ON AN INFLORESCENCE OF A NEW PETRIFIED MONOCOT FLOWER, *SHUKLANTHUS SUPERBUM* GEN. ET SP. NOV. FROM THE DECCAN INTERTRAPPEAN SERIES OF MADHYA PRADESH, INDIA

J. K. VERMA

Mahakoshal Mahavidyalaya, Jabalpur, India

ABSTRACT. In the present paper is described a new genus of petrified monocotyledonous flowers arranged in a racemose inflorescence. The flowers are shortly pedicillate, pistillate and are arranged alternately along six vertical rows on a six-sided inflorescence axis. In each flower, sepals six, free, one against each carpel ; corolla and stamens not present ; pistil hexacarpellary, apocarpous. The six carpels of an individual flower are placed round or partly fused with a flat six-angled carpophore which is the continuation of the flower stalk. Each ovary is drawn out at the apex to form a short, conical blunt style. The carpophore gradually broadens out at the top, covering the six ovaries partly. On the top of each flower there lie thick flat ribs, one on each ovary, radiating out from the centre of the flower more or less to the stigma of each carpel.

The anatomy of the inflorescence axis shows a monocotyledonous pattern. The cellular structure of most of the floral parts is well preserved. Sclerotic tissue is abundant, in the inflorescence axis, carpophore and ovary wall.

From the comparisons made with the living families it is seen that the present genus, though showing resemblances in certain respects with some genera of Scheuchzeriaceae, is outstanding in possessing its own individual characters, and consequently is referred to a new genus *Shuklanthus superbum* gen. et sp. nov., the specific name indicating its superb form.

Among the fossil forms it shows close resemblance with the fruit form *Viracarpon* and it is believed that the present flower might, at maturity, have developed into a species of *Viracarpon*. Since the flower-characters are more authentic than the fruit characters, it is proposed to refer the fruit genus *Viracarpon*, along with its different species, under the new flower genus *Shuklanthus*, the various species of the fruit remaining as such, viz. *Shuklanthus hexaspermum* (*Viracarpon hexaspermum*) and *Shuklanthus elongatum* (*Viracarpon elongatum*).

INTRODUCTION

THE material described here was collected by the author from the Deccan Intertrappean Series exposed near Mohgaon Kalan village in the Chhindwara district, Madhya Pradesh. The age of these beds is believed to be Eocene (Sahni, 1940 ; Sahni & Rode, 1937 and Rama Rao, 1936). These extensive formations have yielded quite a rich flora of modern aspect : leaf impressions of angiosperms, petrified woods both of Dicotyledons and palms, fruits, isolated seeds and even flowers, besides representatives of other groups. The only two fossil flowers, *Sahnianthus* (Shukla, 1944) and *Sahnipushpam* (Shukla, 1948) : *Sahnipushpam shuklai* (Verma, 1956 April and 1956, October) described from this region are both dicotyledonous and the present specimen is the first record of monocotyledonous flowers aggregated in a fairly long, beautifully preserved inflorescence though some monocotyledonous fruits and infructescences have been reported earlier.

The study of the present material is based on two specimens, I and II, exposed on a chert piece in oblique longitudinal sections. A close study of both of these has revealed a unique similarity in their general appearance and morphology. Specimen I lies flat on the rock surface along most of its length and is fractured in a neat

transverse plane at one end. Specimen II is the apex of another similar inflorescence and is exposed, both, along longitudinal and transverse planes ; the longitudinal plane being an oblique tangential section, while the other one exhibits the half transverse view of the specimen. The flowers of this specimen are similar to those of specimen I though, being younger, they are comparatively smaller in size and more crowded on the axis.

The rock containing these specimens is a little soft and it was not possible to take very thin microscopic sections nor peels. Further, when the sections were mounted in Canada balsam they grew rather transparent hardly yielding enough anatomical details. It was quite convenient, however, to take thin serial slices of the rock from the transversely exposed end of specimen I, which after suitable polishing could be studied successfully in strong reflected light. The surfaces of the slices represented serial transverse sections at various levels. These slices, after suitable and adjusted thinning, when mounted in Canada balsam presented clear anatomical details. For microphotography too, strong reflected light with suitable filters proved very useful.

Text-figures were prepared directly from enlarged microphotographs taken on mat paper.

DESCRIPTION OF SPECIMEN I

It is a racemose inflorescence consisting of a large number of shortly stalked flowers (Pl. 32, fig. 1). The total length of the specimen works up to 47 mm., of which 7.5 mm. has gone away while cutting the three slices and the remaining 39.5 mm. is exposed on the rock surface. The inflorescence might, however, have been longer as some of it seems unexposed, lying embedded inside the rock. Also, the inflorescence is not straight but bent twice, a form which it took possibly at the preservation stage. For the sake of convenience the specimen has been divided into four regions, A, B, C and D (Text-fig. 1) ; region A, now in the form of transverse slices : region B, running flat on the rock ; region C, flat but at a lower level and
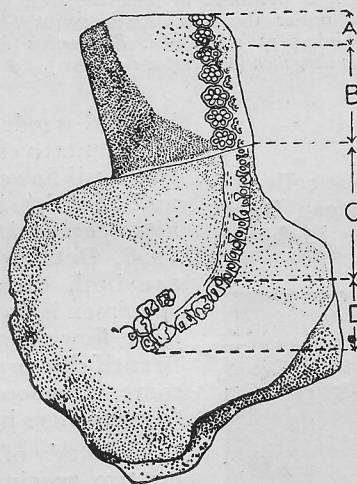
Text-fig. 1—A diagrammatic representation of the specimen I, partly embedded in the rock, showing the four regions into which it has been divided for detailed study. Region A—the portion which was cut into three transverse slices ; region B—the portion which runs flat on the rock surface being exposed in a superficial tangential plane ; region C—the portion fractured along a deep longitudinal plane ; region D—being the sloping part of the inflorescence exposed along a very oblique plane, ×1.3.

region D, which is sloping. The maximum diameter of the body of the inflorescence is 5.2 mm. and that of the inflorescence axis 1.6 mm.

Inflorescence axis :—The transverse plane of the inflorescence axis at the node is distinctly six-angled but in the region of the internodes the angles become rounded off giving it more or less a circular form (Pl. 33, fig. 8 ; pl. 35, fig. 13 ; text-figs. 3 and 8).

Arrangement of the flowers on the axis :—The flowers are pistillate, shortly stalked and are attached at the nodes of the inflorescence axis, along its flat sides, in an alternating fashion in six vertical rows or orthostichies. A transverse section through any node of the inflorescence axis will, thus, show three flowers belonging to the alternating orthostichies, cut radially. A further section through the successive node, either above or below, will again cut three flowers radially belonging to the remaining three orthostichies (Pl. 32, fig. 4 ; Pl. 33, fig. 8 ; Pl. 34, fig. 9 ; text-fig. 3). In other words, the flowers are arranged in alternating whorls at successive nodes. The flowers are quite compact and so placed that those of one row fit closely into the gaps of flowers of the two alternating rows on either side (Pl. 32, fig. 3 ; text-fig. 4). Consequently, a transverse section through an internode will show six flowers tangentially skipped, from the upper and the lower whorls, and hence appearing detached from the inflorescence axis : (Pl. 32, fig. 5 ; Pl. 35, fig. 13 ; text-fig. 8). The average distance between two nodes of the inflorescence axis is 1.2 mm. and approximately its double, between the two superposed whorls of flowers.

Pl. 32, fig. 3 shows a longitudinal tangential section of the regions A and B of the inflorescence passing through one row of flowers, each one of which in its own turn has been cut transversely. Since in this section seven flowers can be counted in one row, it is calculated, there must have been nearly 45 flowers in all the six rows in this portion of the inflorescence alone. Text-fig. 2 indicates the region C of the specimen which is a slightly oblique tangential view of the inflorescence, cutting six

29

flowers of one row longitudinally. This means there must have been nearly 33 flowers in all the six rows of this region. Lastly, coming to the curved part D of the inflorescence, which is again cut longitudinally though obliquely, there can be counted 39 flowers. The total number of flowers thus, on the entire axis—A+B+C +D—comes to 117.
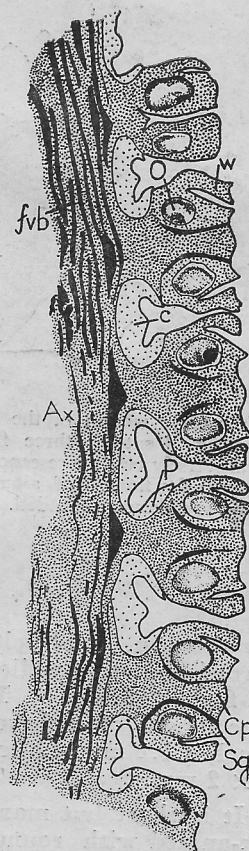
Text-fig. 2—A deep longitudinal section of region C of the inflorescence (specimen I), showing a portion of the inflorescence axis, AX cut longitudinally and a single row of flowers attached to it laterally, the individual flowers being cut along a very oblique vertical plane. c, cortex of the inflorescence axis ; fvb, fibro-vascular bundles ; P, perianth ; Cp, carpophore ; w, detached ovary wall ; Sg, stigma ; O, ovule. ×9.

Flower :—The individual flower, as mentioned above, is pistillate, the pistil being hexacarpellary, apocarpous. Each flower, which is narrow at the base and broadens

text-fig. 3) two of these are seen attached at the base as small appendages. The average length of a sepal is 0.45 mm. and thickness 0.135 mm.
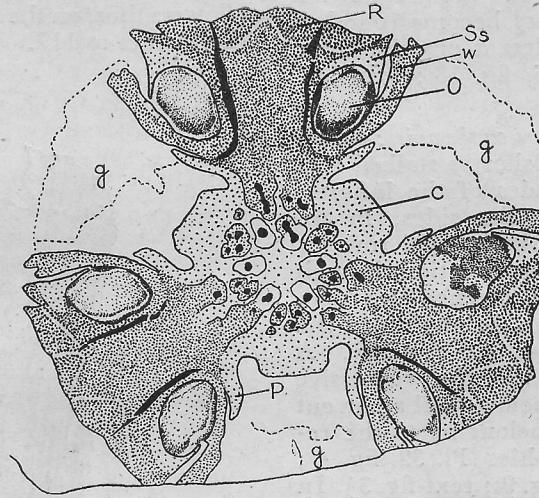
Text-fig. 3—Transverse section of the inflorescence (specimen I) at the node along the plane cc' of text-fig. 4 cutting three flowers of alternate rows radially. These are attached to the transversely cut inflorescence axis. Ss, soft tissue in the style ; R, ridges at the top of the flower; g, gap for flowers of alternating rows. The six fibro-vascular bundles forming the inner ring are shown unshaded. (The other abbreviations for labelling same as in text-fig. 2.) × 15.
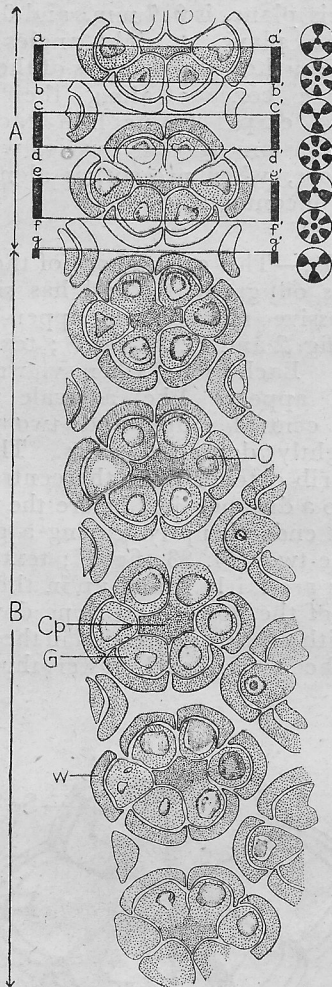
out towards the top, is attached to the axis by a broad and stout pedicel (Pl. 33, fig. 8 ; text-figs. 2 and 3). The maximum average height of a flower, including the pedicel, is 1.8 mm. while the width is 2.7 mm. × 2 mm.

Pedicel :—It is short but massive and is probably six-angled with rounded edges. It is continued between the six carpels forming a carpophore or a central axis of the flower which reaches up to the top of the ovaries. The maximum average width of the pedicel is 0.85 mm.

Calyx :—This may, more appropriately, be called the basal perianth. It consists of six sepals which are probably free, each sepal against a carpel. In the radial longitudinal section of a flower (Pl. 33, fig. 8 ;

Corolla :—Probably absent, since there is neither any trace of its tissues nor any gap to represent its occurrence.

Pistil :—The flower possesses six carpels arranged round a flat six-angled central axis or carpophore, each carpel being placed against its one side (Pl. 32, fig. 3; text-fig. 4). The carpophore becomes broader at the top, measuring 1.1 mm. while only 0.7 mm. in the middle region, thus deflecting the carpels a little towards outside. In each carpel the upper portion of the ovary forms a conical style like projection which ends in a pointed stigma. The average height of a carpel, in a flower from the region A, is 1.35 mm. and its maximum width 0.75 mm. The ovaries, in young condition, are fused with the carpophore along their length.

In most of the flowers of the present specimen, since these are comparatively older, the carpels are getting separated from the carpophore, remaining attached only at the base and at the top, though in a few cases the shreds of fusion tissue are still intact, and in some, the individual carpels may even be at the initial stage, either partly or completely fused. Such fusion areas are marked out distinctly in radial longitudinal and transverse sections of the flower (text-figs. 3 and 4).

Ovary :—Each ovary is longer than broad and is more or less triangular in cross section, with round edges towards outside. The thickness of the ovary wall is not uniform : it is comparatively thicker at the base and on the outer side. The outer wall of each ovary becomes free half way downwards and gets bifid at the top (Pl. 33, fig. 8 ; text-fig. 3). There is, however, left a thin tissue over the solitary ovule in the region where this layer gets separated. In longitudinal and transverse sections this partly detached layer, measuring about 0.55 mm. in length, reminds one of a perianth lobe, one opposite each ovary. In the radial longitudinal section of the flowers, however, these lobes are one with the rest of the ovary wall, being made up of the same kind of tissue, and consequently there remains no ground for considering these as inner whorl of perianth lobes or even corolla units partly fused with the ovary wall.
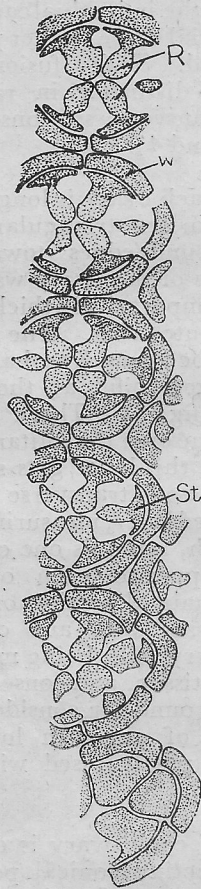
The top of each ovary is drawn out to form a projecting conical pointed structure, the style (text-figs. 2 and 3). When viewed from above, this appears to be present at the outer margin of the carpel, obviously due to the outer tilt of the ovary. Each style is quite thick at the base and is triangular in cross section (Text-fig. 5).

Ovule :— There is a single ovule inside each ovary completely filling up the cavity and its attachment seems basal.

The carpophore :—The carpophore or central axis of each flower, round which the six carpels are arranged, is the direct continuation of the short and stout floral

Text-fig. 4—Tangential longitudinal section (slightly oblique) of regions A and B of the inflorescence (specimen I), showing three rows of flowers ; the flowers in the middle row neatly cut along a transverse plane in the middle. The two rows on either side partly and obliquely exposed. The individual flower, each with six carpels placed round a carpophore and occasionally in the initial state of fusion with it, fitting into the gap of the adjoining rows. G, carpel ; O, ovule ; w, detached portion of the ovary wall ; Cp, carpophore. The lines aa', bb', cc' dd', ee', ff' and gg' represent the transverse planes along which the inflorescence has been sliced for study. The accompanying figures in the margin opposite each line indicate the respective sectional views of the inflorescence (Pl. 32, figs. 4 and 5; Pl. 33, fig. 8 ; Pl. 34, fig. 9 ; Pl. 35, fig. 13). ×8½.

stalk, and is six-angled in transverse section (Text-figs. 3 and 4). The total length of the stalk and the carpophore, taken together, measures on an average 1.55 mm. The carpophore is not round but
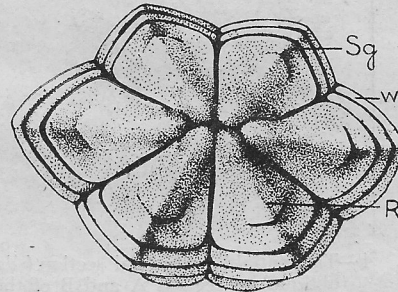
along this plane, is 0.7 mm. and 0.3 mm. along the plane at right angles to the former. Further, the six sides of the carpophore are concave along their length with one carpel fitting into each concavity. Fusion of the ovaries with the carpophore, when present, is along these surfaces of contact.

The ribs:—The carpophore of the flower broadens out gradually and has six stout and massive ribs on its upper surface (Pl. 32, fig. 2 and Pl. 33, fig. 7 ; text-figs. 5 and 6). Each rib, when viewed from the top, appears like a scale with a distinct central ridge and two sloping and slightly depressed sides. The ridge of each rib extends from the centre of the flower to a distance just before the stigma, where it ends abruptly leaving a gap between the two (Pl. 33, fig. 8 ; text-fig. 3). The ribs are fairly raised up in the central portion of the flower and slope down outwards with a gentle depression in the middle. The surface view of each flower, thus, would

Text-fig. 5—Tangential longitudinal section through the regions B and C of the inflorescence (specimen I) obtained by grinding the rock from the back. The sectional plane passes through one row of flowers cutting them superficially along a transverse plane thus exposing the radiating ribs, R. The flowers in the adjacent row on one side exposed just at the margins ; w, detached ovary wall ; St, projecting style appearing triangular in section. × 10.

Text-fig. 6—Top of the flower drawn from a plaster reconstruction, the six ribs, R radiating out from the centre, one lying over each carpel. (Abbreviations for labelling same as in Text-fig. 2). × 18.

flattened along a plane at right angles to the inflorescence axis. The average width of the carpophore in the middle,

show a stretched six-angled depression in the central region, from where the six ribs, one placed above each ovary, radiate out upto the stigmatic projections. These ribs at the top, would thus alternate with the angles of the carpophore,
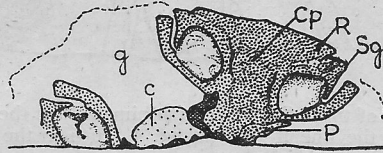
SPECIMEN II

This specimen represents the apical region of a different inflorescence (Pl. 35, fig. 15) bearing about 18 flowers which, but for their size, exhibit the same morphological and anatomical details as seen in specimen I. The acropetal arrangement of the flowers is comparatively more distinct and those near the apex, fractured longitudinally, are younger and smaller in size measuring 1 mm. in height including the pedicel and 2 mm. in width.

The inflorescence is fractured near its apex along a transverse plane (Pl. 35, fig. 17) and the remaining portion, measuring 7.5 mm. in length and 3.5 mm.

it. The detached portion of the ovary wall is still in close contact with the ovary from which it has obviously separated out in the older flowers (text-fig. 3—specimen I). Ribs are present at the top of the flower but are not yet very prominently developed. A detailed study of this specimen lends confirmation to the morphological details of the flowers described above in specimen I.

ANATOMY

The following cellular details of the inflorescence are based on a study of the various sectional planes along which the two specimens I and II are exposed and also


Text-fig. 7—Transverse section through the specimen II at a node showing a portion of the inflorescence axis with two flowers cut radially (compare specimen I text-fig. 3). R, rib ; g, gap for flower of the alternate row. (The other abbreviations for labelling same as in text-fig. 2). × 13½.

in width, along a very oblique longitudinal plane (Pl. 35, fig. 16). The axis of the inflorescence, only half of which is seen in the transverse section, appears round with 1.0 mm. diameter and only one ring of vascular bundles arranged at the periphery of the central medullary region. The flowers here are closely aggregated compared to those in specimen I, the distance between the two superposed flowers of a row being 1.3 mm. The pedicel of each flower is also comparatively narrower and less massive (text-fig. 7). The carpophore is 0.45 mm. in width in the middle and the ovaries, which are displayed round it in a similar manner (Pl. 35, fig. 16), are still at the initial state of attachment with

on the basis of transverse sections taken from these specimens ground up to microscopic transparency.

Inflorescence axis :—The anatomy of the inflorescence axis shows a typical monocotyledonous pattern. In transverse section (text-figs. 3 and 8) it shows a broad cortex and a central zone of thin-walled ground tissue with a large number of fibrovascular bundles closely crowded together, roughly forming two rings. The central zone is demarcated from the cortex by the crowding of the peripheral zone of smaller bundles. The cortex comprises round thin-walled cells, nearly 15 layers thick. Most of these cells are filled with whitish contents, either silica or some other sub-
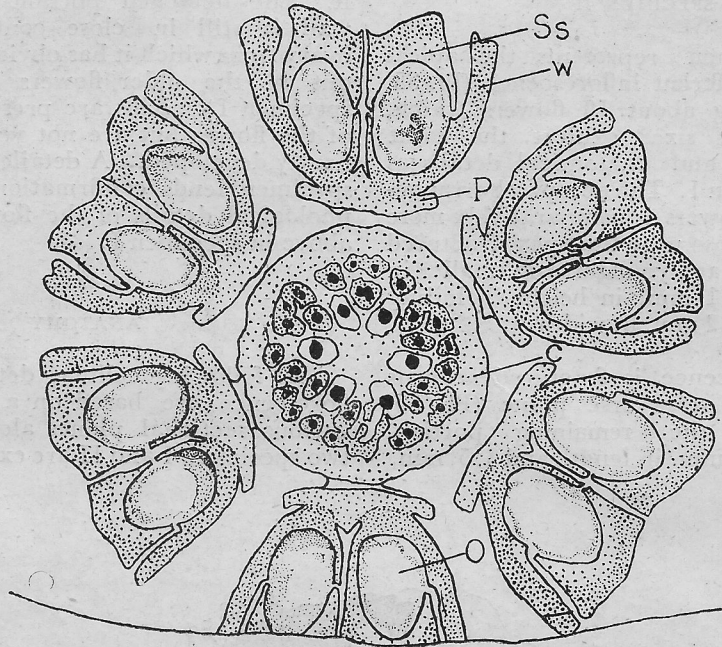
Text-fig. 8—Transverse section of the inflorescence (specimen I) at the level almost midway between two nodes, along the line ff' of text-fig. 4, cutting the flowers in the six rows each along a longitudinal tangential plane just missing the carpophore of the flower, also apparently detached from the axis. The six fibro-vascular bundles of the inner ring shown unshaded. Ss, soft tissue in the style. (The other abbreviations for labelling same as in text-fig. 2). ×20.

stance of indeterminable nature. The epidermis consists of small thin-walled squarish cells forming a distinct layer wherever preserved. The cortex is interrupted at

---

EXPLANATION OF PLATE 32

### SHUKLANTHUS SUPERBUM gen. et sp. nov.

Specimen I

FIG.   1—Surface view of the entire inflorescence exposed unevenly on the rock surface. ×2.6.

2—Photograph of a plaster reconstruction of a single flower showing six radiating ribs at the top, one over each carpel. ×15.5.

3—Longitudinal tangential view of the regions A and B of the inflorescence showing three rows of flowers, those in the middle row exposed along a perfect transverse plane. In each flower the six carpels placed round a flat six-angled carpophore may be seen. ×11.

4—Transverse view of the inflorescence passing through a node along line gg' of text-fig. 4 showing three radially cut flowers attached to the inflorescence axis. ×9.5.

5—Cross section of inflorescence between nodes along line dd' of text-fig. 4 cutting all the six rows of flowers, arranged round the inflorescence axis, tangentially. ×15.
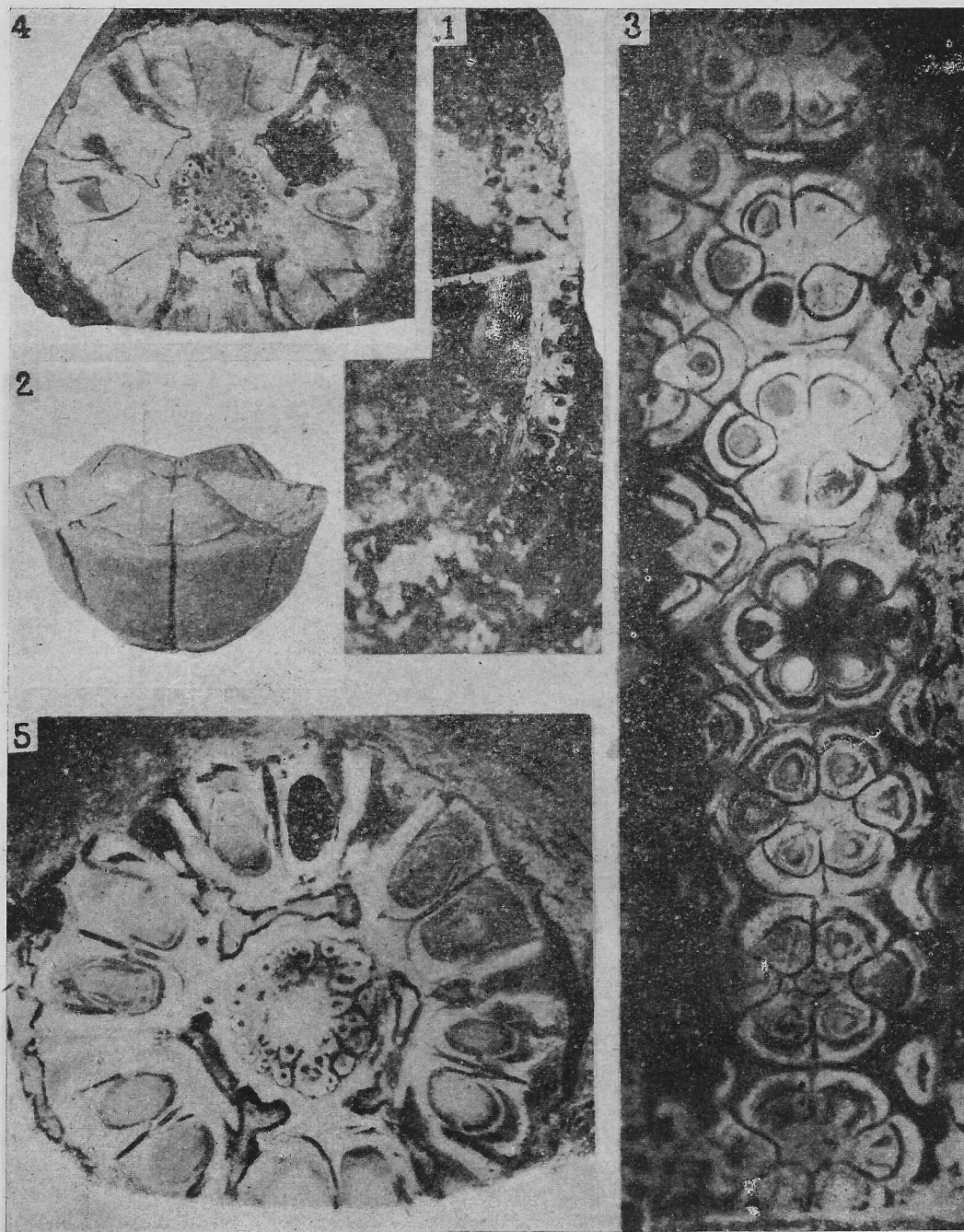
VERMA : A NEW PETRIFIED MONOCOT FLOWER
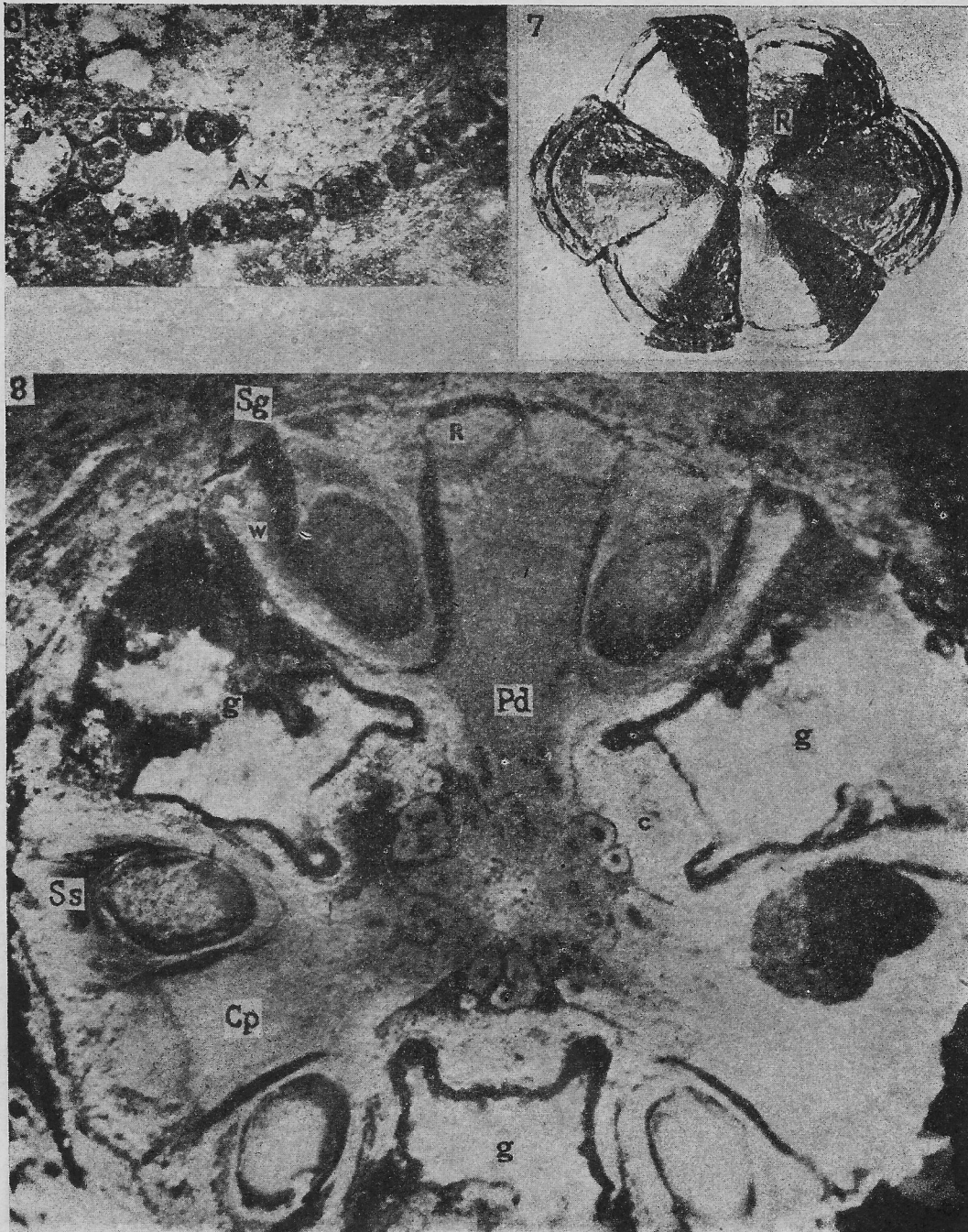
VERMA : A NEW PETRIFIED MONOCOT FLOWER

places where the flowers are attached to the axis, and two or more vascular strands are seen entering each pedicel. In these regions the continuity of the cortex with the thin-walled tissue of the perianth (text-fig. 3, P) is also observed.

*Distribution of bundles :—*The distribution of fibro-vascular bundles in the peripheral region of the ground tissue, as mentioned above, is not entirely at random, on the contrary it shows some regularity of distribution : There is always seen an inner ring of six vascular bundles (Pl. 33, fig. 8 ; Pl. 34, fig. 9 ; Pl. 35, fig. 13 ; text-figs. 3 and 8) which are often quite regular in form and position in the different cross sections taken at various planes. The bundles might possibly be running for several internodes in the inflorescence. These are oval in shape in cross section, measuring on an average 0.325 mm. $\times$ 0.18 mm. along the two diameters, and are so arranged that one bundle lies on each of the six radial planes passing through the six angles of the hexagonal inflorescence axis. In other words, two of these would always be seen at the base of each flower. The remaining bundles, forming the outer ring, are rather irregularly distributed and lie in between the cortex and the inner ring. These are of varying forms and sizes. The smallest of these, often arranged on the periphery, are usually round and measure 0.135 mm. in diameter across the sclerenchyma. The others, which are comparatively larger measuring on an average 0.21 mm., are mostly oval in shape and are closely crowded together being separated

from each other by thin strips of parenchymatous cells of the ground tissue. Occasionally, when two such bundles are very close to each other their fibrous sheaths get fused to form a bilobed mass of sclerenchyma (text-fig. 3). Sometimes, however, when more than two bundles get fused, there is formed an irregular fibrous mass.

*Vascular bundle :—*Each vascular bundle is surrounded by a sclerenchymatous sheath. Some of the bundles, chiefly those nearer the centre, have two sheaths : the dorsal and the ventral (Pl. 35, fig. 14). Both these sclerenchymatous masses are almost equally well developed and are either separated by parenchymatous cells of the ground tissue or just touch each other at the sides. It appears, this condition developed further to form a continuous mass of sclerenchyma round most of the bundles.

The sclerenchymatous fibres are closely compact. In cross section these are either circular or polygonal with a small lumen, their average diameter being 16 μ. Pit canals are quite well seen in the sclerotic fibres.

The preservation of the vascular bundles is often not very satisfactory and a detailed study of their structure could not be possible from any of the available sections. However, in the portions preserved, there appears abundant thin-walled tissue in the xylem region of the vascular bundles (text-fig. 9). The xylem vessels, being scanty and ill preserved, could only be seen at places. The cells of xylem parenchyma have pores on their walls which are either
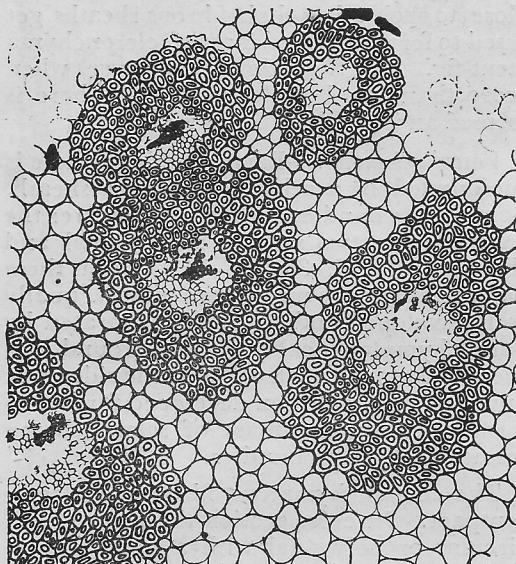

EXPLANATION OF PLATE 33

SHUKLANTHUS SUPERBUM gen. et sp. nov.

(Specimen I)

Fig.   6—Region D of text-fig. 1, showing two rows of flowers arranged on the inflorescence axis, Ax, one row complete and the other, on the left, represented only by a few flowers. $\times 4$.

7—Surface view of a flower model showing six carpels and the radiating ribs, R. w, detached ovary wall. $\times 22$.

8—Transverse view of the inflorescence passing through a node along line cc' of text-fig. 4 showing a whorl of three radially cut flowers, of alternate rows, attached to the inflorescence axis. c, cortex of inflorescence axis ; Pd, pedicel ; Cp, carpophore ; w, detached ovary wall ; Ss, soft tissue in the style ; Sg, stigma ; R, rib ; g, gap for alternate flowers. The six vascular bundles forming an inner ring may be seen. $\times 30$.

round or oval. The xylem, as seen in pedicel traces bending out into the perianth, consists of spiral and pitted tracheae. The probable region of phloem is represented by disorganised tissue. Inside a common sheath are sometimes seen two vascular masses, one smaller than the other. This obviously is a case of branching.

The longitudinal course of the fibro-vascular bundles, as studied from the available cross sections of the inflorescence at various levels and also from the oblique longitudinal tangential sectional view of the regions 'C' and 'D' of specimen I, shows that the six fibro-vascular bundles forming the inner ring run more or less parallel to one another for several internodes. Each one of these runs in a radial longitudinal plane passing through the six angles of the inflorescence axis. The course of the other bundles, however, could not be followed up to sufficient length to warrant positive statement, primarily because it was not possible to take numerous serial sections out of this solitary specimen and secondly, because of the very frequent anastomosing of the bundles which defies precise analysis of their course. In the region of the internodes, however, some of these bundles fused in groups of two or three forming irregular masses of sclerenchyma. At the node itself this fused condition of bundles is not very prominent, possibly because of these bundles separating out or sending branches to the flower stalk.

Text-fig. 9—Magnified view of a portion of inflorescence axis from Pl. 33, fig. 8, showing a few fibro-vascular bundles embedded in the ground-tissue. × 125.

Pith :—In the central region of the 'pith' there are no vascular bundles and the ground tissue again consists of tiny thin-walled iso-diametric cells filled with whitish contents.

Pedicel :—The pedicel is made up of an outer cortical zone of small parenchymatous cells and a central region of comparatively larger, thin-walled cells. The former zone is continuous down below with the similar tissue of the inflorescence axis and upwards with the parenchymatous tissue of the perianth (text-fig. 3). The central region is continuous with the ground tissue of the axis at the base and merges rather abruptly with the sclerotic tissue of

---

EXPLANATION OF PLATE 34

SHUKLANTHUS SUPERBUM gen. et sp. nov.

(Specimen I)

Fig. 9—Tranverse view of the inflorescence at another node along the plane ee' of text-fig. 4 showing three radially cut flowers. These belong to three rows alternate with those seen in Fig. 8 (Plate 33). × 22.

10—Part of fig. 8 (Plate 33), showing a portion of inflorescence axis and one carpel of an attached flower on one side of the carpophore. iw, inner sclerotic layer of the ovary wall ; O, ovule ; g, gap for flower of the alternate row. × 44.5.

11—A deep longitudinal tangential section of part C of the inflorescence showing a row o flowers, each cut along an oblique longitudinal plane. × 10.

12—Sclerotic tissue from an ovary wall. × 533.
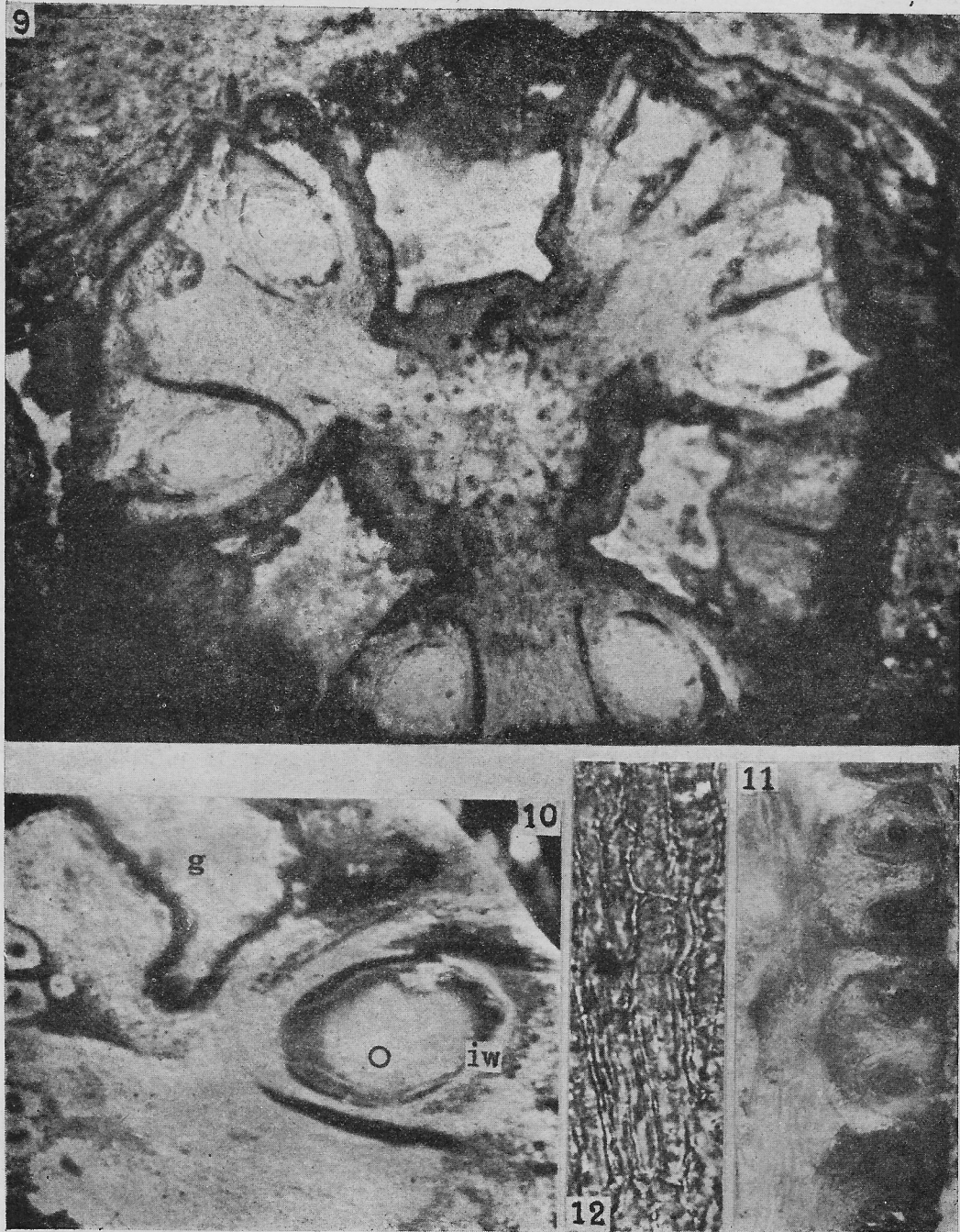
VERMA : A NEW PETRIFIED MONOCOT FLOWER

VERMA : A NEW PETRIFIED MONOCOT FLOWER

the carpophore. In the vertical section of a flower two or three fibro-vascular strands are seen entering the central region of the pedicel from the inflorescence axis and those on the sides, gradually bend outwards entering the perianth lobes. Where these vascular bundles contact the ovary wall and the carpophore, their fibrous sheaths become one with the sclerotic tissue.

Perianth :—Each perianth lobe is thick at the base and gradually tapers outwards. It is made up of thin-walled cells similar to those of the pedicel cortex. An ill preserved epidermis is seen at places.

The carpophore :—The carpophore of the flower is mostly made of sclerenchymatous fibrous elements which run parallel to the long axis of the flower (text-fig. 10). The average size of a sclerenchymatous fibre is 0.086 mm. in length and 0.023 mm. in diameter. The fibres are blunt at the two ends and their cell wall is highly lignified almost obliterating the central cavity. Delicate branching canals, originating from the central lumen, traverse the thickness of the fibre wall.
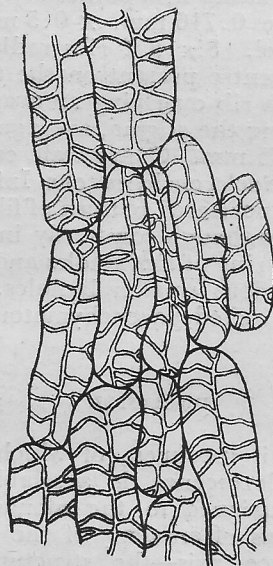
Text-fig. 10—A patch of sclerotic tissue from ovary wall; individual fibre having a central lumen and branching pit canals. × 400.
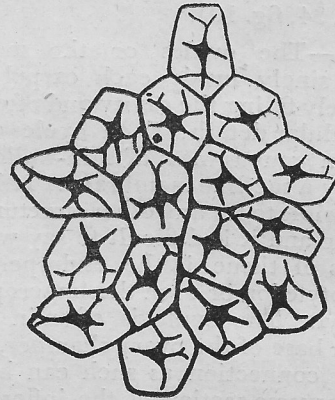
Text-fig. 11—Sclerotic tissue from one of the ribs. × 270.

Ribs :—The six radiating ribs present at the top of each flower are also made of the same texture of sclerotic tissue; its fibres are, however, longitudinally placed (text-fig. 11).

Ovary :—The wall of each ovary is almost entirely made of sclerenchymatous tissue

---

EXPLANATION OF PLATE 35

SHUKLANTHUS SUPERBUM gen. et sp. nov.

Specimen I

FIG. 13—Transverse view of the inflorescence, along plane ff' of text-fig. 4, through the middle of the internode cutting flowers of all the six rows tangentially. × 20.

14—Magnified view of cross section of the inflorescence axis from fig. 9 (Plate 34), showing fibro-vascular bundles embedded in thin-walled ground tissue. The six bundles forming the inner ring may be seen, also the dorsal and ventral sheaths in some bundles. × 60.

Specimen II

15—As seen on the rock. × 2.8.

16—Magnified view of fig. 15, showing the inflorescence exposed along a very oblique longitudinal plane. × 15.5.

17—Transverse section of a part of the inflorescence near the apex, almost at the node, showing the inflorescence axis in transverse section and four flowers all cut along tangential planes at slightly varying levels. × 20.

similar to that of the central axis ; except at the central area of the cone-like projecting style (text-figs. 3 and 8) and a portion of the perianth-like detached portion of the ovary wall, where the cells have become thin-walled and parenchymatous. This soft tissue in the style perhaps facilitated entry of the pollen tube. The thin-walled tissue in the perianth-like lobe is obviously the detached counterpart of the similar tissue in the conical style.

In each ovary the innermost layer of the wall lining the loculus is single layered and composed of closely set thick-walled cells (Pl. 34, fig. 10).

Ovule :—The ovules or the seeds are present singly inside each carpel almost completely filling the cavity and often show some cellular details. Each ovule consists of a homogenous mass of thin-walled cells bound by a sac-like membrane. It has not been possible to see any other structure inside the ovule and it is difficult to say whether, the mass of tissue is the endosperm, the single cotyledon or even the 'macropodous' hypocotyl. The ovule is often in contact with the base of the ovary chamber, but no cellullar connection as such can be seen. In a transverse section of the inflorescence through an internode, cutting the flowers tangentially, traces of vascular strands are seen ending at the base of ovaries, again suggesting basal attachment of the ovules.

Vascular supply of the flower :— The course of vascular supply in the flower could not be studied in detail. Several fibro-vascular bundles enter the pedicel from the axis (text-fig. 3). In some of these, which bend out into the perianth lobes, annular and spiral elements of the vascular tissue are seen for a short distance. But in others, which appear to run up the carpophore, the vascular elements become indistinguishable from the fibrous sheath of the bundles and similar tissue of the carpophore.

DIAGNOSIS

Inflorescence racemose, unbranched ; length—specimen I—47 mm. (though it might have been longer). Flowers ebracteate, unisexual, hypogynous, shortly stalked, closely crowded, arranged along six vertical and alternating rows. Individual flower on an average 1.8 mm. in height and 2.7 mm. in width at the top. Perianth composed of six free units one against each carpel, each unit 0.45 mm. in length ; pistil of six carpels arranged round a six-angled flat carpophore and initially fused with it ; carpophore continuous with the short and stout pedicel. Each carpel 1.35 mm. in length, ovary superior, each ovary wall towards outside getting split half way, inner epidermis of ovary wall made of thick-walled sclerotic cells. Apex of the ovary forming a conical projecting style and ending in a pointed stigma ; one basal ovule 0.716 mm. × 0.5 mm. inside each carpel. Six flat ribs radiating out from the centre present on the top of the flower each rib overlying an ovary though not reaching the stigma, average length of the rib 0.75 mm. Ovary wall, carpophore and the ribs sclerenchymatous. Inflorescence axis with a scattered pattern of fibro-vascular bundles though constantly in the form of an inner ring of six bundles and an outer ring of various smaller bundles. Central 'pith' thin-walled, parenchymatous.

DISCUSSION

The fossil specimen, of which only the female inflorescence is available, can at once be assigned to the monocotyledons on the basis of anatomy of the six-angled inflorescence axis—the structure of the closed vascular bundles and their random distribution in the ground tissue ; and also the trimerous nature of the flowers arranged along six orthostichies on the axis.

A close study of the salient diagnostic characters exhibited by the specimen suggests a reference to the families included under the Order Helobiae. In these families which are mostly aquatic, flowers are hypogynous (epigynous in Hydrocharitaceae) ; bracteate or ebracteate ; bisexual, sometimes unisexual ; with or without a perianth ; perianth when present bract like or differentiated into calyx and corolla ; stamens one to numerous ; capels many, free or united ; endosperm mostly absent or poorly developed.

The Helobiae as defined by Engler includes seven families, Potamogetonaceae, Najadaceae, Butomaceae, Aponogetonaceae, Scheuchzeriaceae (Juncaginaceae), Alismataceae and Hydrocharitaceae, the last one being exclusively epigynous. A careful study of the more important floral characters exhibited by members of these families makes it clear that the fossil can primarily be referred to the family Scheuchzeriaceae in which, the flowers are small, usually bisexual though sometimes unisexual, in spike or racemose inflorescence, with or without bracts, perianth of six mostly similar and free segments ; stamens when present six in number and free. There are 3-6 carpels, free or weakly connate but separating at fruit maturity, ovary one celled with a basal ovule ; style short and stout or absent ; fruit a follicle, seed without endosperm. Macropodous hypocotyl which is an important feature of the Helobiae, could, however, not be recognised here.

The present specimen, though not exactly similar to any of the three genera of Scheuchzeriaceae (Juncaginaceae), shows a fairly close approach to the genus *Triglochin* which is exclusive in possessing ebracteate flowers with 3 to 6 carpels placed round a carpophore or central axis, from which they separate out at the fruiting stage. Of the other species belonging to this genus, *Triglochin maritimum* agrees with our fossil to a fairly good degree in possessing constantly six carpels fused round a central axis. In the present specimen also, there are six carpels displayed in a similar manner. There is one ovule per loculus and the attachment seems basal.

The agreement of the fossil, it may, however, be mentioned, is in no way complete with this species of *Triglochin* since there are several important differences as well. Firstly, the flowers are not so closely crowded on the inflorescence axis of the living form as in the present specimen; secondly, the flowers in *Triglochin maritimum* are definitely bisexual and, thirdly, there is the absence of radiating ribs present on the top of the flower or the fruit. Lastly, in this and most of the other species of *Triglochin*, the stigmas are small and feathery.

It is thus seen that the present specimen, while showing resemblances with the genus *Triglochin*, has various features of its own and may therefore be considered as an extinct genus referable to the family Scheuchzeriaceae.

It may here be mentioned that the present-day plants of the family Scheuchzeriaceae mostly comprise aquatic species and this is in accordance with the fact that the Deccan fossil flora, which includes this family, is also mostly aquatic. The lack of distinct aquatic characters in the present specimen is perhaps due to its very young age and further, it is after all not necessary that the reproductive organs and young fruits should show the aerial parenchyma or other aquatic tissues seen in the vegetative organs of the same plant. Still, however, the genus *Viracarpon* (*Viracarpon hexaspermum*), which is a fully developed infructescence related to the present specimen, does exhibit aquatic characters in possessing aeranchymatous pith in the peduncle and it is likely that this specimen also might have developed such characters at maturity.

The present specimen has also been compared with other fossil monocotyledons, specially those reported from Mohgaonkalan. Of these, it shows remarkable structural similarities with the fructification of *Viracarpon hexaspermum* which was first collected and briefly described by Hislop (1853), and later by Sahni (1934, 1944) and Shukla (1944). Professor Sahni distinguished two species of this genus ; *Viracarpon hexaspermum* and *Viracarpon elongatum* and gave a short account, with figures, of both. Recently, Chitaley (1954) has given more account of *Viracarpon hexaspermum* based on the study of three specimens collected by her from Mohgaonkalan. Professor Shukla had many more specimens of *Viracarpon hexaspermum* in his collection, some of them in excellent state of preservation and often fractured in neat longitudinal and transverse planes. These, he very kindly placed at the disposal of the author for a thorough study. A detailed comparison of the present specimen has been made with Chitaley's description and with the data obtained from Professor Shukla's specimens, in table I.

TABLE I

	Structures.	Present fossil. (Inflorescence).	*Viracarpon hexaspermum.* (Fructescence).
1	Inflorescence or fructification.	Racemose. Specimen I, 47 mm. in length, 5.2 mm. in diameter.	Racemose, 30 mm. in length, 19 mm. in diameter.
2	Arrangement of flowers or fruits.	Along six alternating vertical rows ; not very closely crowded.	Along 8—12 or more alternating vertical rows ; very closely crowded.
3	Dimensions of flower or fruit.	1.8 mm. × 2.7 mm.	5 mm. × 5 mm.
4	Bracteate or ebracteate.	Ebracteate.	Ebracteate.
5	Pedicel.	Short and stout.	Sessile.
6	Perianth.	Present ; free ; comprises small units.	Absent in the fruits.
7	Stamens.	Not seen.	Not seen.
8	Nature and condition of pistil in the flower or fruit.	Six carpels ; some becoming free and others still separating out from the carpophore.	Aggregate fruit ; six loculi or carpels attached round a central core. (Fused or free ?)
9	Carpophore or central core.	Present ; six-angled, flat ; made of sclerotic tissue.	Present ; six-angled ; highly fibrous.
10	Spines.	Absent. (The styles may be considered to represent the inner set of spines of *Viracarpon* while the detached portion of the outer ovary wall may represent the outer set of spines with its flanges—author.)	Hairy ; straight spines in two whorls on the top of the fruit ; members of adjoining whorls opposite each other. The outer spine, an extension of the ridge at the outside of each carpel wall. The inner one springing above the middle of each loculus. At the base of the outer spine, a flange is seen in T. S., formed by an upward extension of the carpel wall.
11	Style and Stigma.	Both present.	Not recognised. (Probably represented by the inner set of spines—author.)
12	Detached outer ovary wall.	Present.	Absent. But suggested by the outer spines, each with flange-like extension of the ovary wall.
13	Ovule or seed.	Single, filling the loculus, probably basal.	Single ; probably pendulus.
14	Ribs.	Six, present at the top of the flower, radiating out from the centre but ending short of the stigma.	Six in number, present at the top of the fruit, radiating out from a central depression.
15	Depressions at the top of the flower or fruit.	Present.	Present.
16	Fibro-vascular bundles in the inflorescence axis or the peduncle.	Scattered, though with an inner ring of six bundles. Smaller bundles of various shapes and sizes present.	Scattered, though with an inner ring of nine bundles. Smaller bundles round ; of various sizes present.
17	Bundle sheath.	Dorsal and ventral sheaths well developed ; these often fuse ; continuous band of fibrous tissue round the smaller bundles.	Broken ring of fibrous tissue consisting of isolated patches.
18	Nature of bundles.	Not well preserved, abundant wood parenchyma present.	Not well preserved ; probably collateral and endarch.
19	Sclerotic tissue.	Abundant in the various parts of the flower—in the carpophore and ovary wall.	Abundant in the various parts of the fruit —in fruit core or central axis and fruit wall.

From a careful persual of this table and also accounting for the fact that *Viracarpon* is a mature fructification and the present specimen an inflorescence, it becomes clear that the similarities are very close indeed. However, it may not be generalised that the present fossil is just the inflorescence which had developed into a *Viracarpon* fructification. Because, while the variations in size, differences in the shape and size of ridges and other minor details of the two specimens may easily be accounted for as normal developmental variations, the more basic differences regarding the number of floral orthostichies—eight or more in *Viracarpon hexaspermum* and only six in the present fossil—also the related number of bundles forming a ring in the inflorescence axis, must necessarily be assessed differently. These may therefore be considered as specific characters. One might perhaps also feel like considering the absence of spines in the present specimen as a case for specific delimitation but it is likely that the spines of *Viracarpon hexaspermum* might have been subsequent outgrowths in the fruit development—a feature, often seen in a number of living plants today.

It is thus concluded that the present fossil and *Viracarpon hexaspermum* are two closely allied species referable to the same genus.

Viracarpon elongatum, the other species mentioned by Professor Sahni (1944), is narrower and has smaller dimensions than *Viracarpon hexaspermum*. It has also been stated to possess ribs at the top. But, from the brief description and a single figure, it has not been possible to compare or identify it with the present specimen.

NAME OF THE FLOWER

As the present specimen is an entirely new form, it is proposed to refer it to the new genus *Shuklanthus superbum* gen. et sp. nov. after Professor V. B. Shukla, who has done such pioneer work on the Deccan intertrappean flora and who has also been a source of great encouragement to the author. The specific name refers to the most pretty and superb form of the entire inflorescence and its unique pattern among the monocotyledons.

NOMENCLATURE

Shuklanthus superbum and *Viracarpon hexaspermum* being the two different species referable to the same genus, the next question arises whether the generic name for these forms should be *Shuklanthus* or *Viracarpon*. On grounds of priority it may perhaps be argued to retain the name *Viracarpon*, *Shuklanthus* having been founded later. But cases are known where the rule of priority has been waived for various reasons. The study of fossils often being a study of isolated organs occasionally even of one and the same plant, a rigid adherence to this rule in palaeobotanical nomenclature may at times lead to erroneous situations. For instance, it is known that the stem and leaf form usually show wide variations in different plants of the same genus and therefore it would not be appropriate to name the entire plant after any stem or leaf genus, particularly when its reproductive organs with their characters of systematic value are available, just for the reason that the stem or the leaf form happened to be instituted earlier. To illustrate, the leaf genera *Zamites*, *Ptilophyllum* or *Otozamites* could not be adopted as a common generic name for the plants to which these leaves belonged in comparison to the term *Williamsonia* instituted for the fructification, though later. Similarly, Professor Sahni preferred the name *Williamsonia* (*Williamsonia Sewardiana*, Sahni, 1932) for his plant instead of *Ptilophyllum* or *Bucklandia* which were instituted earlier for the leaf and stem respectively.

In the same way, the characters of the fruit are also not dependable for systematic purposes, since a wide range of fruit pattern may be produced from flowers having a similar ground plan. For example, in the family Myrtaceae the morphology of the flower is fairly constant though many varied types of fruits develop from this general type. The fruits of *Eugenia caryophyllata*, *Eucolyptus globulus* and *Psidium guyava* are indeed so different from each other that were they to be found as fossils we would have been inclined to keep them apart, perhaps even in separate families. Similarly, in the family Anacardiaceae, *Mangifera indica* and *Anacardium occidentale*

are two extremely varied types of fruits developing from a similar floral form. Last but not least, mention may be made of the most convincing example of the fossil flower *Sahnianthus* which alone could ultimately prove the affinities of the fruit genus *Enigmocarpon* (Sahni, 1943), which otherwise in Professor Sahni's own words "remained an enigma for a long number of years". Professor Shukla has considered it highly probable that the flowers having the general plan of *Sahnianthus* (Shukla, 1944) might have produced probably more varied types of fruits than *Enigmocarpon* alone. Accordingly, he adopted the name *Sahnianthus* for the entire plant to which this flower belonged in preference to the earlier name *Enigmocarpon*.

The present case is a remarkable parallel of *Sahnianthus* and *Enigmocarpon* in terms of its generic relation with *Viracarpon* and consequently the new generic name *Shuklanthus* is now adopted over '*Viracarpon*'. Further, the new form *Shuklanthus* in consequence, embraces the earlier fructifications, *Viracarpon hexaspermum* and *Viracarpon elongatum*, besides the present flower *Shuklanthus superbum*.

Accordingly, *Viracarpon hexaspermum* and *Viracarpon elongatum* being the two species of *Shuklanthus* should henceforth, more appropriately, be designated as *Shuklanthus hexaspermum* (*Viracarpon hexaspermum*) and *Shuklanthus elongatum* (*Viracarpon elongatum*) respectively.

ACKNOWLEDGMENT

REFERENCES

CHITALEY, S., 1954, On a fructification from the Intertrappean Flora of Madhya Pradesh, India. *The Palaeobotanist*, Vol. 3, pp. 9-17.

HISLOP, S., 1853, Remarks on the Geology of Nagpur. *Jour. Bom. Asiat. Soc.* 5 : 58-76, 148-150.

RAMA RAO, L., 1936, The Deccan Traps. *Proc. Ind. Acad. Sci.* 4 (3) : 208-223.

SAHNI, B., 1932, A petrified *Williamsonia* (*Williamsonia Sewardiana*, sp. nov.) from the Rajmahal hills, India. *Palaeont. Ind.*, N. S. 20 : 1-19.

——, 1934, The silicified flora of the Deccan Intertrappean Series, Part II. Gymnospermous and Angiospermous fruits. *Proc. 21st Ind. Sci. Cong.* : 317-318.

——, 1940, The Deccan Traps : an episode of the Tertiary era. *Pres. Addr. 27th Ind. Sci. Cong.* Pt. II. : 3-20.

——, 1943, Indian Silicified Plants (2)—*Enigmocarpon Parijai* a silicified fruit from the Deccan, with a review of the fossil history of the Lythraceae. *Proc. Ind. Acad. Sci.* B., 17 : 27-64.

——, 1944, Takli, near Nagpur—Genus *Viracarpon* Sahni. *Palaeobotany in India—V. Proc. Nat. Acad. Sci. Ind.* 14, Pts. 1 and 2 : 80-82.

——, and RODE, K. P., 1937, Fossil plants from the Intertrappean beds of Mohgaon Kalan in the Deccan, with a sketch of the geology of the Chhindwara District. Pt. I. *Proc. Nat. Acad. Sci. Ind.* 7, Pt. 3 : 165-174.

SHUKLA, V. B., 1944, On *Sahnianthus*, a new genus of petrified flowers from the Intertrappean beds at Mohgaon Kalan in the Deccan and its relation with the fruit *Enigmocarpon Parijai* Sahni from the same locality. *Proc. Nat. Acad. Sci. Ind.*, Vol. 14, Pts. 1 and 2, pp. 1-39.

——, 1944, Mohgaon Kalan, Chhindwara District. *Proc. Nat. Acad. Sci. Ind.* 14, Pts. 1 and 2 : 82-83.

——, 1948, Palaeobotany in India, Vol. 6. Progress Report for 1944-46. *Journ. Ind. Bot. Soc.*, Vol. 26, no. 4, pp. 241-273.

VERMA, J. K., 1956, *Sahnipushpam Shuklai* sp. nov. *Journal of the Bombay Natural Hist. Soc.*, April 1956.

——, 1956, On a new petrified flower, *Sahnipushpam Shuklai* sp. nov. from the Intertrappean beds of Mohgaon Kalan. *Journ. Pal. Soc. Ind.* Vol. I, no. 1, pp. 131-141.