

A REVISION OF THE EASTERN HIMALAYAN  
SPECIES OF THE GENUS *ARISAEMA*  
(ARACEAE)

by

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In 1828 Wallich described and illustrated three Nepalese species under the generic name *Arum*, and Martius in 1831 established the genus *Arisaema* based on those three Himalayan species (*A. nepenthoides*, *A. costatum*, and *A. speciosum*). Since then a large number of species have been described mainly from Asia by Blume, Schott, Buchet, and Engler. Engler (1920) in his monographic work in *Pflanzenreich* recognized 18 species and several varieties from the Himalayas. In 1955 D. Chatterjee enumerated the 40 Indian and Burmese species of *Arisaema*, including 18 Eastern Himalayan species.

Since 1960 I have had several opportunities to visit Eastern Himalaya as the leader of the Botanical Expeditions to Eastern Himalaya organized by the University of Tokyo, and have observed nearly all the Himalayan species of the genus in their natural habitats, and also cultivated most of them in Japan. In this genus, the size of plants and the shape of leaves are extremely variable. But in the field, each species can be readily recognized by the characters of leaves, spathe, and spadix, although it is sometimes difficult to identify herbarium specimens, especially when they were not well prepared.

The present study is mainly based on the materials collected during the expeditions, and those cultivated in Tokyo and Karuizawa of Japan, and also partly on my knowledge and data about the Japanese species obtained since 1933.

SUBDIVISIONS OF THE GENUS *ARISAEMA*

Schott in 1860 first classified all the then known species, and grouped them in four sections based on the arrangement of the leaflets. Engler (1920) in his worldwide monograph subdivided the genus into 15 sections. He used the shape of the basal part of the spadix-appendage as the primary criterion for separating sections, and then the shape of the spadix, appendage, anthers, spathe-blade and leaves as the subsidiary criteria. D. Chatterjee (1955) in his enumeration of the Indian species proposed the natural arrangement dividing them into five main groups.

In this study I have re-evaluated various characters, and tried to propose a classification, in which natural interrelationships are reflected as far as possible.

The plants of the genus are sometimes monoecious with a bisexual spadix, but more often dioecious with a unisexual spadix. However, even in dioecious species it has been well-known (Takeda, Schaffner, Maekawa) that the sexuality of the

plants is influenced mainly by nutritional conditions in the previous year, and male plants are produced from smaller bulbs, and female plants from larger bulbs. So it is possible to control the sex of the plant to some extent by the growth conditions. For this kind of dioecious, a special term 'paradioicus' was proposed by Nakai in *Icon. Pl. Asia. Or.* **1** (4): 66 (1936). But even in the normally paradioecious species, a bisexual spadix is rarely produced in an abnormal case.

The majority of the species have a depressed globose bulb, often with small accessory bulbils, or sending out long creeping stolons in some species (e.g. *A. concinnum*, *A. exappendiculatum*, *A. ternatipartitum*). It is interesting that some trifoliate species from India and W. China such as *A. speciosum*, *A. Roxburghii*, *A. decipiens*, *A. rhizomatum*, and *A. anomalum* have oblique or creeping thick rhizomes which are sometimes branched. This kind of the rhizomes is presumed to be more primitive than globose bulbs.

The number (1-3) of the leaves is not a stable character. Well-grown individuals of usually unifoliate species (e.g. *A. concinnum*, *A. utile*, *A. Jacquemontii*) have sometimes two leaves, and those of usually bi-foliate species (e.g. *A. nepenthoides*, *A. tortuosum*) have occasionally three leaves.

The arrangement of the leaflets is a readily utilized character for dividing the genus, although Engler did not place much stress upon this character. In general it seems reasonable to assume that an evolutionary trend in leaves is 3-lobed → 3-foliate → digitately 5-multi-foliate → radiately 5-multi-foliate, and this trend can be developed parallel in different regions. Also various transitional forms between these stages are occasionally observed, and in some cases both 3-lobed and 3-foliate leaves are observed in one species, and 3-foliate and digitately 5-foliate leaves in another species, influenced possibly by nutritional conditions.

However, in such a group including *A. Griffithii*, *A. costatum*, and *A. speciosum* which is highly differentiated in the Himalayas and W. China but has many common characteristics in spathe, spadix-appendage, and anthers has consistently 3-foliate leaves. Another Asiatic group with radiate leaflets also seems to be a very natural one. So the character of the leaves appears to be one of the important criteria for grouping the species in the genus.

The shape and colouring of the spathe-blade are very attractive and are useful to separate species, although its size is considerably variable by nutritional conditions of the plant. A large galeate spathe with broad auricles or with conspicuous lamellae inside is presumably an advanced character. The spathes of *A. Griffithii*, *A. galeatum* and *A. ringens* are somewhat similar to one another, but one does not seem to be derived from the other.

The spadix is unisexual, or bisexual with female flowers in the lower part and male in the upper part. On the appendage above the spadix, there are horn-like or subulate protuberances in such species as *A. consanguineum*, *A. filiforme*, *A. Negishiï*, *A. tortuosum*, and *A. anomalum*, and they are generally regarded as a modification of sterile flowers. In Sect Fimbriata, the elongate spadix-appendages are sometimes covered with numerous and often filiform projections.

The prolonged axis (appendage) of the spadix is extremely variable in length and in shape. A narrow cylindrical appendage seems to be a primitive type. In one

trend, the appendage becomes thicker and clavate or even capitate at the apex, and truncate at the base with a stipe passing to the axis of the spadix. Another trend leads an elongation, and the appendage is often curved, and flagellate tapering to a thin thread attaining to 50 cm long, and is sometimes thickened into a fleshy disk in the basal part. In Sect. *Trisecta*, when the spathe expands, the long flagellate spadix-appendage comes up firmly clasped at the apex of the spathe-blade and hangs down to the ground.

These characters of the appendage are generally stable in each species, but a similar evolutionally trend may occur parallel in different regions or in different groups.

The female flowers are similar in basic characters throughout the genus, with minor modifications in shape and colour of ovaries and stigmas, and do not offer good criteria for grouping the species. Whereas the male flowers seem to show a phylogenetic trend in the structure of anthers. A male flower consists of (1) 2-5 stamens, and their filaments are generally connate into one columnar stipe. The anthers are basically 2-locular, and each anther-cell is dehiscent by a longitudinal slit, and opens by an oblong, elliptic or roundish pore. The anthers are generally muticous at the apex, but apiculate in some species belonging to several sections, e.g. *Tortuosa*, *Sinarisaema*, and *Fimbriata*.

In Sect. *Trisecta* and a few other species, two anther-cells are confluent at the apex and dehiscent by a crescent or horseshoe-shaped slit (Figs. 50 & 51). In *A. exappendiculatum*, a male flower is composed of apparently a single stamen bearing one anther which is circumscissilely dehiscent at the top (Fig. 56), and which appears to be derived from the fusion of 2 or 3 anthers. This type of stamens is presumably one of the end-products in the genus.

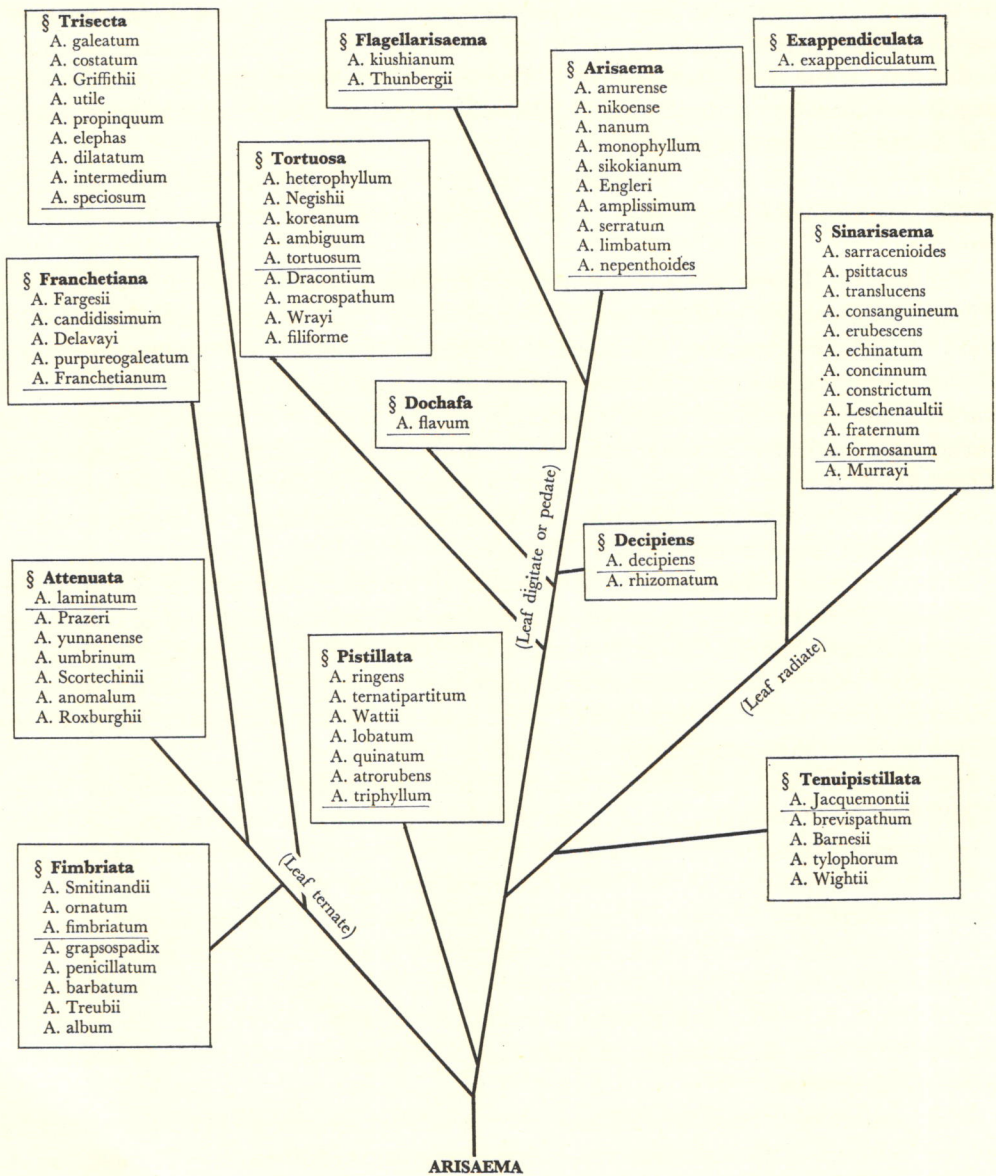
Cytologically about 50 species have hitherto been studied especially by T. Ito (1942) and later workers. The greater part of the species examined has 28 somatic chromosomes, and the primary basic number of the genus is considered to be 7.

Intraspecific polyploidy has been observed in some species, and both chromosome numbers  $2n=28$  and 56 have been confirmed in *A. Dracontium*, *A. nikoense*, and *A. atrorubens*. Also in some cases, polyploidy seems to play an important role in speciation, and different chromosome numbers are reported in allied species. For example, in Sect. *Sinarisaema*, the somatic chromosomes are 28 in *A. consanguineum* and 56 in *A. concinnum*; in Sect. *Flagellarisaema*  $2n=28$  in *A. Urashima* and 56 in *A. kiushianum*.

It is noteworthy that  $2n=26$  has been reported in the *A. tortuosum* group by several authors, although Sharma (1965) recently reported  $2n=28$  also for *A. tortuosum*. The high chromosome numbers were recorded in a few species belonging to different sections; i.e.  $2n=ca. 78$  in *A. ternatipartitum*, 112 in *A. robustum*, and ca. 140 in *A. heterophyllum*. Also such somatic numbers as 24, 32 and 52 were reported in some races.

The more extensive and detailed studies on chromosome number and karyotype of various groups will be useful to discuss the relationships between allied species.

The genus *Arisaema* comprises over 100 species, distributed mostly in Asia, but several species occur in tropical Africa, eastern North America and Mexico. The



Schema showing interrelationships in the sections of the genus *Arisaema*. For each section, representative species are exemplified, and the underlined species are the type or lectotype of the section. The species with primitive characters are arranged in the lower columns, and those with more advanced characters in the upper columns.

greater number of species and also those with primitive characters are concentrated in the tropics and subtropics of continental Asia from India east to China. It may be taken for granted that the secondary center of the origin of the genus was continental Asia where the genus is most variable.

Taking various data mentioned above into consideration, I tried to define natural groups in the genus. The sectional names proposed by Schott (1860) and Engler (1920) are lectotypified and retained, following the International Code of Botanical Nomenclature. But most of those sections are greatly altered in the diagnostic characters and the circumscription. The interrelationships between the remodelled sections of the genus are schematically summarized on page 324. It appears, however, that two similar sections were often developed simultaneously and in a somewhat parallel manner, rather than one of them having been ancestral to the other.

In the trifoliolate group, Sect. *Attenuata* has developed in Malaysia, India, and W. China, and it is noteworthy that *A. Roxburghii*<sup>1)</sup> possesses several primitive characters. To this section, Sect. *Franchetiana* of Malay and W. China and Sect. *Fimbriata* of India, Malay, S. China, and Formosa are closely allied. *A. anomalum* from Malay of Sect. *Franchetiana* also has some prototypic characters. Engler's Sect. *Auriculata* is a heterogeneous group, but if it is lectotypified by *A. Fargesii*, it should be treated as a synonym of Sect. *Franchetiana*. Sect. *Fimbriata* and *Barbata* should be united, but some species are intermediate between these sections and Sect. *Attenuata*.

Sect. *Pistillata* occurs in China, Japan, and Eastern N. America, and may not be monophyletic, and it is related to Sect. *Franchetiana* on the one hand, and to Sect. *Arisaema* on the other hand. Even in these trifoliolate sections, quinate leaves are found in such species as *A. quinatum*, *A. ornatum*, and *A. grapsospadix*. Sect. *Trisecta* with anthers dehiscent by a crescent slit and flagellate spadix-appendage has differentiated in the Himalayas and W. China.

Sect. *Arisaema* generally with pedate leaves and cylindric appendage has migrated towards the north and has been highly differentiated in Japan. While Sect. *Sinarisaema* with radiate leaflets and cylindric appendage has most evolved in India. The Tropical African species, *A. Schimperianum* Schott and *A. enneaphyllum* Hochst., are also near to Sect. *Sinarisaema*, but need further investigations.

The sections which are redefined here but do not include the Himalayan species are as follows:

Sect. ***Pistillata*** Engler in Pfl.-reich IV-23 F: 151 & 199 (1920), pro parte.

Sect. I. *Trisecta* Schott, Prodr. 25 & 27 (1860), pro minor. part. (c. Boreali-Americana).

Sect. *Ringentia* Engler, l.c. 151 & 209 (1920). Type: *A. ringens* Schott.

Sect. *Colocasiarum* Nakai in Journ. Jap. Bot. 25: 6 (1950). Type: *A. ternatipartitum* Makino.

*Ringentiarum* Nakai, l.c. 6 (1950). Type: *A. ringens* Schott.

Leaves 2 or 1, trifoliolate (rarely quinate). Spathe-blade ovate or lanceolate-ovate

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1) This species was recorded from Bhutan by Deb, Sen Gupta and Malik (1968), but I have not had a chance to examine the material, so the species is not included in this enumeration.

and incurved, or rarely galeate and auriculate. Spadix-appendage cylindrical slightly exerted from the spathe-tube, roundish at the top, subtruncate and stipitate at the base. Anthers dehiscent by an elliptic or roundish pore. Paradioecious, with subglobose bulb.

Lectotype: *A. triphyllum* (L.) Torrey (E. N. America).

Includes *A. atrorubens* (Aiton) Blume (E. N. Amer.), *A. Stewardsonii* Britton (E. N. Amer.), *A. quinatum* (Nutt.) Schott (E. N. Amer.), *A. onoticum* Buchet (W. China), *A. lobatum* Engl. (W. & C. China), *A. Wattii* Hook. f. (Assam), *A. ternatipartitum* Makino (S. Japan), *A. ringens* (Thunb.) Schott (S. Japan, S. Korea, Formosa, China).

In 1950 Nakai selected *A. serratum* (Thunb.) Schott of Japan as the type of Sect. Pistillata, but judging from Engler's treatment, it is more proper to regard *A. triphyllum* as the lectotype of the section. This section is closely allied to the *A. Fargesii* group of Sect. Franchetiana, and also bears a resemblance to some species of Sect. Arisaema.

Sect. **Franchetiana** Engler in Pfl.-reich IV-23 F: 184 (1920).

Sect. Auriculata Engler, l.c. 163 (1920), pro minor. part. Lectotype: *A. Fargesii* Buchet.

Leaf 1, trifoliolate, rarely 3-lobed. Spathe auriculate or not at the mouth. Spathe-appendage obclavate suberect or curved, narrowed to an obtuse tip, attenuate at the base. Anthers dehiscent by a roundish or oblong pore. Paradioecious or monoecious, with globose bulb.

Lectotype. *A. Franchetianum* Engler (W. China).

Includes *A. purpureogaleatum* Engl. (W. China), *A. Delavayi* Buchet (W. China), *A. lichiangense* W. W. Smith (W. China), *A. Fargesii* Buchet (W. China), *A. candidissimum* W. W. Smith (W. China).

This section is very close to Sect. Attenuata. *A. petiolulatum* Hook. f. (Assam, Burma), and *A. Lackneri* Engler (Burma) resemble some species of this section, but they are also allied to those of Sect. Attenuata.

Sect. **Flagellarisaema** (Nakai) Hara, comb. nov.

Sect. Tortuosa Engler in Pfl.-reich IV-23 F: 185 (1920), pro minor. part—Nakai in Bot. Mag. Tokyo **43**: 524 (1929), pro parte.

*Flagellarisaema* Nakai in Journ. Jap. Bot. **25**: 6 (1950).

Leaf 1 (rarely 2), pedately 7–17-foliolate. Spathe-blade ovate long acuminate incurved. Spadix-appendage flagelliform, thickened in the lower part, thread-like in the upper part. Anthers dehiscent by a roundish or oblong pore. Paradioecious, with subglobose bulb. Plumule leaves scaly.

Type: *A. Thunbergii* Blume (S. Japan).

Includes *A. Urashima* Hara (Japan), *A. kiushianum* Makino (S. Japan).

#### KEY TO THE EASTERN HIMALAYAN SPECIES

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|-----|---|----|
| 1 { | Leaves trifoliolate. Spadix-appendage long flagellate. Anthers unilocular, dehiscent by a crescent or horseshoe-shaped slit . . . . . | 2  |
|     | Leaves digitately, pedately, or radiately 5–20-foliolate . . . . .  | 11 |

- 2 { Rhizome elongate horizontal. Leaflets longer than breadth, distinctly petiolulate, with red margin. Peduncle short. Spathe dark purple, tapering into a long broad-lanceolate blade ..... 3
- 3 { Bulb globose or depressed globose ..... 4
- 3 { Spadix-appendage smooth throughout ..... 1) *A. speciosum*
- 3 { Spadix-appendage more strongly inflated and exasperate in the lower part. Flowering period later ..... 1a) var. *mirabile*
- 4 { Lateral veins of leaves very numerous, almost parallel, conspicuously elevated beneath. Spathe dark purple with distinct white stripes ..... 3) *A. costatum*
- 4 { Lateral veins of leaves fewer, with reticulate veinlets ..... 5
- 5 { Spathe-blade ovate-lanceolate, long attenuate to the caudate apex, and yellowish-green or dark purplish. Median leaflet elliptic or ovate, distinctly longer than breadth, with conspicuously reticulate-elevated veinlets beneath. Spadix-appendage conspicuously thickened in the lower part and attenuate at the base ..... 2) *A. intermedium*
- 5 { Spathe-blade obovate, ovate, or cucullate, apiculate or abruptly caudate, generally dark-purple. Median leaflet depressed-rhombic or ovate-rhombic. Spadix-appendage generally truncate at the base and stipitate ..... 6
- 6 { Spathe-blade galeate, ending in an ovate pendent terminal lobe. Leaflets longer than breadth, distinctly petiolulate. A large plant, with a scape much shorter than petioles ..... 8) *A. galeatum*
- 6 { Spathe-blade truncate, emarginate or acutish at the apex. Leaflets often broader than length, subsessile ..... 7
- 7 { Spathe-blade laterally dilated (6) 10–20 cm broad, spreading like ears on both sides, incurved, and emarginate at the apex with a tail. Appendage 10–25 cm ..... 8
- 7 { Spathe-blade elliptic-ovate to obovate, 1–11 cm broad ..... 9
- 8 { Petiole generally green and smooth. Spathe-blade with very broad wings strongly involute and coarsely veined ..... 7) *A. Griffithii*
- 8 { Petiole often minutely black-dotted and more or less verrucose. Spathe-blade loosely incurved and more closely veined ..... 7a) var. *verrucosum*
- 9 { Spathe-blade strongly incurved in the upper part, enwrapping the spadix-appendage with roundish lateral lobes, leaving only a small roundish (1 cm across) aperture on the ventral side and caudate at the apex ..... 5) *A. ostiolatum*
- 9 { Spathe-blade incurved, but widely opening on the ventral side. Often larger plants ..... 10
- 10 { Spathe-blade ovate, and long-acuminate at the apex, 3–4 cm broad below the middle ..... 4) *A. propinquum*
- 10 { Spathe-blade obovate, 4.5–11 cm broad above the middle, rounded or emarginate and cuspidate at the apex, brown purple ..... 6) *A. utile*
- 11 { Leaves (1) 2 (3), digitately or pedately 5–11-foliolate ..... 12
- 11 { Leaf 1 (2), radiately 7–20-foliolate, with subequal leaflets. Spadix-appendage cylindrical, rarely absent ..... 15

- 12 { Spathe small 2-4 cm long, bright yellow inside and/or dark purple in the lower part; tube roundish ovoid. Spadix bisexual; appendage very short, clavate, 2-5 mm long. Leaves 1-2, pedately 5-11-foliolate  
 ..... 10) *A. flavum*
- 13 { Spathe more than 6 cm long, green, brownish or dark purple. Spadix-appendage much longer, cylindric or flagellate ..... 13  
 { Spadix-appendage elongate, sigmoidly ascending. Leaves 2-3, pedately foliolate. Spadix often bisexual. .... 9) *A. tortuosum*  
 { Appendage cylindric, obtuse or roundish at the top. Spadix normally unisexual. Leaves 1-2, digitately or pedately foliolate ..... 14
- 14 { Appendage cylindric 5-7 mm across erect. Spathe brown-purple, conspicuously auriculate at the mouth, blade acuminate. Leaves 2 (3), digitately 5 (7)-foliolate, with thicker glossy leaflets ..... 11) *A. nepenthoides*  
 { Appendage slender 0.8-2 mm across, exerted and curved outwards in the upper part. Spathe greenish, not auriculate at the mouth, blade caudate at the apex. Leaves 1-2, pedately 3-9-foliolate, thinner  
 ..... 12) *A. Jacquemontii*
- 15 { Spathe-blade erect, with inrolled margins. Spadix-appendage entirely lacking or less than 1.5 cm. Stamen monandrous, anthers circumscissilely dehiscent. .... 17) *A. exappendiculatum*  
 { Spathe-blade incurved at anthesis. Appendage cylindric as long as spathe-tube or exerted. Stamen with 2-6 anthers, anthers bilocular, dehiscent by a slit ..... 16
- 16 { Spadix-appendage densely setulose in the apical part. Spathe-blade broad ovate, long caudate at the apex, often dark purple in the upper part. Ovaries 8-crenate thickening in the apical part. .... 16) *A. echinatum*  
 { Spadix-appendage smooth or rugose at the apex. Spathe-blade lanceolate-ovate ..... 17
- 17 { Leaflets 7-11, broader, oblong to broad lanceolate, light green and slightly lustrous beneath; lateral nerves more numerous obliquely spreading impressed. Appendage of spadix rugose at the apex. Fruiting peduncle erect.  
 ..... 15) *A. concinnum*  
 { Leaflets narrower, oblanceolate to linear-lanceolate, thicker, glaucescent beneath; lateral nerves fewer, more strongly ascending at the acute angle. Appendage smooth at the apex. .... 18
- 18 { Leaflets 7-14, acute to long acuminate at the apex. Spathe dusty brownish purple; blade long-acuminate at the apex. Fruiting peduncle erect  
 ..... 13) *A. erubescens*  
 { Leaflets 10-20, filiform-caudate at the apex. Spathe usually greenish; blade filiform-caudate at the apex. Fruiting peduncle nodding.  
 ..... 14) *A. consanguineum*

#### ENUMERATION OF THE EASTERN HIMALAYAN SPECIES

Sect. **Trisecta** Schott, Prodr. 25 & 27 (1860), pro parte (a. Himalaiensia).



Sect. *Speciosa* Engler in Pfl.-reich IV-23 F: 151 & 193 (1920).

Sect. *Wallichiana* Engler, l.c. 151 & 211 (1920), excl. *A. Delavayi*.

Sect. *Lunata* Engler, l.c. 151 & 215 (1920).

Leaf 1–2 trifoliate. Spathe-blade lanceolate-ovate and incurved, or broad and galeate. Spadix-appendage long flagelliform long-exserted, hanging down in the upper part, thickened in the lower part, and narrowed to the stipe or dilatate into a fleshy disk and stipitate. Anther-cells generally confluent at the apex, dehiscent by a horseshoe-shaped or crescent slit. Paradioecious, with globose bulb or thick rhizome.

Lectotype: *A. speciosum* (Wall.) Martius (E. Himalaya, W. China).

Includes *A. intermedium* Blume (Himalaya), *A. elephas* Buchet (W. China), *A. dilatatum* Buchet (W. China), *A. Wilsonii* Engl. (W. China), *A. rhombiforme* Buchet (W. China), *A. propinquum* Schott (Himalaya), *A. ostiolatum* Hara (E. Himalaya), *A. costatum* (Wall.) Martius (Nepal), *A. utile* Hook. f. (Himalaya), *A. Griffithii* Schott (E. Himalaya), *A. galeatum* N. E. Brown (E. Himalaya, Burma).

The species included in this section form a very natural group, although Engler (1920) divided them into three sections, *Speciosa*, *Wallichiana*, and *Lunata*, partly based on the shape of the basal part of the spadix-appendage. In *A. utile* and *A. propinquum* which generally have the appendage thickened and truncate at the base, I have observed some individuals with the appendage cuneately narrowed at the base as in *A. speciosum*.

On the basis of the characters of anthers and spadix-appendage, this is the most advanced section in the trifoliate groups. This section is highly differentiated in the Himalayas and Western China, and is very variable in shape of the spathe. In spathe, *A. speciosum* is similar to *A. Fargesii* Buchet of W. China, and *A. galeatum* to *A. ringens* (Thunb.) Schott of Japan and China, but *A. Fargesii* and *A. ringens* have shorter spadix-appendages and anthers dehiscent by a roundish pore. In having long filiform spadix-appendages, the section resembles Sect. *Flagellarisaema*, but the two sections are not closely related phylogenetically.

1) ***Arisaema speciosum*** (Wallich) Martius in Flora **14**: 458 (1831), in nota—Schott, Syn. 26 (1856); Prodr. 27 (1860)—Hook. f. in Bot. Mag. t. 5964 (1872); in Fl. Brit. Ind. **6**: 500 (1893)—Engler in Pfl.-reich IV-23 F: 193 (1920)—Chatterjee in Bull. Bot. Soc. Beng. **8**: 135 (1955)—Spring Fl. Sikkim Himal. f. 119 (1963)—Hara in Fl. E. Himal. 396 (1966). [Pl. 15. c; Fig. 50. A]

*Arum speciosum* Wallich, Tent. Fl. Nepal. 29, t. 20 (1824).

*Arisarma eminens* Schott in Oesterr. Bot. Wochenbl. **7**: 357 (1857); Prodr. 30 (1860).

*A. speciosum* var. *eminens* (Schott) Engler in DC., Monogr. Phaner. **2**: 540 (1879); l.c. 195 (1920).

Paradioecious. Rhizome obliquely *elongate* or shortly creeping, lying near the surface of the ground, 4–10 cm long 2–4 cm in diameter, occasionally forked.

Leaf solitary trifoliate; leaflets *elliptic* or ovate acuminate at the apex, *distinctly petiolulate*, green with red margins, veins impressed above rarely dark purple beneath, petiolule 1–4 cm long; median leaflets 13–30 cm long 6–15 cm wide; lateral ones

larger dimidiate-cordate at the base; petiole elongate green marbled with dark purple, 20–60 cm long. Peduncle much shorter than the leaf.

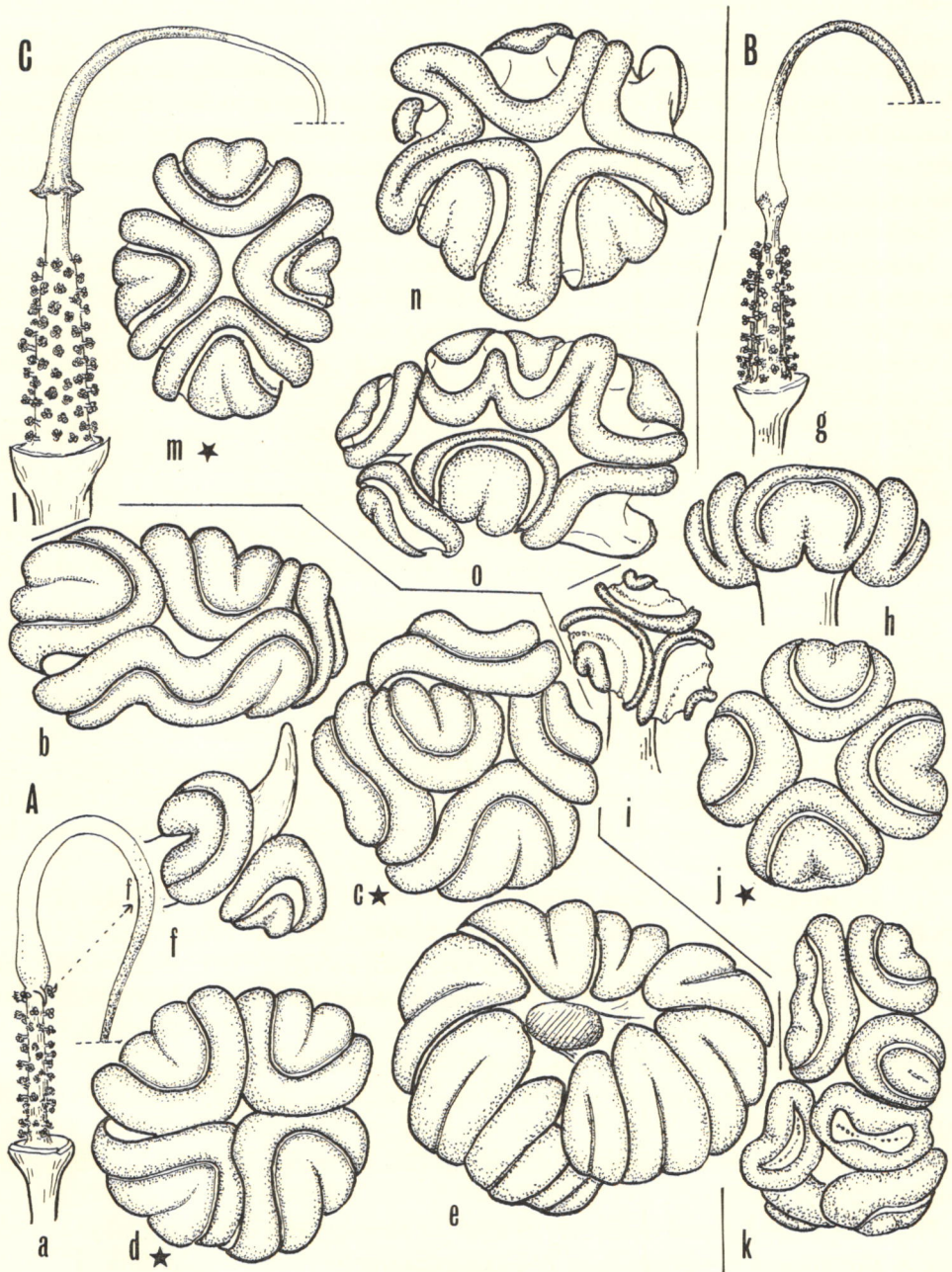


Fig. 50. A. *Arisaema speciosum* Martius. B. *A. intermedium* Blume. C. *A. costatum* Martius.

a, g & l. Male spadix and the lower part of appendage.  $\times 3/4$ . b–f, h–k & m–o. Anthers, showing their variations.  $\times 15$ . \*indicates a common type for the species. (del. Sachiko Kurosawa)

Spathe dark *black-purple*; tube short cylindrical 3.5–7 cm long 2–3 cm in diameter, longitudinally *white-striped* and *smooth* inside; *blade lanceolate-ovate* incurved, long *attenuate* to the apex, 8–20 cm long 2–8 cm wide, longitudinally white-striped on the back.

Spadix unisexual; *anthers* (3) 4–5, *dehiscent by a horseshoe-shaped slit*; *appendage flagelliform* very long 20–80 cm long, dark purple, *smooth* throughout, filiform and hanging down in the upper part, *thickened and curved in the lower part*, 4–12 mm in diameter, white near the base, *cuneately narrowed* to the spadix. Fruits fusiform-obovoid, with 8 longitudinal obtuse ridges.  $2n=28$ .

Representative specimens.

Nepal (Wallich, no. 8923 – type of *A. speciosum*, K); Shioupuri, 2700 m (Ohashi, Jun. 14, 1969, TI); Phulchauki, 2600–2700 m (Hara, Kanai & Ohashi, Jun. 10, 1969, TI); Malemchi Khola, 8,000 ft. (Lyon, May 28, 1962, no. 165, BM).

Darjeeling, 2100 m (Hara & Togashi, Apr. 2, 1960, TI); Mane Bhanjang–Batasi, 2000–2100 m (K. M. T. & T., May 1, 1960, TI).

Sikkim. 7.–10,000 ft. (Hook. f., 2 sheets – type of *A. eminens*, K); Gangtok, 1750 m (Hara, Kanai, Murata, Togashi & Tuyama, Jun. 15, 1960, TI).

Bhutan. Mishichen–Khosa, 1500 m (Kanai, Murata, Ohashi, Tanaka & Yamazaki, May 10, 1967, TI); Chimakhothi, 2300 m (K. M. O. T. & Y., Jun. 2, 1967, TI).

Distr. E. Himalaya (Nepal to NEFA), N. Assam, and W. China.

Among the Himalayan species of the genus, this is the only one with elongate rhizomes.

1a) var. **mirabile** (Schott) Engler in DC., Monogr. Phan. **2**: 540 (1879); in Pfl.-reich IV-23 F: 195 (1920)–Hara in Journ. Jap. Bot. **37**: 97 (1962); in Fl. E. Himal. 396 (1966)–Spring Fl. Sikkim Himal. f. 120 (1963). [Pl. 15. d]

*A. mirabile* Schott in Oesterr. Bot. Wochenbl. **7**: 366 (1857); Prodr. 31 (1860).

Spadix-appendage in the lower part *conspicuously thickened*, fusiform and curved, distinctly *rugose-exasperate*, sometimes forming small reticula.

Representative specimens.

Nepal. Inchu Khola, 9,000 ft. (Lyon, Jun. 14, 1964, no. 2029, BM).

Darjeeling. Senchal–Tiger Hill, 2300–2500 m (H. K. M. T. & T., Jun. 23, 1960; Hara, Kurosawa & Ohashi, Jul. 6, 1969, TI); Tonglu, 2800–3000 m (H. K. & O., Jul. 12, 1969, TI); Sandakphu–Garibas, 3000–2600 m (H. K. M. T. & T., Jun. 7, 1960, TI).

Sikkim. 7.–10,000 ft. (Hook. f. – type of *A. mirabile*, K); Tendong Peak, 2900 m (H. K. & O., Jun. 29, 1969, TI).

Bhutan. Tamji–Gasa, 2400 m (K. M. O. T. & Y., May 13, 1967, TI); Dochu La, 3000 m (K. M. O. T. & Y., May 30, 1967, TI).

Distr. E. Himalaya (Nepal to Bhutan).

This variety is very distinct in having a conspicuously rugose thickened middle part of spadix-appendage. It flowers much later than typical *A. speciosum* at the same locality, and is separated biologically from the latter.

2) ***Arisaema intermedium*** Blume in Rumphia **1**: 102 (1836)–Schott, Prodr. 28 (1860)–Hook. f., Fl. Brit. Ind. **6**: 500 (1893)–Engler, l.c. 156 & 193 (1920)–Collett, Fl. Siml. 539 (1921)–Chatterjee, l.c. 126, f. L (1955).

[Pl. 15. a, b; Fig. 50. B]

*A. Stracheyanum* Schott in Oesterr. Bot. Wochenbl. **7**: 333 (1857); Prodr. 27 (1860).

*A. dolosum* Schott in Bonplandia 7: 26 (1859); Prodr. 28 (1860).

Paradioecious. Bulb depressed globose 2–4 cm in diameter.

Leaf 1 or 2, *trifoliolate*; median leaflets *ovate*, rhombic or elliptic, often longer than the breadth, acuminate at the apex, cuneate at the base subsessile, or shortly petiolulate, *minutely reticulate-veined* beneath, (7) 9–20 cm long 3–11 cm wide, lateral leaflets longer dimidiate cordate at the base; petiole elongate 15–50 cm long. Peduncle much shorter than the petiole, greenish.

Spathe *green* rarely dark purple; tube broad-cylindric, (3) 4–8 cm long 1.5–2.5 cm in diameter, *smooth inside*; *blade ovate-lanceolate*, yellowish pale green, sometimes tinged with dark purple, 7–16 cm long 2–6.5 cm wide, with spreading or slightly recurved margins, *long attenuate* to a long tail (2–3 (5) cm long).

Spadix unisexual; ovaries obovoid with a short style, stigma small whitish; *anthers* generally 4, *dehiscent by a horseshoe-shaped slit*, yellow; *appendage* very long *flagelliform* 15–45 cm long, white and *fusiformly thickened in the lower part* and *attenuate to the stipe*, exerted from the tube then *sigmoidly curved* dark purple, and hanging down in the upper part.  $2n=28$ .

Representative specimens.

W. Himalaya. Ind. orient. (Jacquemont, no. 1026, P – type of *A. intermedium*).

Simla, 8,000 ft. (Herb. Hook. f. et Thoms. – type of *A. dolosum*, K, GH); Simla (Gamble 1879, no. 6222 B, K).

Kumaon. Kathi, 7,200 ft. (Strachey & Winterbottom, Aroid. no. 5 – type of *A. Stracheyanum*, K, GH).

Nepal. Phulchauki, 2900 m (Hara, Kurosawa & Ohashi, May 29 & Jun. 10, 1969, TI); Chhintapu, 9500 ft. (Williams, Jun. 8, 1969, no. 474, BM).

Darjeeling. Sandakphu, 3800 m (H. K. & O., Jul. 14, 1969, TI).

f. **biflagellatum** (Hara) Hara, comb. nov.

*A. biflagellatum* Hara in Journ. Jap. Bot. 36: 77 (1961); Fl. E. Himal. 394 (1966).

Spathe-blade yellowish green, with a longer tail 8–16 cm long. Appendage greenish.

Specimens examined.

Darjeeling. Below Sandakphu, 3500 m (H. K. M. T. & T., Jun. 7, 1960 – type of *A. biflagellatum*, TI).

Distr. sp. Himalaya (Kashmir to Sikkim).

The identity of *A. intermedium* Blume is somewhat difficult. The type specimen (Ind. orient. Jacquemont, no. 1026 in P) consists of one female flowering stem and one leaf. The leaflets are broad rhombic, subsessile, and in the median one about 22 cm long and 14 cm wide; the spathe is large 20 cm long, brownish purple; the tube 8 cm long 2.3 cm in diameter; the blade obovate-oblong, about 13 cm long and 5 cm wide, and abruptly acuminate into a tail (3 cm long); the spadix-appendage is flagellate, thickened in the lower part (about 6 mm thick), and cuneately narrowed at the base.

Considering the great variability in other species of the genus, *A. biflagellatum* seems to fall within the variations of this species.

3) **Arisaema costatum** (Wall.) Martius in Flora 14: 458 (1831), in nota-Blume in Rumphia 1: 101 (1836)–Schott, Synop. 26 (1856); Prodr. 29 (1860)–

Hooker f., Fl. Brit. Ind. **6**: 501 (1893)—Engler, l.c. 217 (1920)—Hara, Phot.-Alb. Pl. E. Himal. f. 104 (1968). [Pl. 6. a & 17; Fig. 50. C]

*Arum costatum* Wallich, Tent. Fl. Nepal. 28, t. 19 (1824).

Paradioicous. Bulb depressed globose 3–5 cm in diameter. Pseudostem short.

Leaf solitary *trifoliolate*; leaflets, *elliptic* or oblong, long acuminate at the tip, *subsessile* at the base, in lateral leaflets very unequal at the base, median leaflets 13–35 cm long 6–16 cm wide, dark green above, pale green beneath; *lateral veins very numerous* and *running almost parallel* depressed above, and *distinctly elevated beneath*; petiole elongate green often slightly purplish. Peduncle shorter than the adult leaf.

Spathe *dark purple with distinct longitudinal white stripes*; tube cylindric 4–8 cm long, slightly *costate inside*, narrowly reflexed at the mouth; *blade oblong-ovate* incurved, 4–10 cm long 2.5–5 cm wide *abruptly acuminate* into a tail 1–4 cm long.

Spadix unisexual; style short, stigma small discoid white; *anther* generally 3–5, *dehiscent by a horseshoe-shaped slit*; *appendage flagelliform*, very long, hanging from the spathe, 20–50 cm long, dark purple, inflated toward the base with a *disk-like thickening* at the base and stipitate, *smooth* throughout.

Specimens examined.

Nepal. Sheopore (Wallich, BM); Shioupuri, 2000 m (Ohashi, Jun. 14, 1969, TI); Phulchauki, 2800 m (Kanai, Murata, Ohashi & Yamazaki, Jun. 26, 1967; Hara, Kurosawa & Ohashi, Jun. 10, 1969, TI); Burungdi Khok, 6.500 ft. (Stainton, Sykes & Williams, May 20, 1954, no. 5329, BM); Malemci, Gosainkund, 8.000 ft. (Stainton, Jun. 29, 1962, no. 3782, BM).

Distr. Endemic to Nepal.

The species is very characteristic in having leaflets with very numerous conspicuous parallel lateral veins (Pl. 17. c). This character is so unusual in the genus that Stapf considered that the nervation of the species illustrated and described by Wallich in 1824 was faulty based on 'the imagination of the draftman' (cf. a footnote under Bot. Mag. t. 9058, 1925).

4) ***Arisaema propinquum*** Schott in Oesterr. Bot. Wochenbl. **7**: 333 (1857); Prodr. 28 (1860)—Hook. f., l.c. 501 (1893)—Engler, l.c. 216 (1920)—Chatterjee, l.c. 131 (1955). [Pl. 16. c; Fig. 51. D]

*A. intermedium* var. *propinquum* (Schott) Engler in DC., Monogr. Phaner. **2**: 541 (1879).

*A. Wallichianum* Hooker f., Fl. Brit. Ind. **6**: 500 (1893)—Engler, l.c. 213 (1920)—Hara in Fl. E. Himal. 396 (1966)—Phot.-Alb. Pl. E. Himal. f. 25 (1968).

*A. costatum* Martius sensu Stapf in Bot. Mag. sub t. 9058 in adnota (1925)—Chatterjee, l.c. 123 (1955)—Spring Fl. Sikkim Himal. f. 113 & 116 (1963).

*A. sikkimense* Stapf ex Chatterjee in Bull. Bot. Soc. Beng. **3**: 18 (1949); **8**: 135 (1955).

*A. costatum* var. *sikkimense* (Stapf) Hara et f. *propinquum* (Schott) Hara in Journ. Jap. Bot. **36**: 76 (1961).

*A. Wallichianum* var. *sikkimense* (Stapf) Hara et f. *propinquum* (Schott) Hara in Journ. Jap. Bot. **40**: 21 (1965).

Paradioecious. Bulb depressed globose, 2–4 cm in diameter.

Leaf 1 or 2, *trifoliolate*; leaflets *subsessile* or shortly petiolulate, green, nerves slightly impressed above, longer than the breadth or sometimes broader than the length, median leaflets depressed rhombic ovate acuminate 8–20 cm long 4–15 cm wide, lateral leaflets often longer; petiole 15–50 cm long. Peduncle shorter or longer than the leaf.

Spathe dark purple or green, with white stripes; tube short cylindrical dark purple with distinct whitish longitudinal stripes, 4–6 cm long 1.5–2 cm in diameter, *longitudinally ribbed inside* with low ridges about 1 mm high, narrowly reflexed at the mouth; *blade* oblong or *ovate*, incurved, *long-acuminate* at the apex, with a tail 1–4 cm long, dark purple or yellowish green, sometimes with dark purple patches, 6–13 cm long 3–6 cm wide.

Spadix unisexual; *anthers* 2–4, *dehiscent by a horseshoe-shaped slit*; *appendage* long *flagelliform*, 8–20 cm long, slightly thickened and minutely rugose at the part just exerted from the mouth of spathe-tube, tapering into a thread in the upper part, slightly thickened towards the base, 5–8 mm in diameter and subtruncate at the base and shortly stipitate.  $2n=28$ .

Representative specimens.

Simla. Kulu, Chaudarkani, 9,500 ft. (Koelz, Jun. 3, 1930, no. 266, NY).

Nepal (Wallich, no. 8922 sub *A. costatum* – type of *A. Wallichianum*, K, K-W); Chankheli Lagna, 11,000 ft. (Polunin, Sykes & Williams, May 19, 1952, no. 4124, BM, TI); Shioupuri, 2700 m (Ohashi, Jun. 14, 1969, TI); Gosainkund, 3000 m (Hara, Kanai, Kurosawa & Ohashi, Jun. 4, 1969, TI); Siringdham, 10,500 ft. (Williams, Jun. 16, 1969, no. 650, BM).

Darjeeling. Sundukphoo, 12,000 ft. (Clarke, no. 34968 A, Jun. 5, 1884 – type of *A. sikkimense*, K); Sandakphu, 3900 m (Hara, Kurosawa & Ohashi, Jul. 14, 1969, TI).

Sikkim, 7–10,000 ft. (Hooker f. sub *A. speciosum* – type of *A. propinquum*, K); Jongri, 4000 m (H. K. M. T. & T., May 24, 1960, TI).

Bhutan. Barshong–Nala, 3700 m (K. M. O. T. & Y., May 25, 1967, TI); Tzatogang–Dotanang, 3000 m (K. M. O. T. & Y., May 27, 1967, TI).

Distr. Himalaya (Kashmir to Bhutan), and S. Tibet.

This well-known Himalayan species has been called as *A. Wallichianum* or *A. costatum*. *A. propinquum* is nothing but a well-grown individual with two leaves, and *A. sikkimense* is a smaller subalpine plant.

5) ***Arisaema ostiolatum*** Hara in Journ. Jap. Bot. **36**: 75, f. 1 (1961); Spring Fl. Sikkim Himal. f. 107 (1963); Fl. E. Himal. 395 (1966).

[Pl. 6. d & 16. a, b; Fig. 51. E]

Paradioecious, Bulb depressed globose 1.2–4 cm across, sometimes bulbiferous.

Leaf 1 or 2, *trifoliolate*; leaflets ovate-, oblong- or roundish-rhombic, long acuminate at the apex, subsessile subentire, lateral nerves 5–8-pairs, median ones 4–10 cm long 2–6.5 cm wide; lateral ones longer, oblique at the base; petiole 7–25 cm long virescent emaculate. Peduncle much shorter than the petiole 5–13 cm tall 2–4 mm thick virescent emaculate.

Spathe smaller, 5–8 cm long excluding the apical tail; tube cylindrical 3–5 cm long, slightly depressed, 8–12 mm in diameter dark purple and longitudinally white-striped, longitudinally *narrow-lamellate inside*; *blade convolute* and *strongly incurved*,

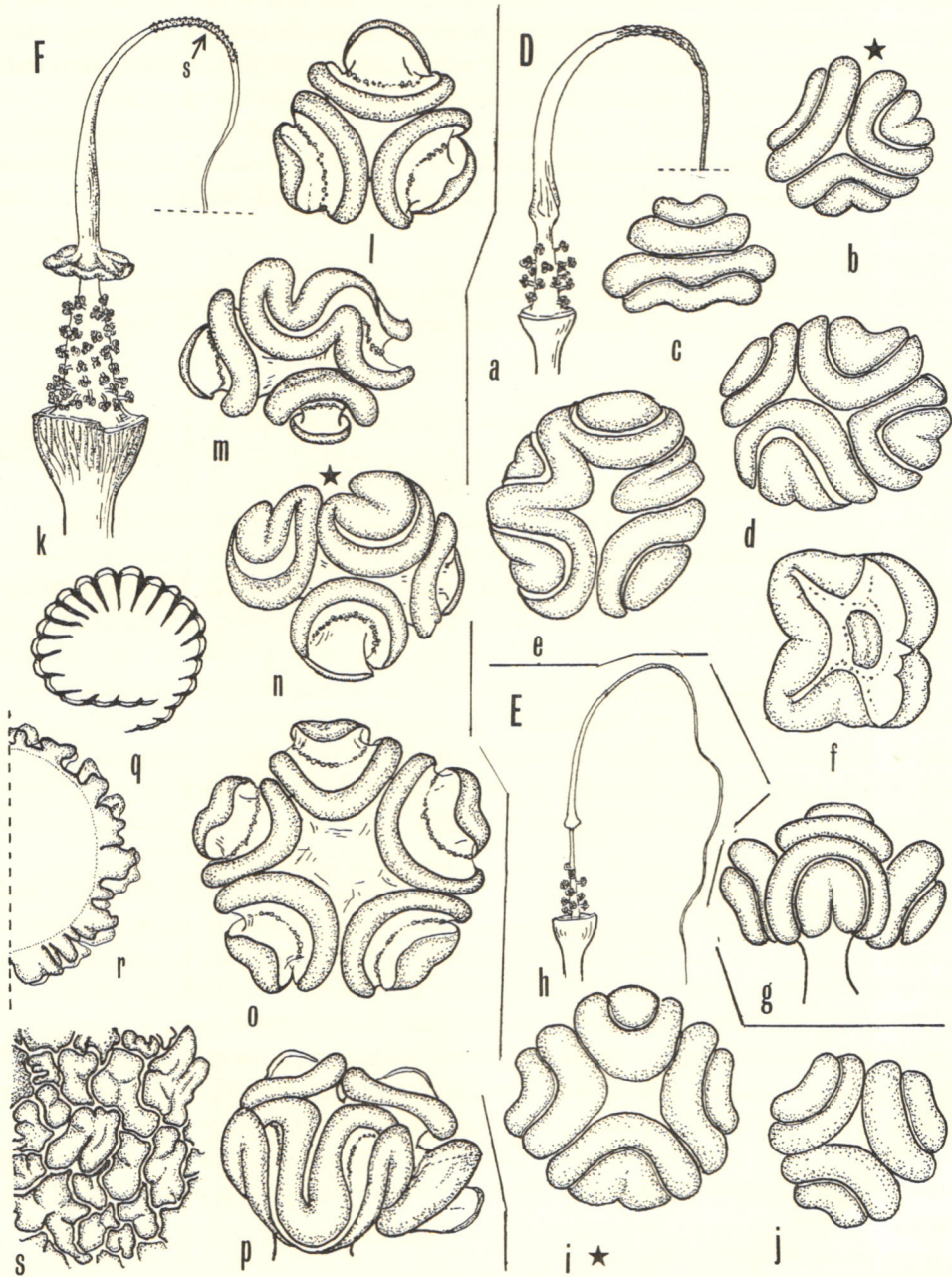


Fig. 51. D. *Arisaema propinquum* Schott. E. *A. ostiolatum* Hara. F. *A. Griffithii* Schott.

a, h & k. Male spadix and the lower part of appendage.  $\times 3/4$ . b-g, i-j & l-p. Anthers showing their variations.  $\times 15$ . \* indicates a common type for the species. q. A cross-section of spathe-tube, showing lamellae inside.  $\times 2/3$ . r & s. Verruculose part of spadix-appendage (r, a cross section). Magnified. (del. Sachiko Kurosawa)

greenish tinged with purple or dark purple and distinctly white-striped, *closed* on the ventral side *with roundish lateral lobes* often dark purple maculate, *opening only by a roundish aperture 8–10 mm long* with narrowly reflexed margins, *abruptly narrowed at the apex into a long tail* often dependent, greenish and 2.5–4.5 cm long.

Spadix unisexual; *anthers 2–4, dehiscent by a horseshoe-shaped slit; appendage flagellate 5–13 cm long, filiform and hanging down in the upper part, dark purple or greenish, smooth, thickened 3–5 mm in diameter, subtruncate and stipitate at the base.*  $2n=28$ .

Representative specimens.

Darjeeling. Phalut, 3500 m (Hara, Kanai, Murata, Togashi & Tuyama, Jun. 5, 1960, no. 5186 – type, TI); Phalut–Sabargan, 3400 m (H. K. & O., Jul. 19, 1969, no. 69260, TI).

Distr. The Singalila Range.

The species is most closely allied to *A. propinquum*, but the spathe is strongly incurved, and the spathe-blade is convolute with overlapping roundish lateral lobes, leaving only a roundish aperture on the ventral side (Pl. 6. d). While the spathe-blade of *A. propinquum* is incurved but widely opening on the ventral side (Pl. 16. c).

6) ***Arisaema utile*** Hooker f. ex Schott, Prodr. 30 (1860)–Hook. f. in Bot. Mag. t. 6474 (1880); Fl. Brit. Ind. 6: 499 (1893)–Engler, l.c. 218, f. 52 (1920)–Chatterjee, l.c. 137 (1955)–Hara, Spring Fl. Sikkim Himal. f. 115 (1963); Fl. E. Himal. 396 (1966) [Pl. 18. c; Fig. 52 & 53]

Paradioecious. Bulb depressed globose 3–5 cm in diameter, often bulbiferous.

Leaf 1 or 2, *trifoliolate*; median leaflets depressed *rhombic* or ovate-rhombic, acuminate, sometimes broader than the length *sessile*, (7) 10–20 cm long (5) 8–20 cm wide, green, reddish near the margin, nerves elevated often reddish beneath; petiole elongate stout 20–40 cm long dark-maculate. Peduncle much shorter than the leaf.

Spathe-tube cylindrical, brown-purple with whitish stripes, 5–10 cm long 1.5–2.7 cm in diameter, longitudinally lamellate inside; *blade obovate*, strongly incurved, 5–15 cm long 3–11 cm wide, *rounded or emarginate* at the apex and abruptly acuminate into a tail (1–3 cm long), *dark brown-purple*, with distinct longitudinal white nerves on the back, and reticulate whitish nerves near the marginal part.

Spadix unisexual; ovaries obovoid, green, with a very short dark purple style; *anthers 3–5, dehiscent by a horseshoe-shaped slit; appendage flagelliform 7–20 cm long, slightly longer than the blade, slightly thickened and minutely rugose at the part just exerted from the spathe-tube, thickened towards the base 5–15 mm across, truncate and stipitate at the base.* Fruits ovoid, not angular, white-striped when young.

Representative specimens.

W. Himalaya. Punjab. Murree Hills, Hazara distr., 9,000 ft. (Webster & Sack, no. 5664, GH); Murree Hills, 8,000 ft. (Stewart, Jun. 30, 1934, GH).

Simla, 8000 ft. (Thomson, sub *A. costatum*, GH).

Nepal. Bhurchula Lekh, near Jumla, 12,500 ft. (Polunin, Sykes & Williams, Jul. 14, 1952, BM, TI); Phulchauki, 2800–2900 m (Hara, Kurosawa & Ohashi, May 29 & Jun. 10, 1969, TI); Kuinekhani, 8,800 ft. (Stainton, Sykes & Williams, May 25, 1954, no. 2839, BM, TI); Junbesi, 11,000 ft. (Lyon, Jun. 5, 1964, no. 2003, BM).



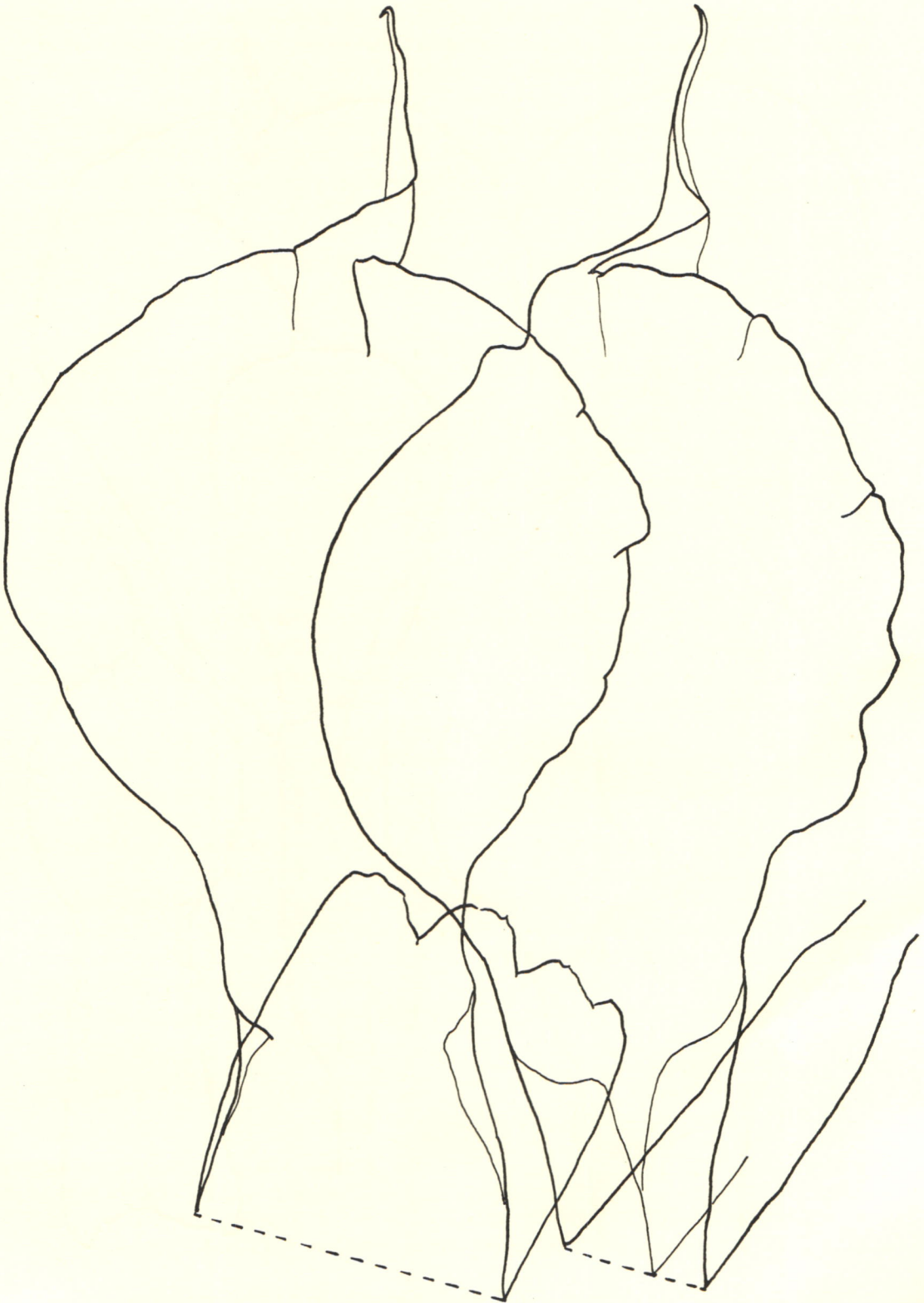


Fig. 52. Spathes of *Arisaema utile* Hook. f.  $\times 1$ .

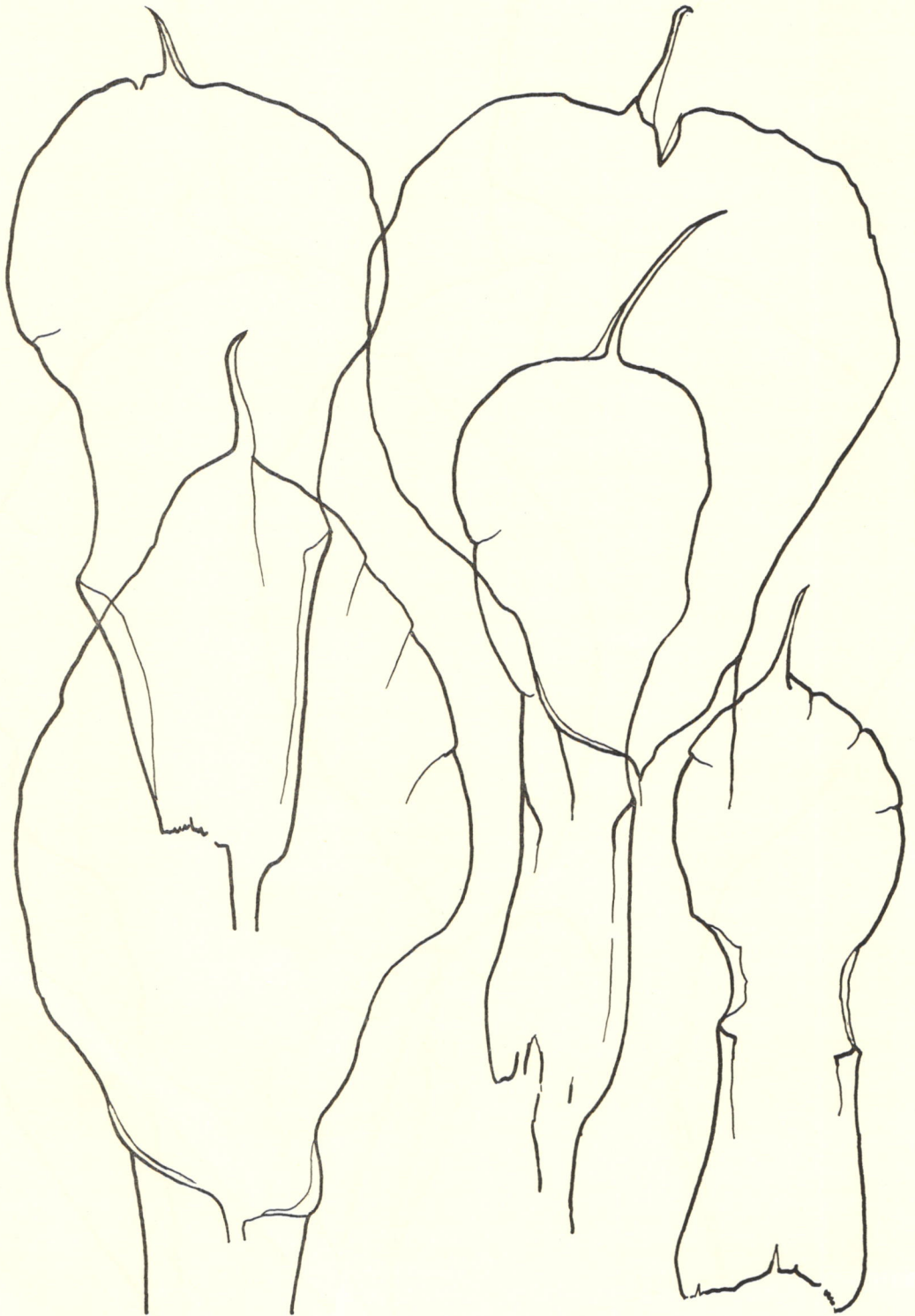


Fig. 53. Spathes of *Arisaema utile* Hook. f., showing the range of variations.  $\times 1$ .

Darjeeling. Ramam, 2400 m (H. K. M. T. & T., May 8, 1960, TI).

Sikkim, 10–12,000 ft. (Hooker f. – type of *A. utile*, K, GH); Lachen, 12–13,000 ft. (Hooker f., 1849, K); Gamothang, 3800 m (H. K. M. T. & T., May 26, 1960, TI).

Bhutan. Gasa–Pari La, 2900 m (K. M. O. T. & Y., May 14, 1967, TI); Barshong–Nala, 3700–3300 m (K. M. O. T. & Y., May 25, 1967, TI).

Distr. Himalaya (Punjab to Bhutan).

As is usual in the genus, the species is very variable in size especially influenced by the nutritional condition of the plant in the previous year. I have observed the range of variations in this species in late May and June of 1969 on Mt. Phulchauki (at about 2700–2800 m high above the sea-level) where no *A. Griffithii* nor *A. propinquum* has been found. The leaf is one or two, and the spathe varies in size and shape as shown in Figs. 52 & 53. It is interesting that most of the plants there were female, and only a very few small ones which have very small leaves and spathes were male.

*A. utile* is clearly distinguished from *A. Griffithii* in the typical form, but rarely individuals having some intermediate characters between the two are found where the two species meet.

7) ***Arisaema Griffithii*** Schott, Syn. 26 (1856); Prodr. 54 (1860)–Hook. f. in Bot. Mag. t. 6491 (1880); Fl. Brit. Ind. 6: 499 (1893)–Engler, l.c. 219, f. 53 (1920)–Chatterjee, l.c. 126 (1955)–Spring Fl. Sikkim Himal. f. 110–112 (1963)–Hara, Fl. E. Himal. 395 (1966)–Phot.-Alb. Pl. E. Himal. f. 103 (1968). [Fig. 51. F]

*Pythonii* sp. Griffith, Itin. Not. 2: 201, no. 1179 (1848).

*Arisaema Hookerianum* Schott in Oesterr. Bot. Wochenbl. 7: 334 (1857); Prodr. 29 (1860).

*A. Hookeri* Schott, Gen. Aroid. in explicatio t. 6, f. 11–19 (1858), nom. nud.

Paradioecious. Bulb depressed globose 3–10 cm in diameter. Pseudostem very short.

Leaves 2 or 1, *trifoliolate*; leaflets rhombic-ovate or depressed roundish *rhombic*, abruptly acuminate at the apex, sessile, or shortly petiolulate, deep green, undulate and purplish or yellowish on the margin, lateral nerves 6–10-pairs reticulately connected by veinlets, nerves conspicuously impressed above and elevated beneath; median leaflets 10–40 cm long 10–40 cm wide; lateral leaflets somewhat longer, very unequal at the base; petiole 15–60 cm long stout green or dark purplish, smooth. Peduncle much shorter than the leaves, 5–20 cm long.

*Spathe* very large dark purple or *chocolate-purple*; tube cylindric 5–10 cm long 2–3.5 cm in diameter longitudinally white-ribbed, longitudinally *lamellate inside* with dark purple lamellae 2–3 mm high; *blade* large and *very broad* dark purple strongly incurved, galeate and convex on the top, densely white ribbed on the back, (7) 9–20 cm wide, with *very broad wings* on both sides which are *strongly involute* and *netted with coarse* whitish or greenish *reticulate veins*, *emarginate* at the incurved apex with a short tail 0.8–4 cm long.

Spadix unisexual; ovaries ovoid green, with a dark purple stigma; *anthers* 3–4, yellow, *dehiscent by a horseshoe-shaped slit*; *appendage long flagellate* 20–50 cm long dark purple, suddenly *expanded into a fleshy disk* (7–15 mm in diameter) and stipitate at the base, thickened in the lower part, and again slightly thickened and minutely rugose at about 3–5 cm from the base, then tapering into a thin thread, often tor-

tuose and hanging down in the upper part.

Representative specimens.

Nepal. Above Chipli, north of Pokhara, 8,000 ft. (Stainton, Sykes & Williams, Apr. 18, 1954, no. 4870, BM); Arum Valley, Maghang Khola, 11,000 ft. (Stainton, May 1, 1956, no. 175, BM); Mechi Zone, Illam, 2650 m (Nicholson, Apr. 7, 1967, no. 3177, BM).

Darjeeling. Senchal, 2400 m (Hara, Mar. 24 & Apr. 29, 1967, TI); Tonglu, 2800–3150 m (Kurosawa, May 2, 1970, TI).

Sikkim (Herb. Hook. f. et Thoms. – type of *A. Hookerianum*, K).

Bhutan. Dochu La, 3000 m (K. M. O. T. & Y., May 3, 1967, TI); Gasa–Pari La, 2800–3000 m (K. M. O. T. & Y., May 14, 1967, TI).

Distr. E. Himalaya (Nepal, Sikkim, Bhutan).

This species is remarkable in its very large dilated, strongly involute, and peculiarly coloured spathe-blade.

7a) var. **verrucosum** (Schott) Hara, comb. nov. [Pl. 6. b]

*A. verrucosum* Schott, l.c. 7: 341 (1857); Prodr. 29 (1860)–Hook. f., l.c. 499 (1893)–Engler, l.c. 214 (1920)–Chatterjee, l.c. 138 (1955).

*A. Pradhanii* C. E. C. Fischer in Bot. Mag. t. 9425 (1936)–Chatterjee, l.c. 130 (1955).

Petiole and peduncle often minutely black-purple-dotted and *more or less verrucose*. Spathe-blade dilated with broad wings 6–11 (15) cm wide, strongly incurved, somewhat depressed in the middle on the top; longitudinal whitish ribs on the hood more numerous and parallel; whitish reticulate veins on wings smaller.

Representative specimens.

Sikkim, 8.–10,000 ft. (Hooker f. – type of *A. verrucosum*, K); above Lachen, 10,000 ft. (Pantling, May 1885, no. 46429, K).

Darjeeling. Garibas–Tonglu, 2800–3000 m (Kurosawa, May 2, 1970, TI).

Distr. E. Himalaya (Sikkim).

The status of *A. verrucosum* is still somewhat doubtful. The type specimen from Sikkim at Kew has a very broad large spathe-blade about 10 cm wide, and is near to *A. Griffithii*. But some specimens from Simla and the drawing of *A. verrucosum* by Schott have obovate spathe-blades similar to those of *A. utile*.

It is noteworthy that *A. elephas* Buchet from Yunnan belonging to the same group has often warty petioles. So far as I have examined, the Chinese specimens with verruculose petioles are different from Himalayan *A. verrucosum* in the shape of the spathe-blade and spadix-appendage, and are identical in those characters with *A. elephas* or its allied species which have sometimes smooth petioles.

It is uncertain whether verrucosity on petioles or peduncles can be considered as a stable character for separating species. Populations with verruculose petioles may be found in *A. Griffithii*, *A. utile* and also in *A. elephas* of W. China.

On the Singalila Range there occur some plants showing intermediate characters between *A. Griffithii* and *A. verrucosum*.

8) **Arisaema galeatum** N. E. Brown in Gard. Chron. 12: 102 (1879); in Journ. Linn. Soc. 18: 246 (1880)–Hook. f. in Bot. Mag. t. 6457 (1879); in Fl. Brit. Ind. 6: 502 (1893)–Engler, l.c. 217 (1920)–Chatterjee, l.c. 125 (1955).

Paradioecious. Bulb subglobose.

Leaf 1, trifoliolate; leaflets elliptic or ovate, distinctly petiolulate, shortly acuminate,

up to 35 cm long and 30 cm wide, crispulate and red on the margins, nerves impressed above and distinctly elevated beneath; lateral leaflets dimidiate-cordate at the base; petiole elongate up to 60 cm high greenish. Peduncle much shorter than the leaf, greenish.

Spathe dull green or brown purple, with white longitudinal stripes; tube cylindric 5–8 cm long, about 2.5 cm in diameter; *blade* strongly incurved and *galeate*, with a roundish *protrudent brow*, narrowly recurved at the margins, suddenly *constricted* and then *dilated into an ovate acute green pendent terminal lobe* 4–5 cm long.

Spadix unisexual; *anthers* 3–5, *dehiscent by a horseshoe-shaped slit*; *appendage* long *flagellate*, thick and truncate at the base, tapering into a thin thread hanging down in the upper part.

Representative specimens.

Sikkim (Gammie – type in K).

Bhutan. Putli Bhir, 2100 m (K. M. O. T. & Y., Jun. 2, 1967, TI).

Mishmi Hills. Adung Valley, 6,000 ft. (K.–Ward, May 3, 1931, no. 9453, BM).

N. Burma. North Triangle, Uring Bhum above Ahkail, 7,000 ft. (K.–Ward, May 13, 1953, no. 20821, GH).

Distr. E. Himalaya (Sikkim, Bhutan), Mishmi Hills, and N. Burma.

The shape of the spathe is very similar to that of *A. ringens* (Thunb.) Schott of Japan and China, but this species is quite distinct from the latter in the shape of the spadix-appendage and anthers. The Chinese plants identified with this species seem to differ from the Himalayan ones in some respects.

Sect. **Tortuosa** Engler in Pfl.-reich IV-23 F: 150 & 185 (1920), excl. *A. Thunbergii*–Nakai in Bot. Mag. Tokyo **43**: 524 (1929), pro parte.

Sect. II. Pedatisecta Schott, Prodr. 34 (1860), pro minor. part. (\*\*a. Indica).

*Muricauda* Small, Fl. S.-E. U.S. 227 (1903); Man. S.-E. Fl. 247 (1933). Type: *M. Dracontium* (L.) Small.

*Heteroarisaema* Nakai in Journ. Jap. Bot. **25**: 6 (1950). Type: *H. heterophyllum* (Bl.) Nakai.

Leaf 1–2 (3), pedately (rarely digitately) foliolate. Spathe-blade generally ovate, upright or incurved, auriculate or not at the mouth. Spadix-appendage elongate sigmoidly curved, long exerted, tapering and often ascending in the upper part, narrowed at the base to the axis of the spadix. Anthers dehiscent often by a longitudinal slit, sometimes apiculate. Monoecious or paradioecious, with subglobose bulb.

Type: *A. tortuosum* (Wall.) Schott (Himalaya, Decan, Burma, W. China).

Includes *A. neglectum* Schott (S. India, Ceylon), *A. ambiguum* Engl. (China), *A. cordatum* N. E. Brown (S. China), *A. heterophyllum* Blume (China, Formosa, Korea, C. & S. Japan), *A. koreanum* Engl. (Korea), *A. Negishii* Makino (Idzu Is. of Japan), *A. filiforme* (Reinw.) Blume (Java, Sumatra), *A. Wrayi* Hemsley (Malay), *A. Dracontium* (L.) Schott (E. N. America, E. Mexico), *A. macrospatum* Benth. (Mexico).

It is to be noted that Nakai (1939 & 1950) described and illustrated pendulous ovules in *A. heterophyllum* Blume of C. & S. Japan. If normally so, that species is very

peculiar, and it is also the highest polyploid species ( $2n=ca. 140$ ) in the genus. *A. Mildbraedii* Engler of Africa also seems to belong to this section.

9) ***Arisaema tortuosum*** (Wallich) Schott, Melet. **1**: 17 (1832); Prodr. 36 (1860)—Fl. Brit. Ind. **6**: 502 (1893)—Engler, l.c. 190, f. 42 (1920)—C. E. C. Fischer in Kew Bull. **1933**: 349 (1933)—Chatterjee, l.c. 136 (1955)—Spring Fl. Sikkim Himal. f. 117 & 118 (1963)—Hara in Fl. E. Himal. 396 (1966). [Fig. 54. G]

*Arum tortuosum* Wallich, Pl. Asia. Rar. **2**: 10, t. 114 (1830).

*Arisaema helleborifolium* Schott, Syn. 29 (1856); Prodr. 36 (1860).

*A. curvatum* Kunth sensu Hook. f. in Bot. Mag. t. 5931 (1871).

*A. tortuosum* var. *helleborifolium* (Schott) Engler in DC., Monogr. Phaner. **2**: 545 (1879).

Generally *monoecious*, occasionally male. Bulb depressed globose 2–6 cm across, white inside. *Pseudostem tall*, often very robust, up to 150 cm high, green somewhat glaucous sometimes dark variegated.

*Leaves* usually 2, rarely 3 or 1, *pedately 5–17-foliolate*; leaflets variable in shape, rhombic ovate, oblong to lanceolate, abruptly acuminate at the apex, cuneate at the base, shortly petiolulate to sessile, lateral veins many slightly impressed above; median leaflets (5) 6–30 cm long 1–7 cm wide, the outer leaflets smaller; petiole elongate, 5–20 cm long, often auriculate at the base. Peduncle *exserted* from the leaves.

Spathe *green* somewhat glaucous, sometimes dark purple; tube cylindrical 2.5–7 cm long 1.5–3 cm in diameter, gaping (not reflexed) at the mouth; *blade ovate-oblong-ovate, shortly acute* sometimes acuminate at the apex, 4–12 cm long 2–5 cm wide, gently incurved.

Spadix *often bisexual*, sometimes male; male flowers in the upper part, rarely a few bristly projections in the uppermost part; *anthers* (1) 2–3, yellow, or purple, generally minutely apiculate, *longitudinally dehiscent*, opened by an oblong pore; *appendage elongate* green sometimes dark purple somewhat glaucous, 7–25 cm long, rather thick, smooth, *sigmoidly curved* in the lower part, 3–12 mm thick at the base, then gradually narrowed to the tip, and almost *upright in the upper part*.  $2n=26$  (24).

Representative specimens.

Nepal (Wallich 1821, no. 8926, K (leaf only), K-W); (Wallich 1821, no. 8927, K, K-W); Phulchauki, 2500–2800 m (Hara, Kurosawa & Ohashi, Jun. 10, 1969, TI); Malemci, Gosainkund, 8,000 ft. (Stainton, May 29, 1962, no. 3784, BM, TI); Pokhara, 900 m (K. M. O. & Y., Jun. 18, 1967, TI); Lumle–Dhampus, 6,500 ft. (Flatt, May 16, 1969, no. 59, BM).

Darjeeling, 2150 m (H. K. & O., Jun. 23, 1969, TI); Senchal–Takhah, 2000 m (Hara & Togashi, Apr. 17, 1960, TI).

Sikkim. Saramsa, 1500 m (Hara, Apr. 26, 1967, TI); Gangtok, 1400 m (H. K. M. T. & T., Jun. 13, 1960, TI).

Bhutan. Khosa–Tamji, 1950 m (K. M. O. T. & Y., May 11, 1967, TI); Chimakhothi, 2300 m (K. M. O. T. & Y., Jun. 1, 1967, TI).

var. ***curvatum*** (Roxb.) Engler, l.c. 191 (1920).

*Arum curvatum* Roxb., Fl. Ind. ed. 2, **3**: 506 (1832).

*Arisaema curvatum* (Roxb.) Kunth, Enum. **3**: 20 (1841)—Schott, Prodr. 37 (1860).

*Leaflets linear-lanceolate*, generally less than 12 mm wide.

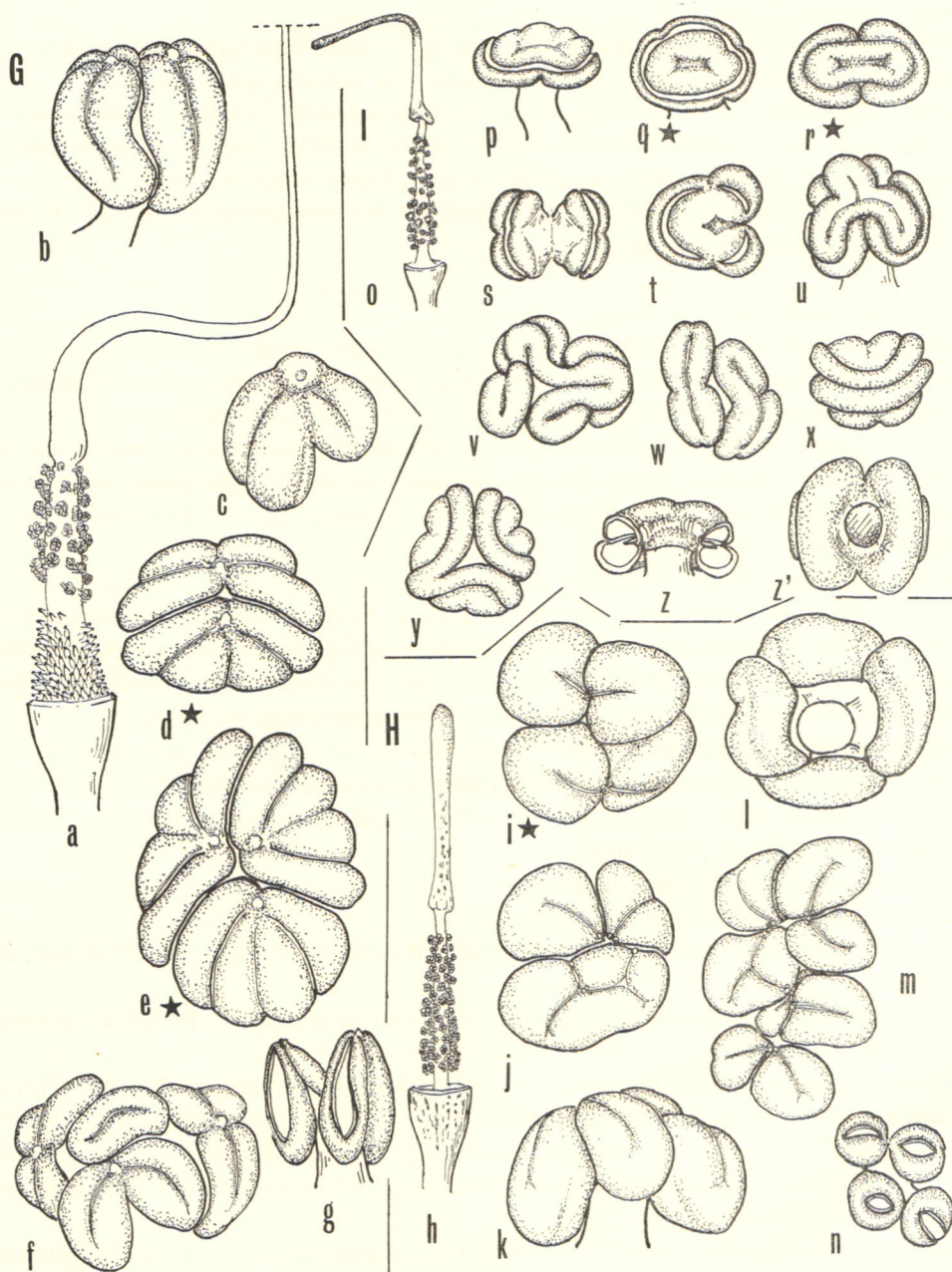


Fig. 54. G. *Arisaema tortuosum* Schott. H. *A. nepenthoides* Martius. I. *A. Jacquemontii* Blume.

a, h & o. Spadix with appendage.  $\times 3/4$ . b-g, i-n & p-z. Anthers showing their variations.  $\times 15$ . \* indicates a common type for the species. z. A longitudinal section of z'. (del. Sachiko Kurosawa)

Distr. sp. Himalaya (Punjab to Bhutan), Khasia, Decan Pen.?, Manipur, N. Burma, and W. China.

The species is generally monoecious, and its chromosome number is mostly 26. The shape of leaflets and the colour of spathe and anthers are variable.

The typical form of *A. tortuosum* originally illustrated by Wallich (1830) and the specimens in the Wallich Herbarium (no. 8926 & 8927) have ovate-lanceolate leaflets, and are identical with *A. helleborifolium*. But a specimen in the type cover of *A. tortuosum* (Wallich, no. 8926) in the Kew Herbarium has large elongate leaflets up to 30 cm long and 4.5 cm wide.

Sect. **Dochafa** (Schott) Hara, comb. nov.

*Dochafa* Schott, Syn. 24 (1856). Type: *Dochafa flava* (Forsk.) Schott.

Sct. II. Pedatisecta Schott, Prodr. 34 (1860), pro minor. part. (a. Indo-Arabica).

Sect. Clavata Engler in Pfl.-reich IV-23 F: 171 (1920), pro minor. part.

Leaves 2 or 1, pedately foliolate. Spathe very small, tube ovoid, blade ovate incurved. Spadix bisexual, male flowers densely congested, appendage very short ellipsoid, anthers sessile, dehiscent by a roundish pore. Monoecious, with subglobose bulb.

Type: *A. flavum* (Forsk.) Schott.

This section is monotypic, and is related to Sect. Arisaema, Tortuosa, and Tenuipistillata in some respects. But *A. flavum* is well characterized in having very small spathe with an ovoid tube, and always bisexual spadix with densely crowded male flowers in the upper part, and a very short appendage at the tip.

10) **Arisaema flavum** (Forsk.) Schott, Prodr. 40 (1860)—Fl. Brit. Ind. **6**: 503 (1893)—Hooker f. in Bot. Mag. t. 7700 (1900)—Engler in Pfl.-reich IV-23 F: 172, f. 34 (1920)—Hand.-Mzt., Symb. Sin. **7**: 1365 (1936)—Chatterjee, l.c. 125 (1955)—Kitamura, Fl. Afghan. 62 (1960).

*Arum flavum* Forsk., Fl. Aeg.-Arab. 157 (1775).

*Dochafa flava* (Forsk.) Schott, Syn. 24 (1856).

*Arisaema abbreviatum* Schott in Oesterr. Bot. Wochenbl. **7**: 382 (1857); Prodr. 39 (1860).

*Monoecious*. Bulb subglobose smaller 1.5–2.5 cm in diameter. Pseudostem elongate, 10–40 cm high.

Leaves 2 or 1, pedately 5–11-foliolate; leaflets oblong-lanceolate or obovate-oblong, acuminate at the apex, cuneate at the base, 2.5–12 cm long 0.6–3 cm wide, bright green, lateral nerves fewer strongly ascending; the median one largest; petiole elongate 3–20 cm long often auriculate at the base. Peduncle generally long exserted 5–15 cm long green.

*Spathe very small* for the genus, 2.5–4 cm long including the tube; tube ovoid or globose 1–1.5 cm long about 1 cm in diameter slightly constricted at the neck, yellowish green, generally dark purplish in the upper part, longitudinally striped and somewhat trellised; blade oblong-ovate 1.5–3 cm long 8–12 mm wide, attenuate to the acute tip, yellowish or greenish, dark purple inside at least in the lower part, slightly incurved.

Spadix bisexual, 1–2 cm long; the lower female part 3–7 mm long, ovaries obovoid,



stigma discoid flattish; the upper male part 3–7 mm long, with very *densely congested stamens*; *stamens* generally 2, *sessile*; anthers dehiscent by a small roundish pore; *appendage very short* ellipsoid, 2–5 mm long 1.5 mm thick, greenish or yellowish, rugose when dried.

Representative specimens.

Simla, 5–8,000 ft. (Thomson – isotype of *A. abbreviatum*, GH).

Nepal. Megu, 11,000 ft. (Stainton, Jun. 24, 1968, no. 6336, BM, TI); Nampa Khola, 10,500 ft. (Tyson, Jun. 21, 1953, no. 54, BM); Dozan Khola near Limikot, 9,500 ft. (Polunin, Sykes & Williams, May 29, 1952, no. 4212, BM).

Distr. Afghanistan, Himalaya (Kashmir to Bhutan), S. Tibet, and W. China (Yunnan, Szechuan).

### Sect. *Arisaema*.

Sect. *Pedatisecta* Schott, Prodr. 34 (1860), pro minor. part.

Sect. *Peltatisecta* Schott, l.c. 48 (1860), p.p., quoad *A. nepenthoides*.

Sect. *Pistillata* Engler in Pfl.-reich IV-23 F: 199 (1920), p.p.–Nakai in Bot. Mag. Tokyo **43**: 525 (1929); in Journ. Jap. Bot. **25**: 6 (1950).

Sect. *Nepenthoidea* Engler, l.c. 151 & 208 (1920). Type: *A. nepenthoides* Mart.

Leaf 1–2 (3), pedately sometimes digitately foliolate. Spathe-blade ovate–ovate-lanceolate incurved, auriculate or not at the mouth. Spadix-appendage cylindrical or clavate, subtruncate at the base and stipitate. Anthers mostly dehiscent by an elliptic or roundish pore. Usually paradioecious, with subglobose bulb.

Type: *A. nepenthoides* (Wall.) Martius (Himalaya to W. China).

Includes *A. limbatum* Nakai et F. Maekawa (Japan), *A. serratum* (Thunb.) Schott (Japan), *A. amplissimum* Blume (Japan), *A. monophyllum* Nakai (Japan), *A. heterocephalum* Makino (Ryukyus), *A. sikokianum* Franch. et Sav. (S. Japan, China?), *A. Engleri* Pampanini (C. China), *A. tosaense* Makino (S. Japan), *A. amurense* Maxim. (Amur, N. China, Korea, Japan), *A. nikoense* Nakai (Japan), *A. iyoanum* Makino (W. Japan), *A. nanum* Nakai (S. Japan), etc.

This section is represented in the Himalayas only by *A. nepenthoides*, the type species of the genus, and it has generally digitately 5-foliolate leaves and conspicuously auriculate spathe. In Japan, this group is highly differentiated, and about 25 Japanese species belong to this section, and are variable in leaves, spathe, and spadix-appendage. It is to be noted that *A. amurense* extends its distribution to Amur where is the northernmost locality of the genus in Asia.

11) ***Arisaema nepenthoides*** (Wallich) Martius in Flora **14**: 458 (1831), in nota–Schott, Prodr. 48 (1860)–Hook. f. in Bot. Mag. t. 6446 (1879)–Fl. Brit. Ind. **6**: 504 (1893)–Engler, l.c. 208, f. 49 (1920)–Chatterjee, l.c. 129 (1955)–Spring Fl. Sikkim Himal. f. 106 (1963)–Hara in Fl. E. Himal. 395 (1966).

[Pl. 18. b; Fig. 54. H]

*Arum nepenthoides* Wallich, Tent. Fl. Nepal. 26, t. 18 (1824).

*Arisaema ochraceum* Schott sensu Journ. Linn. Soc. **43**: 483 (1916).

Paradioicous. Bulb depressed globose, 3–7 cm in diameter. Pseudostem tall, yellowish brown and dark variegated.

Leaves 2, rarely 3, *digitately* (3) 5 (7)-*foliolate*; leaflets oblanceolate acute at the

apex, subsessile, median leaflets 6–20 cm long 2–6 cm wide, the outermost ones smallest, *thicker* in texture, dark green and *somewhat lustrous*; lateral nerves 6–12 pairs slightly impressed above; petioles elongate, (5) 7–30 cm long, yellowish brown and dark-variegated, often auriculate at the base. Peduncle shorter or longer than the leaves, the same colour as the petioles.

Spathe *dusty* greenish brown or dark reddish-brown and irregularly *dark-spotted*, with longitudinal *broad white* 3–5 (7) *stripes* on the back; tube cylindrical 3–8 cm long 1.2–2.5 cm in diameter, *broadly auriculate* at the mouth with roundish reflexed lobe, up to 2 cm long; *blade triangular-ovate* shortly *acute*, rarely obovate and acuminate, incurved, 3–10 cm long 2–5 cm wide.

Spadix unisexual; ovaries obovoid, dark purple in the apical part; anthers usually 4, dehiscent by an elliptic pore; *appendage cylindrical*, 2–7.5 cm long, *obtuse* and 3–6 mm *thick at the tip*, truncate at the base and stipitate.

Representative specimens.

Nepal (Wallich no. 8919, K); Shioupuri, 2500 m (Ohashi, Jun. 14, 1969, TI); Phulchauki, 2100–2800 m (H. K. & O., May 29, 1969, TI); Ankho Khola; Ganesh Himal, 9,000 ft. (Stainton, Jun. 1, 1962, no. 3653, BM); near Lumsum, 8,500 ft. (Stainton, Sykes & Williams, Apr. 25, 1954, no. 2598, BM).

Darjeeling. Tonglu, 3100 m (Hara, May 7, 1960, TI).

Sikkim. Damthang–Tendong, 2300 m (Hara, Mar. 26, 1963, TI).

Bhutan. Tsarza La, 2400–2600 m (H. K. M. O. T. & Y., Apr. 11, 1967, TI); Gasa–Pari La, 3000 m (K. M. O. T. & Y., May 14, 1967, TI).

Burma. Hpare Pass, 8,500 ft. (K.-Ward, no. 446, AA).

Distr. Himalaya (Nepal to Bhutan), Khasia, N. Burma, and W. China.

It is interesting that this species resembles *A. limbatum* Nakai et F. Maekawa of Japan in shape of the spathe, and early-blooming habit.

Sect. **Tenuipistillata** Engler in Pfl.-reich IV-23 F: 151 & 195 (1920).

Leaf 1 or 2, digitately or somewhat pedately foliolate. Spathe-blade ovate or lanceolate-ovate incurved. Spadix-appendage thin cylindrical slender, thickened in the basal part, exserted and erect or slightly curved, obtuse at the tip. Anthers dehiscent by a longitudinal slit, rarely by a ring. Paradioecious, with subglobose bulb.

Lectotype: *A. Jacquemontii* Blume (Himalaya).

Includes *A. Wightii* Schott (S. India), *A. Barnesii* C. E. C. Fischer (S. India), *A. tylophorum* C. E. C. Fischer (S. India), *A. brevispathum* Buchet (W. China), *A. Souliei* Buchet (W. China).

Chatterjee (1955) suggested that *A. Jacquemontii* and *A. exile* are the simplest forms of the genus. But various characters are so combined in this section that one has no basis for speculation as to the primitiveness of this section.

12) **Arisaema Jacquemontii** Blume in Rumphia 1: 95 (1836)–Jacquemont, Voy. t. 168 (1844)–Fl. Brit. Ind. 6: 506 (1893)–Engler, l.c. 197, f. 45 A–C (1920)–Chatterjee, l.c. 127 (1955)–Kitamura, Fl. Afghan. 62 (1960)–Hara in Fl. E. Himal. 395 (1966). [Pl. 18. a; Fig. 54. I]

*A. exile* Schott in *Bonplandia* 7: 26 (1859); Prodr. 42 (1860)—Fl. Brit. Ind. 6: 506 (1893)—Engler, l.c. 198 (1920)—Chatterjee, l.c. 124 (1955).

*A. cornutum* Schott in *Bonplandia* 7: 27 (1859).

Paradioecious. Bulb subglobose 1.2–3 cm in diameter. Pseudostem elongate (5) 10–70 cm high.

Leaf 1, sometimes 2, *digitately* or *pedately* 3–9-foliolate; leaflets ovate, oblong, or oblanceolate long attenuate to both ends or acuminate at the apex, sessile, 3–18 cm long 0.8–7 cm wide; petiole (2.5) 5–20 cm long greenish. Peduncle generally exserted from the leaf (3.5) 5–17 cm tall greenish.

Spathe *green*, pale green inside; tube cylindrical 2.5–9 cm long 8–20 cm in diameter; *blade ovate* or narrow ovate 2–6 cm long 1–3.5 cm wide incurved, spreading or narrowly recurved at the mouth, green with narrow white stripes on the back, *abruptly acuminate into a long generally ascending tail* 1.2–12 cm long and green or dark purple.

Spadix unisexual; ovaries narrow ovoid with a short style; anthers 2–4, dehiscent by a longitudinal slit or a ring; *appendage slender*, 2–8 cm long, thickened above the base, sometimes truncate and stipitate at the base, light green in the lower part, distinctly exserted from the tube of spathe, *slightly curved*, pointing forwards sometimes curved downwards and generally dark purple in the upper part, 0.8–2 mm *thick and obtuse* at the tip.  $2n=28$ .

Representative specimens.

Nepal. Mugu, 11,000 ft. (Stainton, Jun. 24, 1968, BM); Ganesh Himal, Ankhukhola, 12,000 ft. (Stainton, Jul. 10, 1962, no. 3976, BM); Chalike Pahar, 12,500 ft. (Stainton, Jun. 16, 1954, no. 3144, BM); Rambrong, Lanjung Himal, 10,500 ft. (Stainton, Sykes & Williams, Jun. 27, 1959, no. 5965, BM); Tinjure Danla, 8,500 ft. (Williams, Jul. 4, 1969, no. 1131, BM).

Darjeeling. Tonglu, 2800–3100 m (H. K. & O., Jul. 11 & 12, 1969, TI); Phalut, 3800 m (H. K. & O., Jul. 18, 1969, TI).

Bhutan. Shodu–Barshong, 3700 m (K. M. T. O. & Y., May 24, 1967, TI).

Tibet. Above Singma Khangchung, 11,500 ft. (Chapman, Aug. 21, 1936, no. 145, GH).

Distr. Afghanistan (Kuram), Himalaya (Kashmir to N. Assam), and S. Tibet.

*A. exile* seems to be only a well-grown form of *A. Jacquemontii*. It is noteworthy that the anthers of this species show various transitional forms from a common type of the genus to a ring type similar to that of *A. exappendiculatum* (Fig. 54, p-z).

Sect. **Sinarisaema** Nakai in Journ. Jap. Bot. 25: 6 (1950).

Sect. III. Radiatisecta Schott, Prodr. 42 (1860), pro parte.

Sect. IV. Peltatisecta Schott, l.c. 48 (1860), pro parte.

Sect. Clavata Engler in Pfl.-reich IV-23 F: 171 (1920), pro major. part.

Leaf 1 or 2, radiately 7–20-foliolate. Spathe-blade lanceolate-ovate and incurved, or galeate. Spadix-appendage cylindrical, clavate or slender, narrowed at the base, often with subulate projections near the base. Anthers dehiscent by a roundish or oval pore. Generally paradioecious, with subglobose bulb.

Type: *A. formosanum* (Hayata) Hayata (Formosa).

Includes *A. consanguineum* Schott (Himalaya to China, Formosa), *A. erubescens* (Wall.) Schott (E. Himalaya), *A. concinnum* Schott (Himalaya, Burma), *A. fraternum* Schott (Khasia, Burma, W. China), *A. echinatum* (Wall.) Schott (E. Himalaya),

*A. Leschenaultii* Blume (S. India), *A. constrictum* E. Barnes (Ceylon), *A. psittacus* E. Barnes (S. India), *A. translucens* C. E. C. Fischer (S. India), *A. sarracenioides* E. Barnes et C. E. C. Fischer (S. India).

This section is most evolved in India, and is variable in spathe and spadix-appendage. Generally in this section, the median leaflet before expanding takes a upright position, while the other leaflets are folded downwards along the petiole.

*A. Murrayi* (Graham) Hook. of S. India can also be included in this section, but has attenuate appendage and is monoecious.

13) ***Arisaema erubescens*** (Wall.) Schott in Melet. **1**: 17 (1832); Syn. 30 (1856); Prodr. 53 (1860)—Fl. Brit. Ind. **6**: 506 (1893)—Engler, l.c. 174 (1920)—Chatterjee, l.c. 124 (1955). [Pl. 6. a; Fig. 55. J]

*Arum erubescens* Wallich, Pl. Asia. Rar. **2**: 30, t. 135 (1831).

Paradioecious. Bulb depressed globose, 2–4 cm in diameter.

Leaf 1, *radiately 7–14-foliolate*; leaflets *oblanceolate* to narrow oblanceolate, *acute or acuminate* at the apex, sessile, dark green above, thicker in texture, smooth and *glaucous beneath*, 5–15 cm long 6–20 (30) mm wide, *lateral veins strongly ascending*; petiole elongate 12–30 cm long, brown-variegated. Peduncle generally shorter than the petiole, sometimes elongate before the leaf.

Spathe *dusty brown purple*; tube narrow cylindric, 3.5–5 cm long 1.5–1.8 cm across, *dusty brown purple with longitudinal white stripes*, slightly reflexed at the mouth; *blade ovate long-acuminate* at the apex, incurved, 5–7 cm long 2.5–3.7 cm wide, *dusty brownish or greenish purple outside, dark purple with white stripes inside* in the lower part.

Spadix unisexual; ovaries obovoid green, stigma dark purple; anthers 2–4, purple, dehiscent by a roundish pore; *appendage* cylindric slightly exerted from the tube, 2.5–3.5 cm long 2.5–4 mm across, often brown-purplish, and greenish, *obtuse and smooth at the apex*, no bristly projection. Fruiting peduncles upright, fruits turbinate.

Representative specimens.

Nepal (Wallich, 1821, no. 8917 – type in K (the right-hand specimen) [the left-hand specimen is *A. consanguineum*]); Shioupuri, 2200 m (Ohashi, Jun. 14, 1969, TI); Phulchauki, 2500–2700 m (Jun. 23, 1967 & May 29, 1969, TI); Dhunche, Gosainkund, 2200 m (H. K. & O., Jun. 4, 1969, TI); Mailung Khola, Ganesh Himal, 85,000 ft. (Stainton, May 20, 1952, BM, TI); Lumle, 7,000 ft. (Flatt, May 9, 1969, no. 49, BM).

Distr. E. Himalaya (Nepal, Sikkim).

The species is often confounded with *A. consanguineum*, but can be easily distinguished from the latter especially at the habitat, as shown in the key on page 328.

14) ***Arisaema consanguineum*** Schott in Bonplandia **7**: 27 (1859); Prodr. 52 (1860)—Fl. Brit. Ind. **6**: 505 (1893)—Engler, l.c. 175, f. 36 A–C (1920)—Chatterjee, l.c. 122 (1955)—Liu et Huang in Quart. Journ. Taiwan Mus. **16**: 131 (1963)—Spring Fl. Sikkim Himal. f. 108 (1963)—Hara in Fl. E. Himal. 394 (1966).

[Pl. 19. c, d; Fig. 55. K]

*A. vituperatum* Schott, l.c. 28 (1859); Prodr. 54 (1860).

*A. erubescens* var. *consanguineum* (Schott) Engler in DC., Monogr. Phaner. **2**: 558 (1879).

Paradioecious. Bulb depressed globose, 2–4 cm in diameter. Pseudostem longer,

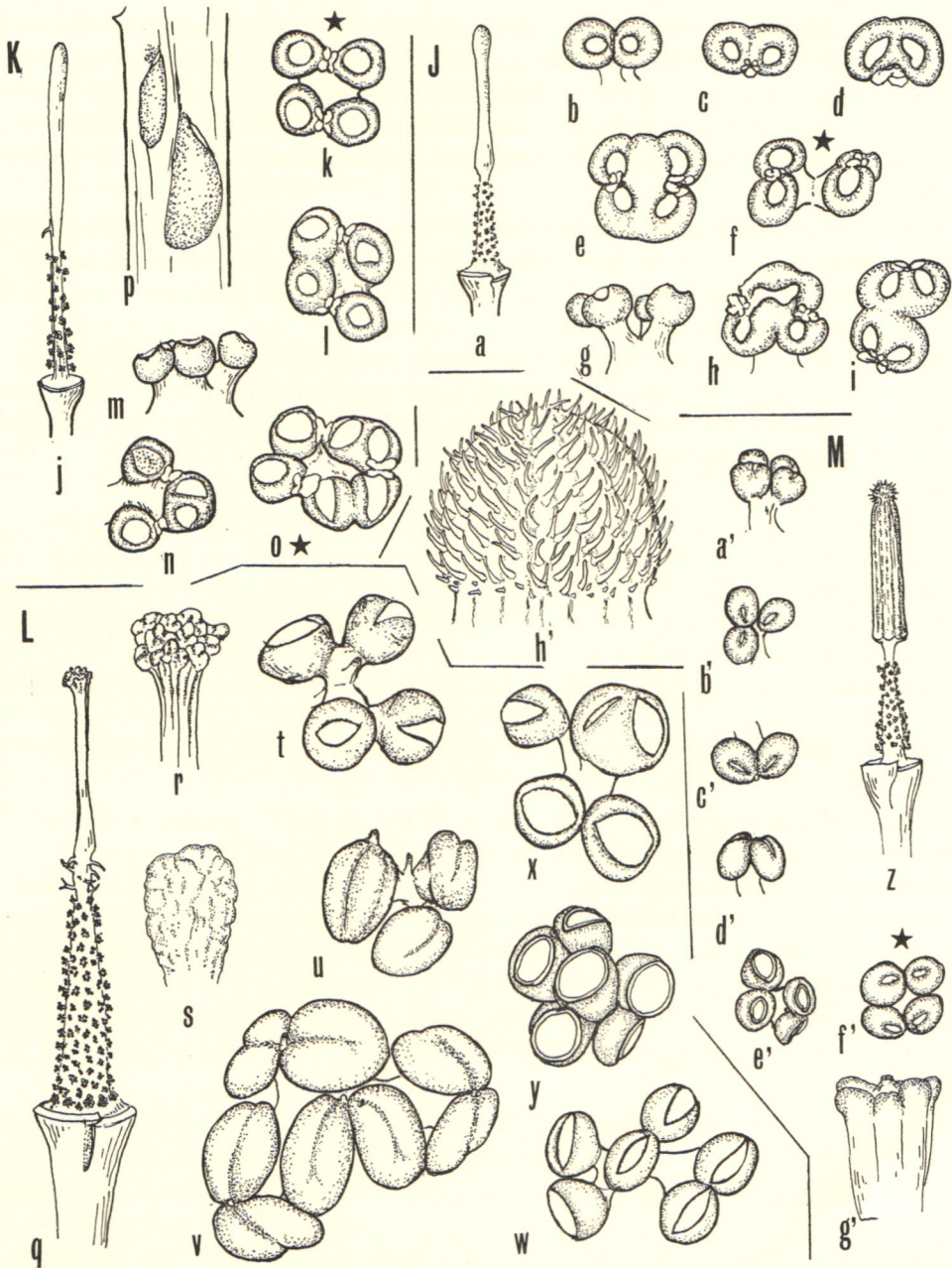


Fig. 55. J. *Arisaema erubescens* Schott. K. *A. consanguineum* Schott. L. *A. concinnum* Schott. M. *A. echinatum* Schott.

a, j, q & z. Male spadix with appendage.  $\times 3/4$ , b-i, k-o, t-y & a'-f'. Anthers showing their variations.  $\times 15$ . \* indicates a common type for the species. p. Abortive anthers.  $\times 15$ . r, s & h'. Apical parts of spadix-appendage. r, s,  $\times 2.5$ , h',  $\times 6$ . g' Young fruit.  $\times 3$ . (del. Sachiko Kurosawa)

dark-variegated.

Leaf 1, *radiately 11–20-foliolate*; leaflets *lanceolate to linear-lanceolate*, sessile, 8–24 cm long 6–35 mm wide, long *caudate-acuminate* to filiform-caudate, with a tail attaining 7 cm long, dark green above, *slightly glaucous beneath*; *lateral veins strongly ascending at a narrow angle* with the midrib, rather *indistinct* (less prominent than those of *A. concinnum*); petiole elongate dark variegated. Peduncle shorter than the petiole, dark variegated.

Spathe *green without distinct white stripes*; tube narrow cylindrical 4–8 cm long 9–20 mm in diameter, not or slightly reflexed at the mouth; *blade* triangular-ovate to oblong-ovate, 4–7 cm long 2.2–6 cm wide, green without prominent stripes, incurved, *acuminate into a long filiform tail* 5–15 cm long.

Spadix longer unisexual; stigma small, black; anthers 2–4, dark purple, dehiscent by a roundish pore; *appendage* slender, exerted from the tube, 2–4 cm long, 2.5–5 mm thick, *obtuse and smooth at the apex*, green, generally with bristly projections in the lower part. *Fruiting peduncles recurved*.  $2n=28$ .

Representative specimens.

Nepal (Wallich, no. 8915 – type of *A. vituperatum*, K); (Wallich no. 8917 (the left-hand specimen), K); Balaju, Kathmandu, 1300 m (K.M.O.T. & Y., Jun. 16, 1967, TI); Gadavari, 1600 m (K.M.O.T. & Y., Jun. 23, 1967, TI); Jumla, 7,600 ft (Polunin, Sykes & Williams, Jul. 5, 1952, no. 4444, BM); Upper Buri Gandaki, Nayak, 7,500 ft. (Stainton, Jun. 30, 1962, no. 3904, BM, TI).

Darjeeling, 2200 m (H.K.M.T. & T., Jun. 22, 1960, TI); Ghum, 2300 m (H.K. & O., Jul. 7, 1969, fr., TI); Batasi–Palmajua, 2300–2600 m (H.K.M.T. & T., May 3, 1960, TI).

Bhutan. Chimakhothi, 2300 m (K.M.O.T. & Y., Jun. 1, 1967, TI); Thimphu–Dochu La, 2400–2800 m (K.M. & Y., May 30, 1967, TI).

Distr. Himalaya (Kumaon to Bhutan), Assam, S. Tibet, Manipur, Burma, N. Thailand, W. & C. China, and Formosa.

Among the species with radiate leaflets, the species can be easily recognized in having narrower leaflets with a filiform-caudate apex and strongly ascending lateral veins, and green spathe-blade filiform-caudate at the apex. It is peculiar that the fruiting peduncle is always nodding, so far as I have hitherto observed (Pl. 19. d).

*A. vituperatum* is a narrow-leaved form of this species with linear-lanceolate leaflets, and the left-hand specimen of Wallich no. 8917 (K) also belongs to *A. con-sanguineum*.

15) ***Arisaema concinnum*** Schott in Bonplandia **7**: 27 (1859); Prodr. 50 (1860)–Hook. f. in Bot. Mag. t. 5914 (1871); Fl. Brit. Ind. **6**: 505 (1893)– $\text{ᠠᠷᠢᠰᠢᠨᠠᠮᠤ}$  l.c. 177, f. 36 F (1920)–Chatterjee, l.c. 122 (1955)–Hara, Fl. E. Himal. 394 (1966).  
[Pl. 19. a, b; Fig. 55. L]

*Pythonium* sp. Griffith, Not. **3**: 156 (1851); Icon. Pl. Asia. **3**: t. 163 (1851).

*Arisaema alienatum* Schott, l.c. **7**: 26 (1859); l.c. 45 (1860).

*A. affine* Schott, l.c. **7**: 27 (1859); l.c. 51 (1860).

*A. concinnum* var. *affine* (Schott) Engler in DC., Monogr. Phan. **2**: 557 (1879).

*A. concinnum* var. *alienatum* (Schott) Engler, l.c. 178 (1920)–Spring Fl. Sikkim Himal. f. 109 (1963)–Hara, l.c. (1966).

Parodioecious. Bulb depressed globose 2–5 cm across, sometimes with thick

creeping stolons. Pseudostem often short, greenish or slightly dark purplish.

Leaf usually 1, *radiately* (6) *7-13-foliolate*; leaflets *oblong* to *oblanceolate*, *acuminate*, sessile, 7-30 cm long 2-5 cm wide, green or yellowish green, *with depressed veins above*, pale green and *slightly lustrous* with elevated veins *beneath*, *lateral veins obliquely ascending*; petiole long greenish, not maculate. Peduncle shorter than the petiole greenish.

Spathe *green* or light green occasionally dark purple, longitudinally *white-striped*; tube narrow cylindrical 4-7 cm long 12-15 mm in diameter, not or slightly reflexed at the mouth; blade ovate or ovate-lanceolate 3-6 cm long 2-4 cm wide, with 5 broad white stripes on the back, incurved, acuminate into a long tail 2-7 (15) cm long, green or dark purple.

Spadix unisexual; stigma discoid green; anthers 3-6, dark purple, dehiscent by a roundish pore; *appendage slender*, slightly exerted from the tube, 2-4 mm thick, slightly *clavate* (2.5-6 mm in diameter), and *more or less rugose at the apex*, green or dark purple, often with stiff bristly projections above the spadix. Fruiting peduncle erect.  $2n=28,56$ .

Representative specimens.

Gurwhal, 6,000 ft. (Thomson, 1845 - type of *A. alienatum*, K).

Nepal (Wallich, no. 8920, K. GH); Phulchauki, 2500-2800 m (H. K. & O., May 29 & Jun. 10, 1969, TI); Gurjakhani, 8,000 ft. (Staiton, Sykes & Williams, Jun. 1, 1954, BM); Samre Banjyang, 6,000 ft. (Stainton, no. 3806a, BM).

Darjeeling. 2200 m (H. K. M. T. & T., Jun. 19, 1960, TI); Senchal, 2400 m (Hara, Apr. 29, 1967, TI); Kurseong, 1500 m (Togashi, Apr. 11 & 12, 1960, TI); Tonglu, 2900 m (H. K. M. T. & T., Jun. 8, 1960, TI).

Sikkim. 6.-10,000 ft. (Hook f. - type of *A. concinnum*, K); *ibid.* (Hook. f. - type of *A. affine*, K); 9.-11,000 ft. (Hook. f., K); Gangtok, 1650 m (H. K. M. T. & T., Jun. 15, 1960, TI).

Bhutan. (Griffith, no. 2630, K); Chimakhothi, 2300 m (K. M. O. T. & Y., Jun. 1, 1967, TI); Mishichen-Khosa, 1700 m (K. M. O. T. & Y., May 10, 1967, TI).

Distr. Himalaya (Punjab to NEFA), Khasia, S. Tibet, and N. Burma.

The leaflets are variable in shape. The type specimen of *A. concinnum* from Sikkim in Kew has oblong-lanceolate leaflets about 11 cm long and 2.5 cm broad, with crispate-undulate on the margin, and cuspidate-acuminate at the apex. While the type of *A. affine* from Sikkim in Kew has elongate lanceolate leaflets about 18 cm long and 2.5 cm wide, and the type of *A. alienatum* from Gurwhal in Kew has broader oblong-lanceolate leaflets about 10 cm long and 3 cm wide. The apical thickened part of spadix-appendage is more or less rugose in this species.

16) ***Arisaema echinatum*** (Wall.) Schott in Melet. **1**: 17 (1832); Syn. 30 (1856); Prodr. 49 (1860)-Fl. Brit. Ind. **6**: 506 (1893)-Engler, l.c. 181 (1920)-Chatterjee, l.c. 124 (1955). [Pl. 20. c, d; Fig. 55. M]

*Arum echinatum* Wallich, Pl. Asia. Rar. **2**: 30, t. 136 (1831).

Paradioecious. Bulb depressed globose 2-4 cm across. Pseudostem generally short.

Leaf solitary, rarely 2, *radiately 7-11-foliolate*; leaflets oblanceolate, long acuminate at the apex, subsessile, 5-20 cm long 1-4 cm wide, dark green above, slightly glaucescent beneath, lateral veins obliquely ascending (at about 45° angle with the midrib); median leaflet slightly shorter than the others; petiole elongate 15-40 cm

long green sometimes purplish. Peduncle much shorter than the leaf, sometimes declining in fruit.

Spathe yellowish green often partly dark purple inside; tube cylindric 3–6 cm long 1.5–2 cm in diameter, green and white-striped outside, longitudinally dark-purple-striped inside, spreading at the mouth; *blade ovate* 3–7 cm long 2.5–5 cm wide, incurved, yellowish green, often dark purple inside, sometimes maculated with green patches, *abruptly narrowed into a long filiform tail* which is 5–14 cm long.

Spadix short 2–3 cm long; *ovaries* obovoid green with 8-lobed thickening in the upper part, and flat discoid in the centre on the top, apiculate with whitish stigma; anther purple generally 4, dehiscent by a pore; *appendage thick cylindric* or slightly compressed, 2.2–3.5 cm long 5–9 mm in diameter, slightly exerted from the tube, light green with dark-purple dotted lines, rounded and *densely echinulate in the apical portion* with white bristles up to 0.7 mm long, subtruncate and stipitate at the base.

Specimens examined.

Nepal (Wallich, no. 8916 – type, K); Phulchauki, 2700 m (Hara, Kurosawa & Ohashi, May 29 & Jun. 10, 1969, TI); Shioupuri, 2600 m (Ohashi, Jun. 14, 1969, TI).

Distr. E. Himalaya (Nepal, Sikkim, Bhutan?), S. Tibet? and Yunnan?

The species is singular in having the echinulate apical part of the spadix-appendage, and 8-lobed thickening in the upper part of the ovaries, but resembles *A. concinnum* in foliage. So far as our observations around Kathmandu are concerned,

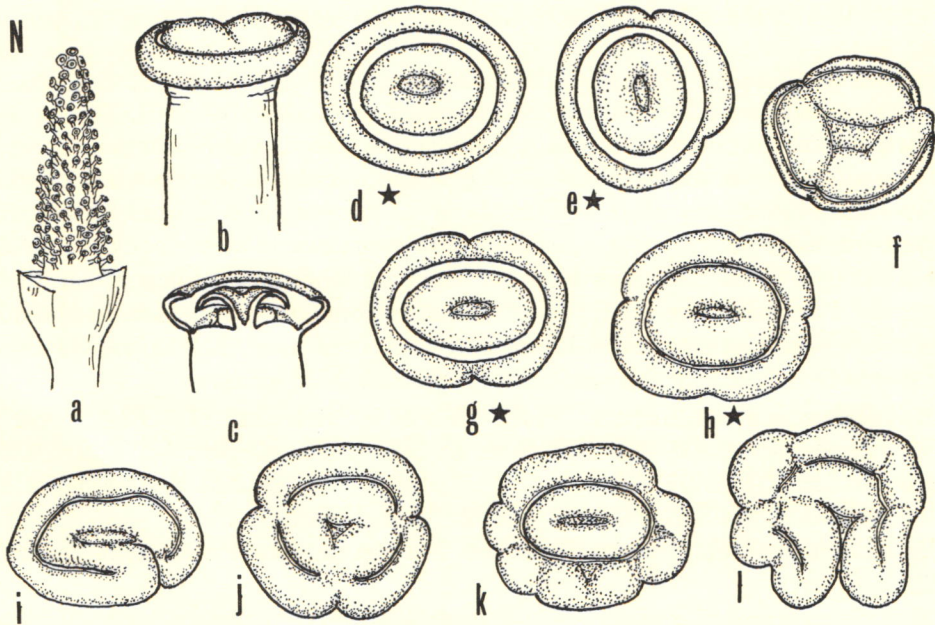


Fig. 56. N. *Arisaema exappendiculatum* Hara.

a. Male spadix.  $\times 3/4$ . b–l. Anthers, showing their variations.  $\times 15$ . \* shows a common type. c. A longitudinal section of b. (del. Sachiko Kurosawa)



most of the plants were female, and only a few very small individuals were male.

Sect. **Exappendiculata** Hara, sect. nov.

Folium solitarium, radiatim 11–13-foliolatum. Spathae lamina ovato-lanceolata suberecta caudato-attenuata margine involuta. Appendix spadicis nulla vel brevissime cylindrica. Antherae unicae circumscissae dehiscentes. Paradioica; bulbosus depresso globosus.

Typus: *Arisaema exappendiculatum* Hara (Nepal).

This section is represented by a single species. In foliage, it is the same as Sect. *Sinarisaema*, but is unique in the structure of the anthers (Fig. 56, b–l) and also in degenerate spadix-appendage.

17) ***Arisaema exappendiculatum*** Hara in Journ. Jap. Bot. **40**: 21, f. 1 (1965); Fl. E. Himal. 395, pl. 8 a–c & 23 (1966); Phot.-Alb. Pl. E. Himal. f. 27 (1968). [Pl. 20. a, b; Fig. 56].

Paradioecious. Bulb depressed globose 2–5 cm in diameter, sometimes with thick creeping stolons. Pseudostem very short.

Leaf solitary, *radiately 11–13-foliolate*; leaflets oblanceolate, long acuminate at the apex, long attenuate to the base, subsessile, 8–22 cm long 2–4 cm wide, nerves obliquely ascending; median leaflet slightly shorter than the others; petiole tall erect 30–55 cm long greenish sometimes dark purple. Peduncle much shorter than the leaf, 10–20 cm high, green sometimes slightly purplish.

Spathe green, occasionally dark purple, slightly glaucous inside; tube cylindrical 2–7 cm long 1.2–2 cm in diameter pale green without distinct stripes, not broadened nor spreading at the mouth; *blade* ovate-lanceolate *suberect* 8–15 cm long 2.5–3 cm broad at the base, generally *with inrolled margins*, tapering into a long *caudate apex* 5–8 cm long.

Spadix unisexual, 1.5–3 cm long; ovary green turbinate slightly angular apiculate, stigma small; *stamen solitary*, *anther* apparently one, *circumscissilely dehiscent* stipitate; *appendix* entirely *lacking*, or very rarely short cylindrical up to 1.5 cm long.  $2n = 28$  (Kurosawa 1966).

Specimens examined.

Nepal (Dec. 1963), cult. in Tokyo (Hara, Jul. 4, 1964 – type, TI; Jun. 2, 1964; Jul. 24, 1965; Jul. 1966 & Jun. 24, 1967); Malemci, Gosainkund, 8,000 ft. (Stainton, May 29, 1962, no. 3783, BM); Jumbesi (Solu Khola), 9,000 ft. (Lyon, Jun. 4, 1964, no. 2001, BM).

Distr. Endemic to Nepal.

In foliage, this plant is similar to *A. concinnum*, but is remarkable in lacking the appendage of the spadix, and in having solitary anther circumscissilely dehiscent, and upright blade of the spathe involute on the margin. It is noteworthy that the short appendage attaining to 1.5 cm long has developed in one plant flowered at Tokyo in 1965. On this basis of androecial characters, this plant can be considered as one of the most advanced species in the genus.

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