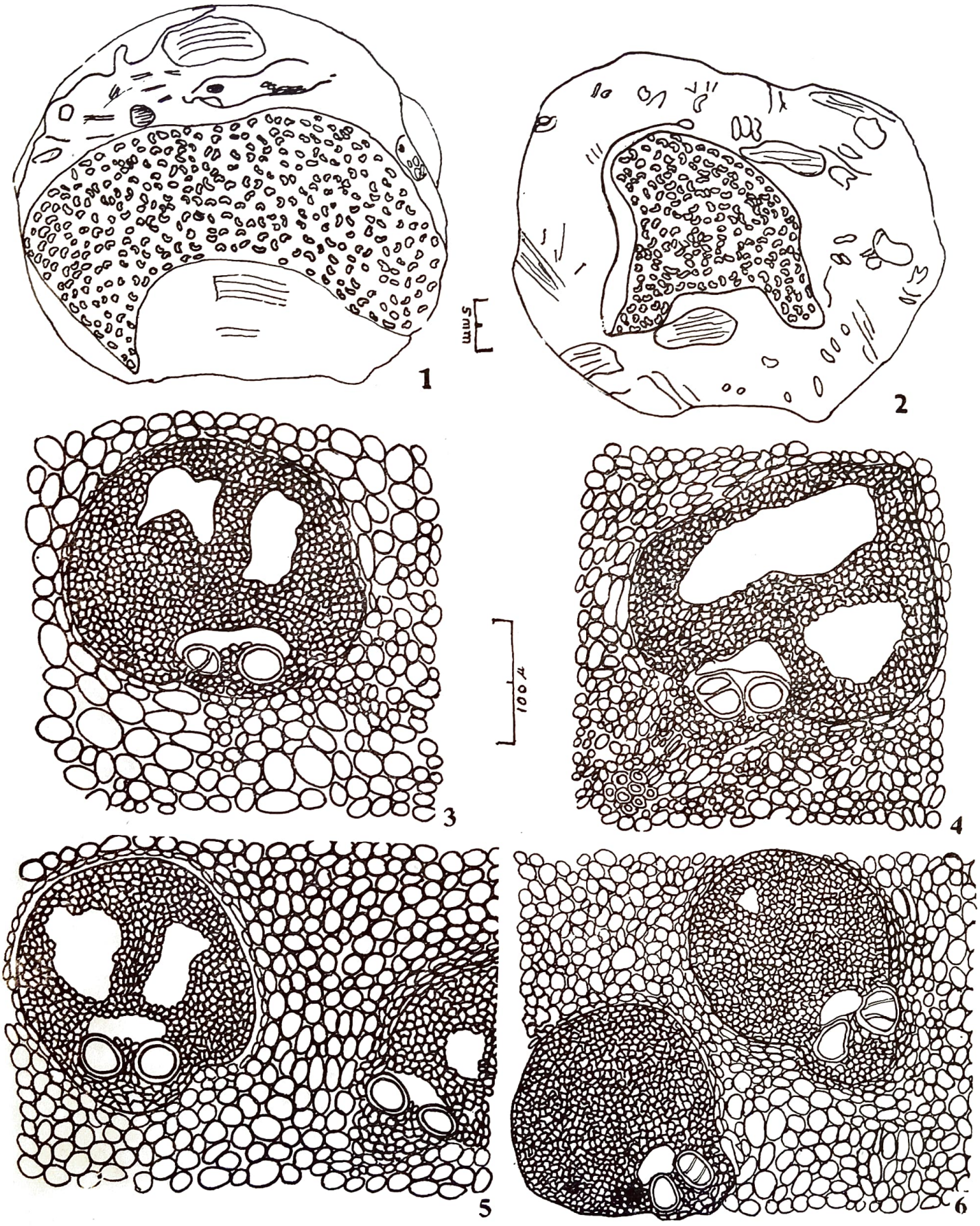
Only a few palm leaf-axis have been described from Tertiary deposits. These are placed in the genus *Palmocaulon* Menon (1964). Four species of *Palmocaulon* are known. These are, *Palmocaulon mohgaoense* Deshpande (1960), *P. raoi* Menon (1964), *P. mahabalei* Menon (1965) and *P. monodii* Boureau & Prakash (1968). The first three are described from Mohgaonkalan of the Deccan Intertrappean Series of India and the last one from Eocene of Senegal.

P. monodii resembles the present fossil in the shape of the petiole and ground parenchyma pattern but differs from it in having diminutive bundles and fibre bundles. *P. mohgaoense* has also lunate outline but details of this species are yet to be published. *P. raoi* and *P. mahabalei* have oval to round outline. Both resemble the present fossil in general ground parenchyma pattern and in the absence of fibre bundles but differ in details. In the vascular bundles of *P. mahabalei* both dorsal and ventral fibre caps are present and ventral cap is larger than the dorsal. There is but one metaxylem element in each fibro-vascular bundle and number of diminutive bundles are also found in the ground parenchyma. *P. raoi* has complete fibrous sheath round the vascular bundle, though ventral part is more pronounced than the dorsal ; metaxylem vessels are many and are arranged in crescentic fashion.

The comparison thus shows that none of the four species of *Palmocaulon* described so far fully agrees with the present fossil. Hence the fossil has been placed under a new species of *Palmocaulon*, *P. costapalmatum* sp. nov.; the species name is after its affinity to costapalmate palms.

Specific diagnosis

Axis 5 cm high with concavo-convex basal surface and triangular upper surface. The vascular region not differentiated into peripheral and central zones. The fibrovascular bundles evenly distributed on both the surfaces. Majority of the fibrovascular bundles in the outermost row have vascular part directed towards the centre of the axis. Fibrovascular bundles 42-50 cm^2, 68 cm^2 at the angles of the lower surface, $990 \times 850\ \mu$ in size. The dorsal cap lunate, reniform to cordate in a few bundles. Vascular tissue with two meta-


5mm
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xylem elements placed side by side ; end plate slanting with about 7 transverse bars. Phloem typically an undivided patch. F/V ratio of the bundles 3/1.

Leaf trace bundles 1800 × 1260 μ in size ; vascular tissue with 2 metaxylem elements and a patch of angular protoxylem elements arranged in the conjunctive parenchyma ; F/V ratio 9/1.

The ground parenchyma of loosely arranged round cells, tabular parenchyma present ; radiating parenchyma on ventral side of leaf trace bundles.

Holotype—Department of Botany, Shivaji University Museum No. N79.

Locality—Nawargaon, Wardha District, Maharashtra.

Horizon—Deccan Intertrappean Series.

Age—Early Tertiary (Probably Eocene).

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EXPLANATION OF PLATE 1

Palmocaulon costapalmatum sp. nov.

1. Cross section of an entire lower surface of the chert showing petiolar outline in T. S. and distribution of fibrovascular bundles in it ×3.3.
2. Cross section of the upper surface of the chert showing rachis part of the leaf axis in T.S. ×3.3.
3. A fibrovascular bundle with surrounding ground parenchyma from the central portion of the T. S. of rachis part of the leaf axis ×20.
4. A leaf trace bundle with associated parenchyma in T.S. ×20.
5. Central portion of the petiolar part of leaf axis in T. S. showing fibrovascular bundles and ground parenchyma ×16.6.
6. Central portion of the rachis part of the leaf axis in T.S. showing fibrovascular bundles and ground parenchyma ×16.6. (*mx*, metaxylem elements ; *px*-protoxylem elements).