

**REVISION OF *AMORPHOPHALLUS*  
(ARACEAE) IN INDIA**

**Thesis submitted to the  
UNIVERSITY OF CALICUT  
in part-fulfilment of the requirements  
for the award of the degree of  
DOCTOR OF PHILOSOPHY  
in  
BOTANY**

*By*

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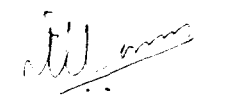
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## CERTIFICATE

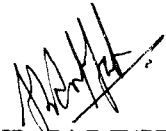
This is to certify that the thesis entitled, **Revision of *Amorphophallus (Araceae) in India*** submitted by Mr. V. Abdul Jaleel in part-fulfilment of the requirements for the award of the degree of **Doctor of Philosophy** in Botany of the **University of Calicut** is a record of *bona fide* research work carried out by him during the period of his study under my supervision and guidance, and that the thesis has not previously formed the basis for award of any degree, diploma, associateship, fellowship or other similar titles of recognition.

Mr. V. Abdul Jaleel has successfully completed the preliminary qualifying examination prescribed by the University of Calicut.

  
(M. Sivadasan)

## DECLARATION

I hereby declare that the thesis entitled **Revision of *Amorphophallus* (Araceae) in India** submitted by me to the University of Calicut in part-fulfilment of the requirements for the award of the degree of Doctor of Philosophy in Botany has not been submitted by me for the award of any other degree or diploma and represents the original work done by me.



**ABDUL JALEEL, V.**

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# INTRODUCTION

V. Abdul Jaleel "Revision of Amorphophallus (Araceae) in India " Thesis.  
Department of Botany , University of Calicut, 2002

## INTRODUCTION

The aroids – the members of the family Araceae are very much familiar to everyone, but paradoxically little known. The family is extraordinarily diverse in appearance, with the foliage being probably its most widely appreciated and admired, and cultivated for their beauty, variety and uniqueness for years. The family is a natural group of monocotyledons comprising 105 genera and approximately 3300 species (Mayo *et al.*, 1997).

The genera of the Araceae are highly diverse with respect to growth habit, leaf morphology, flower morphology, and most other characters that have been investigated. They have been grouped together mainly on the basis of the distinctive inflorescences (Grayum, 1984).

The genus *Amorphophallus* is best known to the public because of the publicity that has been amassed in the literature about the gigantic *A. titanum* (Becc.) Becc. ex Arcang. discovered in the last century by the Italian botanist Odoardo Beccari. It has the biggest unbranched inflorescence in the plant kingdom. The genus *Amorphophallus* is with about 170 species distributed in Tropical Africa, Malay Archipelago, Melanesia and Australia.

The word *Amorphophallus* is originated from the two Greek words, *Amorphos* means irregularly shaped, and *phallus* means male genital organ, thus giving the meaning 'irregularly shaped penis'.

The species of *Amorphophallus* vary greatly in size and shape of inflorescence and many are poorly known and probably quite rare. They produce some of the most fascinating inflorescences in the family because of the beautifully patterned and fine floral parts (Deni Bown, 1988).

To the aroid systematists, the genus *Amorphophallus* is a true treasure of diversity and is unmatched with any of the other genera of the family. The diversity is exhibited in the tuber (shape, skin colour and size), petiole (dimension, colour and pattern of blotching), spathe (size, colour and shape), spadix (size, shape and organisation of fertile parts) and spadix-appendix (size, shape and texture), and finally the individual female flowers (shape, size and colour of ovary, style and stigma). The mysterious character of most of the flowering *Amorphophallus* specimens is the stunning heat production of the spadix-appendix on the first day of flowering. The temperature of the appendix may rise up to ca. 13°C above the temperature of the surrounding atmosphere (Hettterscheid & Ittenbach, 1996).

In the genus *Amorphophallus*, the inflorescences are not usually produced along with the leaves, but produced prior to the emergence of leaves. The flowering is restricted to a very short period. These make collection of vegetative and

reproductive parts together difficult. Identification of the species may not be possible with vegetative specimens alone. Apart from these, the succulent and massive nature of the plant parts like tubers, petioles and inflorescences makes collection and preservation of the specimens very difficult. All these factors might have been the reason for neglecting the family by the botanists and the consequent poor representation of the genus in Indian and International herbaria. It is in this context that it was proposed to undertake a revisionary study of the genus *Amorphophallus* in India for a better understanding of the species diversity, and taxonomic delimitation of the constituent species and their correct nomenclature.

#### GENERAL CHARACTERS OF THE GENUS *AMORPHOPHALLUS*

##### **Habit**

The plants are tuberous herbs, seasonally dormant, sometimes irregularly so, or rarely evergreen herbs, often large or sometimes gigantic (Mayo *et al.*, 1997).

##### **Stem**

Stems are subterranean, tuberous, rarely a chain of tubers, or rhizomatous. Tubers are usually globose, sub-globose, depressed globose, saucer-shaped, or vertically elongate and then unbranched or branched, representing one module, and are being renewed each season; chain-like tubers are not being renewed every season. Rhizomes are long, terete, creeping horizontally consisting of several

modules; offset development is absent, seasonal, or gradual. Offsets are globose, spindle-shaped, shortly elongate, or rhizomatous (Fig. 1).

## Leaves

The leaves are usually solitary, rarely paired in adult plants, emerging from the top of the tuber or rhizome, lasting one growing season, or rarely long-lasting (Fig. 2). *Petioles* are terete, rarely angulate, smooth, shallowly grooved or partly rugulose, rarely entirely verrucate or hairy (*A. atroviridis*), unicolourous or variously blotched (Plate 1).

*Lamina* is decomposed, divided into three main branches (Fig. 2); all the branches are equally long or the anterior main branch is longer, or in some it is shorter than the posterior two main branches. *Rachises* unbranched, or once or more pseudodichotomously branched, naked, narrowly or broadly winged and often carrying supernumerary leaflets on the proximal parts; sometimes bulbils are present on the leaves, either epiphyllar, intercalary or semi-epiphyllar. *Distal leaflets* obovate, elliptic, elongate-elliptic, elongate-oblong, lanceolate or linear, sessile or rarely petiolulate, base often assymetric and decurrent on one side, apex acute, acuminate or rarely caudate; margin entire, rarely erose, often undulate, upperside green or dark green, rarely with reddish margin or variegation. Primary lateral veins of ultimate lobes pinnate, forming distinct submarginal collective vein, higher order venation is reticulate (Fig. 3).

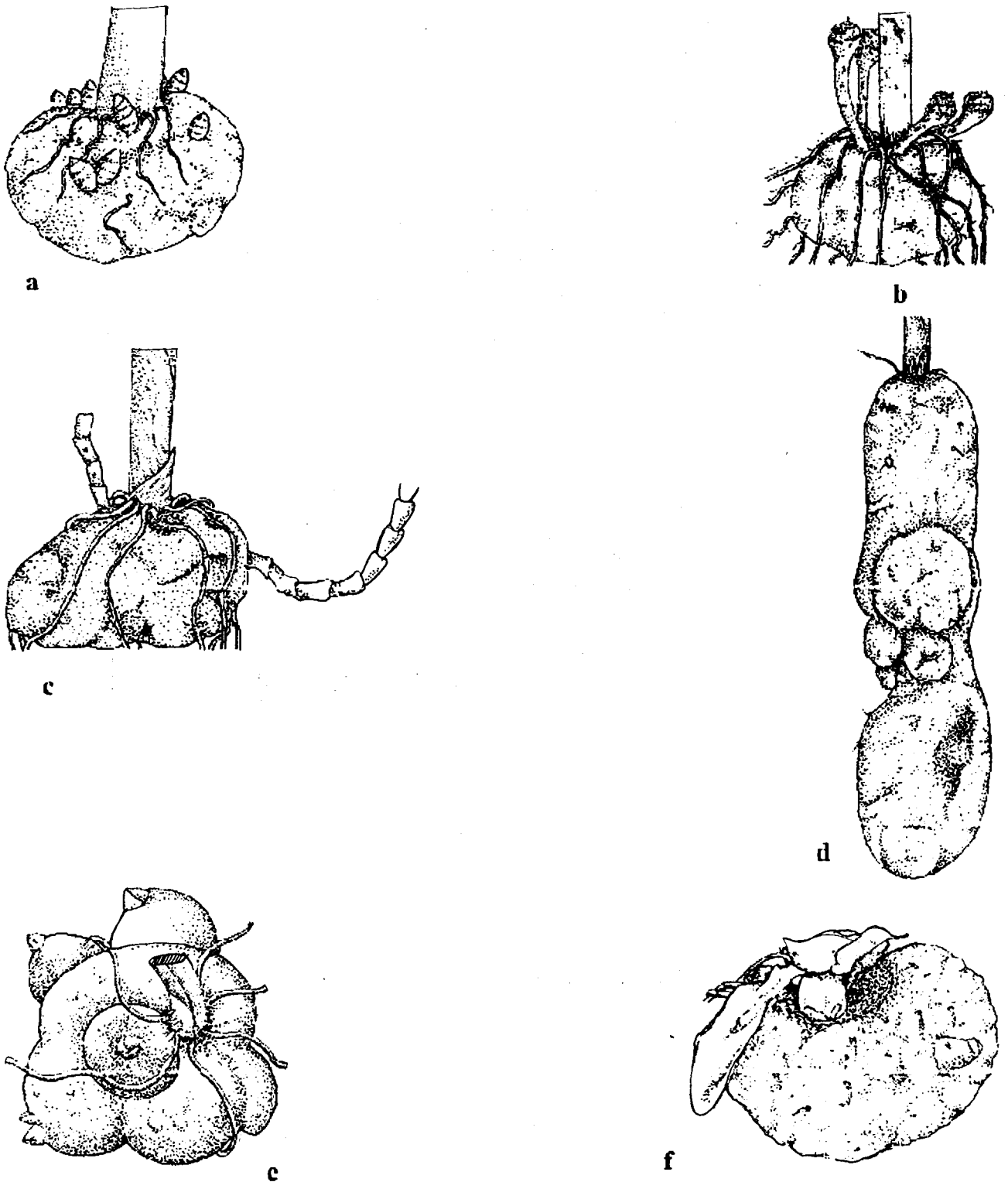


Fig. 1. Various types of tubers and offsets: a. Subglobose tuber with small globose to fusiform offsets (*Amorphophallus margaritifer*); b. Subglobose tuber with elongated offsets with swollen subspherical tips (*Amorphophallus napalensis*); c. Subglobose tuber with elongated stolons (*Amorphophallus bonaccordensis*); d. Cylindrical tuber (*Amorphophallus nicolsonianus*); e. Irregularly subglobose tuber with globose-fusiform offsets (*Amorphophallus smithsonianus*); f. Depressed globose tuber (*Amorphophallus paeoniifolius*).

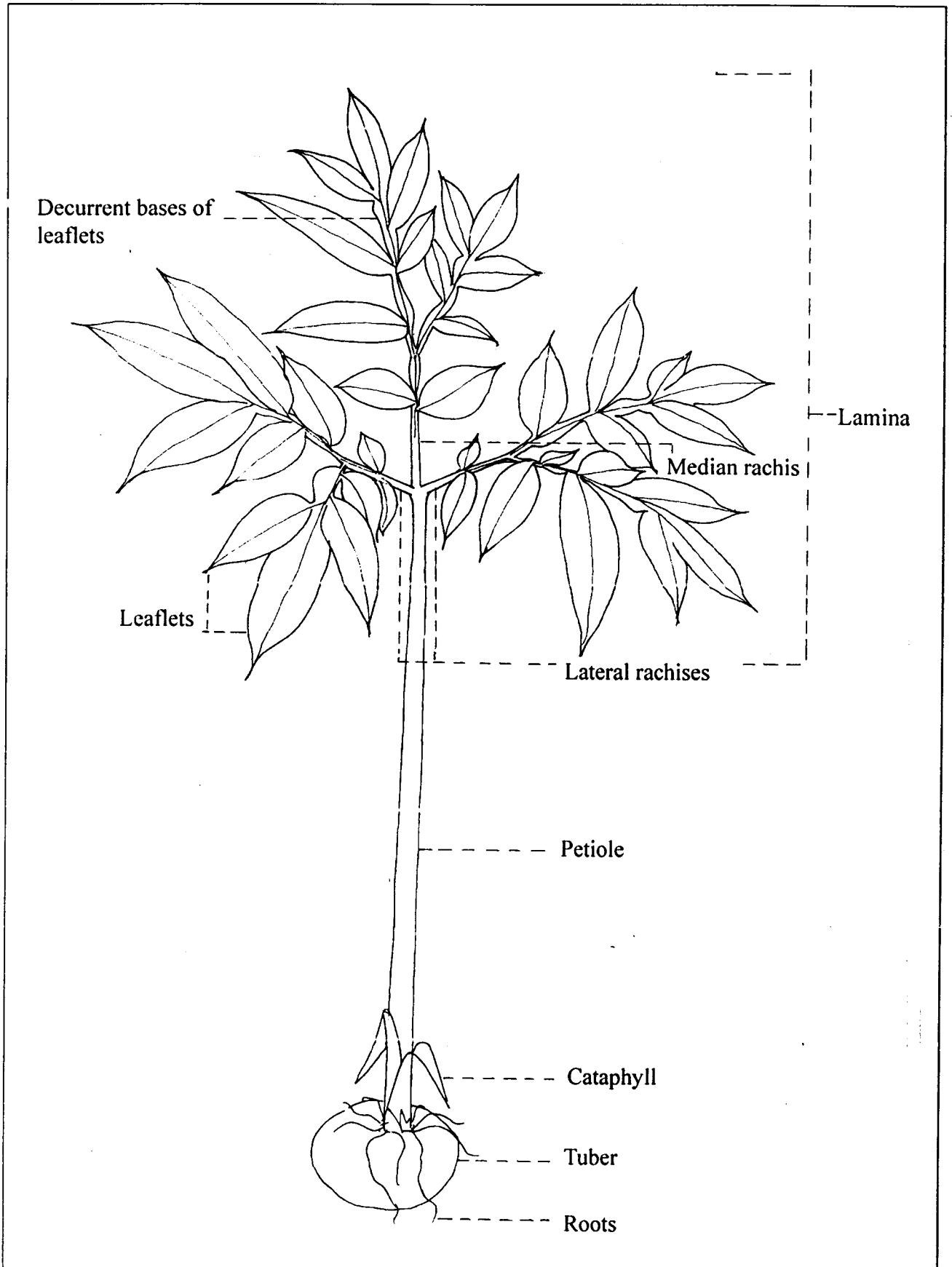


Fig. 2. *Amorphophallus* Bl. ex Decaisne : Habit – Vegetative phase : Tuber with leaf (Schematic sketch)



Plate I. Portions of petioles of different species of *Amorphophallus* showing various patterns of mottlings : a. *A. bognerianus*; b. *A. bulbifer*; c. *A. carnosus*; d. *A. commutatus* var. *commutatus*; e. *A. commutatus* var. *anmodensis*; f. *A. commutatus* var. *wayanadensis*; g. *A. hirsutus*; h. *A. hohe-nackeri*; i. *A. konkanensis*; j. *A. longiconnectivus*; k. *A. longistylus*; l. *A. margaritifera*; m. *A. mysorensis*; n. *A. napalensis*; o. *A. oncophyllus* var. *oncophyllus*; p. *A. oncophyllus* var. *rayhillianus*; q. *A. paeoniifolius* var. *paeoniifolius*; r. *A. paeoniifolius* var. *campanulatus*; s. *A. keralensis*.



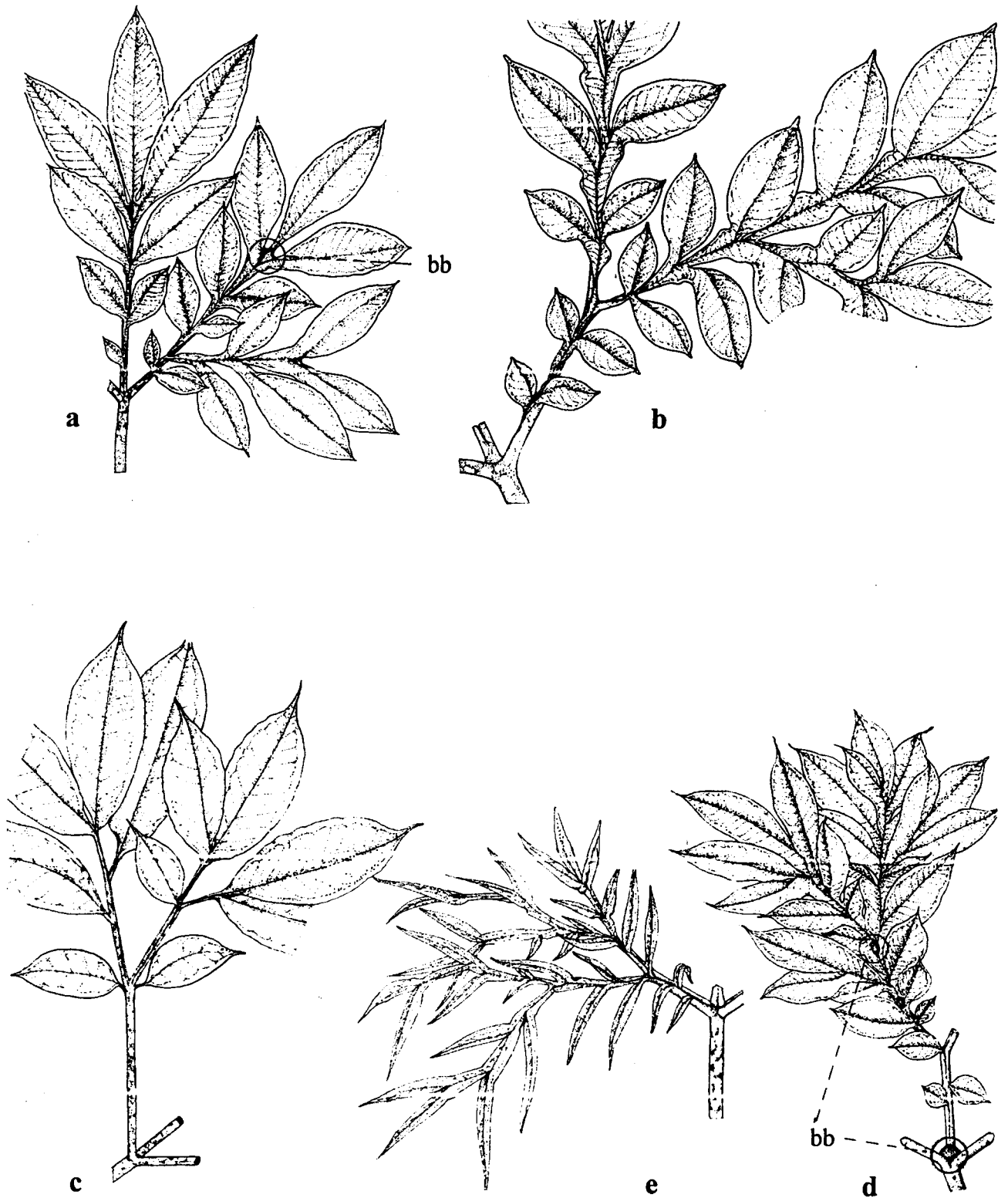


Fig. 3. Various types of lamina and leaflets: a. Lamina with intercalary bulbils; b. Lamina showing ovate-elliptic leaflets with bases decurrent on branches of rachis; c. Lamina showing slender cylindrical rachises and leaflets with distinct petiolules with and without decurrent bases; d. Lamina showing linear-lanceolate leaflets with decurrent bases; e. Lamina with epiphyllar bulbils ; bb-bulbil.

## **Inflorescence**

The inflorescence is a spadix, and is covered by a bract-like structure called spathe (Fig. 4). The inflorescences with distinct peduncles are usually epigeal, rarely partly burried, always solitary, initially covered by cataphylls, simultaneous with or directly preceeding leaf development; rarely emerging after leaf development. The *peduncles* are short or long, often resemble the petioles in texture and colour, and often elongate in infructescence stage.

The *spathes* may be elongate-triangular, triangular or ovate to broadly ovate, and variously shaped: cymbiform or campanulate, tubular, more rarely funnel-shaped, or differentiated into a basal convolute *tube* and an upper expanded *limb* (Fig. 5); variously coloured, but often with shades of brownish purple or whitish green outside, inside mostly paler than outside, but base within often dark maroon. The *tube* is convolute, rarely open or not, or clearly separated from limb by a constriction; ovoid, rounded, urceolate or funnel-shaped, inside smooth or clothed with ridges or sometimes with small or large warts, rarely with minute hair like structures. The *limb* is erect to spreading, smooth, oblique or fornicate, margin entire, sometimes wavy, flat, variously undulate; apex acute, rarely acuminate (*A. costatus*) or caudate (*A. pendulus*).

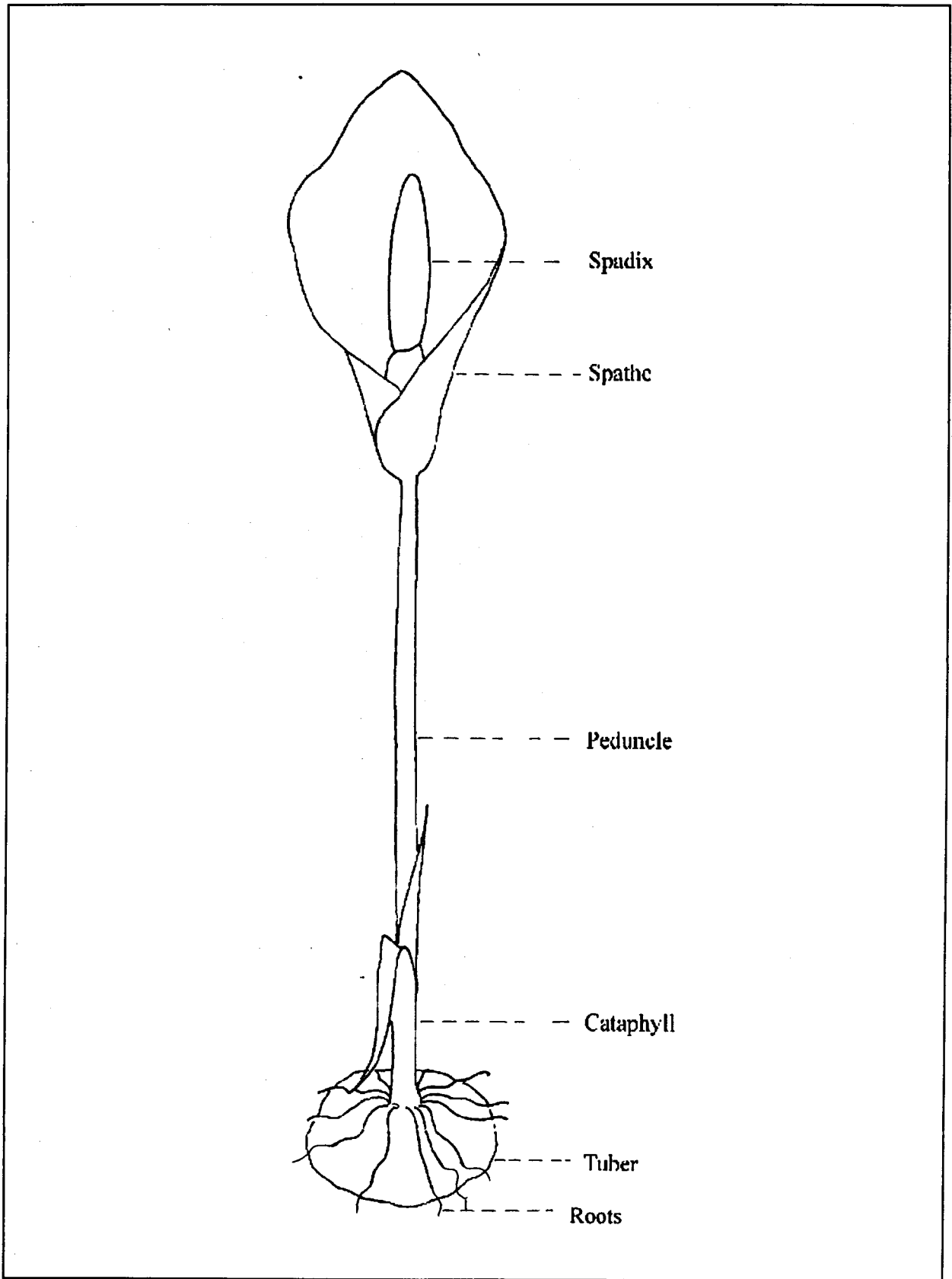


Fig. 4. *Amorphophallus* Bl. ex Decaisne: Habit – Reproductive phase : Tuber with inflorescence (Schematic sketch).

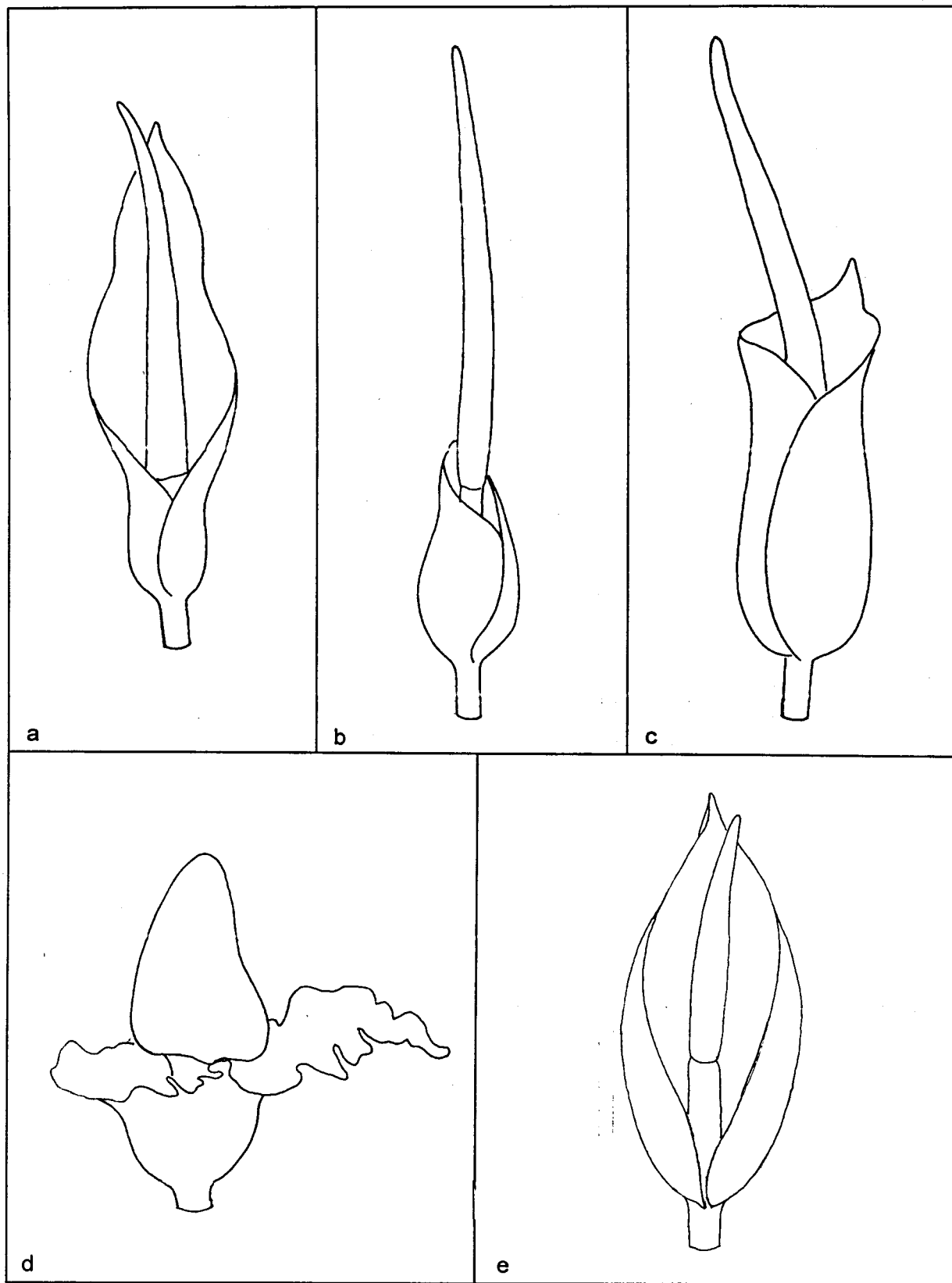


Fig. 5. Inflorescence with various types of spathes in *Amorphophallus* : a. Spathe with a basal convolute tube and upper open, erect, long limb (*A. commutatus*); b & c. Fully convolute spathe without well differentiated limb (b. *A. konkanensis* & c. *A. mysorensis*); d. Campanulate spathe (*A. paeoniifolius*); e. Spathe – fully opened without convolute basal tube (*A. hohenackeri*).

## Spadix

Spadices may be sessile or shortly stipitate, shorter than, equalling, or longer than the spathe; differentiated into basal female zone, followed by male zone, and a terminal sterile appendix, or with neuteriflorous zone in between the female and male zones, or rarely spadix-appendix is completely lacking (*A. margaritifera* and also observed in some specimens of *A. longiconnectivus*) or very rarely with neuter flowers above the female zone and above the male zone (Fig. 6), and in some cases both basal neuteriflorous zone and spadix-appendix lacking (observed in some specimens of *A. longiconnectivus*).

*Female zone* is shorter, equalling, or longer than the male zone; cylindrical, fusiform or conoid, contiguous with male zone or separated by a sterile zone or neuteriflorous zone. The flowers are congested or rarely distant in spirals, some times surrounded by hair like staminodes (*A. cirrifer*).

*Sterile zone* consists of neuter flowers, staminodes, rarely mixed with pistillodes; or rarely partly or entirely naked; in very rare cases two zones of neuter flowers - one between male and female zones, and the other between male zone and the spadix-appendix are present (observed in some specimens of *A. longiconnectivus*).

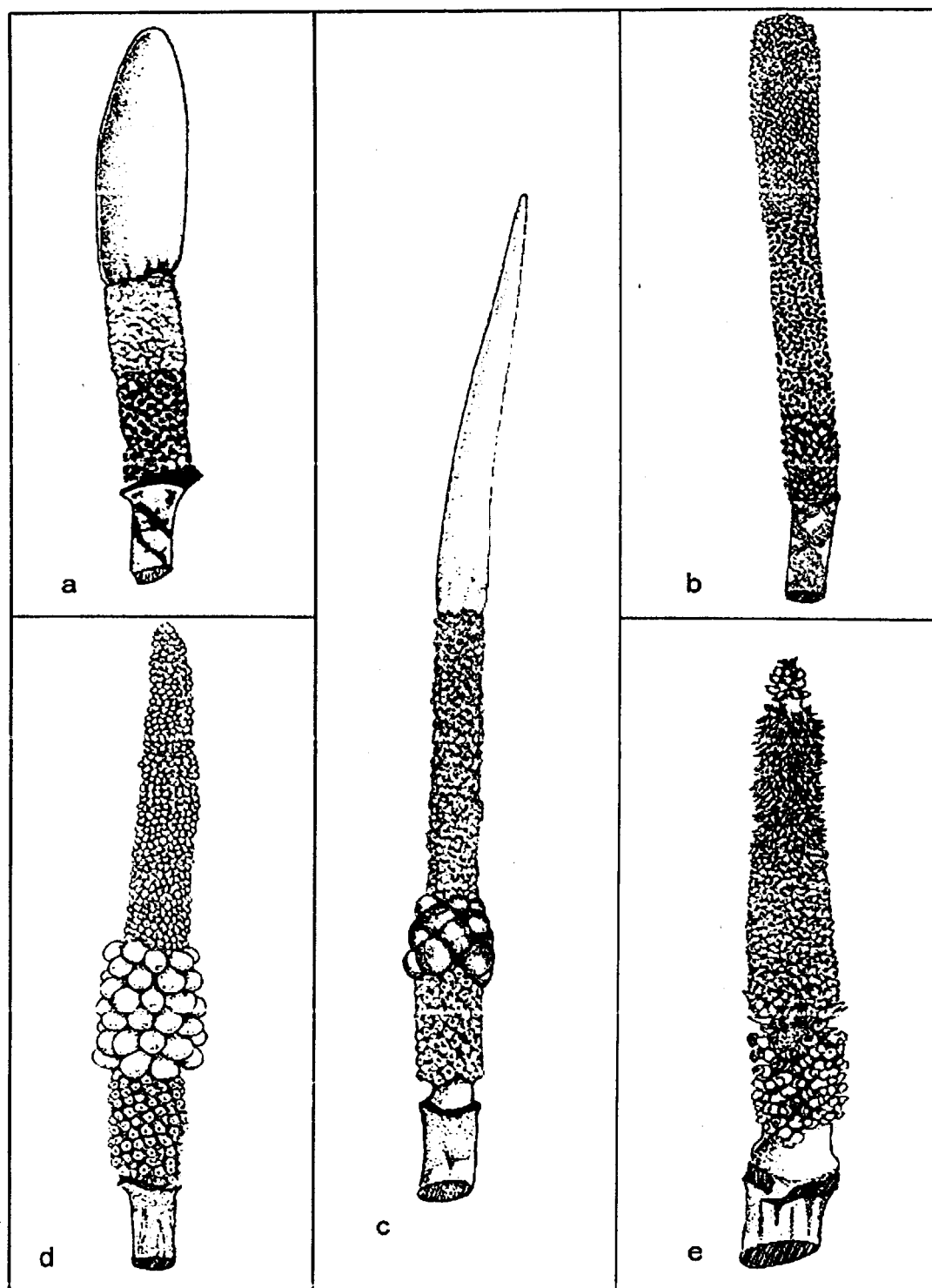


Fig. 6. Various types of spadices: a. Spadix with basal female zone, middle male zone, and terminal smooth appendix; b. Spadix with basal female zone, middle male zone and terminal rough appendix; c. Spadix with basal female zone, a neuteriflorous zone above, a male zone, and a terminal appendix; d. Spadix with basal female zone, middle neuteriflorous zone, and terminal male zone; e. Spadix with basal female zone, a neuteriflorous zone above, male zone, a staminode zone, and a terminal stipitate appendix.

*Male zone* is cylindric, fusiform, or obconic. It is usually contiguous with female zone. The flowers are congested, rarely distant, often variously fused in the upper part of the zone, sometimes aligned into vertical rows (*A. angulatus*) or helicals or sometimes mixed with staminodes.

*Spadix appendix* is usually present, rarely absent or reduced to a stub; contiguous with the male zone or separated by a constriction or short stipe, erect, rarely horizontal, arching, nodding or pendulous; conoid, fusiform, myosuroid, ovoid, sub-globose or globose, sometimes with deep longitudinal valleculation; apex of the appendix rounded, acute, or obtuse; wall thin or massive, inside a narrow canal or a large cavity with cellular tissue and become spongy on ageing; naked, smooth or rugulose, or with distinct, variously shaped staminodes or protuberances, usually only at the base (Fig. 7); often warming up during male anthesis and emitting strong scent, sometimes emitting droplets of clear fluid.

## **Flowers**

The flowers are unisexual and without perigone, and hence naked. Female flowers are at the base and male flowers above on the spadix.

*Female flowers* are usually many. Each flower is with the *ovary* sessile or shortly stipitate, globose, subglobose, depressed globose or ovoid, rounded or angulate in cross section, 1-4-locular, ovule one per locule, basifixed, or rarely axile

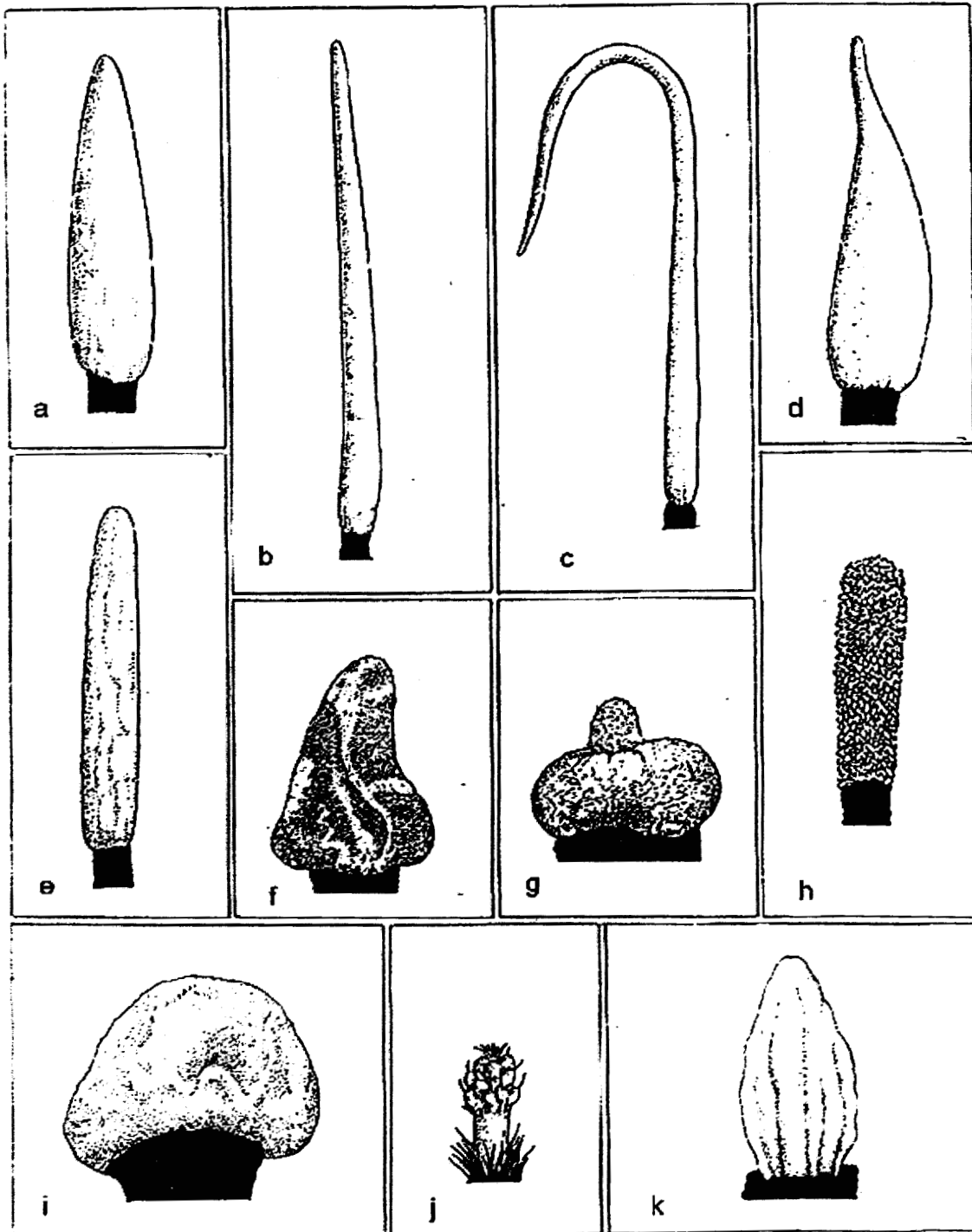


Fig. 7. Various types of spadix-appendices: a. Elongate-obovoid; b. Cylindric and apically tapering; c. Very long, cylindric and hanging; d. Elongate-conical; e. Cylindric and rounded at the apex; f. Elongate-conoid – longer than the breadth; g. Subglobose with a cylindrical columnar truncate apical portion having short stiff papillae; h. Cylindric and rough with prominent elongated rounded protuberances; i. Hemispheric, broader than the height; j. Stipitate appendix bearing irregularly formed rudimentary male or female flowers or irregular protuberances; k. Ellipsoid or ovoid with several deep longitudinal irregular fissures.



with about half way up the locule, anatropous; funicle very short to distinct, erect; *style* present or absent, cylindrical or rarely slightly conic or obconic, clearly separated from the ovary or less so, equalling or shorter or longer than the height of the ovary; *stigma* indistinct or large, terminal or rarely sub-terminal, globose, hemispheric, concave or flattened, entire or variously lobed (Fig. 8), surface spongy, papillate, scabrate or echinate, sometimes large and brightly coloured, usually covered with a sticky fluid during anthesis.

*Male flowers* are with 1-6 stamens; stamens depressed or elongate; filaments present or nearly absent, massive or rarely thin, separate, or partly or entirely fused into groups; anthers short or elongate, truncate, rarely sub-globose or globose; connective indistinct or massive, sometimes with 1 or more projections projecting beyond the thecae (Fig. 9); dehiscence by pores, which are apical, rarely lateral or sub-terminal, round, curved or elongate.

*Pollen grains* are usually extruded in strands; they are inaperturate, mostly ellipsoid to ellipsoid-oblong, occasionally spherical or subspheroidal, ranging from 34-82  $\mu\text{m}$  in size; exine striate, striate-reticulate, psilate, scabrate, areolate, fossulate, punctate-foveolate, verrucate, or spinose, or exine rarely absent.

*Neuter flowers* are of varying shapes and size. They may be shield like, globose, obovoid, rhomboid, elongate-obovoid, oblong, echinate or

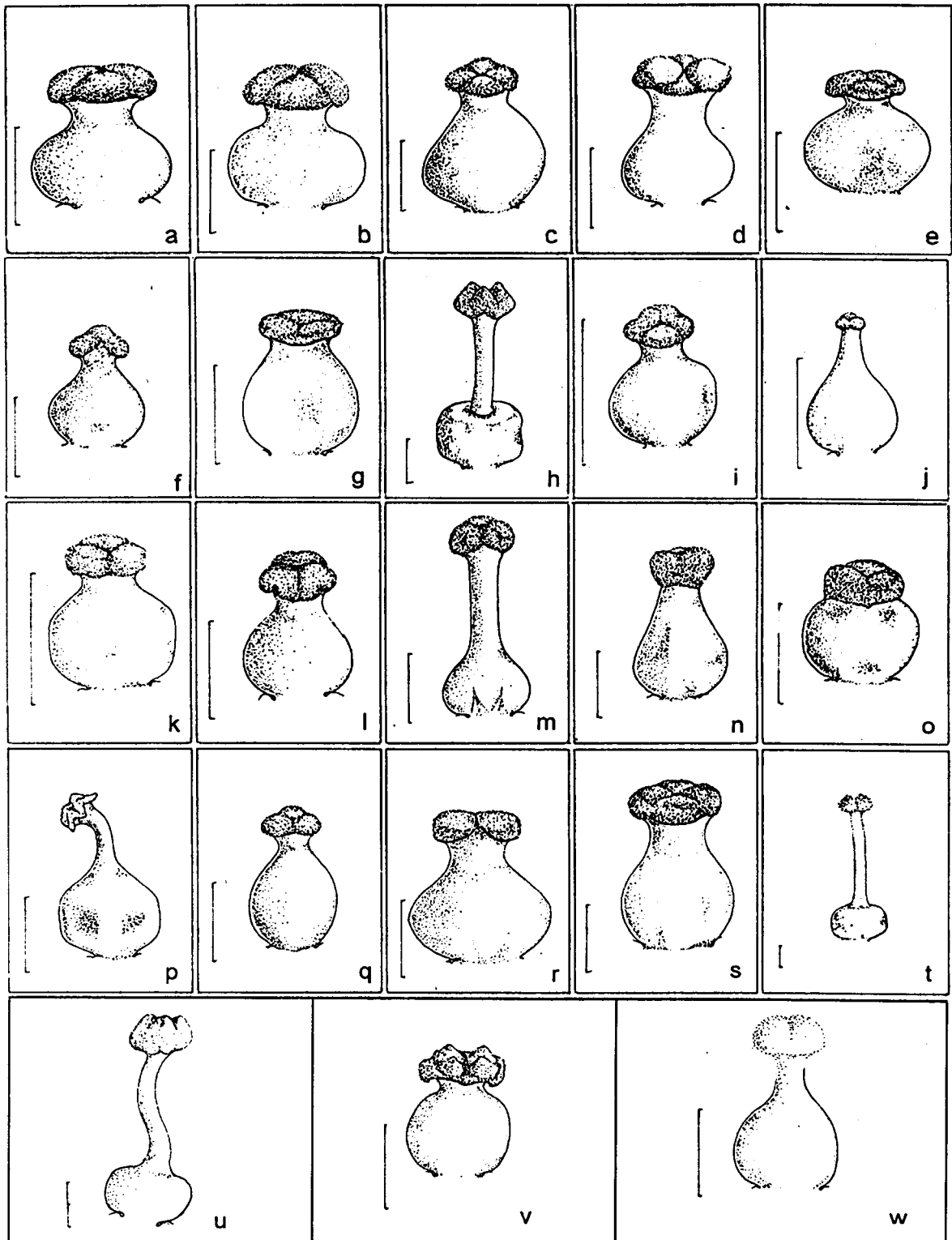


Fig. 8. Female flowers of various species of *Amorphophallus* Bl. ex Decaisne: a. *A. bognerianus*; b. *A. bonaccordensis*; c. *A. bulbifer*; d. *A. carnosus*; e. *A. commutatus* var. *commutatus*; f. *A. commutatus* var. *anmodensis*; g. *A. commutatus* var. *wayanadensis*; h. *A. hirsutus*; i. *A. hohenackeri*; j. *A. kachinensis*; k. *A. konkanensis*; l. *A. longiconnectivus*; m. *A. longistylus*; n. *A. margaritifera*; o. *A. mysorensis*; p. *A. napalensis*; q. *A. nicolsonianus*; r. *A. oncophyllus* var. *oncophyllus*; s. *A. oncophyllus* var. *rayhillianus*; t. *A. paeoniifolius* var. *paeoniifolius*; u. *A. paeoniifolius* var. *campanulatus*; v. *A. smithsonianus*; w. *A. sylvaticus* (All scales – 2mm).

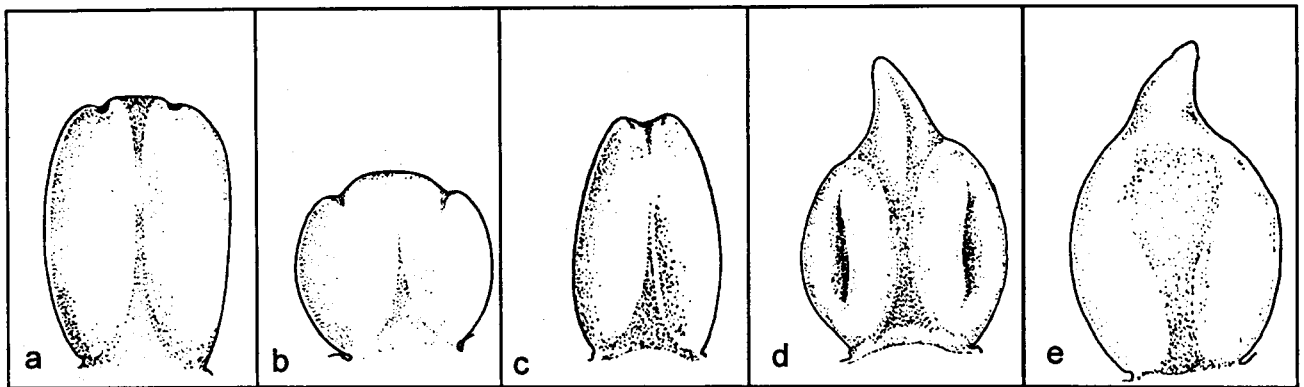


Fig. 9. Various types of male flowers: a, b & c. Male flowers without projected connective; d & e. Dorsal and ventral views of male flowers with long projected connective.

hair-like (Fig. 10); those on the spadix appendix are shield like, hair-like, rounded or conoid or resemble rudimentary sterile male flowers or female flowers.

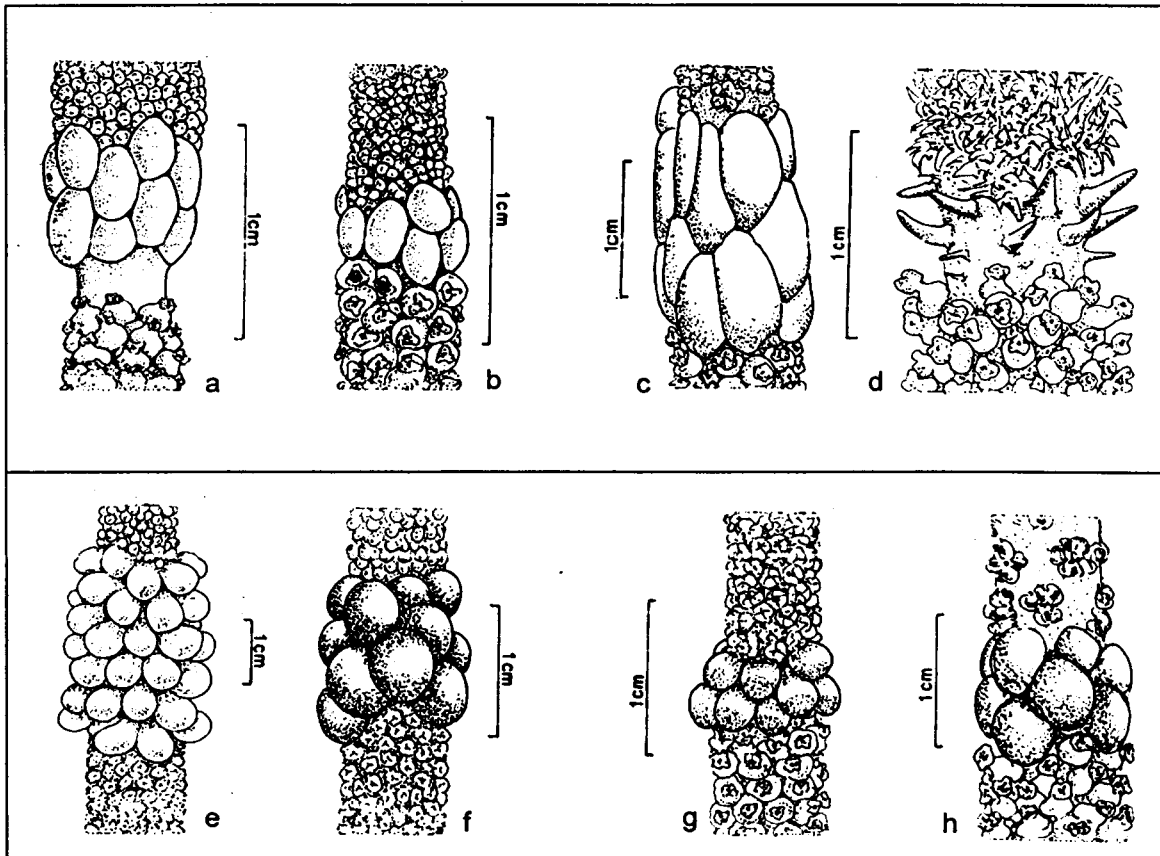


Fig. 10. Portions of spadices showing neuter flowers in various species of *Amorphophallus* sect. *Rhaphiophallus*: a. *A. bonaccordensis*; b. *A. hohenackeri*; c. *A. konkanensis*; d. *A. longiconnectivus*; e. *A. margaritifera*; f. *A. mysorensis*; g. *A. smithsonianus*; h. *A. sylvaticus*.

## Infructescence

Usually during the fruiting stage the peduncle elongates. The infructescence may be long peduncled, rarely short-peduncled; fruiting part globose or elongate. The sequence of maturation of fruits is from top to the bottom of the infructescence (Plate II).



Plate. II. Various stages with basipetal ripening of the fruits on the peduncle.

The *fruits* are berries and are globose, sub-globose, ellipsoid or ovoid; yellowish-red, orange-red, red, rarely blue or white. *Seeds* are globose, sub-globose, ovoid, ellipsoid, usually with a distinct raphe; testa smooth, thin; embryo large, somewhat green superficially; endosperm absent.

POSITION OF *AMORPHOPHALLUS* IN ARACEAE

Blume in 1837 presented the first systematic treatment of the genus including 9 species divided over 3 sections. In the meantime Wallich (1830) had published the genus *Thomsonia* with the only species *T. nepalensis*, collected from Nepal and now it is treated under the genus *Amorphophallus* (Bogner *et al.*, 1985).

Heinrich Wilhelm Schott, of aroid lore, did not contribute too much to a better understanding of *Amorphophallus*. He (1858, 1860) split Blume's genera up into several new genera, as *Brachyspatha*, *Conophallus*, *Corynophallus*, *Hansalia*, *Hydrosme*, *Plesmonium*, *Rhaphiophallus* and *Synantherias*.

Adolf Engler, on the other hand, did concern himself extensively with the systematics of *Amorphophallus*, and in the period between 1876 and 1908 he reduced all but two viz., *Plesmonium* and *Hydrosme* of Schott's genera to sections of *Amorphophallus*. Finally in 1911, Engler gave up *Hydrosme* as well in his famous treatment in **Das Pflanzenreich**. Next to Wallich's genus *Thomsonia*, only Schott's *Plesmonium* remained, but both were later reduced to *Amorphophallus* by Bogner *et al.*, (1985).

Engler (1876) placed *Amorphophallus* in the sub-family Lasioideae and maintained his position in the monograph of 1911 also. Grayum (1984, 1990) was the first to challenge Engler's opinion and he reclassified *Amorphophallus*,

*Thomsonia*, *Plesmonium* and *Pseudodracontium* together forming the tribe Thomsonieae in the sub-family Aroideae.

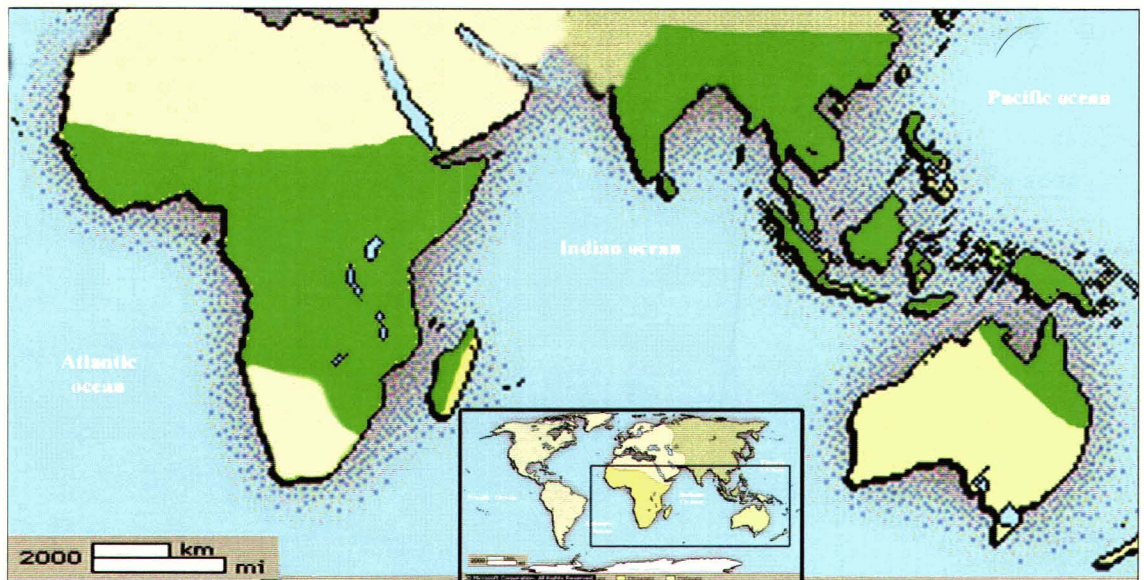
Grayum was followed by Bogner and Nicolson (1991) and Hay (1992) in the reclassification of the genus. The phylogenetic studies of the **Genera of Araceae** project have confirmed the separation of *Amorphophallus* from the Lasioideae and its inclusion in the sub-family Aroideae, but at the same time this sub-family has been greatly enlarged, and the relative position of *Amorphophallus* to any of the other genera except of *Pseudodracontium* remains unclear. The phylogenetic studies undertaken as part of the **Genera of Araceae** project (Mayo, Bogner & Boyce, 1997) did not solve this problem.

#### DISTRIBUTION AND ECOLOGY

The present geographical distribution of *Amorphophallus* comprises the paleotropics. The western most limit is Western Africa, the eastern most limit is Polynesia; this eastern boundary is formed by the occurrence of *A. paeoniifolius*, a species that has a long history of cultivation in Asia. Within the west and east boundaries *Amorphophallus* is found throughout the tropical and sub-tropical zones (Map 1).

Wide range of endemism is seen in *Amorphophallus* species. Only three species show a fair geographical range of distribution. *A. paeoniifolius* is found

from Madagascar eastward into Polynesia. *A. muelleri* is found from central Thailand, southward via Sumatra, Java to the Lesser Sunda islands, and *A. abyssinicus* has a fairly large distribution in Africa. Other species show local distributions, closely related species are often found in neighbouring areas.



Map - 1. World Distribution of the genus *Amorphophallus* Bl. ex Decaisne

Seven large areas of endemism in the distribution of the species of the genus are: 1. Africa, 2. Madagascar, 3. Southern and Central India, 4. Northern India, Myanmar - Northern Thailand - Southern and Southeastern China - Laos - North Vietnam, 5. Central Thailand - Cambodia - South and Central Vietnam - Eastern.

China - Taiwan - Japan, 6. Malaysia - Sumatra - Java - Borneo - Lesser Sunda Islands - New Guinea - Northern Australia, and 7. Borneo - Sulawesi - Philippines.

The areas of endemism in India are: South Western India, Central India and Andaman Islands.

Majority of the *Amorphophallus* species seem to be pioneers in disturbed vegetations; many are found along forest margins, on open Savannah forests, slopes, in disturbed parts of primary forests, sometimes in very exposed parts in limestone karst areas and few species are known to live in dense forests. The altitudinal range varies from sea level to ca. 3000 m (Hettterscheid & Ittenbach, 1996).

## CULTIVATION

Unless provided with minimum conditions, many of the species of *Amorphophallus* are very difficult to grow. These includes rich soil, use of additional fertilizer, shading against direct sunlight, a minimum temperature of 22°C during the day time and 19°C during the night, a well defined resting period, and control measures against pests.

**Soil:** Based on the nature of soil, two types of soil are roughly needed for *Amorphophallus*, and both should be rich in organic matter and trace elements. The type I includes well drained soil without loam, and type II includes the soil heavier and enriched with loam.



*Amorphophallus* species are grouped into two, based on the preference of soil. Both group I and II require a rich soil, especially in trace elements, which may be added with fertilizer and organic matter. Group I species can be grown in heavier soil and it include all species with elongate tubers, and those from Africa, China, Japan, India, Thailand, Indochina, Philippines, Java, Eastern Indonesia, New Guinea and Australia and also three Asian species with large geographical distribution (*A. muelleri*, *A. paeoniifolius* and *A. prainii*). Group II species must be kept in well drained soil, because their roots only survive in a well aerated soil. It include all species from Sumatra, Borneo (= Kalimantan, Sarawak, Sabah & Brunei), and West Malesia.

**Temperature:** *A. bulbifer* seems to tolerate a high range of temperature and thrives well between 15°C and 30°C. *A. kiusianus* from southern Japan does not appreciate particularly high temperature in cultivation, and the leaves dies back quickly when the temperature rises well above 25°C. *A. konjac* seems to thrive best between 20°C and 25°C (Hetterscheid & Ittenbach, 1996).

**Planting:** Top portion of the *Amorphophallus* tuber must always be well below the soil surface, since the roots emerge from the top and must secure the tuber to carry the long leaf or inflorescence. The diameter of the pot must be at least twice the length of the tuber. Those species produce elongate tubers need very deep pots to accommodate the strong vertical growth (Hetterscheid & Ittenbach, 1996).

**Fertilizers:** Group I species when grown in a rich soil, do not need fertilizer very frequently. Group II species however must be fed extra fertilizers when the soil indeed is loose and contains only organic matter.

Excess fertilizer may kill off all the roots. The ideal fertilizer is one with a high phosphate content which stimulate tuber growth. The tuber may increase its weight up to three times per season (Hetterscheid & Ittenbach, 1996).

**Watering:** Group I species are quite resistant to excess water with the exception of those with elongate tubers. Group II species are sensitive to excess water; they need to be grown in very well drained soils (Hetterscheid & Ittenbach, 1996).

**Dormancy:** Group I species show the strongest tendency for dormancy in cultivation, while species of group II may at occasions skip dormancy altogether as a rule.

Dormancy may take place in two parts during the growing cycle of a species. When a leaf dies down after a regular growing season, the tubers will invariably take a resting period of 3-7 months, depending on the species, after which a leaf may emerge. When the plant is mature enough to flower, the resting period is usually considerably shorter and may no longer than a month or even less at times.

In group II, tubers must be left in the soil because they are usually prone to desiccation and group I species can be stored dry, but not seedling tubers or thin rhizomatous offsets.

A second type of dormancy is set in after flowering. This may hold true for Asian, non-evergreen species that in nature invariably refuse to develop a leaf after flowering and effective pollination (Hetterscheid & Ittenbach, 1996).

### **Vegetative propagation**

Most group I species readily produce offsets every year of vegetative growth; it may still be attached to the main tuber and should be severed when the mother tuber is replanted for a new season. In other species the offsets are already loose when the plant is dug up after a season's growth. Rhizomatous offsets should be kept in soil during resting period (*A. hohenackeri*, *A. krausei*, etc.).

Some species produce bulbils on the leaves and are of two main types. One type produces bulbils entirely on the surface of branching points of the leaf and are epiphyllar bulbils (e.g.: *A. bulbifer*, *A. muelleri*, etc.). The other type produces the bulbils at the entire branching points of a leaf by intercalary meristematic activity and are intercalary bulbils, and these bulbils are dislodged when the leaf dries away (e.g.: *A. angulatus*, *A. manta*, *A. sparciflorus*, etc.). In a third-type – less common as exemplified by *A. yuloensis* – the bulbils are half epiphyllar and half intercalary.

Some species produce seeds without pollination and fertilization (apomictic seeds) as in the case of *A. bulbifer*, *A. muelleri* and *A. kiusianus*. The first two species exhibit a genome with 39 chromosomes and thus cannot form normal haploid gametes for sexual reproduction (Hettterscheid & Ittenbach, 1996).

Vegetative propagation through tissue culture has succeeded. Cell suspensions have been prepared from tuber parts as well as from leaf parts (*A. titanum*) (Hettterscheid & Ittenbach, 1996).

### **Sexual propagation**

Seed setting is common except in few taxa like the cultivated variety of *A. paeoniifolius*. Fresh seeds of *Amorphophallus* usually germinates between one and three weeks. The seeds may be taken from flesh of the berries which are not stored dry. Once became dry, *Amorphophallus* seeds cannot be rehydrated successfully. The seed coat of *Amorphophallus* is rather thin and there is no endosperm layer to protect the embryo from desiccation. The first leaf is already 3 or 5-parted, rarely 7-parted (*A. prainii*) and soon new leaves will emerge. This may go on for more than an year before the first real resting period starts.

Crosses between various species have been found to be successful (Hettterscheid & Ittenbach, 1996).

## **Pests**

Nematodes and mealybugs are the two major primary pests of *Amorphophallus*. No biological control mechanism yet exists. The best method is using a systemic pesticide with a broad activity spectrum; but must be given in small doses to avoid leaf damages. Nematodes can be effectively fought off only with use of pesticides.

Tubers that have been in wet soil for too long periods may start rotting at the base of the roots. This type of rot spreads through the tubers with a tremendous speed and is usually detected too late. The only method of protection is to cut away all rotting parts and seal off with topsin (Hetterscheid & Ittenbach, 1996).

## **ECONOMIC IMPORTANCE**

Tuber crops, a cheap source of food are rich in nutrients, vitamins and minerals. They play a major role in sustaining people from famine. Aroids are mainly herbaceous plants, often with an enlarged root stock, consisting mainly of starch, which acts as a storage organ and is the part of the plant normally eaten. The aroid tubers essentially provide starchy carbohydrate foods. Like other root crops, the aroids contain appreciable amounts of vitamin C (Coursey, 1968).

In most parts of the world the corms of the edible aroids are prepared for food simply by boiling or roasting in much the same way as other root or tuber

crops; it may also be used for the manufacture of chips, but in the case of yams, a parboiling prior to the frying improves the quality of the product (Coursey, 1968).

Many aroids are handsome ornamental plants and often cultivated, and many are poisonous in the fresh stages including those which are used as food (*Amorphophallus*). Their rhizomes, tubers or leaves must be cooked or roasted to become edible. Several aroids have been used in folk-medicine.

Elephant-foot yam - *Amorphophallus paeoniifolius* - considered as the king of tubers is an age-old food and medicine. It is used in Ayurveda, as a home remedy and as a detoxifying agent. There are two varieties of elephant-foot yam - cultivated and the wild. Of these the wild variety is considered more potent and is used in therapeutics. Apart from tubers, the petiole and flowers are also used as food. As a home remedy the tuberous portion is cut into small pieces and fried in log fire; these pieces when consumed reduce piles and constipation. A preparation of the tuber with buttermilk is widely used for treating gastric troubles. Tuber of the wild variety is boiled in milk, dried, powdered and left for a long time; the powder is again mixed with buttermilk and consumed. It is useful in treating many disorders associated with the digestive tract. It increases digestion by stimulating digestive enzymes, removes constipation, protects the gastro-intestinal tract from infection. This mixture helps a patient to get relief from chronic piles. Consumption of boiled tuber using buttermilk as an adjunct is also a good remedy for old piles. To treat wart-

like growths, a paste of the tubers boiled and ground with jaggery is applied. In Indian alchemy, the tuber is used for defoxification of copper (Rasheed, 2000).

In Ayurveda, *Amorphophallus paeoniifolius* (elephant-foot yam) is regarded as both *Balya* (enhancing body strength) and *Rasayana* (rejuvenator). It stimulates liver secretion and acts as a mild aphrodisiac. It is an excellent laxative. It is externally applied to reduce inflammation, filarial swelling and certain types of tumours. A paste prepared from ground seed is used for uterine contraction (Rasheed, 2000).

Elephant-foot yam is contraindicated in certain cases like eczema and 'raktapitta'. If the seed comes in contact with the human body, that part becomes swollen. Consumption of tuber belonging to the wild variety causes itching, throat-swelling, increased salivation and burning sensation. Hence purification is necessary to remove toxicity. To remove toxicity, the tubers are to be boiled in tamarind leaf-juice or buttermilk, left in sunlight for a few days and then powdered (Rasheed, 2000).

The two species of *Amorphophallus* viz., *Amorphophallus paeoniifolius* (Dennst.) Nicolson, and *A. bulbifer* (Roxb.) Bl., contain large amounts of edible carbohydrates in their tuber and are grown as food in Southern India. The former is used in the form of dried flour for the preparation of some food items, as well as used fresh after cooking, and also as fodder. *A. rivieri* Durieu ex Carriere

var. *konjac* (C. Koch) Engl. (= *A. konjac* Koch), is cultivated to a considerable extent as a food crop. The carbohydrates of the tuber consists largely of mannan and the plant has been used commercially as a source of mannose. The root can also be dried and prepared into a kind of flour, or may be pounded with lime and water into a gelatinous mass (Coursey, 1968). Tubers of few species including *A. konjac* K. Koch, *A. muelleri* Bl. and *A. variabilis* are also edible (Bailey, 1950). *A. asterostigmatus* are ground and made into one of Thailand's best curries, *A. koratensis* is quite often sold in Thai markets and the tuber cannot be distinguished from *A. paeoniifolius*. *A. sylvaticus* is used as a remedy for tooth ache and gland enlargements (Chopra *et al.*, 1956).

Few species like *A. konjac* K. Koch are grown also as ornamentals. Several of the other larger species are also sometimes cultivated as ornamentals. Wild congeners of cultivated *Amorphophallus* harbour genetic resources of potential value. The cultivated species are losing their ability to reproduce sexually because of selective pressures to preferentially allocate more photosynthate towards their tuber production (Singh & Gadgil, 1995).

The corms of *Amorphophallus* contain abundant crystals of calcium oxalate and are irritant. However, Manno *et al.* (1967) suggested the irritating component to be a protein, probably not a saponin and certainly not calcium oxalate.



# REVIEW OF LITERATURE

V. Abdul Jaleel "Revision of Amorphophallus (Araceae) in India " Thesis.  
Department of Botany , University of Calicut, 2002

## REVIEW OF LITERATURE

### Floristic and taxonomic treatments

#### *World Scenario*

Kunth (1841) in his **Enumeratio Plantarum** listed 15 species of *Amorphophallus*. Heinrich Wilhelm Schott (1856, 1858, 1860) was the first monographer of Araceae and contributed much for the understanding of Araceae in general, but very little for the genus *Amorphophallus*. Adolf Engler (1911) did concern himself extensively with the systematics of *Amorphophallus* and made a worldwide revision of the genus. Backer (1920) carried out the work on *Amorphophallus* of Java and listed 9 species. Gagnepain (1941) in his work on Araceae of Indochina described 12 new species of *Amorphophallus*. Hotta (1970) in his work on the Araceae of Japan and adjacent areas described 3 species of *Amorphophallus*. Li Hen (1988) described several new species of *Amorphophallus* from Yunnan. Hetterscheid (1994) described thirty-three new species from Tropical Asia. Ittenbach (1997) carried out a revision of African species of *Amorphophallus*. Ittenbach and Lobin (1997) brought to light six new species and two new subspecies from Africa. Mayo *et al.* (1997) in their book **The Genera of Araceae** provided a consolidated account of the general characters of *Amorphophallus*. Recently Hetterscheid and Van der Ham (2001) described sixteen

new species from East Malaysia, Thailand and Vietnam; and synonymised four species earlier published as new by Hettterscheid. Hettterscheid of the Netherlands is currently attempting a worldwide revision of the genus *Amorphophallus*, and in one of his preliminary publications with Ittenbach (1996) provided details of 91 species.

### *Indian Scenario*

The oldest systematic record of *Amorphophallus* specimens dates back to 1692 when the Dutchman Van Rheede tot Drakenstein published Vol. 11 of his *magnum opus*, entitled **Hortus Indicus Malabaricus** (1678-1693). He described and illustrated two plants named in the Malayalam language as *Mulenschena* and *Schena* and written in four scripts viz., Malayalam, Arabic, Devanagari and Latin. In 1747 Rumphius described similar plants from the Indonesian island of Ambon under the generic name *Tacca*. In the literature of the previous century *Amorphophallus* species were often identified as *Arum* or *Dracontium*. It was the Dutch botanist Blume, who in 1834 published for the first time the generic name *Amorphophallus*. He simultaneously gave a name to Rheede's *Mulenschena* as *Amorphophallus campanulatus*, a name fraught with nomenclatural problems and finally changed into *A. paeoniifolius*.

Hooker's monumental work, **Flora of British India** (1872-1897) still remains as an authentic floristic work in Indian sub-continent. But the fact remains that it is more than a century old, and since its publication many advances have occurred in our knowledge about plant taxonomy. Hooker included seventeen species of *Amorphophallus*, out of which only eight are stated to be occurring in India.

Since Hooker's work there has been a spurt in investigations on regional floras, and these contributed further to our knowledge of the genus *Amorphophallus*. The only floristic record of the major portion of the south India is the **Flora of the Presidency of Madras** by Gamble (1916-1935) eventhough it does not cover the entire geographic limits of South India. In this work Fischer (1931) described five species viz., *A. campanulatus*, *A. bulbifer*, *A. sylvaticus*, *A. hohenackeri* and *Plesmomium margaritifera* (= *A. margaritifera*).

Mitra (1958) in his **Flowering Plants of Eastern India** described four species, viz. *A. campanulatus*, *A. bulbifer*, *Thomsonia napalensis* (= *A. napalensis*) and *Plesmonium margaritifera* (= *A. margaritifera*).

Nairne (1976) in his **Flowering Plants of Western India** described five species, viz. *A. campanulatus*, *A. commutatus*, *A. bulbifer*, *Thomsonia napalensis* (= *A. napalensis*) and *A. sylvaticus*.

Several new species, rediscoveries and new reports have been published from time to time which included *A. nicolsonianus* (Sivadasan, 1986), *A. smithsonianus* (Sivadasan, 1989), *A. bonaccordensis* (Sivadasan *et al.*, 1994), *A. konkanensis* (Hettterscheid *et al.*, 1994), *A. longistylus* (Sivadasan & Abdul Jaleel, 1998), *A. logiconnectivus* (Sivadasan & Abdul Jaleel, 1998), *A. carnosus* (Bogner, 1994; Sivadasan & Abdul Jaleel, 2000), *A. hirsutus* (Sivadasan & Abdul Jaleel, 2000) and *A. mysorensis* (Sivadasan & Abdul Jaleel, 2001).

### **Anatomy**

Grayum (1984) observed that the epidermis of epigeal organs in Araceae is typically glabrous; trichomes and other types of ornamentation are quite rare. Most aroid roots possess a simple, one-cell layer thick epidermis; two epidermal layers occur in roots of *Amorphophallus* (Lierau, 1888; Solereder & Meyer, 1928). Vascular bundles are more or less scattered in aroid stems, as in typical monocots (Cronquist, 1981).

French (1986) carried out studies on the patterns of stamen vasculature in Araceae. According to him, the Araceae exhibit highly varied stamen vasculature with three main patterns: (i) vascular bundles unbranched, 1-3 per stamen, (ii) forked bundles in some or all stamens, and (iii) anastomosing vascular system with several to many bundles entering a single stamen. Three major groups of taxa in the family can be recognised on the basis of their predominant pattern of stamen

vasculature. All genera with bisexual flowers have unbranched bundles except few species. Forked stamen bundles are restricted to and occur nearly throughout the monoecious Lasioideae, Philodendroideae, Colacasioideae and among certain Aroideae. No forked bundles were found in the members of the tribe Areae except in *Theriophonum indicum*. Anastomosing systems are virtually limited to members of the tribe Areae with larger stamens, such as in *Arum*, *Helicodiceros*, *Eminium* and *Dracunculus* species. A similar pattern occurs in some *Amorphophallus*, but other patterns occur as well. Virtually all the genera with forked bundles are grouped in the Philodendroideae – Colacasioideae. All of the genera with anastomosing systems are in the Areae, including the complex and variable *Amorphophallus* which has systematically been placed under different subfamilies. Since some species of *Amorphophallus* resemble the forked type and other the distally anastomosing type, it is a complex genus which needs more detailed study.

French (1986) also carried out the ovular vasculature in Araceae, and he examined about 97 genera and over 280 species. It included 32 species of *Amorphophallus*, out of which nine occur in India, and they are *A. bulbifer* (Roxb.) Bl., *A. commutatus* (Schott) Engl., *A. hohenackeri* (Schott) Engl. & Gehrm., *A. margaritifera* (Roxb.) Schott, *A. mysorensis* Barnes & Fisch., *A. napalensis* (Wall.) Bogner & Mayo, *A. oncophyllus* Prain, *A. paeoniifolius* (Dennst.) Nicolson, and *A. sylvaticus* (Roxb.) Kunth.

In Thomsonieae, Nephthylideae and Montrichardieae two different patterns of vasculature were observed: (i) species have either a procambial strand or a single unbranched bundle, including *Pseudohydrosme*, *Nephthytis*, *Plesmonium* and many species of *Amorphophallus* such as *A. mellii*, *A. hohenackeri* and *A. longituberosus*, (ii) unbranched multiple bundles extend through the funiculus to the chalaza in both *Anchomanes* species and some species of *Amorphophallus*, *Cercestis* and *Rhektophyllum*.

*Amorphophallus* exhibits a varied array of ovule orientation, and there are three major patterns in the genus:

- (i) a typical anatropous form (*A. lambii*).
- (ii) a highly distinctive type with a greatly elongated funiculus that may be partly coiled and very small cylindrical ovular body proper, with narrow integuments, nucellus and embryosac, the inner integuments form the micropyle (*A. kerrii*).
- (iii) hemianatropous ovules having thin integuments with a micropyle formed by the inner integuments (*A. paeoniifolius*).

Sabu (1992) carried out morphological studies of some members of Indian Araceae and included anatomical investigations of stem, root, cataphyll, petiole, lamina, stomata and venation of *A. hohenackeri* and *A. napalensis*.

Prasad and Jos (1983) reported the anatomical deviations in *Amorphophallus* leaf infected with *Amorphophallus* mosaic virus.

### **Physiology**

Van der Pijl (1937) described the process of heat generation in the species of *Amorphophallus*. Van Herk (1937a, 1937b, 1937c), Meeuse and Buggeln (1969) determined male flower primordia that are stimulated by a certain sequence of light and dark periods, particular to each species, that activates the heat production of the inflorescence. Van Herk (1937b) suggested that the male flower primordia thus stimulated to produce an unknown hormone that he named as 'Calorigen' and that is responsible for triggering the heating process. Raskin *et al.* (1987) have observed thermogenesis in the inflorescences of several diverse families of plants including that in Araceae.

Bendall (1958) determined that mature aroid spadices contained elevated amounts of cytochrome B. Robacker *et al.* (1988) reported that salicylic acid is responsible for initiating the production of odoriferous chemicals and unfolding the spathe. Moodie (1976) proved that chemicals and compounds are effectively dispersed by heat because they are quite volatile. Bay (1995) considered that thermogenesis to be an advantageous process to plants for maximising pollination and limiting hybridisation.



## Cytology

Asana and Sutaria (1939) studied the chromosome number in *A. sylvaticus*. Jos and Magoon (1970) and Chaudhuri and Sharma (1979) found that  $2n = 28$  in *A. campanulatus* (= *A. paeoniifolius*). Marchant (1971) made chromosome counts of eleven species of *Amorphophallus* and found the basic number  $x = 13$  and  $14$ , with the former being the more frequent. Most species were diploid but one, viz. *A. bulbifer* was triploid with  $2n = 39$ . Larsen and Larsen (1974) reported  $2n$  to be  $28$  in *A. dixenii*, probably a synonym of *A. paeoniifolius*.

Ramachandran (1977) carried out the karyological studies on four South Indian species of *Amorphophallus*, and reported chromosome number  $2n$  to be  $26$  in *A. hohenackeri*,  $2n$  to be  $28$  in *A. campanulatus* and *A. dubius*, and  $2n$  to be  $39$  in *A. bulbifer*. Meiosis was found to be normal in *A. campanulatus* and  $14$  bivalents were observed at the first metaphase. *A. hohenackeri* has larger chromosomes with more symmetrical karyotype than the other species. The close phylogenetic relationship of *A. campanulatus* and *A. dubius* indicated by their morphological characters is further supported by the similarity exhibited by their karyotypes; and it was found that *A. dubius* is just a synonym of *A. campanulatus* (= *A. paeoniifolius*). In *A. bulbifer* ( $2n=3x=39$ ), the chromosomes of the three genomes of the triploid cannot be matched into groups of three homologues. Karyotype analysis suggested either extensive chromosome repatterning or that

*A. bulbifer* is an allotriploid with two genomes derived from one species and the other from a different species.

De Sarkar and Hettterscheid (1977) reported that the cytological investigations undertaken in *A. margaritifera* revealed that  $2n$  to be 26. Rajendran *et al.* (1977) reported autotetraploidy in *Amorphophallus campanulatus*. Jose and Vijayabai (1978) reported the diploid chromosome number in *A. commutatus* as 26. Brandham (1982) reported that *A. bulbifer* and *A. oncophyllus* bypass the sexual process which in triploids is at worst completely inoperative or at best is unstable, producing aneuploid progeny.

Narayan (1983), Narayan and Durrant (1983), and Brandham (1983) noted that within a single basic chromosome number, taxa with high DNA values are usually more advanced than those with low values.

Chauhan and Brandham (1984) carried out chromosome and karyotype studies of 17 species of *Amorphophallus* and analysed the quantitative distinction of the DNA of 13 species. They classified the chromosomes according to Naranjo *et al.* (1983) as follows, with the terminology being based on centromere position. *M* = median, *sensu stricto*, as in isochromosomes, *m* = median region, *sm* = submedian region, *st* = subterminal region, *t* = terminal region; T - terminal, *sensu stricto*, as in telocentrics. In this group no *M* or *T* chromosomes were observed. Intermediate chromosome types were termed *sm*, *st*, etc. He also reported that two

species of *Amorphophallus* apparently consist entirely of triploid individuals with  $2n = 39$  in *A. bulbifer* and *A. oncophyllus*. According to Chauhan and Brandham (1984) the species of *Amorphophallus* can be divided into two major chromosomal groups - a smaller group having  $2n=28$  with quite small chromosomes and low DNA values (*A. paeoniifolius*, *A. dubius* and *A. prainii*) and a much larger group with  $2n=26$  or triploid  $2n=39$  chromosomes with greater variation in DNA amount.

Peterson (1989) stated that the chromosome number of  $2n=26$  is common in *Amorphophallus*. Peterson (1993) reported the chromosome numbers of various genera of Araceae and has given the list of diploids ( $2n$ ) and assumed basic ( $x$ ) chromosome numbers in different genera of Araceae. In *Amorphophallus*  $2n$  was reported to be 26, 39 and 28; and  $x$  to be 13 and 14.

Jos *et al.* (1997) carried out the polyploid studies in the microspores of *A. campanulatus* (= *A. paeoniifolius* var. *paeoniifolius*). The polyploidization in this species represented an interpolation of events not represented in its normal history and attributed to the absence of some regulatory factor controlling the nature and stage of divisions.

Rajendran *et al.* (1977) reported the genetic variability in *Amorphophallus campanulatus* (= *A. paeoniifolius* var. *campanulatus*) seedlings. The presence of low oxalic acid up to 0.05% in *Amorphophallus* seedling tubers suggested that by proper screening genotypes having still lower oxalic acid content may be obtained.

## Phytochemistry

Hegnauer (1987) reported that many members of the Araceae taste painfully acrid and are toxic. The toxic principles are still incompletely known; generally it is assumed that raphides of calcium oxalate, which occur in most members of the family in readily exploding raphide cells, cause minute lesions in the mouth and act as vectors for the true toxins.

Calcium oxalate crystals are wide spread in Araceae. Oxalic acid which is generally present in the form of calcium oxalate crystals causing irritation in the throat lowers the quality of tubers in *Amorphophallus campanulatus* (= *A. paeoniifolius* var. *campanulatus*) (Rajendran *et al.*, 1977). Raphides, the most widely distributed oxalate crystals occur in all putative aroid relatives. Silica bodies are unknown in Araceae and all other putative near relatives (Dahlgren & Clifford, 1982). The principal irritations in the mouth and throat after chewing of many aroids are caused by a combination of raphides (as vectors) with solutions of proteolytic enzymes (histamine releasers) and irritating phenolic compounds (Hegnauer, 1987). Manno *et al.* (1967) had suggested the irritating component to be a protein, probably not a saponin and certainly not calcium oxalate.

According to Hegnauer (1987) there are various important chemical compounds in aroids. Saponins seems to be rather wide spread in Araceae and their chemistry however is still not well known, Anzaldo *et al.* (1957) noted that

saponins are present in *A. campanulatus* (= *A. paeoniifolius*). Phenolic compounds occur in large amounts in Araceae and are biosynthetically diverse; Proanthocyanidins, condensed tannins, and their di- and trimeric precursors are deposited in excretory cells or canals in Araceae; Cinnamic acids are ubiquitous, p-coumaric, caffeic, ferulic and sinapic acids were observed in many species of Araceae; flavonoids with glycoflavones and flavones are of more restricted occurrence; alkaloids belonging to the phenylisoquinoline group were isolated from the roots of few Araceae; Polyhydroxy alkaloids or alkaloidal glycosidase inhibitors (AGIs) were detected in leaves of several genera of the subfamily Aroideae, trace amounts of AGIs were present in species of *Amorphophallus*; Dopa and dopamine are responsible for melanogenesis which can often be observed during the dying of plant parts; Essential oils are rather rare in the family Araceae, where present they accumulate in idioblasts or excretory canals.

Mucilage is very abundant in the Araceae, as in monocots in general (de Wildeman, 1942). Dalitzsch (1886) characterized the mucilage of Araceae as “tanniniferous”. The genus *Amorphophallus* is well-known for the storage of appetite suppressing glucomannans in the tubers of many species (Hegnauer, 1963), however this substance has not been reported from any other genera. Yimin *et al.* (1998) reported the developmental aspects and structure of mannan glands in corms of *Amorphophallus konjac*.

Amines are supposedly common in inflorescences of aroids (Gibbs, 1974) although virtually all reports concern *Amorphophallus* and members of the Arinae (*Sauromatum*, *Dracunculus*, *Arum*). Volatile amines are produced by many species and they are responsible for the foetid odour of many Araceae during anthesis (Hegnauer, 1987). Free indoles have also been reported from some genera; all of these compounds appear to be concerned with the production of heat and starch associated with pollination by flies and carrion beetles (Chen & Meeuse, 1971) and ought to be expected in any genus exhibiting this syndrome.

Most higher plants contain one or more of six common anthocyanin pigments, hence they are not regarded as having great systematic value (Fairbrothers *et al.*, 1975). In Araceae they occur in reddish fruits, some spathes and spadices, and petioles and in the epidermis of some leaf blades (Williams *et al.*, 1981). Delphinine is a rather exceptional anthocyanin found in Araceae.

Within the Araceae, according to Nahrstedt (1975) cyanogenesis is known for members of all subfamilies except *Monsteroideae*, *Calloideae* and *Pistioideae*. Triglochinin, a *seco*-derivative of dhurrin or taxiphyllin is a cyanogenic glucoside occurring in the members of Araceae. It is accompanied by a substrate-specific enzyme ("triglochininase") which rapidly splits the glucoside after injury, cyanogenesis is therefore often extremely rapid in Araceae and in many instances the HCN is totally lost during the drying plant parts (Hegnauer, 1987). Volatile

terpenoids (ethereal oils) are very uncommon in Araceae, being best known in the idioblasts of *Acorus*. Gibbs (1974) recorded mono- and sesquiterpenoids only from that genus which is now treated under a separated family Acoraceae.

Grob *et al.* (2002) in their study of phylogeny of the tribe Thomsonieae analysed the nucleotide sequences of the chloroplast gene *matK* and the *trnL* intron of 46 *Amorphophallus* species. The study resulted in the conclusion of a monophyly of the African *Amorphophallus* species and the nesting of *Pseudodracontium* within *Amorphophallus*, making *Amorphophallus* in the traditional sense paraphyletic to *Pseudodracontium*.

### **Palynology**

According to Bogner (1987) the pollen grains of aroids are of different types and their morphology is very useful for the classification of genera or higher taxa. The pollen grains are usually shed in monads. The most primitive aperture is the monosulcate type, a few genera have dicolpate, periporate or extensive-sulcate or zonate-sulcate pollen grains. Inaperturate pollen grains are however quite common. The ornamentation of the exine also shows great variation from smooth, rough, reticulate, foveolate, striate, echinulate (spiny), verrucose (warty), areolate to baculate.

Thanikaimoni (1969) reported that the pollen of Araceae are either monosulcate, extensive sulcate, dicolpate, inaperturate or periporate. Their ornamentation is either smooth, reticulate, foveolate, spinulate, verrucate, areolate, scabre, striate or baculate.

*Amorphophallus* is palynologically the most diverse genus in Araceae. Indeed the whole gamut of diversity occurs within the huge sect. *Conophallus* which spans the entire geographic range of the genus (Grayum, 1984).

Spherical or subspherical, inaperturate pollen in Araceae presents no problem with regard to polarity, shape, and symmetry. It may simply be described as apolar, spherical and radiosymmetric. It is seen in numerous species of *Amorphophallus* (Grayum, 1984). The presence of boat-shaped, inaperturate pollen in Araceae comes from Huynh's (1975) work on *Spathiphyllum* and there are indications that this condition may be more widespread. On pollen of many Araceae with elongate, inaperturate grains, one can perceive a weak to more or less pronounced longitudinal raphe or keel on one face, and it is seen in *Amorphophallus bulbifer* (Grayum, 1984).

Stout (1937) has reported that up to 80% of the pollen produced by *A. titanum* consists of small, sterile grains as also observed in *A. prainii*, *A. lambii*, *A. kerrii* and *A. puttii*. Sterile grains of the last two species are psilate.



Bogner and Hettterscheid (1992) noted that pollen grains of *A. asterostigmatus*, *A. hottae* and *A. palawanensis* as inaperturate and ellipsoid, with exine striate, striate-reticulate, and striate with variously anastomosed respectively. Barthlott and Bogner (1981) described pollen of *A. staudtii* as psilate; Knecht (1983) as foveolate, a condition virtually unknown in this genus. The pollen grains of *A. eburneus* are inaperturate, globular with smooth exine (Bogner, 1989). Pollen grains of *A. longiconnectivus* are nearly globose to slightly ellipsoid, inaperturate, c. 40  $\mu\text{m}$  in diameter; exine is smooth (Bogner, 1994).

Grayum (1984) studied the morphology of the pollen of twenty species of *Amorphophallus* and provided the details of shape, size, aperture type, symmetry and exine sculpturing. All the species of the genus are with inaperturate grains. Palynological observations of the two new Vietnamese species have been made by Hettterscheid and Serebryanyi (1994); and the new Indian species (*A. konkanensis*) by Hettterscheid *et al.* (1994). Ittenbach and Lobin (1997) described six new species of *Amorphophallus* from Africa and studied their palynological details were provided. Van der Ham *et al.* (2000) described the exine architecture of five *Amorphophallus* species with echinate pollen using light and electron microscopical observations. The various characteristics of the pollen of different species are studied by various workers are given in the table 1.

**Table 1. Pollen characteristics of various species of *Amorphophallus***

Sl. No.	Name of <i>Amorphophallus</i> species	Pollen shape	Exine sculpture	Reference
1	2	3	4	5
1	<i>A. abyssinicus</i>	Globose or subglobose	Densely verrucate	Grayum, 1984
2	<i>A. amygdaloides</i>	Ellipsoid	Striate	Hetterscheid & Van der Ham, 2001
3	<i>A. asterostigmatus</i>	Ellipsoid	Striate	Bogner & Hetterscheid, 1992
4	<i>A. atrorubens</i>	Ellipsoid	Striate	Hetterscheid & Van der Ham, 2001
5	<i>A. barthlottii</i>	Globose	Psilate	Ittenbach & Lobin, 1997
6	<i>A. borneensis</i>	NA	Striate with a median groove	Grayum, 1984
7	<i>A. boyceanus</i>	Ellipsoid	Striate	Hetterscheid & Van der Ham, 2001
8	<i>A. brachyphyllus</i>	Ellipsoidal or globose	Striate or fossulate	Hetterscheid & Van der Ham, 2001
9	<i>A. bulbifer</i>	Boat-shaped	Psilate	Grayum, 1984
10	<i>A. canaliculatus</i>	Globose	Psilate	Ittenbach & Lobin, 1997
11	<i>A. chlorosphathus</i>	Globose	NA	Thanikaimoni, 1969
12	<i>A. commutatus</i>	Sub globose	NA	Thanikaimoni, 1969
13	<i>A. corrugatus</i>	Globose	Striate	Grayum, 1984
14	<i>A. dzui</i>	Ellipsoid	Striate	Hetterscheid & Van der Ham, 2001
15	<i>A. eburneus</i>	Globose	Psilate	Bogner, 1989
16	<i>A. eichleri</i>	Boat-shaped	Psilate	Thanikaimoni, 1969; Grayum, 1984

1	2	3	4	5
17	<i>A. flavovirens</i>	Globose	Spinose with long, stout, straight sided spines	Grayum, 1984
18	<i>A. gallaensis</i>	Globose	Striate; striae broad and few	Grayum, 1984
19	<i>A. hetterscheidii</i>	NA	Psilate	Ittenbach & Lobin, 1997
20	<i>A. hottae</i>	Ellipsoid	Striate-reticulate	Bogner & Hetterscheid, 1992
21	<i>A. impressus</i>	NA	Psilate	Ittenbach & Lobin, 1997
22	<i>A. kerrii</i>	Boat-shaped	Striate; Striae narrow and many, sparingly anastomosing	Grayum, 1984
23	<i>A. konkanensis</i>	Globose	Psilate	Hetterscheid <i>et al.</i> , 1994
24	<i>A. lambii</i>	Globose	Psilate	Grayum, 1984
25	<i>A. longicomus</i>	Globose	Psilate	Hetterscheid & Van der Ham, 2001
26	<i>A. longiconnectivus</i>	Globose- slightly ellipsoid	Smooth	Bogner, 1994
27	<i>A. longituberosus</i>	Boat-shaped	Striate-reticulate	Grayum, 1984
28	<i>A. margaritifera</i>	Globose or subglobose	Minutely fossulate and verruculate Psilate	Thanikaimoni, 1969; Grayum, 1984 Hetterscheid & De Sarkar, 1996
29	<i>A. napalensis</i>	Boat-shaped to elliptic	Striate; striae broad, sparingly anastomosing	Thanikaimoni, 1984; Grayum, 1984

1	2	3	4	5
30	<i>A. ochroleucus</i>	Ellipsoid	Reticulate	Hetterscheid & Van der Ham, 2001
31	<i>A. paeoniifolius</i>	Globose or subglobose	Densely verrucate	Thanikaimoni, 1969; Grayum, 1984
32	<i>A. palawanensis</i>	Ellipsoid	Striate, variously anastomosing	Bogner & Hetterscheid, 1992
33	<i>A. polyanthus</i>	Ellipsoid	Striate	Hetterscheid & Van der Ham, 2001
34	<i>A. prainii</i>	Globose or Subglobose	Psilate	Grayum, 1984
35	<i>A. pusillus</i>	NA	Finely striate	Hetterscheid & Serebryanyi, 1994
36	<i>A. purpurescens</i>	NA	NA	Thanikaimoni, 1969
37	<i>A. putii</i>	NA	Striate-reticulate (sub-foveolate)	Grayum, 1984
38	<i>A. richardsiae</i>	NA	Striate	Ittenbach & Lobin, 1997
39	<i>A. rivieri</i>	Globose	Deeply and coarsely fossulate	Grayum, 1984
40	<i>A. saururus</i>	Ellipsoid	Striate	Hetterscheid & Van der Ham, 2001
41	<i>A. scaber</i>	NA	Psilate	Hetterscheid & Serebryanyi, 1994
42	<i>A. schweinfurthii</i>	Subglobose	Densely verrucate	Grayum, 1984
43	<i>A. scutatus</i>	Globose	Areolate	Hetterscheid & Van der Ham, 2001
44	<i>A. sizemoreae</i>	Ellipsoid	Striate	Hetterscheid & Van der Ham, 2001

1	2	3	4	5
45	<i>A. staudtii</i>	NA	Psilate	Grayum, 1984; Barthlott & Bogner, 1981
			Foveolate	Knecht, 1983
46	<i>A. stuhlmannii</i>	Globose or subglobose	Sparingly verrucate	Grayum, 1984
47	<i>A. sutepensis</i>	NA	Striate with a median groove	Grayum, 1984
48	<i>A. sylvaticus</i>	NA	Densely verrucate	Grayum, 1984
49	<i>A. symonianus</i>	Ellipsoid	Psilate	Hetterscheid & Van der Ham, 2001
50	<i>A. synandrifer</i>	Ellipsoid	Indistinctly reticulate	Hetterscheid & Van der Ham, 2001
51	<i>A. tinekeae</i>	Ellipsoid	Psilate	Hetterscheid & Van der Ham, 2001
52	<i>A. titanum</i>	Globose or subglobose	Psilate; sparingly punctate- foveolate	Grayum, 1984
53	<i>A. variabilis</i>	Subglobose	Striate	Thanikaimoni, 1969; Grayum, 1984

NA – Data not available.

According to Grayum (1984), the evolution of the more derived exine types from striate-reticulate pollen in *Amorphophallus* possibly occurred according to the following scenario. Boat-shaped, striate-reticulate pollen such as that in *A. longituberosus* gave rise, via closure of the reticulum to boat-shaped, simply striate pollen such as that of *A. kerrii* and eventually to globose, striate pollen as that of *A.*

*corrugatus*. Striations in the genus *Amorphophallus* might have evolved via reduction rather than by an expansion of the basic foveolate-reticulate exine pattern.

Grayum (1984) further noted that *Amorphophallus* is the eurypalynous genus in the Araceae, comprising in addition to striate pollen, psilate, verrucate and even spinose types. The status striate pollen as the most primitive type in this genus is of course, strongly suggested by the fact that this is the only type showing evidence of a reticulum. In addition, boat-shaped pollen in *Amorphophallus* is almost exclusively associated with striate exine sculpturing. The mean size of striate pollen in *Amorphophallus* (46  $\mu$ ) is considerably smaller than that of non-striate pollen (61  $\mu$ ) and thus much closer to the putatively primitive condition for Araceae. Furthermore, *A. longituberosus*, one of the species with striate-reticulate pollen has as its name implies an elongate sub-rhizomatous rootstock which surely is primitive condition in this largely tuberous genus. The necessary postulation of a connection between reticulate and striate pollen types in Araceae is facilitated by the existence of more or less intermediate striate reticulate forms in two species of *Amorphophallus* (*A. puttii* and *A. longituberosus*). The reticulum in *A. puttii* is so large and the striae so flat that at high magnification, it is difficult to detect the striate pattern.

Pollen nuclear number is a highly conservative character at the genus level in Araceae. Araceae is one of the relatively few families for which bi- and tri-nucleate

pollen have been reported (Brewbaker, 1967). A total of 13 species of *Amorphophallus* were found to be trinucleate (Grayum, 1984). Inflorescences of at least few aroid genera including *Amorphophallus* produce abundant pollen, some times including a high proportion of sterile pollen.

Mameli Calvino (1952) was correct in characterising araceous pollen as starchy. All 14 species of *Amorphophallus* he had studied have starchy pollen.

### **Seed and Seed dispersal**

Madison (1979) investigated the nature of protection of developing seeds in neotropical Araceae. In the neotropical species of Araceae distinct mechanisms are found for protection of developing seeds. It includes, (i) changes of pericarp from white, yellow or orange to green after anthesis, (ii) presence of bundles of calcium oxalate raphides in the unripe pericarp, etc. In most cases these mechanisms are contrary to the requirement of dispersal, so that a corresponding array of adaptations is required to reverse them when fruits ripen.

Little is known about the distribution of seeds of *Amorphophallus*. Birds are considered to be the main agents of distribution. The gigantic berries of *A. titanum* are almost certainly eaten and dispersed by hornbills, whereas those of *A. gigas* are dispersed by bulbuls (Hettterscheid, 1994). Two bird species of bulbuls (red-whiskered bulbul – *Pycnotus jocosus* L. and red-vented bulbul – *Pycnotus cafer* L.),

and Koel – *Edynamys scolopacca* L. are locally well known to favour *Amorphophallus* fruits and are snared at these plants by some people belonging to mukri and karivokkaliga communities of Karnataka state, India (Singh & Gadgil, 1995).

Peckover (1985) observed the seed dispersal of *Amorphophallus paeoniifolius* by birds of paradise in Papua - New Guinea. A magnificent Rifle bird was reported as having eaten the fruits and regurgitated the seeds of *Amorphophallus paeoniifolius* in captivity in Papua - New Guinea. A glossy mantled Manucode bird of paradise was also observed leaving a fruiting head of the same plant species in the wild.

Many fruit eating birds regurgitate large seeds and pass small seeds through their alimentary canal unharmed (Howe & Westley, 1988).

### **Pollination**

Beetle pollinated aroids may have psilate, globose pollen (*A. lambii*, *A. titanum*). Along with other carrion beetles and flies, nitidulids help to pollinate some of the species of *Amorphophallus*, *Dracunculus*, etc. (Grayum, 1984).

Studies on pollination are scarce in *Amorphophallus* species. Van der Pijl (1937) observed that the pollination in *A. muelleri*, *A. titanum* and *A. variabilis* is mainly effected by carrion beetles.



Sivadasan and Sabu (1989) carried out pollination study in *Amorphophallus hohenackeri*. The beetle *Haptoncurina motschulskii* (Reitter) Jelinek (Coleoptera: Nitidulidae) was found to be an effective agent of cantharophily in *A. hohenackeri*, an endemic to South West India. The role of beetles in pollination was long overlooked even after Diel's (1916) demonstration of cantharophily and its importance (Grinfeld & Issi, 1958; Meeuse, 1959). Beetle pollination is as characteristic of the tropical zone as bee pollination is of temperate regions (Faegri & Van der Pijl, 1979). Pollination of different species of *Amorphophallus* are given in the following Table 2.

**Table 2. Pollinators of *Amorphophallus***

Species	Orders of pollinators	Authority
<i>Amorphophallus flavovirens</i>	Diptera	Knecht, 1983
<i>A. hohenackeri</i>	Coleoptera	Sivadasan & Sabu, 1989
<i>A. lambii</i>	"	Mayo <i>et al.</i> , 1982
<i>A. muelleri</i>	"	Van der Pijl, 1937
<i>A. oncophyllus</i>	"	Van der Pijl, 1937
<i>A. variabilis</i>	"	Backer, 1913; Van der Pijl, 1937
<i>A. titanum</i>	"	Van der Pijl, 1937
	Diptera	Knuth, 1909

Pollinating plants of different clones in cultivation is usually successful. The pollen must be put on the stigmas on the first day of flowering, when the stigmas are

very sticky and no pollen will fall off. On the day that the pollen is released the stigmas of the same inflorescence are no longer receptive to pollen. Pollination within one and the same clone has been successful in a limited number of cases (*A. atroviridis*). Pillai (1996) found out variability among the progenies in elephant-foot yam (= *Amorphophallus paeoniifolius* var. *campanulatus*) following hybridisation and open pollination. Hybrids between different species have been raised in Leiden (Hettterscheid & Ittenbach, 1996).

### **Agronomy**

Works on various aspects of agronomy are centred around the widely cultivated taxon *Amorphophallus paeoniifolius* var. *campanulatus*. Rajendran and Hrishikesh (1976) reported on the breaking of seed dormancy in *Amorphophallus*. Exposure of seeds to running water for six days was found to be the most effective treatment in inducing sprouting of seeds. Some water soluble material present in the seed coat inhibited the germination of seeds, and dormancy can be broken once it is removed by water. Nedunzhiyan and Mohan Kumar (1994) also reported the effect of pre-treating in breaking dormancy and inducing sprouts in elephant-foot yam.

Ashokan *et al.* (1984) reported the relative effect of size of seed-corm and manures on the development of tuber in *Amorphophallus* (= *A. paeoniifolius* var. *campanulatus*). Sen and Das (1990) also reported the effect of cut and whole seed-corm of same size on growth and yield of elephant-foot yam. Sen *et al.* (1984)

reported the effect of seed-corm weight and spacing on the total corm yield of *Amorphophallus*. Sen *et al.* (1987) also reported the effect of set-size and spacing on the production of seed-corm in *Amorphophallus campanulatus* (= *A. paeoniifolius* var. *campanulatus*). Other works in this and related aspects have been carried out by various workers (Katyal, 1977; Goswami and Sen, 1992; George & Nair, 1993; Sen *et al.*, 1993; Das *et al.*, 1995). Sreekumari and Pillai (1994) reported the morphological variations in the seedlings of elephant-foot yam.

Dhua *et al.* (1988) reported the effect of some chemicals on sprouting, growth, and corm-yield of *Amorphophallus campanulatus* (*A. paeoniifolius* var. *campanulatus*). The treatment of cut-corm from mother corm with chemicals such as thiourea, potassium nitrate and (2-chloroethyl)trimethyl ammonium chloride were found to be effective in promoting sprouting. Mukhopadhyay and Sen (1986) found out the effect of nitrogen and potassium on yield and quality of elephant-foot yam. The quality of corm was improved with increasing levels of both nitrogen and potassium. Other works on similar and related aspects have been carried out by various workers (Kabeerathumma *et al.*, 1987; Nair *et al.*, 1990; Ravindran & Kabeerathumma, 1990; Nair & Kumar, 1991).

Bhaumik *et al.* (1988) discovered the effects of herbicides and planting methods on the yield of *Amorphophallus campanulatus* (= *A. paeoniifolius* var. *campanulatus*). Experiments involving five herbicides, hand-weeding with two

methods of planting and unweeded control showed that hand-weeding always showed higher responses for producing high corm yield followed by the application of fluchloralin. Hand-weeding can be effectively replaced by a single preplanting application of fluchloralin.

Palanisami and Pillai (1979) recorded mealy bugs, the pests of elephant-foot yam, under storage. They are *Pseudococcus citriculus* Green and *Rhizoecus* species.

# METHODOLOGY

V. Abdul Jaleel "Revision of Amorphophallus (Araceae) in India " Thesis.  
Department of Botany , University of Calicut, 2002

## METHODOLOGY

Various species of *Amorphophallus* have been collected by extensive and intensive field explorations made all over India including Andaman and Nicobar Islands. Repeated collection trips during different seasons were essential to get the taxa both in reproductive and vegetative phases. All relevant data about the plants have been recorded in field book. Photographs of entire plant, inflorescence, inflorescence with spathe cut-open showing spadix, tubers, leaves, etc. were taken and collected the sufficient number of plants based on the population, for making herbarium. Herbarium specimens were prepared following wet method (Fosberg & Sachet, 1965). Additional inflorescence were preserved in Formalin Acetic Acid (FAA) solution in glass bottles for further study and illustration work. Tubers were collected for cultivation in Calicut University Botanical Garden for future observations and studies. Soil mixed with cowdung and sand was used as potting media for planting corms. Tubers were also planted directly in soil beds prepared in the Garden, and all the plants were labelled using aluminium T- labels.

Illustrations of the entire plant of both vegetative and reproductive phases and separate inflorescences were made; neuter flowers, male and female flowers, etc. were also made with the help of Wild stereozoom microscope and camera lucida.

Under the systematic treatment the genus is provided with an updated nomenclatural citations, citation of type, detailed description and world distribution, followed by a key to the identification of the species. The treatment of the species are in alphabetic sequence. In the case of species with varieties, key to the varieties is given, and the treatment of the varieties the typical variety is given first irrespective of alphabetical sequence, and the other varieties are in alphabetic sequence. Each species is also provided with an updated nomenclatural citations, citation of type, detailed description, phenology, distribution, citation of specimens examined, and also relevant notes on nomenclature, variations, distribution, uses, etc., if any.

Specimens available at the following major Indian herbaria were consulted to study them: The Central National Herbarium, Howrah, Calcutta (CAL); Madras Herbarium, Southern Circle of the Botanical Survey of India, Coimbatore (MH); Herbarium of the Andaman and Nicobar Circle, Portblair (PBL), Herbarium of the Central Circle of the Botanical Survey of India, Allahabad (BSA); Herbarium of the Eastern Circle of the Botanical Survey of India, Shillong (ASSAM); Herbarium of the Sikkim Himalayan Circle of the Botanical Survey of India, Gangtok (BSHL); Herbarium of the Northern Circle of the Botanical Survey of India, Dehra Dun (BSD); Herbarium of the Forerst Research Institute, Dehra Dun (DD); Calicut University Herbarium, Calicut (CALI); Herbarium of the Tropical Botanical Garden

and Research Institute, Thiruvananthapuram (TBGT); and Herbarium of Kerala Forest Research Institute, Trichur (KFRI).

Names of the authors of the species are given in abbreviated forms as given by Brummit and Powell (1992) and acronyms of the herbaria are as given in the 8<sup>th</sup> edition of the *Index Herbariorum* (Holmgren *et al.*, 1990). Names of the journals and the periodicals are in abbreviated forms as given in *Botanico-Periodicum-Huntianum* (B-P-H) (Lawrence *et al.*, 1968).

Details of the abbreviations used in the text are given below.

Infl.	:	Inflorescence
Infr.	:	Infructescence
Acc.No.	:	Accession number
s. coll.	:	Without collector's name
s.n.	:	Without collection number
s.d.	:	Without collection data
<i>Ibid.</i>	:	<i>Ibidem</i> (In the same place)
ca.	:	<i>circa</i> (about)



# TAXONOMIC TREATMENT

V. Abdul Jaleel "Revision of Amorphophallus (Araceae) in India " Thesis.  
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## TAXONOMIC TREATMENT

### AMORPHOPHALLUS

Blume [Bat. Courant 1825, descript. but no name] ex Decne., Nouv. Ann. Mus. Hist. Nat. 3: 366. 1834, *nom. cons.*; Rumphia 1: 138. 1837; Schott, Syn. Aroid. 37. 1856, Gen. Aroid. t. 31. 1858, Prodr. Syst. Aroid. 127. 1860; Engl. in DC., Monogr. Phan. 2: 308. 1879; Hook. f. in Benth. & Hook. f., Gen. Pl. 3: 970. 1883; Fl. Brit. India 6: 513. 1894; Engl. & Prantl, Pflanzenfam. 2(3): 126. 1889; Engl., Pflanzenr. IV.23C(48): 61. 1911; Fischer in Gamble, Fl. Pres. Madras 1585. 1931, Repr. ed. 2, 3: 1106. 1967; Mitra, Pl. E. India 1: 74. 1958; Nicolson, Taxon 26: 337. 1977; Hett. & Ittenb., Aroideana 19: 7. 1996; Mayo *et al.*, Gen. Araceae 235. 1997.

*Type: Amorphophallus campanulatus* Decne.

*Thomsonia* Wall., Pl. Asiat. Rar. 1: 83, t. 99. 1830; Blume, Rumphia 1: 149. 1837; Engl., Pflanzenr. IV 23C (48): 56. 1911; Bogner, Pl. Syst. Evol. 125(1): 15. 1976, *nom. rej.*

*Pythion* Mart., Flora 14: 458. 1831, *nom. rej.* [type same as *Arum campanulatum* Roxb. (= *A. paeoniifolius* (Dennst.) Nicolson)].

*Candarum* Reichb. [Consp. 44. 1828, *nom. nud.*] ex Schott in Schott & Endl.,  
Melet. Bot. 17. 1832, *nom. illegit.* [same type as of *Pythion* Mart., 1831].

*Pythonium* Schott in Schott & Endl., Melet. Bot. 17. 1832, *nom. illegit.*

*Kunda* Raf., Fl. Tellur. 2: 82. 1836, *nom. illegit.* [same type as of *Pythion* Mart.,  
1831].

*Brachyspatha* Schott, Syn. Aroid. 35. 1856. [Lectotype: *B. variabilis* (Bl.) Schott (= *Amorphophallus variabilis* Bl.) Gen. Aroid. t. 29. 1858, Prodr. Syst. Aroid.  
127. 1860; Nicolson, Taxon 16: 515. 1967.

*Conophallus* Schott, Syn. Aroid. 34. 1856 [Lectotype: *A. bulbiferum* (Roxb.) Schott  
(= *Arum bulbiferum* Roxb.), Prodr. Syst. Aroid. 127. 1860; Nicolson, Taxon  
16: 516. 1967].

*Corynophallus* Schott, Oesterr. Bot. Wochenbl. 7: 389. 1857, Gen. Aroid. 6, t. 32.  
1858, Prodr. Syst. Aroid. 132. 1860.

*Allopythion* Schott, Gen. Aroid. t. 24. 1858.

*Hansalia* Schott, Oesterr. Bot. Zeitschr. 8: 82. 1858, Prodr. Aroid. 133. 1860.

*Hydrosme* Schott, Oesterr. Bot. Wochenbl. 7: 389. 1857, Gen. Aroid. t. 33. 1858,  
Prodr. Syst. Aroid. 132. 1860; emend. Engl. in DC., Monogr. Phan. 2: 321.

1879, in Engl. & Prantl, *Pflanzenfam.* 2(3): 128. 1889; Jumelle, *Ann. Mus. Colon. Manseille*, Ser. 3(7): 181, t. 1. 1919.

*Rhaphiophallus* Schott, *Gen. Aroid.* t. 27. 1858.

*Synantherias* Schott, *Gen. Aroid.* t. 28. 1858, *Prodr. Syst. Aroid.* 126. 1860; Engl. in DC., *Monogr. Phan.* 2: 319. 1879, in Engl. & Prantl., *Pflanzenfam.* 2(3): 126. 1889; Benth. & Hooker, *Gen. Pl.* 3: 972. 1883.

*Proteinophallus* Hook. f., *Bot. Mag.* 101: t. 6195. 1875.

Seasonally dormant tuberous herbs; tubers depressed globose, sometimes irregularly more or less elongate cylindric. Cataphylls smooth, 3-7 in number, varying in length, broad, lorate, tip rounded and minutely apiculate, or tip acute with stiff projection with bifid apex. Leaves solitary; petiole long, cylindrical, smooth, rarely verrucose; usually conspicuously spotted and marked in a variety of patterns, sheath very short. Lamina trichotomously decompose, bulbils rarely present at the junction of divisions; leaflets oblong-elliptic to linear, tip acuminate or acute, base decurrent or not, primary lateral veins of ultimate lobes pinnate forming distinct submarginal collective vein, higher order venation reticulate.

Inflorescence solitary, preceded by cataphylls; flowering without leaves, peduncle short to long, similar to petiole in colour and texture; spathe variously shaped, coloured, deciduous, boat-shaped and not or hardly convolute, or clearly

differentiated into a basal tube and an upper limb, sometimes constricted between them; tube convolute, rarely connate [*A. pusillus*, *A. elliotii*], campanulate to cylindric or ventricose, inner surface smooth or longitudinally ribbed or verruculose or densely covered with scale or hair like processes near the base; limb erect to spreading, smooth, ribbed, variously undulate or frilled at margins. Spadix sessile or stipitate, more or less equal or shorter or longer than the spathe; usually differentiated into a basal female zone, a middle male zone, and a terminal sterile appendix; female zone shorter, equalling or longer than the male zone; male zone cylindric, ellipsoid, conoid or obconoid; terminal appendix usually prominent, rarely reduced to a stub; erect, sometimes horizontal, rarely pendent; very variable in shape, usually more or less conoid or cylindric, globose, subglobose, stipitate or sessile, basally narrowed, usually smooth, glossy or bearing staminode-like structures near the base, or entirely covered with staminodes, sometimes corrugate or densely to sparsely hirsute, or irregularly valliculate. Male zone usually contiguous with female, sometimes separated by a sterile zone which may be naked or bear prismatic, subglobose, ovoid, obovoid or hair like or echinate sterile flowers. Flowers unisexual, perigone absent; male flowers 1-6-androus, stamens free or sometimes connate in basal flowers or throughout male zone, connective fairly thick, thecae obovoid or oblong, opposite, dehiscing apically by an apical pore or terminal slit; pollen extrude in strands, inaperturate, mostly ellipsoid to ellipsoid-oblong, occasionally spherical or subspheroidal, medium sized to large,

exine striate, striate-reticulate, psilate, scabrate, areolate, fossulate, punctate-foveolate, verrucate or spinose; female flowers usually crowded, sometimes more or less distinct, ovary subglobose to ovoid or obovoid, 1-4-locular, ovules 1 per locule, anatropous, funicle very short to distinct, erect, placenta axile to basal; style absent, short or very long, conoid or cylindrical; stigma variously shaped, entire and sub-globose or 2-4-lobed or stellate or rarely punctiform, sometimes large and brightly coloured. Infructescence more or less cylindrical. Berry sometimes very large, 1 to few-seeded, orange to reddish, Seeds ellipsoid, testa smooth, thin, embryo large, superficially somewhat green, endosperm absent.

*Distribution:*

Tropical Africa, Madagascar, tropical Asia and Australasia (Angola, Australia, Bangladesh, Benin, Bhutan, Botswana, Brunei, Burkina Faso, Myanmar, Burundi, Cabinda, Cambodia, Cameroon, Central African Republic Chad, S. China (incl. Taiwan), Congo, Equatorial Guinea (Bioko, Rio Muni), Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, India, Indonesia, Ivory Coast, Japan, Kenya, Laos, Liberia, Madagascar, Malawi, Malaysia, Mali, Mozambique, Namibia, Nepal, Niger, Nigeria, Papua New Guinea, Philippines, Rwanda, Senegal, Sierra Leone, Somalia, South Africa, Sri Lanka, Sudan, Tanzania, Thailand, Togo, Uganda, Vietnam, Zaire, Zambia, Zimbabwe) (Mayo *et al.*, 1997; Croat, 1979).

### Key to the species

- 1a. Leaves bulbiferous; spadix without neuter flowers; spadix-appendix elongate-ovoid or elongate-ellipsoid, erect, cream-coloured.
- 2a. Peduncle short, less than 15 cm, usually 11-15 cm long; spathe-limb apically fornicate ..... *A. bognerianus*
- 2b. Peduncle long, 35 cm, usually 38-68 cm long, spathe-limb apically erect, not fornicate.
- 3a. Leaflet-tips twisted in mature leaflets; spathe ovate-oblong, more than 60 cm long, with indistinct blotches outside; ..... *A. carnosus*
- 3b. Leaflets tip not twisted in mature leaflets; spathe ovate-obtuse, ca. 14-25 cm long with distinct blotches outside.
- 4a. Spathe with distinct small constriction between the tube and limb; at base within rose-pinkish and slightly muricated, and paler towards the tip ..... *A. oncophyllus*
- 4b. Spathe without constriction between the tube and limb; at base within pale pinkish and distinctly muricated, middle purplish with oblong to ovate blotches, and pale green with small green blotches towards the tip ..... *A. bulbifer*

- 1b. Leaves not bulbiferous; spadix with or without neuter flowers; spadix-appendix elongate-cylindrical with tapering tip, erect or pendulous, conoid or hemispherical, cream or dark purplish coloured.
- 5a. Spadix with neuter flowers in between male and female zones; or rarely if neuter flowers absent, sterile flowers present above the male zone.
- 6a. Spadix without a terminal naked appendix; neuter flowers large, elongate-obovoid, cream-coloured ..... *A. margaritifera*
- 6b. Spadix with a terminal naked appendix; neuter flowers spherical, rhomboid, rounded, or short, stout-echinate, cream-coloured or dark pinkish or purplish or brownish red or greenish.
- 7a. Spadix-appendix very long, to ca. 16-25 cm long, cylindric, tapering to the tip, pendent; female flowers with stigma having 3-5 stout echinate projections .....  
..... *A. smithsonianus*
- 7b. Spadix-appendix medium sized, to ca. 7.5-20 cm long or very short (less than 4 cm), cylindric, tapering to the tip, erect; female flowers with stigma without stout echinations.



- 8a. Neuter flowers short, stout, echinate and greenish; spadix-appendix very short, ca. 2 cm long, stalked with irregularly formed sterile structures (resembling rudimentary male or female flowers); male flowers with projected long connectives (rarely neuteriflorous zone and spadix-appendix are lacking)  
 ..... *A. longiconnectivus*
- 8b. Neuter flowers rhomboid, obovoid or oblong-gibbous or globose; spadix-appendix sessile, smooth; male flowers without projected connectives.
- 9a. Spathe less than half the length of the spadix-appendix.
- 10a. Neuter flowers oblong-gibbous, pinkish; stigma 2-lobed with irregular small warts at maturity; male flowers sparsely arranged in groups of 2-5; spadix-appendix pale brownish-yellow ..... *A. sylvaticus*
- 10b. Neuter flowers rhomboid, slightly convex, whitish or with faint purplish hue; stigma 3-lobed, without irregular small warts at maturity; male flowers arranged loosely (especially at the base), not in groups; spadix-appendix dirty olive green .....  
 ..... *A. konkanensis*
- 9b. Spathe more than half the length of the spadix-appendix.

11a. Spathe differentiated into a basal convolute tube and an upper limb with a shallow constriction in between, tip shortly acuminate; barren naked zone present between pistillate and neuteriflorous zones; spadix-appendix cylindrical .....

..... *A. bonaccordensis*

11b. Spathe not differentiated into tube and limb and hence without a constriction in the spathe; barren naked zone between pistillate and neuteriflorous zones absent; spadix-appendix cylindrical, tapering to the tip.

12a. Spathe broadly ovate, fully convolute, limb not differentiated, dull purplish; neuter flowers globose, brownish red; spadix-appendix dark purplish .....

..... *A. mysorensis*

12b. Spathe ovate, basally convolute at early stage and completely opens throughout at maturity without a tubular portion at base, light pinkish yellow with purplish black mottles; neuter flowers rounded elongate-rhomboid, gibbous, cream-coloured; spadix-appendix cream-coloured .....

..... *A. hohenackeri*

5b. Spadix without neuter flowers.

- 13a. Peduncle short, 3-8 cm long; spathe broadly campanulate with basal convolute tube and horizontally spreading limb; spadix-appendix subglobose or conoid.
- 14a. Petiole smooth; spadix-appendix with subglobose base and apical short cylindric column with truncate tip, bearing short stiff hairs ..... *A. hirsutus*
- 14b. Petiole smooth or rough; spadix-appendix subglobose or slightly elongate-conoid, glabrous without hairs ..... *A. paeoniifolius*
- 13b. Peduncle long, more than 20 cm long; spathe ovate with basal convolute tube and upper open erect limb; spadix-appendix elongate-ovoid, cylindric, or cylindric and tapering towards tip.
- 15a. Spadix shorter than spathe; appendix elongate-ovoid with longitudinal valleculation, or cylindric with protuberances.
- 16a. Spadix stipitate; appendix elongate-ovoid, surface with longitudinal irregular valleculation; style straight; stigma inconspicuously 3-lobed ..... *A. kachinensis*
- 16b. Spadix sessile; appendix cylindric, stout, surface rough with short prominent protuberances; style bent towards the spadix-axis; stigma 4-lobed ..... *A. napalensis*
- 15b. Spadix longer than spathe; appendix elongate, narrow-conoidal or cylindrical and tapering to the tip, smooth.

- 17a. Surface of petiole and peduncle smooth but uneven with small swellings; style length about twice or more than twice the height of the ovary ..... *A. longistylus*
- 17b. Surface of petiole and peduncle smooth and even; style length very short, less than the height of the ovary.
- 18a. Tuber subglobose in reproductive and vegetative phases; petiole and peduncle not brittle; spathe with a constriction between the tube and the limb ..... *A. commutatus*
- 18b. Tuber cylindrical in reproductive phase, small and obconic in vegetative phase; petiole and peduncle very turgid and brittle; spathe without a constriction between the tube and the limb ..... *A. nicolsonianus*

**1. *Amorphophallus bognerianus* Sivad. et Jaleel, *sp. nov.* (ined.).** (Figs. 11 & 12; Plate III).

*Type:* India, Arunachal Pradesh, Bhalukpong, alt. 217 m, 8<sup>th</sup> June 1999, *Abdul Jaleel RIA 371* (Holo-K).

Tubers depressed globose, ca. 9 cm diam. and ca. 4.5 cm thick in reproductive phase, 7-14.5 cm diam. and 4.5-10.5 cm thick in vegetative phase, skin light brownish; roots many, pale yellow in colour, 8-14 cm long, and ca. 0.2 cm diam. Petiole smooth, 77-105 cm long, 1.5-3.8 cm diam. at base and tapers

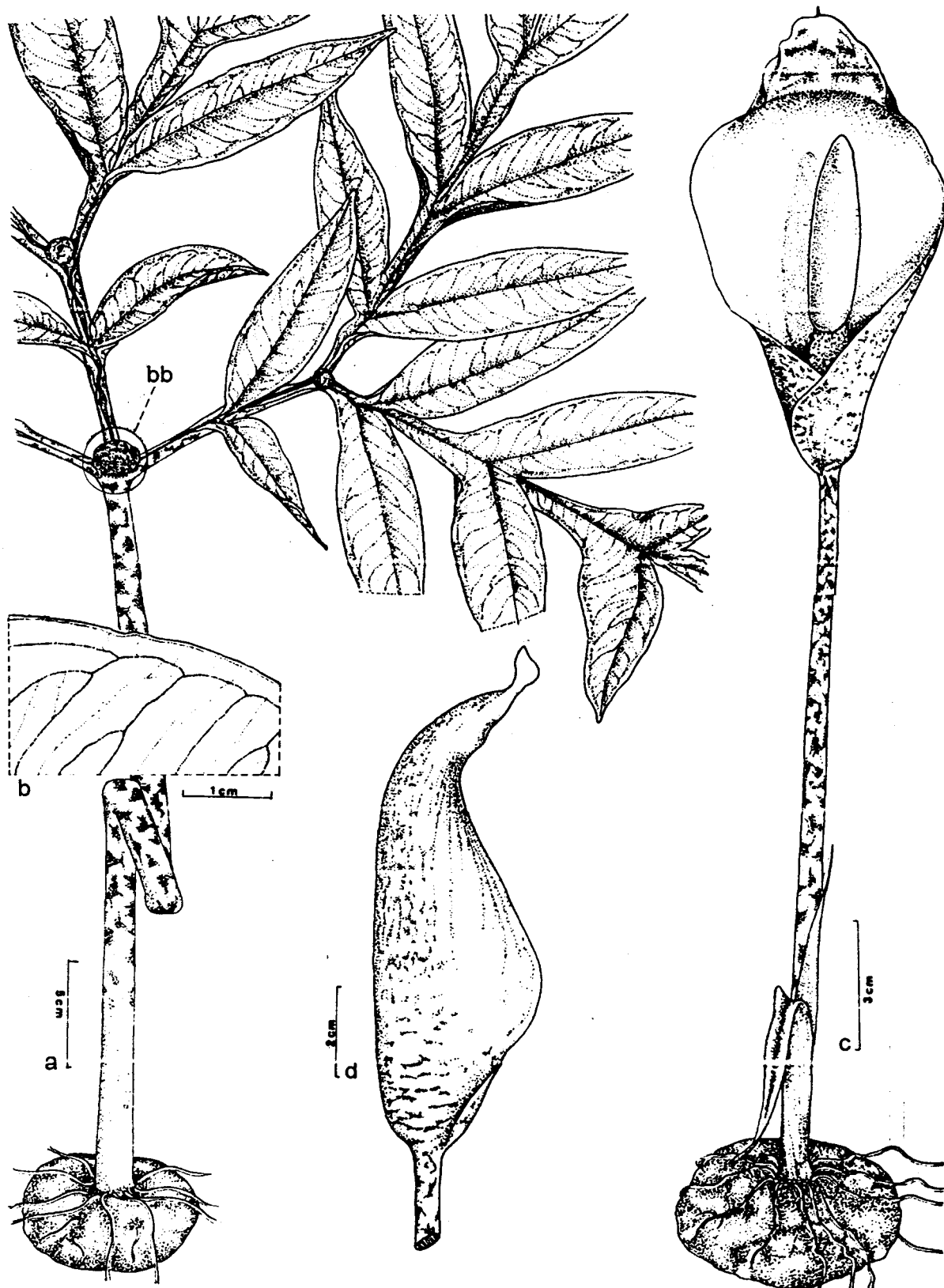


Fig. 11. *Amorphophallus bognerianus* Sivad. et Jaleel, sp. nov.: a. Tuber with leaf; b. Marginal portion of a leaflet showing venation; c. Tuber with inflorescence; d. Inflorescence – side view; bb – bulbil.

towards tip, dark greenish with pale green irregular ovoid to oblong, horizontal mottles and minute pale green lines also seen within the mottles, colour paler towards the tip, extreme base pale pink. Lamina 60-90 cm diam., middle segment of rachis 7-11.2 cm long and lateral segments 4-8 cm long. Leaflets oblong to elliptic, acuminate at apex, base unequal and decurrent on rachis, margin wavy, greenish above, paler below, varying in size, small leaflets 6-10 cm long and 3-5.2 cm broad, large leaflets 20-26 cm long and 5.5-8.0 cm broad; primary veins closely parallel and united below the margin forming a submarginal collective vein. Bulbils produced at the junction of the rachises and at axils between the rachises and their branches, brown in colour, subspherical, each ca. 0.6-3.5 cm diam. and 0.5-1.5 cm thickness.

Peduncle short, cylindric, smooth, ca. 11.0-15.5 cm long and 0.7-0.9 cm diam. at base, gradually narrowed to tip, identical with the petiole in colour and pattern of mottles. Spathe broadly lanceolate, 13.0-25.0 cm long, differentiated into a basal convolute tube and an upper expanded limb without constriction in between, convolute basal tube apically dilated, funnel-shaped, 2.0-2.6 cm diam. at base, 3.5-4.0 cm diam. at top, limb 8.5-13.0 cm broad at the centre, tip acute and fornicate, pale pinkish outside with narrow horizontal brownish green patches at basal convolute part, the patches vertical on the limb portion, and brownish green mottles towards the tip, pinkish inside with minute murications at base and smooth and paler above. Spadix sessile, shorter than spathe, 9.5-13.0 cm long; stipe

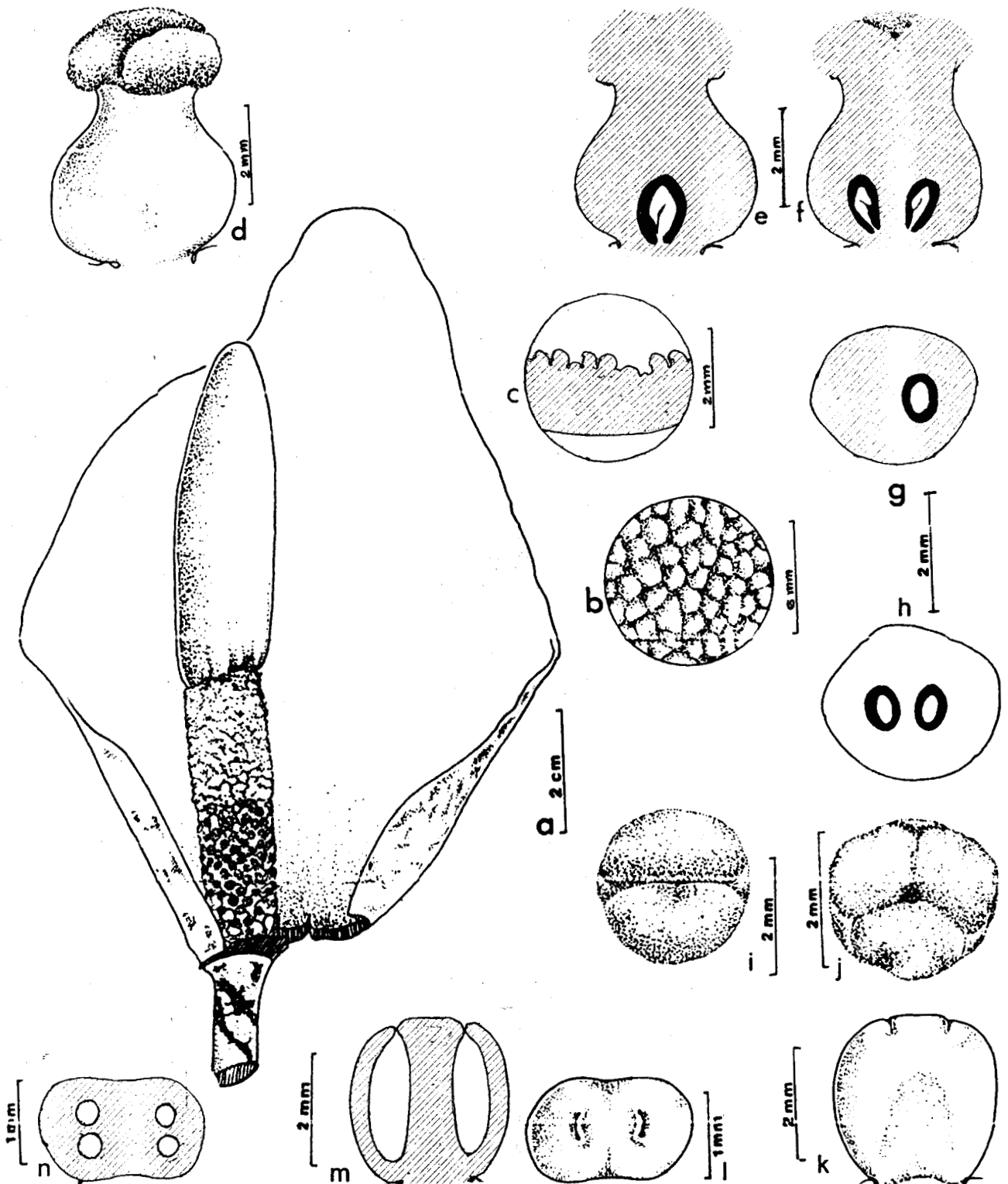


Fig. 12. *Amorphophallus bognerianus* Sivad. et Jaleel, sp. nov.: a. Inflorescence - spathe cut open showing spadix; b. A small basal inside portion of the spathe - magnified; c. A small basal portion of the spathe - c.s.; d. Single female flower; e. Female flower - l.s. passing through one locule; f. Female flower - l.s. passing through two locules; g. C.s. of ovary with one locule; h. C.s. of ovary with two locules; i. Two-lobed stigma - view from top; j. Three-lobed stigma - view from top; k. Male flower - view from broad side; l. Male flower - view from top showing the openings; m. Male flower - l.s.; n. Male flower - c.s.

0.2-0.3 cm long, 0.6-0.9 cm diam., pale pinkish; basal pistillate portion ca. 2.5-2.9 cm long, 1.2-1.7 cm diam., followed by a staminate portion of 2.1-2.5 cm long, 1.2-1.7 cm diam., and terminal fusiform appendix. Female flowers densely arranged, each flower ca. 2.5-3.0 mm high, ovary ca. 1 mm high, 2-2.5 mm diam., spherical, dark reddish, one or two-loculed, each locule with a single anatropous ovule; style very short, ca. 1.0 mm long, 1.5-2.0 mm diam., same colour as at that of ovary; stigma discoid, 2 or 4-lobed, ca. 2.5 mm diam. Male flowers closely arranged, each ca. 3 mm high, ca. 2 mm broad, cream-coloured, dehiscence by apical confluent pores. Spadix-appendix fusiform, 4.5-7.5 cm long, base ca. 1.2-1.7 cm diam., 1.5-2.0 cm at middle and gradually tapering to a rounded tip, yellow in colour with slight brownish minute spinescent projections at maturity, especially towards the tip. Fruits elongate-ellipsoid, ca. 1.5-1.7 cm long, ca. 0.7 cm diam. Seeds ca. 1.1-1.2 cm long and ca. 0.5 cm diam.

*Flowering:* May – June.

*Fruiting:* August – September.

*Distribution:* Hitherto known only from the type locality in Arunachal Pradesh.

*Notes:* *Amorphophallus bognerianus*, sp. nov. is related to *A. bulbifer* (Sims) Bl., but differs in having the inflorescence with short peduncle and erect vaulted spathe limb. It also differs from *A. bulbifer* in having the spadix-appendix which more or less equals to the length of the fertile portion of the spadix. In *A. bulbifer* the



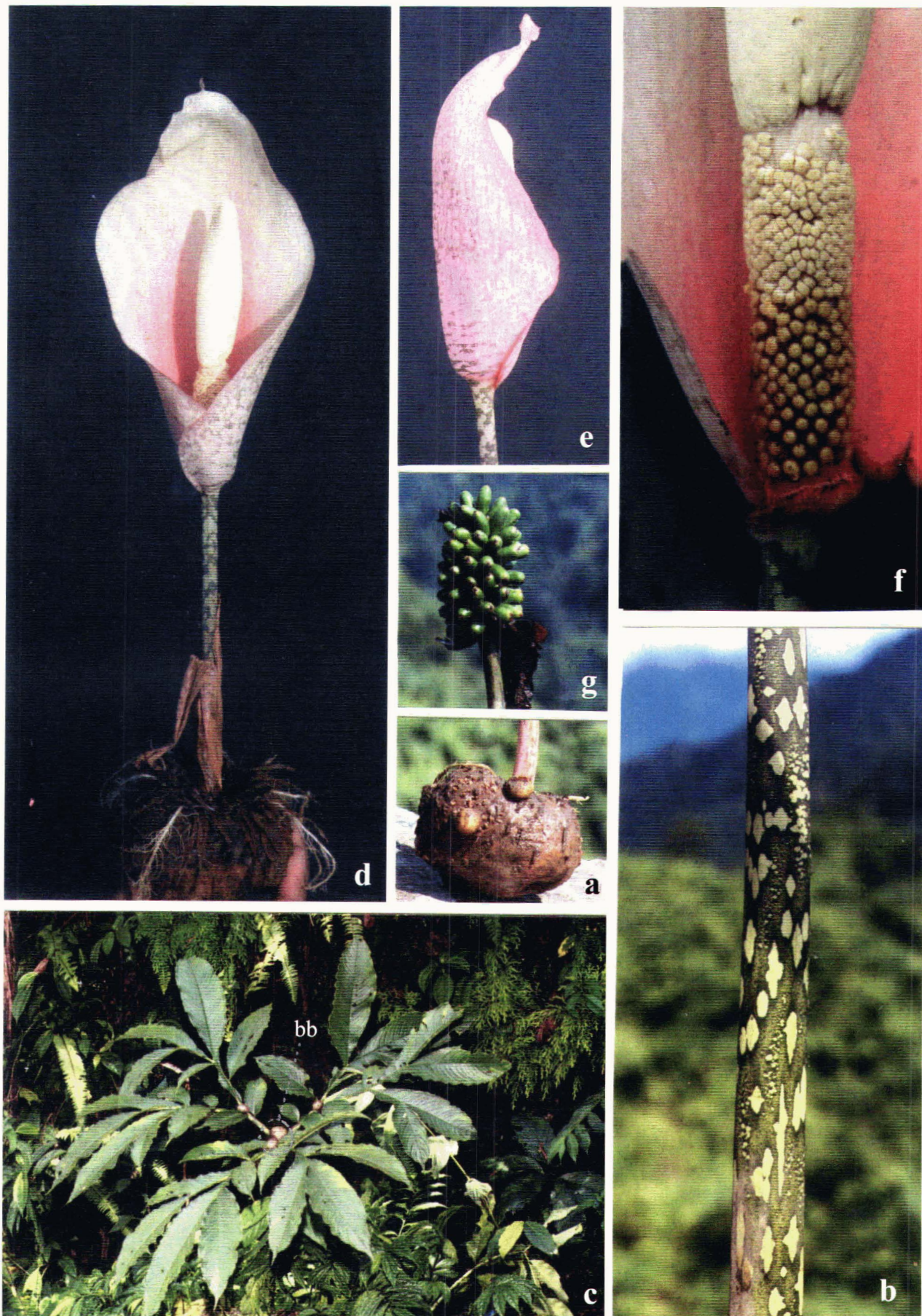


Plate III. *Amorphophallus bognerianus* Sivad. et Jaleel: a. Tuber; b. A portion of petiole showing mottlings; c. Lamina – top view showing bulbils; d. Tuber with inflorescence – front-view; e. Inflorescence – side view; f. Inflorescence with spathe cut open showing fertile portion of spadix and base of spadix appendix; g. Infructescence; bb- bulbil.

spadix more or less equals the length of the spathe; and the limb of the spathe is fully expanded and erect at maturity. In *A. bognerianus* the spathe is much longer than the spadix.

*Specimens examined:* **Arunachal Pradesh**, Balukpong, alt. 217 m, 2<sup>nd</sup> October 1997, *Abdul Jaleel* RIA 199 (leaf) (CALI); *Ibid.*, 2<sup>nd</sup> October 1997, *Abdul Jaleel* RIA 200 (infr.) (CALI); Kerala State, Calicut University Botanical Garden, 13<sup>th</sup> May 1999, *Abdul Jaleel* RIA 370 (infl.) (CALI); *Ibid.*, 8<sup>th</sup> June 1999, *Abdul Jaleel* RIA 371 (infl.) (CALI) (originally collected from Balukpong, Arunachal Pradesh and introduced in the Calicut University Botanical Garden).

**2. *Amorphophallus bonaccordensis*** Sivad., Mohanan & Rajkumar, *Blumea* 39: 295. 1994. (Figs. 13 & 14; Plate IV).

*Types:* India, Kerala State, Thiruvananthapuram Dist., Bonaccord on the Agasthyamala Hill ranges, 700 m, 20<sup>th</sup> April 1990, *Mohanan TBG&RI 8219* (Holo - K; Iso - CAL, M, TBGT, US).

Tubers subglobose, 3-6 cm diam. and 1.5-2.5 cm thick in vegetative phase; 4-7.5 cm diam. and 3-4 cm thick in reproductive phase; stolons are produced from the corms of fertile individuals, each stolon 4.5-5.5 cm long, and 0.4-0.6 cm diam., nodes with thin scale-leaves and few root primordia. Petiole 40-80 cm long, 0.7-1.5 cm diam. at the base, slightly tapering to the tip, green with dark greenish brown mottles, paler towards the tip. Lamina 70-90 cm diam., leaflets sessile,

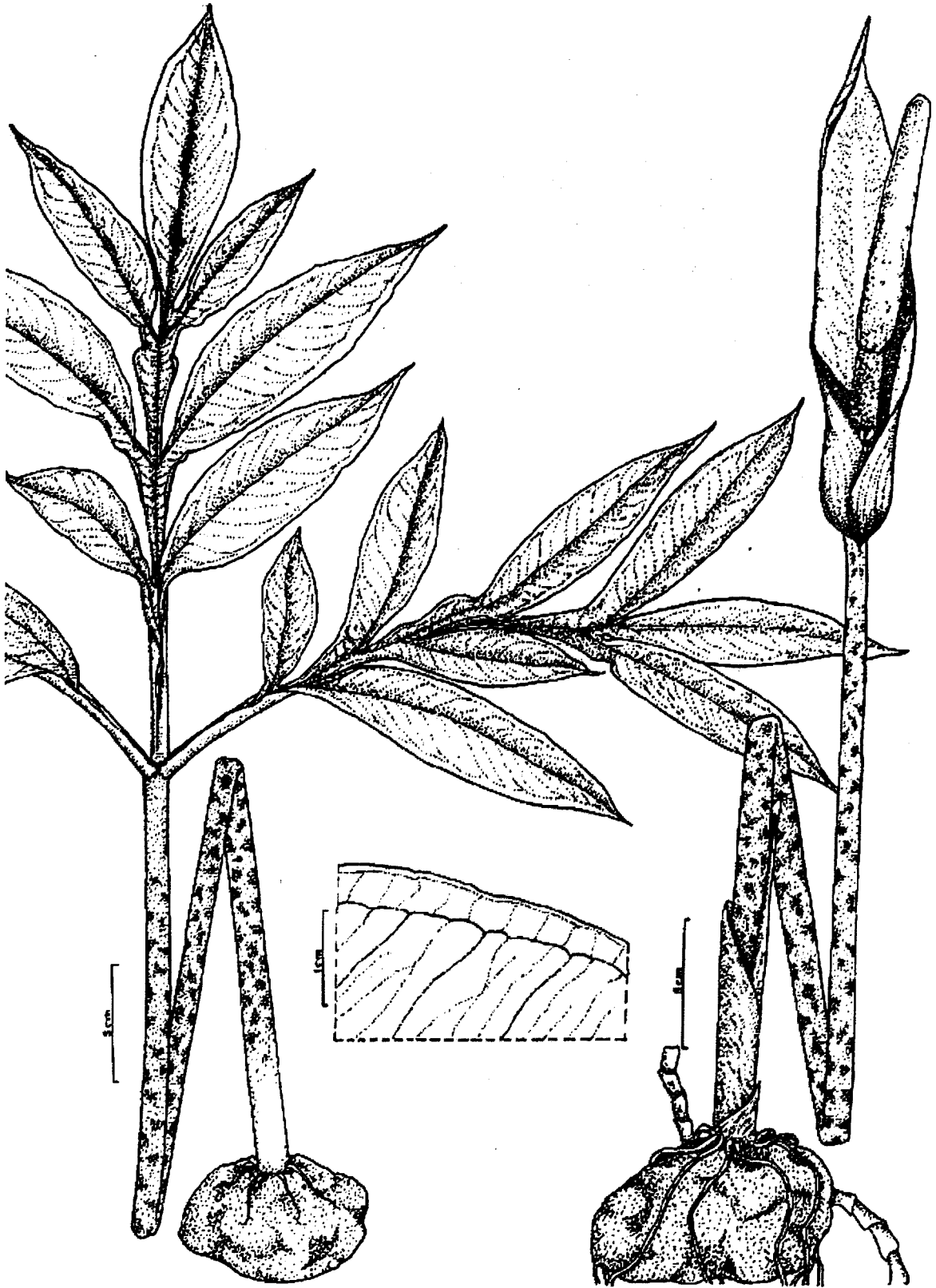


Fig. 13. *Amorphophallus bonaccordensis* Sivad. et al.: a. Tuber with leaf; b. Marginal portion of a leaflet showing venation; c. Tuber with inflorescence.

ovate-oblong, acuminate at apex, base acute and unequal, decurrent on rachis, greenish above, paler below, slightly undulate; large leaflets 9-14 cm long, 3.5-6.5 cm broad, small leaflets 4.5-6 cm long, 1.5-2.5 cm broad, secondary lateral veins united below the margin forming a sub-marginal collective vein.

Peduncle smooth, cylindric, 35-70 cm high, 0.8-1.5 cm diam. at the base, gradually narrowed to the tip, identical with petiole in colour and pattern of mottles. Spathe ovate-oblong, greenish yellow, 13-20 cm long, 4-5.5 cm broad, differentiated into a basal convolute tube and an upper expanded erect limb with a shallow constriction in between, tip shortly acuminate. Spadix more or less equal in length of the spathe, 11-16 cm long, with a basal stipe of about 0.6-1 cm long, ca. 0.5 cm diam., pale greenish, basal female zone 2.5-3.5 cm long, middle neuter zone 0.8-1.3 cm long, upper male zone 3-3.8 cm long, and a terminal appendix; a barren naked zone of ca. 0.2 cm present in between female and neuteriflorous zones. Female flowers sub-spirally arranged; ovary sessile, sub-globose, greenish, ca. 2 mm high, 3 mm diam., 2 or 3-loculed, each locule with one sub-basal anatropous ovule; unicellular trichomes present on funicle and on placenta around the area of funicular attachment; style very short, cylindric, ca. 0.7 cm long, ca. 0.8 cm diam.; stigma 2 or 3-lobed, covered with short unicellular papillae, cream-coloured; neuter flowers in 1-3 rows, creamy white in colour, obovoid, each ca. 0.5 cm long, ca. 0.25 mm diam. Male flowers closely arranged in groups of 2-5, each group borne on a white cushion like tissue of ca. 1 mm thickness; each stamen ca. 1 mm high,

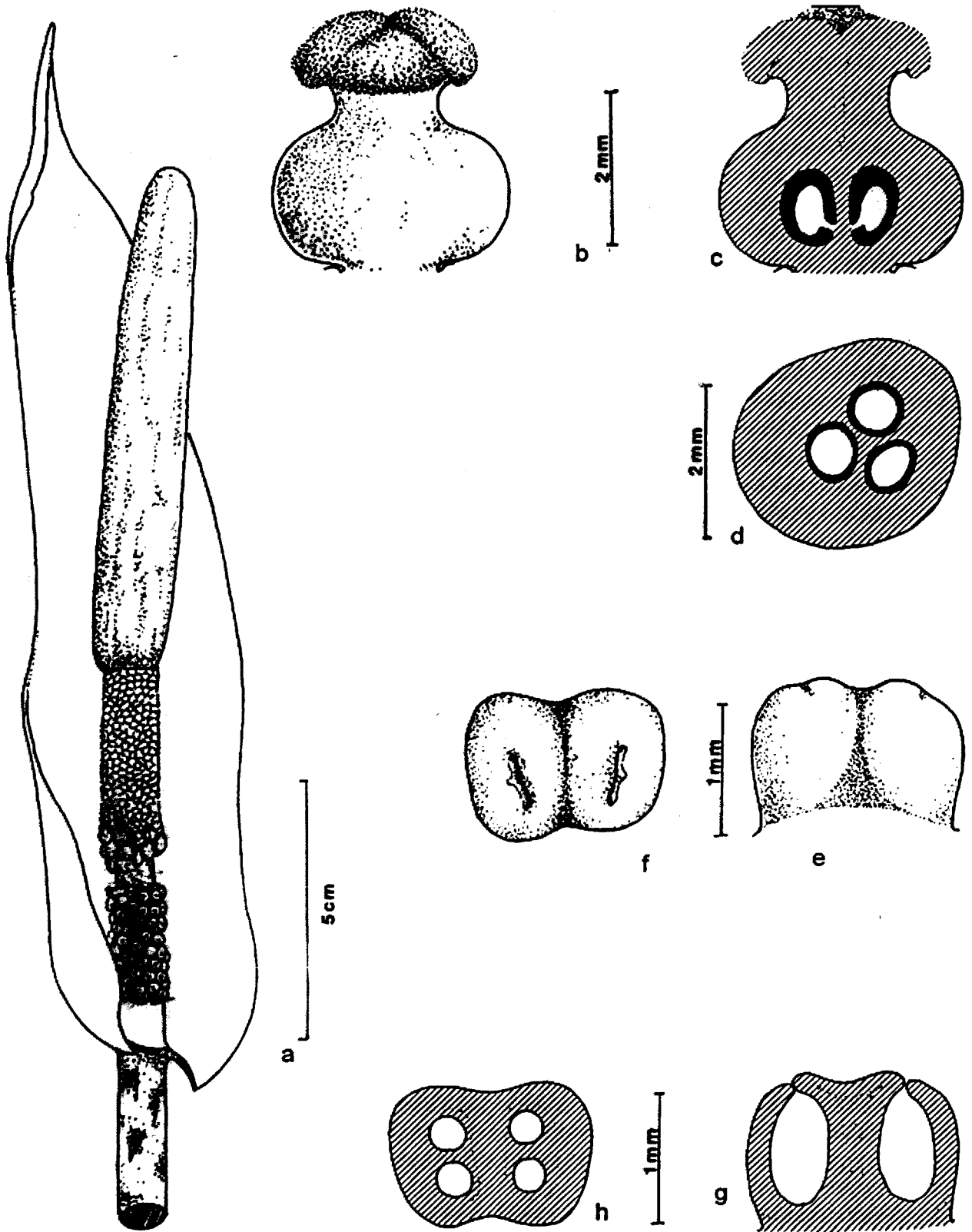


Fig. 14. *Amorphophallus bonaccordensis* Sivad. et al. : a . Inflorescence - spathe cut open showing spadix ; b. Female flower; c. Female flower - l.s.; d. Ovary - c.s.; e. Male flower - view from broad side; f. Male flower - view from top; g. Male flower - l.s; h. Male flower - c.s.

inconspicuously 2-lobed, thecae dehisce by apical narrow horizontal slits. Spadix appendix cylindric, 7.5-10.5 cm long, ca. 1 mm diam., rounded at the apex, cream-coloured, smooth, base rarely with very shallow rhomboidally oriented projections.

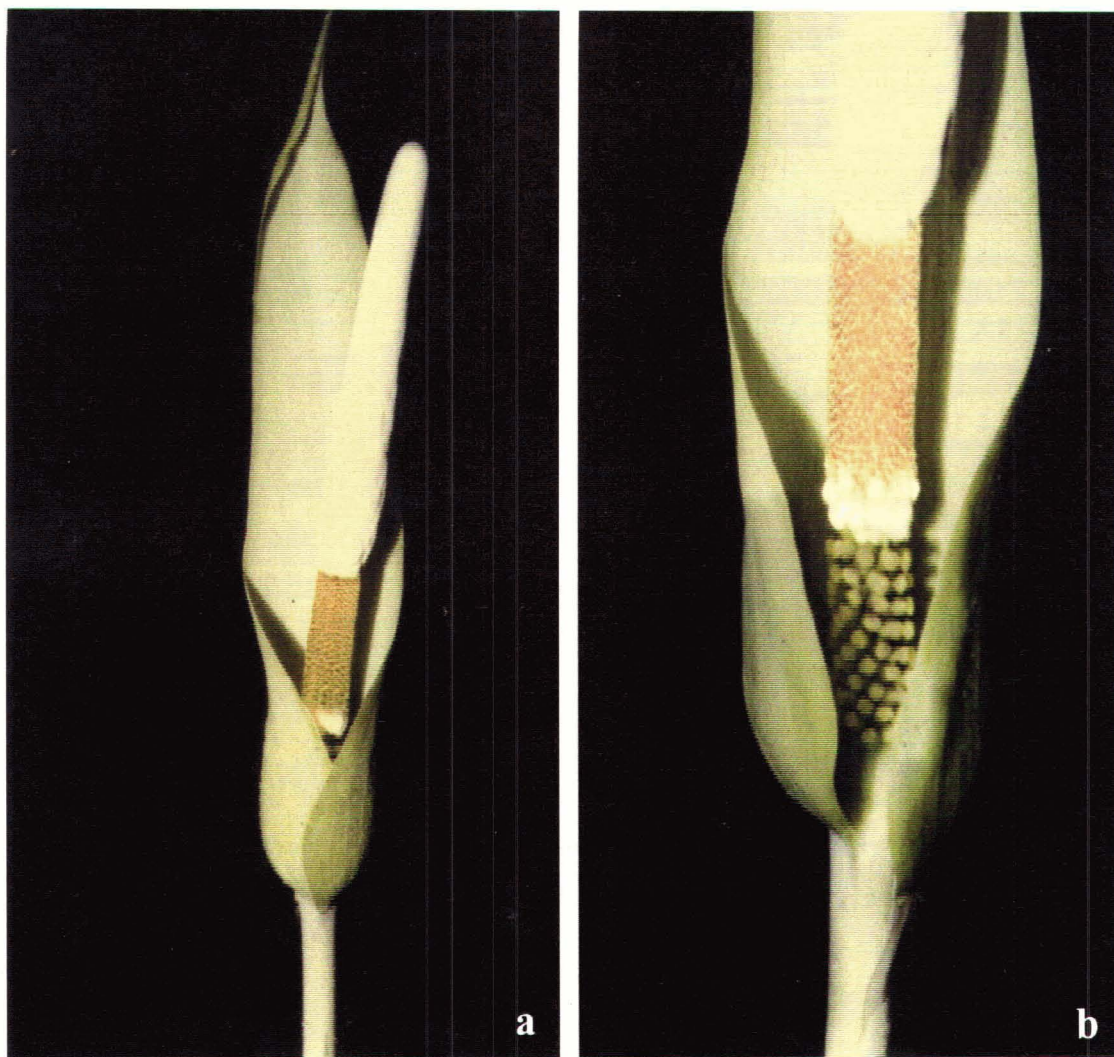


Plate. IV. *Amorphophallus bonaccordensis* Sivad. et. al.: a. Inflorescence; b. Inflorescence with spathe cut open showing fertile portion of spadix and base of spadix-appendix.

*Distribution:* So far known only from the type locality in Kerala.

*Flowering:* April.

*Fruiting:* Fruiting specimens could not be collected.

*Notes:* *A. bonaccordensis* differs from other species in having the ovate-oblong spathe with a prominent basal convolute tubular portion separated from the oblong erect limb by a slight constriction. The spadix appendix is cylindrical with round tip and is much shorter than the spathe, and never reaches the tip of the spathe.

*A. bonaccordensis* closely resembles *A. hohenackeri* in its general morphological features, but in *A. hohenackeri* the mature spathe is completely open throughout its length without a basal convolute tubular portion, the limb of the spathe is ovate-lanceolate with sub-acuminate tip, and the spadix-appendix tapers to the tip and reaches almost to the tip of the spathe or rarely exceeds it.

The other species that are similar to *A. bonaccordensis* only in having neuter flowers are *A. hohenackeri*, *A. konkanensis*, *A. longiconnectivus*, *A. margaritifera*, *A. mysorensis*, *A. smithsonianus* and *A. sylvaticus*. But the neuter flowers are rhomboidal and creamy whitish in colour or with a faint purplish hue in *A. konkanensis*; short, stout, echinate, a few with bifurcate tips and greenish in *A. longiconnectivus*; large, elongate-obovate and buff in colour in *A. margaritifera*; obovoid or ellipsoid, dark purplish or sometimes varying to brownish in *A. smithsonianus*; oblong-gibbous and pinkish in *A. sylvaticus*.

*Specimens examined:* **Kerala State**, Thiruvananthapuram Dist., Agasthyamala Hills, Bonaccord, 700 m, 25<sup>th</sup> April 1990, *Mohanan 8219* (infl.) (CALI); *Ibid.*, 26<sup>th</sup> April 1995, *Mohanan 22326* (infl.) (TBGT).

**3. *Amorphophallus bulbifer*** (Sims) Bl., Rumphia 1: 148. 1837; Kunth, Enum. Pl. 3: 34. 1841; Regel, Gartenflora t. 688. 1871; Engl. in DC., Monogr. Phan. 2: 317. 1879; Hook. f., Fl. Brit. India 6: 515. 1893; Prain, Bengal Pl. 2: 1110. 1903 (Repr. ed., 2: 835. 1963); Cooke, Fl. Pres. Bombay 825. 1908; Haines, For. Fl. Chota Nagpur 554. 1910; Engl. in Engl., Pflanzenr. IV. 23C(48): 98. 1911; Haines, Bot. Bihar and Orissa 3: 903. 1924; Fisch. in Gamble, Fl. Pres. Madras 1587. 1931; Blatt., J. Bombay Nat. Hist. Soc. 35: 27. 1932; Santapau, Rec. Bot. Sur. India (Fl. Khandala) 16(1): 292. 1953; Mitra., Flowering Pl. E. India 75. 1958; Hara, Fl. E. Himalaya 394. 1966; Hara *et al.*, Spring Fl. Sikkim Himalaya 394. 1966; Nairne, Fl. Pl. W. India 363. 1976; Nicolson in Saldanha & Nicolson, Fl. Hassan Dist. 783. 1976; Bennet, Fl. Howrah Dist. 93. 1979; Vajr. & Bhargavan, J. Econ. Tax. Bot. 3: 96. 1982; Deb, Fl. Tripura State 2: 397. 1983; Balakr., Fl. Jowai 2: 562. 1983; Bakshi, Fl. Murshidabad Dist. 336. 1984; Mukh., Fl. Pachmarhi & Bori Reserv. 312. 1984; Rao, Fl. Goa, Diu, Daman & Nagarhaveli 452. 1986; Karth., Jain, Nayar & Sanjappa, Fl. Ind. Enum. Monocot. 6. 1989; Almeida, Fl. Savantwadi 52. 1990; Roy, Shukla & Datt, Fl. Madhya Pradesh 449. 1992; Vajr., Fl. Palghat Dist. 531. 1990; Hajra & Verma, Fl. Sikkim 1: 186. 1996; Saxena & Brahmam, Fl. Orissa 4: 2038. 1996; Sharma, Karth. & Singh, Fl. Maharashtra Monocot. 209. 1996; Sivar.



& Mathew, Fl. Nilambur 749. 1996; Pullaiah, Fl. Andhra Pradesh 3: 1022. 1997; Murti & Panigrahi, Fl. Bilaspur Dist. 2: 646. 1999; Sivad. in Mohanan, Biju, Nayar & Easa, Silent Valley – Whisp. Reas. 228. 1999. (Figs. 15 & 16; Plate V).

*Arum bulbiferum* Roxb. [Hort. Beng. 65. 1814, *nom. nud.*] ex Sims Curtis's Bot. Mag. 46: t. 2072. 1819, *Ibid.* 51: t. 2508. 1824; Sprengel, Syst. Veg. 3: 770. 1826; Roxb., Fl. Ind. 3: 510. 1832; Graham, Cat. Bombay Pl. 229. 1839; Wight, Icon. Pl. Ind. Or. 3: 783. 1844.

*Pythonium bulbiferum* (Sims) Schott in Schott & Endl., Melet. Bot. 18. 1832, Prodr. Syst. Aroid. 123. 1860.

*Conophallus bulbifer* (Sims) Schott, Syn. Aroid. 34. 1856, Prodr. Syst. Aroid. 128. 1860.

*Conophallus tuberculiger* Schott, Bonplandia 7: 28. 1856; Prodr. Syst. Aroid. 128. 1860.

*Amorphophallus tuberculiger* (Schott) Engl. in DC., Monogr. Phan. 2: 317. 1879; Hook. f., Fl. Brit. India 6: 517. 1893.

*Amorphophallus bulbifer* var. *marmoratus* Engl., Pflanzenr. IV. 23C (48): 99. 1911.

*Amorphophallus bulbifer* var. *atroviridimaculatus* Engl., Pflanzenr. IV. 23C (48): 99. 1911; Karth., Jain, Nayar & Sanjappa, Fl. Ind. Enum. Monocot. 6. 1989.

*Amorphophallus bulbifer* var. *tuberculiger* (Schott) Engl., Pflanzenr. IV. 23C (48):

99. 1911; Karth., Jain, Nayar & Sanjappa, Fl. Ind. Enum. Monocot. 6. 1989.

*Type:* Illustration of *Arum bulbiferum*, t. 2072, published by Sims in Bot. Mag., 1819.

Tubers sub-globose, ca. 6 cm diam. and 3.0 cm thick in vegetative phase, 9-16 cm diam. and 6-9 cm thick in reproductive phase, skin pale brownish in colour; roots numerous, cream-coloured, ca. 5-9 cm long, ca. 0.15 cm diam. Petiole smooth, 60-82 cm long, 1-1.5 cm diam. at the base and slightly tapering to the tip, pinkish green to brownish green with cream to white irregular vertical linear patches, paler towards the tip. Lamina 70-80 cm diam., bulbils produced at the junction of the petiole with lamina and other intersections; leaflets sessile, ovate-oblong lanceolate, acuminate at apex; small leaflets 4-6 cm long and 2-3 cm broad, larger leaflets 16-18 cm long and 4-4.5 cm broad; greenish above and paler below, margin entire, extreme margin pale pinkish, secondary lateral veins united below the margin forming a sub-marginal collective vein; bulbils sub-globose, ca. 0.7-0.9 cm diam. and 0.3-0.5 cm thick.

Peduncle smooth, ca. 60-68 cm long and 1.5-2.0 cm diam. at the base, and gradually narrowed to the tip, identical with petiole in colour and pattern of stripes, covered by 3-4 cataphylls at the base; pale greenish with irregular pinkish patches at the base and paler towards the tip with minute green dots; each cataphyll lorate,

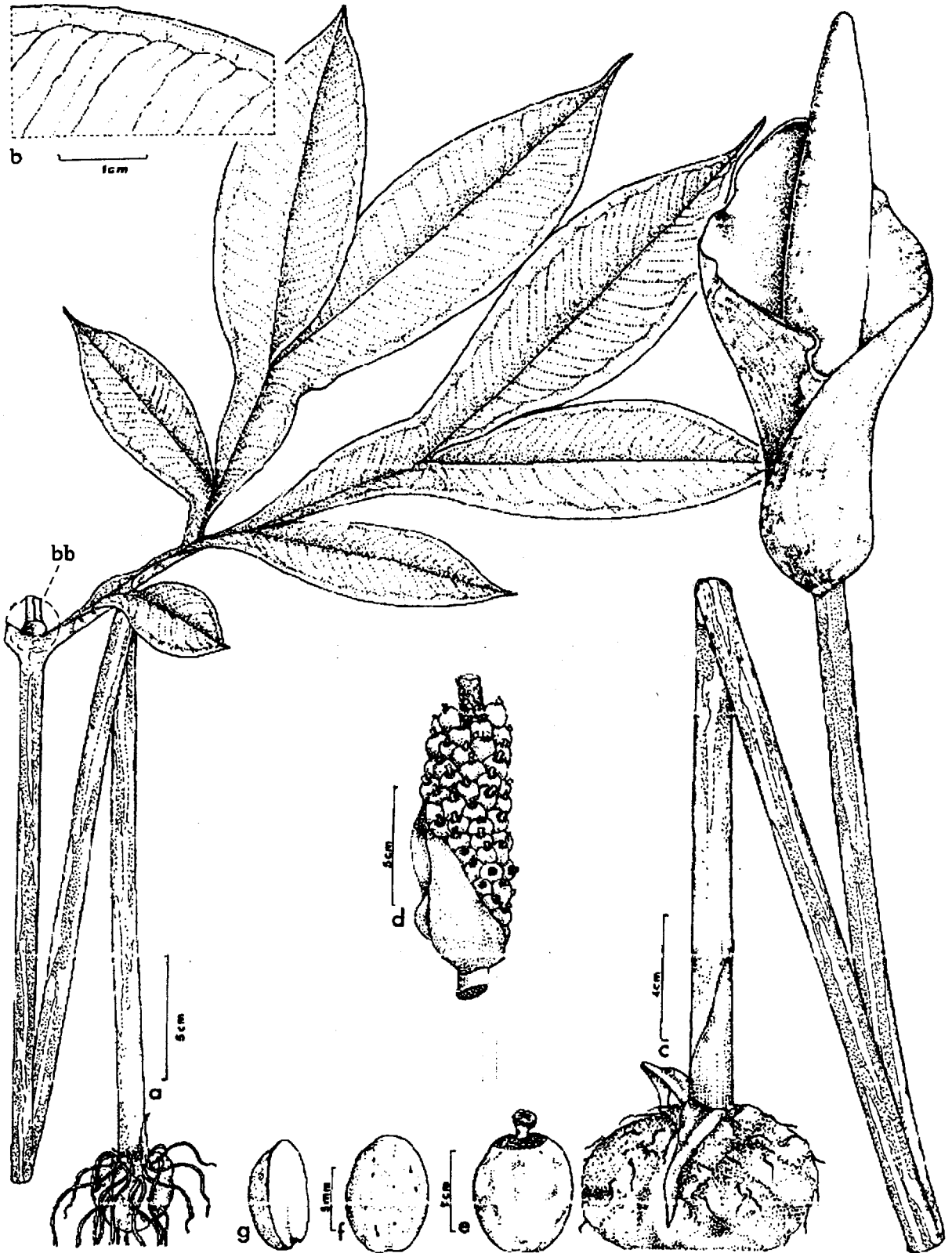


Fig. 15. *Amorphophallus bulbifer* (Sims) Bl.: a. Tuber with leaf; b. Marginal portion of a leaflet showing venation; c. Tuber with inflorescence; d. Infructescence; e. A single fruit; f & g. seeds; bb- bulbil.

tip rounded, minutely apiculate, ca. 3-20 cm long, 4-5.5 cm broad. Spathe ovate-obtuse, erect, open at the top, 18-22 cm long, 5.5-6 cm diam. at basal convolute tube (8-10 cm), pale green to greenish yellow outside with white to cream rounded blotches, pinkish at the base and paler at the top within. Spadix longer than the spathe, 20-24 cm long, with a stipe of ca. 0.5 cm long; female zone 2.5-3.0 cm long and 1.7-2.0 cm diam., male zone 4.0-4.5 cm long and 1.6-1.8 cm diam., followed by a terminal appendix of 12-14 cm long and 2.8-3.8 cm diam. Female flowers compactly arranged, ovary sub-globose, pale purplish in colour, 2.5-3 mm diam., ca. 1.5 mm high, 1-2 locular with one ovule in each locule; style short, 1-1.5 mm high, ca. 1.5 mm diam., pale yellowish in colour; stigma ca. 2.5 mm diam., 1 mm thickness, yellowish greenish in colour. Male flowers closely arranged, pale pinkish in colour, 2-2.5 cm high and ca. 2 mm broad., dehisces by apical slit. Spadix-appendix cylindric, elongate-oblong, buff coloured, smooth, spongy within. Fruits broadly ovoid, 1.0-1.4 cm long, 1.1-1.4 cm diam., style prominent in fruiting stage. Seeds 1-3, 0.8-0.9 cm long and 0.8-0.9 cm diam.

*Distribution:* India and Myanmar. In India - Kerala, Karnataka, Andhra Pradesh, Goa, Maharashtra, Madhya Pradesh, Orissa, Bihar, West Bengal, Sikkim, Assam, Arunachal Pradesh, Manipur, Meghalaya and Tripura.

*Flowering:* May - June.

*Fruiting:* July - November.

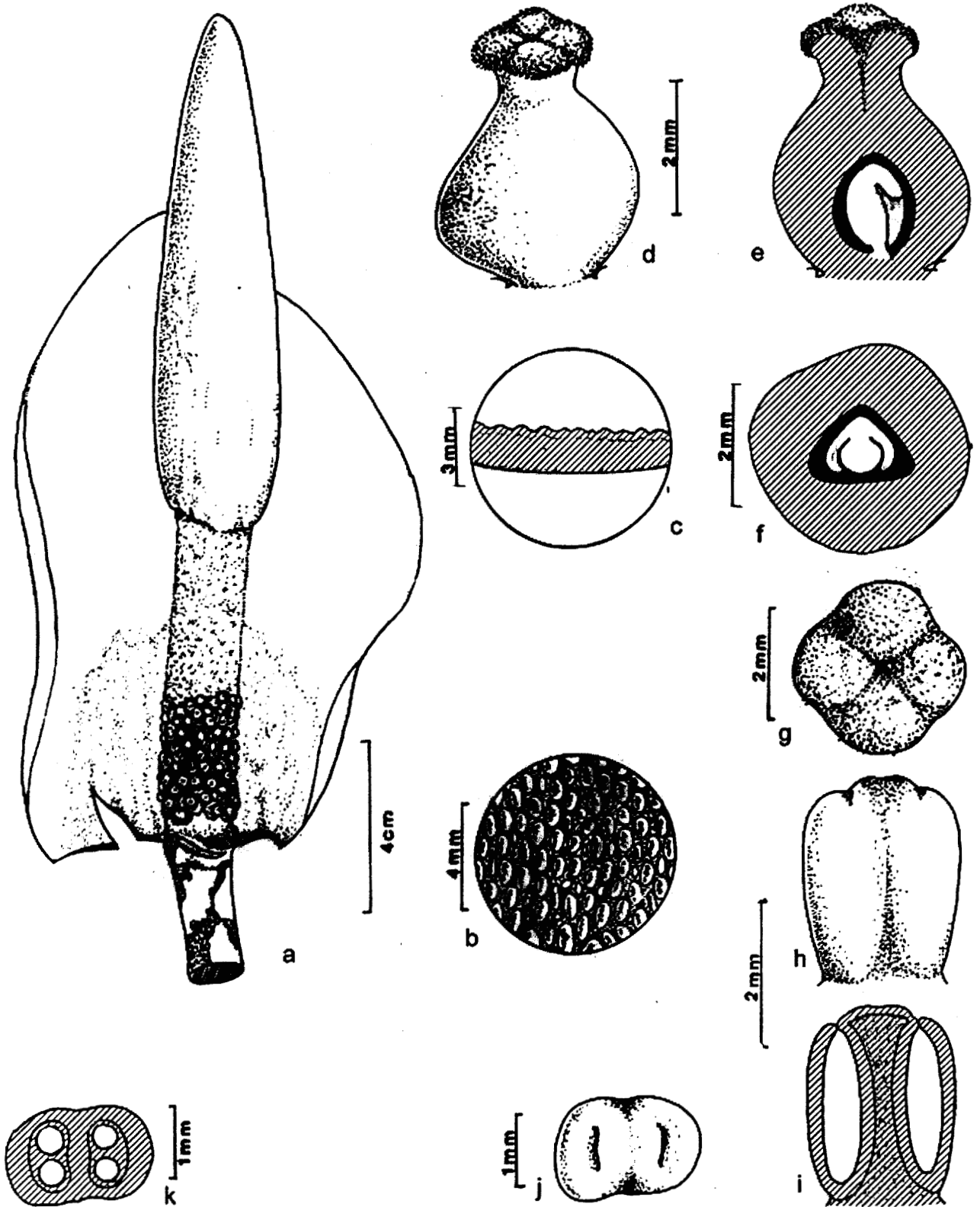


Fig. 16. *Amorphophallus bulbifer* (Sims) Bl.: a. Inflorescence – spathe cut open showing spadix; b. A small basal inside portion of the spathe – magnified; c. A small basal portion of spathe - c.s.; d. Female flower; e. Female flower – l.s.; f. Ovary – c.s.; g. Stigma – view from top; h. Male flower – view from broad side; i. Male flower – l.s.; j. Male flower – view from top showing the openings; k. Male flower – c.s.

*Notes:* *A. bulbifer* differ from other species in having an erect, ovate-obtuse spathe, without any constriction between tube and limb, and the presence of bulbils at the junction of the rachises and the axils of the rachis-branches. The other Indian species that produce bulbils are *A. bognerianus*, *A. carnosus*, *A. oncophyllus* and *A. keralensis*.

*A. bulbifer* closely resembles *A. bognerianus* but the latter differs by having the inflorescence with short peduncle and erect fornicate spathe limb. It resembles *A. oncophyllus*, but the latter differs in having a basal convolute ovoid tube and an upper expanded orbicular limb with a constriction in between the two.

*Specimens examined:* **Kerala State:** Malappuram Dist.: Nilambur ghat, July 1937, *Barnes s.n.* (leaf) (DD); Palghat Dist.: Manthampotti, 8<sup>th</sup> June 1979, *Sivadasan CU 21463* (leaf) (CALI); Nelliampathy, Karappara, 15<sup>th</sup> August 1997, *Abdul Jaleel & Bobby Thomas RIA 125* (leaf) (CALI). **Goa State:** Anveldem (Malem), 18<sup>th</sup> Sept. 1970, *Mudaliar Acc. No. 124346* (CAL); Dodamarg, 5<sup>th</sup> June 1997, *Abdul Jaleel & Bobby Thomas RIA 71* (infl.) (CALI). **Maharashtra State:** Poona, Ambowne, 6<sup>th</sup> Sept. 1964, *Venkata Reddi Acc. No. 99013* (leaf) (CAL); Poona, Lonavala, 10<sup>th</sup> Sept. 1964, *Venkata Reddi Acc. No. 99178* (leaf) (CAL); Bhiwandi range, Mohali RF, 20<sup>th</sup> July 1968. *Billore Acc. No. 116243* (leaf) (CAL); Tungar Hill, Mandi range, 22<sup>nd</sup> July 1968, *Billore Acc. No. 116331* (leaf & infl.) (CAL); Amboli Ghat, 8<sup>th</sup> June, 1997, *Abdul Jaleel & Bobby Thomas RIA 75* (infl.) (CALI); *Ibid.*, 14<sup>th</sup> July 1997, *Abdul Jaleel RIA 105* (leaf) (CALI); *Ibid.*, 12<sup>th</sup> November 1997, *Abdul Jaleel*



Plate V. *Amorphophallus bulbifer* (Sims) Bl.: a. Tuber; b. A portion of petiole showing mottlings; c. A portion of lamina – top view showing bulbils; d. Inflorescence; e. Inflorescence with spathe cut open showing spadix; f. Infructescence ; bb – bulbil.

*RIA 206* (infr.) (CALI). **Madhya Pradesh:** Bilaspur, Paranta Pendra, 14<sup>th</sup> July 1973, *Murti Acc. No. 19128* (BSA); Amodai, 29<sup>th</sup> Sept. 85, *S. Coll., Acc. No. 42442* (BSA). **Orissa:** K & J. Hill Dist., Barpani, May 1945, *Deka 22282* (leaf) (ASSAM); Koraput Dist., Jeypore Circle, Papadahandi, Sept. 1966, *Das 40* (leaf) (DD). **West Bengal:** Lower Bengal, 21<sup>st</sup> May 1896, *Davies s.n.* (infl.) (DD); Lower Bengal, 4<sup>th</sup> June 1896, *Prain Acc. No. 496661* (infl.) (CAL); Lower Bengal, Baltikari, 6<sup>th</sup> June 1896, *Dairy Acc. No. 496655* (infl.) (CAL); Shilpur, May 1897, *Prain Acc. No. 496651* (infl.) (CAL); Calcutta, May 1897, *Prain Acc. No. 496738* (infl.) (CAL); Andul, 27<sup>th</sup> July 1964, *Bennet Acc. No. 884* (leaf) (CAL); Lower Bengal, Chandermangoore *s.d.*, *Kurz, Acc. No. 496650* (leaf) (CAL). **Sikkim:** Sikkim, July 1894, *Pantling Acc. No. 496648* (infl.) (CAL); Sikkim, Munghoo, July 1894, *Pantling s.n.* (infl.) (DD). **Assam:** Assam, 6<sup>th</sup> May 1897, *Prain Acc. No. 496735* (infl.) (CAL); N. Kanrup Dist., *s.d. Panigrahi Acc. No. 9491* (CAL); Turatop, 12<sup>th</sup> Dec. 1960, *Panigrahi 22448* (infr.) (ASSAM); Dermukh Reserve forest, 16<sup>th</sup> May 1966, *Verma 46372* (infl.) (ASSAM). **Manipur:** Manipur, 4<sup>th</sup> Jan. 1994, *Sinha 10772* (BSHC). **Tripura:** Tripura, Shipaijak, 4<sup>th</sup> June 59, *S. Coll. 1792* (infl.) (CAL). "NEFA", Kamang Front Division, Khellong, 17<sup>th</sup> April 1964, *Sahni 5128* (infl.) (DD).

4. ***Amorphophallus carnosus*** Engl., *Pflanzenr.* IV 23C (48): 93. 1911; Srivast. & Rao in *Higher Pl. Ind. Subcont.* IV: 32. 1993; Sivad. & Jaleel, *Rheedea* 10(1): 63. 2000 (Figs. 17 & 18; Plate VI).



*Type:* India, Andamans, March 1899, *Prain's Collector, s.n.* (Holo-CAL).

Tubers sub-globose, 2.5-7.5 cm diam. and 2.0-6.0 cm thick in vegetative phase, ca. 20 cm diam. and 14 cm thick in reproductive phase; skin brownish in colour; roots numerous, 13-28 cm long and 0.2-0.3 cm thick, cream in colour. Petiole smooth, 70-208 cm long, 1.0-6.0 cm diam. at base, slightly tapering towards tip, dark greenish brown with few minute pale green mottlings, and paler towards the tip. Lamina 45-135 cm diam., leaflets sessile, ovate to elliptic lanceolate, tip long-acuminate, and twisted in mature leaflets, base unequal and decurrent on rachis; small leaflets 5-9 cm long and 2.6-6.0 cm broad, large leaflets 18.8-23 cm long and 7-8 cm broad; margin undulate, green above and paler below; veins depressed above and projected below, secondary laterals close, united below the margin by arches forming a sub-marginal collective vein. Bulbils produced at junction of rachises, pale greenish in colour, sub-spherical, ca. 0.5 cm diam. and 0.1 cm thickness.

Peduncle cylindrical, smooth, ca. 68 cm long, 4.0 cm diam., identical with petiole in colour and patterns of mottlings. Spathe ca. 39.5 cm long, ovate-oblong, differentiated into a basal convolute tube and an upper expanded limb; pale green outside with few minute white mottlings, and dark green minute mottlings towards the margin, basal portion with dark green dense mottlings; spathe-tube ca. 15.5 cm long and 7.5 cm diam. towards the base, rough within with irregular verrucogranulate protuberances; limb margin undulate, tip obtuse, purplish orange in

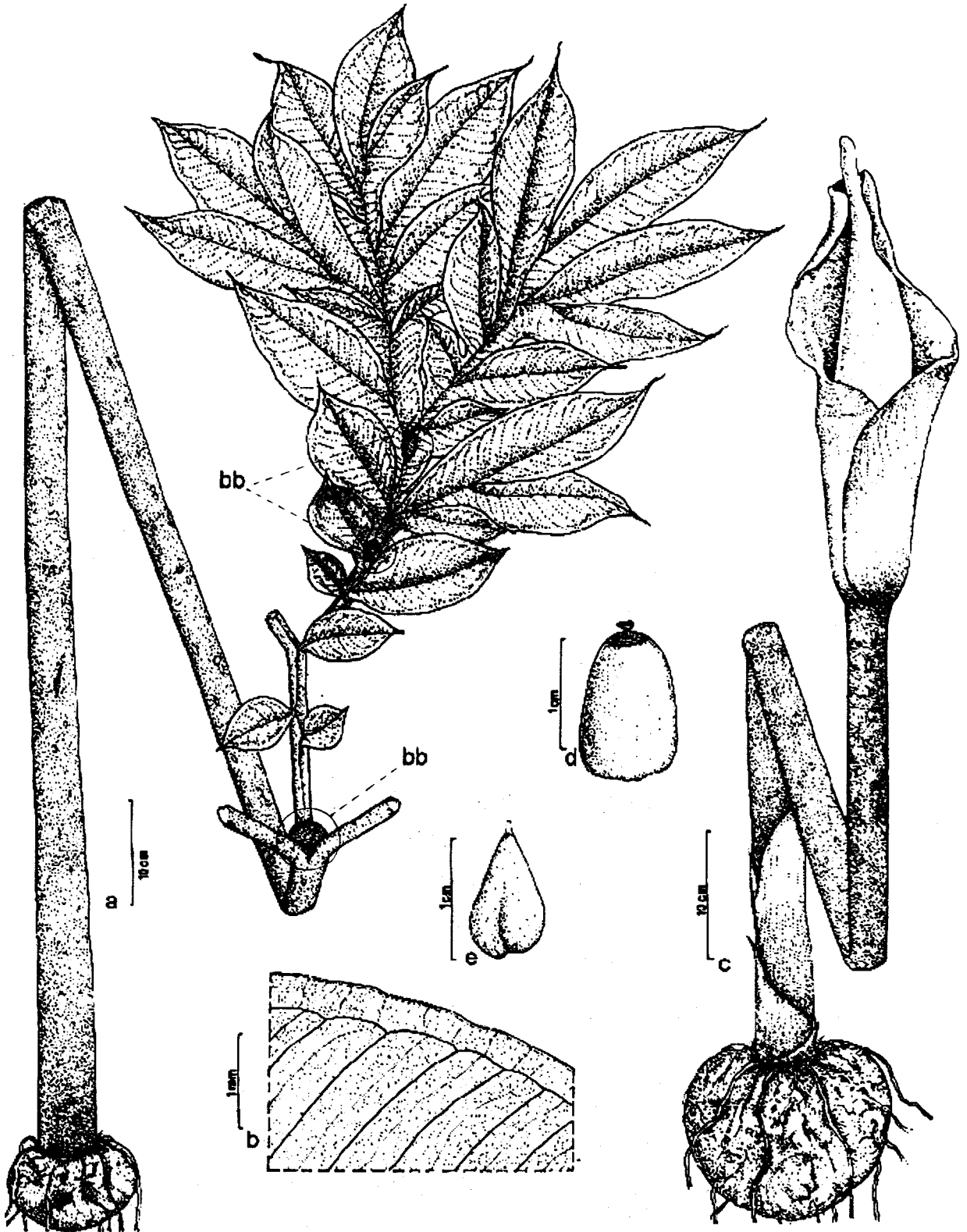


Fig. 17. *Amorphophallus carnosus* Engl.: a. Tuber with leaf; b. Marginal portion of a leaflet showing venation; c. Tuber with inflorescence; d. Single fruit; e. Single seed; bb - bulbil.

colour inside, reddish pink above with small ovate yellow mottlings, mottlings sparse towards the margin; closely oriented vertical veins prominent on outer surface of the spathe. Spadix slightly longer than the spathe, sessile, ca. 41 cm long, differentiated into a basal portion of female zone, followed by male zone, and an apical appendix; female zone ca. 9.0 cm long, basally 4.5 cm diam. and 3.7 cm diam. at top; male zone about half the length of female zone, ca. 5.5 cm long, 3.3 cm diam. at base and 4.3 cm diam. at top; spadix-appendix sterile, ca. 28 cm long, ca. 7 cm diam. at base and tapers towards the tip. Female flowers closely and sub-spirally arranged, the arrangement is irregular towards the base; each flower ca. 4 mm high, ovary sub-globose, ca. 1.5 mm high and ca. 3 mm diam., reddish, 2-locular, each locule with a single basal anatropous ovule; style very short, ca. 1.5 mm long, 1.5 mm diam., pale red in colour; stigma 2 or 4-lobed, 2 mm diam., yellowish in colour. Male flowers closely arranged, sessile, each ca. 2 mm high, 1.5 mm broad, inconspicuously 2-lobed, yellowish in colour. Spadix-appendix elongate-conical, cream-coloured, slightly rough with minute depressions at base, and smooth towards the top. Fruit ovoid, elliptical, 1.2-1.5 cm long, 0.8-1.0 cm diam. Seeds 1-2 each, 0.9-1.1 cm long and 0.5-0.6 cm diam.

*Flowering:* May – June.

*Fruiting:* September – October.

*Distribution:* So far known to occur only in Andaman islands, India.

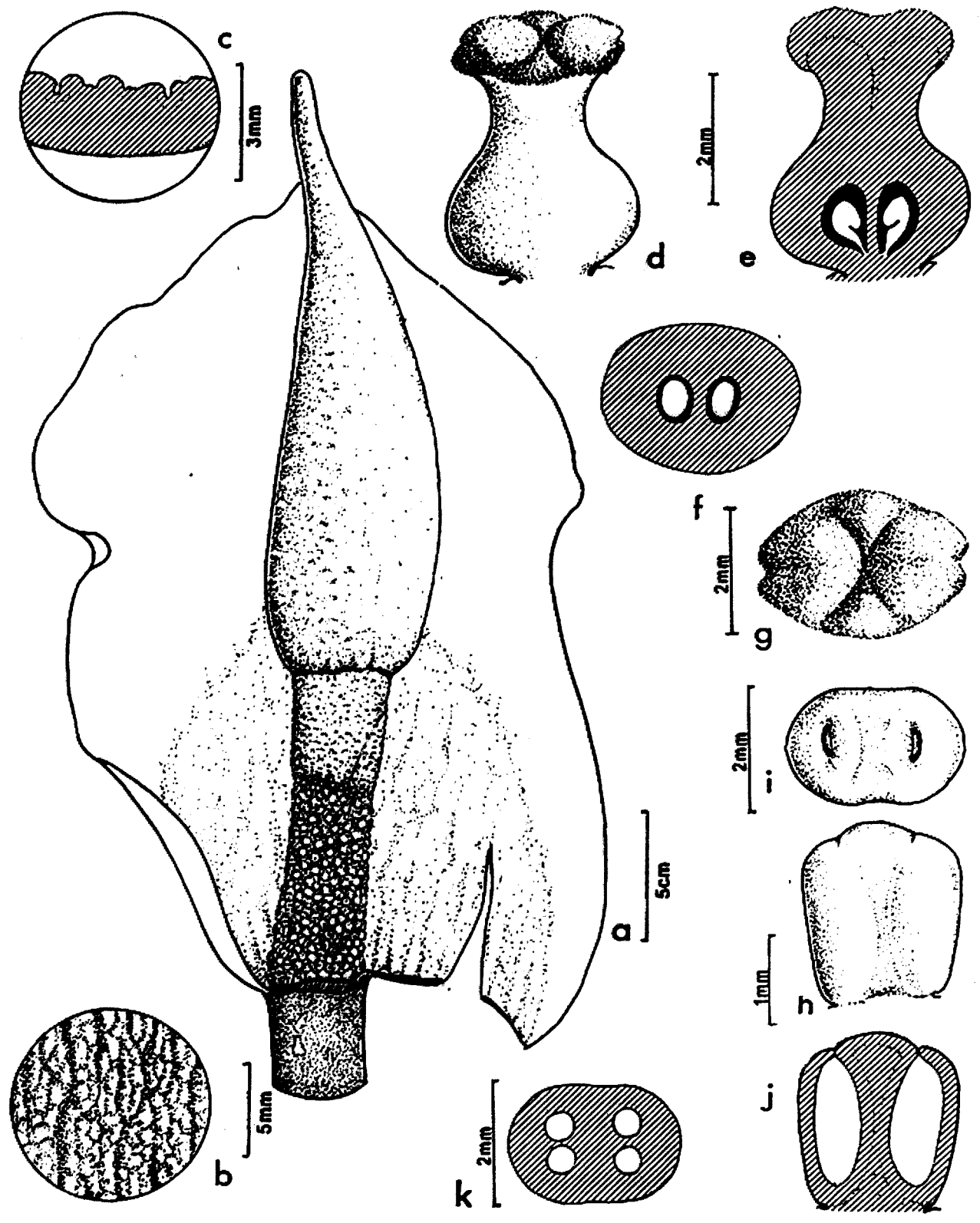


Fig. 18. *Amorphophallus carnosus* Engl.: a. Inflorescence - spathe cut open showing spadix; b. A small basal inside portion of the spathe - magnified; c. A small basal portion of spathe - c.s.; d. Female flower; e. Female flower - l.s; f. Ovary - c.s; g. Stigma - view from top; h. Male flower - view from broad side; i. Male flower - view from top showing the openings; j. Male flower - l.s; k. Male flower - c.s.

*Notes:* *Amorphophallus carnosus* Engl., a little known rare and endemic species has been rediscovered from Andaman after it was first collected by Prain's collector in the year 1899. The protologue contained only a scanty and incomplete description, and Srivastava and Rao (1993) in their account on aroids of Andaman and Nicobar Islands had stated that no subsequent collections of the species are available from the islands. After over 100 years, during May 1999 the species was rediscovered and collected both in flowering and vegetative from its type locality – Andaman islands.

*A. carnosus* is quite remarkable in having a long erect spathe of about 39.5 cm long with prominently pale green colour outside and purplish orange colour at base, and reddish pink above within.

It resembles *A. oncophyllus*, but differs by having a large erect pale green spathe, male zone about half the length of the female zone and an elongate conical spadix-appendix.

*Specimens examined:* **South Andaman:** Ograbraj, 9th May 1999, *Abdul Jaleel RIA 335* (infl.) (CALI); *Ibid.*, 9<sup>th</sup> May 1999, *Abdul Jaleel RIA 336* (leaf) (CALI); *Ibid.*, 31<sup>st</sup> May 1999, *Abdul Jaleel RIA 369* (leaf) (CALI); **Kerala state,** Calicut University Botanical Garden, 20<sup>th</sup> October 2000, *Abdul Jaleel RIA 387* (leaf) (CALI) (Originally collected from Ograbraj, South Andaman and introduced in the Calicut University Botanical Garden).

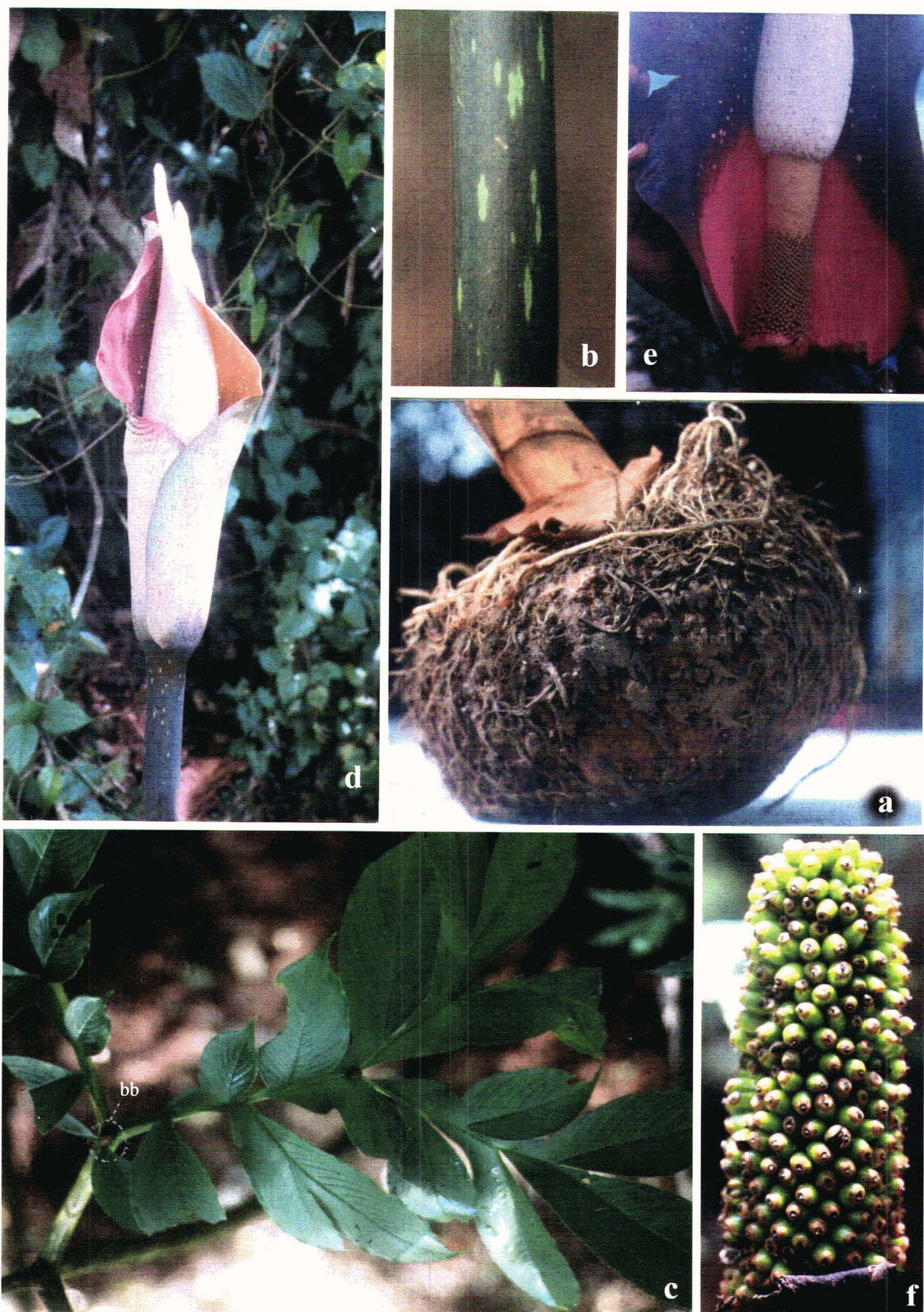


Plate VI. *Amorphophallus carnosus* Engl.: a. Tuber; b. A portion of petiole showing mottlings; c. A portion of lamina – top view showing bulbils; d. Inflorescence; e. Spathe cut open showing fertile portion of spadix and base of spadix-appendix; f. Infructescence; bb – bulbil.

**5. *Amorphophallus commutatus*** (Schott) Engl. in DC., Monogr. Phan. 2: 319. 1879; Hook. f., Fl. Brit. India 6: 515. 1893; Engl., Pflanzenr. IV. 23C (48): 95. 1911; Rama Rao, Fl. Pl. Travancore 426. 1914; Blatt., J. Bombay Nat. Hist. Soc. 35: 27, t. 7. 1931; Santapau, Rec. Bot. Sur. India (Fl. Khandala), 16(1): 291. 1953; Cooke, Fl. Pres. Bombay, repr. ed. 3: 337. 1958; Nairne, Fl. Pl. W. India 363. 1976; Shah, Fl. Gujarat 2: 697. 1978; Bole & Pathak, Fl. Saurashtra 3: 338. 1988; Kamble & Pradhan, Fl. Akola Dist. 233. 1988; Kulk., Fl. Sindhudurg 466. 1988; Karth., Jain, Nayar & Sanjappa, Fl. Ind. Enum. Monocot. 6. 1989; Almeida, Fl. Savantwadi 53. 1990; Lakshmin. & Sharma, Fl. Nasik Dist. 448. 1991; Kothari & Moorthy, Fl. Raigad Dist. 420. 1993; Shetty & Singh, Fl. Rajasthan 3: 69. 1993; Samvatsar, Fl. W. Tribal Madhya Pradesh 295. 1996; Sharma, Karth. & Singh, Fl. Maharashtra Monocot. 210. 1996; Sasi. & Sivar., Fl. Pl. Thrissur For. 483. 1996; Sivar. & Mathew, Fl. Nilambur 750. 1996; Abraham, Fl. Trombay 108. 1997; Sivad. in Manoharan, Biju, Nayar & Easa, Silent Valley – Whisp. Reas. 228. 1999.

*Conophallus commutatus* Schott, Bonplandia 7: 28. 1859, Prodr. Syst. Aroid. 128.

1860.

*Dracontium polyphyllum* Graham, Cat. Bombay Pl. 229. 1839, non L., 1753.

*Pythonium wallichianum* Kirt., J. Bombay Nat. Hist. Soc. 7: 312. 1893, non Schott,

1832.

*Amorphophallus sylvaticus* Dalz. & Gibs., Bombay Fl. 289. 1861, non Kunth, 1850.

*Type:* Bombay (no date), *Anonymous (Dalzell?)*, *s.n.* (K).

Tubers oblate-spherical, to ca. 16 cm diam. and ca. 10 cm thick, producing short cylindrical offsets, skin pale brown. Petiole 50-100 cm long, to 2 cm diam., pale green to pale brownish background with numerous elongate to irregular brown to dark brown spots. Lamina to ca. 100 cm diam., leaflets elliptic, elongate-elliptic or more or less oblong, base long decurrent on rachis, tip acuminate. Inflorescence long or short peduncled, peduncle resembles petiole in colour. Spathe erect, ovate-oblong or narrowly elongate triangular, acute or acuminate, tube and limb separated by a shallow constriction, greenish brown or brownish green outside, dark purplish inside with short rounded bumps, rarely with silvery hairs at base. Spadix usually longer than spathe, sessile or stipitate.

*Distribution:* Kerala, Karnataka, Tamil Nadu, Goa, Maharashtra, Gujarat, Madhya Pradesh and Rajasthan.

#### Key to the varieties

1. Peduncle short, 8-10 cm long; tubular portion of the spathe slightly compressed obovoid; male zone cylindrical ..... var. *anmodensis*



NB 2962

TH

584.64

ABD/R



1. Peduncle long, 20-95 cm long; tubular portion of the spathe slightly obovoid or cylindrical; male zone fusiform or obconic.
2. Spathe tube cylindrical, purplish brown verrucose with silvery hairs within ..... var. *commutatus*
2. Spathe tube slightly compressed obovoid, purplish with blunt verrucations within ..... var. *wayanadensis*

**5a. Amorphophallus commutatus var. commutatus** (Figs. 19 & 20; Plate VII).

*Type:* Same as that of the species. (Bombay (no date), *Anonymous (Dalzell?)*, s. n. (K).

Tubers sub-spherical, ca. 6-14 cm in diam. and 4.5-5.5 cm in thickness, with 4-5 rhizomatous offsets of each ca. 5-10 cm long and 0.7-0.9 cm diam. Petiole 40-65 cm long, 0.9-1.2 cm diam. at base, and tapering towards the tip; greenish yellow with dark green patches. Leaflets ovate-acuminate, 8-13 cm long, 3.5-5.0 cm broad, base long decurrent on rachis, upper side dark green, lower side pale green.

Peduncle cylindrical, 20-40 cm long, 0.8-1.1 cm in diam. at base and tapering towards the tip, colour same as petiole, covered by 4-5 cataphylls; each cataphyll ca. 3.5-14 cm long and 2.5-7.0 cm wide. Spathe erect, ovate acuminate, 10-23 cm long, 3.5-5.5 cm broad, basal portion convolute forming an ovoid tube of 2.5-5 cm long, limb expanded, erect; greenish brown with white mottles and dark pinkish

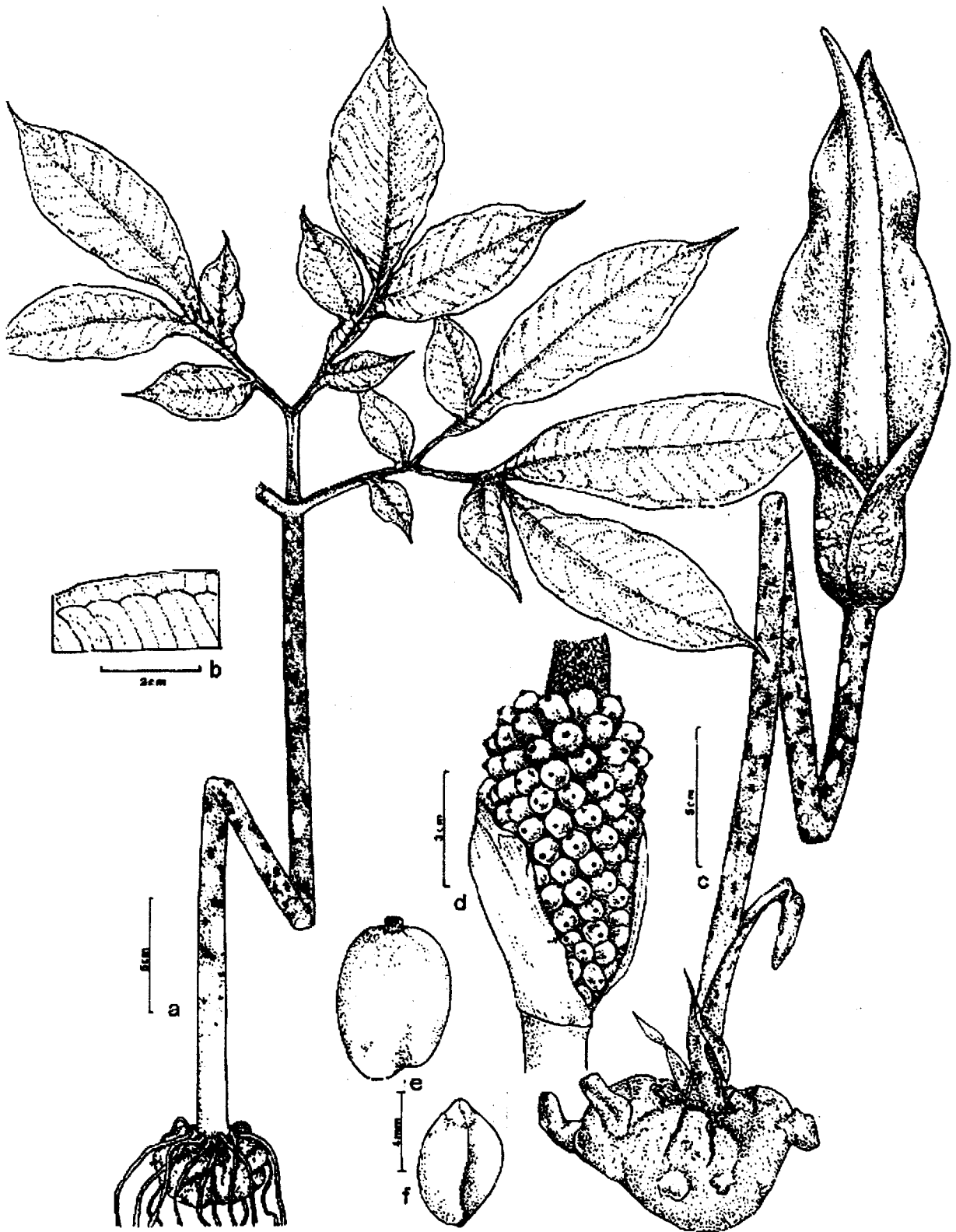


Fig. 19. *Amorphophallus commutatus* (Schott) Engl. var. *commutatus*: a. Tuber with leaf; b. Marginal portion of a leaflet showing venation; c. Tuber with inflorescence; d. Infructescence; e. Single fruit; f. Single seed.

towards the margin, inner portion at base of the spathe dark purplish brown, verrucose with small unicellular short silvery hairs. Spadix shortly stipitate to ca. 0.5 cm, 8-20 cm long with basal pistillate portion 1.8-2.0 cm long, followed by a staminate portion ca. 2.8-3 cm long, and terminal sterile appendix ca. 10-12 cm long. Female flowers sub-spirally arranged; each flower with ovary ca. 1.5 mm high and 1.25 mm diam., pale green and purplish at top, unilocular with basal anatropous ovule; style very short, purplish, ca. 0.25 mm long; stigma disciform, pale orange in colour. Male flowers densely arranged, each ca. 2.0 mm high and 1.25 mm broad, pale pinkish. Spadix-appendix elongate-narrowly conoidal, 10-12 cm long, 0.8-1.2 cm at base, tapering to the tip, smooth or with inconspicuous rhomboidal projection at base, pale yellowish or rarely light reddish brown in colour. Fruits sub-globose to ellipsoid, reddish, ca. 0.8-0.9 cm long and 0.5-0.6 cm diam. Seeds 0.7-0.8 cm long and 0.4-0.5 cm diam.

*Flowering:* May – June.

*Fruiting:* July – August.

*Distribution:* Karnataka, Goa and Maharashtra.

*Notes:* *Amorphophallus commutatus* var. *commutatus* resembles the other two new varieties viz., *A. commutatus* var. *anmodensis* and var. *wayanadensis* in general appearance of the spathe and spadix. But it differs from the latter two in having unicellular silvery hairs inside the tube of the spathe; male zone obconical, more

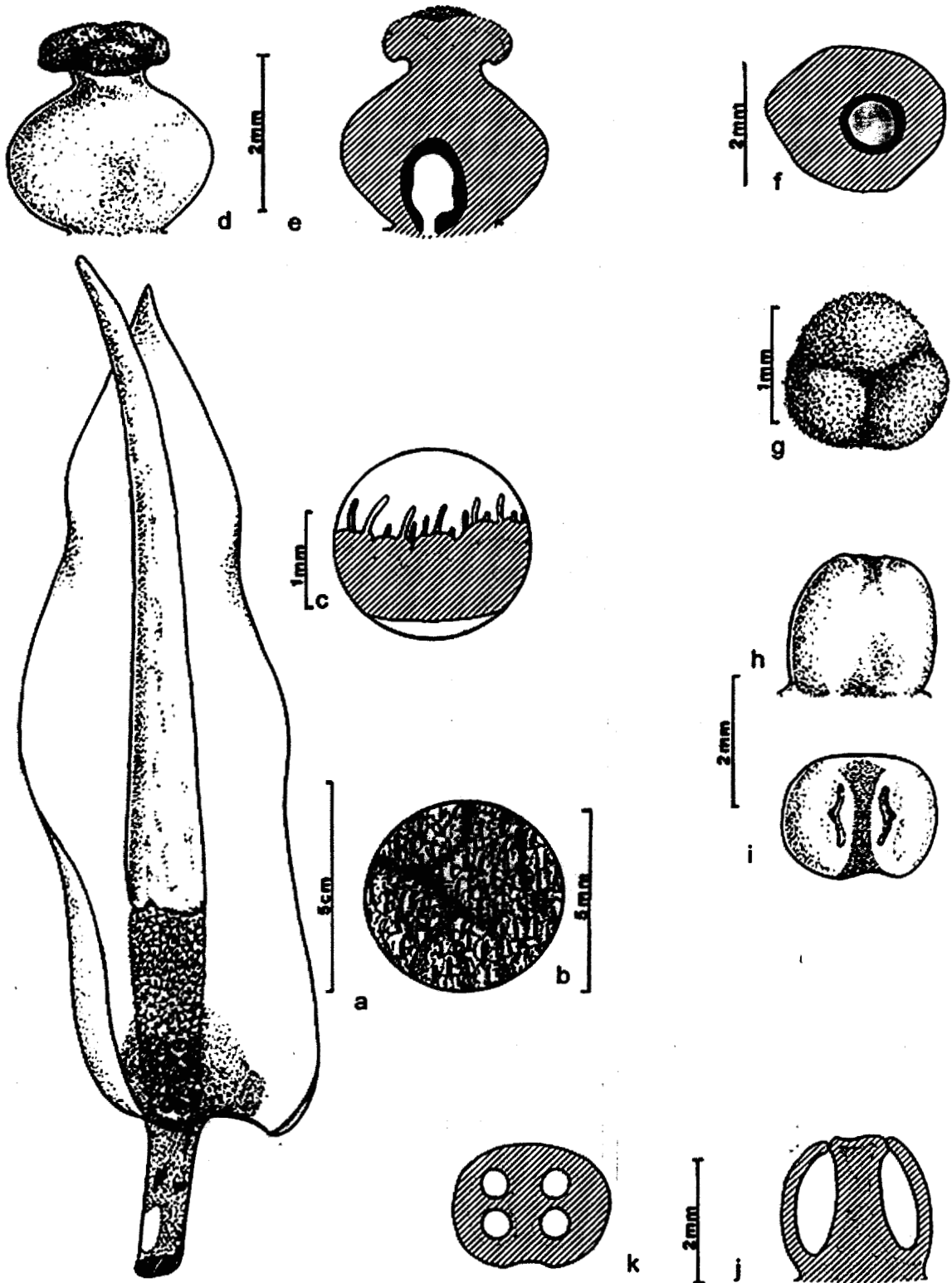


Fig. 20. *Amorphophallus commutatus* (Schott) Engl. var. *commutatus*: a. Inflorescence – spathe cut open showing the spadix; b. A small basal inside portion of the spathe – magnified; c. A small basal portion of the spathe – c.s.; d. Female flower; e. Female flower – l.s.; f. Ovary – c.s.; g. Stigma – view from top; h. Male flower – view from broad side; i. Male flower – view from top showing openings of thecae; j. Male flower – l.s.; k. Male flower – c.s.

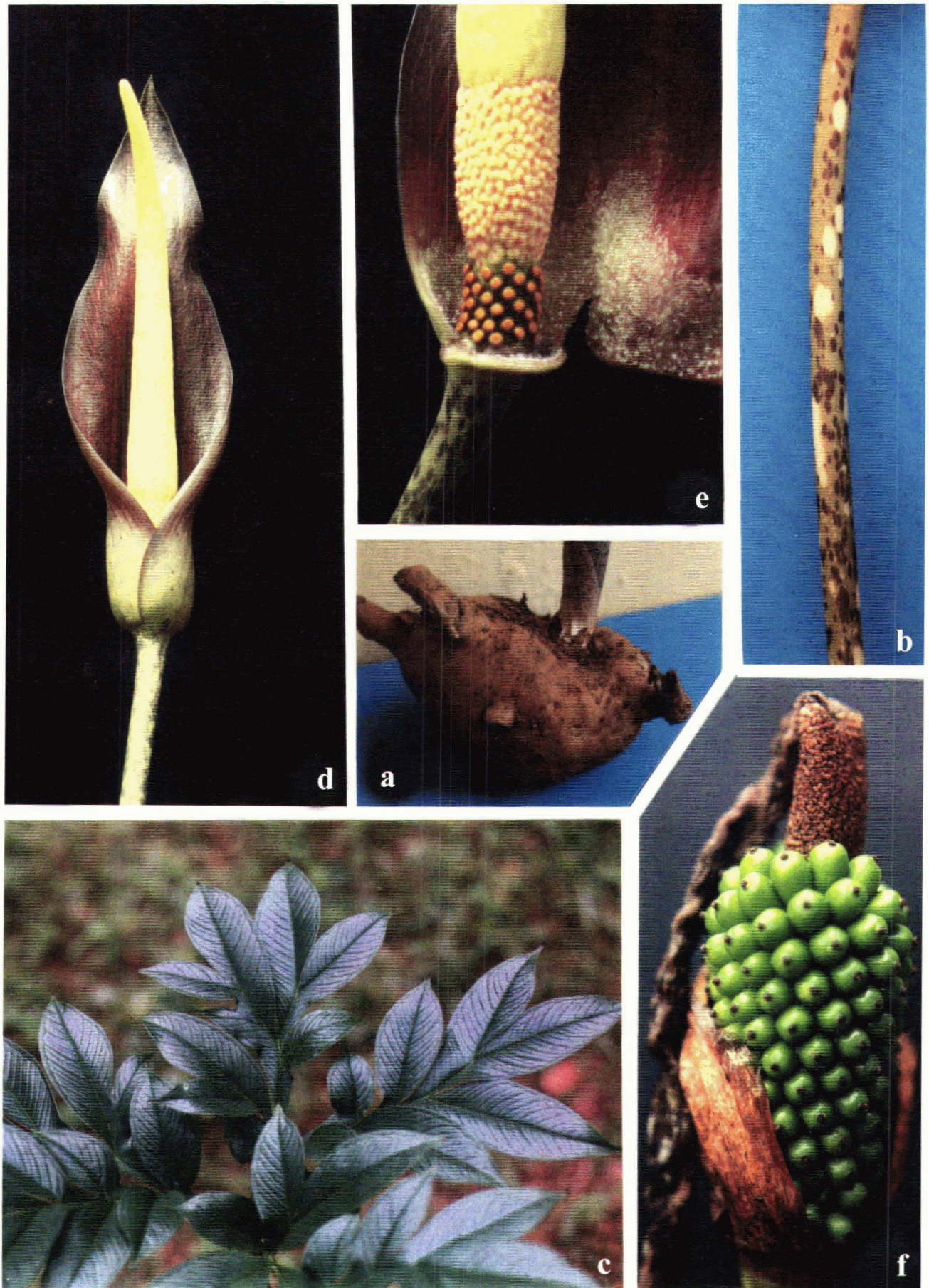


Plate VII. *Amorphophallus commutatus* (Schott) Engl. var. *commutatus*: a. Tuber; b. A portion of petiole showing mottlings; c. A portion of lamina – top view; d. Inflorescence; e. Inflorescence with spathe cut open showing fertile portion of spadix and base of spadix appendix; f. Infructescence.

than twice or more or less thrice the length of female zone and purplish colour at the upper portion of the ovary and the short style.

*Specimens examined:* **Karnataka State:** Uduppi, 24<sup>th</sup> May 1997, *Abdul Jaleel RIA 56* (infl.) (CALI); *Ibid.*, 25<sup>th</sup> May 1997, *Abdul Jaleel RIA 57* (infl.) (CALI); *Ibid.*, 10<sup>th</sup> July 1997, *Abdul Jaleel RIA 103* (infr.) (CALI); *Ibid.*, 3<sup>rd</sup> July 1999, *Abdul Jaleel RIA 372* (leaf) (CALI). **Goa State:** Anmod Ghat, 4<sup>th</sup> June 1997, *Abdul Jaleel RIA 67* (CALI). **Maharashtra State:** Poona, Ambauni Taluk, near Forest Rest House, 6<sup>th</sup> Sept. 1964, *Venkata Reddi 99014* (leaf) (CAL); Bhivadikkund Hill Range, Junnar, 30<sup>th</sup> Sept. 1965, *Hemadri 107505* (leaf) (CAL); Khurvada R.F., Bodhi Range, 11<sup>th</sup> Jan. 1968, *Billore* Acc. No. 113449 (infl.) (CAL); Kolhapur, Amba Ghat, 7<sup>th</sup> June 1997, *Abdul Jaleel RIA 74* (infl.) (CALI).

**5b. *Amorphophallus commutatus* var. *anmodensis*** Sivad. *et* Jaleel, var. nov. (in ed.) (Figs. 21 & 22; Plate VIII).

*Type:* India, Goa, Anmod Ghat, 4<sup>th</sup> June 1997, *Abdul Jaleel & Bobby Thomas RIA 67* (Holo – K).

Tubers sub-globose, 8-10 cm diam. and 5-7 cm thick, produce rhizomatous offsets, 2-3 in number, each ca. 4-5 cm long and 0.8-1.2 cm diam. Petiole 50-52.5 cm long and ca. 1.5 cm diam. at base and tapering towards the tip, smooth, blackish brown with white mottlings, and paler towards the tip. Lamina 50-52 cm. in diam., leaflets ovate acuminate to oblong acuminate, smaller leaflets 5-8 cm long and

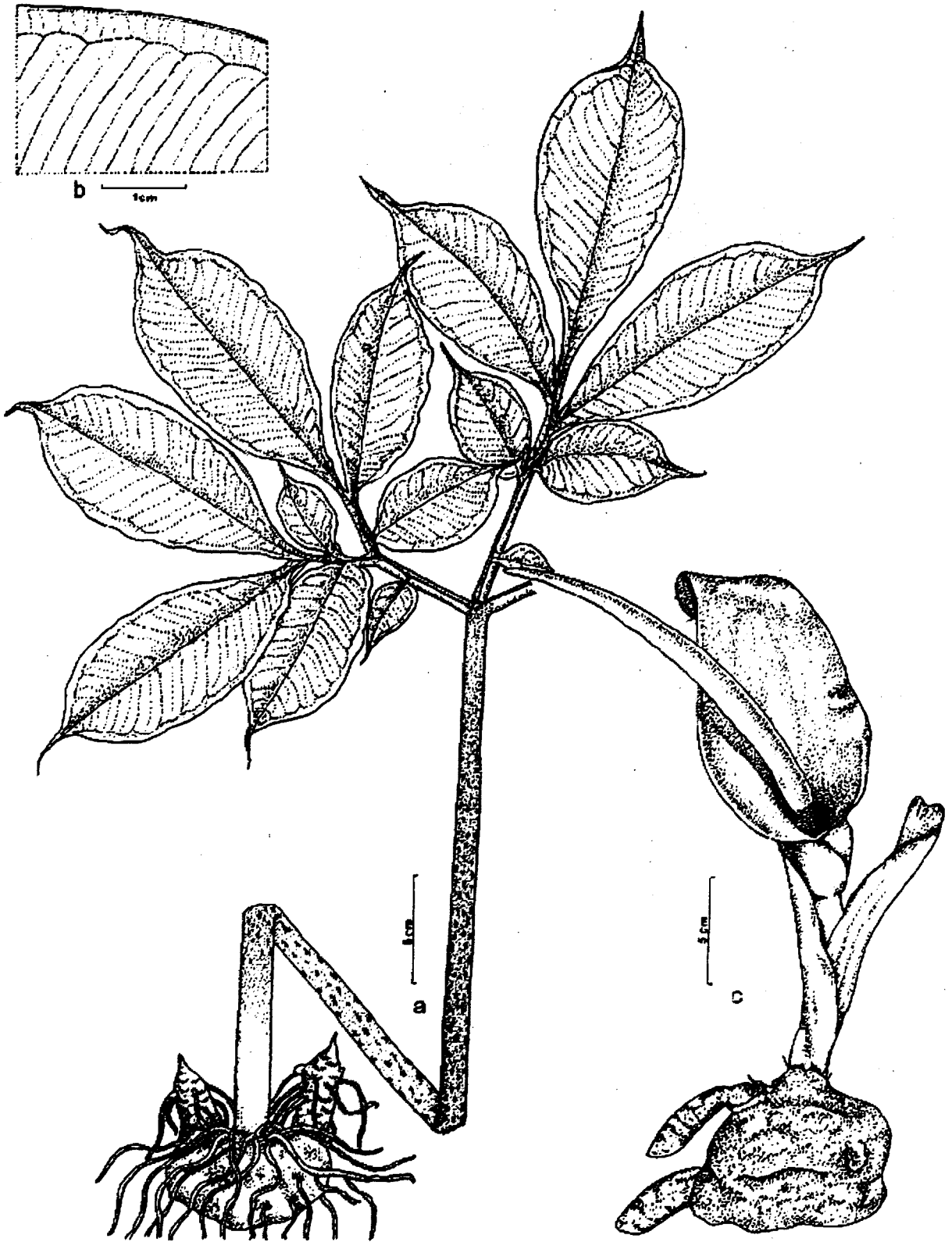


Fig. 21. *Amorphophallus commutatus* (Schott) Engl. var. *anmodensis* Sivad. et Jaleel: a. Tuber with leaf; b. Marginal portion of a leaflet showing venation; c. Tuber with inflorescence.

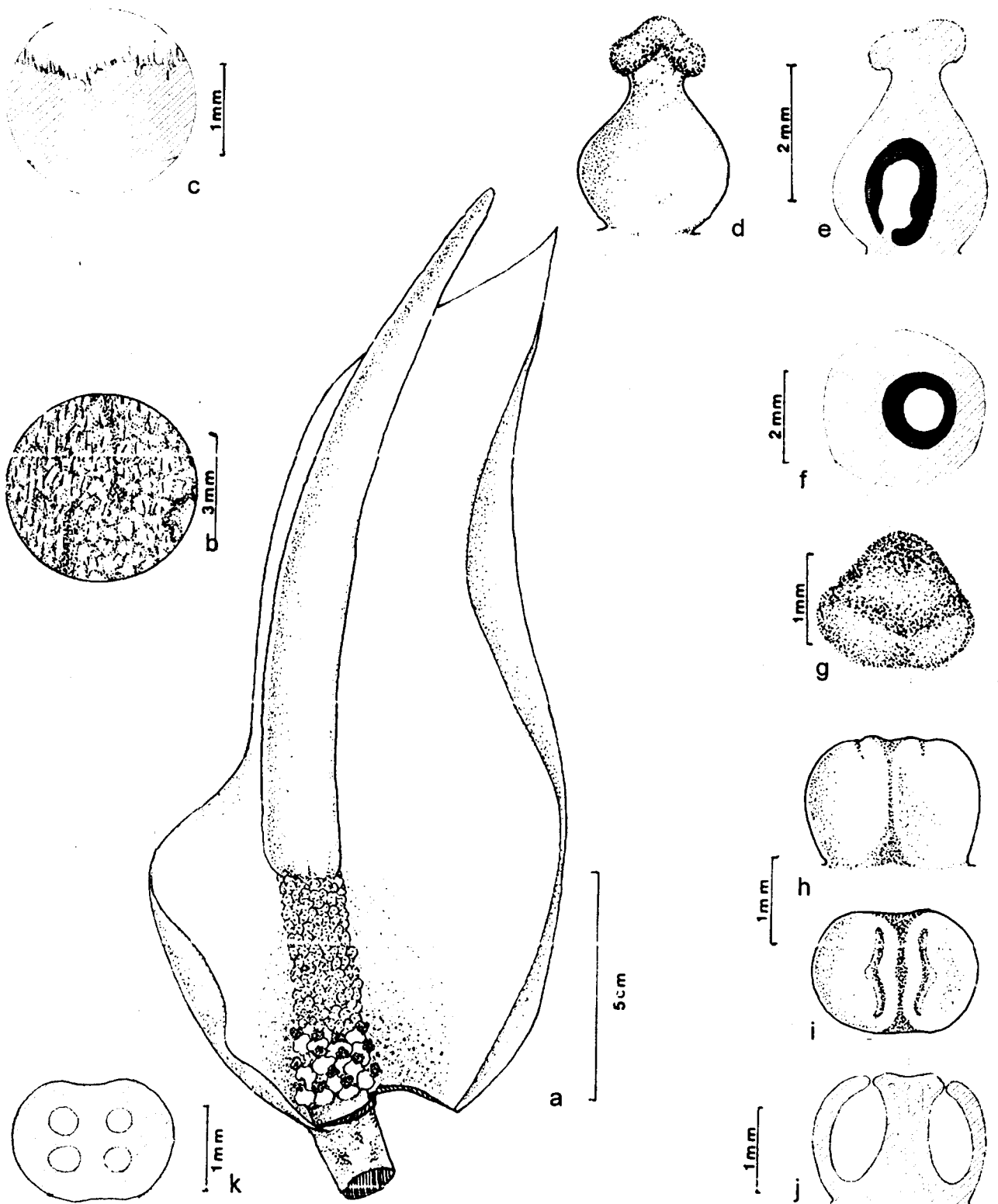


Fig. 22. *Amorphophallus commutatus* (Schott) Engl. var. *anmodensis* Sivad. et Jaleel: a. Inflorescence – spathe cut open showing spadix; b. A small basal inside portion of the spathe – magnified; c. A small basal portion of the spathe – c.s.; d. Female flower; e. Female flower – l.s.; f. Ovary – c.s.; g. Stigma – view from top; h. Male flower – view from broad side; i. Male flower – view from top showing openings of the thecae; j. Male flower – l.s.; k. Male flower – c.s.



3-3.5 cm broad, bigger ones 14.5-16.5 cm long and 6-6.5 cm broad, slightly undulate, dark green above and paler below.

Peduncle 8-10 cm long and 0.7-0.9 cm diam., smooth, pale yellowish in colour, covered by about 4 cataphylls, each cataphyll 2.5-15 cm long and 1.5-5.0 cm broad, tip acute, cream coloured. Spathe ovate-acute, 17-18 cm long and 4-5 cm broad, basal tube slightly compressed obovoid, ca. 2.5-3 cm long, limb expanded, erect, pale yellowish outside and pale brownish towards the margin, inner side slightly purplish and pale yellow towards the base, verrucose with unicellular hairs within. Spadix sessile, 23-25 cm long, female zone ca. 1.5 cm long, male zone cylindrical, ca. 3 cm long, appendix elongate, narrowly conical with rounded apex, 18-20 cm long, 1.3-1.5 cm diam. at base and tapering towards the tip, pale-yellowish brown to dark purplish brown in colour. Female flowers ca. 2.5 mm long, ovary sub-globose, ca. 1.5 mm high, 2 mm diam., pale greenish, unilocular with a basal anatropous ovule; style very short; stigma inconspicuously 3-lobed with a bigger medium lobe, ca. 1.5 mm diam., narrower than the ovary, obliquely oriented towards the axis and with a notch at the abaxial side, yellowish orange in colour. Male flowers pale yellowish, densely arranged, sessile; each ca. 1.25 mm high and 1.25 mm broad, inconspicuously 2-lobed; dehiscence by apical slit-like pores. Infructescence not observed.

*Flowering:* June.

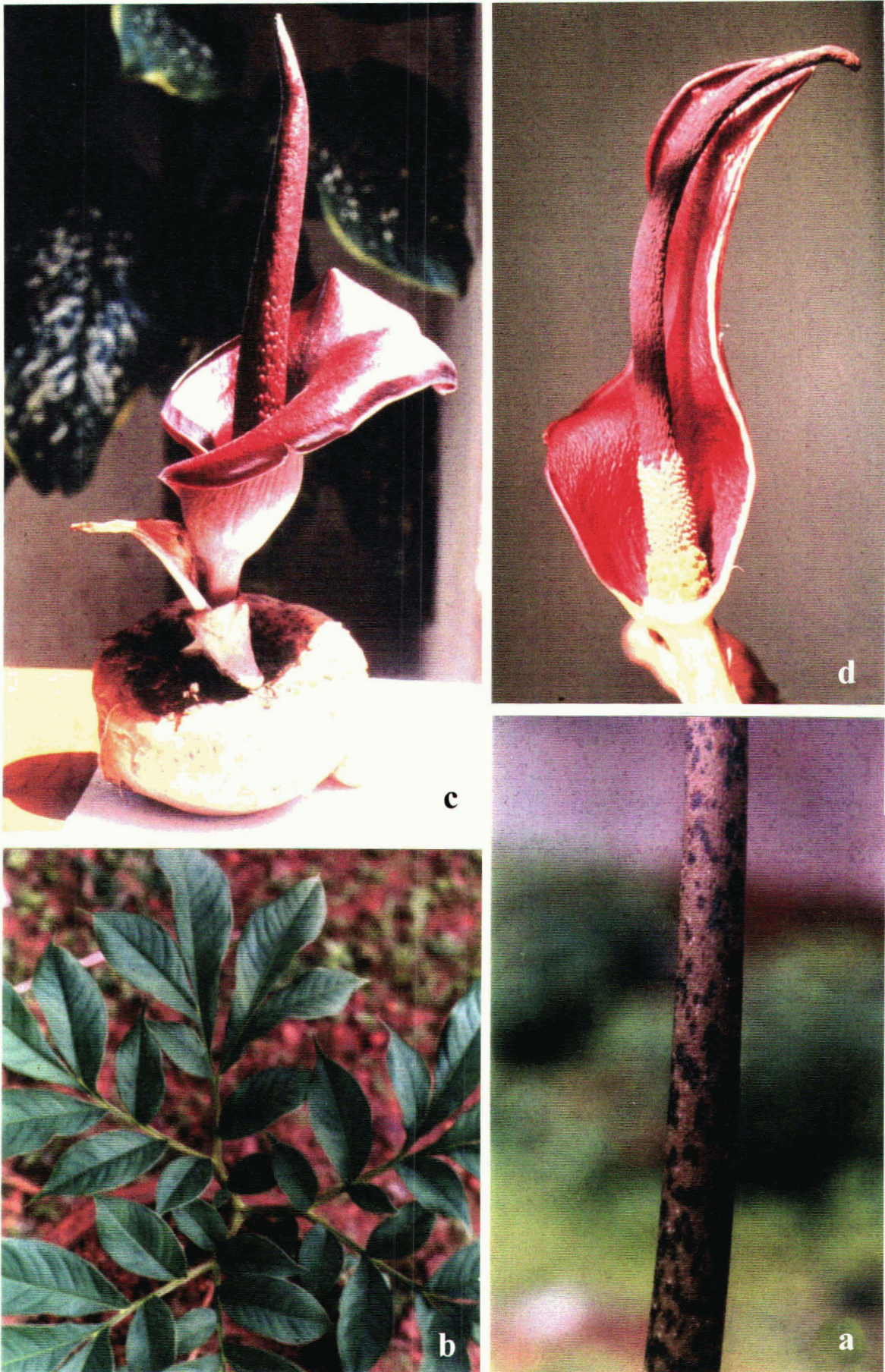


Plate VIII. *Amorphophallus commutatus* (Schott) Engl. var. *anmodensis* Sivad. et Jaleel:  
 a. A portion of petiole showing mottlings; b. Lamina - view from top; c. Tuber with  
 Inflorescence ; d. Slightly withered inflorescence - spathe cut open showing spadix.

*Distribution:* A narrow endemic known to occur only in Anmod Ghat, Goa state.

*Etymology:* The specific epithet is indicative of the name of the type locality – Anmod Ghat in Goa.

*Notes:* *Amorphophallus commutatus* var. *anmodensis* resembles other varieties viz. var. *commutatus* and var. *wayanadensis* in its general appearance of spathe and spadix, but differs from latter two by having a short peduncle of ca. 8-10 cm long, male zone cylindrical and less than twice the length of the female zone, and the spathe-tube slightly purplish and verrucose with unicellular hairs at the base within.

*Specimens examined:* Goa: Anmod Ghat, 4th June 1997, *Abdul Jaleel RIA 68* (infl.) (CALI); *Ibid.*, 25th August 1998, *Abdul Jaleel RIA 322* (leaf) (CALI).

**5c. *Amorphophallus commutatus* var. *wayanadensis* Sivad. et Jaleel, var. nov.** (ined.) (Figs. 23 & 24; Plate IX).

*Type:* India, Kerala, Wayanad Ghat, 29<sup>th</sup> April 1997, *Abdul Jaleel & Bobby Thomas RIA 62* (Holo – K).

Tubers sub-globose, 10-16 cm diam. and 4.5-6.5 cm thick; skin pale brown in colour; roots numerous. Petiole cylindrical, smooth, light greenish with whitish mottles and dark green dots, extreme base bluish green. Lamina 70-90 cm in diam., leaflets ovate-oblong, acuminate, base cuneate, decurrent on the rachis, smaller leaflets ca. 4.5-8 cm long and 2.2-4.0 cm broad, bigger ones 12-18 cm long and

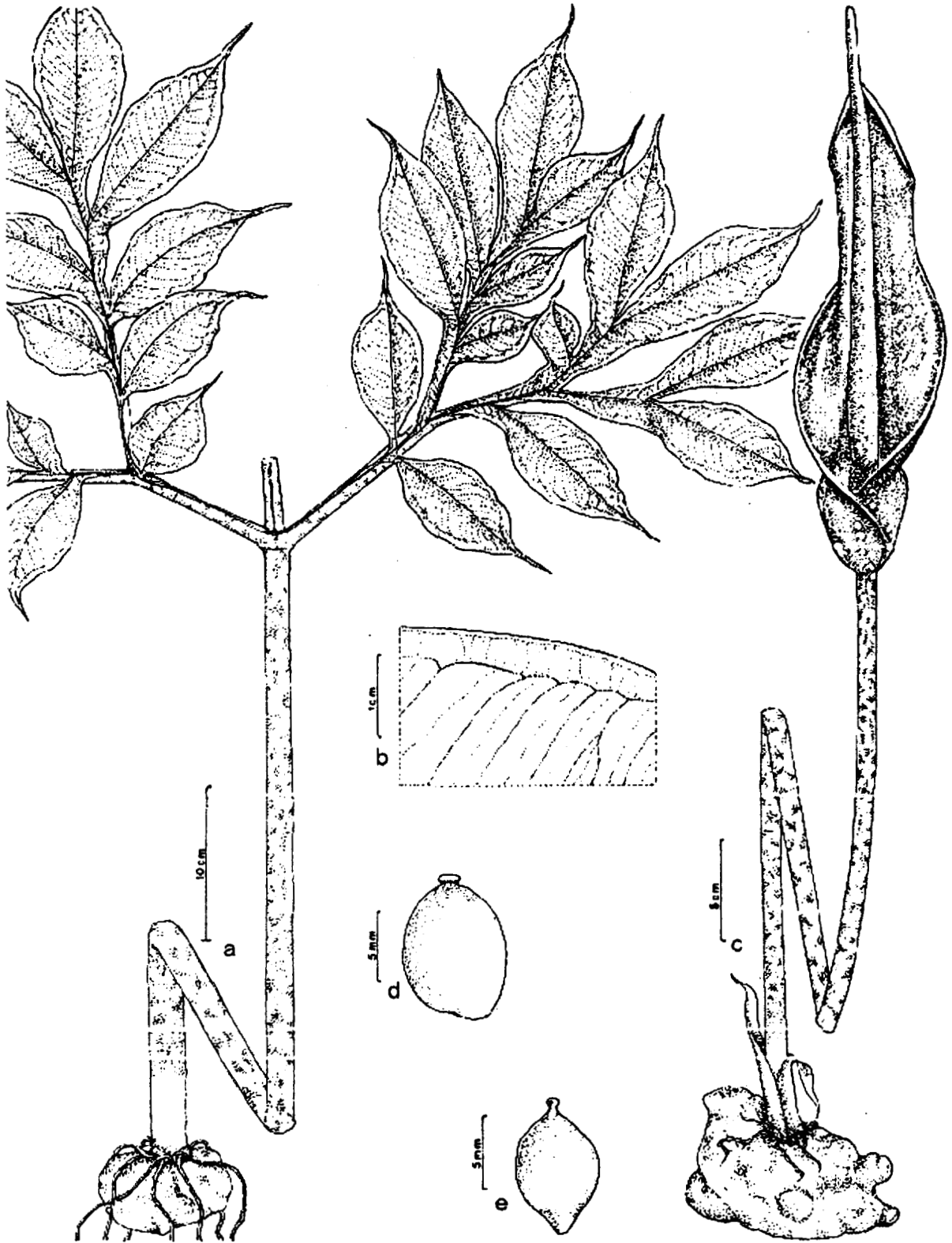


Fig. 23. *Amorphophallus commutatus* (Schott) var. *wayanadensis* Sivad. et Jaleel: a. Tuber with leaf; b. Marginal portion of a leaflet showing venation; c. Tuber with inflorescence; d. Single fruit; e. Single seed.

4.0-5.5 cm broad, upper surface dark green and lower surface light green, margin entire, marginal surface undulate.

Peduncle ca. 75-95 cm long and 1.4-1.8 cm in diam. at base, tapering towards the top, light green with greenish black and purplish green spots, small striations and yellowish green mottles, covered by about four cataphylls; each cataphyll ca. 4.0-35 cm long and 2-4.5 cm broad. Spathe ovate-oblong, as long as the spadix, ca. 26-32 cm long and 9-12 cm broad, basal portion convolute forming a slightly compressed obovoid tube of ca. 5-7 cm long, slightly constricted at the mouth, limb expanded, erect, apex acute, margin incurved, purplish at the top, greenish purplish at the base with white mottles, inside purplish at the top, pale yellowish to light purplish with short rounded bumps at base. Spadix sessile, ca. 27-30 cm long; female zone ca. 2.3-2.5 cm long and 1.3-1.5 cm in diam., male zone ca. 3.7-4.0 cm long and 1.5-1.8 diam., terminal spadix-appendix elongate narrowly conoid with a rounded apex, ca. 20.5-23.0 cm long, and 1.4-1.6 cm diam. at base, tapering towards the tip, smooth, reddish brown coloured, base with inconspicuous, irregularly elongate rhomboid projections. Female flowers with ovary sub-globose, 1.5-1.75 mm high and ca. 0.2 mm diam., green in colour, unilocular with a single basal anatropous ovule; style very short or absent, light purplish in colour; stigma discoid with orange in colour. Male flowers sessile, loosely arranged, pale yellowish, connectives purplish or connective thecae and completely purplish; each flower ca. 2 mm high, 2.25 mm broad, inconspicuously 2-lobed; dehiscence of

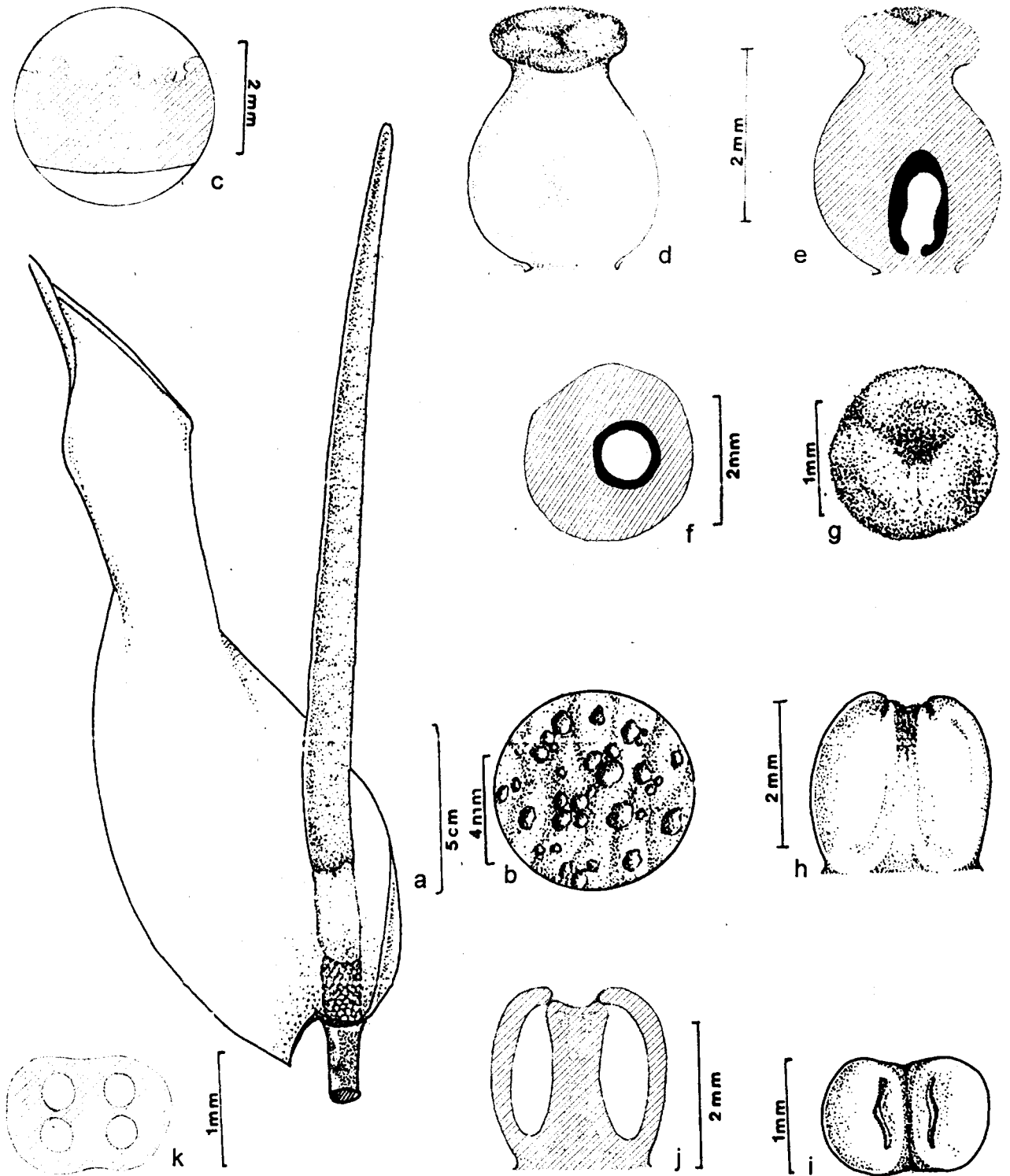


Fig. 24. *Amorphophallus commutatus* (Schott) Engl. var. *wayanadensis* Sivad. et Jaleel: a. Inflorescence – spathe cut open showing spadix; b. A small basal inside portion of the spathe – magnified; c. A small basal portion of the spathe – c.s.; d. Female flower; e. Female Flower – l.s.; f. Ovary – c.s.; g. Stigma - view from top; h. Male flower – view from broad side; i. Male flower – view from top showing openings of thecae; j. Male flower – l.s.; k. Male flower – c.s.

thecae by an apical slit-like pore, very near to the connective, with the lateral side of the thecae away from the connective much bulged. Fruits broadly ovate, red-coloured berries, ca. 1.2 cm long and 0.8 cm diam. Seeds ca. 0.8 cm long and 0.5 cm diam.

*Flowering:* May – June.

*Fruiting:* July – August.

*Distribution:* Kerala.

*Etymology:* The specific epithet is indicative of the name of the type locality – Wayanad – where the species is fairly common in certain areas.

*Notes:* *Amorphophallus commutatus* var. *wayanadensis* resembles the other two varieties viz., var. *anmodensis* and var. *commutatus* in its general appearance of the spathe and spadix, but more with var. *anmodensis* in the slightly compressed ovoid nature of the basal tube of the spathe with a slight constriction between the tube and limb, but differs in having a long peduncle. It is distinct in having a long peduncle, of about 75-95 cm, male zone fusiform, the male flowers with the apical connective region depressed, and dehiscence of the thecae very near to the connective. The tube of the spathe yellowish with slight purplish colour at the base with blunt bumps within.

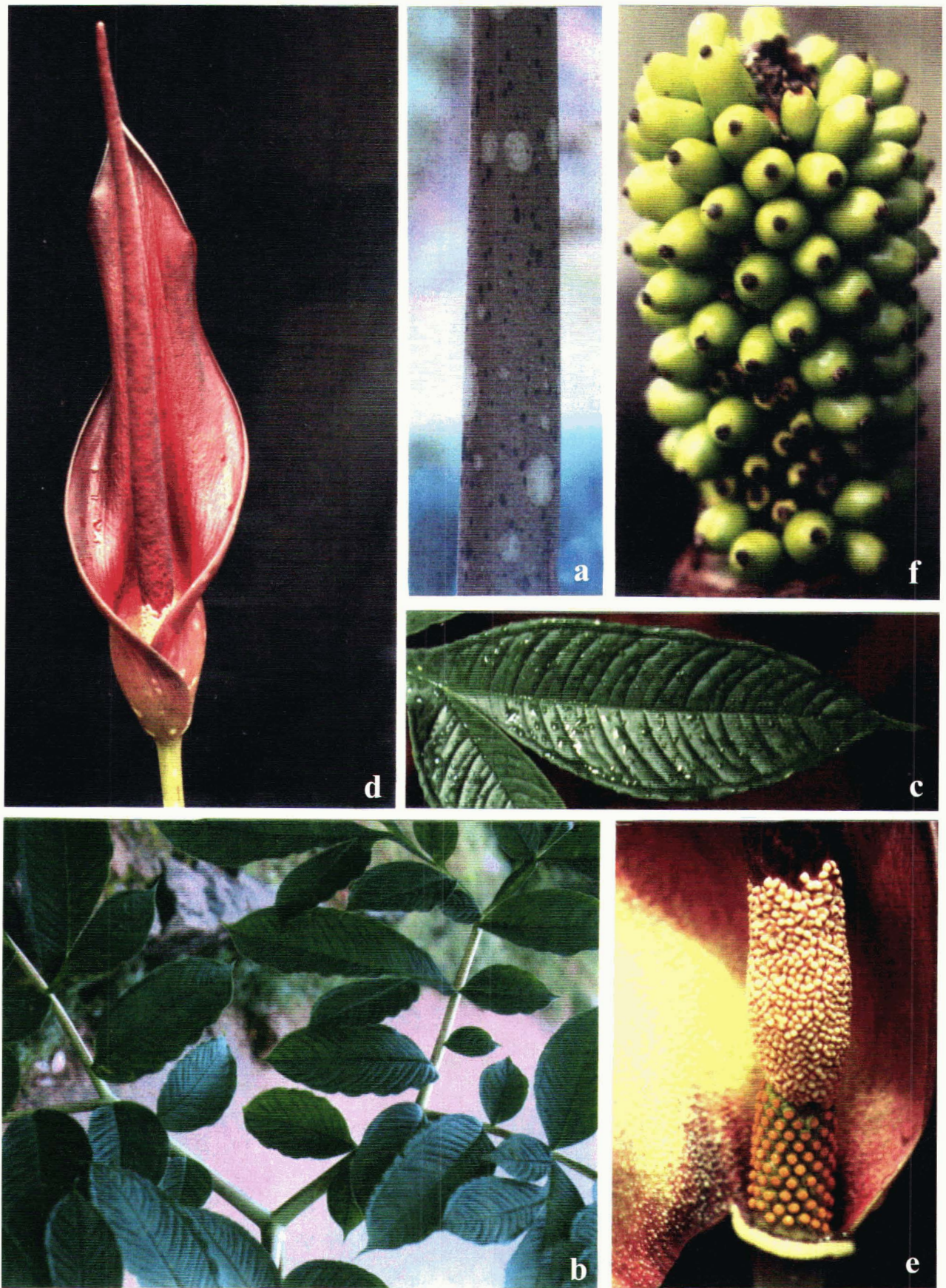


Plate IX. *Amorphophallus commutatus* (Schott) Engl. var. *wayanadensis* Sivad. et Jaleel: a. A portion of petiole showing mottlings; b. A portion of lamina – top-view; c. Leaflet showing venation; d. Inflorescence; e. Inflorescence with spathe cut open showing fertile portion of spadix ; f. Infructescence.



*Specimens examined:* **Kerala State**, Palghat Dist.: Mukkali, 29<sup>th</sup> May 1966, *Vajravelu 27711* (infl.) (MH); Manthampotti, 16<sup>th</sup> May 1977, *Sivadasan CU 19174* (leaf) (CALI); *Ibid.*, 11<sup>th</sup> May 1984, *Sabu 36542* (leaf) (CALI); *Ibid.*, 11<sup>th</sup> May 1984, *Sivadasan 36544* (infl.) (CALI); Dhoni Hills, 26<sup>th</sup> Jan. 1978, *Sivadasan 21434* (infr.) (CALI); *Ibid.*, 25<sup>th</sup> May 1978, *Sivadasan 21426* (infl.) (CALI); Dhoni Hills, 24<sup>th</sup> June 1978, *Sivadasan 21434 B* (leaf) (CALI); Wayanad Dist.: Vaithiri, 13<sup>th</sup> Sept. 1975, *Sivadasan CU 7815* (infl.) (CALI); Wayanad Ghat, 29<sup>th</sup> April 1997, *Abdul Jaleel & Bobby Thomas RIA 61* (leaf) (CALI); *Ibid.*, 29<sup>th</sup> April 1997, *Abdul Jaleel & Bobby Thomas RIA 62* (infl.) (CALI).

**6. *Amorphophallus hirsutus*** Teysm. & Binn., *Naturk. Tijdschr. Nederl. Ind.* XXIV: 332. 1862; Miq., *Ann. Mus. Lugd. Bat.* I: 286. 1863; Engl. in DC., *Monogr. Phan.* II: 311. 1879; Engl., *Pflanzenr.* IV. 23C(48): 106. 1911; Hett. & Ittenb., *Aroideana* 19: 80. 1996; Sivad. *et* Jaleel, *Rheedea* 10(2): 143. 2000. (Figs. 25 & 26; Plate X).

*Type:* West Sumatra, Soeka Menanti, Ophir, (No date), *Buenbemeijer 1019* (Neo-BO).

Tubers depressed globose, 4.5-8.5 cm diam. and 2.5-5.0 cm thick in vegetative phase; ca. 11 cm diam. and 7 cm thick in reproductive phase; root scars annuliform, thickened, annulate. Petiole 73-82 cm long, 2.0-2.5 cm diam. at base, slightly tapering to the tip, smooth, pale green with small blackish green irregular

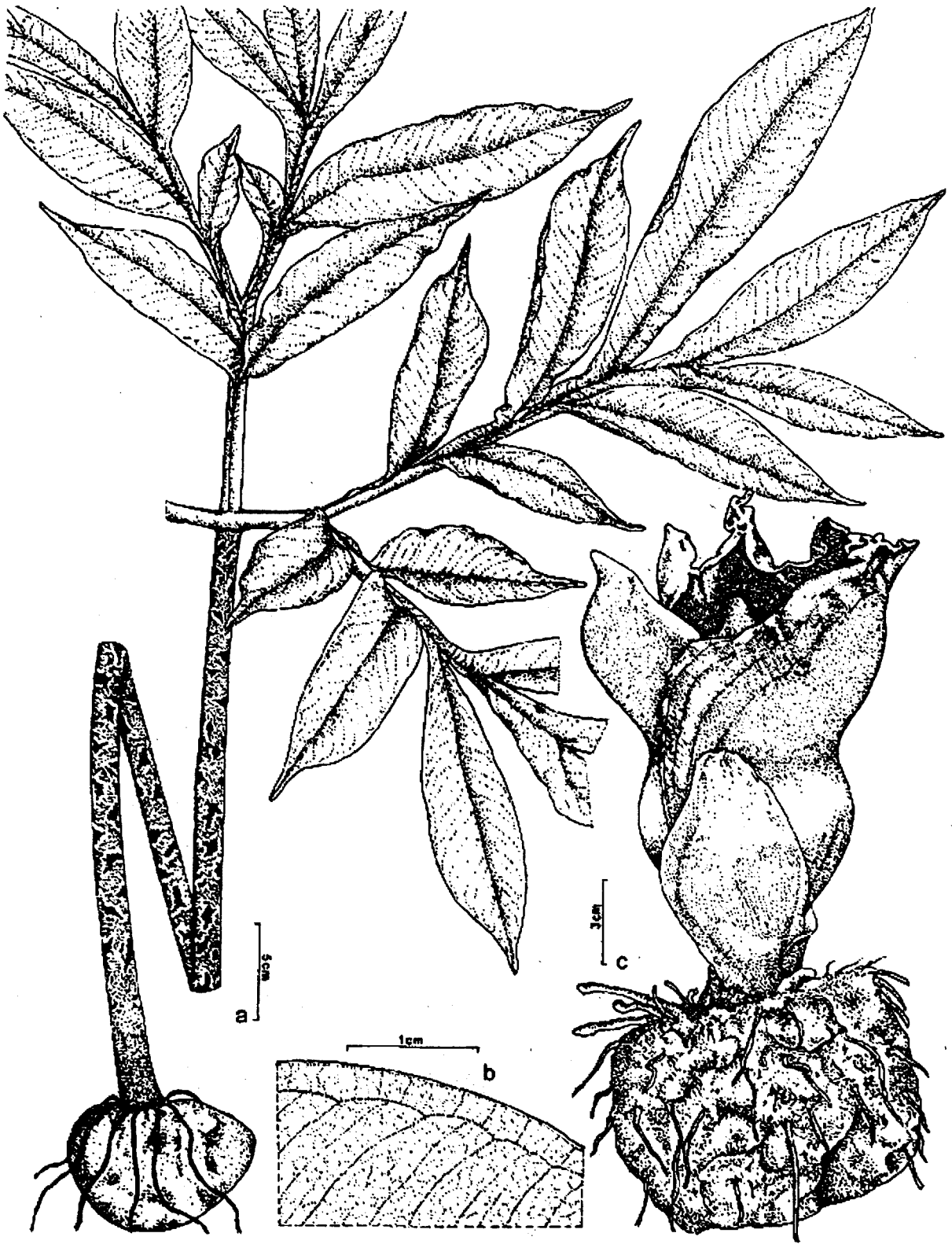


Fig. 25. *Amorphophallus hirsutus* Teysm. & Binn.: a. Tuber with leaf; b. Marginal portion of a leaflet showing venation; c. Tuber with inflorescence.

specks and mottles with minute dark green spots in between, paler towards the tip, extreme base with purplish blue hue; some petioles with pale green background having large irregular blackish green patches with light greyish margin, and minute greenish spots in between, and paler towards the tip. Lamina 48-86 cm diam., leaflets sessile, elliptic-lanceolate, larger leaflets 11-17 cm long and 3-5 cm broad, smaller 6.2-10.5 cm long and 1.8-4.0 cm broad, acuminate at apex, base unequal and decurrent on rachis, greenish above and pale below; lateral veins united below the margin forming a sub-marginal collective vein.

Peduncle short, ca. 3-5.5 cm long and 1.5-2 cm diam., greenish in colour, surrounded by ca. 4 cataphylls; each cataphyll ca. 2.3-10.5 cm long and 2-6.2 cm broad, green in colour. Spathe campanulate, broad triangular-ovate, ca. 17.5 cm long and ca. 26 cm broad, basal tube is separated from the limb by a constriction, tip acute, margin undulate; tube 7.5 cm diam. and 5.5 cm high, greenish outside with few small white mottlings, smooth; pale greenish inside, purplish-orange or maroon at extreme base, rough, irregularly and longitudinally rugose and verrucate; limb ca. 9.5 cm long spreading to ca. 12 cm diam., purplish outside and inside. Spadix shorter than the spathe, ca. 12.5 cm long, sessile, differentiated into a basal fertile portion of female zone of ca. 3.3 cm long and 3.5 cm diam., a male zone of ca. 3.8 cm long, 3.5 cm diam. at the base and 4.5 cm diam. at the top above, and a terminal appendix. Female flowers densely arranged, each flower ca. 10 mm high; ovary subglobose, pale greenish, ca. 4 mm diam. and 3 mm high, 2-3-locular, each

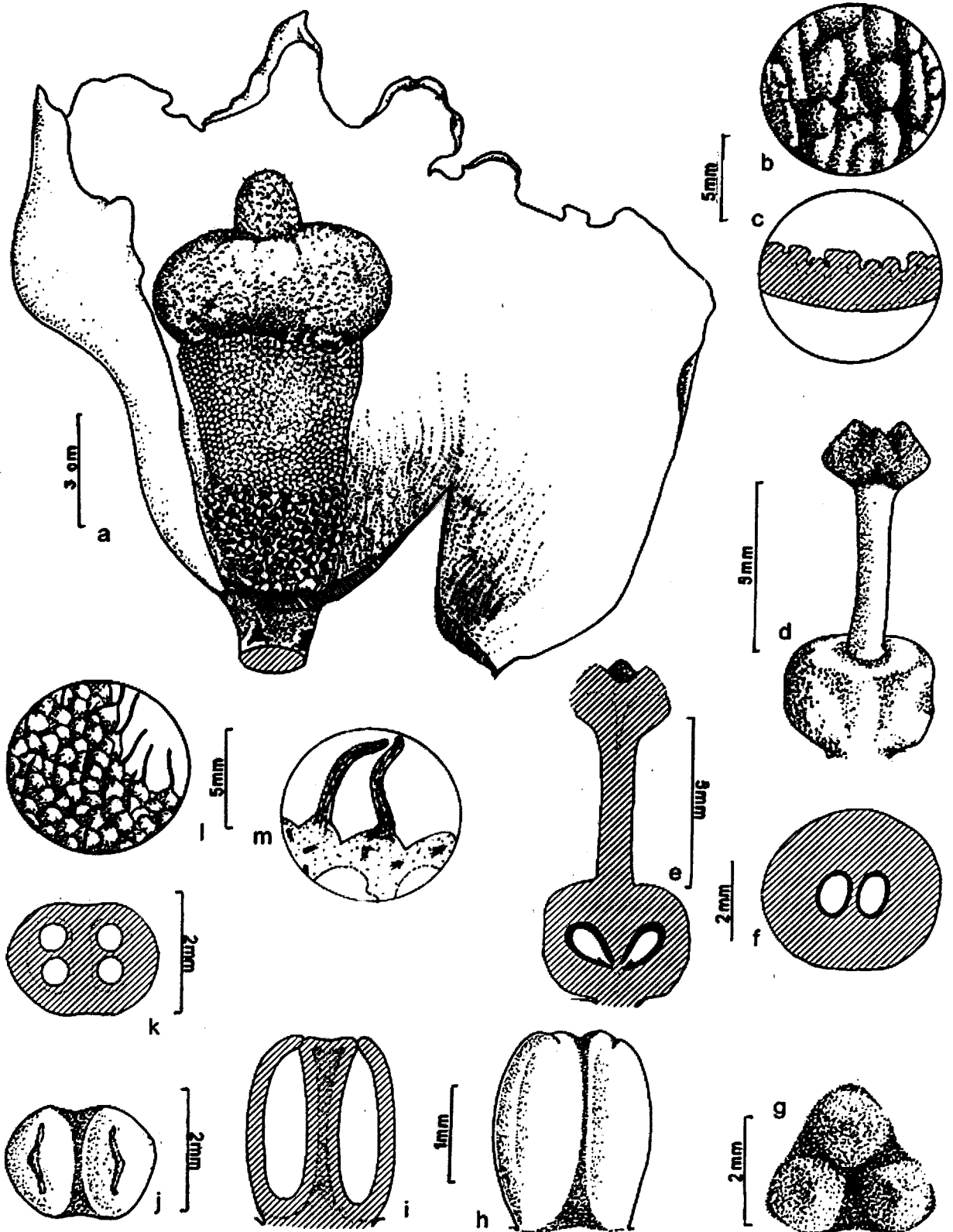


Fig. 26. *Amorphophallus hirsutus* Teysm. & Binn.: a. Inflorescence – spathe cut open showing spadix; b. A small basal inside portion of the spathe – magnified; c. A small basal portion of the spathe – c.s.; d. Single female flower; e. Female flower – l.s.; f. Ovary – c.s.; g. Stigma – view from top; h. Male flower – view from broad side; i. Male flower – l.s.; j. Male flower – view from top showing openings of thecae; k. Male flower – c.s.; l. A small portion of the apical portion of the appendix showing papillae; m. Papillae – enlarged.

locule with a single basal anatropous ovule; style ca. 5 mm long and 1 mm diam., purplish; stigma 2-3-lobed, ca. 2.5 mm diam., pale yellowish. Male flowers closely arranged, pale yellowish with purplish tinge along the connectives; each ca. 2 mm high and 1.5 mm broad, sessile, inconspicuously 2-lobed. Spadix-appendix subglobose, ca. 5.5 cm diam. and 3 cm high; light purplish yellow, rough, and suddenly narrowed to a cylindric, columnar truncate apical portion of ca. 1.8 cm high and 0.9 cm diam., light purplish yellow, rough; the cylindrical columnar portion and its basal surrounding areas are covered with stiff slender papillae arising from bulbous bases; the papillae on the cylindrical column are smaller compared to that of the basal neighbouring areas; appendix becomes unevenly bullate after anthesis.

*Flowering:* May.

*Fruiting:* Fruiting specimens could not be collected.

*Distribution:* Originally collected from Java and described by Teysmann and Binnendijk (1862). Hettterscheid and Ittenbach (1996) reported its occurrence in Western Sumatra. The present collection of the species is from Great Nicobar islands of India where it is rare.

*Notes:* *Amorphophallus hirsutus* resembles *A. paeoniifolius* and *A. prainii* in general vegetative morphology and the inflorescence, especially during the early stages. It differs from the latter two by the presence of a subglobose appendix with a



Plate X. *Amorphophallus hirsutus* Teysm. & Binn.: a. Tuber; b. A portion of a petiole showing mottlings; c. A portion of lamina-view from top; d. Inflorescence; e. Inflorescence – top-view; f. Inflorescence with spathe cut open showing spadix.

cylindric columnar truncate apical portion, covered with short stiff papillae. The other species with hairs on the appendix are: *A. cirrifer* Stapf., *A. henryi* N.E.Br., *A. hirtus* N.E. Br., *A. kiusianus* Makino, *A. lanuginosus* Hett., *A. laoticus* Hett., *A. pilosus* Hett., etc. In *A. cirrifer*, hairs are seen throughout its spadix. There is no other Indian species with hairs on the spadix-appendix. The shape and sculpture of the appendix in *A. hirsutus* render the species unique in the entire genus.

*Specimens examined:* **Great Nicobar Islands**, on the way to East-West Road, 17<sup>th</sup> May, 1999, *Abdul Jaleel RIA 350* (Infl.) (CALI); *Ibid.*, 17<sup>th</sup> May 1999, *Abdul Jaleel RIA 351* (tuber and leaf) (CALI); *Ibid.*, 20<sup>th</sup> May 1999, *Abdul Jaleel RIA 355* (tuber and leaf) (CALI); **Kerala State**, Calicut University Botanical Garden, 17<sup>th</sup> April 2000, *Abdul Jaleel RIA 382* (Infl.) (CALI) (originally collected from East West Road, Great Nicobar, and introduced and flowered in the Calicut University Botanical Garden).

7. ***Amorphophallus hohenackeri*** (Schott) Engl. *et* Gehrm. in Engl., Pflanzenr. IV. 23C(48): 103. 1911; Fisch. in Gamble, Fl. Pres. Madras 1587. 1931; Manilal & Sivar., Fl. Calicut 306. 1982; Karth., Jain, Nayar & Sanjappa, Fl. Indicae Enum. Monocot. 6. 1989; Hett. & Ittenb., Aroideana 19: 83. 1996; Sasi. & Sivar., Fl. Pl. Thrissur For. 483. 1996 (Figs. 27 & 28; Plate XI).

*Rhaphiophallus hohenackeri* Schott, Gen. Aroid, t. 27. 1858; Schott, Prodr. Syst. Aroid. 125. 1860; Engl. in DC., Monogr. Phan. II: 321. 1879.

*Hydrosme hohenackeri* (Schott) Engl. in Engl. & Prantl, Pflanzenfam. II(3): 128. 1887; *Ibid.* Nachtr., I: 59. 1897.

*Type:* Mangalore, Canara, (No date), *Hohenacker* 21646 (B).

Tubers depressed sub-globose, 2-3.5 cm diam. and 2-3 cm high in vegetative phase, 3.5-6.5 cm diam. and 2.5-4.0 cm high in reproductive phase, skin pale brownish; offsets 2-3 cm long and 0.5-0.7 cm diam.; roots numerous, 5-20 cm long and 0.2-0.3 cm diam., pale yellowish. Petiole 35-68 cm long, 0.8-1.4 cm diam. at the base, slightly tapering to the tip, smooth, pale yellowish green with dark green mottlings and minute cream-coloured dots, covered by 3-4 cataphylls, each cataphyll 10.5-30 cm long and 1.3-2.0 cm broad, pale pinkish in colour with tiny green dots. Lamina 30-45 cm diam., leaflets sessile, elliptic, long leaflets 9-10 cm long and 3-3.5 cm broad; small leaflets 3-5 cm long and 1.5-2.5 cm broad, acuminate at apex, base unequal and decurrent on rachis, greenish above, pale below, margin slightly undulate, secondary lateral veins united below the margin forming a submarginal collective vein.

Peduncle 18-50 cm long, 0.6-1.0 cm diam. at base and gradually narrowed to the tip, identical with petiole in colour and pattern of mottling. Spathe erect, light pinkish yellow with purplish black mottlings and with pale purplish streak along the centre outside, yellowish green within, 10.5-15.5 cm long and 4.0-5.5 cm broad, basally convolute during the early stage and completely open throughout its length



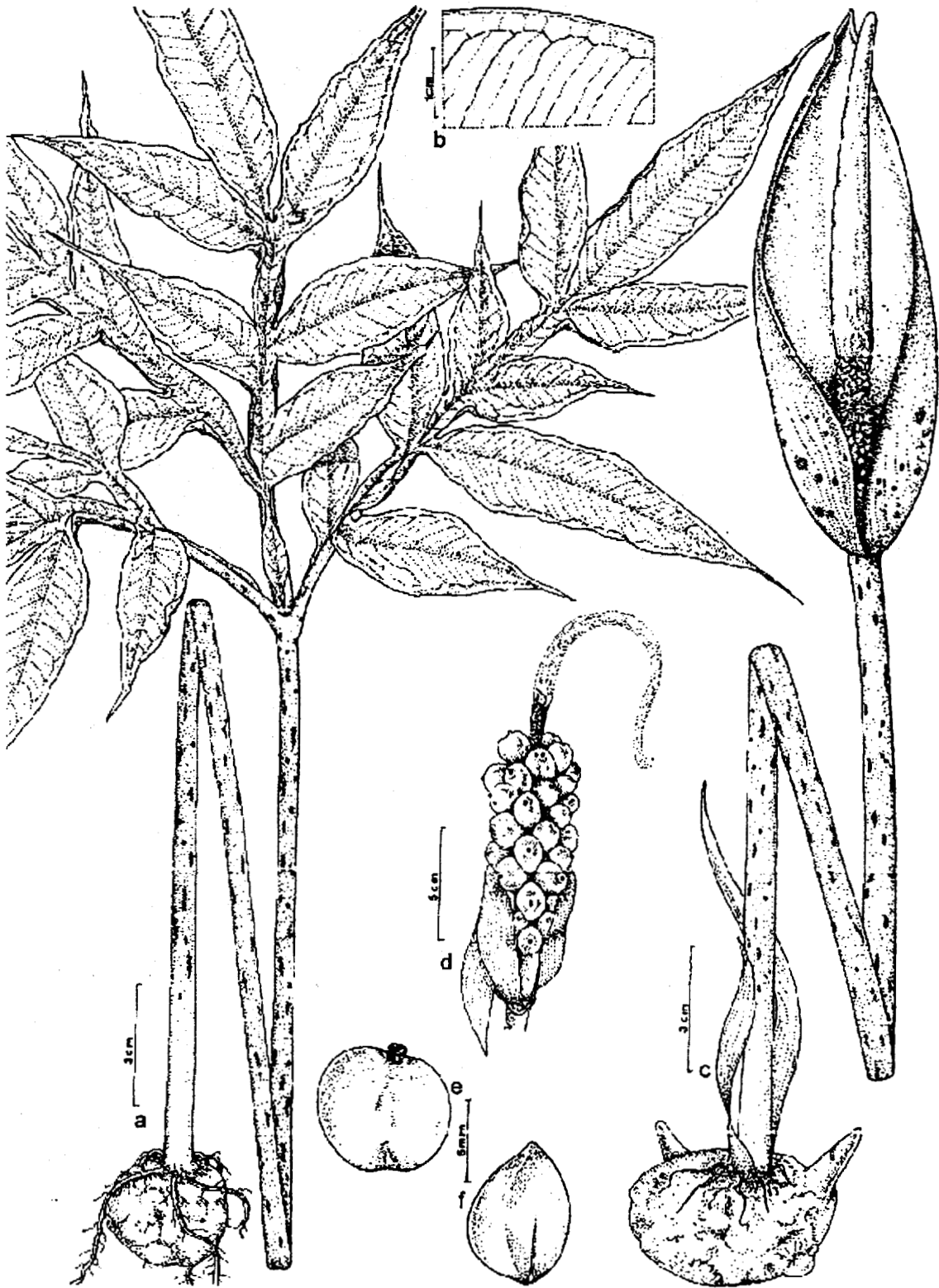


Fig. 27. *Amorphophallus hohenackeri* (Schott) Engl. et Gehrm.: a. Tuber with leaf; b. Marginal portion of a leaflet showing venation; c. Tuber with inflorescence; d. Infructescence; e. Single fruit; f. Single seed.

at maturity. Spadix more or less equals the length of the spathe or slightly longer with a stipe of ca. 0.5-0.8 cm long and 0.6-0.7 cm diam., cream coloured; female zone 1-1.5 cm long and 0.9-1.1 cm diam., neuteriflorous zone between male and female zone ca. 0.5-0.7 cm long and 0.8-1.0 cm diam., and male zone 1.5-2.0 cm long and 0.8-0.9 cm diam. Female flowers sub-spirally arranged; each flower with ovary sub-globose, ca. 1.25 mm high, 1.75 mm diam., greenish, 2-3-loculed, each locule with a single anatropous ovule; style very short; stigma inconspicuously 2-3-lobed, ca. 1 mm diam., yellowish. Neuter zone with closely arranged rounded to elongate rhomboid, gibbous, cream-coloured, neuter flowers arranged in 1-3 rows, each neuter flower ca. 0.4-0.5 cm long, ca. 0.3 cm diam. Male flowers closely arranged, yellowish in colour, each ca. 1.0 mm high and 1.25 mm broad, dehisce by apical pores. Spadix-appendix 8.5-12.5 cm long and 1-1.2 cm diam. at the base and tapering to the tip, base with inconspicuous rhomboid projections, and smooth above, cream-coloured. Fruits oblong, green when young and turning scarlet red when ripe, ca. 0.8 cm long and 0.9 cm diam. Seeds ovoid, 2-3 in number, each ca. 0.6 cm long and 0.6 cm diam.

*Distribution:* Very limited in distribution and known only from Kerala and Mangalore in South Kanara Dist. of Karnataka State.

*Flowering:* March - May.

*Fruiting:* May - August.

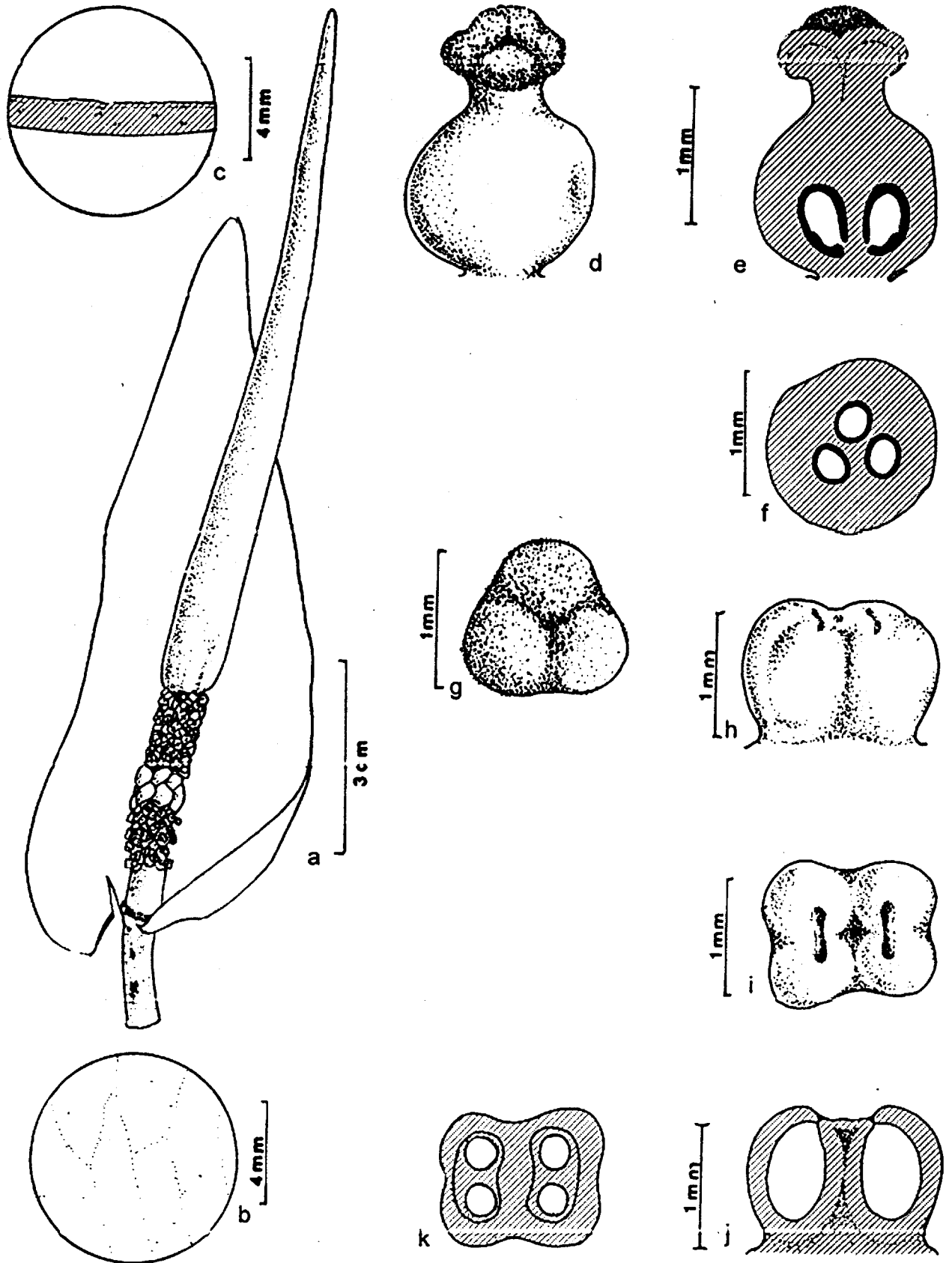


Fig. 28. *Amorphophallus hohenackeri* (Schott) Engl. et Gehrm.: a. Inflorescence – spathe cut open showing spadix; b. A small basal inside portion of the spathe – magnified; c. A small basal portion of the spathe – c.s.; d. Single female flower; e. Female flower – l.s. passing through two locules; f. Ovary – c.s.; g. Stigma – view from top; h. Male flower – view from broad side; i. Male flower – view from top showing openings of the thecae; j. Male flower – l.s.; k. Male flower - c.s.

*Notes:* *Amorphophallus hohenackeri* differs from other species in the nature of the spathe. The spathe is basally convolute during the early stage and completely opens throughout its length at maturity. The neuter flowers are rounded to elongate rhomboid, gibbous, cream-coloured.

It is closely related to *A. bonaccordensis* but the latter differ in having a spadix shorter than the spathe, a barren zone below the neuteriflorous and female flower zones, and a more or less cylindrical spadix-appendix without terminal tapering.

*Specimens examined:* **Kerala State:** Trivandrum Dist.: Attayar, 800 m, 3<sup>rd</sup> Mar. 1993, *S. Coll.*, 11342 (infl.) (TBGT); Bonaccord, 700m, *Mohanan 8450* (leaf & infr.) (TBGT). Ernakulam Dist.: Kalady, 5<sup>th</sup> Nov. 1931, *S. Coll.*, *Acc. No. 0764* (infl.) (TBGT). Palakkad Dist.: Munderoor, 8<sup>th</sup> Jun. 1984, *Sabu 36549* (infl.) (CALI); Nelliampathy, 7<sup>th</sup> Apr. 1997, *Abdul Jaleel RIA 43* (leaf) (CALI); Kavalod, Melarcode-Nemmara road, 20<sup>th</sup> May 1997, *Abdul Jaleel RIA 51* (infl.) (CALI); Vadakkencherry, 16<sup>th</sup> Aug. 1997, *Abdul Jaleel RIA 128* (leaf) (CALI); *Ibid.*, 1<sup>st</sup> Apr. 1998, *Abdul Jaleel RIA 260* (infl.) (CALI); Malappuram Dist.: Calicut University Campus, 17<sup>th</sup> Mar. 1976, *Sivadasan CU 13124* (infl.) (CALI); *Ibid.*, 28<sup>th</sup> Apr. 1976, *Sivadasan CU 13124 a* (infl.) (CALI); *Ibid.*, 23<sup>rd</sup> May 1977, *Sivadasan 19178* (leaf) (CALI); *Ibid.*, 23<sup>rd</sup> May 1977, *Sivadasan 19179* (infr.) (CALI); *Ibid.*, 24<sup>th</sup> Apr. 1997, *Abdul Jaleel RIA 38* (infl.) (CALI); *Ibid.*, 27<sup>th</sup> April 1997, *Abdul Jaleel RIA 45* (infr.) (CALI); *Ibid.*, 23<sup>rd</sup> June 1997, *Abdul Jaleel RIA 92* (veg.)

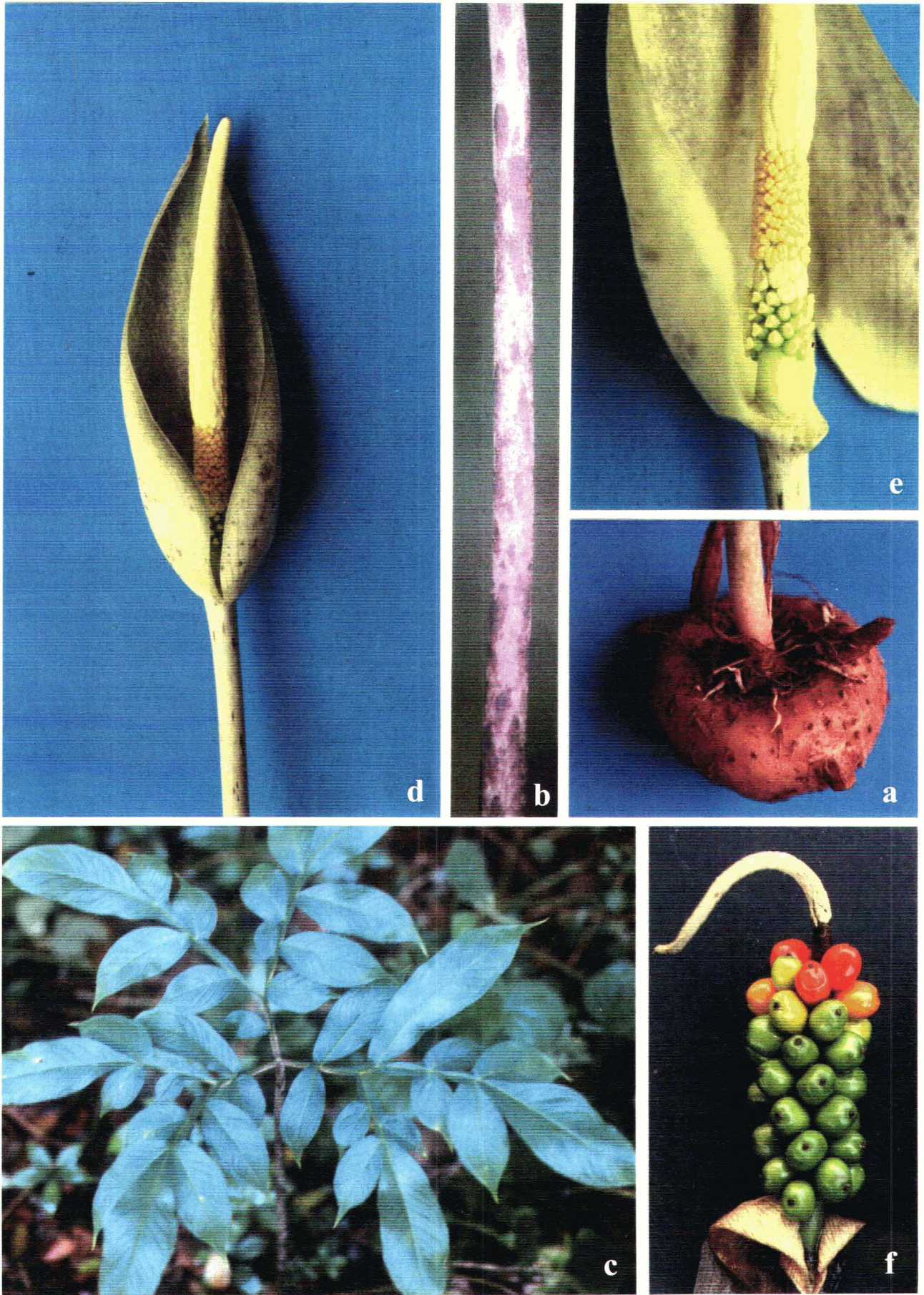


Plate XI. *Amorphophallus hohenackeri* (Schott) Engl. et Gehrm.: a. Tuber; b. A portion of petiole showing mottlings; c. Lamina – top-view; d. Inflorescence; e. Inflorescence with spathe cut open showing fertile portion of spadix and base of spadix appendix; f. Infructescence.

(CALI); *Ibid.*, 6<sup>th</sup> Jul. 1997, *Abdul Jaleel*, *RIA 102* (leaf) (CALI); Kannur Dist.: Vengad, 19<sup>th</sup> May 1997, *Anil Kumar* *RIA 50* (infl.) (CALI).

**8. *Amorphophallus kachinensis*** Engl. & Gehrm., in Engler, *Pflanzenr.* IV. 23C (48): 91. 1911; Hett. & Itten., *Aroideana* 19: 87. 1996. (Fig. 29).

*Type*: Upper Burma, Kachin Hills, 20<sup>th</sup> May 1898, *Shaik Mokim*, *s.n.* (Holo – CAL).

Tubers depressed globose, 5.0-30 cm diam. and 3-5 cm thick, skin brownish in colour; produce offsets. Petiole ca. 20 cm long, smooth, dirty white background with green to reddish brown spots. Lamina ca. 100 cm diam., leaflets elliptic, 6-9 cm long and 2-3 cm broad, tip acute-acuminate.

Peduncle 24-80 cm long, 0.7-1.0 cm diam. at the base, gradually narrowed to the top, ivory white, greyish or greenish background with brownish or purplish blotches and greenish patches. Spathe more or less boat shaped with slightly convolute at the base, 8-29 cm long, 7-14 cm broad, tip rounded or truncate, green or greenish brown outside with green spots or purplish stripes and spots; light purplish within, with scattered, shallow, punctiform warts at base. Spadix much shorter than the spathe, 6.5-18 cm long, stipitate, stipe 0.2-1.0 cm long and 0.4-1.0 cm diam.; female zone ca. 5.0 cm long and ca. 3.5 cm diam., male zone ca. 7.5 cm long and 3.5 cm diam. at the base, 7.0 cm at the top; spadix-appendix ellipsoid or ovoid with several longitudinal deep irregular valleculation. Female flowers

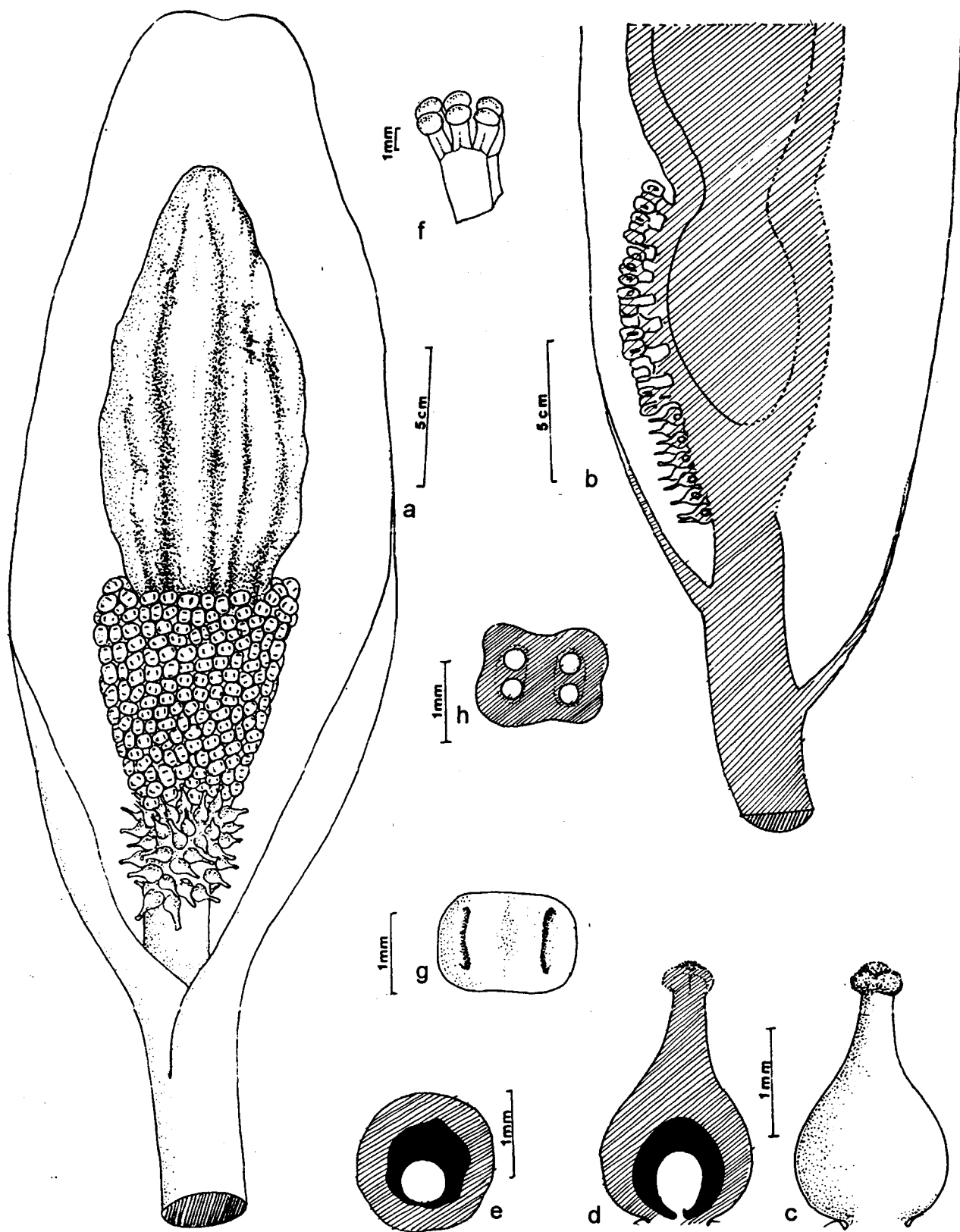


Fig. 29. *Amorphophallus kachinensis* Engl. & Gehrm.: a. Inflorescence; b. Inflorescence - l.s. from mid portion of the appendix downwards; c. Female flower; d. Female flower. l.s. e. Ovary - c.s.; f. Stalked male flowers with 3 stamens; g. Single stamen - view from top; h. Stamen - c.s.

closely arranged, each flower ca. 2.5 mm high; ovary sub-globose, ca. 1.5 mm diam. and 1.5 mm high, unilocular with basal anatropous ovule; style ca. 0.75 mm long; stigma inconspicuously 3-lobed, ca. 0.5 mm diam. Male flowers closely arranged, each ca. 2 mm broad, sessile, inconspicuously 2-lobed. Spadix-appendix ca. 7.5 cm diam. at the middle and ca. 15 cm high.

*Flowering:* April – May.

*Distribution:* Northern Myanmar (Kachin state), Northern Thailand, Laos, China (Yunnan) and India. In India collected from Arunachal Pradesh. The present collection of the species forms a new distributional record for India.

*Notes:* *Amorphophallus kachinensis* is morphologically very close to *A. corrugatus* N.E. Br. (1912) and *A. yunnanensis* Engl. (1911) but differs in having a much less complexity in the valleculate nature of the spadix-appendix. From *A. yunnanensis* it differs in having female flowers with long style, smaller stigma and unilocular ovary.

*Specimens examined:* The only specimen collected from Arunachal Pradesh, based on which the illustration was made has been lost by decay during the processing.



**9. *Amorphophallus konkanensis*** Hett., Yadav & Patil, *Blumea* 39: 289. 1994; Hett. & Itten., *Aroideana* 19: 90. 1996. (Figs. 30 & 31; Plate XII).

*Types*: India, Maneri, Sindhudurg Dist., 15<sup>th</sup> Apr. 1992, *Patil 4687-A* (Holo - CAL);

*Paratypes*: *Patil 4687-B* (BLAT), *Patil 4687-C* (L), both same data as holotype.

Tubers globose or depressed globose, 3-4 cm diam. and 1.5-2.5 cm thickness in vegetative phase; 6-9 cm diam. and 4-5 cm thickness in reproductive phase, skin pale brownish; roots 3-10 cm long, ca. 0.1 cm diam. Petiole 20-80 cm long, 0.8-1.5 cm diam. at the base and gradually tapering towards the tip, pale brownish or greenish brown with pale yellowish green to white stripes and pinkish mottlings. Lamina 38-80 cm diam., rachises winged, leaflets linear lanceolate, acuminate at the apex, long leaflets 16-20 cm long and 3.5-4.5 cm broad, small leaflets 6.5-7.0 cm long and 1.75-2.5 cm broad, greenish above, pale below; lateral veins united below the margin forming a sub-marginal collective vein.

Peduncle smooth, cylindrical, 28-60 cm long, 0.5-0.9 cm diam. at the base and tapering towards the tip, colour and pattern of mottling same as that of the petiole. Spathe erect, broadly ovate when spread out, ca. 6-8 cm long and ca. 5-6.5 cm broad, tip acute, completely convolute throughout the length with an opening at the top, limb poorly differentiated from the tube, dirty pinkish with brownish hue and faint brownish spots with dark purple brown veins outside, dark maroon within.

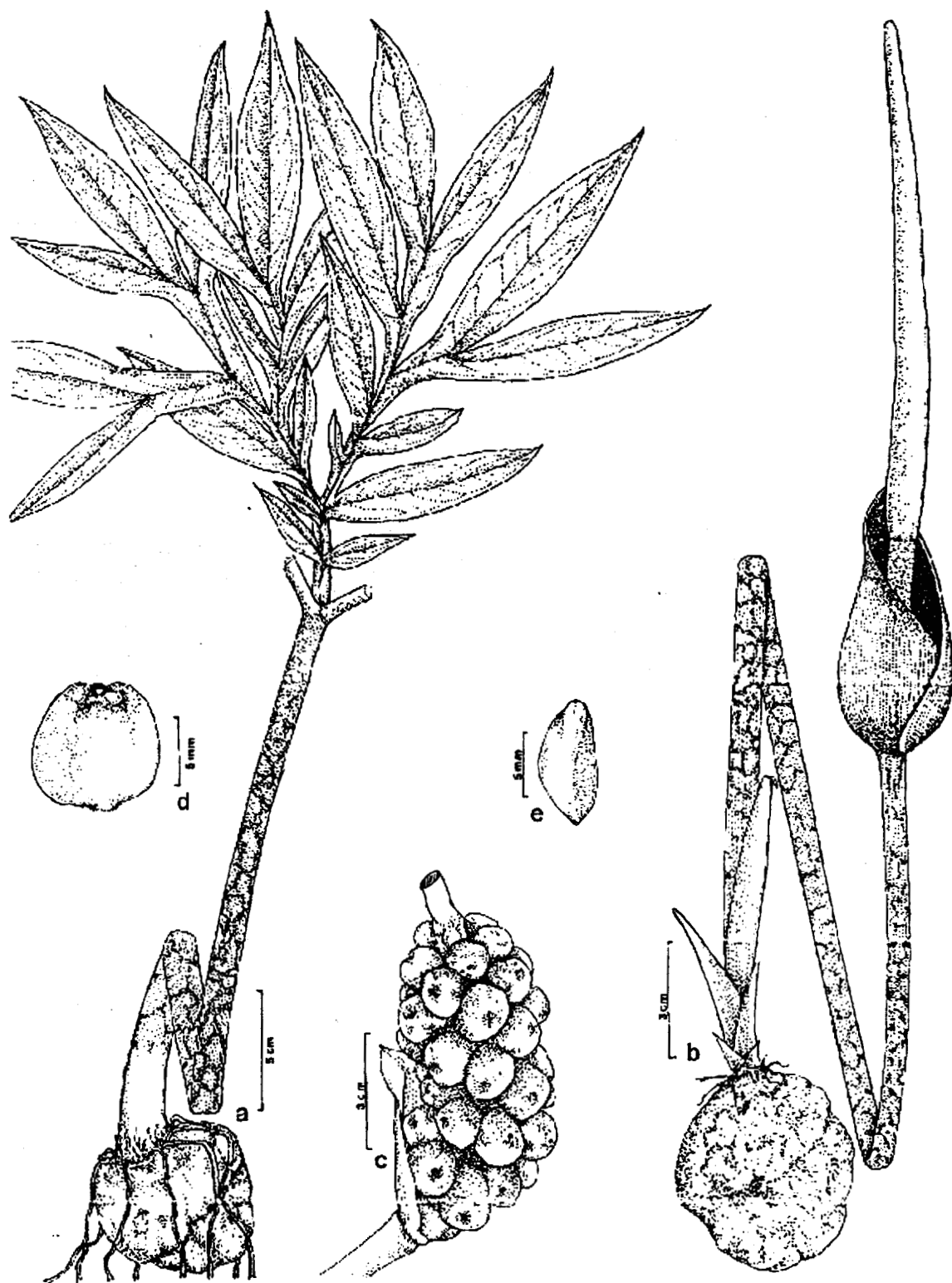


Fig. 30. *Amorphophallus konkanensis* Hett., Yadav et Patil: a. Tuber with leaf; b. Tuber with inflorescence; c. Infructescence; d. Single fruit; e. Single seed.

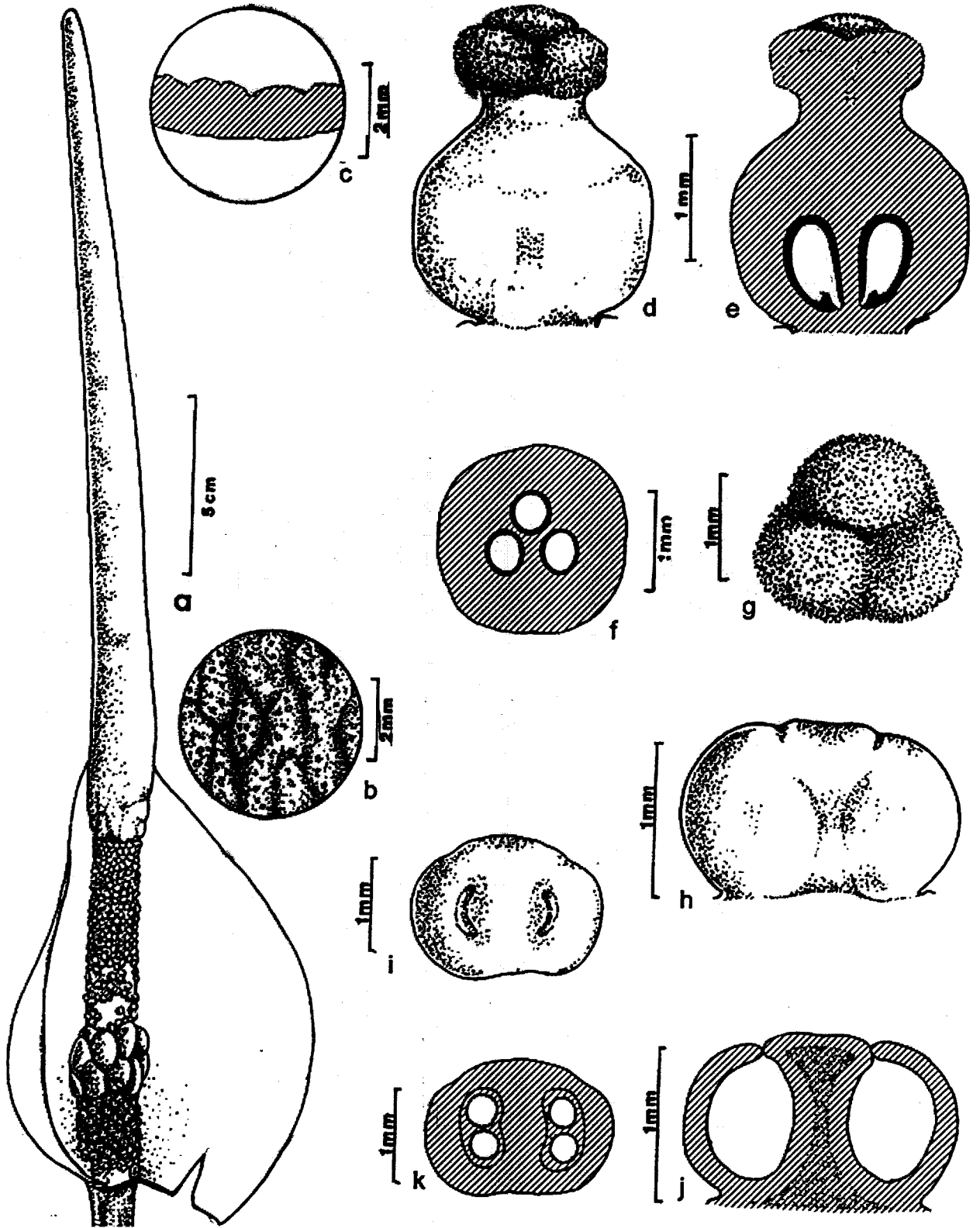


Fig. 31. *Amorphophallus konkanensis* Hett., Yadav *et* Patil: a. Inflorescence – spathe cut open showing spadix; b. A small basal inside portion of the spathe – magnified; c. A small basal portion of the spathe – c.s; d. Single female flower; e. Female flower – l.s; f. Ovary – c.s.; g. Stigma – view from top; h. Single male flower – view from broad side; i. Male flower – view from top showing openings of the thecae; j. Male flower – l.s; k. Male flower – c.s.

Spadix much longer than the spathe, 17-21 cm long, with a greenish stipe of ca. 0.5 cm long; female zone 1.3-1.8 cm long, neuter zone 0.8-1.2 cm long, male zone 3.7-4.2 cm long; spadix-appendix; ca. 10.5-14.0 cm long and 0.5-1 cm diam. at the base. Female flowers densely arranged, ovary globose, ca. 2 mm diam., 1 mm high, pale green and becoming purplish near the top, usually 3-locular, rarely 2 or 4-locular; each locule with one basal anatropous ovule; style very short, ca. 3 mm long, 2 mm diam, purplish; stigma 3- or 4-lobed, ca. 2 mm diam, 8 mm high, verruculate, pale yellowish; neuter flowers rhomboid, slightly convex, whitish or with faint purplish hue. Male flowers loosely arranged, each flower ca. 0.8 cm high, 1.25 cm broad, thecae whitish, connective brownish; spadix-appendix cylindrical, apically tapering, dirty olive green. Fruits green in colour and turns to pink at maturity, each fruit ca. 0.8-1 cm diam.; usually 3-seeded, rarely 2 or 4-seeded. Seeds ovoid; each ca. 7-8 mm long, ca. 5 mm diam.

*Distribution:* Known to occur only in Goa and Maharashtra states.

*Flowering:* April – May.

*Fruiting:* May – June.

*Notes:* *Amorphophallus konkanensis* differs from other species in having a completely convolute spathe and the spadix with rhomboid, slightly convex neuter flowers with whitish or faint purplish hue.



Plate XII. *Amorphophallus konkanensis* Hett., Yadav *et* Patil. : a. A portion of petiole showing mottlings; b. Leaf; c. Inflorescence; d. Inflorescence with spathe cut open showing fertile portion of spadix e. Infructescence.

The general morphology and colour pattern of the spathe of *A. konkanensis* closely resembles that of *A. mysorensis* Barnes et C.E.C. Fisch., but the latter differs in having a spadix with globose neuter flowers. Three other species viz., *A. bonaccordensis* Sivad. et Mohanan, *A. hohenackeri* (Schott) Engl. and *A. sylvaticus* (Roxb.) Kunth. of *Amorphophallus* section *Rhaphiophallus* also possess closely similar neuter flowers.

*Specimens examined:* **Goa State:** Dodamarg, 5<sup>th</sup> June 1997, *Abdul Jaleel & Bobby Thomas RIA 70 a* (infl.) (CALI); *Ibid.*, 5<sup>th</sup> June 1997, *Abdul Jaleel & Bobby Thomas RIA 70b* (infr.) (CALI); *Ibid.*, 15<sup>th</sup> July 1997, *Abdul Jaleel RIA 106* (leaf) (CALI).

**10. *Amorphophallus longiconnectivus*** Bogner, Kew Bull. 50(2): 397. 1995; Sivad. & Jaleel, Rheedeia 8(2): 243. 1998. (Figs. 32, 33 & 33a; Plate XIII).

*Type:* India, "Central Provinces", Piparia, June 1910, *H. Haines 3590* (holo - K).

Tubers subglobose or depressed globose, ca. 4.5-7.0 cm diam. and 2-5 cm thick in vegetative phase; ca. 6.5-8.0 cm diam. and 4-6 cm thick in reproductive phase; roots numerous, 0.1-0.2 cm diam.; offsets small, globose or fusiform, ca. 6-12 in number, each ca. 0.8-1.0 cm diam. and 1.2-1.8 cm long. Petiole 35-77 cm long, 1.2-2.3 cm in diam. at base, slightly tapering to the tip, smooth, light green with dark brownish narrow elongated stripes, paler towards the tip portion; leaflets sessile, linear-lanceolate, 14.0-7.5 cm long and 2-4 cm broad, acuminate at apex,

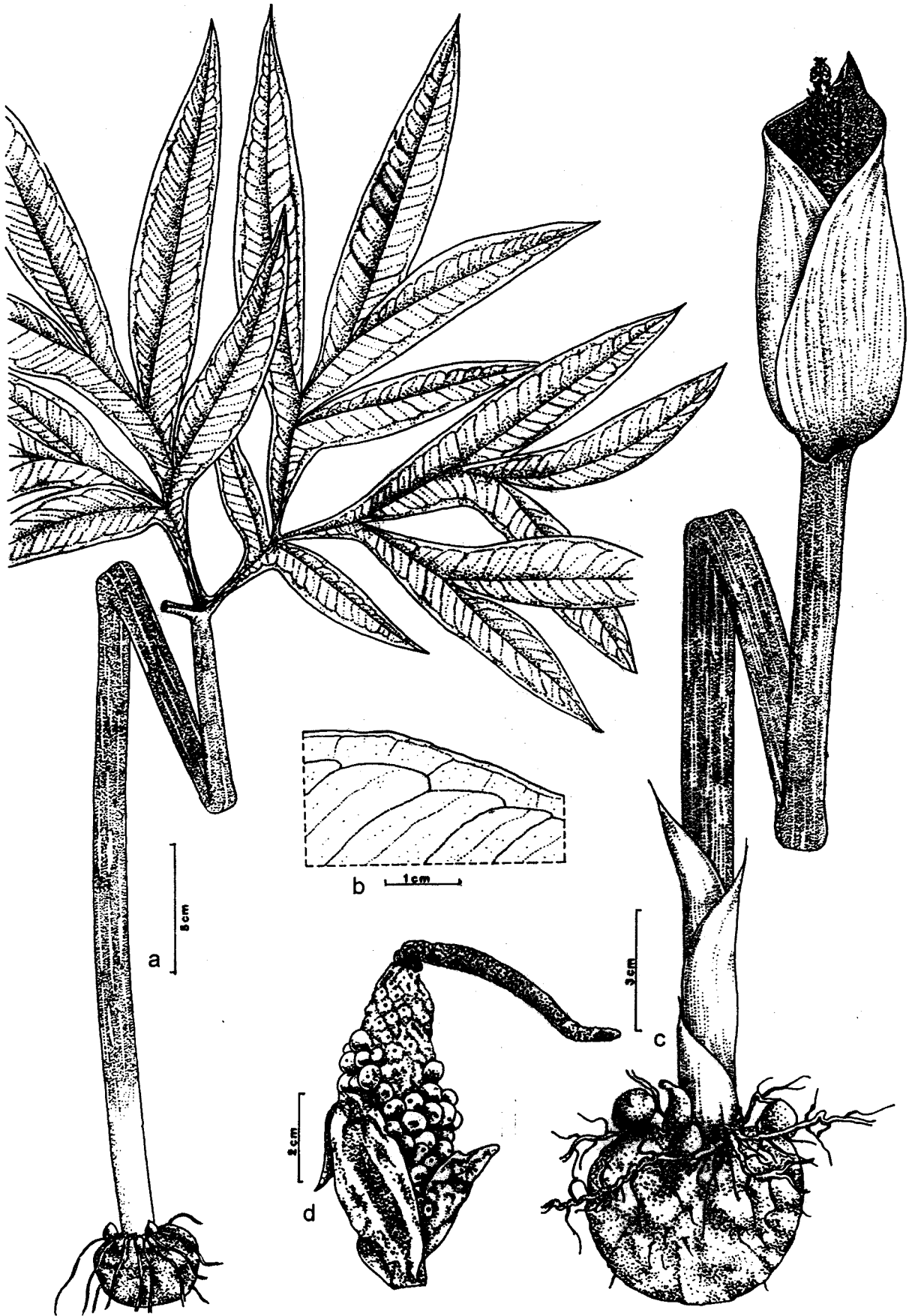


Fig. 32. *Amorphophallus longiconnectivus* Bogner: a. Tuber with leaf; b. Marginal portion of a leaflet showing venation; c. Tuber with inflorescence; d. Infructescence.

acute at the base, base unequal and decurrent on rachis, greenish above, pale below; margin slightly undulate; secondary lateral veins close, united below the margin forming a submarginal collective vein.

Peduncle smooth, 62-110 cm long, 1.2-1.7 cm diam. at base, gradually narrowed to the tip, identical with petiole in colour and pattern of stripes. Spathe erect, broadly ovate or broadly triangular, usually broader than long, 10-14 cm long, tip acute, completely convolute, not differentiated into basal tube and upper limb, pale green in colour outside, pale purplish within with dark purplish, verrucose base. Spadix as long as or slightly smaller than the spathe, with a pale green stipe of ca. 1 cm long and ca. 1.2 cm diam., female zone of ca. 1.3-2.5 cm long and 1.2-1.4 cm diam., neuteriflorous zone between male and female zones ca. 0.8-0.9 cm long and 1.2-1.4 cm diam., male zone 3.2-4.0 cm long and 0.8-1.3 cm diam., upper sterile flower zone 1.5-3.0 cm long with sterile flowers and rarely with few scattered fertile stamens; and without or usually with a terminal stipitate appendix. Female flowers sub-spirally arranged; ovary subglobose, ca. 2 mm high, ca. 2.5 mm diam., greenish, 2-3-locular, each locule with a semi-anatropous ovule; style very short, ca. 1 mm long; stigma 2-3-lobed, 1-2 mm diam., papillate. Neuteriflorous zone with loosely arranged thick based echinate fleshy neuter flowers, each 0.3-0.5 cm long, ca. 0.1 cm broad at base, rarely few with forked tips, greenish in colour. Male flowers closely arranged, golden yellow in colour, each 2-3 mm high, 1-2 mm broad, filaments short, flat, thecae lateral, ellipsoid,



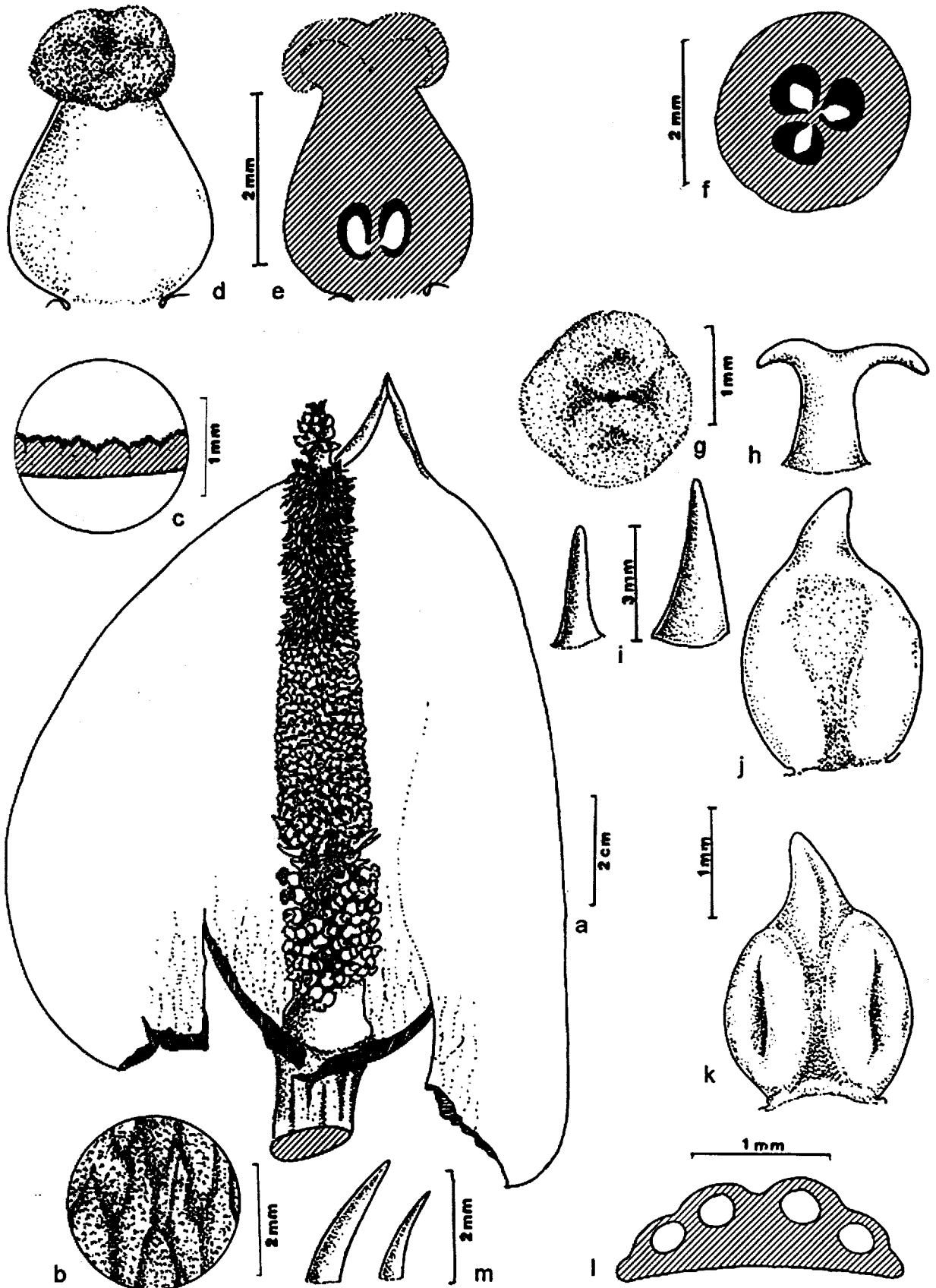


Fig. 33. *Amorphophallus longiconnectivus* Bogner: a. Inflorescence – spathe cut open showing spadix; b. A small inside portion of the spathe – magnified; c. A small basal portion of the spathe – c.s.; d. Single female flower; e. Female flower – l.s.; f. Ovary – c.s.; g. Stigma – view from top; h & i. Neuter flowers; j. Single male flower – dorsal view; k. Male flower - ventral view; l. Male flower – c.s.; m. Apical sterile flowers.

1.5-2.5 mm long; connective projected to 1-1.5 mm above the level of the thecae. Sterile flowers more or less subulate, creamy in colour. Spadix-appendix stipitate, stipe 0.3-0.8 cm long, 0.25-0.4 cm diam., green in colour, terminal part ca. 0.7-0.8 cm long, ca. 0.3 cm diam., bearing irregularly formed rudimentary male or female flowers or irregular protuberances. Rarely plants without neuter flowers and spadix-appendix are also observed. Fruits ellipsoid, 0.8-1.0 cm long, 0.6-0.8 cm diam. Seeds 2-3, ellipsoid, 0.6-0.8 cm long and 0.4-0.6 cm diam.

*Distribution:* So far known to occur only in Piparia in Madhya Pradesh State.

*Flowering:* June - July.

*Fruiting.:* August - September.

*Notes:* *Amorphophallus longiconnectivus* Bogner, a little known rare endemic species has been rediscovered from its type locality in Madhya Pradesh, after it was first discovered by Haines in the year 1910. The plants were collected in vegetative and fruiting stages during August 1997 and in flowering stage during July 1998. As the first description was based on only a single herbarium specimen representing inflorescence, detailed description of this species was not available; and it was later provided by Sivadasan and Jaleel (1988).

*Amorphophallus longiconnectivus* is very distinct and seems close to members of *Amorphophallus* sect. *Rhaphiophallus* which includes *A. hohenackeri*

(Schott) Engl. Gehrm., *A. margaritifera* (Roxb.) Kunth, *A. mysorensis* E. Barnes & C.E.C. Fisch., *A. smithsonianus* Sivad. and *S. sylvaticus* (Roxb.) Kunth. The section *Rhaphiophallus* is characterised by the presence of a zone of neuter flowers between male and female zones. *A. longiconnectivus* is very unique in various aspects and is highly variable in its spadix structure. Usually the spadix has a stipe, followed by a female zone of female flowers, a neuteriflorous zone, a male zone of male flowers, an upper sterile flower zone, and a spadix-appendix with a stipe (Fig. 33a: a). But variations from the typical condition have also been noted. In some specimens the spadix appendix is completely lacking (Fig. 33a: b). In some, both basal neuteriflorous zone and spadix-appendix are lacking (Fig. 33a: c), but this condition is very rare or may be abnormal.

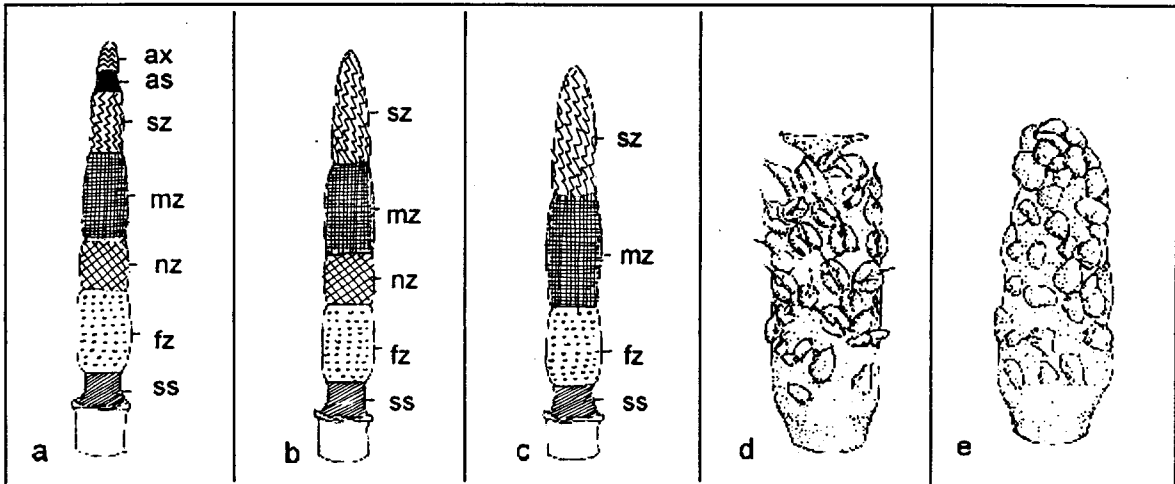


Fig. 33a. *Amorphophallus longiconnectivus* Bogner: a, b, c. Schematic diagrams showing various kinds of spadices: a. Spadix with terminal stipitate appendix; b. Spadix without terminal appendix; c. Spadix without neuteriflorous zone and terminal appendix d. Spadix appendix showing rudimentary structures, few of which resembling male flowers; e. Spadix appendix showing rudimentary structures, few of which resembling female flowers; (as- stipe of spadix appendix; ax - spadix appendix; fz- female zone; nz- neuteriflorous zone; mz- male zone; ss- stipe of spadix; sz - sterile flower zone).

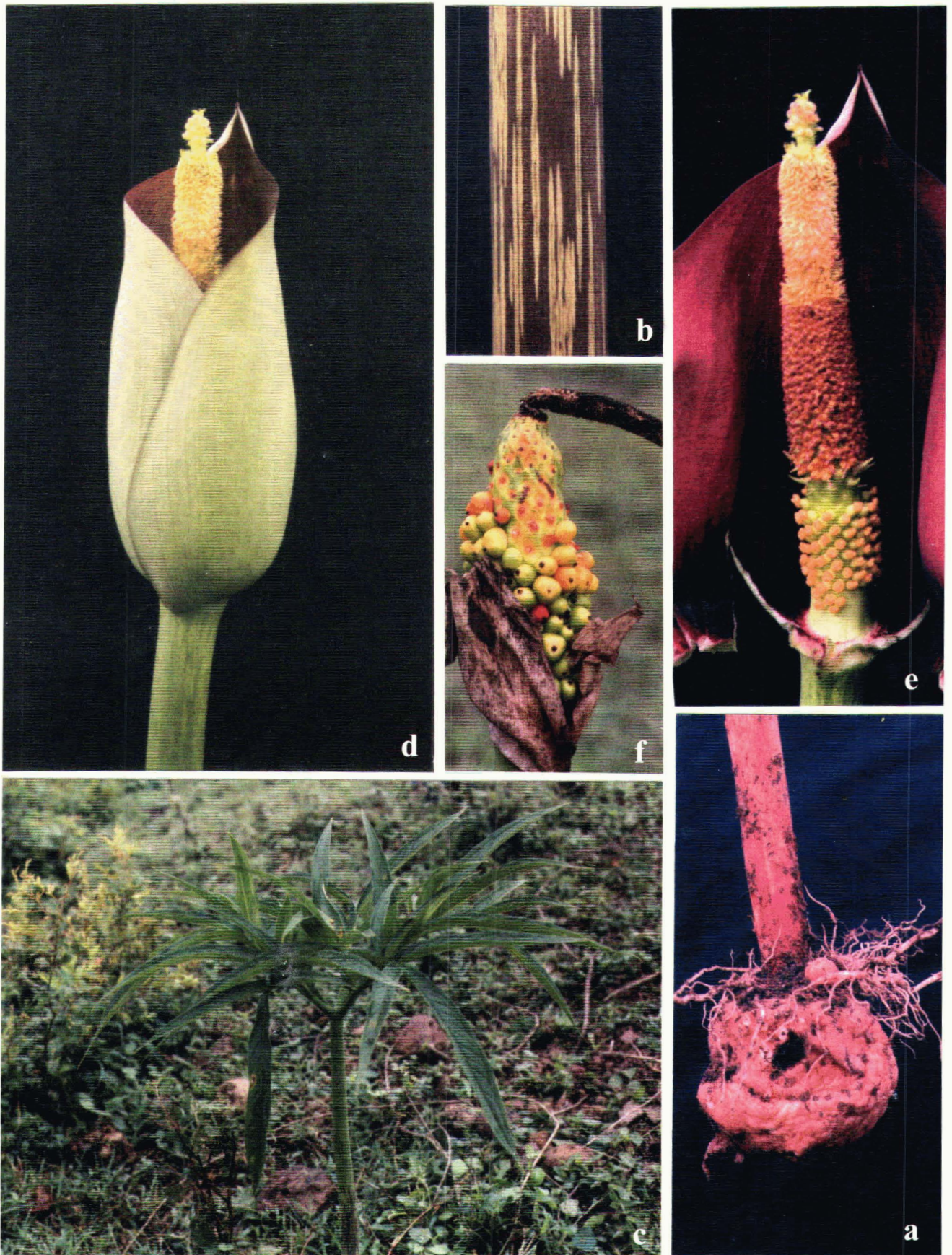


Plate XIII. *Amorphophallus longiconnectivus* Bogner: a. Tuber with basal part of petiole; b. A portion of petiole showing mottlings; c. Leaf - side view; d. Inflorescence; e. Inflorescence with spathe cut open showing spadix; f. Infructescence.

The connectives of the male flowers exhibit variation in their length. Flowers of the basal part of the male zone are with comparatively longer protruding connectives, whereas they are shorter in the flowers of the upper part. In inflorescences without appendices, male flowers have longer connectives compared to that of other inflorescences.

Appendix of the spadix also shows variation. In some cases the appendix bears irregularly formed structures, some of which resemble rudimentary sterile male flowers; in others it bears structures some of which resemble irregularly formed female flowers (Fig. Fig. 33a: d & e).

*Specimens examined:* **Madhya Pradesh State:** Piparia, 28<sup>th</sup> Aug. 1997, *Abdul Jaleel & Bobby Thomas RIA 131* (leaf) (CALI), *RIA 132* (infr.) (CALI); *Ibid.*, 16<sup>th</sup> July, 1998, *Abdul Jaleel RIA 316* (infl.) (CALI).

**11. *Amorphophallus longistylus* Kurz** (Rep. Andaman 50. 1866, *nomen*) ex Hook. f., Fl. Brit. India 6: 515. 1893; Engl., Pflanzenr. IV. 23(48): 83. 1911; Srivast. & Rao in Higher Pl. Ind. Subcont. 4: 32. 1993; Sivad. & Jaleel, Rheedeia 8(1): 103. 1998. (Figs. 34 & 35; Plate XIV).

*Types:* India, South Andaman, (No date), *Kurz s.n.* (Holo – CAL; Iso – K).

Tubers sub-globose, 5.0 - 6.5 cm diam. and 4-5 cm thick in vegetative phase, ca. 6.2 cm in diam. and 4.2 cm thick in reproductive phase; skin pale brown or dark

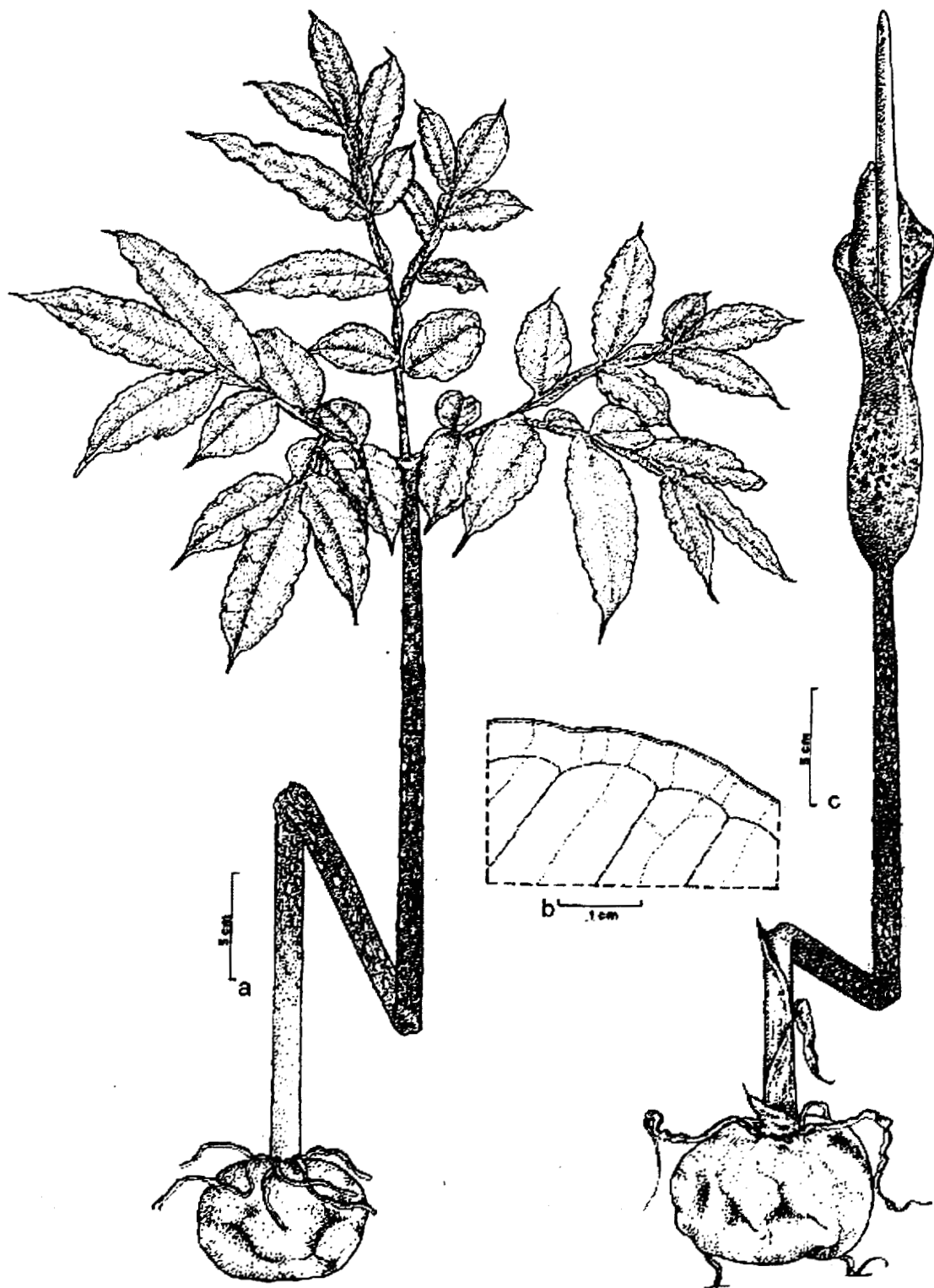


Fig. 34. *Amorphophallus longistylus* Kurz ex Hook. f.: a. Tuber with leaf; b. Marginal portion of a leaflet showing venation; c. Tuber with inflorescence.

cream in colour; roots numerous, cream in colour, ca. 8.5-11.5 cm long. Petiole ca. 43-71 cm long, ca. 1-2.5 cm diam. at base, slightly tapering to the tip, surface uneven with white elongated or round thickened swellings or projections; pale greenish with greenish black and white mottles. Lamina 44-57 cm diam.; leaflets sessile, ovate to oblong, apex acuminate, 6.5-12 cm long and 2.8-4.6 cm broad; base of the leaflets of the secondary rachises decurrent on rachis, leaflets of the primary rachises usually without basal decurrence; greenish above, paler below with pinkish tinge along the veins, margins and tip; margin undulate; primary veins closely parallel, 12-14 pairs, united below the margins by arches forming sub-marginal collective vein; veins depressed above and projected below.

Peduncle resembling the petiole in colour and texture, ca. 30.5-42.5 cm long, 1.0-1.2 cm in diam., surrounded at base by 3-4 cataphylls; each cataphyll ca. 3-13 cm long and ca. 2.2-3.4 cm broad, smooth, tip acute, creamy-purplish with green patches, tip purplish. Spathe erect, ovate-lanceolate, ca. 18.5-23.5 cm long, 9.5-10.5 cm broad at the base, 10.5 cm at the middle, tip acute, basal convolute tube to ca. 7.5-14 cm high, and 3.5-4 cm diam.; upper expanded limb portion with longitudinal shallow folds on either sides of the mid-portion; light purplish with greenish black blotches and small dark spots on the outside, more on the basal tube; smooth, dark purplish and verrucose at base, pale purplish and smooth above with few light greenish-black blotches above within. Spadix longer than the spathe, exerted, ca. 24-26 cm long, differentiated into a basal short stipe, a fertile portion of

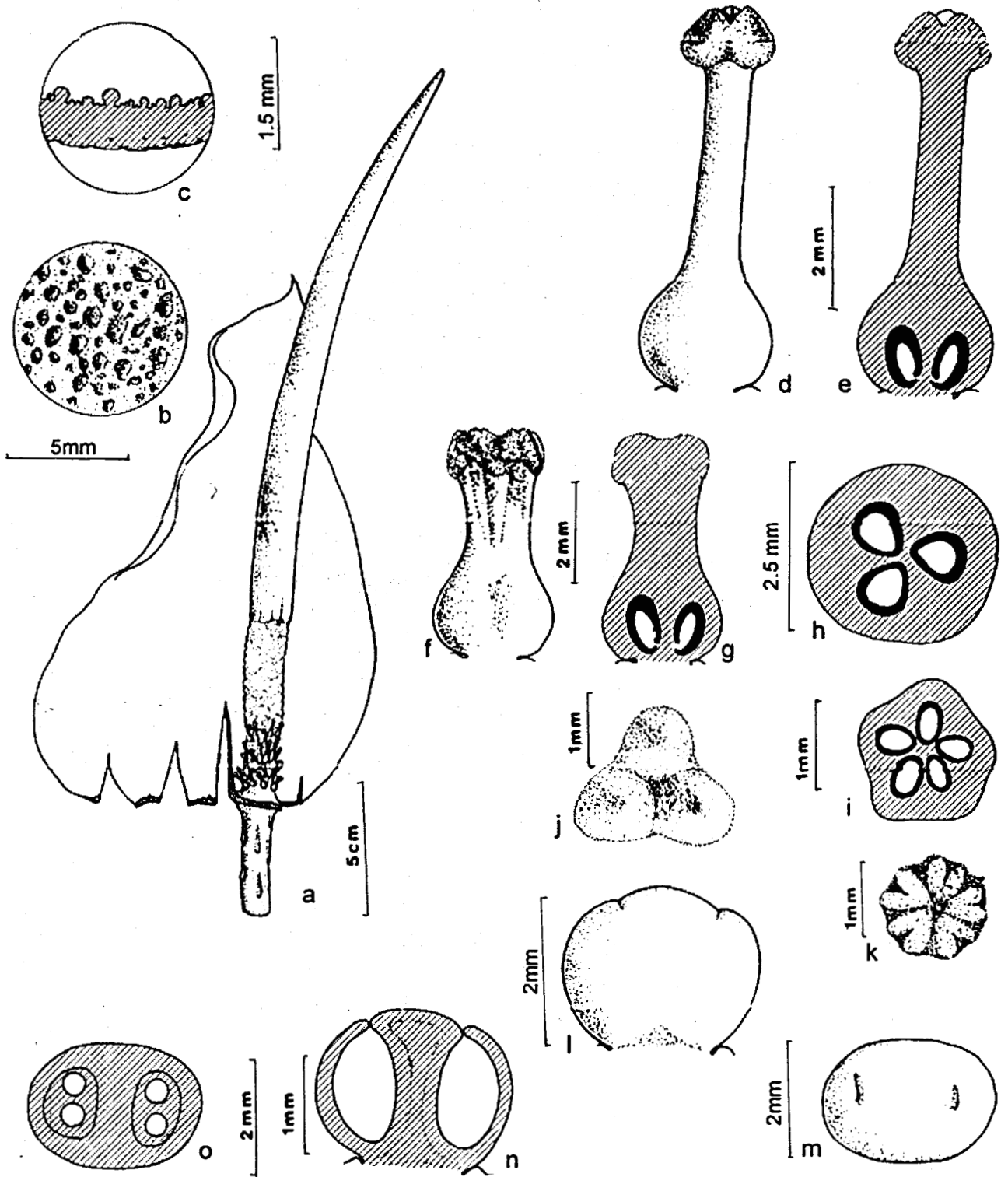


Fig. 35. *Amorphophallus longistylus* Kurz ex Hook. f.: a. Inflorescence – spathe cut open showing spadix; b. A small basal inner portion of spathe – magnified; c. A small basal portion of spathe – c.s.; d. Single female flower with long style; e. Long-styled female flower – l.s.; f. Single female flower with short style; g. Short-styled female flower – l.s.; h. C.s. of ovary with three locules; i. C.s. of ovary with five locules; j. Three-lobed stigma – view from top; k. Five-lobed stigma – view from top; l. Male flower – view from broad side; m - Male flower - view from top showing openings of thecae; n. Male flower – l.s.; o. Male flower – c.s.



female and male zones above, and a terminal sterile naked appendix; stipe to ca. 0.2-0.4 cm long, ca. 0.7 cm diam., cream-coloured with purplish tinge; female zone ca. 2.4-3.2 cm long with about 60-80 flowers, loosely arranged in spiral sequence; male zone longer than female zone, ca. 3.2-3.7 cm long, and 1.3-1.7 cm diam. Female flower ca. 5-8 mm high, ovary shallowly 3-5 lobed, greenish yellow in colour, ca. 2-2.5 mm diam., 1.75-2 mm high, 3-5-locular, each locule with a single basal anatropous ovule; style ca. 3-7 mm long, 1 mm diam., rarely slightly broader, dark purplish in colour, rarely with longitudinal ridges at the upper portion; stigma 3-5-lobed, rarely 2-lobed, 1.5-2 mm diam., creamy in colour. Male flowers closely arranged, each ca. 1.5 mm diam. and 2 mm high, sessile, inconspicuously 2-lobed, yellowish-creamy in colour with purplish tinge on the connective at top, dehiscence by apical slits appearing as pores. Spadix-appendix cylindrical, gradually tapering to the tip, ca. 17-20 cm long, ca. 1.2-1.8 cm diam. at base and 0.2 cm at top.

*Flowering:* May - June.

*Fruiting:* Fruits could not be collected.

*Distribution:* Known to occur only in Andaman Islands.

*Notes:* The species *A. longistylus* was first collected by Kurz during his visit to the Andaman Islands in the months of April-June of 1866. No later collection are known to have been made. The species was rediscovered from the evergreen forest in Panchawati, Middle Andaman during the study. The present collection is a



Plate XIV. *Amorphophallus longistylus* Kurz ex Hook. f.: a. Tuber; b. A portion of petiole showing mottlings; c. Central portion of lamina – topview; d. Inflorescence; e. Inflorescence with spathe cut open showing fertile portion of spadix.

second authentic collection of the species after about 131 years of its discovery and first collection by Kurz. Two plants of the species were collected in vegetative phase during November 1997, and were introduced in the Calicut University Botanical Garden. One of them flowered in May 1998. The detailed study of the inflorescence confirmed the identity of the species. Later more specimens were collected from South Andaman during the field trip carried out in May 1999. The inflorescences of the later collected specimen are with female flowers having long styles which are more than twice or thrice the height of the ovary.

*Amorphophallus longistylus* Kurz is distinguished from other species by having petioles and peduncles which are pale green with greenish black and white mottles and with elongated round thickened bumps or projection or swellings, the style more than twice or thrice the length of the ovary, spathe ovate-lanceolate, and spadix longer than the spathe.

*Specimens examined:* **South Andaman**, *s.d.*, Kurz *s.n.* (CAL, K); Middle Andaman, Panchawati, 7<sup>th</sup> Dec. 1997, *Abdul Jaleel & Bobby Thomas* RIA 224 (leaf) (CALI); **Kerala State**, Calicut University Botanical Garden, 2<sup>nd</sup> May 1998, *Abdul Jaleel & Sivadasan* RIA 227 (Leaf) (CALI) (Originally collected on 7<sup>th</sup> Dec., 1997, *Abdul Jaleel & Bobby Thomas* RIA 224 - from Panchawati, Middle Andaman and introduced in the Calicut University Botanical Garden); South Andaman, Chidiyatappu, 24<sup>th</sup> May 1999, *Abdul Jaleel* RIA 357 (leaf) (CALI); **North**

**Andaman**, Ray Hill, 26<sup>th</sup> May 1999, *Abdul Jaleel RIA 363* (infl.) (CALI); *Ibid.*, 26<sup>th</sup> May 1999, *Abdul Jaleel RIA 364* (leaf) (CALI).

**12. *Amorphophallus margaritifer* (Roxb.) Kunth**, Enum. Pl. 3: 34. 1841; Hett. & De Sarkar, Aroideana 19: 131. 1996. (Figs. 36 & 37; Plate XV).

*Arum margaritifera* Roxb., Fl. Ind. (Ed., Carey) 3: 512. 1832; Wight, Ic. 3(1): 6, t. 795. 1844.

*Plesmonium margaritifer* (Roxb.) Schott, Syn. Aroid. 34. 1856 ("*margaritifera*"), Gen. Aroid. 5. 26. 1858, Prodr. Syst. Aroid. 124. 1860; Engl. in DC., Monogr. Phan. II: 303. 1879; Hook. f., Fl. Brit. India 6: 518. 1893; Haines, For. Fl. Chota Nagpur 553. 1910; Engl., Pflanzenr. IV 23C (48): 49. 1911; Fisch. in Gamble, Fl. Pres. Madras 1588. 1931; Mitra, Fl. Pl. E. India 1: 75. 1958; Duthie, Fl. Upper Gangetic Plain, repr. ed. 2: 364. 1960; Haines, Bot. Bihar & Orissa, repr. ed. 3: 902. 1961; Prain, Bengal Pl., repr. ed. 2: 835. 1963; Babu, Herb. Fl. Dehra Dun 538. 1977; Singh, Fl. Banswara 230. 1983; Mukh., Fl. Pachmarhi & Bori Reserv. 313. 1984; Verma, Fl. Raipur 396. 1985; Henry, Chitra & Balakrishnan, Fl. Tamilnadu, 3: 57. 1989; Ellis, Fl. Nallamalais 2: 403. 1990; Shetty & Singh, Fl. Rajasthan 3: 867. 1993; Pullaiah, Fl. Andhra Pradesh 3: 1026. 1997.

*Lectotype*: Wight, Ic. Pl. Ind. Or. 3(1) (1844), Plate 765.

Tubers more or less sub-globose to depressed globose, 2.5-5.0 cm diam. and 1.8-3.5 cm thick in vegetative phase, ca. 7-13 cm diam. and 5-6.5 cm thick in

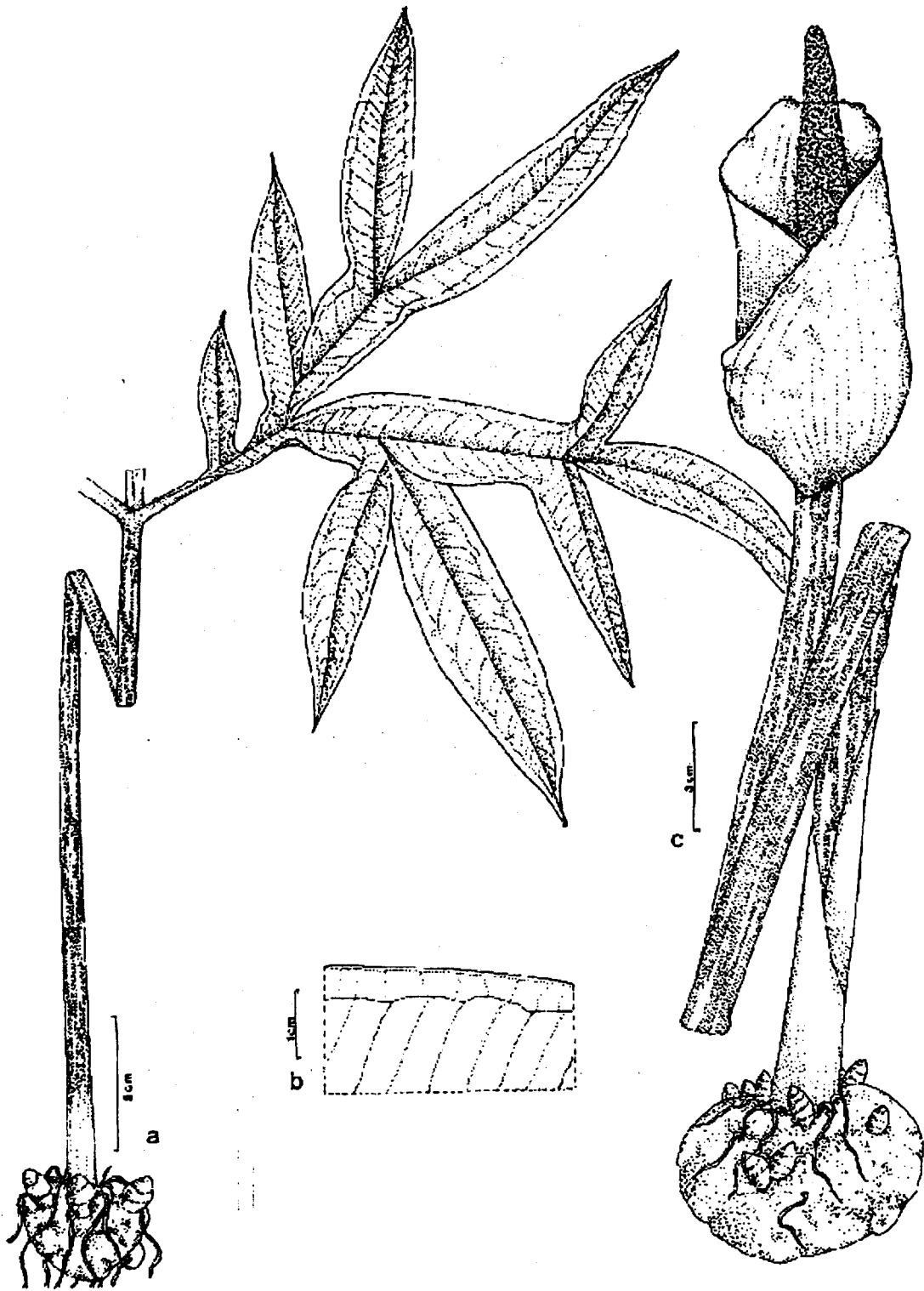


Fig. 36. *Amorphophallus margaritifera* (Roxb.) Kunth: a. Tuber with leaf; b. Marginal portion of a leaflet showing venation; c. Tuber with inflorescence.

reproductive phase, seasonally producing numerous small globose to fusiform offsets, varies in number from 7-11, each 0.5-0.7 cm diam. and 0.8-1.4 cm thick; skin pale brown to yellowish brown in colour. Petiole smooth, ca. 24-84 cm long, 1-3.25 in diam. at base and narrows to the tip; green with numerous narrowly elongated pale green stripes with black margin, and small spots in between, paler towards the tip, dark green to blackish green at the extreme base. Lamina 32-76 cm diam., the primary rachises smooth, terete, colour same as that of petiole, 3-9 cm long, 0.4-1.2 cm diam., larger leaflets ca. 13.5-24 cm long, 1.7-3.5 cm broad; small leaflets 8-16 cm long, 1.1-3.0 cm broad, linear to lanceolate, decurrent at bases, upper surface green and paler below, venation pinnately reticulate, primary veins united below the margin forming a sub-marginal collective vein.

Peduncle cylindrical, smooth, 50-70 cm long, 2-4 cm diam., colour same as that of the petiole. Spathe erect, broader than long, broadly ovate or broadly triangular, 11-17.5 cm long, 13-20 cm broad, tip acute, not differentiated into basal tube and upper limb; pale greenish outside, pale purplish within, dark purplish with prominent murications at the base within. Spadix as long as or slightly longer than the spathe, 14-20 cm long, differentiated into a basal stipe, followed by female, neutral and male zones, terminal appendix lacking; stipe 0.6-1.1 cm, greenish; female zone 1.1-2.8 cm long, 0.9-1.8 cm diam.; neuteriflorous zone 2.0-3.5 cm long; male zone elongate-conoidal, 6-9 cm long, 1-1.5 cm diam. at base and narrows to the tip. Female flowers loosely arranged; each flower 5-6 mm high,

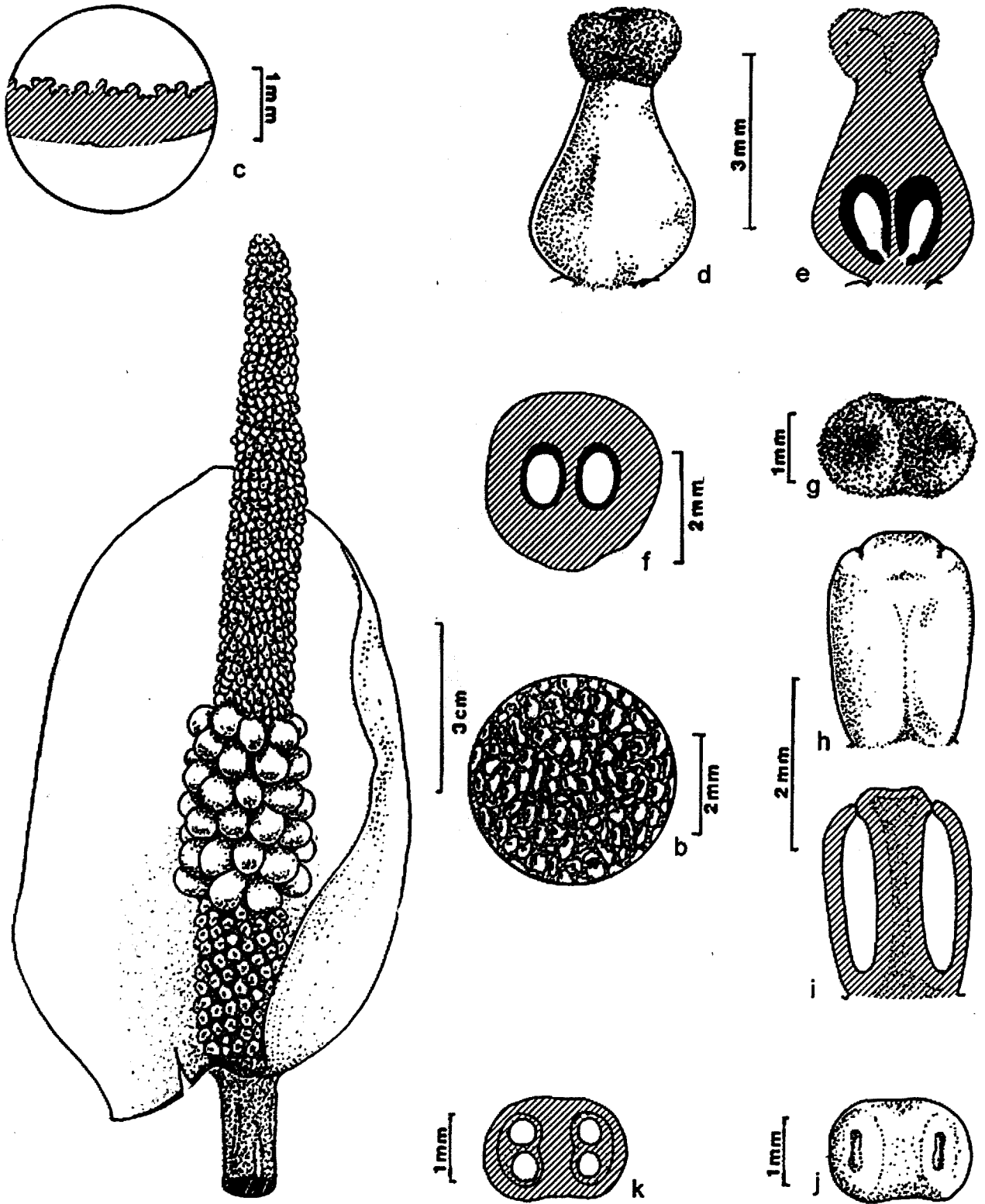


Fig. 37. *Amorphophallus margaritifera* (Roxb.) Kunth: a. Inflorescence – spathe cut open showing spadix; b. A small basal inside portion of the spathe – magnified; c. A small basal portion of the spathe – c.s.; d. Single female flower; e. Female flower – l.s.; f. Ovary – c.s.; g. Stigma – view from top; h. Male flower – view from broad side; i. Male flower – l.s.; j. Male flower – view from top showing the openings; k. Male flower – c.s.

ovary pale green, slightly broader than stigma, 2.5-3.0 mm high, ca. 2.5 mm diam., 2-locular, each locule with one basal anatropous ovule; style very short, 0.5-1 mm high, ca. 1 mm diam., colour same as that of ovule; stigma yellowish, capitate, hemispherical, distinctly 2-lobed, rarely 3-lobed, ca. 2 mm high, 2 mm diam., surface verrucate. Neuter flowers loosely arranged, large, each neuter flower elongate-obovoid, ca. 7-9 mm long, 4-5 mm diam. at top, cream-coloured, tip obtuse or subtruncate. Male flowers densely arranged, each flower 2-3 mm high, 1.5-2 mm broad, pale brownish yellow. Fruit subglobose, red-coloured berry, ca. 8 cm long.

*Flowering:* May - June.

*Fruiting:* August.

*Distribution:* Andhra Pradesh, Madhya Pradesh, Uttar Pradesh, Rajasthan, Bihar, West Bengal, Sikkim and Assam.

*Notes:* *Amorphophallus margaritifer* closely resembles *A. longiconnectivus* in its general appearance of greenish spathe that is not differentiated into tube and limb, and the nature of the spadix. But the former differs from the latter in having large elongate-obovoid, cream-coloured neuter flowers, and the lack of spadix-appendix. *A. longiconnectivus* is having a short stipitate appendix and in some cases the appendix bears irregularly formed structures, some of which resemble rudimentary



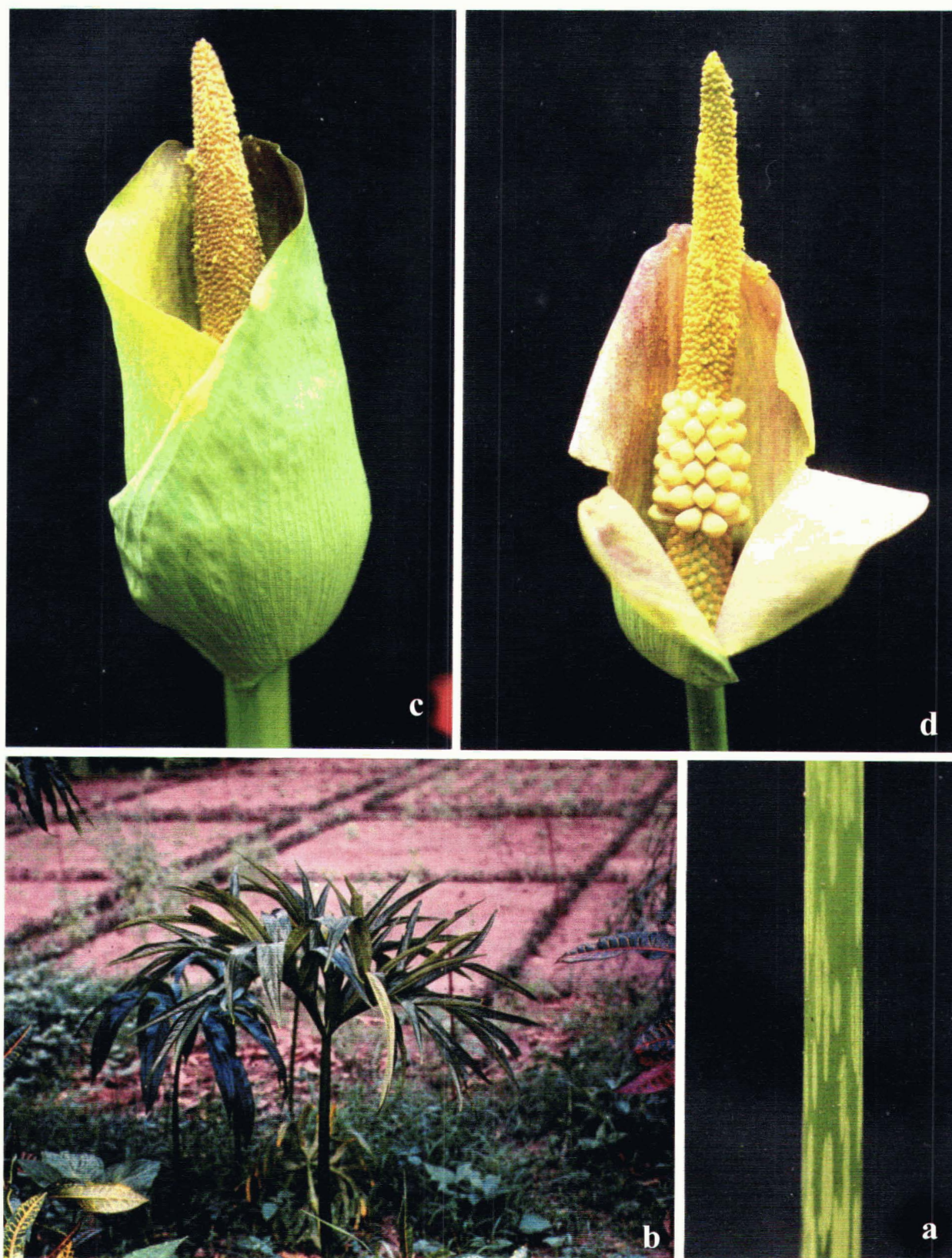


Plate XV. *Amorphophallus margaritifer* (Roxb.) Kunth: a. A portion of petiole showing mottlings; b. Leaf; c. Inflorescence; d. Inflorescence with spathe cut open showing spadix.

sterile male or female flowers; and the neuter flowers are greenish, short, stout and echinate.

Rarely in some of the species of *A. longiconnectivus* the neuter flowers and spadix-appendix are lacking and hence there may be a chance of gradual reduction of appendix size and its absence. This evidence shows that *A. margaritifera* may have evolved from species like *A. longiconnectivus*.

*Specimens examined:* **Madhya Pradesh State:** Hoshangabad, Mahaba, 16<sup>th</sup> July 1964, *Panigrahi & Singh 4205* (BSA); Hoshangabad, 26<sup>th</sup> July 64, *Panigrahi & Singh, Acc. No. 4514* (BSA); Sidhi Dist., Chitrang, 25<sup>th</sup> July 1968, *Sen Gupta 12791* (BSA); "Central Prov.", Raipur, 24<sup>th</sup> Oct. 1896, *Martin, Acc. No. 496881* (leaf) (CAL); Raipur, Khalani, 3<sup>rd</sup> June 1971, *Verma 17523* (BSA); Ambikapur, Kamleshwarapur, 1000 m, 26<sup>th</sup> Nov. 1972, *Sen Gupta, Acc. No. 15930* (BSA). **Uttar Pradesh State:** Dehra Dun, June 1895, *Mac Kurin S. Coll.* (Infl.) (DD); *Ibid.*, 27<sup>th</sup> Jun. 1929, *Champion Acc. No. 49373* (Infl.) (DD). Lucknow, Chapruwakhida, 23<sup>rd</sup> July 58, *Patil 1217* (leaf) (BSA); Mirzapur, 27<sup>th</sup> July 65, *Misra 9978* (BSA); Bareilly Dist., Mailani, 28<sup>th</sup> Aug. 1962, *Malhotra 22864* (leaf) (BSD); Kheri Dist., Mohrina, 1<sup>st</sup> June 00, *Inayal 23886* (Infl.) (DD); Bahraich Dist., Bhachkai, 15<sup>th</sup> June 98, *Hansukh 22848a* (DD); **Bihar State:** Purneah Dist., Purneah, 9<sup>th</sup> Aug. 1906, *Burkill 27322* (CAL); **West Bengal State:** Uttar Dinajpur, 14<sup>th</sup> Sept. 1997, *Abdul Jaleel & Bobby Thomas RIA 149* (leaf) (CALI); *Ibid.*, 21<sup>st</sup> June 1998, *Abdul Jaleel 287* (infl.) (CALI).

**13. *Amorphophallus mysorensis*** E. Barnes *et* C.E.C. Fisch., Bull. Misc. Inform. 10: 661. 1939; Siavad. *et* Jaleel, Aroideana 24: 94. 2001. (Figs. 38 & 39; Plate XVI).

*Type*: Karnataka State ("Mysore State"), Punjur Ghat, Billigirirangan Hills, 3500', 22 April 1939, *Barnes 2133* (K).

Tubers depressed globose, 2.5-9.0 cm in diam. and 2.0-5.0 cm thick in vegetative phase; ca. 8.5 cm diam. and 3.0 cm thickness in flowering phase, skin cream-coloured. Leaf with petiole smooth, 37.5-54.0 cm long, 0.5-1.5 cm diam. at base, slightly tapering to the tip, pale greenish with dark olive-green and brownish-black mottlings, paler towards the tip portion, extreme base whitish or pale pink in colour; leaflets sessile, linear-lanceolate, acuminate at apex and decurrent at base, large leaflets 9.0-18.5 cm long and ca. 1.8 cm broad, small leaflets 1.8-4.0 cm long and ca. 0.8 cm broad, light green above and paler below, lateral nerves 7-11 pairs, distally uniting forming a submarginal vein; veins depressed above and projected below.

Inflorescence with peduncle slender, smooth, ca. 63 cm long, and ca. 1.0 cm diam. at base, gradually narrowed to the tip, identical with petiole in colour and pattern of mottling. Spathe erect, broadly-ovate, ca. 12.5 cm long, and ca. 12 cm broad; tip acute, fully convolute, ca. 4.5 cm diam. at base and 3.7 cm diam. at top just below the mouth; mouth dilated, 4.8 cm diam., not differentiated into tube and

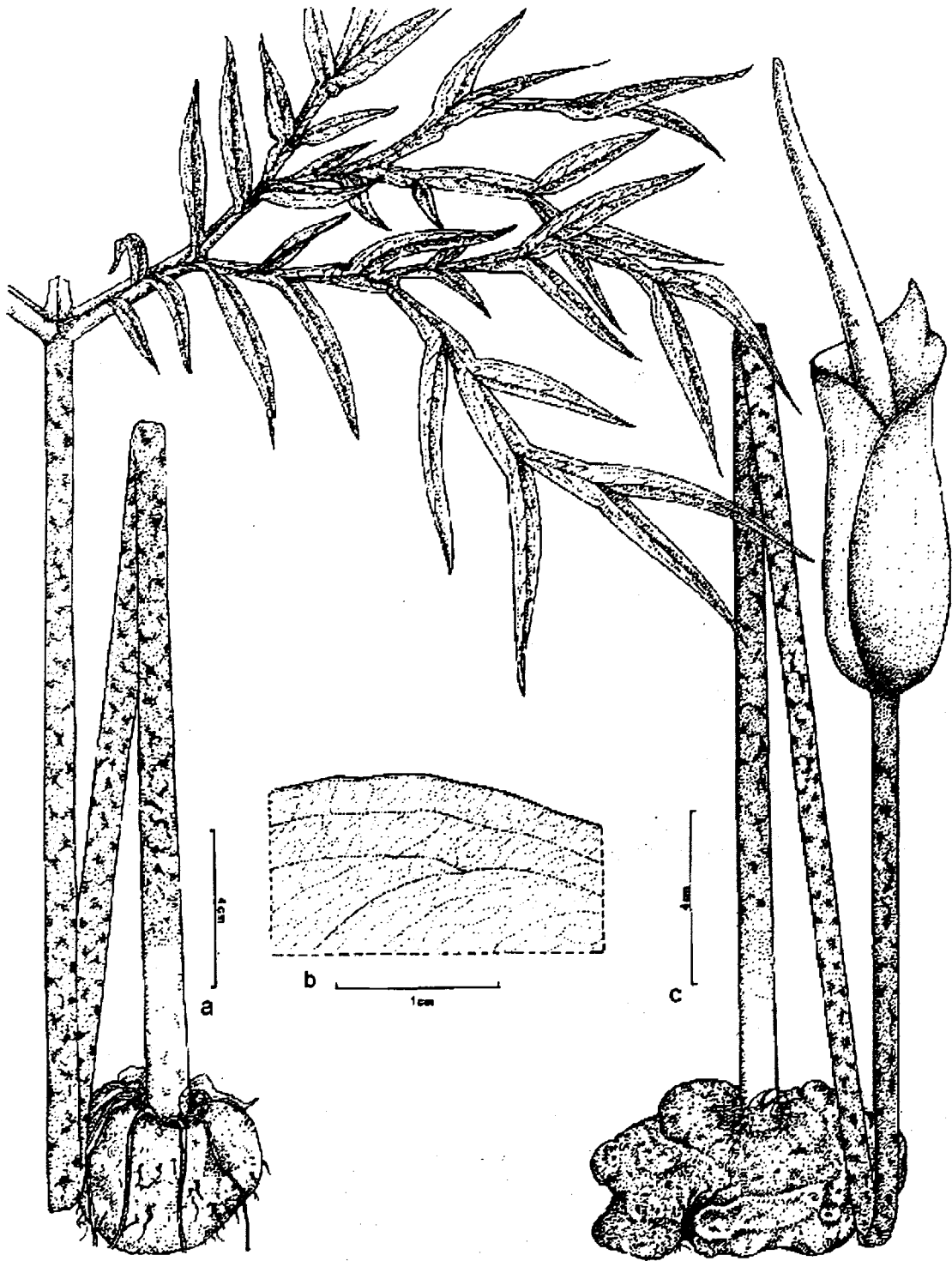


Fig. 38. *Amorphophallus mysorensis* E. Barnes et C.E.C. Fisch.: a. Tuber with leaf; b. Marginal portion of a leaflet showing venation; c. Tuber with inflorescence.

limb; dull purplish in colour outside with numerous fine, raised parallel veins; purplish at top and dark purplish and verrucose at base within. Spadix longer than the spathe, ca. 18 cm long with a stipe of ca. 0.6 cm long and 1.2 cm diam.; female zone ca. 2.0 cm long and 1.2 cm diam., male zone ca. 5.8 cm long and 1.0 cm diam., neuteriflorous zone between male and female zones ca. 1 cm long, terminal sterile appendix of ca. 8.5 cm long, and 0.7 cm diam. at base and narrowed to the tip. Female flowers closely arranged; ovary spherical, ca. 2 mm diam., yellowish green, 2-4-locular, each locule with single basal anatropous ovule; stigma sessile, 2-4-lobed, pale yellow in colour. Neuter flowers closely arranged, each flower spherical, brownish-red, glossy, ca. 0.6 cm diam. Male flowers closely arranged, each ca. 1.75 mm high, ca. 1.5 mm broad, 4-celled, opening by 2 apical elongated pores, yellowish flushed with red at top along the connective. Spadix-appendix cylindrical, tapering towards the tip, dark purplish, inconspicuously irregularly furrowed at the base, smooth above, becoming warty and wrinkled after anthesis. Infructescence could not be collected and observed.

*Distribution:* Known to occur only in the type locality - Karnataka State: Mysore Dist., Billigirirangam Hills.

*Flowering:* March – April.

*Fruiting:* Fruits could not be collected.

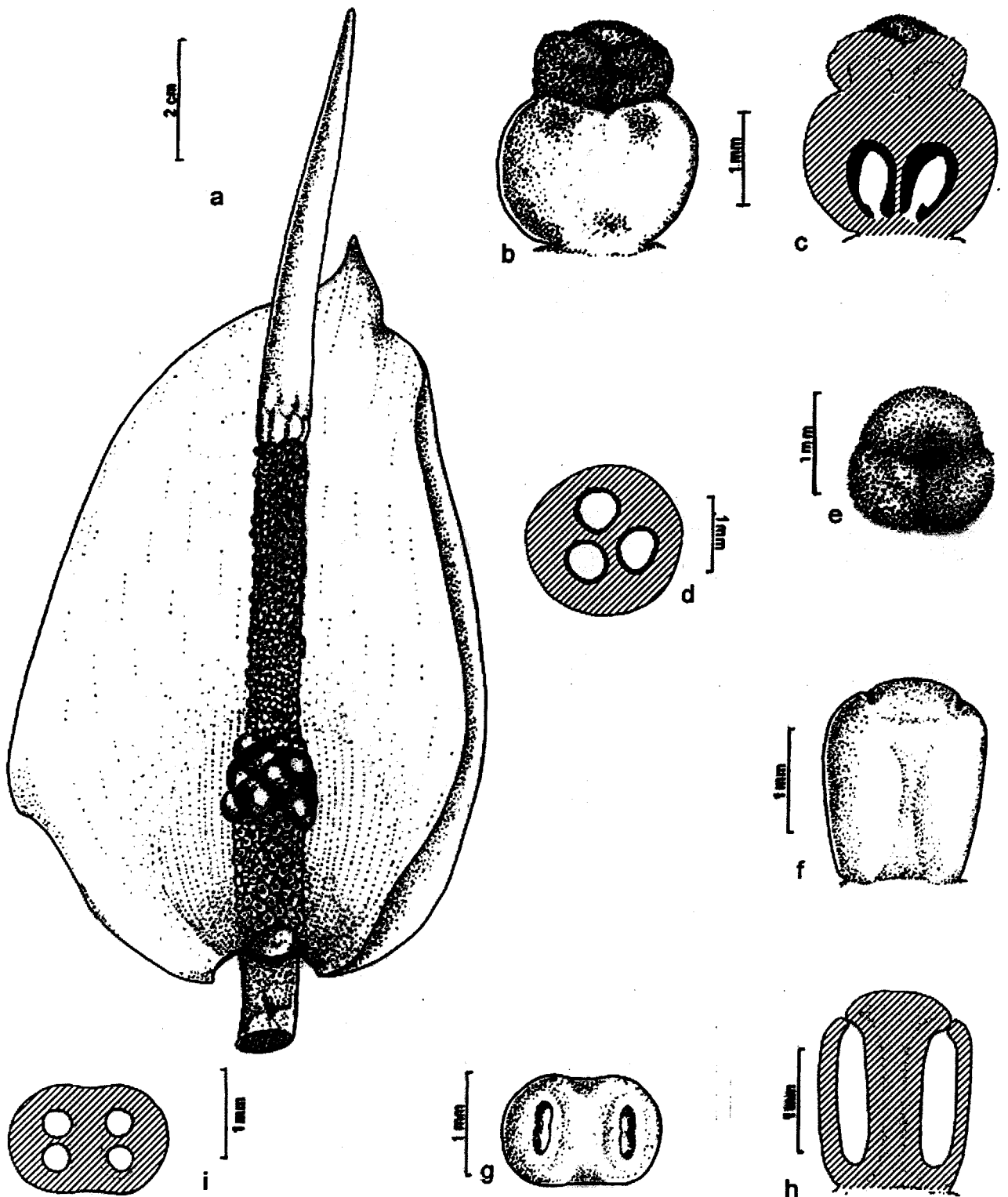


Fig. 39. *Amorphophallus mysorensis* E. Barnes et C.E.C. Fisch.: a. Inflorescence - spathe cut open showing spadix; b. A single female flower; c. Female flower - l.s.; d. Ovary - c.s.; e. Stigma - view from top; f. Male flower - view from broad side; g. Male flower - view from top showing the openings; h. Male flower - l.s.; i. Male flower - c.s.

*Notes:* *Amorphophallus mysorensis* differs from other species in having a dull purplish-coloured completely convolute spathe, globose brownish-red, glossy, neuter flowers, and an exerted dark purplish spadix-appendix.

It does not resemble with any of the Indian species in its general appearance and colour pattern of the spathe, but it shows similarity with *A. longiconnectivus* and *A. margaritifera* only in its fully convolute spathe; but the latter two species entirely differ in its shape, structure and colour pattern of spathe and spadix.

*Specimens examined:* **Karnataka State:** Mysore Dist.: Billigirirangan Hills, Punjur Ghat, 3500 ft, 22<sup>nd</sup> April 1939, *Barnes 2131* (2 inflorescences) (K); *Ibid.*, 22<sup>nd</sup> April 1939, *Barnes 2133* (4 inflorescences) (K); *Ibid.*, 3<sup>rd</sup> mile, 3500 ft, May 1939, *Barnes 2160* (tuber with leaf) (K); *Ibid.*, June 1939, *Barnes 2158* (leaf) (K); *Ibid.*, 3<sup>rd</sup> mile, 3500 ft., June 1939, *Barnes 2159* (leaf without basal portion of petiole) (K); *Ibid.*, June 1939, *Barnes 2159A* (fruiting specimen and portion of petiole) (K); *Ibid.*, June 1939, *Barnes 2161* (tuber with leaf) (K); *Ibid.*, June 1939, *Barnes 2156* (tuber with leaf) (K); *Ibid.*, 12<sup>th</sup> Sept., 1999, *Abdul Jaleel RIA 378* (tuber with leaf) (CALI); **Kerala State:** Malappuram, Calicut University Botanical Garden, 31<sup>st</sup> March 2000, *Abdul Jaleel RIA 380* (tuber with inflorescence) (originally collected from Billigirirangan Hills, Mysore, and introduced in the Calicut University Botanical Garden) (CALI); *Ibid.*, 20<sup>th</sup> October 2000, *Abdul Jaleel RIA 388* (leaf) (CALI).



Plate XVI. *Amorphophallus mysorensis* E. Barnes et C.E.C. Fisch.: a. Tuber; b. A portion of petiole showing mottlings; c. Lamina – top view; d. Inflorescence; e. Inflorescence with spathe cut open showing fertile portion of spadix.



**14. *Amorphophallus napalensis* (Wall.) Bogner et Mayo**, in Bogner, Mayo & Sivadasan, *Aroideana* 8(1): 19. 1985; Hajra & Verma, *Fl. Sikkim* 1: 186. 1996; Hett. & Ittenbach, *Aroideana* 19: 103. 1996. (Figs. 40 & 41; Plate XVII).

*Thomsonia napalensis* Wall., *Pl. Asiat. Rar.* 1: 83, t. 99. 1830; Bl., *Rumphia* 1: 150. 1837; Engl. in DC., *Monogr. Phan.* II: 306. 1879, in Engl. & Prantl., *Pflanzenfam.* II. 3: 126. 1899; Hook. f., *Fl. Brit. India* 6: 518. 1893; Hooker, *Bot. Mag.* 120: t. 7342. 1894; Engl., *Pflanzenr.* IV. 23C. (48): 56. 1911; Hara, *Fl. E. Himalaya* 398. 1966.

*Pythonium wallichianum* Schott in Schott & Endl., *Melet. Bot.* 17. 1832, *Syn. Aroid.* 36. 1856, *Gen. Aroid.* t. 25. 1858, *Prodr. Syst. Aroid.* 123. 1860.

*Arum grandiflorum* Herb. Ham.-Aroid. *Wall. Cat. n.* 8949.

*Type*: Nepal, in mountain forests, flowering in June, illustration – t. 99 – published by Wallich (*Pl. As. Rar.* I: 1830).

Tubers subglobose or depressed globose, 5-8.5 cm diam. and 4.5-6.5 cm thick in vegetative phase, 7.5-10 cm diam. and 5-8 cm thick in reproductive phase, skin pale brown to dark dirty brown in colour, offsets are produced (observed only in the corms of vegetative and not in reproductive) from the corm, each offset elongated and gradually thickened and becomes sub-spherical at tip, 3.5-7.5 cm long, 0.5-0.7 cm diam. at cylindrical base, and 1.3-1.7 cm diam. at sub-spherical

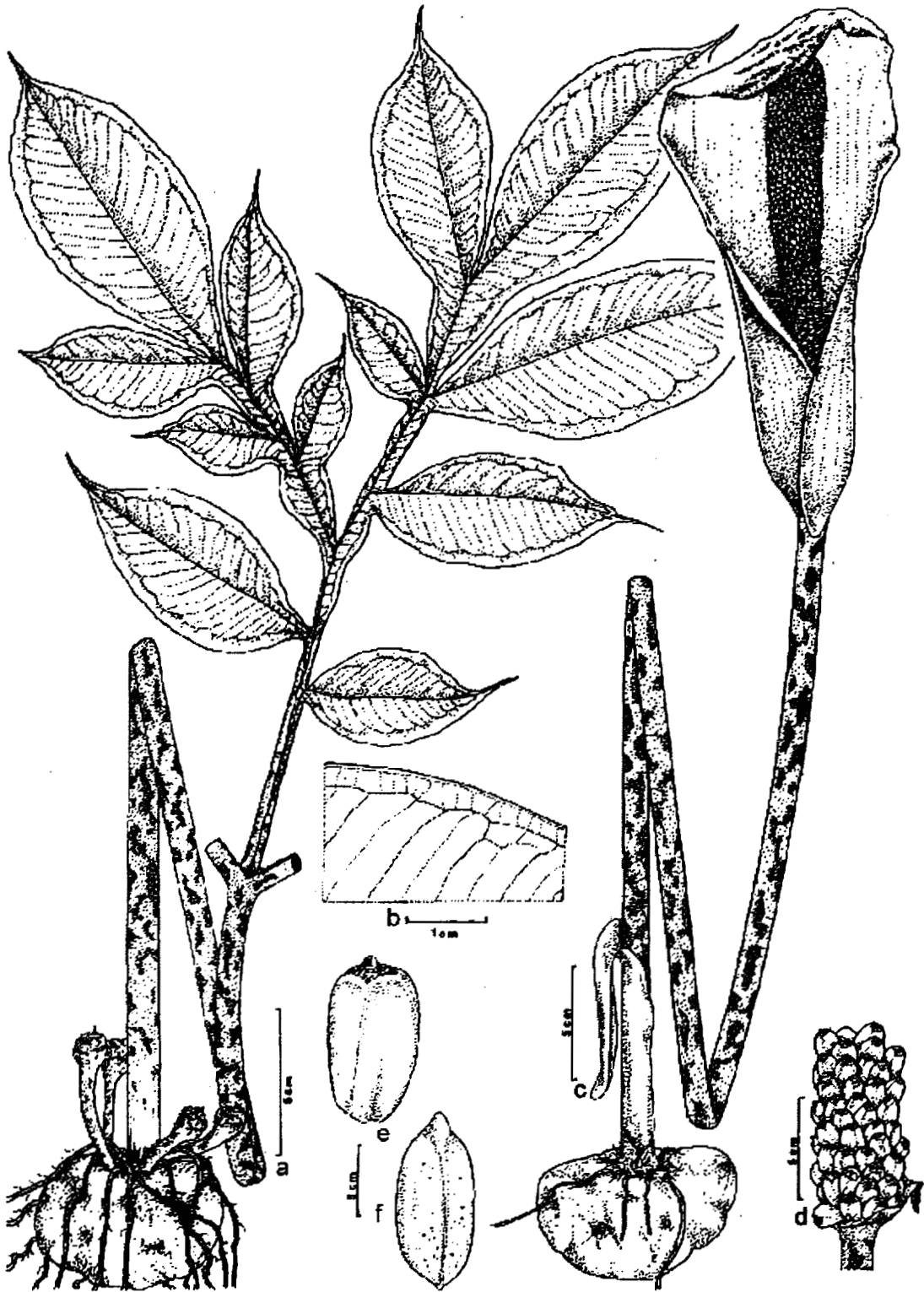


Fig. 40. *Amorphophallus napalensis* (Wall.) Bogner *et* Mayo: a. Tuber with leaf; b. Marginal portion of a leaflet showing venation; c. Tuber with inflorescence; d. Infructescence; e. Single fruit; f. Single seed.

tip; roots numerous, ca. 4.5-14.5 cm long, pale yellowish in colour. Petiole smooth, 41.5-78 cm long, 0.8-1.5 cm at base, gradually narrows to the tip, pale green with more or less irregular or oval elongate, brown or dark brown patches. Lamina, 41.5-86 cm diam., leaflets sessile, ovate-lanceolate, marginal surface undulate, tip long-acuminate; large leaflets 12.2-19.2 cm long and 5.3-6.0 cm broad, small leaflets 5.5-9.0 cm long, and ca. 2.5-4.5 cm broad, primary veins closely parallel, united below the margin forming a sub-marginal vein; upper surface green, lower surface pale green in colour.

Peduncle smooth, 67-76 cm long and 1.2-2.3 cm diam. at base and tapers towards the tip. Spathe elongate-obovate when spread out, ca. 24-27 cm long, differentiated into a basally convolute tube, and open limb, convolute tube 4.5-6.0 cm long and 5.5-7.0 cm diam., tip acute, pale green with greenish brown at base outside, pale green within, colour changes to yellowish after male anthesis, mouth of tube wide with limb expanded and become apically cucullate. Spadix sessile, shorter than the spathe, ca. 18-20 cm long, differentiated into a basal female zone of ca. 3-4 cm long, middle male zone of ca. 6-7 cm long, and a terminal sterile appendix. Female flowers closely arranged in a sub-spiral manner, each flower ca. 4-5 mm high, ovary sub-spherical, greenish, ca. 3 mm diam., 2-2.5 mm high, unilocular with a single basal anatropous ovule; style apically bent towards the axis of the spadix, ca. 2 mm long, 0.75 mm diam., colour same as that of the ovary; stigma 4-lobed, ca. 1 mm diam., greenish yellow; male flowers closely arranged,

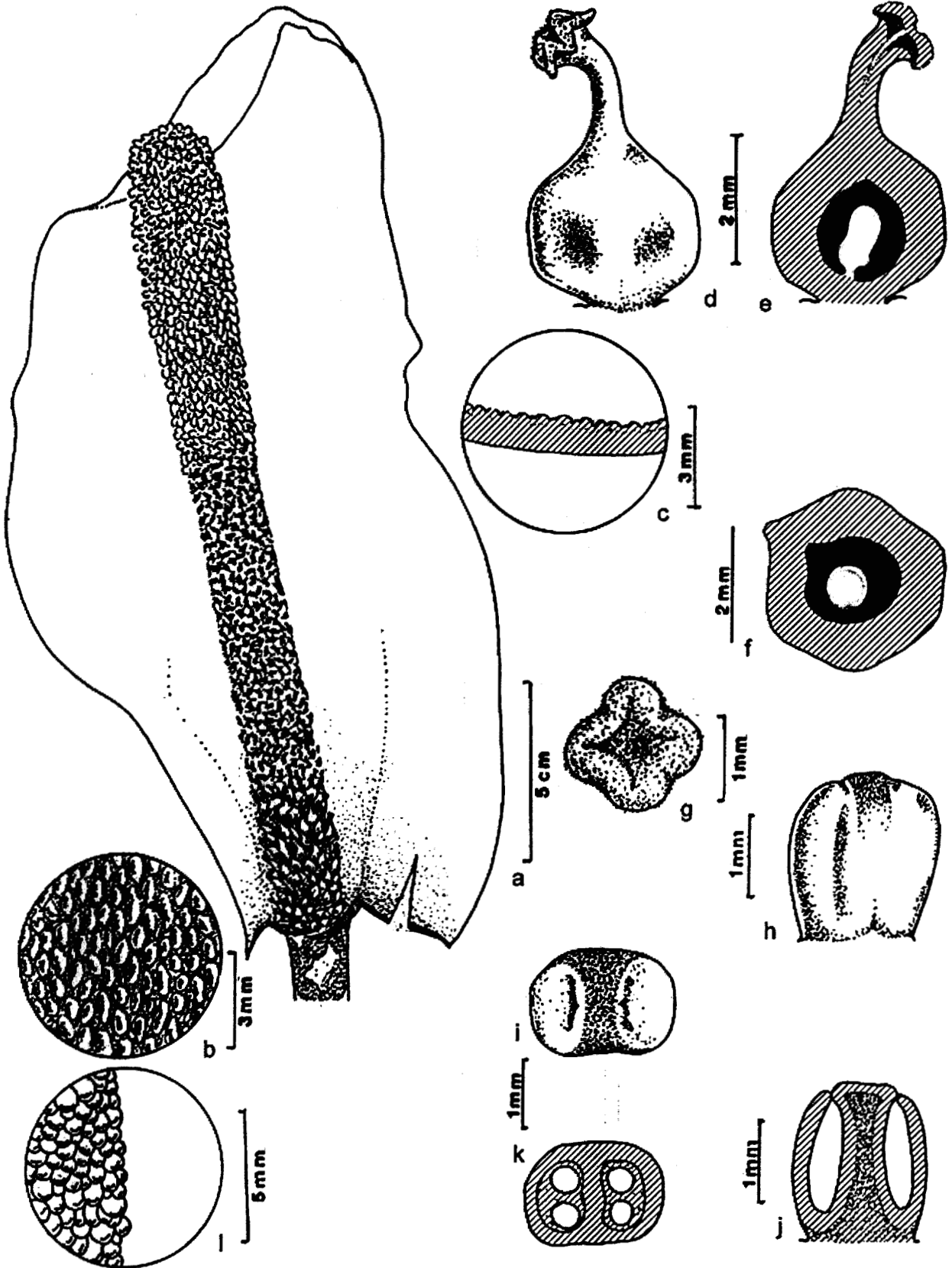


Fig. 41. *Amorphophallus napalensis* (Wall.) Bogner et Mayo: a. Inflorescence - spathe cut open showing spadix; b. A small basal inside portion of the spathe - magnified; c. A small basal portion of spathe - c.s.; d. Single female flower; e. Female flower - l.s.; f. Ovary - c.s.; g. Stigma - view from top; h. Male flower - view from broad side; i. Male flower - view from top showing the openings; j. Male flower - l.s.; k. Male flower - c.s.; l. A portion of appendix enlarged showing protuberances.

each ca. 2-2.5 mm high, 2 mm broad, inconspicuously 2-lobed, pale yellowish with reddish brown tinge on the connective at top. Spadix-appendix cylindrical with obtuse tip, ca. 10-12 cm long, ca. 1.8-4 cm diam., rough with prominent, short cylindrical or obovoid protuberances, greenish in unopened and partially opened inflorescence, brownish yellow in fully opened inflorescence, and yellowish after anthesis. Fruits ovoid elliptical, ca. 1.4-1.5 cm long, ca. 0.7-0.8 cm diam. Seeds ellipsoid, ca. 1.2-1.3 cm long and ca. 0.5-0.6 cm diam.

*Flowering*: May – June.

*Fruiting*: July – September.

*Distribution*: Bhutan, Nepal and India (Sikkim, Assam, Meghalaya and Arunachal Pradesh).

*Notes*: *Amorphophallus nepalensis* differs from other Indian species in having a rough appendix with short, prominent protuberances, style apically bent towards the spadix-axis, and stigma 4-lobed. It resembles *A. curvistylus* distributed in Western Thailand, Kanchanaburi Prov. but differs in its smooth appendix and bilabiate stigma.

*Specimens examined*: **Sikkim State**: Gangtok, Deurali, 23<sup>rd</sup> Sept. 1997, *Abdul Jaleel & Bobby Thomas RIA 168* (leaf) (CALI); *Ibid.*, 24<sup>th</sup> Sept. 1997, *Abdul Jaleel & Bobby Thomas RIA 171* (infr.) (CALI). **Assam State**: Assam, 29<sup>th</sup> May 1896,

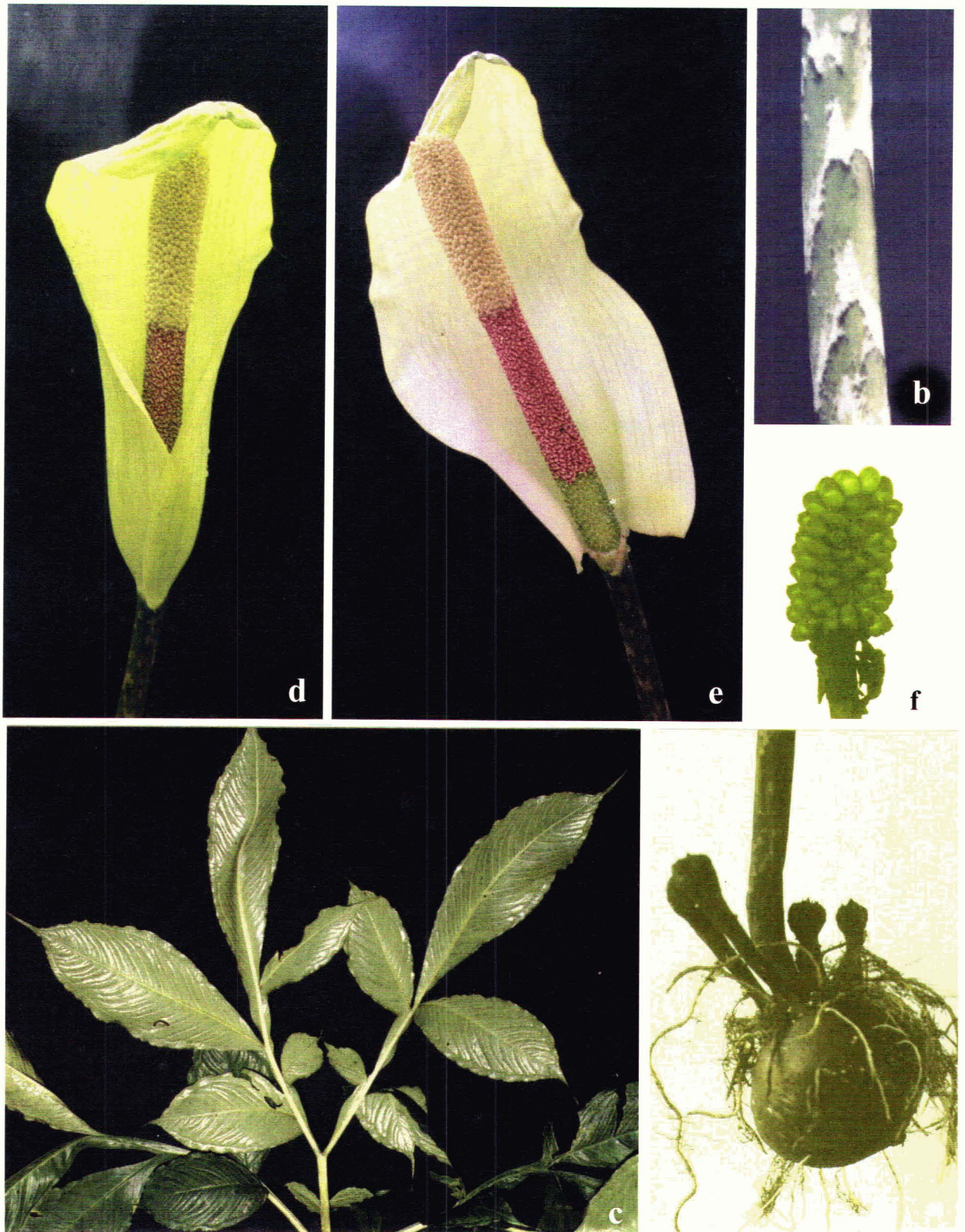


Fig. XVII. *Amorphophallus napalensis* (Wall.) Bogner *et* Mayo: a. Tuber with offsets; b. A portion of petiole showing mottlings; c. A portion of a lamina – side view; d. Inflorescence; e. Inflorescence with spathe cut open showing spadix; f. Infructescence.

*Prain*, Acc. No. 496857 (leaf) (CAL); Chirapunji, 3<sup>rd</sup> June 1956, *Rolla Seshagiri Rao* 2697 (infl.) (ASSAM). **Meghalaya State**: Shillong, Woodlands, BSI Campus (Introduced; exact locality of original collection not known), 15<sup>th</sup> July 1967, *Verma* 35658 (infl.) (ASSAM); Shillong, Oakland, 24<sup>th</sup> June 1998, *Abdul Jaleel RIA* 289 (infl.) (CALI); **Arunachal Pradesh**: Sessa Orchid Sanctuary, 2<sup>nd</sup> July 1998, *Abdul Jaleel RIA* 314 (leaf) (CALI).

**15. *Amorphophallus nicolsonianus* Sivad., Pl. Syst. Evol. 153: 165. 1986;** Manilal, Fl. Silent Valley 330. 1988; Sasi. & Sivar., Fl. Pl. Thrissur For. 483. 1996; Sivad. in Manoharan, Biju, Nayar & Easa, Silent Valley – Whisp. Reas. 230. 1999. (Figs. 42 & 43; Plate XVIII).

*Types*: Kerala State, Palghat Dist., Silent Valley Dam site, alt. ca. 1000 m, 3<sup>rd</sup> Jan. 1983, *Sivadasan CU* 21516-A (holo-K), *Sivadasan CU* 21516-B (Iso-K), *CU* 21516-C, *CU* 21516-D (Iso-US), *CU* 21516-E (Iso-CAL), *CU* 21516-F (Iso-M).

Tubers more or less obconical to napiform or sub-cylindrical, ca. 3-5.5 cm long and 1.5-3.5 cm diam. in vegetative phase; cylindric, ca. 10-17 cm long and 1.5-4 cm diam. in reproductive phase; skin smooth, cream coloured; roots ca. 4-17.5 cm long and ca. 0.1 cm diam. Petiole smooth, 18-50 cm long, 0.5-1.2 cm diam. at the base, gradually tapering to the tip, green with pale green mottles and small dark purplish spots, extreme base white. Lamina 80-95 cm diam., rachises smooth, terete, without decurrent leaflet-bases, ca. 16-19 cm long, 0.5-0.7 cm diam;

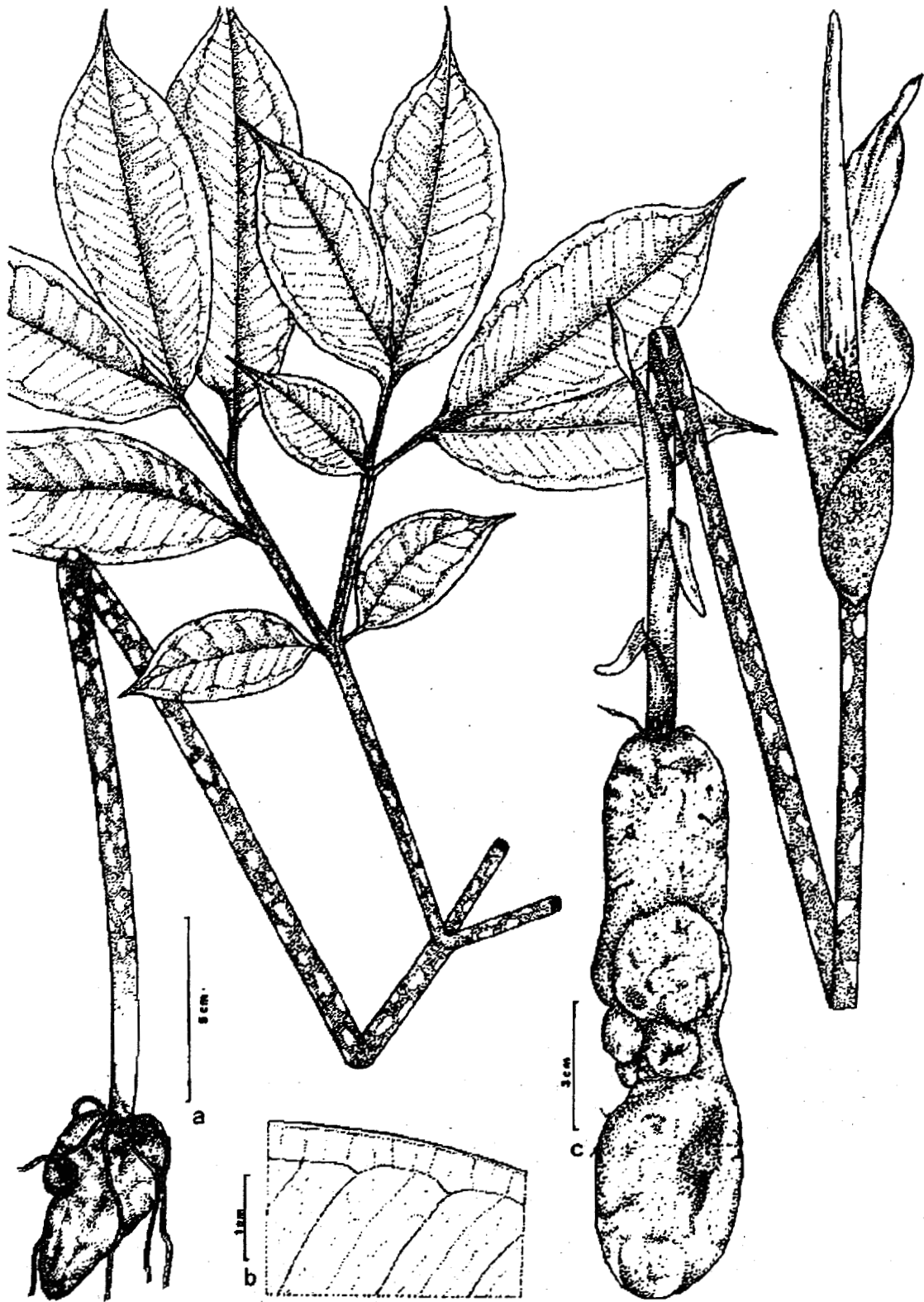


Fig. 42. *Amorphophallus nicolsonianus* Sivad.: a. Tuber with leaf; b. Marginal portion of a leaflet showing venation; c. Tuber with inflorescence.



petiole and rachises very turgid, breaking easily when bent without becoming crushed; leaflets with distinct petiolules or rarely sessile, ovate-acuminate to oblong-acuminate, base round and unequal; margin undulate; biggest leaflets ca. 10-16.5 cm long and 3.5-5.0 cm broad; small leaflets ca. 4-6 cm long and 1.6-2.5 cm broad, upper surface dark green and glossy, lower surface pale green; lateral veins united below the margin forming a sub-marginal collective vein.

Peduncle smooth, ca. 21-31 cm long and 0.4-0.6 cm diam. at the base, gradually tapering to the tip; colour same as that of the petiole, surrounded by 5-7 cataphylls; each cataphyll ca. 2-18 cm long, ca. 1.4 cm broad, lorate, tip rounded, minutely apiculate. Spathe erect, ovate-lanceolate, acuminate, ca. 10.6-12.0 cm long, ca. 5 cm broad, basally convolute forming a tube, limb expanded, erect, usually two halves of the limb longitudinally reflexed at maturity; greenish brown to greenish purple with light green mottlings and dark purple spots outside, greenish yellow and smooth within; sometimes very light pinkish-green tinged and with purple spots at the base within; margin of the spathe reflexed at maturity. Spadix sessile, ca. 11-12.5 cm long, slightly longer than the spathe, basal ca. 1.2-1.4 cm long pistillate zone, middle ca. 2-2.5 cm staminate zone, and the rest ca. 7.2-8.5 cm produced into a sterile appendix. Female flowers loosely or densely arranged in a sub-spiral manner, ovary sub-globose, ca. 2 mm high, 2 mm diam., pale yellowish, unilocular with a single basal anatropous ovule; style very short, ca. 0.5 mm long, greenish; stigma capitate, more or less discoid, 1.5 mm diam.,

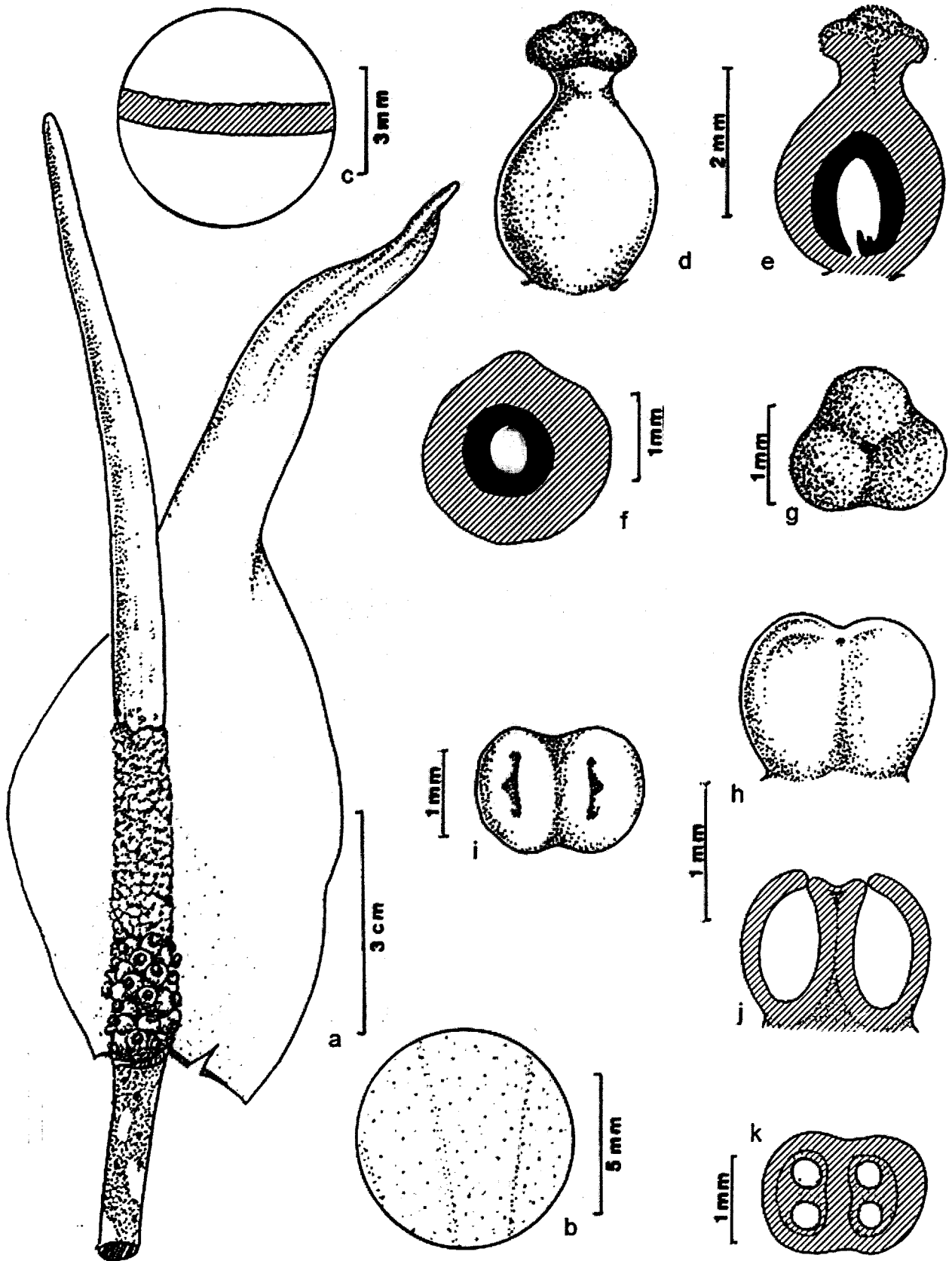


Fig. 43. *Amorphophallus nicolsonianus* Sivad.: a. Inflorescence - spathe cut open showing spadix; b. A small basal inside portion of the spathe - magnified; c. A small basal portion of spathe - c.s.; d. Single female flower; e. Female flower - l.s.; f. Ovary - c.s.; g. Stigma - view from top; h. Male flower - view from broad side; i. Male flower - view from top showing the openings; j. Male flower - l.s.; k. Male flower - c.s.

greenish. Male flowers densely arranged, sessile, ca. 1.25 mm high, 1.5 mm broad, cream-coloured, inconspicuously 2-lobed; dehiscence by narrow apical clefts. Spadix appendix sessile, terete, tapering to the tip, pale yellowish green, spinescent or with irregular shaped vestiges of staminate flowers and irregular longitudinal furrows at the base, becoming completely corrugated and creamy or light yellowish on ageing. Fruits ellipsoid, dark red coloured at maturity, one-seeded; each fruit 1-1.3 cm long, 0.6-0.8 cm diam. Seeds ellipsoid, ca. 1 cm long and 0.7 cm diam.

*Distribution:* So far known to occur only in Kerala State.

*Flowering:* December-February.

*Fruiting:* February - April.

*Notes:* *Amorphophallus nicolsonianus* differs from all other Indian species by having a cylindrical tuber in reproductive phase, turgid and brittle petiole and peduncle, and the two halves of the limb of the spathe longitudinally reflexed at maturity.

It resembles few of the species occurring outside India (Madagascar) like *A. hildebrandtii* (Engl.) Engl. et Gehrm. (1911) in its general appearance of the spathe and spadix, but differs in contrast to its large size, with the petiole up to 2 m long, the spathe up to 90 cm long and 20-25 cm broad, and a depressed globose tuber. The other species that resemble in the general appearance with cylindric tubers are



Plate XVIII. *Amorphophallus nicolsonianus* Sivad.: a. Tuber; b. Lamina – top view; c. Inflorescence; d. Inflorescence with spathe cut open showing spadix.

*A. longituberosus* (Engl.) Engl. & Gehrm. (1911) (Thailand and N.W. Malaysia), *A. parvulus* Gagnep. (1941) (Central Thailand), *A. napiger* Gagnep. (1941) (Central Thailand), and *A. macrorhizus* Craib (1912) (N. Thailand). *A. variabilis* Blume (1935) (Indonesia) somewhat resembles *A. nicolsonianus* in its general appearance of spathe and spadix, but differs by its depressed globose tuber and multilocular ovary.

*Specimens examined:* **Kerala State:** Thiruvananthapuram Dist., Bonaccord, 16<sup>th</sup> Feb. 1991, *Mohanan 10333* (infl.) (CALI); *Ibid.*, 16<sup>th</sup> Feb. 1991, *Mohanan 10333* (infl.) (TBGT). **Palghat Dist.:** Silent Valley, 1<sup>st</sup> Jan. 1977, *Sivadasan CU 19184* (leaf) (CAL); Silent Valley; Dam site, 3<sup>rd</sup> Jan 1983, *Sivadasan CU 21516-G* (leaf) (CALI); Silent Valley, Walakkad, 1700 m, 28<sup>th</sup> Feb. 1983, *Sathish Kumar SV 10797C* (infl.) (CALI); *Ibid.*, 14<sup>th</sup> Feb. 1984, *Sabu 36534* (leaf) (CALI); Silent Valley, 6<sup>th</sup> Feb 1998, *Abdul Jaleel RIA 251* (leaf) (CALI). **Kozhikode Dist.:** Thenpara forest, 26<sup>th</sup> Dec. 1997, *Abdul Jaleel RIA 241* (infl.) (CALI). **Wayanad Dist.:** Meppadi 27<sup>th</sup> Dec. 1997, *Abdul Jaleel RIA 242* (leaf); *Ibid.*, 27<sup>th</sup> Dec. 1997, *Abdul Jaleel, RIA 243* (infl.). **Kannur Dist.:** Walathode, Kannavam forest, 24<sup>th</sup> Dec. 1984, *Sabu & Sivadasan CU 36578* (leaf) (CALI).

**16. *Amorphophallus oncophyllus*** Prain ex Hook. f., Fl. Brit. India 6: 516. 1893, J. Asiat. Soc. Beng. 62(2): 80. 1893, Bot. Mag. 69: t. 7327. 1893; Srivast. & Rao in Higher Pl. Ind.Subcont. IV: 32. 1993.

*Types:* Birma, Great Cocos Island, 1889/1890, *Prain s.n.* (Holo – CAL; Iso – CAL, K).

Tubers depressed, globose. Leaf with petiole to ca. 100 cm long, dark green blotched with elongated greenish white and minute greenish white mottles, or dark green with irregular elongated blotches, with margin pale green and centre dark green in colour. Inflorescence with long peduncle, to 50 cm long, colour same as the petiole. Spathe ovate-obtuse having slight constriction between tube and limb, to ca. 20 cm long, pale greenish brown with greenish white blotches and dark minute spots in between the blotches; spadix longer than the spathe, differentiated into a basal short stipe, followed by female and male zones, and a terminal fusiform or elongate-conical appendix.

#### Key to the varieties

- 1a. Stigma 2-lobed, rarely 3-lobed; blotches of the petiole and peduncle light coloured without distinct marginal or border coloration .... var. *oncophyllus*
- 1b. Stigma inconspicuously 4-lobed, blotches of the petiole and peduncle dark with light marginal or border coloration ..... var. *rayhillianus*

**16a. *Amorphophallus oncophyllus* Prain ex Hook. f. var. *oncophyllus* (Figs. 44 & 45; Plate XIX).**

*Type:* Same as that of the species (Birma, Great Cocos Island, 1889/1890, *Prain s.n.* (Holo – CAL; Iso – CAL, K).

Tubers sub-globose, ca. 2.5-4.5 cm diam. and 2.0-3.0 cm thick in vegetative phase, ca. 7.5-9.0 cm diam. and 4.5-6.5 cm thickness in flowering phase; skin pale brown in colour, root scars annuliform; roots numerous, ca. 10-14 cm long, ca. 0.2 cm diam., cream coloured. Petiole smooth, ca. 52.5-96.0 cm long and 1-2 cm diam. at base and gradually narrows towards tip, dark green blotched with elongated greenish white and minute greenish white mottles in between the blotches, paler towards the tip, extreme base pale purplish. Lamina ca. 40-85 cm diam., leaflets ovate-elliptic lanceolate, base unequal and decurrent on rachises, tip acuminate, margin entire, large leaflets 13.5-22.5 cm long and 4.5-7.2 cm broad, small leaflets 4.2-10 cm long and 2.2-4.8 cm broad, secondary lateral veins close, united below the margin forming a sub-marginal collective vein; upper surface glossy, green in colour, lower surface pale green, veins protruded, bulbils produced at the junctions of the rachises, each ca. 0.6-1.5 cm diam. and 0.4-0.8 cm thick, skin pale brownish.

Peduncle smooth, ca. 38-56 cm long and ca. 1.5 cm diam., colour same as that of petiole, surrounded at base by 3-4 cataphylls, each cataphyll ca. 7-25 cm long and 4.0-6.0 cm broad smooth, purplish brown with pale purplish ovate-elongate blotches and minute dark greenish spots in between, paler towards the tip, extreme base pale purplish, and pale purplish within, tip broadly acute. Spathe broader than long, broadly ovate-obtuse, ca. 14-18 (26 cm) cm long and 18-22

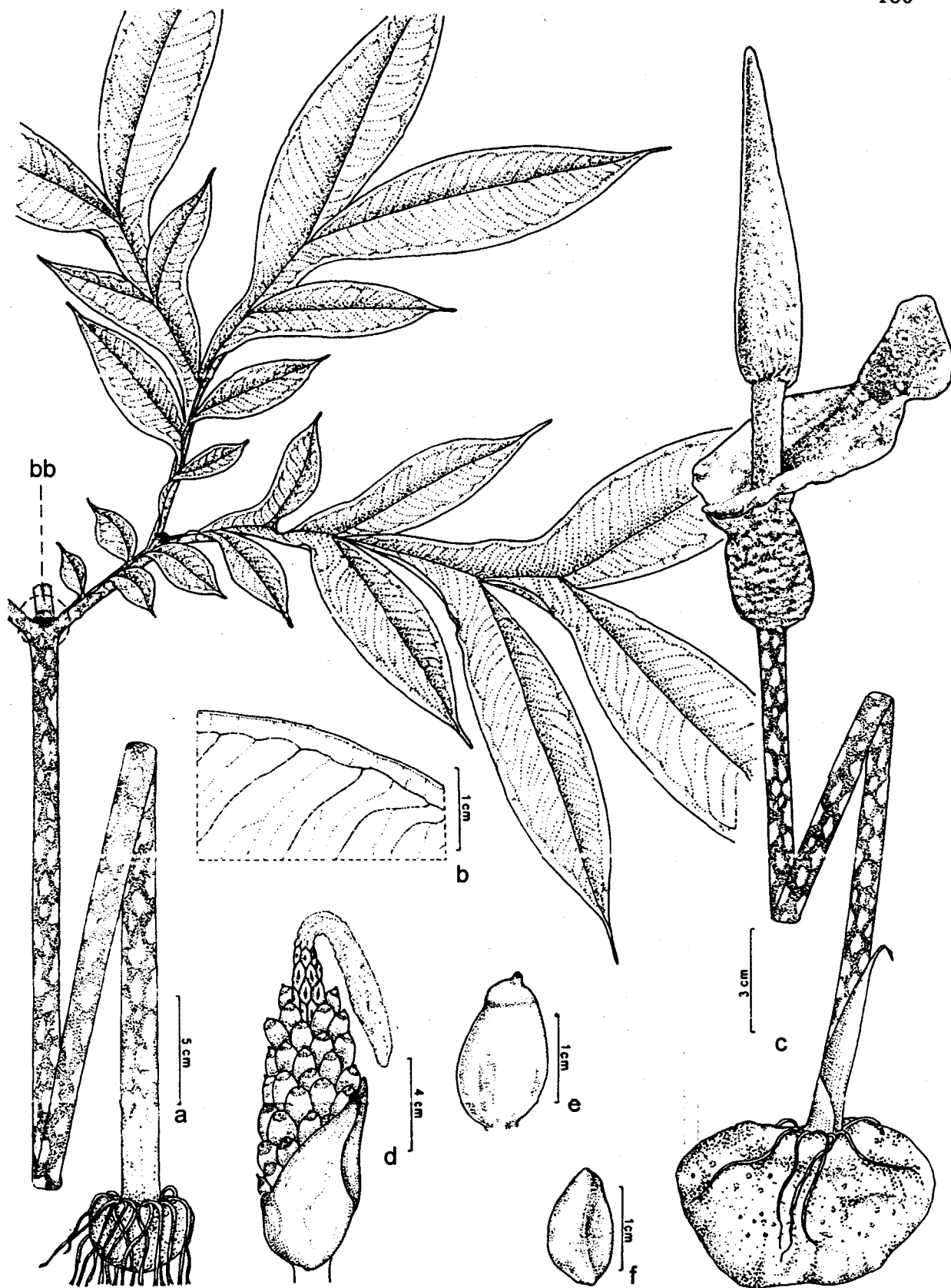


Fig. 44. *Amorphophallus oncophyllus* Prain ex Hook. f. var. *oncophyllus*: a. Tuber with leaf; b. Marginal portion of a leaflet showing venation; c. Tuber with inflorescence; d. Infructescence; e. Single fruit; f. Single seed; bb - bulbil.



broad when spread, differentiated into a basal convolute ovoid tube of ca. 6-7 cm long and 3.2-4.0 cm diam. and an upper expanded orbicular-ovate limb of ca. 10 cm long with a slight constriction in between the tube and limb, initially erect, reflexed and horizontal at maturity, tip obtuse or broadly acute; pale greenish brown with irregular elongate greenish white blotches and dark minute spots in between outside, inside extreme base pale pinkish with murications, middle purplish with oblong to ovoid blotches, pale green with small green blotches at apical portion within. Spadix slightly longer than the spathe, exerted, ca. 16.5-20 cm long, differentiated into a basal short stipe, a fertile portion of female and male zones above, and a terminal appendix; stipe pale greenish, ca. 0.5-1.0 cm long and 1.0-1.2 cm diam., female zone ca. 3.5-4.0 cm long and 1.5-1.9 cm diam., male zone ca. 4.0-4.5 cm long and 1.5 cm diam., and a terminal appendix. Female flowers loosely arranged in a sub-spiral sequence, each flower ca. 4 mm high; ovary sub-globose, much broader than stigma, reddish in colour, ca. 3.5 mm diam. and 2 mm high, 2-locular, rarely 3-locular with a basal anatropous ovule; style very short, colour same as that of the ovary, ca. 1.25 mm long, 1.75 mm diam.; stigma 2-lobed, rarely 3-lobed, yellowish in colour, ca. 2.25 mm diam. Male flowers densely arranged, each flower ca. 2.0 mm high and 1.5 mm broad, yellowish in colour. Spadix-appendix fusiform or elongate-conical, pale yellowish in colour, basal most part with rhomboid marking, ca. 8.0-10.5 cm long and ca. 1.8-2.2 cm diam. at base

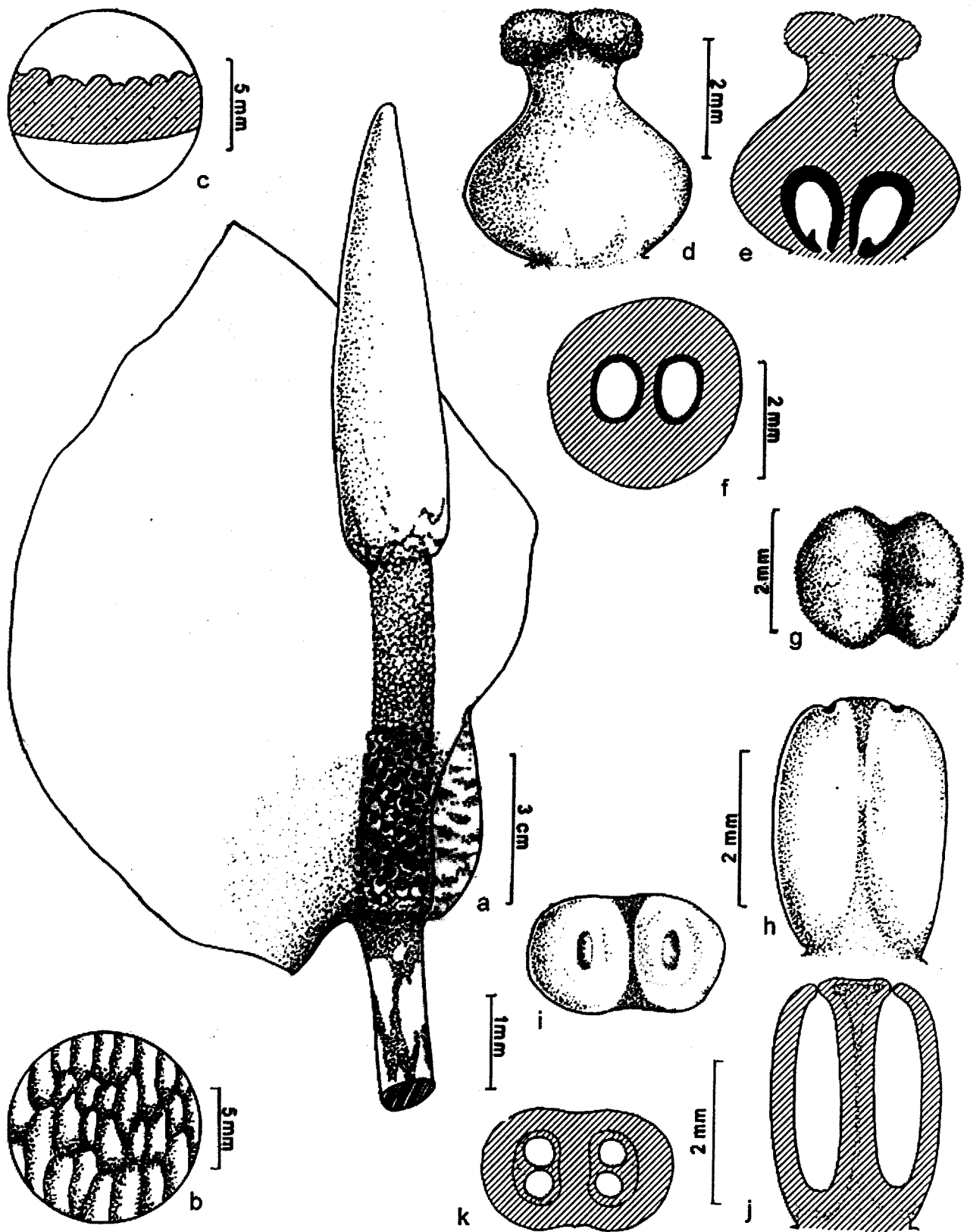


Fig. 45. *Amorphophallus oncophyllus* Prain ex Hook. f. var. *oncophyllus*: a. Inflorescence - spathe cut open showing spadix; b. A small basal inner portion of the spathe - magnified; c. A small basal portion of spathe - c.s.; d. Single female flower; e. Female flower - l.s.; f. Ovary - c.s.; g. Stigma - view from top; h. Male flower - view from broad side; i. Male flower - view from top showing the openings; j. Male flower - l.s.; k. Male flower - c.s.

and gradually tapers to the tip. Fruits ellipsoid, ca. 1.5-1.8 cm long and 0.7-0.9 cm diam. Seeds 1-3, ellipsoid, ca. 1.1-1.3 cm long and 0.5-0.6 cm diam.

*Distribution:* Endemic to the Andaman and Nicobar islands.

*Flowering:* April - June.

*Fruiting:* July - December.

*Notes:* *Amorphophallus oncophyllus* var. *oncophyllus* resembles *A. bulbifer*, but the latter differ in the absence of constriction between tube and limb of the spathe, and stigma inconspicuously 4-lobed. The Indian species that produce epiphyllous bulbils are *A. bognerianus*, *A. bulbifer*, *A. carnosus* and *A. oncophyllus*, and the only species that produce intercalary bulbils, *A. keralensis*. It differs from the var. *rayhillianus* by having the stigma 2-lobed (rarely 3-lobed), the spadix-appendix fusiform or elongate-conical, and the blotches of the petiole and peduncle without a distinct coloured border.

*Specimens examined:* **South Andaman:** Port Mount, Hill jungle, 2<sup>nd</sup> June 1893, *Dr. King's Collector*, *Acc.No. 496692* (infl.) (CAL); Calcutta, Botanical Garden Div. nursery (cultivated) (Originally collected from Andaman islands), 16<sup>th</sup> April 1894, *S. Coll.*, *Acc. No. 496695* (infl.) (CAL); Guptapara, 28<sup>th</sup> Nov. 1997, *Abdul Jaleel & Bobby Thomas RIA 216* (leaf) (CALI); Gunnighat, 29<sup>th</sup> Nov. 1997, *Abdul Jaleel & Bobby Thomas RIA 217* (leaf) (CALI); Dandras point, 29<sup>th</sup> Nov. 1997,



Plate. XIX. *Amorphophallus oncophyllus* Prain ex Hook. f. var. *oncophyllus* : a. Tuber; b. A portion of petiole showing mottlings; c. A portion of a lamina – top view showing bulbils; d. A bulbil ; e. Inflorescence; f. Inflorescence with spathe cut open showing spadix; g. Infructescence; bb – bulbil.

*Abdul Jaleel & Bobby Thomas RIA 218* (infr.) (CALI); Ograbraj, 9<sup>th</sup> May 1999, *Abdul Jaleel RIA 334* (veg.) (CALI). **Middle Andaman**: Baratang, 3<sup>rd</sup> Dec. 1997, *Abdul Jaleel & Bobby Thomas RIA 220* (infr.) (CALI); *Ibid.*, 30<sup>th</sup> April 1999, *Abdul Jaleel RIA 332* (infl.) (CALI); *Ibid.*, 29<sup>th</sup> May 1999, *Abdul Jaleel RIA 367* (infl.) (CALI); *Ibid.*, 29<sup>th</sup> May 1999, *Abdul Jaleel RIA 368* (leaf) (CALI); **North Andaman**: Lamia Bay, 13<sup>th</sup> Dec. 1997, *Abdul Jaleel & Bobby Thomas RIA 235* (infr.) (CALI).

**16b. *Amorphophallus oncophyllus* Prain ex Hook. f. var. *rayhillianus* Sivadasan et Jaleel, var. nov. (ined.)** (Figs. 46 & 47; Plate XX).

*Type*: India, Andaman Islands, North Andaman, Ray Hills, 26<sup>th</sup> May 1999, *Abdul Jaleel RIA 361* (Holo – K).

Tubers depressed-globose, ca. 4-10 cm diam. and 1.5-5 cm thick in vegetative phase, ca. 15 cm diam. and ca. 10 cm thick in reproductive phase, skin dark brownish. Petiole smooth, ca. 42-103 cm long and ca. 2.2-4.0 cm diam. at base, slightly narrows to the tip, dark green with irregular elongated blotches, with margin pale green and centre dark green in colour. Lamina ca. 44-108 cm diam., leaflets ovate-elliptic to lanceolate, leaflet base broadly decurrent, slightly undulate, secondary lateral veins close, united below the margin forming a sub-marginal collective vein, upper surface green, lower surface pale green, margin pinkish red; large leaflets ca. 18.5-28 cm long and 5.6-7.0 cm broad, small leaflets

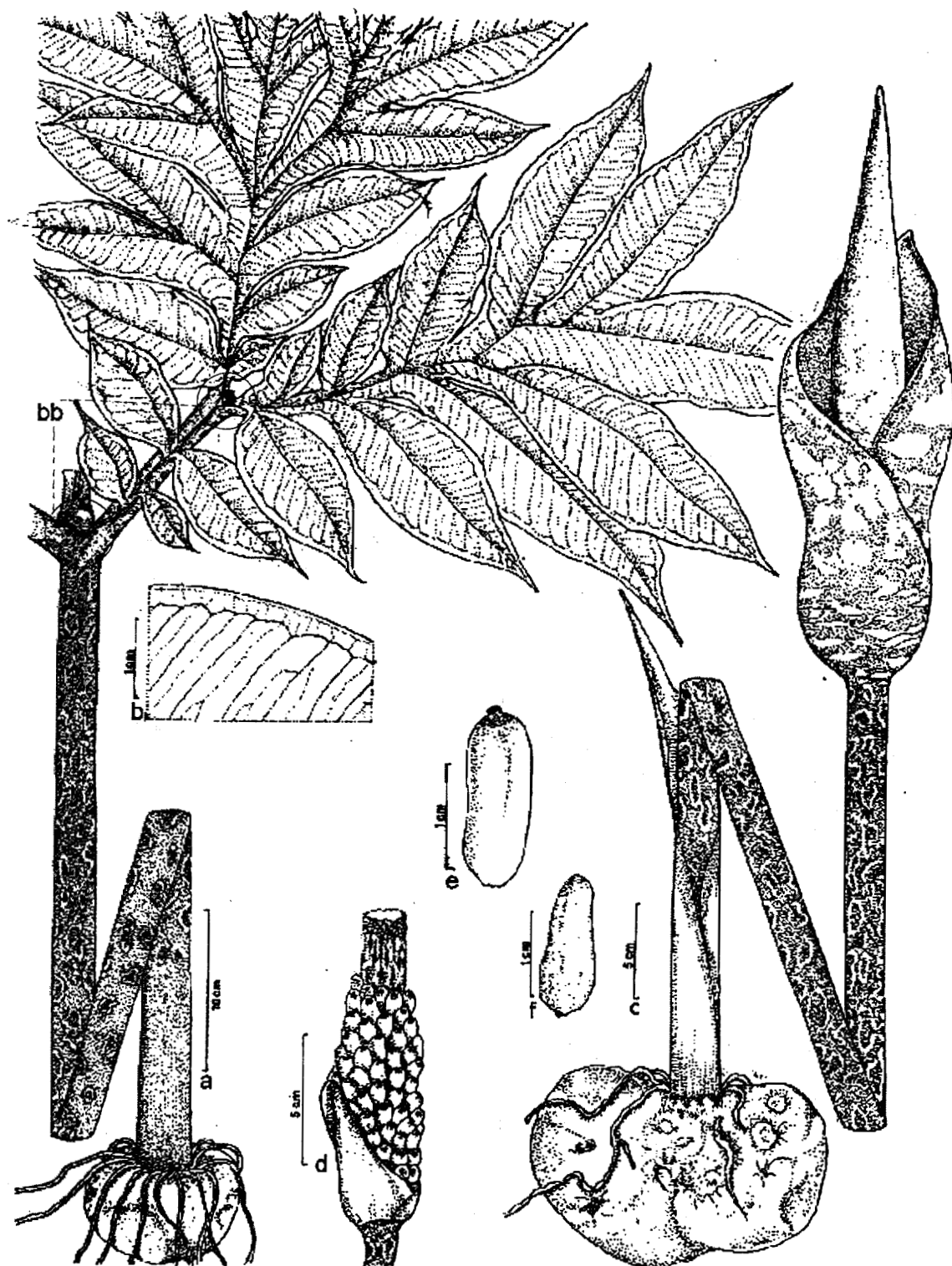


Fig. 46. *Amorphophallus oncophyllus* Prain ex Hook. f. var. *rayhillianus* Sivad. et Jaleel: a. Tuber with leaf; b. Marginal portion of a leaflet showing venation; c. Tuber with inflorescence; d. Infructescence; e. Single fruit; f. Single seed; bb - bulbil.

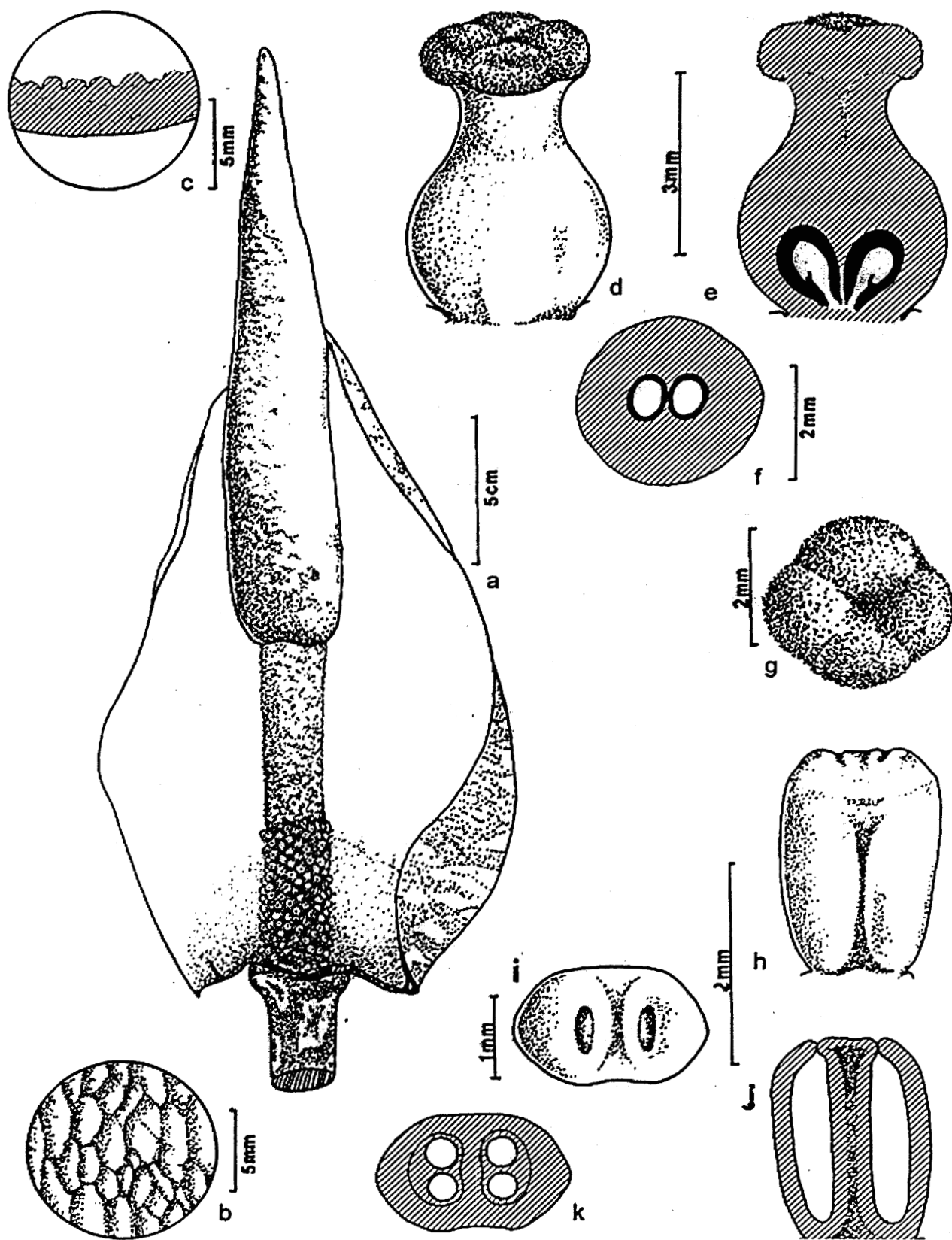


Fig. 47. *Amorphophallus oncophyllus* Prain ex Hook. f. var. *rayhillianus* Sivad. et Jaleel: a. Inflorescence - spathe cut open showing spadix; b. A small basal inside portion of the spathe - magnified; c. A small basal portion of spathe - c.s.; d. Single female flower; e. Female flower - l.s.; f. Ovary - c.s.; g. Stigma - view from top; h. Male flower - view from broad side; i. Male flower - view from top showing the openings; j. Male flower - l.s.; k. Male flower - c.s.

ca. 5.6-16 cm long and 2.5-2.8 cm broad; bulbils produced at the junction of rachises, ca. 0.4-2.6 cm diam. and 0.2-1 cm thickness, skin pale brownish.

Peduncle smooth, ca. 56 cm long and ca. 3 cm diam. at base and slightly tapers towards the tip, colour same as that of the petiole, surrounded at base by 3-4 cataphylls, each cataphyll ca. 7-23 cm long and 7 cm broad, smooth, pale pinkish with greenish blotches and minute green dots, tip acute, pale pinkish within. Spathe ovate-oblong, ca. 26 cm long and 18 cm broad when spread, tip acute, basally convolute with to ca. 6.5 cm diam. outside pale greenish brown with irregular elongate white or pale green blotches and dark minute spots in between, inside dark brown in colour with green ovoid patches and extreme base dark pinkish with small mottles. Spadix ca. 36 cm long, differentiated into a very short stipe, a fertile portion of female zone of ca. 4.5 cm long and 2.8 cm diam. at base and ca. 2.3 cm diam. at top, and male zones of 6.5 cm long and 2.1 cm diam. above, and a terminal appendix; stipe ca. 0.3-0.5 cm long, cream-coloured. Female flowers with ovary sub-globose, pinkish, ca. 3 mm diam. and ca. 1.5 mm high, 2-locular, each locule with a basal anatropous ovule; style short, colour same as that of the ovary, 2 mm diam. and 1.5 mm high; stigma inconspicuously 4-lobed, yellowish, ca. 2.3 mm diam. Male flowers densely arranged, each flower ca. 2.25 mm high, 2 mm broad, yellowish. Spadix-appendix elongate-conical, yellowish with pale brownish tinge at extreme apex, ca. 22 cm long, 4 cm diam. at base, and gradually narrows to the tip.



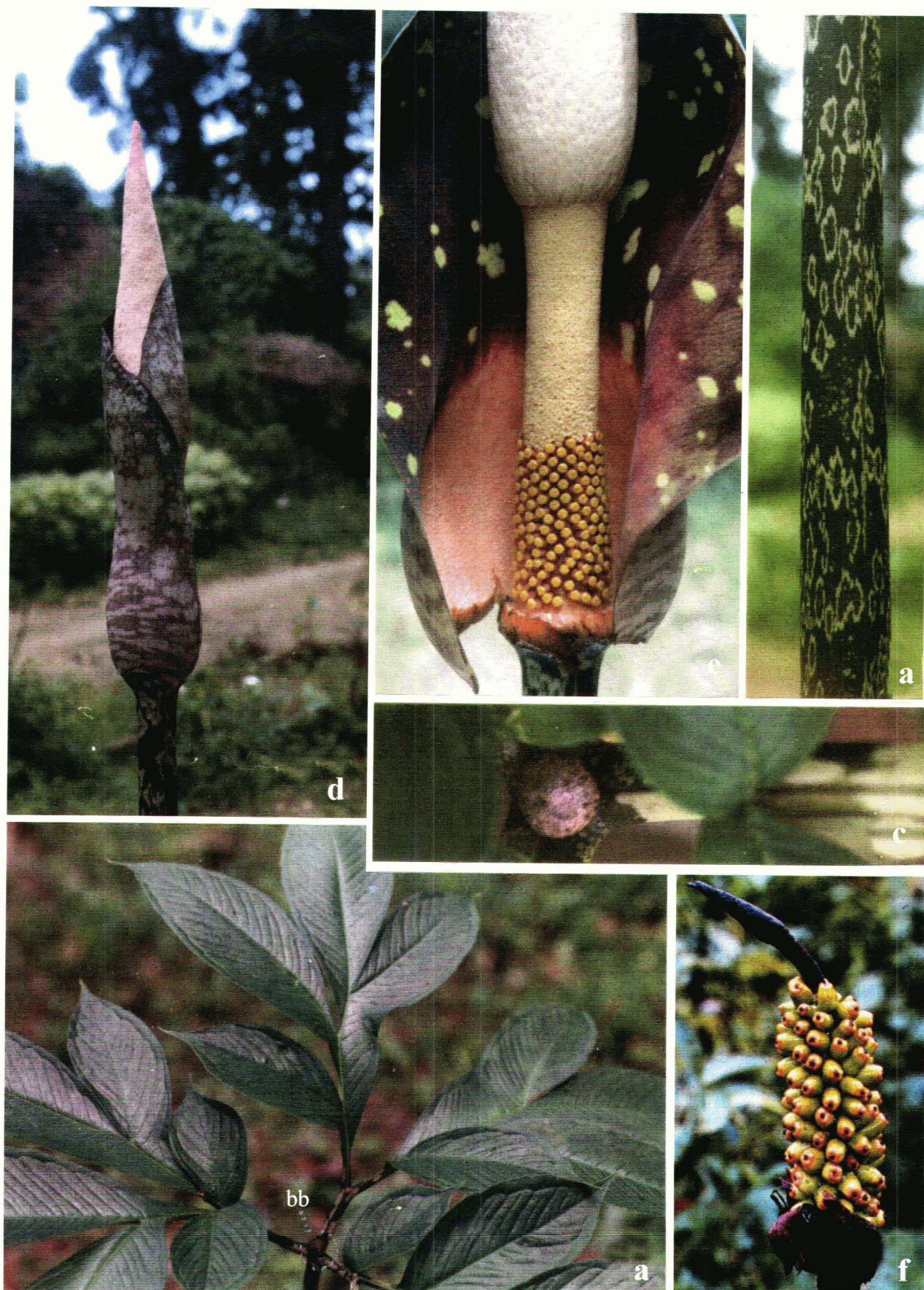


Plate XX. *Amorphophallus oncophyllus* Prain ex Hook. f. var. *rayhillianus* Sivad. et Jaleel: a. A portion of petiole showing mottlings; b. A portion of lamina – top view showing bulbil ; c. A bulbil ; d. Inflorescence; e. Inflorescence with spathe cut open showing spadix and base of spadix-appendix; f. Infructescence ; bb – bulbil .

Fruits ellipsoid, 1.2-1.6 cm long, 0.7-1.0 cm diam. Seeds 2-4, rarely 6 in number, ellipsoid, ca. 1.0-1.2 cm long and 0.6-0.8 cm diam.

*Distribution*: Confined to North Andaman islands.

*Flowering*: April - June.

*Fruiting*: July - December.

*Etymology*: The specific epithet is indicative of the locality, Ray Hills in North Andaman, where the species is fairly common.

*Notes*: *Amorphophallus oncophyllus* var. *rayhillianus* (ined.) resembles the var. *oncophyllus* in general appearance of spathe and spadix, but differ from the var. *oncophyllus* by having the stigma inconspicuously 4-lobed, and the spadix-appendix elongate conical, and blotches of petiole and peduncle with distinctly coloured border.

*Specimens examined*: **Andaman Islands**: North Andaman, Ray Hills, 9th Dec. 1997, *Abdul Jaleel & Bobby Thomas* RIA 227 (infr.) (CALI); *Ibid.*, 10th Dec. 1997, *Abdul Jaleel & Bobby Thomas* RIA 229 (leaf) (CALI); *Ibid.*, 26th May 1999, *Abdul Jaleel* RIA 361 (infl.) (CALI).

17. ***Amorphophallus paeoniifolius*** (Dennst.) Nicolson, *Taxon* 26: 338. 1977 & in Saldanah & Nicolson, *Fl. Hassan Dist. App. II.* 7: 1978 ("1976"); Manilal & Sivar., *Fl. Calicut* 305. 1982; Bakshi, *Fl. Murshidabad* 336. 1984; Rao & Sreeramulu, *Fl.*

Srikakulam 484. 1986; Kulk., Fl. Sindhudurg 466. 1988; Murthy & Yogan., Fl. Coorg (Kodagu) 489. 1990; Kothari & Moorthy, Fl. Raigad 420. 1993; Shetty & Singh, Fl. Rajasthan 3: 869. 1993; Srivast. & Rao in Higher Pl. Ind. Subcont. IV: 33. 1993; Mohanan & Henry, Fl. Thiruvananthapuram 495. 1994; Deshpande *et al.*, Fl. Mahabaleshwar 2: 618. 1995; Saxena & Brahmam, Fl. Orissa 2038. 1996; Sivar. & Mathew, Fl. Nilambur 750. 1996; Lakshminarayana, Venkanna & Pullaiah, Fl. Krishna Dist. 295. 1997; Pullaiah, Fl. Andhra Pradesh 3: 1022. 1997; Bhattach. & Sarkar, Fl. Champra Dist. 400. 1998.

*Dracontium paeoniifolium* Dennst., Schlüssel Hort. Malab. 13, 38. 1818; Manitz, Taxon 17: 449. 1968.

*Arum campanulatum* Roxb., (Hort. Beng. 66. 1814, *nom. nud.*) Pl. Corom. 3: 68. 1819, *nom. illeg.* (incl. type of *D. paeoniifolium* Dennst., 1818); Sprengel, Syst. Veg. 3: 770. 1826; Wight, Icon. Pl. Ind. Or. 3: 5. 1844.

*Amorphophallus campanulatus* Decaisne, Nouv. Ann. Mus. Hist. Nat. Paris 3: 336. 1834.

*Lectotype*: Rheede's illustration of *Mulenschena* in Hort. Malab. 11: t. 19. 1692 (vide Nicolson, Taxon 26: 338. 1977).

Tuber depressed-globose. Petiole long, to 1.2 m long, mottled and often muricated. Inflorescence short-peduncled and elongating after anthesis. Spathe

broadly campanulate, to 25 x 28 cm, convolute below and spreading above, light greenish with whitish patches outside, dark purplish and rough near base within, and light greenish yellow and smooth above. Spadix sessile, differentiated into a basal pistillate portion, a subturbinate or subcylindric staminate portion and an apical naked sterile, sessile, dark purple, short or long conical with round or acute tipped appendix, wrinkling on maturity, spongy within. Ovary light purplish or pale yellowish; style elongate; stigma yellowish, reniform or two-lobed to 3-lobed. Male flowers creamish yellow; pollen orange or yellowish in colour. Berries to 1.5 cm long.

*Distribution:* India, Sri Lanka and Pacific islands. In India in almost all States.

*Notes:* Rheede (1692), illustrated and described *Schena* (Hort. Malab. 11: 35, t. 18. 1692), and *Mulenschena* (Hort. Malab. 11: 37, t. 19. 1692), both belonging to present day's genus *Amorphophallus*. Dennstedt (1818), named Rheede's *Schena* as *Dracontium polyphyllum* L. and *Mulenschena* as *Dracontium paeoniifolium*. In 1814 Roxburgh published *Arum campanulatum*, but was a *nomen nudum* and validated later in 1819. As he included Rheede's *Mulenschena*, the type of Dennstedt's *D. paeoniifolium* in the synonymy, Roxburgh's binomial is superfluous and hence illegitimate. Decaisne (1834), published *Amorphophallus campanulatus* based on Gaudichaud's element from Timor which resembled the *Schena* of Rheede. Decaisne explicitly excluded *Schena*, the obligatory type of Roxburgh's *Arum campanulatum*, and hence *A. campanulatus* Decaisne is a legitimate new

name. Because of the close morphological similarities of *Schena* and *Mulenschena* and unawareness of the existence of an earlier legitimate epithet for *Mulenschena*, the name *Amorphophallus campanulatus* Decaisne had been used till recently for both the cultivated and wild elements represented by *Schena* and *Mulenschena* respectively. Realizing that the epithet of the earliest legitimate name must be used (Art. 55.1 of ICBN), Nicolson (1977) made a new combination of binomial namely, *Amorphophallus paeoniifolius* (Dennstedt) Nicolson, as applying to *Amorphophallus campanulatus* (*sensu lato*). The wild and cultivated elements differ in many respects even though they resemble in general appearance and many other characteristics; and hence they are treated as two distinct varieties of *A. paeoniifolius*.

#### Key to the varieties

- 1a. Petiole usually purplish brown with light pinkish blotches, strongly muricate especially at basal half; leaflet-bases strongly decurrent on rachises to the main junction; spadix-appendix elongate-conoid, longer than broad; style ca. twice the ovary height; stigma usually 2-lobed; fruit-setting common  
 ..... var. *paeoniifolius*
- 1b. Petiole usually greenish with white blotches, smooth, rarely slightly rough at basal half; leaflet bases not decurrent to the junction of the rachises; spadix-appendix hemispheric, broader than the height; style three or four times the

ovary height; stigma usually 3-lobed; fruit-setting very rare .....

..... var. *campanulatus*

**17a. *Amorphophallus paeoniifolius* (Dennst.) Nicolson var. *paeoniifolius*.** Sivad. in Suresh, Sivad. & Manilal, *Taxon* 32: 128. 1983; Nicolson in Dassan. & Fosb., *Rev. Handb. Fl. Ceylon* 6: 39. 1987; Henry, Chitra & Balakrishnan, *Fl. Tamilnadu* 3: 55. 1989; Sasi. & Sivar., *Fl. Pl. Thrissur For.* 484. 1996; Karth., Jain, Nayar & Sanjappa, *Fl. Ind. Enum. Monocot.* 6. 1989; Sivad. in Manoharan, Biju, Nayar & Easa, *Silent Valley Whisp. – Reas.* 230. 1999. (Figs. 48 & 49; Plate XXI).

[*Serpentaria polyphylla indica caule maculato aspero* Breyne, *Prodr. Rar. Pl.* 2. 1680, *n.v.*]

[*Mulenschena* Rheede, *Hort. Malab.* 11: 37, t. 19. 1692].

[*Arum ceylanicum polyphyllum caule scabro* Commelin, *Hort. Med. Amstel.* 1: 99, t. 52. 1697].

[*Arum ceylanicum polyphyllum caule aspero* Commelin, *Hort. Med. Amstel.* 1: 101, t. 53. 1697].

[*Dracontium zeylanicum ramoso folio caule ex viridi & flavo variegato aspero* Hermann, *Parad. Bat.* 89. 1698].

[*Dracunculus zeylanicus polyphyllus maximus, caule trifido*  $\alpha$  L., *Fl. Zeyl.* 198. 1747].

*Dracontium polyphyllum* sensu Burm., Fl. Malab. 6. 1769, non L., 1753.

*Dracontium paeoniifolium* Dennst., Schlüssel Hort. Malab. 13, 21, 38. 1818 ('*paeoniaefolium*'); Manitz, Taxon 17: 499. 1968. (Type: Kerala: Illustr. *Mulenschena* Rheede, Hort. Malab. 11: t. 19. 1692).

*Arum campanulatum* Roxb. [Hort. Beng. 65. 1814], Pl. Corom. 3: 68. 1820, *nom. illegit.* [incl. type of *Dracontium paeoniifolium* Dennst., 1818]; Wight, Ic. Pl. Ind. Or. 3: 5, t. 785 (as to leaf) 1844.

*Arum rumphii* Gaud. in Freyc., Voy. Uranie 43. 1826; 4: t. 39. 1827; 10: 427. 1829, *nom. illegit.* (incl. type of *Dracontium paeoniifolium* Dennst., 1818).

*Candarum hookeri* Schott in Schott & Endl., Melet. Bot. 17. 1832, *nom. illegit.* (indirectly incl. type of *Dracontium paeoniifolium* Dennst., 1818, cited by Hook., Bot. Mag. 55: t. 2812. 1828).

*Candarum roxburghii* Schott in Schott & Endl., Melet. Bot. 17. 1832, *nom. illegit.* (indirectly incl. type of *Dracontium paeoniifolium* Dennst., 1818, cited by Roxb., Pl. Corom. 3: 68. 1820).

*Candarum rumphii* Schott in Schott & Endl., Melet. Bot. 17. 1832, *nom. illegit.* (indirectly incl. type of *Dracontium paeoniifolium* Dennst., 1818, cited by Gaud. in Freyc., Voy. Uranie 427. 1829).

*Amorphophallus giganteus* Blume in Rumphia 1: 147. 1835, (non sensu *op. cit.*, t. 34) *nom. illegit.* (incl. type of *Dracontium paeoniifolium* Dennst., 1818).

*Kunda verrucosa* Raf., Fl. Tellur. 2: 82. 1837, *nom. illegit.* (indirectly incl. type of *Dracontium paeoniifolium* Dennst., 1818).

*Conophallus giganteus* Schott, Syn. Aroid. 34. 1856, *nom. illegit.* (incl. type of *Dracontium paeoniifolium* Dennst., 1818).

*Conophallus sativus* (Bl.) Schott, Syn. Aroid. 35. 1856.

*Plesmonium nobile* Schott, Ann. Mus. Bot. Lugd.-Bat. 1: 279. 1863; Engler, Pflanzenr. IV 3C (48): 51. 1911.

*Amorphophallus chatty* Andre, Illustr. Hort. 19: 361. 1872, *n. v.*

*Amorphophallus virosus* N.E. Br., Gard. Chron. 21: 757. 1885; Hook. f., Bot. Mag. 114: t. 6978. 1888. (Type: reported from Siam., *N.E. Brown s.n.* (K), *n.v.*).

*Amorphophallus rex* Prain, J. Asiat. Soc. Bengal 62: 79. Aug. 1893; Hook. f., Fl. Brit. India 6: 514. Sept. 1893; Engl., Pflanzenr. (IV. 23C) 48: 75. 1911. (Type: Narcondam Island (Andamans), *Prain 111* (K?) *n.v.*).

*Amorphophallus nobilis* (Schott) Backer & Bakh., Fl. Java 3: 112. 1968, ('*nobile*') *nom. prov.*



*Amorphophallus campanulatus* "hoofdgroep" *sylvestris* Backer, Trop. Nat. 9: 2  
(reprint p. 2). 1920, rankless name.

*Amorphophallus campanulatus* f. *sylvestris* Backer ex Backer & Bakh., Fl. Java 3:  
112. 1968.

*Type*: Same as of the species. [*Lectotype*: Rheede's illustration of *Mulenschena* in Hort. Malab. 11: t. 19. 1692 (vide Nicolson, Taxon 26: 338. 1977)].

Tubers depressed-globose, ca. 9-14 cm diam. and 8-11 cm thickness in vegetative phase; ca. 13-20 cm diam. and 7-9 cm thickness in reproductive phase; skin pale brown to dark brown-coloured with prominent root scars; roots ca. 20-42 cm long and ca. 0.2 cm diam., cream-coloured. Petiole rough, ca. 55-105 cm long and 2-4 cm diam. at the base and tapering to the tip, dark brownish green with round to ovoid green blotches, and paler towards the tip, extreme base pale pinkish or greenish brown with many sub-circular irregular white margined greenish yellow blotches, and paler towards the tip, and extreme base pinkish with minute pale greenish dots; or pale greenish brown with irregular cream-coloured blotches and paler towards the tip, extreme base pinkish with brown irregular patches; covered by 2-3 cataphylls, each cataphyll ca. 12-25 cm long and 1.5-4.0 cm broad, greenish brown with minute pink dots and extreme base pale pinkish. Lamina ca. 50-80 cm diam., leaflets sessile, large leaflets ca. 17-20 cm long and 5-6 cm broad, small leaflets ca. 8-10 cm long and 2.5-3.5 cm diam., obovate, tip acute, base unequal and

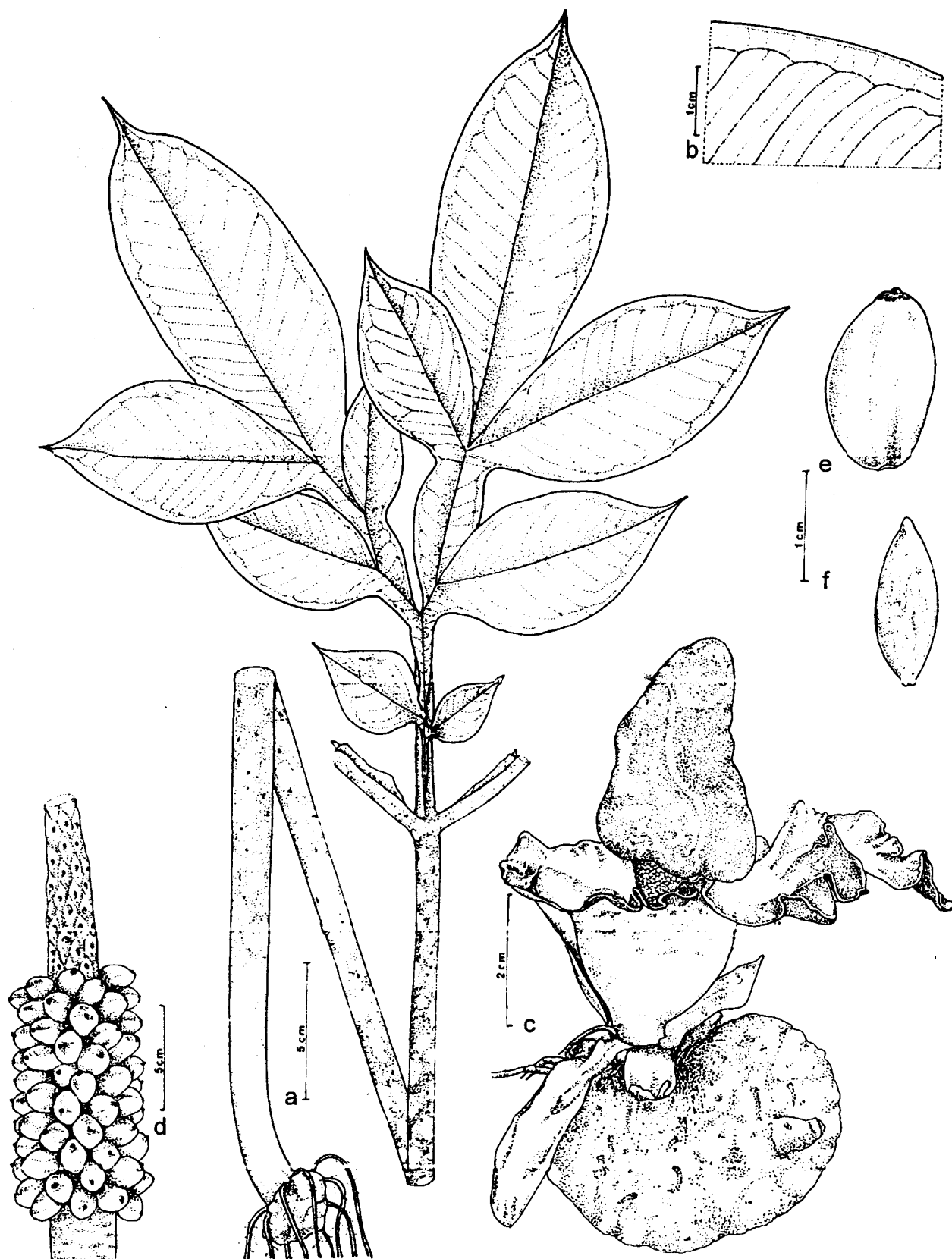


Fig. 48. *Amorphophallus paeoniifolius* (Dennst.) Nicolson var. *paeoniifolius* : a. Tuber with leaf; b. Marginal portion of a leaflet showing venation; c. Tuber with inflorescence; d. Inflorescence; e. Single fruit; f. Single seed.

decurrent on rachis, greenish above and paler below, margin entire, secondary lateral veins close, united below the margin forming a sub-marginal collective vein.

Peduncle slightly rough, short, ca. 3-6 cm long and 1-1.5 cm diam., colour same as that of the petiole, pale yellowish green, elongate to ca. 45 cm in infructescence. Spathe campanulate, tip acute and margins undulate, ca. 10-21 cm long, and ca. 12-22 cm broad, basally convolute and expanded above; greenish yellow with green blotches and at the upper portion pale brownish with pale yellow blotches; pale green within, extreme base brownish green with prominent murications; at maturity the spathe reflexes back horizontally and exposing the spadix. Spadix sessile, ca. 15.5-16 cm long, more or less equals the length of the spathe, female zone ca. 4-5 cm long and 3.5-4.5 cm diam., male zone ca. 3.5-4.5 cm long and 3-3.5 cm diam. at the base and gradually broadens towards the top to 4-4.5 cm diam.; terminal spadix-appendix elongate-conoid, ca. 9.5-10.5 cm long, 7-8 cm diam. at the base, gradually narrows towards the tip. Female flowers densely arranged, each flower with ovary sub-globose, pinkish brown, ca. 2 mm long, 3 mm diam., 2-locular, each locule with single basal anatropous ovule; style 4-5 mm long, ca. 1 mm diam., colour same as that of the ovary; stigma 2-lobed, or rarely inconspicuously 3-lobed, ca. 2 mm diam., ca. 2 mm high, pale yellowish. Male flowers closely arranged, cream-coloured, each male flower ca. 4-4.5 cm high and ca. 2 mm broad. Spadix-appendix dark purplish red, become vallecuate at maturity, spongy within. Fruits green, and turns reddish at maturity, each fruit ca.

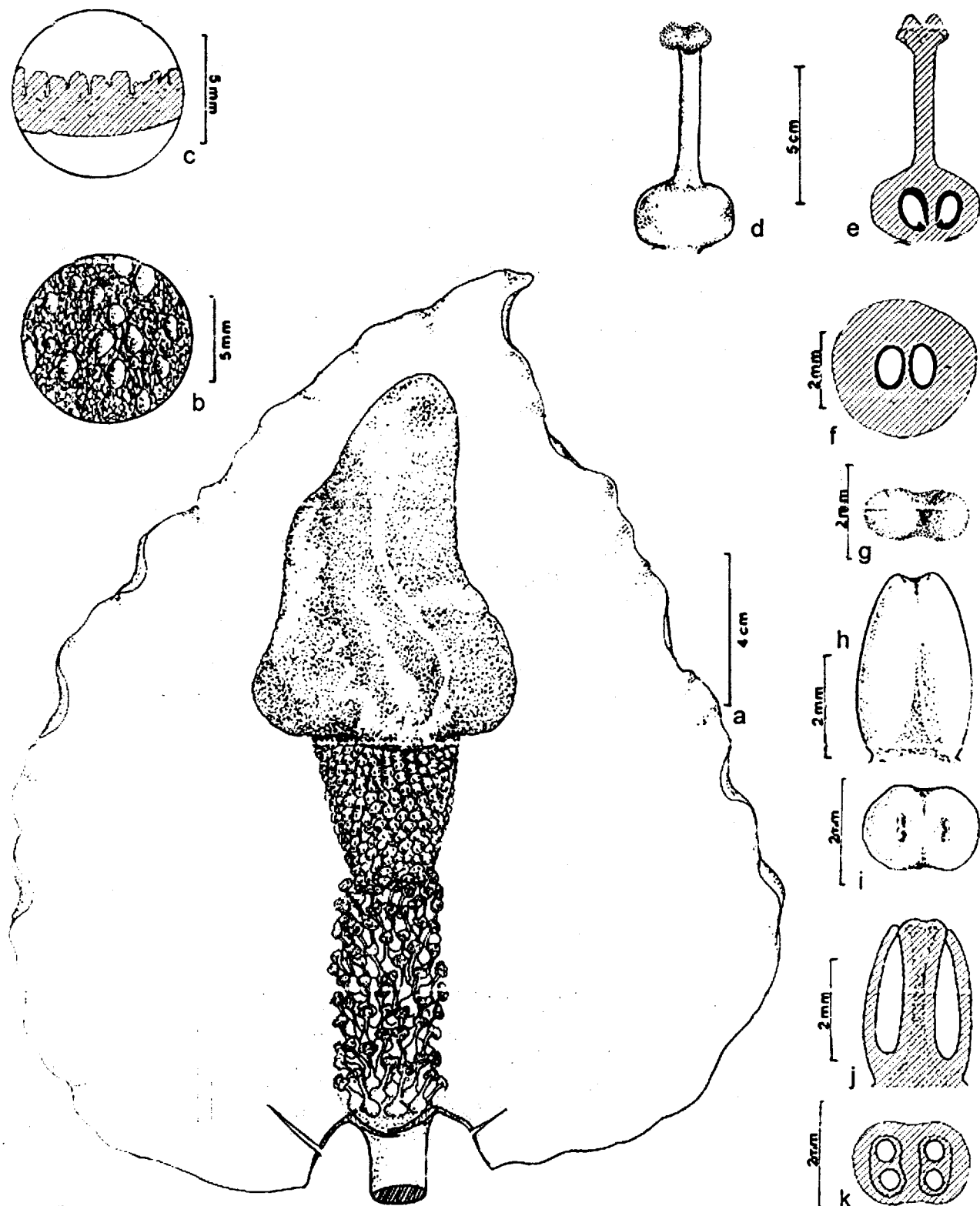


Fig. 49. *Amorphophallus paeoniifolius* (Dennst.) Nicolson var. *paeoniifolius*: a. Inflorescence - spathe out open showing spadix; b. A small basal inner portion of the spathe - magnified; c. A small basal portion of spathe - c.s.; d. Single female flower; e. Female flower - l.s.; f. Ovary - c.s.; g. Stigma -view from top; h. Single male flower - view from broad side; i. Male flower - view from top showing the openings; j. Male flower - l.s.; k. Male flower - c.s.

1.6-1.8 cm long and 1-1.2 cm diam. Seeds 1-2, each ca. 1.1-1.3 cm long and 0.6-0.7 cm diam.

*Distribution:* India, Sri Lanka and Pacific Islands. In India in almost all States.

*Flowering:* May - June.

*Fruiting:* July - November.

*Notes:* Rheede (1692) described *Mulenschena* as having, ". . . . in cortice qui exterius viridi dilutus, albicans, undulis, viridifuscus, pulchre variegatus, densis asperisque . . . ." (. . . on the outside of the bark light green, whitish, with undulate green brownish, beautiful variegations, densely rough . . . .). Only the leaf was illustrated, the petiole being clearly asperate.

Hooker (1828), published a good illustration (Bot. Mag. 55: t. 2812) under the name *Arum campanulatum* Roxb. Schott (in Schott & Endlicher, Melet. Bot. 1: 17, 1832) treated it as *Candarum hookeri*. This taxon was characterised (as illustrated) by an appendix of the spadix agreeing to the description given by Schott for his new genus *Candarum* which reads as ". . . . depresso dilatatus . . . ." The petiole was illustrated as rough, which is contrary to the description given by Roxburgh for his *Arum campanulatum*, where it was given as "pretty smooth". This might be again another reason for recognizing it as different from Roxburghian element by Schott. Hooker's illustration was stated to be prepared

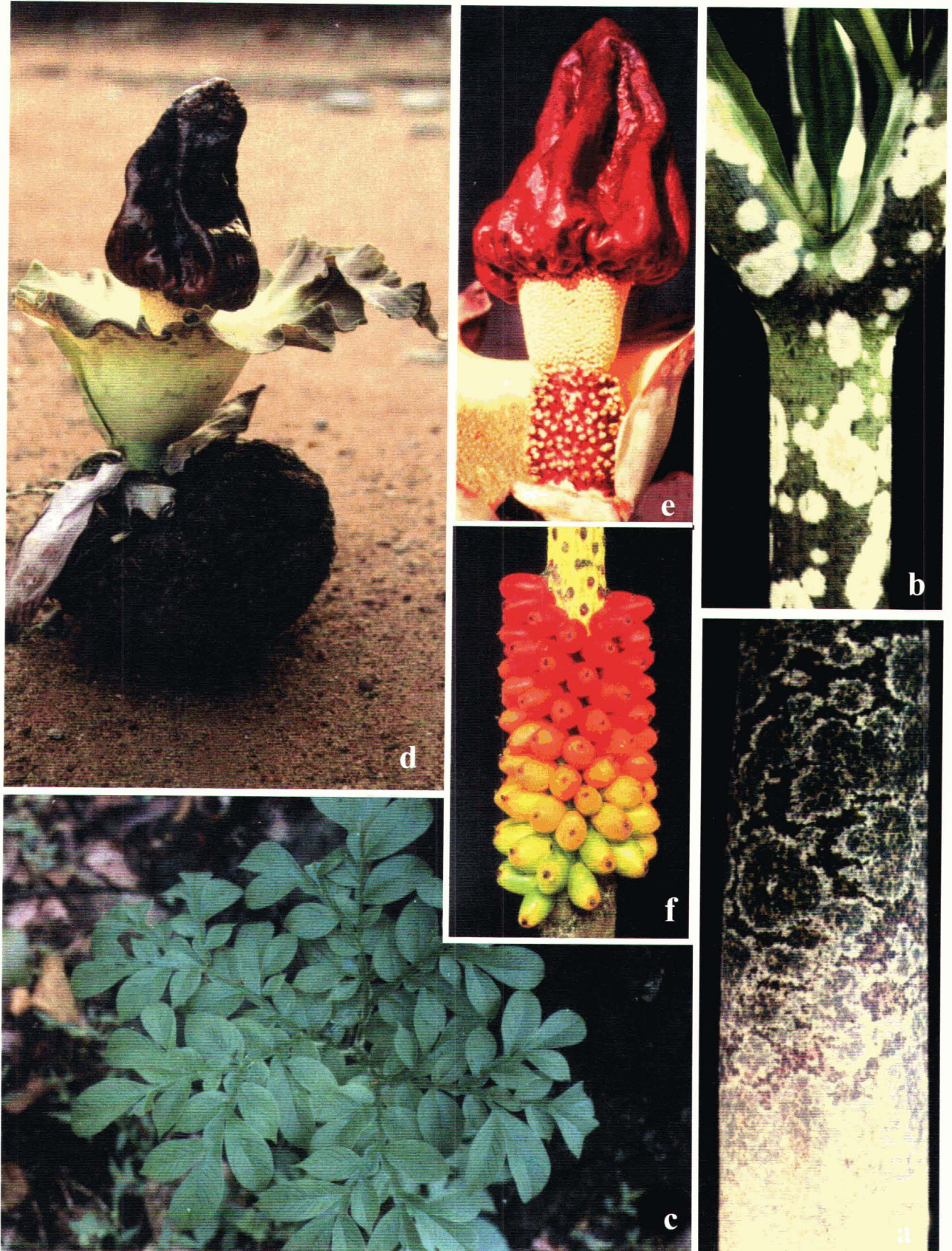


Plate. XXI. *Amorphophallus paeoniifolius* (Dennst.) Nicolson var. *paeoniifolius* (Decaisne) Sivad.:  
 a. A portion of petiole showing mottlings; b. Apical portion of petiole at junction of rachises;  
 c. Lamina – top view; d. Inflorescence with tuber; e. Inflorescence with spathe cut open showing  
 spadix; f. Infructescence.

based on two elements, one from Madagascar and the other from Java and there are possibilities of involving a mixture of two taxa. It is surprising to note that nothing had been mentioned about this taxon in Schott's **Synopsis Aroidearum** (1856), and **Prodromus Systematis Aroidearum** (1860). In the words of Hooker (Bot. Mag. 44: t. 6978. 1888), ". . . . in Schott's latest work, however, his **Prodromus Systematis Aroidearum** (p. 130) these are passed over in silence".

Decaisne (1834), published a new genus *Amorphophallus* (Nouv. Ann. Mus. Nat. Hist. Paris 3: 366) based on a description probably provided by Blume of a Timorese element, characterised by ". . . . petiolis verrucose-asperis-" and described a new species *Amorphophallus campanulatus*, but explicitly excluded Rheedean elements *Schena* and *Mulenschena*. By the exclusion of these elements, this binomial is to be treated as a new name and not a new combination. Blume (1837), described *A. campanulatus* and also provided two illustrations (Rumphia 1: t. 32, 33. 1837), where the appendix of spadix was shown to be with height about one and a half times more than the breadth, and leaf with verrucose petiole which is identifiable with *Mulenschena* of Rheedee and hence treated here as synonym of *A. paeoniifolius*. Decaisne's *Amorphophallus campanulatus* included both the cultivated and wild elements as evident from the specimens he had (indirectly) referred and the illustration given respectively. Gaudichaud's Timorese specimen now at P is with spadix-appendix having breadth more than its height (a character

of cultivated variety), whereas the illustration is of a wild variety with spadix-appendix having breadth less than its height.

Blume (Rumphia 1: 144, t. 34. 1837) published another species namely *A. giganteus* but included *Mulenschena*, type of *D. paeoniifolium*, thereby rendering the binomial superfluous and illegitimate. Here there is another problem regarding the authenticity of the species. According to Backer (Tropische Natuur. 9: 8. 1920) the above said illustration of *A. giganteus* is a mixture of two elements; the leaf possibly of *A. campanulatus* (= *A. paeoniifolius*) and the inflorescence of another taxon, possibly of *A. oncophyllus*.

Backer (1920), recognised the Javanese wild elements as belonging to a separate 'group' of *A. campanulatus* and named "*Sylvestris*". Backer did not assign a botanical rank but just called it 'hoofdgroep'. Backer and Bakhuizen van den Brink (1968) assigned the status of 'forma' to the above group and called it *A. campanulatus* forma *sylvestris*.

*Specimens examined:* **Kerala State:** Pathanamthitta Dist.: Sabarimala, 17<sup>th</sup> Sept., 1976, *Sivadasan CU 19152* (infr.) (CALI); *Ibid.*, 18<sup>th</sup> May 1997, *Sivadasan CU 19152A* (infl.) (CALI). Idukki Dist.: Cheruthony, 19<sup>th</sup> Dec. 1982, *Mohanan 76220* (infr.) (CALI). Ernakulam Dist.: "Cochin", Chalakkudi, Nov. 1910, *S. coll. 348* (leaf and infr.) (CAL). Thrissur Dist.: Kuthiran, 20<sup>th</sup> May 1997, *Abdul Jaleel RIA 52* (leaf) (CALI); *Ibid.*, 20<sup>th</sup> May 1997, *Abdul Jaleel RIA 53* (leaf) (CALI); *Ibid.*,



20<sup>th</sup> May 1997, *Abdul Jaleel RIA 54* (leaf) (CALI); *Ibid.*, 20<sup>th</sup> May 1997, *Abdul Jaleel RIA 55* (infl.) (CALI). Palakkad Dist.: Walayar, 28<sup>th</sup> July 1929, *Raju & Ratnavelu 18644* (leaf & infr.) (MH); Walayar forest, 15<sup>th</sup> April 1979, *Sivadasan CU 21442* (infl.) (CALI); *Ibid.*, 15<sup>th</sup> April 1979, *Sivadasan CU 21442* (fruit) (CALI); Parambikulam, Tunakkadavu, Wengoli Peak, 28<sup>th</sup> April 1976, *Sivadasan CU 13192* (leaf) (CALI); Parambikulam, Tunakkadavu, 28<sup>th</sup> March 1978, *Sivadasan CU 13157* (infl.) (CALI); Manthampotti forest, 2<sup>nd</sup> June 1977, *Sivadasan CU 19190* (leaf) (CALI); Manthampotti, 25<sup>th</sup> May 1978, *Sivadasan CU 21427* (leaf) (CALI); Pothundy, 15<sup>th</sup> Aug. 1997, *Abdul Jaleel RIA 123* (leaf) (CALI); *Ibid.*, 15<sup>th</sup> Aug. 1997, *Abdul Jaleel RIA 124* (infr.) (CALI). Malappuram Dist.: Calicut University Campus, 26<sup>th</sup> June 1997, *Abdul Jaleel RIA 96* (infl.) (CALI); *Ibid.*, 28<sup>th</sup> June 1997, *Abdul Jaleel RIA 100* (leaf) (CALI); *Ibid.*, 10<sup>th</sup> Nov. 1997, *Abdul Jaleel RIA 205* (infr.) (CALI). Kozhikode Dist.: Areecode, 16<sup>th</sup> May 1997, *Abdul Jaleel RIA 47* (leaf) (CALI); Mukkam, Pannicode, 30<sup>th</sup> May 1997, *Abdul Jaleel RIA 65* (infl.) (CALI). Wayanad Dist.: Waithiri, 16<sup>th</sup> May 1977, *Sivadasan CU 19175* (CALI); Wayanad Ghat, 29<sup>th</sup> May 1997, *Abdul Jaleel RIA 63* (leaf) (CALI). Kannur Dist.: Taliparamba, 16<sup>th</sup> May 1982, *Nair 73916* (infl.) (MH). **Karnataka State:** Uduppi, Padigara, 25<sup>th</sup> May 1997, *Abdul Jaleel RIA 58* (infl.) (CALI). **Andhra Pradesh State:** Iradumathu, 1<sup>st</sup> October 1920, *Narayanaswami 890* (infr.) (CAL); Rampa Hill, 9<sup>th</sup> Aug. 1914, *Ramaswami 1594* (leaf) (CAL); Sreekakulam Dist., 17<sup>th</sup> May 1979, *Subha Rao 62460* (infl.) (MH).

**Maharashtra State:** Rajpurla, 11<sup>th</sup> Sept. 1957, *Jain 24248* (leaf) (CAL). **Madhya Pradesh State:** Indore, Mandu, 20<sup>th</sup> Sept. 1964, *Amwa Acc. No. 5980* (BSA). **Orissa State:** Dandarkarmya, Bichacakotta coffee plantation area, 27<sup>th</sup> May 1959, *Rao 18585* (infl.) (ASSAM). **Bihar State:** Borin HB, 13<sup>th</sup> Dec. 1957, *Panigrahi 11707* (leaf) (ASSAM); **Rajasthan State:** Rajputana, Chitargo, 29<sup>th</sup> April 1896, *Prain Acc. No. 496617* (infl.) (CAL). **West Bengal State:** Botanical Garden, Calcutta (cultivated, originally collected from Bhitorgarh, Rajputana), 3<sup>rd</sup> May 1895, *S. coll., s.n.* (spathe) (CAL); Howrah Dist., Sanha galche, 31<sup>st</sup> Oct. 1895, *Banerji 596598* (leaf) (CAL); Botanical garden, Calcutta (cultivated, originally collected from near Dangor lines in Royal Botanical Garden), Nov. 1895, *Prain s.n.* (spadix) (CAL); Saragatchi, 24<sup>th</sup> April 1896, *Prain, Acc. No. 496599* (infl.) (CAL); H.B.C. (cultivated, originally collected from Andaman), April 1896, *Prain, Acc. No. 496760* (infl.) (CAL); H.B.C. Nursery (cultivated, original collection not known), 17<sup>th</sup> May 1897, *Prain, Acc. No. 496613* (infl.) (CAL); Shibpur, 29<sup>th</sup> May 1898, *Sadrniali, Acc. No. 496608* (infl.) (CAL); Howrah Dist.: Santa gatchi, *S.d., Banerji, Acc. No. 496600* (leaf) (CAL); Howrah, IBG, 9<sup>th</sup> Sept. 1997, *Abdul Jaleel & Bobby Thomas RIA 143* (leaf) (CALI). **Assam State:** Moshmai falls, 11<sup>th</sup> Nov. 1938, *Biswas 3928* (infr.) (CAL). **Tripura State:** Agarthala, 10<sup>th</sup> June 1915, *Debbarmar, Acc. No. 496616* (leaf) (CAL). **Andaman Islands:** South Andaman, Ograbraj, 30<sup>th</sup> Nov. 1997, *Abdul Jaleel & Bobby Thomas RIA 219* (leaf) (CALI); North Andaman, Kalipur, 13<sup>th</sup> Dec. 1997, *Abdul Jaleel & Bobby Thomas RIA 234*

(infr.) (CALI). **Nicobar islands:** Car Nicobar, Lapathi – on the way to Tip Top, 12<sup>th</sup> may 1999, *Abdul Jaleel RIA 339* (leaf) (CALI); Kamorta, Nancowry island, 13<sup>th</sup> May 1999, *Abdul Jaleel RIA 342* (leaf) (CALI).

**17b. *Amorphophallus paeoniifolius* (Dennst.) Nicolson var. *campanulatus*** (Decaisne) Sivad. in Suresh, Sivad. & Manilal, *Taxon* 32: 130. 1983 (Based on the autonym *A. campanulatus* var. *campanulatus*, generated by and taking precedence over *A. campanulatus* var. *blumei* Prain, *Bengal Pl.* 1109. 1903); Nicolson in Dassan. & Fosb., *Rev. Handb. Fl. Ceylon* 6: 40. 1987; Nicolson, Suresh & Manilal, *An Interpr. Hort. Malab.* 274. 1988; Henry, Chitra & Balakrishnan, *Fl. Tamilnadu* 3: 55. 1989; Karth., Jain, Nayar & Sanjappa, *Fl. Indicae Enum. Monocot.* 6. 1989; Sharma, Karth. & Singh, *Fl. Maharashtra Monocot.* 210. 1996 (Figs. 50 & 51; Plate XXII).

[*Serpentaria polyphylla indica caule maculato laevi* Breyne, *Prodr. Rar. Pl.* 2. 1680, n.v.].

[*Schena* Rheede, *Hort. Malab.* 11: 35, t. 18. 1692].

[*Dracontium zeylanicum ramoso folio caule ex viridi & albo variegato laevi* Hermann, *Parad. Bat.* 90. 1698].

[*Dracontium zeylanicum non spinosum esculentum* Hermann, *Mus. Zeyl.* 21. 1717.]

[*Dracunculus zeylanicus polyphyllus maximus, caule trifido*  $\beta$  L., Fl. Zeyl. 198. 1747.]

[*Tacca sativa* Rumph., Herb. Amboin. 5: 324, t. 112. 1747.]

[*Tacca phallifera* Rumph., Herb. Amboin. 5: 326, t. 113, f. 2 (infl. only). 1747.]

*Dracontium polyphyllum* sensu Dennst., Schlüssel Hort. Malab. 13, 38. 1818, non L., 1753.

*Arum campanulatum* sensu auctt. in part, not as to type of Roxb., 1820, *nom. illegit.*: Roxb., Pl. Corom. 3: t. 272. 1820; Hook., Bot. Mag. 55: t. 2812. 1828; Wight, Ic. Pl. Ind. Or. 3: 5, t. 782 (as to infl.). 1844.

*Arum rumphii* sensu Gaud. in Freyc., Voy. Uranie, t. 39. 1827, as to illustration, not as to type of *Arum rumphii* Gaud., 1826, *nom. illegit.*

*Candarum hookeri* sensu Schott in Schott & Endl., Melet. Bot. 17. 1832, as to illustr. of *Arum campanulatum* Hook., Bot. Mag. 55: t. 2812. 1828, not as to type of *C. hookeri* Schott, 1832, *nom. illegit.*

*Candarum roxburghii* sensu Schott in Schott & Endl., Melet. Bot. 17. 1832, as to illustr. of *Arum campanulatum* Roxb., Pl. Corom. 3: 272. 1820, not as to type of *C. roxburghii* Schott, 1832, *nom. illegit.*

*Candarum rumphii* sensu Schott in Schott & Endl., Melet. Bot. 17. 1832, as to illustr. of *Arum rumphii* Gaud. in Freyc., Voy. Uranie t. 39. 1827, not as to type of *C. rumphii* Schott, 1832, *nom. illegit.*

*Amorphophallus campanulatus* Decne., Nouv. Ann. Mus. Hist. Nat. Paris 3: 366. 1834; Bl., Rumphia 1: 139. 1837; Dalzell & Gibson, Bombay Pl. 259. 1861; Thwaites, Enum. Pl. Zeyl. 335. 1864; Hook. f., Fl. Brit. India 6: 513. 1893, in Trimen, Handb. Fl. Ceylon 4: 355. 1898; Haines, Forest Fl. Chota Nagpur 554. 1910; Engl., Pflanzenr. IV. 23C (48): 76. 1911; Rama Rao, Fl. Pl. Travancore 426. 1914; Bamber, Pl. Punjab 455. 1916; Haines, Bot. Bihar & Orissa 861. 1924; Fisch. in Gamble, Fl. Pres. Madras 1587. 1931; Mitra, Fl. Pl. E. India 1: 75. 1958; Cooke, Fl. Pres. Bombay, repr. ed. 3: 336. 1958; Duthie, Fl. Upp. Gang., Plain, repr. ed., 2: 363. 1960; Maheshw., Fl. Delhi 346. 1963; Backer & Bakh. f., Fl. Java 3: 111. 1968; Merr., Fl. Manila 130. 1968; Subr., Fl. Bhutan 229. 1973; Srivast., Fl. Gorakpurensis 326. 1976; Nairne, Fl. Pl. W. India 363. 1976; Nicolson in Saldanha & Nicolson, Fl. Hassan Dist. 783. 1976; Oommachan, Fl. Bhopal 389. 1977; Bennet, Fl. Howrah 93. 1979; Deb, Fl. Tripura 2: 397. 1983; Singh, Fl. Banswara 230. 1983; Naithani, Fl. Chamoli 2: 669. 1985; Rao & Sreeramulu, Fl. Srikakulam 484. 1986; Rao, Venkanna & Reddy, Fl. W. Godavari 412. 1986; Rao, Fl. Goa, Diu, Daman & Nagarhaveli 453. 1986; Ugemuge, Fl. Nagpur 363. 1986; Almeida, Fl. Savantwadi 53. 1990; Mohanan & Henry,

Fl. Thiruvananthapuram 495. 1994; Samvatsar, Fl. W. Tribal Madhya Pradesh 295. 1996.

*Amorphophallus dubius* Bl., Rumphia 1: 142. 1837; Kunth, Enum. Pl. 3: 32. 1841; Schott, Syn. Aroid. 38. 1856, Prodr. Syst. Aroid. 130. 1860; Hook., Bot. Mag. 86: t. 5187. 1860; Thw., Enum. Pl. Zeyl. 335. 1864; Trimen, Cat. 98. 1885; Engl. in DC., Monogr. Phan. 2: 310. 1879; Hook. f., Fl. Brit. India 6: 514. 1893; Hook. f. in Trimen, Handb. Fl. Ceylon 4: 356. 1898; Engl., Pflanzenr. (IV. 23C) 48: 74. 1911; Fisch. in Gamble, Fl. Pres. Madras 1587. 1931, (*Type*: Kerala, illustr. of *Schena* Rheede, Hort. Malab. 11: t.18. 1692).

*Amorphophallus sativus* Bl., Rumphia 1: 145. 1837; Engl., Pflanzenr. (IV. 23C) 48: 109. 1911. (*Type*: Amboina, Description of *Tacca sativa* Rumph., Herb. Amboin. 5: 324. 1747. Blume stated that the associated illustration (t. 112) is bad and not to be referred to this).

*Amorphophallus campanulatus* var. *blumei* Prain, Bengal Pl. 1109. 1903. *Type*: Bengal, Prain s.n. (C? K?) n.v.

*Amorphophallus campanulatus* "hoofdgroep" *hortensis* Backer, Trop. Nat. 9: 2. (reprint p.2). 1920 (rankless name).

*Amorphophallus campanulatus* f. *hortensis* Backer ex Backer & Bakh., Fl. Java 3: 112. 1968.

*Type:* Timor, *Gaudichaud s.n.* (P).

Tubers depressed-globose, ca. 8-12 cm diam. and 7-10 cm thickness in vegetative phase; ca. 16-23 cm diam. and 10-12 cm thickness in reproductive phase (huge-sized tubers are also produced); skin pale brownish, with prominent root scars; roots ca. 20-45 cm long, and ca. 1.5 mm diam., cream coloured. Petiole ca. 75-150 cm long and 2.5-4.5 cm diam. at the base and tapering to the tip, green with ovoid to elongate ovoid pale green blotches and minute pale green spots in between, and paler towards the tip. Lamina ca. 70-110 cm diam., leaflets sessile, long leaflets ca. 18-22 cm long and 5-6.5 cm broad; small leaflets ca. 7.5-10.5 cm long and 3-4.5 cm broad, obovate, tip acute, base unequal and decurrent on rachis, greenish above, paler below, margin entire, secondary lateral veins close, united below the margin forming a sub-marginal vein.

Peduncle smooth, short, ca. 6-8 cm long and 1-1.5 cm diam., yellowish green, surrounded by 2-3 cataphylls; each cataphyll ca. 20 cm long and ca. 4 cm broad, pale green outside with cream coloured blotches, extreme base pale pinkish, pale pinkish within. Spathe campanulate, tip acute, margin undulate, ca. 19-23.5 cm long and ca. 16-19 cm broad, basally convolute and expanded above; convolute portion greenish yellow, expanded portion purplish green with white blotches; dark purplish at the base within with prominent murications, middle pale green, pale purplish above, margin pale green; spathe reflexes back and horizontally oriented at maturity exposing the spadix. Spadix sessile, ca. 20-21.5 cm long, more or less



Fig. 50. *Amorphophallus paeoniifolius* (Dennst.) Nicolson var. *campanulatus* (Decaisne) Sivad.: a. Tuber with leaf; b. Marginal portion of a leaflet showing venation; c. Tuber with inflorescence.



equals the size of the spathe, female zone ca. 4-4.5 cm long and ca. 3.5 cm diam.; male zone ca. 5.5-6 cm long and ca. 3 cm diam. at the base, gradually broadens to the tip; spadix-appendix hemispherical, ca. 8.5-9.5 cm long, and 10.5-11.5 cm diam. at the base. Female flowers densely arranged, each flower with ovary sub-spherical, pale yellowish, ca. 3-3.5 cm diam. and ca. 2-2.5 cm high; style terete, pale yellowish, ca. 7-7.5 mm long and ca. 1 mm diam.; stigma 3-lobed, rarely 2-lobed, yellowish, ca. 2.5-3 mm diam. and ca. 2-2.5 mm high. Male flowers closely arranged, anthers yellowish cream coloured, ca. 2.5-3.5 mm high and 1.5-2 mm broad. Spadix-appendix dark purplish red, broader than long, spongy inside and irregularly valliculate outside.

*Distribution:* India, Sri Lanka, Java and Myanmar. In India common in all States. Widely cultivated for the edible tubers.

*Flowering:* May - June.

*Fruiting:* Not common.

*Notes:* *Amorphophallus paeoniifolius* var. *paeoniifolius* differs from var. *campanulatus* in its texture of the petioles, characters of the female flowers and spadix-appendix. The former is having purplish petiole with light pinkish blotches, strongly muricate; leaflet-bases strongly ducurrent, usually to the junction of the three main rachises; style of the pistil more or less twice the height of the ovary; spadix-appendix longer than broad (long-conoidal); fruit commonly set. The latter

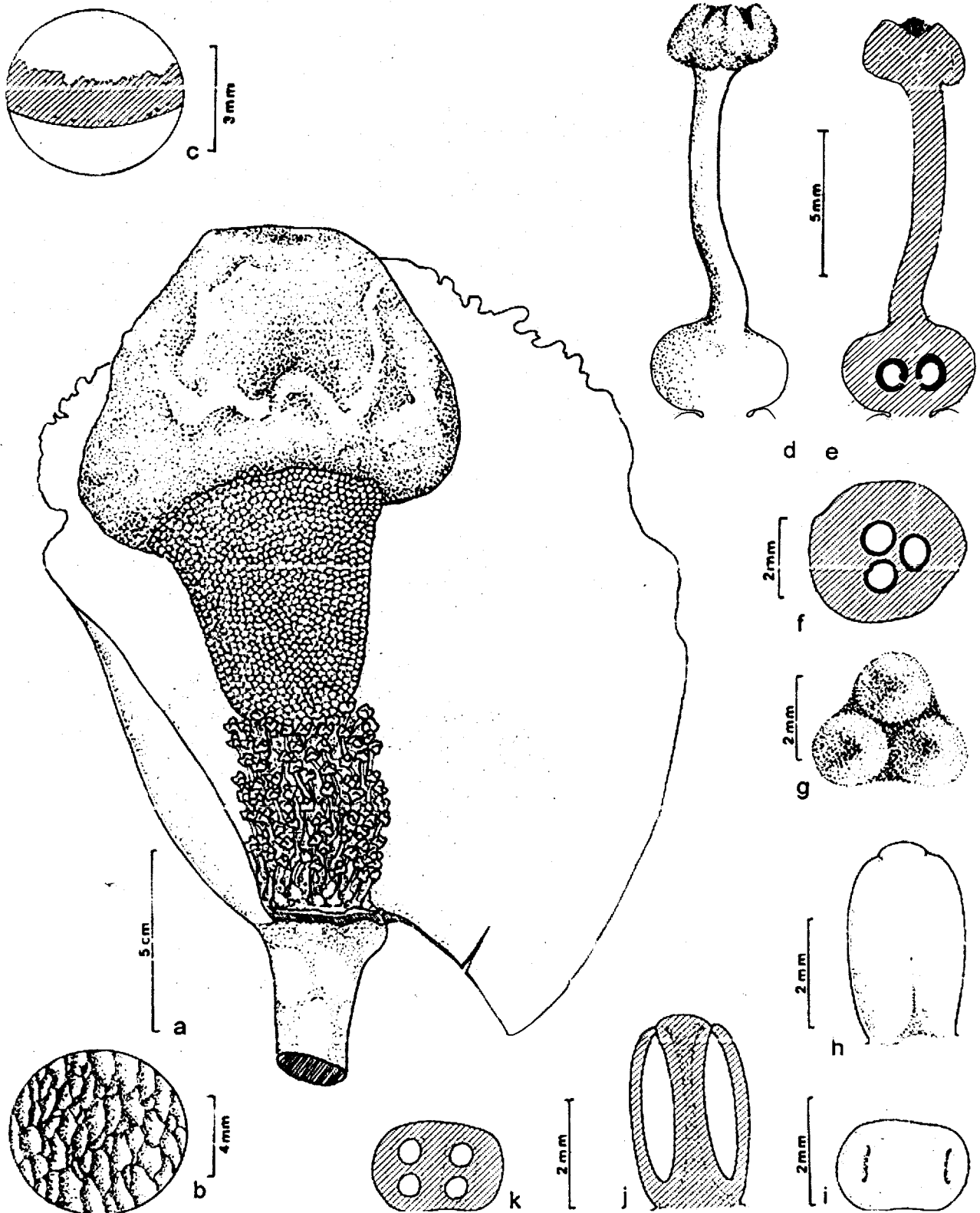


Fig. 51. *Amorphophallus paeoniifolius* (Dennst.) Nicolson var. *campanulatus* (Decaisne) Sivad.: a. Inflorescence - spathe cut open showing spadix; b. A small basal inner portion of the spathe - magnified; c. A small basal portion of spathe - c.s.; d. Single female flower; e. Female flower - l.s.; f. Ovary - c.s.; g. Stigma - view from top; h. Single male flower - view from broad side; i. Male flower - view from top showing the openings; j. Male flower - l.s.; k. Male flower - c.s.

is having greenish petiole with white blotches, not muricate but sometimes slightly rough; leaflet-bases not decurrent to the junction of the petiolules; style more than thrice (about four times) the height of the ovary; spadix-appendix with height less than its breadth (round-obtuse to broadly hemispherical); fruiting not common.

*Amorphophallus paeoniifolius* var. *paeoniifolius* and var. *campanulatus* are phenotypically very much similar, and in its general appearance it also resembles *A. hirsutus*, but the latter differs in having a smooth petiole, spadix-appendix with subglobose base and an apical short cylindrical truncate tip bearing short stiff hairs.

Rheede described *Schena* (Hort. Malab. 11: 35, t. 18. 1692), with the petioles as ". . . caules & amati teneri, molles, glabri, viridi diluti . . ." (. . . the stems and tender twigs soft, glabrous, light-green . . .). The illustration of the inflorescence shows the spadix-appendix broader than long and the petiole smooth. Dennstedt (1818), named Rheede's *Schena* as *Dracontium polyphyllum* L., a misidentification with the neotropical element. Roxburgh (1814), first published the binomial *Arum campanulatum* nom. nud. which he validated in 1819. Roxburgh (1819), described *Arum campanulatum* as having the petiole, ". . . round, tapering, clouded with darker coloured green, pretty smooth . . .". This character agree with that of the cultivated element. In addition, Roxburgh's publication (*Plants of the Coast of Coromandel* 3: t. 272. 1819), included an excellent illustration where the nature of the spadix-appendix was shown as broader than long as in Rheede's illustration of *Schena*. But Roxburgh (1819) cited *Mulenschena*, the type of



Plate. XXII. *Amorphophallus paeoniifolius* (Dennst.) Nicolson var. *campanulatus* (Decaisne) Sivad.:  
 a. Tuber; b. A portion of petiole showing mottlings; c. A portion of a lamina – top view; d. Inflorescence;  
 e. Inflorescence with spathe cut open showing spadix; f. A portion of male zone – enlarged.

*D. paeoniifolium* Dennst. (1818), in addition to *Schena* in the protologue. The inclusion of *Mulenschena* resulted in treating Roxburgh's name as superfluous and hence illegitimate (Suresh *et al.*, 1983).

Gaudichaud (in Freycinet, *Voy. Uranie* 2: 43, 1826; 4: t. 39. 1827; 10: 427. 1829), described a Timorese element with the binomial *Arum rumphii* where no mention was made of the texture (form) of the petiole as to whether smooth or rough, but the illustration of the inflorescence with the spadix-appendix shows that it resembles Rheede's element. Here also, Gaudichaud had cited *Mulenschena* as synonym rendering the binomial illegitimate for being superfluous as in the previous case.

Schott (1832), published a new genus *Candarum* attributing the authorship to Reichenbach, and treated Roxburgh's *Arum campanulatum* as a species of *Candarum* with the binomial *C. roxburghii*. But this again is an illegitimate name, indirectly including the type of *D. paeoniifolium* Dennst. Hooker (1828), published *Arum campanulatum* with an excellent illustration (*Bot. Mag.* 55: t. 2812), and it was also treated by Schott (1832) as a species of *Candarum* but with a new specific epithet, *hookeri*. This taxon was characterised (as illustrated) by an appendix of the spadix agreeing to the description given by Schott for the genus *Candarum*. *C. hookeri* again is an illegitimate binomial because of indirect inclusion of the type of *D. paeoniifolium*. Decaisne's (1834) *Amorphophallus campanulatus* (discussed in detail elsewhere) based on a Timorese element, qualifies as a new species and not

bearing a new combination of name and its type (Gaudichaud's specimen from Timor, now at P) is identifiable with Rheede's *Schena*.

Blume (1837) described and published a new species namely *A. dubius*, mainly based on Rheede's *Schena* and Hermann's Ceylonese specimen having ". . . . petiolis glabris . . . .", and treated as identical with Rheede's *Schena*. Thus the first legitimate valid name for Rheede's *Schena* is *Amorphophallus dubius* (1837) which in turn is identifiable with *A. campanulatus* Decne. (1834) and considering the rule of priority, *A. dubius* is treated as a synonym.

It is worth mentioning the existence of two 'groups' "a. *sylvestris*" and "b. *hortensis*" of *A. campanulatus* Decne. (= *A. paeoniifolius*). Backer (1920), recognised Javanese cultivated elements as belonging to a distinct group of *A. campanulatus* and called it as *A. campanulatus* hoofdgroep *hortensis*. Backer and Bakhuizen van den Brink (1968), treated the above group as belonging to a 'forma' namely 'forma *hortensis*'.

Prain (1903), recognised a new variety namely *Amorphophallus campanulatus* var. *blume* to include the cultivated elements. As per Art. 26.2 of ICBN-1983, Art. 26.3 of ICBN-1994 & 2000, the publication of first varietal name of a species automatically establishes an autonym of the species at varietal rank, and the autonym will take precedence over that of the name of equivalent rank

which has established it. Accordingly, the varietal epithet '*campanulatus*' takes precedence over '*blumei*' and hence accepted.

*Specimens examined:* **Kerala State:** Kozhikode Dist.: Areecode, 16th May 1997, *Abdul Jaleel RIA 46* (infl.); Vada kara, Azhiyur, 9th August 1997, *Abdul Jaleel RIA 119* (leaf) (CALI). Malappuram Dist.: Calicut University Campus, 10th August 2000, *Abdul Jaleel RIA 386* (leaf). Palakkad Dist.: Athicode, Chittur, 10<sup>th</sup> April 1976, *Sivadasan CU 13132* (infl.) (CALI); Kumbalakode, Elavancherry, 24<sup>th</sup> April 1997, *Sivadasan CU 19170* (infl.) (CALI).

**18. *Amorphophallus smithsonianus*** Sivad., Willdenowia 18: 435. 1989. (Figs. 52 & 53; Plate XXIII).

*Types:* India, Kerala, Thiruvananthapuram Dist., near Attayar on the way to Agasthyamala peak from Bonaccord, 590 m, 25<sup>th</sup> Dec. 1985, *Sivadasan CU 21547* (Holo – K; Iso – B, CAL, M, US).

Tubers compressed-globose or irregularly sub-globose, ca. 2.5-4.0 cm diam. and ca. 1.8-2.3 cm thickness in vegetative phase; ca. 4-6 cm diam. and ca. 2.8-3.5 cm thickness in reproductive phase, skin smooth, glossy. Petiole smooth, cylindric, ca. 25-55 cm long and ca. 1-1.7 cm diam. at base, gradually slightly narrowing to the tip; green with white specks and mottles; extreme base whitish and apical portion green, basally surrounded by 4-6 cataphylls, each cataphyll ca. 8-11 cm long and 2.2-3.0 cm broad, tip acute with stiff projection with bifid apex, pale

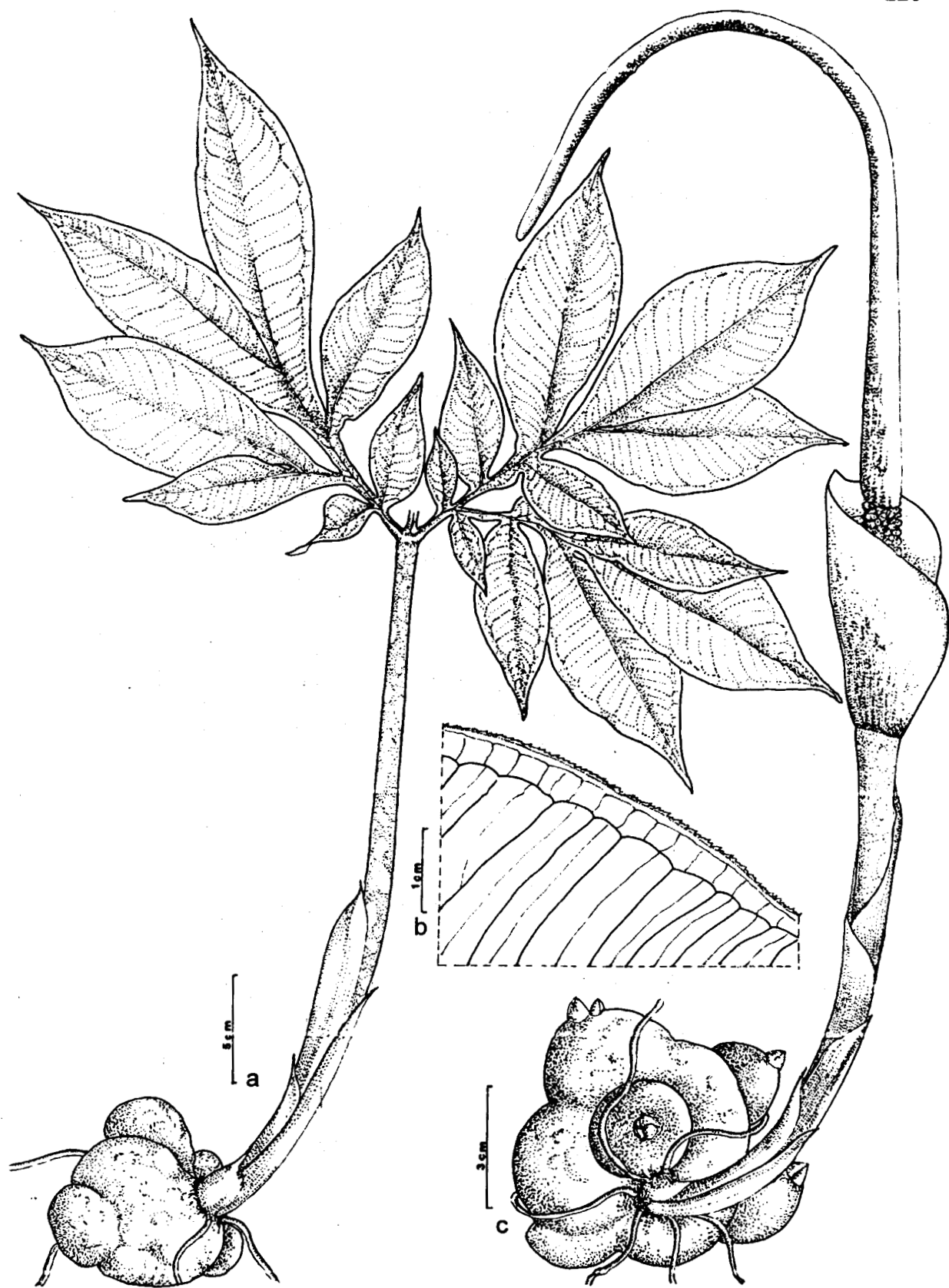


Fig. 52. *Amorphophallus smithsonianus* Sivad.: a. Tuber with leaf; b. Marginal portion of a leaflet showing venation; c. Tuber with inflorescence.



pinkish. Lamina ca. 30-40 cm diam., leaflets obovate-oblong, acuminate, upper surface green, lower surface pale green, margin erose, glossy, venation closely pinnate, lateral veins united below the margin forming a sub-marginal collective vein.

Peduncle smooth, ca. 9-10.5 cm long and ca. 0.6-0.7 cm diam. at the base, gradually tapering to the tip, colour same as that of the petiole surrounded by ca. 4-6 cataphylls. Spathe funnel-shaped, broadly obovate when spread with round or obtuse base, apex entire or notched, ca. 4-4.5 cm long and 4.5-5 cm broad, basally convolute with broadened mouth, pale green with minute purplish specks outside, dark purplish with minute truncate projections at the base within for about one third of the length, pale yellowish green or creamy and smooth above. Spadix sessile, ca. 4 times longer than the spathe, basal female zone ca. 0.6-0.9 cm long, neuteriflorous zone ca. 0.5-0.6 cm long, followed by a staminate portion of ca. 2-2.2 cm long, and a terminal sterile appendix. Female flowers densely arranged, each flower with ovary ca. 1.5 mm high and ca. 2 mm diam., cream-coloured; style very short ca. 0.5 mm high; stigma subequalling the ovary in diameter with ca. 3-5 stout echinations, pale green becoming cream in colour after anthesis. Neuter flowers in 2-5 rows, each obovoid or ellipsoid, dark-purplish or sometimes pale green, ca. 5 mm high and ca. 3 mm diam., becoming shrunken and thin at maturity. Male flowers loosely or densely arranged, each ca. 1-1.25 mm high and ca. 1.5-1.75 mm broad, sub-rectangular in outline with rounded corners, cream-coloured or

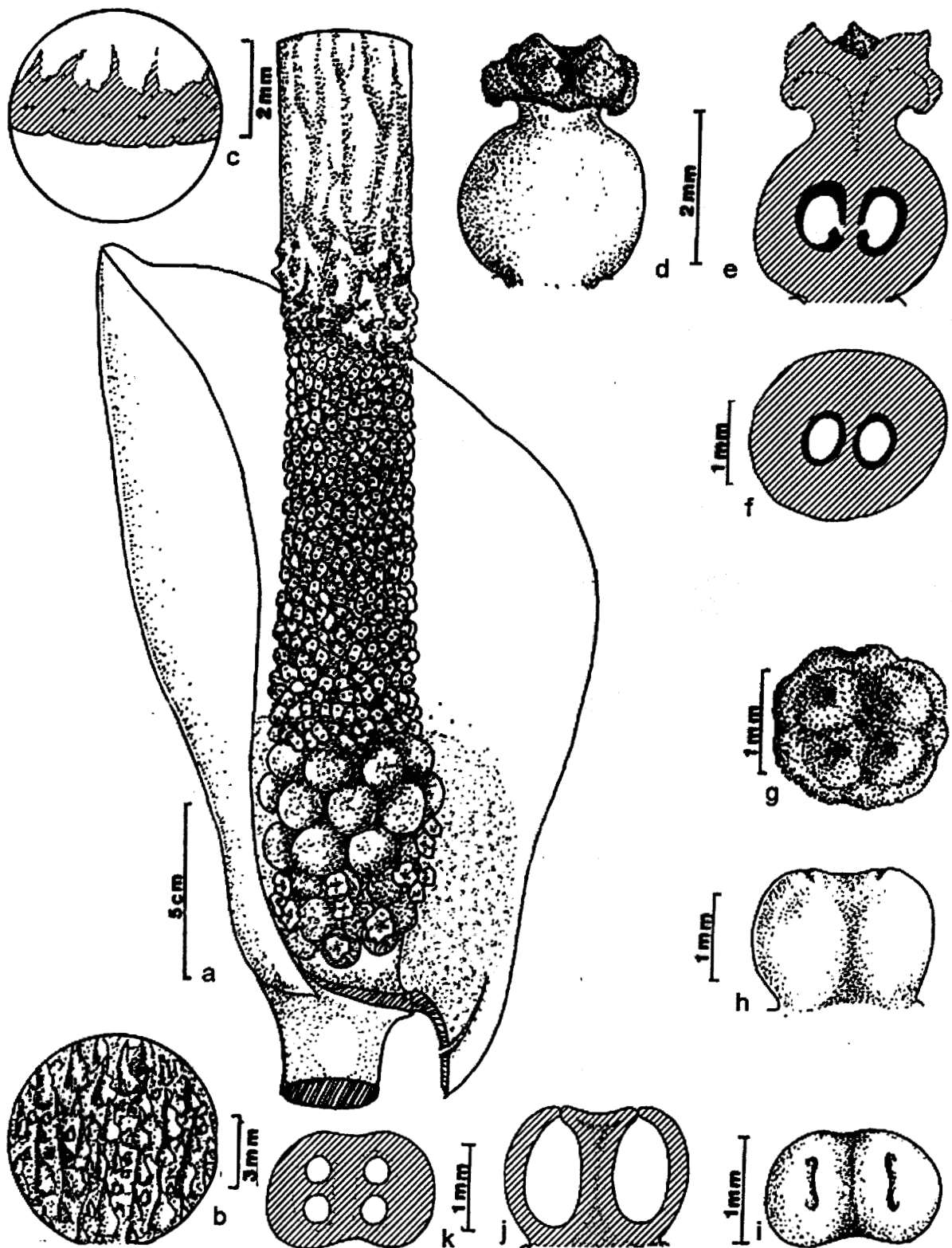


Fig. 53. *Amorphophallus smithsonianus* Sivad.: a. Inflorescence - spathe out open showing fertile portion of spadix; b. A small basal inside portion of the spathe - magnified; c. A small basal portion of a spathe - c.s.; d. Single female flower; e. Female flowers - l.s.; f. Ovary - c.s.; g. Stigma - view from top; h. Single male flower - view from broad side; i. Male flower - view from top showing the openings; j. Male flower - l.s.; k. Male flower - c.s.

pale greenish to yellowish green with pale purplish tinge at the top, dehiscence by apical confluent pores. Spadix-appendix ca. 12.5-21 cm long, ca. 0.8 cm diam. at the base and tapering to the tip, bent or hanging from the middle, dark purplish, tip sometimes purplish green, with irregular longitudinal shallow furrows and few small spinescent projections at the base.

*Distribution:* Endemic to Kerala State. Confined to very few localities in the State.

*Flowering:* December.

*Fruiting:* Fruiting specimens could not be collected and observed.

*Notes:* *Amorphophallus smithsonianus* differ from other species in having a long bent or hanging spadix-appendix, an echinate stigma and erose leaflet margins. It resembles with *A. sylvaticus* (Roxb.) Kunth (1841) and *A. konkanensis* Hett. *et al.* (1994) only in the structure the spadix, but the latter two differs in the shape of neutral flowers, arrangement of male flowers, nature of the stigma and the nature of the spadix-appendix.

*Specimens examined:* **Kerala State:** Thiruvananthapuram Dist.: Attayar, 24th Dec. 1985, *Sivadasan CU 21547* (infl.) (CALI); *Ibid.*, 30<sup>th</sup> Dec. 1997, *Abdul Jaleel RIA 268* (infl.) (CALI); Karamanayar, 700 m, 18<sup>th</sup> May 1991, *Mohanan 10824* (leaf) (TBGT); *Ibid.*, 700 m, *S.d.*, *Mohanan 11596* (infl.) (TBGT); *Ibid.*, 700 m, *S.d.*, *Mohanan 11301* (infl.) (TBGT).



Plate XXIII. *Amorphophallus smithsonianus* Sivad.: a. Leaf; b. Inflorescence with tuber; c. Inflorescence with spathe cut open showing fertile portion of spadix and basal portion of spadix - appendix.

**19. *Amorphophallus sylvaticus* (Roxb.) Kunth, Enum. Pl. 3: 34. 1841; Dalzell & Gibson, Bombay Pl. 259. 1861; Engl., Pflanzenr. IV. 23C(48): 103. 1911; Mayur., Fl. Pl. Madras 271. 1929; Fisch. in Gamble, Fl. Pres. Madras 1587. 1931, Barnes, Suppl. Fl. Madras City 9, 43, Pl. VII, figs. C1, C2, C3. 1938; Nairne, Fl. Pl. W. India 364. 1976; Shah, Fl. Gujarat 2: 697. 1978; Sivad. & Nicols. in Matthew, Fl. Tamilnadu Carnatic 2: 1687. 1983; Verma, Fl. Raipur, Durgapur & Rajnandgaon 394. 1985; Rao & Sreeramulu, Fl. Srikakulam 413. 1986; Rao, Venkanna & Reddy, Fl. W. Godavari 413. 1986; Nicolson in Dassan. & Fosberg, Rev. Handb. Fl. Ceylon 6: 42. 1987; Henry, Chitra & Balakrishnan, Fl. Tamilnadu 3: 55. 1989; Karth., Jain, Nayar & Sanjappa, Fl. Ind. Enum. Monocot. 1989; Raju & Pullaiah, Fl. Kurnool 462. 1995; Pullaiah & Rao, Fl. Nizamabad 346. 1995; Samvatsar, Fl. W. Madhya Pradesh 295. 1996; Naik, Fl. Marathwada 2: 894. 1998; Matthew, Fl. Palni Hills 1368. 1999. (Figs. 54 & 55; Plate XXIV).**

*Arum sylvaticum* Roxb., Fl. Ind. 511. 1832; Wight, Ic. Pl. Ind. Or. 3: 7, t. 802. 1844.

*Lectotype*: Roxburgh's illustration of *Arum sylvaticum* no. 250 (K) based on plants from "Circars" (Andhra Pradesh).

[*Dracontium caule immaculato minus & humilius* Hermann, Parad. Bat. 88. 1698].

[*Dracunculus zeylanicus polyphyllus*  $\beta$  L., Fl. Zeyl. 198, 422. 1747].

*Amorphophallus zeylanicus* Bl., Rumphia 1: 148. 1837; Thw., Enum. Pl. Zeyl. 335. 1864; Trimen, Syst. Cat. Ceylon 98. 1885. (Type: Ceylon, s.d., Koenig s.n. (L)].

*Brachyspatha sylvatica* (Roxb.) Schott, Syn. Aroid. 35. 1856.

*Brachyspatha zeylanica* (Bl.) Schott, Syn. Aroid. 36. 1856, Prodr. Syst. Aroid. 127. 1860 ('zeilanica').

*Synantherias sylvatica* (Roxb.) Schott., Gen. Aroid. t. 28. 1858, Prodr. Syst. Aroid. 126. 1860; Engl. in DC., Monogr. Phan. 2: 320. 1879; Trimen, Syst. Cat. Ceylon 98: 1885; Hook. f., Bot. Mag. 117: t. 7190. 1892; Hook. f., Fl. Brit. India 6: 518. 1893; Rama Rao, Fl. Pl. Travancore 426. 1914.

Tubers depressed sub-globose, ca. 3-5 cm diam. and ca. 1.5-3 cm thickness in vegetative phase; ca. 5-6 cm diam. and ca. 3-4 cm in thickness in reproductive phase; skin smooth, whitish or cream-coloured; roots numerous, ca. 6-12 cm long and ca. 0.1 mm diam. Petiole cylindrical, smooth, ca. 31-65 cm long and 0.5-1.5 cm diam. at the base and tapering to the tip, greenish with pale green ovate-elongate irregular blotches with white margin, or pale green with pale yellowish ovate-elongate blotches, or pale green with whitish blotches, or light brown with pale brown blotches, and in all with minute mottlings in between the blotches. Lamina ca. 32-60 cm diam., leaflets glabrous, ovate-elliptic lanceolate or linear lanceolate, decurrent at the base, tip acute, or acuminate in the case of linear lanceolate

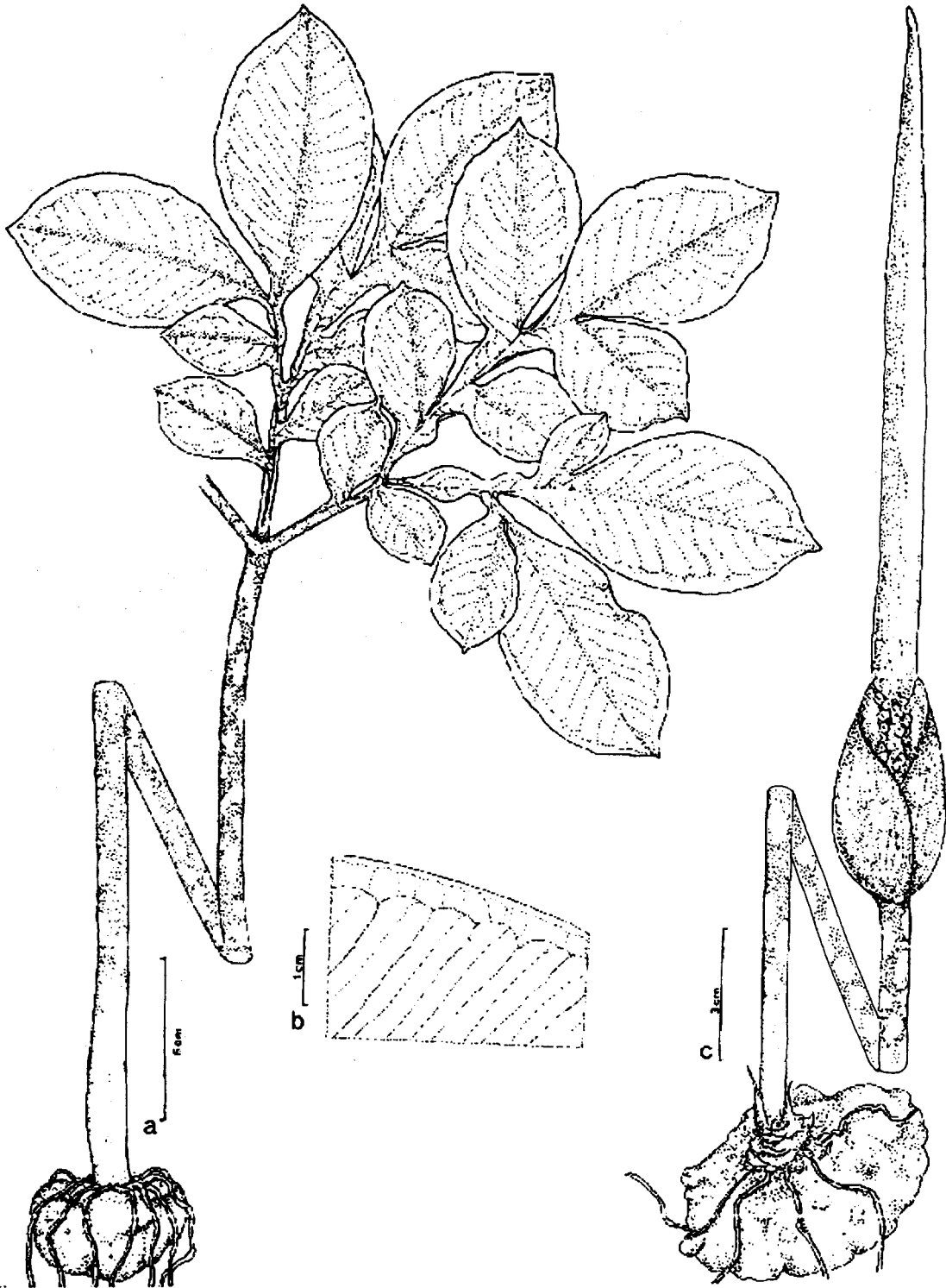


Fig. 54. *Amorphophallus sylvaticus* (Roxb.) Kunth: a. Tuber with leaf; b. Marginal portion of a leaflet showing venation; c. Tuber with inflorescence.

leaflets, dorsal side green, ventral side pale green, margin slightly undulate; large leaflets ca. 6.7 - 7.5 cm long and ca. 3.5 cm broad., small leaflets ca. 4-5.2 cm long and ca. 2.5 cm broad.

Peduncle smooth, ca. 40-50 cm long and ca. 1 cm diam. at the base, gradually narrowed to the tip, identical with petiole in colour and pattern of blotches. Spathe erect, ovate, ca. 3-5.5 cm long and ca. 4-6.5 cm broad, completely convolute and open at the top; pale pinkish or greenish purple outside, purple and verrucose within. Spadix 5-6 times longer than the spathe, ca. 14-22 cm long, stipitate; stipe ca. 0.3-0.5 cm long, pale greenish; female zone ca. 0.8-1.2 mm long, neuteriflorous zone ca. 0.4-0.8 cm long; male zone 1.6-3.0 cm long; terminal spadix-appendix ca. 18 cm long and ca. 0.6-0.9 cm diam. at the base. Female flowers densely arranged, each flower with ovary sub-globose, ca. 2 mm high and ca. 2 mm diam., 2-locular with single basal anatropous ovule in each locule; style short, ca. 1 mm long, pale yellowish; stigma ca. 1.5 mm broad, 2-lobed, sometimes obliquely oriented at the tip of the style; smooth at early stage but with irregular small warts at maturity. Neuter flowers oblong-gibbous, ca. 4-5 cm long, 3-4 cm diam., dark pinkish. Male flowers arranged in groups, each group with 2-5 male flowers, each male flower ca. 1.25 mm high and ca. 1.5 mm broad. Spadix-appendix purplish. Berries usually 2-seeded, scarlet when mature.

*Distribution:* Sri Lanka and South India (Tamil Nadu, Karnataka, Andhra Pradesh, Maharashtra and Gujarat).



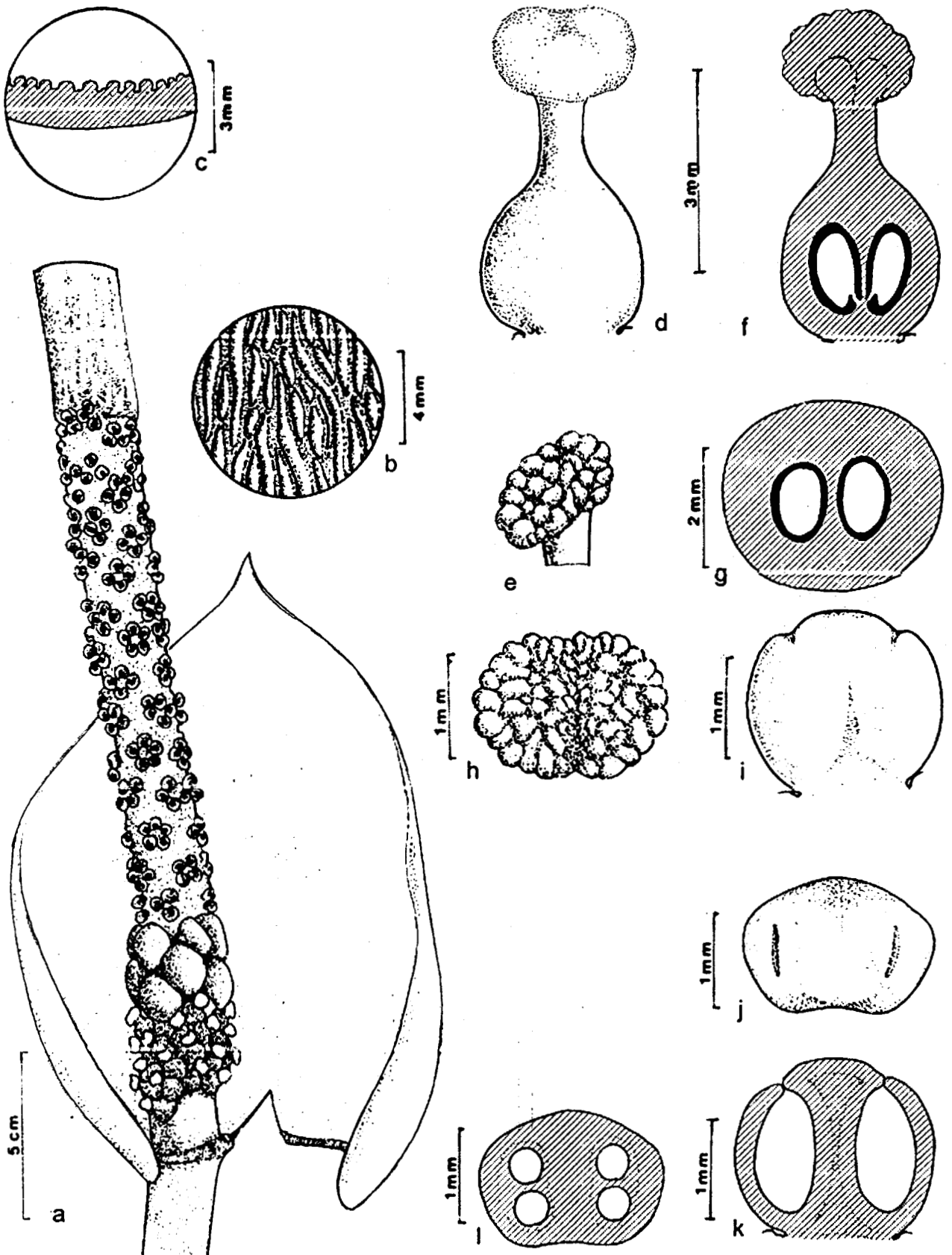


Fig. 55. *Amorphophallus sylvaticus* (Roxb.) Kunth: a. Inflorescence - spathe cut open showing the fertile portion of spadix; b. A small basal inner portion of the spathe - magnified; c. A small basal portion of spathe - c.s.; d. Single female flower; e. Stigma with protuberances - side view; f. Female flower - l.s.; g. Ovary - c.s.; h. Stigma - view from top; i. Single male flower - view from broad side; j. Male flower - view from top showing the openings; k. Male flower - l.s.; l. Male flower - c.s.

*Flowering:* April – June.

*Fruiting:* July – August.

*Notes:* *Amorphophallus sylvaticus* differs from other species in having a spathe about one-fifth or one-sixth of the length of the spadix, neuter flowers oblong-gibbous, pinkish, stigma 2-lobed with many lobules, male flowers arranged in groups of 2-5 and spadix-appendix purplish.

It resembles *A. konkanensis* Hett. *et al.* (1994) in its general appearance of spathe and spadix, but the latter differs in having neuter flowers which are rhomboid, slightly convex, whitish or faint purplish, male flowers arranged loosely, and the spadix-appendix dirty olive green in colour.

The leaflet shape is highly variable from linear lanceolate to ovate elliptic lanceolate.

*Specimens examined:* **Tamilnadu State:** Coimbatore, Ethamibatta path, Kollegal, 4<sup>th</sup> July 1930, *Narayanaswami 3461* (leaf) (MH); Maruthamalai, 15<sup>th</sup> April 1970, *Viswanathan, MVV 524* (infl.) (MH); Pillathikkuppam, near Vedanthangal Bird Sanctuary, Chengalpet Dist., Maduranthakan Taluk, 25<sup>th</sup> Dec. 1986, *Sivadasan CU 21560C* (infl.) (CALI); *Ibid.*, 16<sup>th</sup> Nov. 1997, *Abdul Jaleel & Bobby Thomas RIA 207* (leaf) (CALI); *Ibid.*, 3<sup>rd</sup> July 1998, *Abdul Jaleel RIA 315* (infl.) (CALI); *Ibid.*, 21<sup>st</sup> July 1998, *Abdul Jaleel RIA 317* (infl.) (CALI). **Karnataka State:**

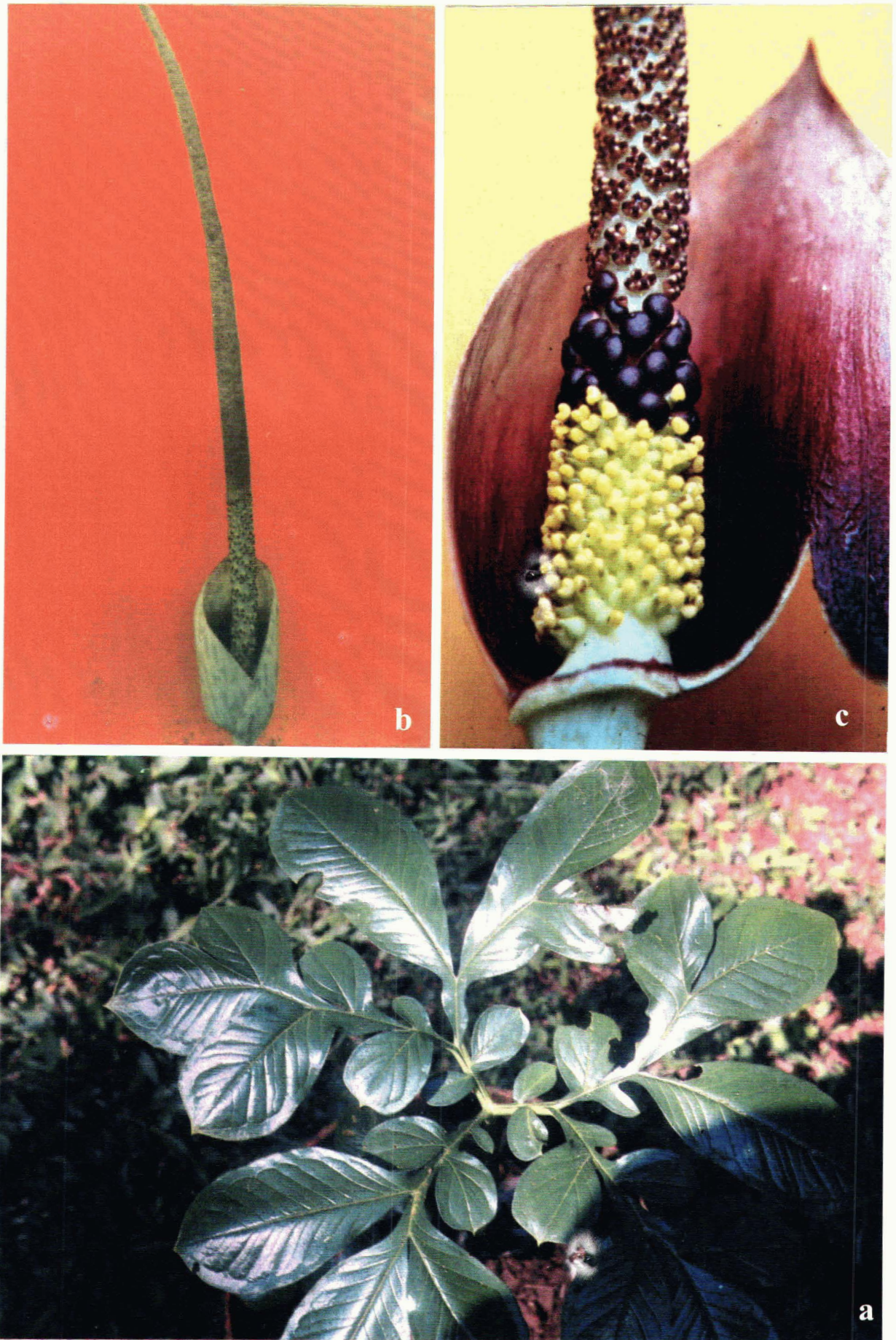


Plate XXIV. *Amorphophallus sylvaticus* (Roxb.) Kunth: a. Lamina – top view; b. Inflorescence; c. Inflorescence with spathe cut open showing fertile portion of spadix.

Ainurmarigudi forest, 11<sup>th</sup> Aug. 1981, *Suresh CU 21493a* (part of a leaf) (CALI);  
 Ibid., 11<sup>th</sup> Aug. 1981, *Suresh CU 21493b* (part of a leaf) (CALI). **Andhra Pradesh State:** Adilabad Dist., Palsi loddhi, 7<sup>th</sup> July 1987, *Ravi Sankar 85266* (infl.) (MH);  
*Ibid.*, 7<sup>th</sup> July 1987, *Ravi Sankar 85266* (infr.) (MH). **Madhya Pradesh State:**  
 Raipur, 6<sup>th</sup> June 1972, *Verma 17572* (BSA); Gurumanur, 16<sup>th</sup> Nov. 1984, *s. coll.*,  
 35270 (BSA).

### **Plantae valde dubia atque imperfecte cognita**

1. *Amorphophallus arunachalensis* Sivadasan et Jaleel, *sp. nov. (ined.)*. (Fig. 56; Plate XXV).

Tubers depressed-globose, ca. 3-8.5 cm diam., 2.5-4.5 cm thick in vegetative phase; ca. 20 cm diam. and 16 cm thick in infructescence stage; skin pale brown in colour; roots numerous, pale yellowish, ca. 7.5-17.2 cm long, 0.1 cm diam. Petiole smooth, ca. 69.5-125 cm long, 1.2-2.8 cm diam. at the base and slightly narrows to the tip, pale green to dark greenish, or brownish green with rounded or irregular dark green mottles and few elongated yellowish blotches. Lamina 58-82 cm diam.; leaflets sessile, ovate-elliptic, tip long acuminate and spirally coiled, margin undulate; small leaflets 6.1-14.5 cm long and 2.5-5.2 cm broad; large leaflets 22.5-26.5 cm long and 6-6.5 cm broad, dark greenish and glossy above, pale greenish below; secondary veins united below the margin forming a submarginal collective vein.

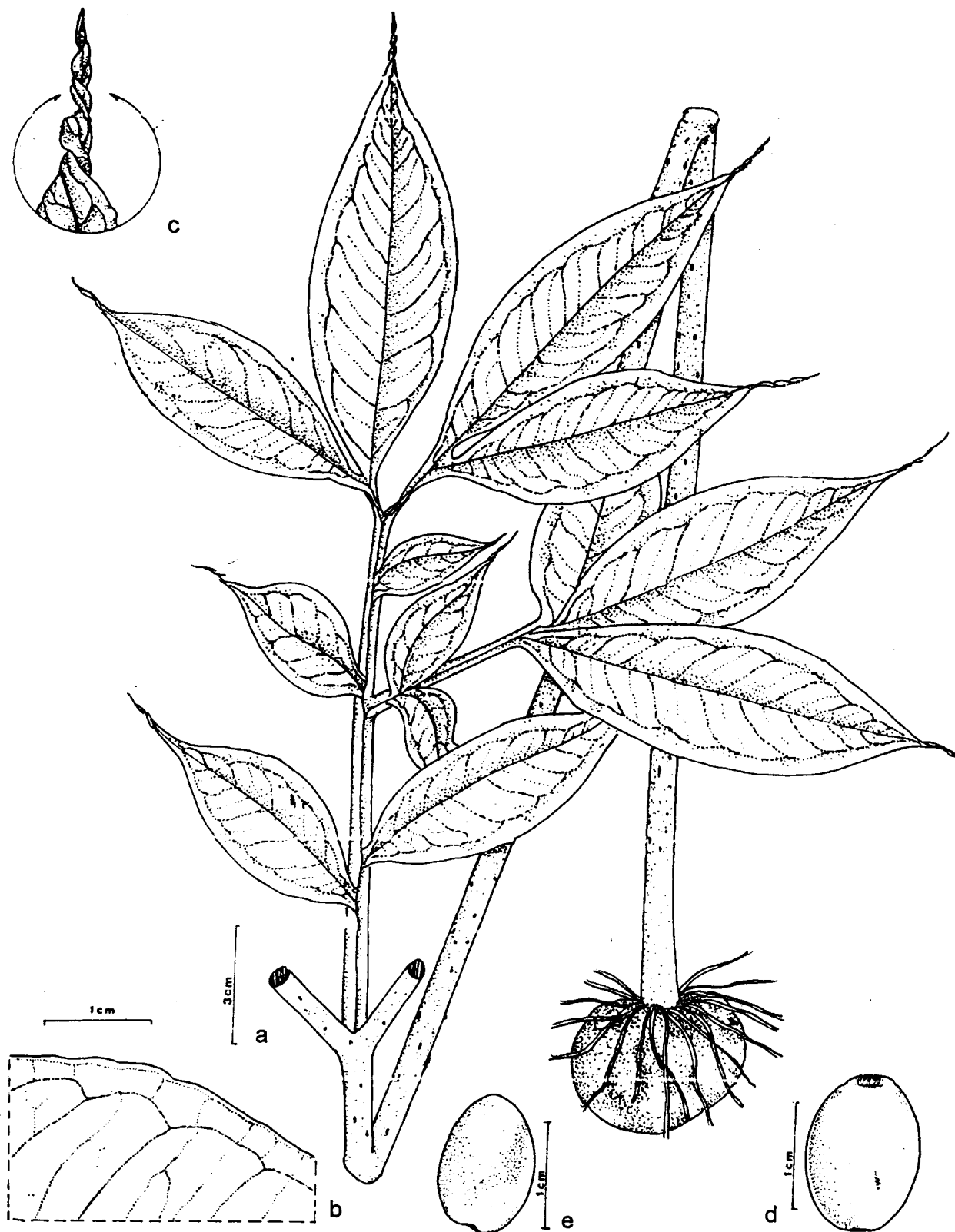


Fig. 56. *Amorphophallus arunachalensis* Sivad. et Jaleel : a. Tuber with leaf; b. Marginal portion of a leaflet showing venation; c. Leaflet tip showing spirally twisted nature; d. Single fruit; e. Single seed.



Plate XXV. *Amorphophallus arunachalensis* Sivad. et Jaleel: a. Tuber with basal portion of petiole; b. A portion of petiole showing mottlings; c. Lamina; d. Few leaflets showing venation and spirally twisted leaflet tip.

Infructescence with peduncle smooth, cylindrical, ca. 136 cm long, 3.2 cm, diam. at the base and gradually narrows to the tip; reddish brown with dark brownish or blackish blotches. Fruits ovoid-ellipsoidal, 1.0-1.2 cm long, 0.5-0.7 cm diam. Seed 1, ca. 1.0 cm long, 0.5 cm diam.

Inflorescence could not be collected and hence details are not known.

*Distribution:* So far known to occur only in Tipinala area of Arunachal Pradesh.

*Flowering:* Not known.

*Fruiting:* September – October.

*Notes:* The present suspected new species differs from all the other known species of India in having long acuminate, spirally coiled leaflet tip.

*Specimens examined:* **Arunachal Pradesh:** Tipinala area, 1<sup>st</sup> October 1997, *Abdul Jaleel RIA 191* (leaf) (CALI); *Ibid.*, 1<sup>st</sup> October 1997, *Abdul Jaleel RIA 192* (Infr.).

**2. *Amorphophallus keralensis* Sivadasan et Jaleel, sp. nov. (*ined.*).** (Fig. 57; Plate XXVI).

Tubers depressed-globose, ca. 5.0-7.5 cm diam. and ca. 3.5-5.0 cm thick in vegetative phase, skin smooth, pale reddish brown in colour; roots numerous, cream-coloured, ca. 15-25 cm long and 0.1-0.2 cm diam. Petiole

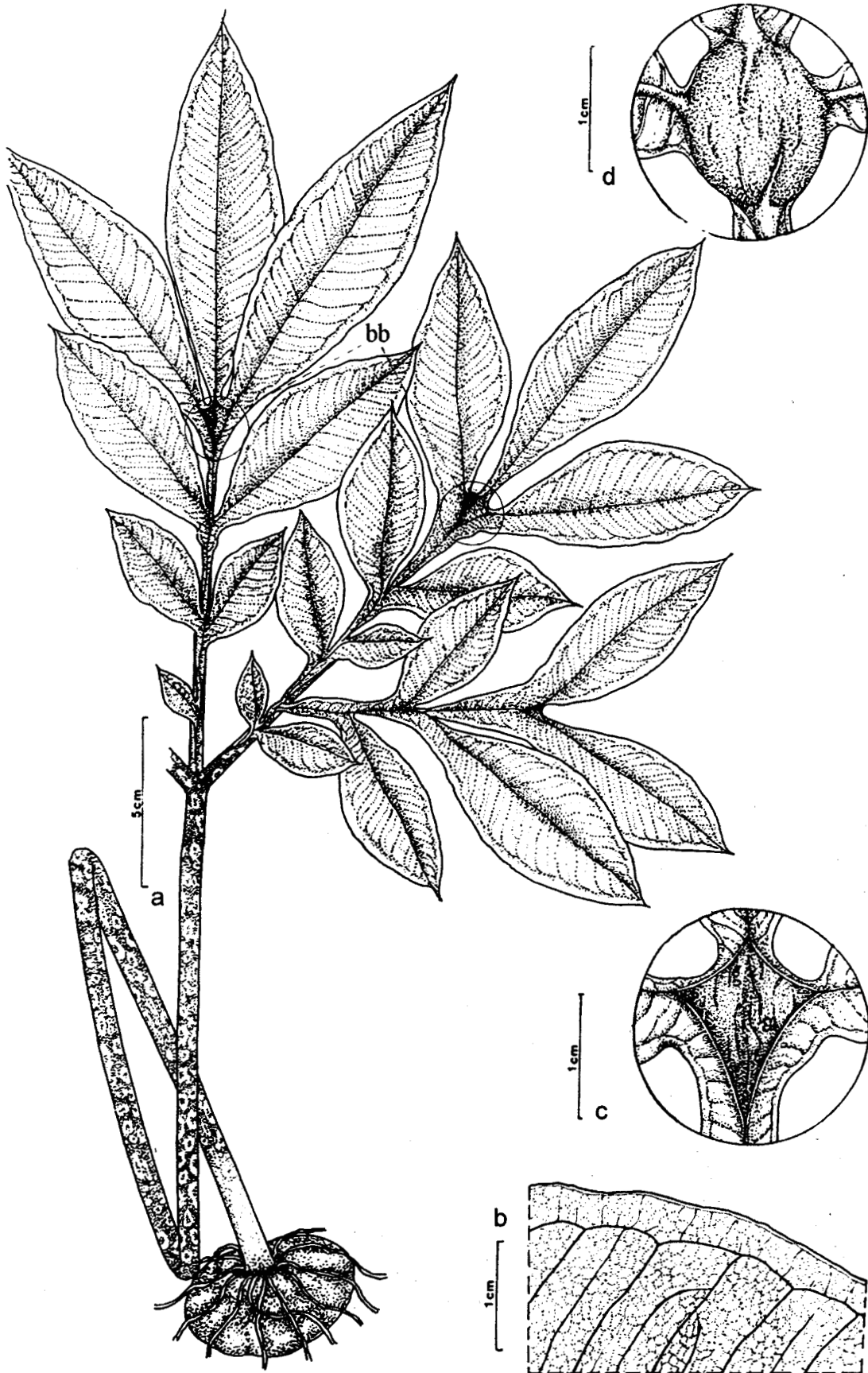


Fig. 57. *Amorphophallus keralensis* Sivad. et Jaleel: a. Tuber with leaf; b. A small marginal portion of a leaflet showing venation; c. Intercalary bulbil – view from upper side; d. Intercalary bulbil – view from lower side; bb - bulbil.



smooth, ca. 60-85 cm long, 1.2-1.7 cm diam. at base and slightly narrows to the tip, brownish or rarely reddish brown with elongated-ovate pale brown blotches with greyish margin and numerous ovate to oblong greyish mottlings, blotches and mottlings are closer and darker, paler and distant towards the tip, extreme base of petiole pinkish. Lamina 50-65 cm diam.; leaflets sessile, ovate-elliptic, tip acute, margin undulate; small leaflets ca. 4.5-5.5 cm long and 2.3-2.7 cm broad, large leaflets 9.5-14.0 cm long and 3.5-5.0 cm broad, greenish above and paler below; secondary lateral veins united below the margin forming a submarginal collective vein; bulbils intercalary, produced at the points of insertion of terminal leaflets on the rachises, each bulbil ca. 1.0-1.6 cm diam. and 0.7-1.2 cm thick, hemispherical or ovoid with the adaxial surface flat, the bulbils are protruded on the lower surface of the lamina than the upper surface; skin pale brown or reddish brown.

Inflorescence could not be collected and hence details are not known.

*Distribution:* So far known to occur only in Nelliampathy Hills of Palakkad District, Kerala State.

*Flowering & Fruiting:* Not known.

*Notes:* The suspected new species, tentatively named as *Amorphophallus keralensis* resembles *A. bognerianus*, *A. bulbifer*, *A. carnosus* and *A. oncophyllus* only in the presence of bulbils, but the above four species are having epiphyllar



Plate. XXVI. *Amorphophallus keralensis* Sivad. et Jaleel: a. A portion of petiole showing mottlings; b. Lamina – top view showing intercalary bulbils; c. Intercalary bulbil – adaxial view; d. Intercalary bulbil – abaxial view; bb-bulbil.

bulbils in contrast to the intercalary bulbils of the former. This is the only taxon hitherto known from India having intercalary bulbils.

*Specimens examined:* **Kerala State:** Palakkad Dist., Nellyampathy, Karappara, 30<sup>th</sup> August 1999, *Abdul Jaleel RIA 377* (leaf) (CALI).

# TAXONOMIC ANALYSIS

V. Abdul Jaleel "Revision of Amorphophallus (Araceae) in India " Thesis.  
Department of Botany , University of Calicut, 2002

## TAXONOMIC ANALYSIS

Engler (1911) in his revision of the family Araceae, recognised 11 sections under the genus *Amorphophallus* Bl. They are *Amorphophallus* sect. *Dysamorphophallus* Engl., sect. *Dracontiopsis* Engl., sect. *Hydrosme* (Schott) Engl., sect. *Rapyogkos* Engl., sect. *Candarum* Engl., sect. *Cundaropsis* Engl., sect. *Conophallus* (Schott) Engl., sect. *Synantherias* (Schott) Engl., sect. *Rhaphiophallus* (Schott) Engl., sect. *Corynophallus* (Schott) Engl. and sect. *Interruptiflorus* Engl. Sivadasan (1989) merged the *Amorphophallus* sect. *Synantherias* with the sect. *Rhaphiophallus* based on their resemblances and at present the number of sections is reduced to 10. Out of the ten sections, only 3 sections are represented in India. They are sect. *Candarum* Engl., sect. *Conophallus* (Schott) Engl. and sect. *Rhaphiophallus* (Schott) Engl.

Engler (1911) in his monographic treatment of the family Araceae, treated the species presently recognised as belonging to the genus *Amorphophallus* under 3 genera namely *Amorphophallus*, *Plesmonium* and *Thomsonia*. Bogner *et al.* (1985) treated the latter two genera as congeneric with *Amorphophallus* and one species each of these genera viz., *P. margaritifera* and *T. nepalensis* respectively were transferred to *Amorphophallus*. As per the current standards of generic and species delimitation, a total of 21 species and 4 varieties have been recognized during the present study. Hooker (1894) in his **Flora of British India** described 17 species,

out of which only eight were recorded as occurring in India. They are *A. bulbifer*, *A. commutatus*, *A. longistylus*, *A. margaritifer* (*Plesmonium margaritiferum*), *A. napalensis* (*Thomsonia napalensis*), *A. oncophyllus*, *A. sylvaticus* and *A. campanulatus* (= *A. paeoniifolius*). Fischer (1931) in Gamble's **Flora of the Presidency of Madras** described six species viz., *A. bulbifer*, *A. hohenackeri*, *A. margaritifer* (*Plesmonium margaritiferum*), *A. sylvaticus*, *A. campanulatus* (= *A. paeoniifolius*) and *A. dubius* (= *A. paeoniifolius*). The two species mentioned as *A. campanulatus* and *A. dubius* are synonymous with *A. paeoniifolius*, so the total number of species is five. All the species described by Fischer except *A. hohenackeri* are included in the **Flora of British India**.

Engler (1911) in his **Das Pflanzenreich** listed 10 species as occurring in India. Hettterscheid of the Netherlands is the only one scientist currently attempting a world-revision of the genus and in one of his publications with Ittenbach (1996) listed fourteen species occurring in India. They treated *A. carnosus* and *A. oncophyllus* as the synonym of *A. muelleri*, Javanese species; but the present investigation proved that *A. carnosus* and *A. oncophyllus* are two distinct species.

The percentage of Indian species in relation to the total number of species for the genus is 12.35. In India *Amorphophallus* sect. *Rhaphiophallus* (Schott) Engl. is the largest one, which is characterised by having male zone in the spadix separated from the female by a neuteriflorous zone, and is represented by eight species viz., *A. bonaccordensis*, *A. hohenackeri*, *A. konkanensis*, *A.*

*longiconnectivus*, *A. margaritifera*, *A. mysorensis*, *A. smithsonianus* and *A. sylvaticus*. The next largest section is *Conophallus* (Schott) Engl., which is characterised by having a spadix-appendix long, usually surpassing spathe, and style much shorter than ovary, and it is represented by six species viz., *A. bognerianus*, *A. bulbifer*, *A. carnosus*, *A. commutatus*, *A. nicolsonianus* and *A. oncophyllus*. The third largest section is *Candarum* characterised by having spathe convolute below, and limb above tube sometimes ovate, usually oblong or oblong-ovate or ovate lanceolate, spadix (rarely) shorter than spathe, sometimes the broadly conoid appendix thicker than the inflorescence, style 2-4 times longer than ovary and it is represented by five species viz., *A. hirsutus*, *A. kachinensis*, *A. longistylus*, *A. napalensis* and *A. paeoniifolius*.

The number of species in different states of India based on the available data is as follows: Kerala – 8 (*A. bonaccordensis*, *A. bulbifer*, *A. commutatus*, *A. hohenackeri*, *A. keralensis*, *A. nicolsonianus*, *A. paeoniifolius* and *A. smithsonianus*), Karnataka – 6 (*A. bulbifer*, *A. commutatus*, *A. hohenackeri*, *A. mysorensis* and *A. paeoniifolius*, *A. sylvaticus*), Tamil Nadu – 3 (*A. margaritifera*, *A. paeoniifolius* and *A. sylvaticus*), Andhra Pradesh – 4 (*A. bulbifer*, *A. margaritifera*, *A. paeoniifolius* and *A. sylvaticus*), Maharashtra – 5 (*A. bulbifer*, *A. commutatus*, *A. konkanensis*, *A. paeoniifolius* and *A. sylvaticus*), Goa – 4 (*A. bulbifer*, *A. commutatus*, *A. konkanensis* and *A. paeoniifolius*), Madhya Pradesh – 4 (*A. bulbifer*, *A. longiconnectivus*, *A. margaritifera* and *A. paeoniifolius*),

Uttar Pradesh – 2 (*A. margaritifera* and *A. paeoniifolius*), Gujarat – 2 (*A. paeoniifolius* and *A. sylvaticus*), Orissa – 2 (*A. bulbifer* and *A. paeoniifolius*), Bihar – 3 (*A. bulbifer*, *A. margaritifera* and *A. paeoniifolius*), West Bengal – 3 (*A. bulbifer*, *A. margaritifera* and *A. paeoniifolius*), Assam – 4 (*A. bulbifer*, *A. margaritifera*, *A. napalensis* and *A. paeoniifolius*), Arunachal Pradesh – 5 (*A. bognerianus*, *A. bulbifer*, *A. kachinensis*, *A. napalensis* and *A. paeoniifolius*), Rajasthan – 2 (*A. margaritifera* and *A. paeoniifolius*), Meghalaya – 3 (*A. bulbifer*, *A. napalensis* and *A. paeoniifolius*), Tripura – 2 (*A. bulbifer* and *A. paeoniifolius*), Manipur – 2 (*A. bulbifer* and *A. paeoniifolius*), Sikkim – 4 (*A. bulbifer*, *A. margaritifera*, *A. napalensis* and *A. paeoniifolius*) and Andaman & Nicobar Islands – 5 (*A. carnosus*, *A. hirsutus*, *A. longistylus*, *A. oncophyllus* and *A. paeoniifolius*). One species *A. paeoniifolius* is present in all states of India. Based on the earlier reports, present collection and herbarium study, maximum number of species present is in Kerala State.

The number of species discovered after the works of Hooker (1899), Engler (1911) and Fischer (1931) in India is eleven. They are *A. arunachalensis* Sivad. et Jaleel, *A. bognerianus* Sivad. et Jaleel, *A. bonaccordensis* Sivad. et al., *A. hirsutus* Teysm. & Binn., *A. kachinensis* Engl. et Gehrm., *A. keralensis* Sivad. et Jaleel, *A. konkanensis* Hett. et al., *A. longiconnectivus* Bogner, *A. mysorensis* Barnes et Fisch., *A. nicolsonianus* Sivad. and *A. smithsonianus* Sivad. The total number of taxa including the varieties are 25 and the percentage of increase in the number of



taxa after the treatments of Hooker (1894), Engler (1911) and Fischer (1931) is 127.27, and, the percentage of increase in the number of species is 110.

Out of the 21 species four viz., *A. carnosus* Engl., *A. longiconnectivus* Bogner, *A. longistylus* Kurz ex Hook. f. and *A. mysorensis* E. Barnes et C.E.C. Fisch. have been rediscovered recently after more than 100 years, 87 years, 131 years and 60 years respectively of their first discovery and collection. *A. longiconnectivus* which was described by Bogner (1975) based on a single specimen collected by Haines in the year 1910 and available at Kew herbarium (K). No other earlier or later collections are known to be available in any Indian or foreign herbaria at the time of its publication. The collections made during the present investigation forms the second collection of the species after 87 years of its first collection.

*A. commutatus* forms a complex with three distinct varieties viz., var. *commutatus*, var. *anmodensis*, and var. *wayanadensis*. *A. oncophyllus* also forms a complex with two distinct varieties viz., var. *oncophyllus* and var. *rayhillianus*. *Amorphophallus bulbifer* is reported to have four varieties (Engler, 1911) viz., var. *bulbifer*, var. *atroviridimaculatus* Engl., var. *marmoratus* Engl. and var. *tuberculiger* (Schott) Engl., and the present investigation does not corroborate this recognition, considering those as representing variations of a single species – *A. bulbifer*.

### **New Records to India**

The discovery of *A. hirsutus* Teysm. et Binn. from Great Nicobar Islands and *A. kachinensis* Engl. & Gehrm. from Arunachal Pradesh form new records of their extended distribution and addition to the aroid flora of India. The original centre of distribution of *A. hirsutus* is Sumatra, and *A. kachinensis* is N. Thailand, Laos, China: Yunnan.

### **Imperfectly known new species**

A species collected from Karappara, Nelliampathy Hills in Palakkad Dist., Kerala is confirmed to be a new species eventhough the collection represented only vegetative phase. The presence of intercalary bulbils is a very distinct character to distinguish the species from the rest of the species found in India producing bulbils. The bulbils of all the other bulbiferous Indian species are epiphyllar in nature. Sivadasan (pers. comm.) informed that he had seen a herbarium specimen of an inflorescence of a species collected from Karappara, Nelliampathy Hills and was kept as an indetrmned species in MH during the early 1970s. Later efforts to study the specimens were futile as it could not be re-located. It is suspected that the specimen might have been completely ruined by insect attack. The schematic sketch provided by Sivadasan is believed to be representing that of the inflorescence of the supposed new species with intercalary bulbils. This conclusion

is based on the collection of the plants in vegetative phase from the same locality of collection of the reproductive one available at MH.

A species collected from Tipinala area in Arunachal Pradesh with vegetative phase and infructescence was suspected to be a new species because of the following characters; petiole dark greenish; leaflets margin highly undulate, tip long-acuminate and highly twisted.

### **Species with wide distribution**

The species with wide distribution are: *A. bulbifer* (India and Myanmar), *A. kachinensis* (N. Myanmar, N. Thailand, Laos, China and India – Arunachal Pradesh), *A. hirsutus* (W. Sumatra, and India – Great Nicobar Island), *A. nepalensis* (Bhutan, Nepal and India – Sikkim, Assam, Meghalaya and Arunachal Pradesh), *A. paeoniifolius* (Sri Lanka, Pacific Islands and India – in almost all states) and *A. sylvaticus* (Sri Lanka and South India). *A. hohenackeri* is endemic to Kerala and South Kanara Dist. of Karnataka state. *A. commutatus* is endemic to South India (including Goa), Gujarat and Madhya Pradesh.

### **Endemic species**

The species strictly endemic to Andaman Islands are *A. carnosus*, *A. longistylus* and *A. oncophyllus*. The narrow endemic species are *A. arunachalensis* (Arunachal Pradesh), *A. bognerianus* (Arunachal Pradesh), *A. bonaccordensis*

(Kerala State), *A. keralensis* (Kerala), *A. longiconnectivus* (Madhya Pradesh), *A. mysorensis* (Karnataka State), *A. nicolsonianus* (Kerala State) and *A. smithsonianus* (Kerala State). All the species mentioned as narrow endemics species and *A. carnosus* and *A. longistylus* are considered as endangered. The indiscriminate deforestation at fast pace poses threat to the habitat of the endemic species. And, proper monitoring of their habitats and distribution are essential for appropriate conservation measures to be resorted to for their conservation.

# SUMMARY

V. Abdul Jaleel "Revision of Amorphophallus (Araceae) in India " Thesis.  
Department of Botany , University of Calicut, 2002

## SUMMARY

The genus *Amorphophallus* Bl. of the family Araceae is with about 170 species distributed in Tropical Africa, Malay Archipelago, Melanesia and Australia. It is an economically important genus with further potentials. Taxonomically and botanically it is one of the most difficult genera of the family due to a number of reasons. The inflorescences are not usually produced along with the leaves, and the flowering is usually prior to the emergence of leaves, and is restricted to a very short period. The flowering period varies based on the variations in the commencement of rainy season in different areas; and some species flower out of the usual season. These make collection of the species, both in vegetative and reproductive phases together difficult. The morphological similarity of the leaves of many species and the variations of the leaves within the species, especially in the colour and mottling patterns of the petiole make the identification of the species with vegetative specimens impossible. Apart from these, the succulent and massive nature of the plant parts like tubers, petioles, peduncles and inflorescences makes collection and preservation of the specimens very difficult. The raphide contents in the plant body also make the collectors keep away from collecting. So, even though the number of species are comparatively less, the collection, preservation, identification and detailed study are difficult and requires intensive and extensive repeated field trips for collection, and keen and strenuous labour for preservation

and study. All these factors might have been the reason for neglecting the genus by the botanists, and consequent poor representation of the genus in Indian and International herbaria.

In India the number of species reported by Hooker (1894) in **Flora of British India** is eight. Fischer (1931) in Gamble's **Flora of the Presidency of Madras** recognised five species. Engler (1911) in his revision of the family Araceae recognised ten species of *Amorphophallus* that occur in India. Hettterscheid of the Netherlands is currently carrying out a world revision of the genus. But in India no revisionary study on the genus has been carried out, and it is in this context the present study was undertaken.

During the last five years (1997-2002) intensive and extensive field trips were conducted throughout India including Andaman and Nicobar Islands and recognized 21 species and 4 varieties viz., *Amorphophallus bognerianus* Sivad. et Jaleel sp. nov., *A. bonaccordensis* Sivad., Mohanan & Rajkumar, *A. bulbifer* (Sims) Bl., *A. carnosus* Engl., *A. commutatus* (Schott) Engl. var. *commutatus*; *A. commutatus* (Schott) Engl. var. *anmodensis* Sivad. et Jaleel; *A. commutatus* (Schott) Engl. var. *wayanadensis* Sivad. et Jaleel; *A. hirsutus* Teysm. & Binn., *A. hohenackeri* (Schott) Engl. et Gehrm., *A. kachinensis* Engl. & Gehrm., *A. konkanensis* Hett., Yadav et Patil; *A. longiconnectivus* Bogner; *A. longistylus* Kurz ex Hook. f., *A. margaritifera* (Roxb.) Kunth; *A. mysorensis* E. Barnes & C.E.C. Fisch., *A. napalensis* (Wall.) Bogner et Mayo; *A. nicolsonianus* Sivad.,

*A. oncophyllus* Prain ex Hook. f. var. *oncophyllus*; *A. oncophyllus* Prain ex Hook. f. var. *rayhillianus* Sivad. et Jaleel, *A. paeoniifolius* (Dennst.) Nicolson var. *paeoniifolius*; *A. paeoniifolius* (Dennst.) Nicolson var. *campanulatus* (Decaisne) Sivad., *A. smithsonianus* Sivad.; *A. sylvaticus* (Roxb.) Kunth., including the two imperfectly known species viz., *A. keralensis* Sivad. et Jaleel from Nelliampathy in Palakkad Dist., Kerala and *A. arunachalensis* Sivad. et Jaleel from Arunachal Pradesh. This denotes a significantly high number of species occurring in India and the increase is 110% more than all the species recorded in the works of Hooker (1894), Fischer (1931), and Engler (1911).

The present study brought to light 3 new species (*A. bognerianus*, *A. keralensis* and *A. arunachalensis* – the latter 2 imperfectly known) and 3 new varieties (two of *A. commutatus* and one of *A. oncophyllus*). Two species viz., *A. hirsutus* Teysm. et Binn. and *A. kachinensis* Engl. et Gehrm. have been collected during the study from Great Nicobar Island and Arunachal Pradesh respectively, and these form first reports of their distribution in India.

Rediscoveries of endangered and threatened species like *A. carnosus* Engle from Andaman Islands, *A. longistylus* Kurz from Andaman Islands, *A. mysorensis* E. Barnes et C.E.C. Fisch. from Billigirirangan Hills in Karnataka State, and *A. longiconnectivus* Bogner from Piparia from Madhya Pradesh have been made after 100 years; 131 years, 60 years and 87 years respectively of their first collection.



Under the taxonomic treatment, a key to the identification of the species is provided. The imperfectly known species are excluded from the key. Each species is provided with an up-dated nomenclatural citation, citation of types, detailed description, phenology, distribution, citation of specimens examined, and also relevant notes on nomenclature, variations, distribution, uses, etc., if any.

Out of the 21 species occurring in India, 15 species are strictly endemic to India and the percentage of endemism is 71. Three species viz., *A. carnosus*, *A. longistylus* and *A. oncophyllus* are confined to Andaman islands. The other endemic species and area of endemism are as follows: *A. bognerianus* (Arunachal Pradesh state), *A. bonaccordensis* (Kerala State), *A. longiconnectivus* (Madhya Pradesh State), *A. mysorensis* (Karnataka State), *A. nicolsonianus* (Kerala State), *A. smithsonianus* (Kerala State), *A. hohenackeri* (Kerala and Karnataka States), and *A. commutatus* (Kerala, Karnataka, Tamil Nadu, Goa, Maharashtra, Gujarat, Madhya Pradesh and Rajasthan States).

The species having distribution outside India are: *A. bulbifer* (India and Myanmar), *A. kachinensis* (N. Myanmar, N.Thailand, Laos, China and India – Arunachal Pradesh), *A. hirsutus* (W. Sumatra and India – Great Nicobar Island), *A. nepalensis* (Bhutan, Nepal and North-East India), *A. paeoniifolius* (Sri Lanka, Pacific Islands, and India – in almost all states), and *A. sylvaticus* (Sri Lanka and South India).

*Amorphophallus bulbifer* is reported to have four varieties (Engler, 1911), but the present investigation does not corroborate the recognition of the varieties and consider those as representing variations of a single species.

The number of species discovered after the works of Hooker (1894), Engler (1911) and Fischer (1931) in India is eleven, including two imperfectly known species. They are *A. bognerianus* Sivad. et Jaleel, *A. bonaccordensis* Sivad., Mohanan & Rajkumar, *A. hirsutus* Teysm. & Binn., *A. kachinensis* Engl. & Gehrm., *A. konkanensis* Hett. et al., *A. longiconnectivus* Bogner, *A. mysorensis* E. Barnes & C.E.C. Fisch, *A. nicolsonianus* Sivad., *A. smithsonianus* Sivad., *A. keralensis* Sivad. et Jaleel (*ined.*) and *A. arunachalensis* Sivad. et Jaleel (*ined.*).

The percentage of increase in the number of species after the treatments of Hooker (1894), Engler (1911) and Fischer (1931) is 110, and this indicates the lack of study in the genus in India. The fast and indiscriminate deforestation and destruction of natural habitats of the constituent species would render most of the narrow endemic species endangered and lead to subsequent extinction. In view of this, proper monitoring of the distribution and conservation measures of the species are to be resorted to, for saving the members of the genus *Amorphophallus* which contain wild relatives of a widely used and economically important cultivated species.

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## Appendix I

### Publications during the period of research

1. Sivadasan, M. & V. Abdul Jaleel. 1998. Rediscovery of *Amorphophallus longistylus* (Araceae), a little known rare endemic species from Middle Andaman, India. *Rheedea* 8(1): 103-106.
2. Sivadasan, M. & V. Abdul Jaleel. 1998. Rediscovery of *Amorphophallus longiconnectivus* Bogner, a little known rare endemic species of Araceae. *Rheedea* 8(2): 243-247.
3. Sivadasan, M. & V. Abdul Jaleel. 2000. Rediscovery of *Amorphophallus carnosus* (Araceae), a rare and narrow endemic species from South Andaman, India. *Rheedea* 10(1): 63-67.
4. Sivadasan, M. & V. Abdul Jaleel. 2000. *Amorphophallus hirsutus* Teysm. et Binn. (Araceae): A new report from India. *Rheedea* 10(2): 143-147. 2000.
5. Sivadasan, M. & V. Abdul Jaleel. 2001. *Amorphophallus mysorensis* E. Barnes & C.E.C. Fisch. (*Amorphophallus* sect. *Rhaphiophallus*) (Araceae) in India with notes on related species. *Aroideana* 24: 94-99.
6. Sivadasan, M., V. Abdul Jaleel & Bobby Thomas. 2001. *Lagenandra keralensis* (Araceae), a remarkable new species from India. *Bot. Bull. Acad. Sin.* 42: 153-157.
7. Sivadasan, M., V. Abdul Jaleel & Bobby Thomas. 2002. *Lagenandra keralensis* Sivadasan & Jaleel (Araceae), eine bemerkenswerte neue Art aus Indien. *Aqua Planta* 2002(1): 16-21.

## Appendix II

### Paper Presented at Seminars/Conferences

1. Rediscovery of *Amorphophallus longiconnectivus* Bogner (Araceae), a rare and endemic species in India. National Seminar on Biodiversity, Conservation and Taxonomy of Tropical Flowering Plants, held on 27-29<sup>th</sup> Nov. 1988, at Calicut, Kerala.
2. The genus *Amorphophallus* Blume ex Decaisae (Araceae) in Andaman and Nicobar Islands, India. National Seminar on Plant Systematics, Biodiversity, Conservation and Ethnobotany, held on 18-19<sup>th</sup> Dec. 1999, at Calicut, Kerala.
3. Precursor of a revision of the genus *Amorphophallus* in India. National Seminar on Plant Biodiversity – Systematics, Conservation and Ethnobotany, held on 9-11<sup>th</sup> Nov. 2000, at Siliguri, West Bengal.
4. Generic Diversity in the tribe Areae (Aroideae – Araceae) in India. National Seminar on Plant Systematics in 21<sup>st</sup> Century Approaches and Prospects, held on 7-8<sup>th</sup> Nov. 2001, at Dehradun, Uttaranchal.

### **Appendix III**

#### **Awards received for best research papers presented at various Seminars/Conferences**

1. **Dr. K.S. Manilal Award** for the best paper in floristics presented at the National Seminar on Plant Systematics, Biodiversity, Conservation and Ethnobotany, held on 18-19<sup>th</sup> Dec. 1999, at Calicut, Kerala.
2. **Dr. K.S. Manilal Award** for the best paper in floristics presented at the National Seminar on Plant Biodiversity – Systematics, Conservation and Ethnobotany, held on 9-11<sup>th</sup> Nov. 2000, at Siliguri, West Bengal.



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