

# The Systematic Study of Taiwanese *Arisaema* (Araceae)

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**Abstract.** The genus *Arisaema* (Araceae) in Taiwan is revised based on comparative morphological, palynological, and cytotaxonomical studies. Nine species and one variety, including two new taxa (*A. ilanense* J. C. Wang *sp. nov.* and *A. thunbergii* ssp. *autumnale* J. C. Wang, J. Murata & Ohashi *ssp. nov.*), are recognized. By the re-collection of fresh materials and a detailed comparison, *A. matsudai* Hayata, which was previously reduced to synonymy under *A. grapsospadix* Hayata, is now treated as distinct. Rhizome shape, arrangement of leaflets, ratio of pseudostem to petiole length, and spadix-appendage morphology are all important characters in separating the Taiwanese taxa. Pollen morphology also displays interspecific variation in size, spinule length, and spinule density. Cytologically, all examined species have 28 chromosomes (diploid), but three of them are also found to have 56 chromosomes (tetraploid). The chromosome numbers  $2n=28$  of *A. ilanense* and *A. thunbergii* ssp. *autumnale*, and  $2n=56$  of *A. formosanum* and *A. heterophyllum* are determined for the first time. A key to the taxa along with descriptions, illustrations, distribution maps, and taxonomic notes are provided.

**Keywords:** Araceae; *Arisaema*; Chromosome number; Pollen; Systematics; Taiwan.

## Introduction

The genus *Arisaema* consists of about 150 species (Murata, 1990a) with the center of distribution and differentiation in warm to cool temperate regions of Asia (Li, 1980; Murata, 1984). The genus was first established by Martius in 1831 based on the Himalayan species (Murata, 1990a). The most important early monograph was by Engler (1920), who divided the genus into 15 sections based predominantly on the floral morphology. His system was later revised by Hara (1971), who emphasized the arrangement of leaflets rather than floral morphology and rearranged the Himalayan species into 13 sections. Hara's system was adopted by Li (1979) in her study of the Chinese species. Recently, Murata (1984) re-examined the characters which were used in the previous studies, and with special reference to fresh materials, he found many new taxonomic characters. Based on extensive studies—including gross morphology, chromosome numbers, and pollen morphology—he proposed a revised system (Murata, 1984, emend 1991) in which the genus was divided into 11 sections.

The Taiwanese *Arisaema* have been studied by few taxonomists. Most species hitherto known were described by Hayata (1915, 1916, 1920), Hosokawa (1936), and Kitamura (1941). The first revision of the Taiwanese species was by Huang (1960), who recognized five species and two forms. His treatment was adopted with little modification by Liu & Huang (1978) in the Flora of Taiwan, first edition. Subsequently, four taxa, viz. *A. formosanum* var. *bicolorifolium* Huang, *A. taiwanense* J. Murata, *A. taiwanense* var. *brevipedunculatum* J. Murata and *A. thunbergii* ssp. *urashima* (Hara) Ohashi & J. Murata, have been reported from Taiwan (Huang, 1982; Murata, 1985; Wang, 1992).

In the present paper an intensive revision is made based on comparative morphological, palynological, and cytological studies. As a result, nine species and one variety, including two new taxa, are recognized in Taiwan. All of these taxa are classified into five sections based on the system proposed by Murata (1984, 1991).

## Materials and Methods

Materials used in the present study were collected from the field throughout Taiwan. Most material was pressed and dried for voucher specimens deposited in the Herbarium, Department of Biology, National Taiwan Normal University (TNU). Voucher specimens for pollen observation and chromosome counts were also deposited in TNU. Living material for the study was cultivated in the shade house of the Department of Biology, National Taiwan Normal University. In addition, specimens preserved in the following herbaria were examined: HAST: Herbarium, Institute of Botany, Academia Sinica, Taipei; PPI: Herbarium, Department of Forest Resource Management and Technology, National Pingtung Polytechnic Institute; TAI: Herbarium, Department of Botany, National Taiwan University; TAIF: Herbarium, Taiwan Forestry Research Institute; TNU: Herbarium, Department of Biology, National Taiwan Normal University.

Although most type specimens were unavailable, photographs of type specimens preserved in the Herbarium of Tokyo University (TI) (Ohashi, 1981) were examined by the author.

Pollen grains for scanning electron microscopic (SEM) study were collected from fresh anthers and prepared by the method proposed by Erdtman (1952). The acetolyzed grains were dehydrated through ethanol series and

acetone, critical point dried, coated with gold, and examined under an ABT DS-180S scanning electron microscope in the Department of Biology, National Taiwan Normal University.

Root tips for chromosome counts were cut from living plants. After being pretreated with 0.05% colchicine for 3-5 hours, the material was fixed in a mixture of absolute alcohol and glacial acetic acid (3:1/v:v), then macerated with 0.5% pectinase, stained with acetocarmine, squashed, and observed under a Leitz Aristoplan microscope.

## Taxonomic Characters

Previous studies (Engler, 1920; Hara, 1971; Li, 1979) have shown that the arrangement of leaflets, shape of the spathe and spadix-appendage, sterile flowers, and dehiscence pattern of anthers were important characters for the taxonomy of this genus. Moreover, Murata (1984) intensively examined living plants and proposed some new taxonomic characters such as the growth pattern of the stem, position of the foliage leaves, phyllotaxy, etc.. Huang (1960) critically revised the characters used for the taxonomy of the Taiwan species. He also described in detail the infraspecific variation of characters. The taxonomic characters used for the present study are concisely described in the following categories:

### Stem

The stem of *Arisaema* is can be either an abbreviated subterranean tuber or rhizome. The former occurs in all the Taiwanese taxa except *A. grapsospadix*. These tubers are characterized by a more or less depressed globose shape with a whorl of roots growing at the top around the pseudostem. As a rule, this kind of stem forms an abscission layer at the base of the new stem and separates the old stem of the previous year (Murata, 1984). Plants with tubers often are deciduous and mainly found in the temperate regions. Taxa with a rhizome have a stem that is more or less cylindrical in shape with somewhat scattered roots growing on the upper part. Plants with rhizomes are evergreen and mainly found in the tropics. In Taiwan, the rhizome type stem is uniquely found in *A. grapsospadix* and can be used to easily distinguish it from a similar species, *A. matsudai* Hayata, which has the tuber type stem.

### Leaves

The plants of *Arisaema* bear two kinds of leaves on the top of the stem, the outer cataphyll (a sheath-like leaf) and the inner foliage leaf. The basal part of the petiole forms a sheath-like pseudostem encircled the peduncle. The foliage leaves display a wide variation in the number, arrangement, and shape of leaflets. Most Taiwanese species produce one or two foliage leaves except *A. grapsospadix*, which may produce up to three leaves. In some species the number of foliage leaves is rather stable. For example, *A. thunbergii* ssp. *autumnale* and *A. heterophyllum* always produce a single foliage leaf while

*A. ilanense* and *A. ringens* always produce two. However, in species belonging to *Arisaema* sections *Fimbriata* and *Sinarisaema*, the number of foliage leaves is unstable. In these species, as Huang (1960) pointed out, female plants usually have two leaves and males only one.

The arrangement of leaflets is an important character in identifying species or species groups. Among Taiwanese species, three patterns of leaflets arrangement can be recognized, namely trifoliolate, radiate, and pedate compound (Figure 1). These patterns are distinguished not only by the number of leaflets but also the presence or absence of petiolules.

Trifoliolate (Figure 1A): Leaves comprise three leaflets, but sometimes pedate five leaflets in *A. grapsospadix*. The leaflets in *A. ringens* are sessile (Figure 1A) but those of *A. matsudai* and *A. grapsospadix* are petiolulate.

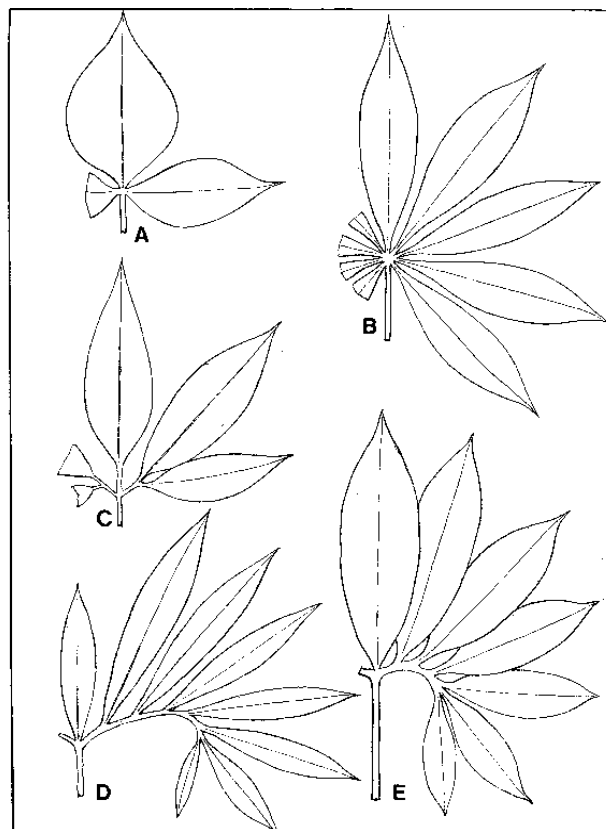
Radiate (Figure 1B): Each leaf comprises more than seven leaflets which are sessile or subsessile. Also, the rachis between leaflets is undeveloped so that the leaflets are palmately arranged (Figure 1B). Species of this type all belongs to *Arisaema* section *Sinarisaema*.

Pedate: Leaves have more than seven leaflets, except for *A. grapsospadix* which is 5-foliolate but is characterized by having well-developed rachis. *A. grapsospadix*, *A. ilanense* and *Arisaema* section *Tortuosa* (*A. thunbergii* ssp. *autumnale* and *A. heterophyllum*) belong to this type. The leaves of *A. grapsospadix* are characterized by 5-foliolate and having a long petiolule on the middle leaflet (Figure 1C). The other three species have more than 7 leaflets in which the middle one is sessile or nearly so. Among the three taxa, the size of middle leaflet is an important character for identification. In some species (*A. ilanense* and *A. thunbergii* ssp. *autumnale*, Figure 1E) the middle leaflet is larger or as large as the adjacent lateral ones, or much shorter than the adjacent lateral ones in other species (*A. heterophyllum*, Figure 1D).

### Inflorescence

The inflorescence of *Arisaema* is a spadix enveloped by a foliaceous spathe. The upper part of the inflorescence-axis, called the spadix-appendage, is often covered with modified sterile flowers (projections). The morphology of the inflorescence, including spathe, spadix, and spadix-appendage, has the most important characters in the taxonomy of the genus and has been used to discriminate between infrageneric groups (Engler, 1920; Murata, 1984).

*Spathe*—The shape and coloration of the spathe varies greatly between species. Basically, the lower part of spathe forms a cylindrical tube with overlapping spathe-margins called the spathe-tube which usually gradually opens to the mouth. The mouth of the spathe-tube often widely spreads outward with an auricle on each side. In some species, namely *A. grapsospadix*, *A. matsudai*, and *A. heterophyllum*, the mouth of the spathe-tube spreads very narrowly, rendering the auricles inconspicuous. By contrast, in *A. ringens* the auricles are particularly obvious.



**Figure 1.** Leaflets arrangement of *Arisaema* in Taiwan. A, *A. ringens*; B, *A. formosanum*; C, *A. grapsospadix*; D, *A. heterophyllum*; E, *A. thunbergii* ssp. *autumnale*.

The upper part of the spathe is laminar and is called the spathe-blade, which often arches over the spadix-appendage. In general, the spathe-blade is triangular or triangular-ovate with an aristate tip, but some species have a distinctive feature. For example, the spathe-blade tip of *A. taiwanense* is thread-like and up to 40 cm long; the spathe-blade base of *A. heterophyllum* enlarges into an auricle on each side. The spathe-blade of *A. ringens* is firstly concave then convex and forms a galeate structure which is unique to the Taiwanese species.

Coloration of the spathe provides an obvious character, although it is variable in some taxa especially those of *Arisaema* section *Sinarisaema*. For example, in *A. consanguineum* and *A. formosanum* variously colored spathes, from green to red, are found in different individuals. The most conspicuous feature is the white semilunar mottling on the spathe throat of *A. grapsospadix* and *A. matsudai*. This feature is sometimes found in *A. formosanum*, but it is not so obvious and is somewhat irregular (Figure 3B). In *A. grapsospadix*, *A. matsudai*, and *A. heterophyllum* both surfaces of the spathe are green and concolorous. In *A. ilanense*, the outer surface is pale to greenish yellow while the inner is reddish brown to dark purple. In *A. thunbergii* ssp. *autumnale*

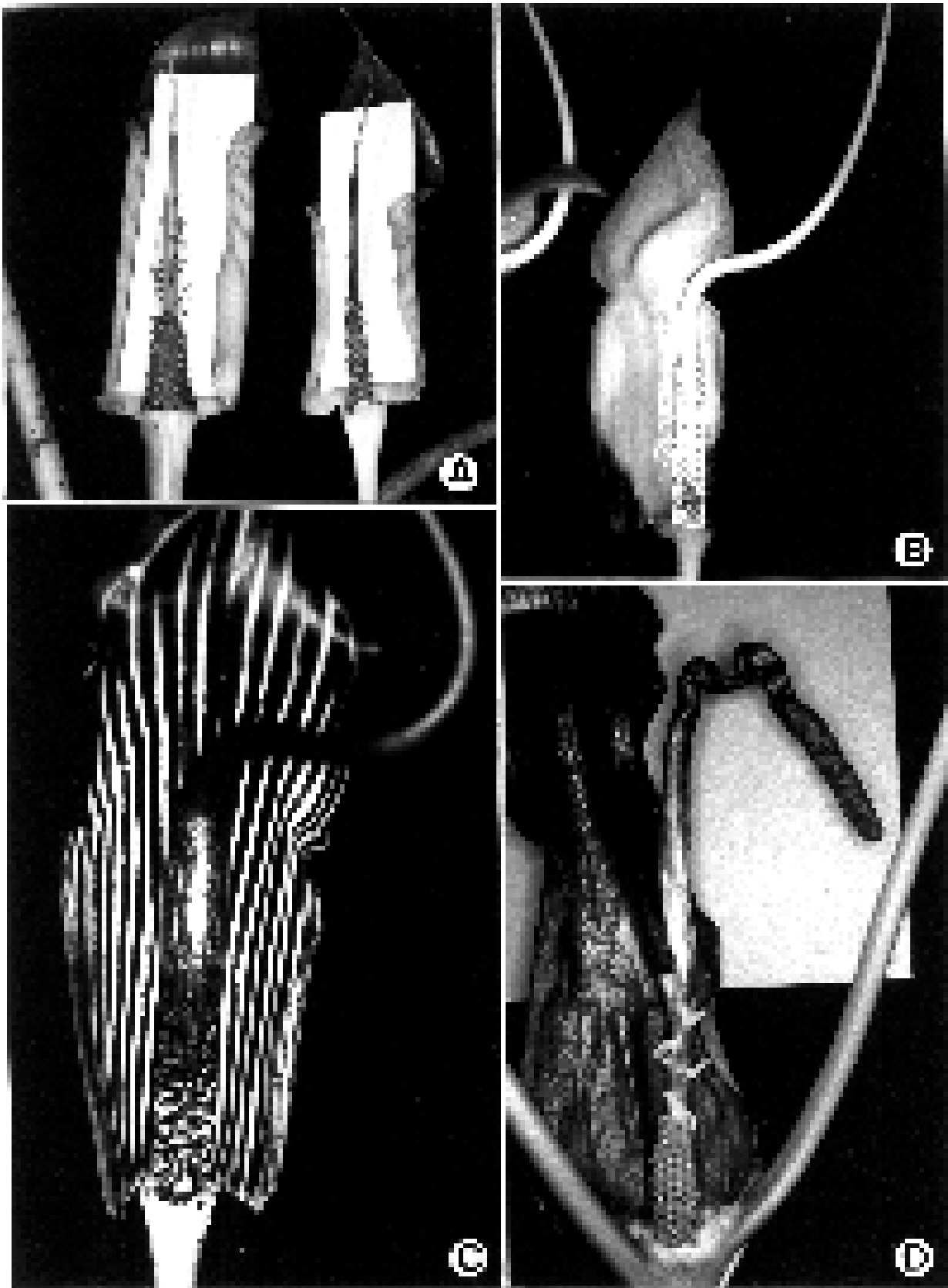
(Figure 2C), *A. ringens* (Figure 3D), and the species of *Arisaema* section *Sinarisaema* (Figures 3A-C), the inner surface of spathe is longitudinally striped, though those of the *Arisaema* section *Sinarisaema* are not always stable as mentioned above.

**Pistillate flowers**—The pistillate flowers of the genus consist of an unilocular ovary which contains one to several orthotropous ovules. The structure is so simple that previous taxonomists have not considered it important. Hosokawa (1936) proposed *A. taihokense* which is separated from *A. ringens* by having more ovules per ovary. However, Huang (1960) pointed out that the ovule number in this taxa ranged from two to six and was not a constant character. Therefore, he reduced *A. taihokense* to synonymy under *A. ringens*. The ovary (i.e. pistillate flower) is usually ovoid and perpendicular to the inflorescence-axis except that of *A. grapsospadix* which is bottle-shaped and slanting.

**Sterile flowers**—The spadix (especially female) of most Taiwanese *Arisaema* bears some projections above the fertile flowers (Figures 2, 3). These are considered to be modified sterile flowers (Engler, 1920; Hara, 1971) because a rudimentary reproductive structure (e.g. ovule or anther-like organ) is occasionally found (Murata, 1984). I have also observed that *A. heterophyllum* bears an anther on the top of some projection. In Taiwan, the modified sterile flowers are found on the spadix of almost all species except *A. thunbergii* ssp. *autumnale* and *A. ringens* (Figure 3D). Among the species in Taiwan, two patterns of modified sterile flowers are recognized. The first type, found in *A. grapsospadix* and *A. matsudai*, bears baccate modified sterile flowers at the top of spadix-appendage. The second type, found in most other species, bears echinate sterile flowers just above the fertile flowers, i.e. at the base of spadix-appendage. The former sometimes also have linear sterile flowers at the base of the spadix-appendage (especially on the female spadix of *A. matsudai*) just like the latter pattern (Figure 2A).

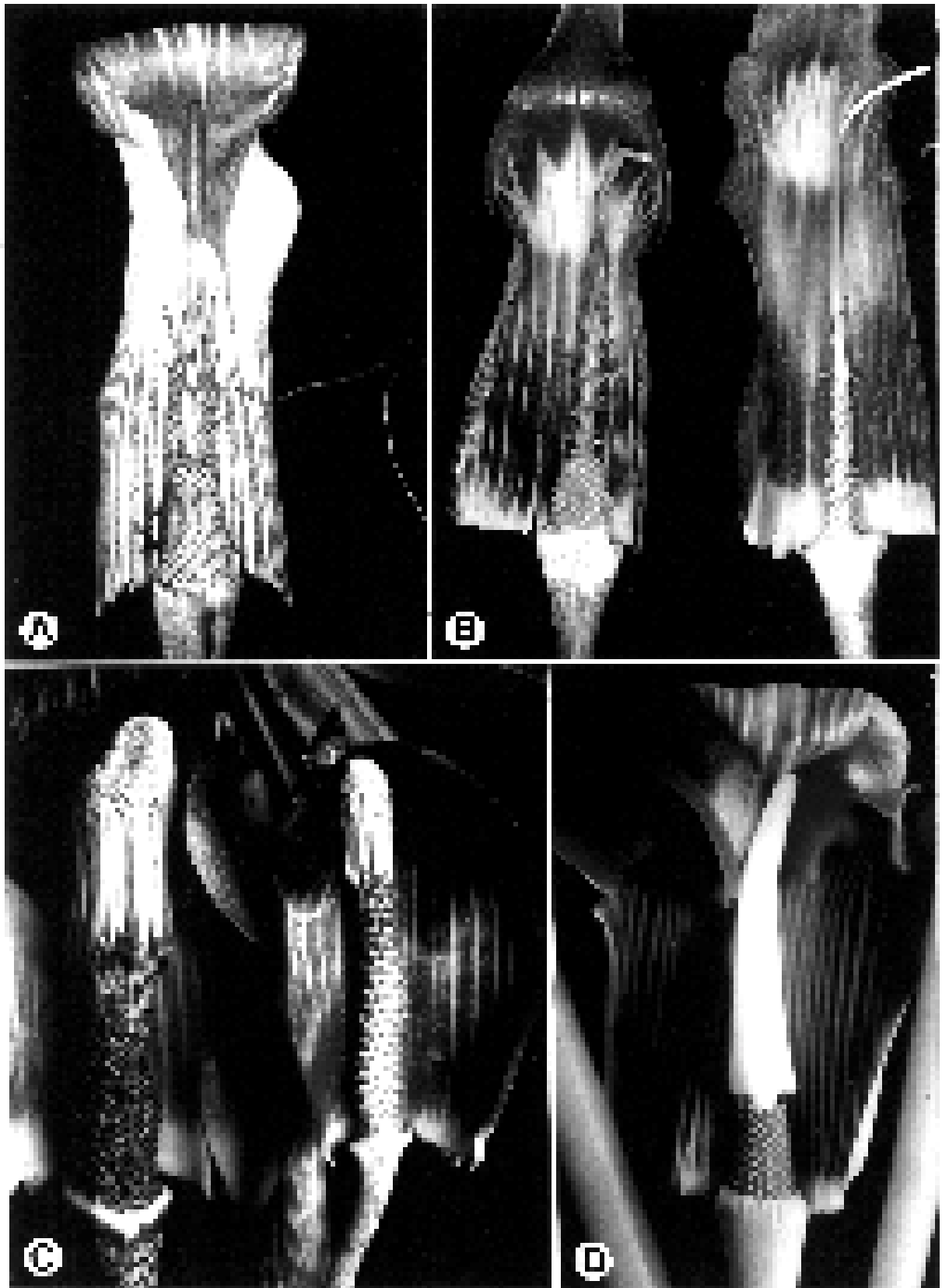
**Spadix appendage**—Morphology of the spadix-appendage is also greatly diversified (Figures 2, 3) and has been considered to be important in discriminating species and infrageneric groups (Li, 1979; Murata, 1984). The spadix-appendage can be divided into sessile and stipitate types. In the most Taiwanese taxa, the basal part gradually narrows or enlarges, so the appendage is sessile (Figures 2, 3A & 3B). In *A. ringens* and some individuals of *A. taiwanense* the basal part suddenly constricts and forms a stalk, so the appendage is stipitate (Figures 3C & 3D).

For most species in Taiwan, the spadix-appendage is erect, cylindrical, and included in the spathe; but in *A. heterophyllum* and *A. thunbergii* ssp. *autumnale*, the spadix-appendage gradually narrows to form a flagellate tip which is long-exserted from the spathe (Figures 2B, 2C). In *A. taiwanense*, the appendage tip is distinguished by its rugose surface, an important identifying character. A key based on the characters of the spadix-appendage is given below to distinguish each taxa in Taiwan.



**Figure 2.** Inflorescences of *Arisaema* in Taiwan. A, *A. matsudai*, female; B, *A. thunbergii* ssp. *autumnale*, male; C, *A. thunbergii* ssp. *autumnale*, female; D, *A. ilanense*, female.

Key to the Taiwanese Taxa Based on the Characters



**Figure 3.** Inflorescences of *Arisaema* in Taiwan (cont.). A, *A. consanguineum*, female; B, *A. formosanum*, female (left) and male (right); C, *A. taiwanense*, female (left) and male (right); D, *A. ringens*, female.

## of Spadix-Appendage

1. Spadix-appendage filiform, long-exserted from the spathe.
  2. Spadix-appendage black, upper part bent forward and pendulous (Figure 2C) .....  
*A. thunbergii* ssp. *autumnale*
  2. Spadix-appendage green, upper part erect (Figure 2B) .....  
*A. heterophyllum*
1. Spadix-appendage short-cylindrical or filiform, included in the spathe.
  3. Spadix-appendage tip slender, less than 1.5 mm in diameter
    4. Spadix-appendage tip smooth, without modified sterile flowers .....  
*A. formosanum*
    4. Spadix-appendage tip with baccate or linear sterile flowers.
      5. Spadix-appendage tip usually with baccate sterile flowers, base with linear sterile flowers in mature (female) plant .....  
*A. matsudai*
      5. Spadix-appendage tip usually with linear sterile flowers, base glabrous .....  
.....  
*A. grapsospadix*
  3. Spadix-appendage tip thick, more than 3 mm in diameter
    6. Spadix-appendage tip rugose (Figure 3C).....  
*A. taiwanense*
    6. Spadix-appendage tip smooth
      7. Spadix-appendage stipitate at the base (Figure 3D).....  
*A. ringens*
      7. Spadix-appendage sessile at the base
        8. Spadix-appendage erect, cylindrical (Figure 3A).....  
*A. consanguineum*
        8. Spadix-appendage incurved, clavate (Figure 2D).....  
*A. ilanense*

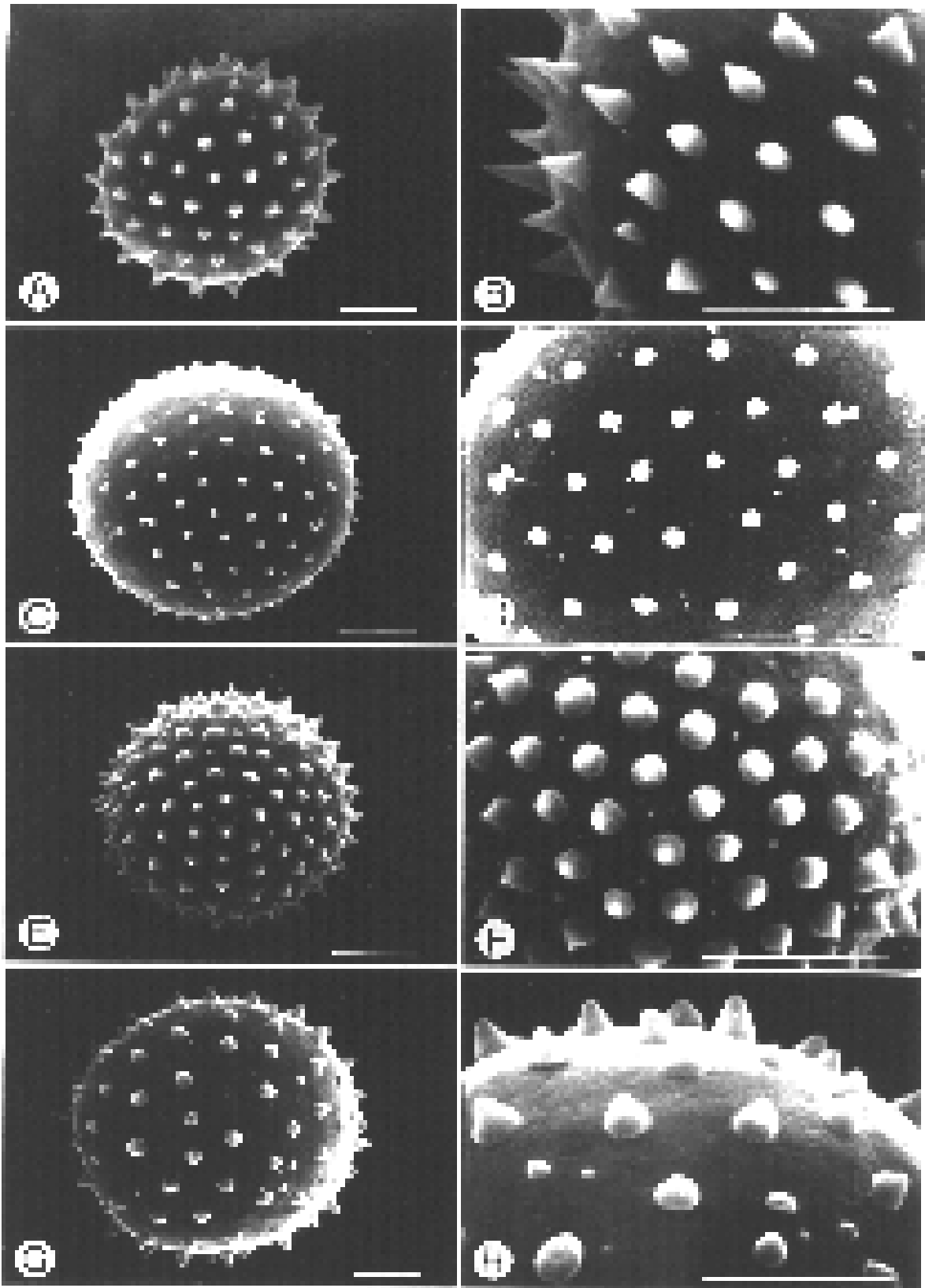
## Pollen

Huang (1972) briefly described pollen morphology of five Taiwanese species, and illustrated three of them, based on optical microscopic observation. Ohashi & Murata (1980) and Ohashi, Murata, & Takahashi (1983) reported palynological differences among Japanese species and suggested that pollen morphology might be useful in distinguishing between Japanese species. Moreover, Murata (1984) observed 24 species of *Arisaema* outside Japan, of which three are present in Taiwan, and pointed out considerable variation between species in pollen size, pollen shape, size and density of the pollen spinules, and pollen surface structure.

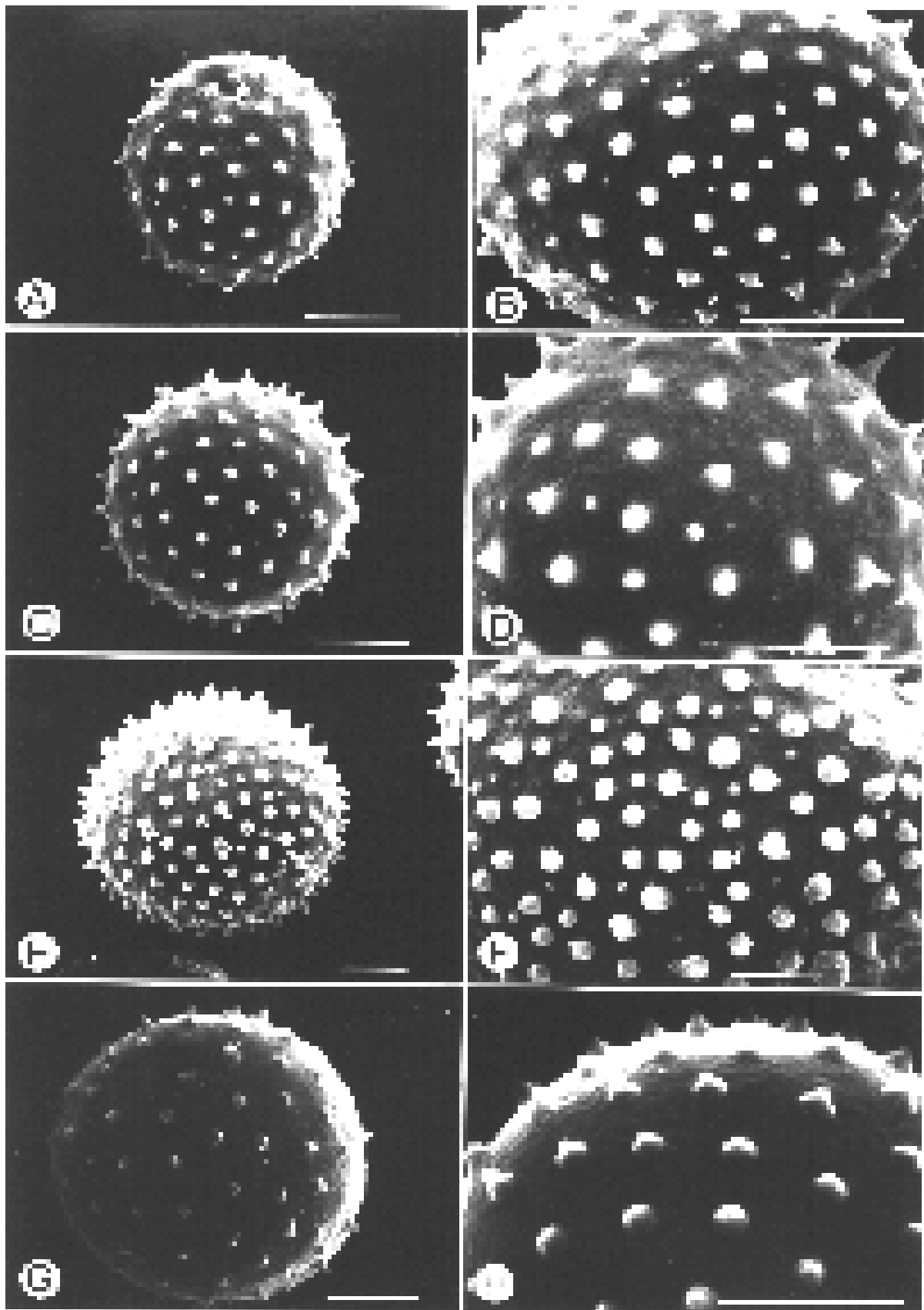
Pollen grains of *Arisaema* are generally spherical, inaperturate, intectate, echinate or spinulate (Murata, 1984). In the present study, pollen grains of eight taxa in Taiwan were examined with SEM (Figures 4 & 5). In general, the results were consistent with the above description. Pollen grains ranged in size from 12µm (in *A. consanguineum*, Table 1) to 21µm (in *A. thunbergii* ssp. *autumnale*) in diameter. The surface of grains is uniformly distributed with conical or echinate spinules. The length and the density of spinules seem distinct for each species (Table 1). Generally the spinule density is lower in larger grains. Therefore, the large grains of *A. thunbergii* ssp. *autumnale* have low spinule density (2.4 spinules in an area 5jÑ5µm) while the small grains of *A. consanguineum* have high density (9.8 spinules in an area 5jÑ5 µm). However, *A. taiwanense* has large grains (18.2 µm) but the highest spinule density (15 spinules in an area 5jÑ5 µm). Furthermore, the new species *A. ilanense* is palynologically unique (Figures 4, C & D) in having the rather large grain (18.6 µm), with the shortest spinules (0.4–0.5 µm) and low spinule density (5.2 spinules in an area 5jÑ5 µm) on the surface among the taxa examined in Taiwan. *A. thunbergii* ssp. *autumnale* was previously misidentified as *A. thunbergii* ssp. *urashima* of Japan by Wang (1992), but when compared with Ohashi & Murata (1980), the grains of *A. thunbergii* ssp. *autumnale* are slightly different from those of *A. thunbergii* ssp. *urashima*. The pollen grains of *A. thunbergii* ssp.

**Table 1.** Pollen grains of *Arisaema* in Taiwan.

Taxa	Diameter (µm)	Spinule length (µm)	Spinules in area 5×5 µm	Voucher specimen	Figure
<i>A. sect. Fimbriata</i>					
<i>A. grapsospadix</i>	15.0	1.2–1.7	6.7	<i>Wang 7079</i>	4-A, B
<i>A. sect. Clavata</i>					
<i>A. ilanense</i>	18.6	0.4–0.5	5.2	<i>Wang 6705</i>	4-C, D
<i>A. sect. Tortuosa</i>					
<i>A. thunbergii</i> ssp. <i>autumnale</i>	20.9	1.0–1.2	2.4	<i>Lu &amp; Horng 1361</i>	4-G, H
<i>A. heterophyllum</i>	14.2	0.7–1.1	11.1	<i>Wang 6741</i>	4-E, F
<i>A. sect. Sinarisaema</i>					
<i>A. consanguineum</i>	12.1	0.6–0.8	9.8	<i>Deng 354</i>	5-A, B
<i>A. formosanum</i>	12.7	0.9–1.2	9.6	<i>Wang 7081</i>	5-C, D
<i>A. taiwanense</i>	18.2	0.8–1.0	15.0	<i>Deng 355</i>	5-E, F
<i>A. sect. Pedatisecta</i>					
<i>A. ringens</i>	16.7	0.7–1.0	4.9	<i>Wang 6455</i>	5-G, H



**Figure 4.** Pollen grains of *Arisaema* in Taiwan. A & B, *A. grapsospadix* (Wang *et al.* 7079); C & D, *A. ilanense* (Wang *et al.* 6705); E & F, *A. heterophyllum* (Wang 6741); G & H, *A. thunbergii* ssp. *autumnale* (Lu & Horng 1361). Scale bars equal 5  $\mu\text{m}$ .



**Figure 5.** Pollen grains of *Arisaema* in Taiwan (cont.). A & B, *A. consanguineum* (Deng 354); C & D, *A. formosanum* (Wang et al. 7081); E & F, *A. taiwanense* (Deng 355); G & H, *A. ringens* (Wang 6455). Scale bars equal 5  $\mu\text{m}$ .



*autumnale* have shorter spinules (1–1.3  $\mu\text{m}$ ) with a somewhat obtuse apex (Figure 4H) while those of *A. thunbergii* ssp. *urashima* have longer spinules (1.7–1.9  $\mu\text{m}$ ) with an acute apex.

On the whole, our knowledge concerning the palynology, especially of the infraspecific variation, is still incomplete. A broad comparative study would be necessary to confirm and clarify the above observations.

### Chromosome Numbers

All the Taiwanese taxa, except *A. ilanense*, *A. matsudai* and *A. thunbergii* ssp. *autumnale*, have been examined cytologically by Huang (1962), Hotta (1971), and Murata (1985, 1990b). These previous studies show that nearly all the species have the chromosome numbers of  $2n=28$ . However, some species were reported to have infraspecific heteroploidy (Murata, 1990b). For example, *A. consanguineum* was reported to have diploid ( $2n=28$ ) and tetraploid ( $2n=56$ ); *A. heterophyllum* was reported to have diploid and hexaploid ( $2n=84$ ) (Murata, 1990b).

The present study re-examined all the Taiwanese taxa, except *A. matsudai*. The preliminary results were consistent with the previous studies. All examined species have  $2n=28$  chromosomes (diploid), but  $2n=56$  (tetraploid) was also found in *A. consanguineum*, *A. formosanum* and *A. heterophyllum*. The chromosome numbers  $2n=28$  of *A. ilanense* and *A. thunbergii* ssp. *autumnale*, and  $2n=56$  of *A. formosanum* and *A. heterophyllum* are determined for the first time. The cytological study is still in progress and will be published elsewhere.

## Systematic Treatment

### ARISAEMA Mart.

Terrestrial herbs. Stem subterranean, rhizomatous, or tuberous, bearing a peduncle, 1-3 foliaceous leaves, and several cataphylls at the top. Foliaceous leaves trifoliolate, radiate, or pedate compound. Basal part of petiole of foliage leaf connate into a sheath-like pseudostem encircling the peduncle. Cataphyll sheath-like, surrounding the pseudostem and peduncle. Inflorescence forming a spadix enveloped by a foliaceous spathe. Lower part of spathe forming a cylindrical tube (spathe-tube), usually gradually opening to the mouth; upper part laminar (spathe-blade), usually hanging over the spadix-appendage. Upper part of the inflorescence-axis (spadix-appendage) various in morphology, naked or partly or entirely covered with modified sterile flowers (projections). Upper part of spadix-appendage elongate or not; basal part sessile or truncate to subtruncate and stipitate. Flowers unisexual, without perianth, tightly arranged on lower part of inflorescence-axis, paradioecious or in some species monoecious. Staminate flowers consisting of two to several anthers growing on a columnar stalk. Pistillate flowers consisting of a unilocular ovary. Ovules orthotropous, one to many in each locule. Fruit a berry, one to several-seeded.

### Key to the Taxa of Taiwanese *Arisaema*

1. Leaves trifoliolate or pedately 5-foliolate
  2. Spadix-appendage filiform, sessile, with baccate or linear sterile flowers at the tip (*Arisaema* sect. *Fimbriata*)
    3. Subterranean stem rhizomatous; plant evergreen .....1. *A. grapsospadix*
    3. Subterranean stem tuberous; plant deciduous .....2. *A. matsudai*
  2. Spadix-appendage cylindrical conical, stipitate, without modified sterile flowers (*A.* sect. *Pedatisecta*).....9. *A. ringens*
1. Leaves pedate or radiate compound, leaflets more than 7
  4. Leaves pedate compound
    5. Spadix-appendage clavate, within the spathe (*A.* sect. *Clavata*).....3. *A. ilanense*
    5. Spadix-appendage filiform, long-exserted from the spathe tube (*A.* sect. *Tortuosa*)
      6. Spathe white to pale yellow with dark stripes; anterior portion of spadix-appendage pendulous; pseudostem and peduncle shorter than petiole; terminal leaflet as large as or larger than the adjacent lateral ones (*A.* subsect. *Flagellarisaema*).....4. *A. thunbergii* ssp. *autumnale*
      6. Spathe green; spadix-appendage erect; pseudostem and peduncle longer than petiole; terminal leaflet much shorter than the adjacent lateral ones (*A.* subsect. *Tortuosa*) .....5. *A. heterophyllum*
  4. Leaves radiate compound (*A.* sect. *Sinarisaema*)
    7. Spadix-appendage sessile at the base, smooth on the apex
      8. Spadix-appendage columnar, 4-5 mm thick at apex.....6. *A. consanguineum*
      8. Spadix-appendage linear, 1-2 mm thick at apex.....7. *A. formosanum*
    7. Spadix-appendage stipitate at the base, rugose on the apex
      9. Peduncle 5-15 cm long, spathe tube 3.8-5 cm long, limb 5-7 cm long.....8. *A. taiwanense*
      9. Peduncle 1-5 cm long, spathe tube 2-4 cm long, limb 3-5 cm long.....8a. *A. taiwanense* var. *brevipedunculatum*

**I. *Arisaema* sect. *Fimbriata*** Engler, Pfl.-reich IV, 23F: 151. 1920; Li in Wu & Li, Fl. Reipubl. Popularis Sin. 13(2): 123. 1979; J. Murata, J. Fac. Sci. Univ. Tokyo III 13: 466. 1984.—TYPE: *Arisaema fimbriatum* Mast.

**1. *Arisaema grapsospadix*** Hayata, Icon. Pl. Form. 5: 244, pl. 17. 1915; Kitamura, Acta Phytotax. Geobot. 10: 186. 1941; Huang, J. Forest NTU 27: 8. 1960; Huang,

Taiwania 7: 94, fig. 2, 8, 9. 1960; Liu & Huang, Quart. J. Taiwan Mus. 16: 133. 1963; Liu & Huang in H. L. Li *et al.*, Fl. Taiwan 5: 803. 1978; Li in Wu & Li, Fl. Reipubl. Popularis Sin. 13(2): 124. 1979.—TYPE: Formosa. Arisan, inter Funkiko et Taroyen, ad 6000 ped. alt., Mar 1914, *Hayata & Ito s.n.* (lectotype: TI, chosen by H. Ohashi, 1981; figured in Ohashi, Univ. Mus. Univ. Tokyo, Mater. Rep. 5, pl. 14. 1981); *loc. cit.*, Jan. 1912, *Hayata & Sasaki s.n.* (syntype: TI).

## Figure 9

*Arisaema quinquefoliolum* Hayata, Icon. Pl. Form. 9: 146. pl. 7. 1920 (“*quinquefoliola*”).—TYPE: Formosa. Ako, Kuwarusu, 1 Jan. 1917, *E. Matuda* (“*Y. Matsuda*”) 46 (lectotype: TI, chosen by H. Ohashi, 1981:16; figured in Ohashi, Univ. Mus. Univ. Tokyo, Mater. Rep. 5, pl. 36. 1981).

Stem rhizomatous, oblong-ovoid, 3-5 cm long, 1.5-2.2 cm in diameter. Pseudostem 13-25 cm long, usually longer than petiole. Leaves two or three; petiole terete, 5-15 cm long; lamina ternate or pedately 5-foliolate; leaflets acute to acuminate at apex, often mucronate on the tip, round to cuneate at base, entire or near so on margin; terminal leaflet elliptic to lanceolate, petiolule 1-2.5 cm long; lateral leaflets lanceolate to oblong, oblique at base, petiolule 3-10 mm long. Peduncle 3-13 cm long. Spathe greenish on both surfaces with a semilunar white mottle in throat; tube cylindrical, (3-)4-6 cm long, 1-1.7 cm in diameter; limb triangular ovate, 1.5-2 cm wide, acute to apex. Spadix bisexual in mature plants, unisexual (male) in small plants, 5-9 cm long including appendage; staminate flowers sparsely arranged on the inflorescence-axis, short stalked to nearly sessile; pistillate flowers ovoid, ascending; appendage filiform, erect or bent, with a bottle brush-like tip.

*Specimens examined.* NANTOU: Chitou, 1924, *Siematsu s. n.* (TAIF); Fenghuangshan, *Peng & Chen 10524* (HAST); Luku Hsiang: Hsitou Exp't Forest of NTU, *Peng 15016* (HAST). YUNLIN: Tsaoling, Shihpi, *Wang 13865* (HAST). CHIAYI: Alishan highway 18-66K, *Wang 10253* (HAST); Dardungshan, *Wang et al. 7079* (TNU), *Yang 468* (TNU). KAOHSIUNG: Tengchu, *Ohashi et al. 13041* (TAI). PINGTUNG: Chachayalaishan, *Yang 20090* (TNU); Chunjih Hsiang: Chachayalaishan protection area, *Liao et al. 220* (HAST); Chaopu to Linchang, Province Road No.9, 471.5K, *Wang 16972* (HAST); Chiaogulats, *Wang et al. 7426* (HAST, TNU); Daibuzan (Mt. Tawushan), *Soma A229* (TAI); Lilungshan, *Yang 8382, 8449* (PPI); Manchou to Chufengku, *Wang 7394* (HAST); Mutan, *Chang 4786, 5171* (PPI); Peitawushan, *Wang et al. 9090* (TNU); on the way to Tawushan, *Chen et al. 535* (HAST); Pu-an-shan, *Wang 19038* (HAST); Shantimen to Chihpen, Province Road No. 22, 58-61K, *Wang 13702* (HAST); Shihtzu Hsiang: Lilungshan, *Chen & Leu 837, 850* (HAST); Shoka, *Wang 13470* (HAST); Wantao to Nanzenshan, *Yang et al. 4326* (TAI); Nanjenshan, *Ohashi et al. 14579* (TAI), *Lu & Chen 1407* (TNU), *Wang & Lu 5568* (TNU), *Chiu s. n.* 1993 (TNU); Kuwarusu, *Matuda 448* (TAI), *A335* (TAI).

*Distribution.* Endemic to Taiwan, in the southern part from low to medium altitudes (Figure 6).

*Notes.* The species is characterized by its evergreen habit, rhizomatous subterranean stem, slanting ovary, bottle brush-like spadix-appendage, and white semilunar mottle on the throat of the spathe-blade. The first three characters are very unique and useful in identifying this taxa. The last two are shared with *A. matsudai*, and their distinctions are discussed below. Its foliage leaves are rather variable, from trifoliolate to pedately 5-foliolate (*A. quinquefoliolum* Hayata), with both sometimes found in the same individual.

2. *Arisaema matsudai* Hayata, Icon. Pl. Form. 9: 149. fig. 55. 1920; Li in Wu & Li, Fl. Reipubl. Popularis Sin. 13(2): 124. 1979.—TYPE: Formosa. Kuwarusu, April 1917, *E. Matsuda* (“*Y. Matsuda*”) *s.n.* (holotype: TI, figured in Ohashi, Univ. Mus. Univ. Tokyo, Mater. Rep. 5, pl. 24. 1981). (Figure 10)

Tuber subglobose, 1-2(-3)cm in diameter. Pseudostem 8-25(-30)cm long, usually longer than the petiole. Cataphyllstwo or three, membranous. Leavesone or two;

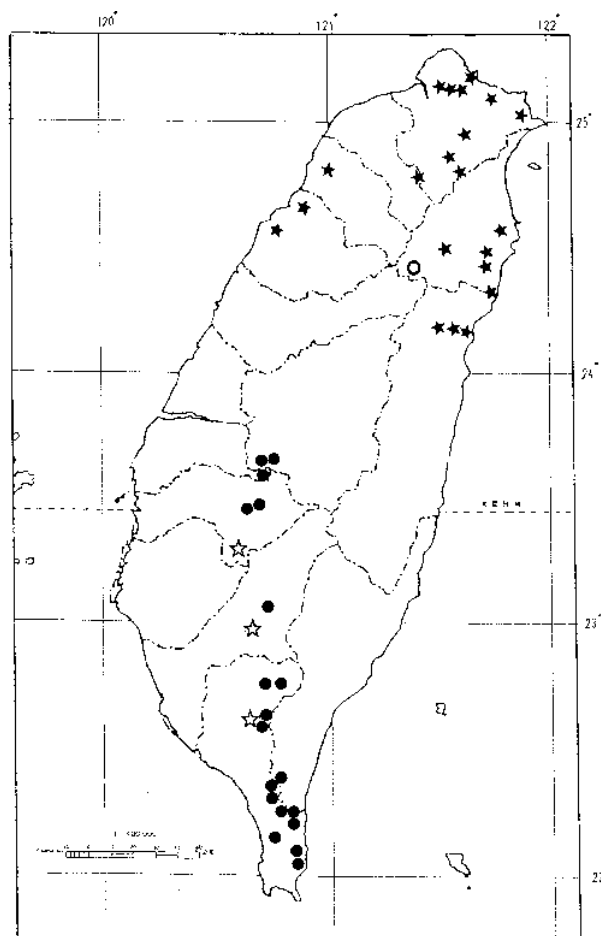
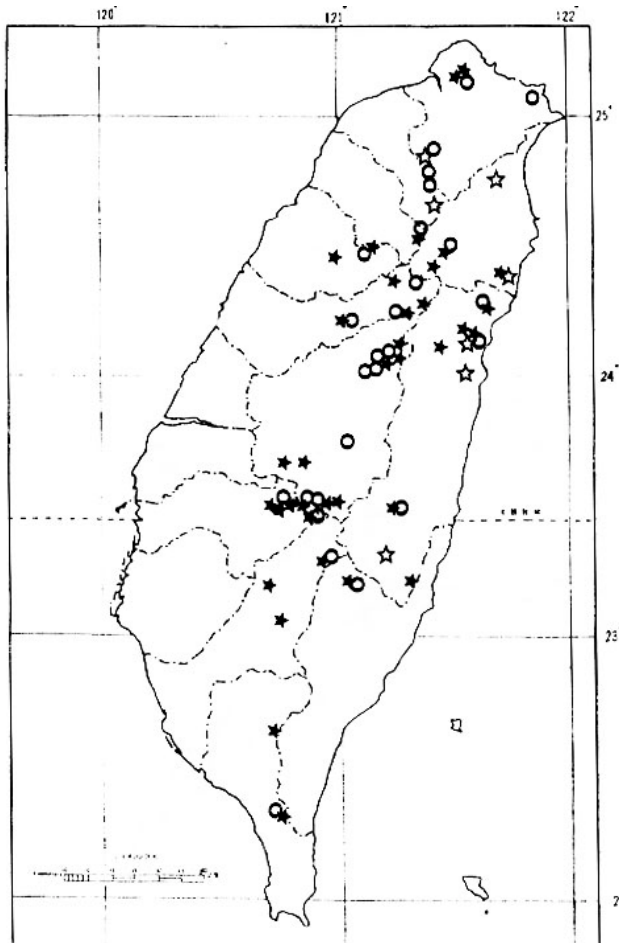
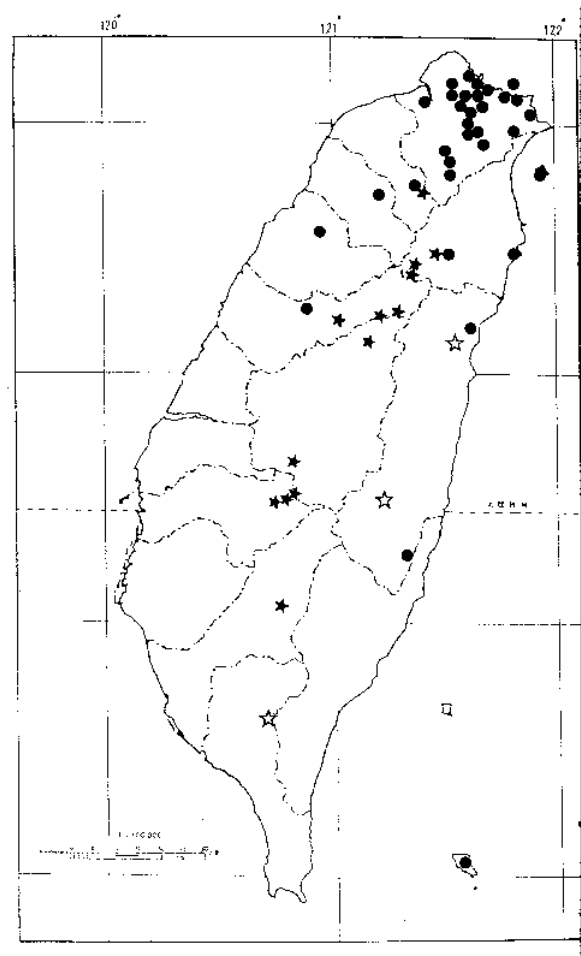


Figure 6. Distribution of *Arisaema grapsospadix* (solid circle), *A. matsudai* (star), *A. ilanense* (circle), and *A. heterophyllum* (solid star) in Taiwan.



**Figure 7.** Distribution of *Arisaema thunbergii* ssp. *autumnale* (star), *A. consanguineum* (circle), and *A. formosanum* (solid star) in Taiwan.



**Figure 8.** Distribution of *Arisaema taiwanense* (solid star), *A. taiwanense* var. *brevipedunculatum* (star), and *A. ringens* (solid circle) in Taiwan.

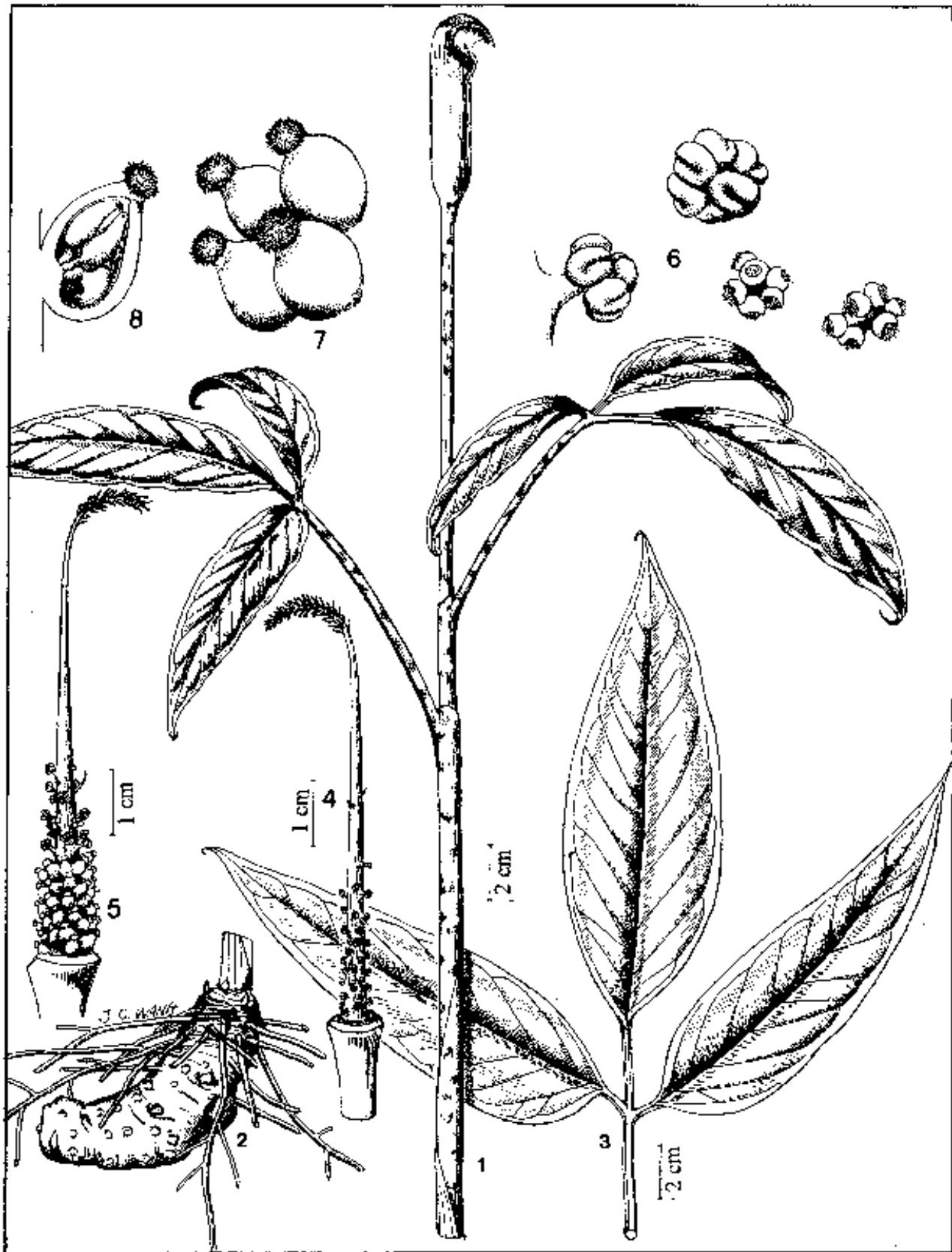
petiole terete, 6-12 cm long; lamina trifoliolate, leaflets acute to acuminate at apex, often with a short tail on tip, entire or near so on margin; terminal leaflet ovate-lanceolate to rhomboid-elliptic, cuneate at base, petiolule 0.6-1.5 cm long; lateral leaflets obliquely ovate to lanceolate, oblique at base, petiolule 2-4 mm long or sometimes near sessile. Peduncle 4-10 cm long, often shorter than petiole. Spathe greenish on both surfaces with a semilunar white mottle on the throat; tube cylindrical, 2.5-3.5 cm long, 0.6-1 cm in diameter; limb triangular ovate, 1-1.5 cm wide, acute at apex. Spadix paradioecious, female in mature plants, male in small plants, 3-4.5 cm long including appendage; staminate flowers short stalked, anthers 2; pistillate flowers ellipsoid, perpendicular to the inflorescence-axis; appendage filiform, erect or bent, with linear projections at the base (in female spadix) and baccate ones at the tip.

*Specimens examined.* CHIAYI: Tsengwen reservoir, Pinglin Yentzuyai, Wang 11008 (HAST). KAOHSIUNG: Shanping, Summer collecting team s.n. 1986 (TNU), Wang et al. 9552, 9687 (TNU), Chen 526 (HAST); PINGTUNG: Kuwarusu, Matuda 447 (TAI).

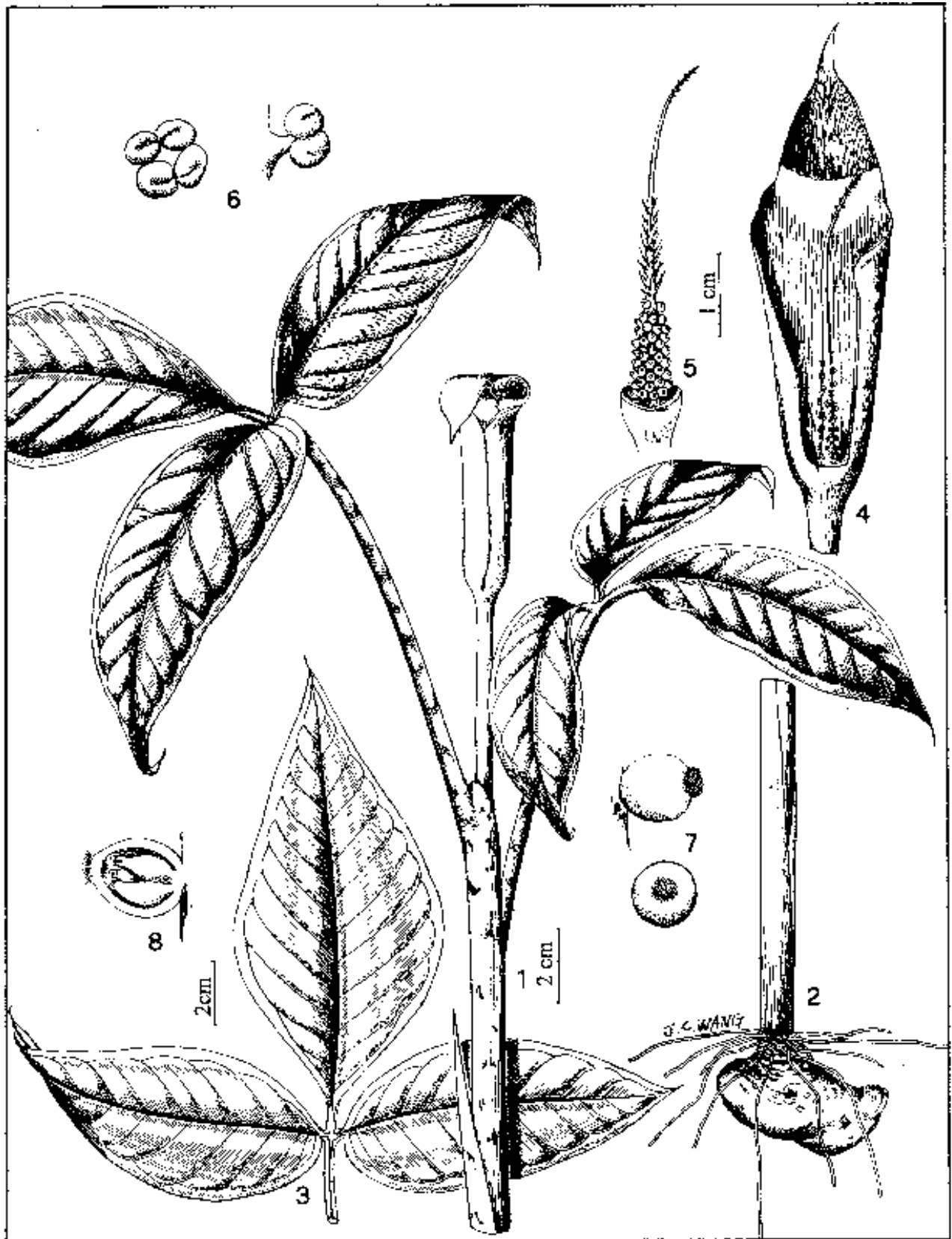
*Distribution.* endemic to the low altitudinal mountainous region of southern part of Taiwan (Figure 6).

*Notes.* *A. matsudai* Hayata was originally described based on an incomplete (lacking subterranean stem) male plant (Type: *Matsuda s.n.* 1917, TI photo!). Most taxonomists (e.g. Kitamura, 1941; Huang, 1960; Liu & Huang, 1978) thought it synonymous with *A. grapsospadix* Hayata because both taxa share many aspects such as trifoliolate leaves, a greenish spathe with a semilunar white mottle on the throat, and the filiform appendage. However, after comparing numerous fresh, complete, and matured collections in detail, *A. matsudai* can be distinguished easily from *A. grapsospadix* in having a deciduous habit, a subglobose subterranean stem, a unisexual spadix in the mature plant, many linear sterile flowers born above the fertile flowers in the female spadix, and pistillate flowers perpendicular to the inflorescence-axis, etc.

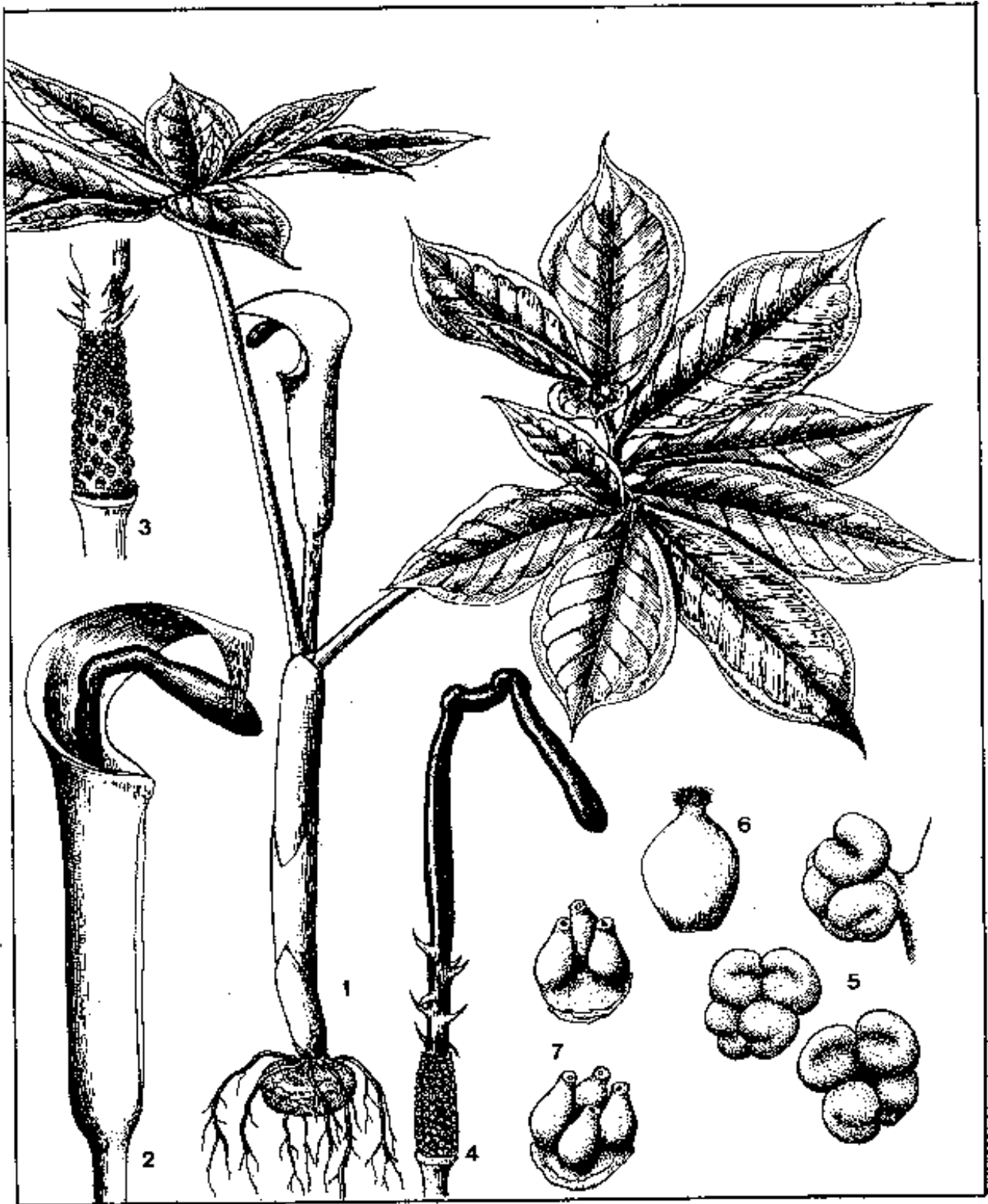
*A. matsudai* is also similar to *A. inclusum* N. E. Brown in Java, but may be distinguished by having baccate sterile flowers at the spadix-appendage tip. The species probably also resembles *A. penicillatum* N. E. Brown of southern China, and *A. laminatum* Blume of Malay



**Figure 9.** *Arisaema grapsospadix* Hayata. 1 & 2, Habit and rhizome; 3, Leaf; 4, Male spadix; 5, Female spadix; 6, Male flowers; 7, Female flower; 8, Longitudinal section of ovary showing ovules. (Wang et al. 9090)



**Figure 10.** *Arisaema matsudai* Hayata. 1 & 2, Habit and tuber; 3, Leaf; 4, Male spadix with spathe; 5, Female spadix; 6, Male flowers; 7, Female flower; 8, Longitudinal section of ovary showing ovules. (Wang et al. 9552)



**Figure 11.** *Arisaema ilanense* J. C. Wang sp. nov. 1, Habit; 2, Spadix with spathe; 3, Male spadix; 4, Female spadix; 5, Male flowers; 6, Female flower; 7, Ovules. (Wang et al. 6705)

Archipelago. An intensive study is necessary to clarify their classification.

**II. *Arisaema* sect. *Clavata*** Engler, Pfl.-reich IV, 23F: 150 et 171. 1920; J. Murata, J. Fac. Sci. Univ. Tokyo III 13:470. 1984.—TYPE: *Arisaema clavatum* Buchet.

**3. *Arisaema ilanense*** J. C. Wang, sp. nov. (Figure 11)

Species *A. du-bois-reymondiae* Engl. affinis, sed spathe intus atro-purpurea, appendice spadice claviformibus sursum amplificatis 9-14 cm longa apice obstipa vel leviter procurva differt. —TYPE: Taiwan, Ilan Hsien: Ssuyuan to Nanshan, Wang *et al.* 6705 (holotype: TNU; isotypes: HAST, TAI, TNU, TUS).

Tuber depressed-globose, 1.5-3 cm in diameter. Pseudostem 10-30 cm long, deeply subterranean. Cataphylls three or four, fleshy, whitish to greenish, apex mucronate. Leaves two; petiole terete, 10-22 cm long; lamina pedate, leaflets 7-15, sessile, oblanceolate to elliptic, cuneate at base, acuminate at apex, the terminal one 10-22 cm long, 2-4.5 cm wide, longer than or equal to the adjacent one. Peduncle 1.5-7 cm long, usually much shorter than the petiole. Spathe pale to greenish yellow outside, dark purple inside; tube cylindrical, slightly auriculate at the mouth, 6-9 cm long, 1.3-2 cm in diameter, pale to greenish yellow outside, dark purple inside and gradually paled to reddish brown downward; blade ovate, 6-10 cm long, 3-5 cm wide, acute or sometimes acuminate to the apex. Spadix 1.5-2.4 cm long in male, 1.5-3.4 cm long in female, appendage clavate, 9-15 cm long, slightly exerted, upper portion dark purple to black, bent outward or slightly downward, lower portion reddish, gradually narrowed toward the floriferous part or sometimes stipitate at the base with some echinate projections.

*Specimens examined.* ILAN: Ssuyuan to Nanshan, Wang *et al.* 6705 (holotype TNU, isotypes HAST, TAI, TNU, TUS); same loc., Wang *et al.* 8145 (TNU)

*Distribution.* endemic to northern Taiwan at medium altitude from 1600 to 1900 m (Figure 6).

*Notes.* *Arisaema* sect. *Clavata* comprises seven species distributed in Japan and China (Murata, 1984). The section is characterized by having pedate foliolate leaves with many sessile leaflets and a sessile spadix-appendage with modified sterile flowers (Murata, 1984). Among those species belonging the section, *A. ilanense* closely resembles *A. du-bois-reymondiae* Engler in China and *A. heterocephalum* Koidz. in the Ryukyu Islands, but *A. ilanense* also somewhat resembles *A. negishii* Makino of Japan and *A. hunanense* Hand.-Mazt. of mainland China. The former two have an clavate or cylindrical spadix-appendages which are rather short and often included in the spathe; while the latter two have an elongate spadix-appendage with a somewhat slender tip. *A. ilanense* has a characteristic clavate spadix-appendage which is longer than those of *A. du-bois-reymondiae* and *A. heterocephalum*, but is not as elongated as those of *A. negishii* and *A. hunanense* (Ohashi, *pers. comm.*).

*A. ilanense* was only found in Ssuyuan, northern Taiwan. This region forms a saddle between the Central Mountain Range and the Hsuehshan Mountain Range, and is also the source of the Lanyanghsi River. The habitat is cool and moist. Thousands of individuals grow on the forest floor under broad-leaved trees. *A. taiwanense* occurs at the same locality, but their flowering season seems different. *A. ilanense* flowers from February to late March while *A. taiwanense* flowers from late March to May. The two species are possibly isolated by the flowering season.

**III. *Arisaema* sect. *Tortuosa*** Engler, Pfl.-reich IV, 23F: 150 et 185. 1920; Nakai, Bot. Mag. Tokyo 43:524. 1929; Hara, Fl. East. Himalayas 2: 324 et 341. 1971; Li in Wu & Li, Fl. Reipubl. Popularis Sin. 13(2): 156. 1979; J. Murata, J. Fac. Sci. Univ. Tokyo III 13:471. 1984.—TYPE: *Arisaema tortuosum* (Wall.) Schott.

**IIIa *Arisaema* subsect. *Flagellarisaema*** (Nakai) J. Murata, J. Fac. Sci. Univ. Tokyo III 13:471. 1984.—TYPE: *Arisaema thunbergii* Blume.

*Flagellarisaema* Nakai, J. Jap. Bot. 25:6. 1950.

**4. *Arisaema thunbergii* ssp. *autumnale*** J. C. Wang, J. Murata & Ohashi, sp. nov. (Figure 12)

*Arisaema thunbergii* ssp. *urashima* auct. non (Hara) Ohashi & J. Murata: J. C. Wang, Taiwania 37: 54, fig. 1. 1992.

Ex affinitate *A. thunbergii* ssp. *urashima* (Hara) Ohashi et J. Murata, sed spathe intus et lamina extus alternatim atropurpureo- et albo-striatus, autumnno florens differt. —TYPE: Taiwan, Taipei Hsien: Sanhsia, Hsiung-kung to Man-yue-yuan, on the floor of broadleaf forest, Wang, Sang & Chen 9460 (holotype: TNU; isotype: HAST, TNU).

Tuber depressed-globose, 3-6 cm in diameter. Pseudostem 5-15 cm long, much shorter than the petiole. Cataphylls membranous, purplish to brownish, apex mucronate. Leaf solitary; petiole terete, 20-55 cm long; lamina pedate; leaflets 11-15, oblanceolate to elliptic, cuneate at base, acuminate at apex, the terminal one 10-28 cm long, 2-7.5 cm wide. Peduncle 10-20 cm long, usually shorter than petiole. Spathe white to pale yellow with dark to bronze-purple or reddish purple stripes; tube cylindrical, auriculate at the mouth, 5-7 cm long, 2-2.5 cm wide, white to pale yellow with longitudinal purple stripes outside and dark purple stripes inside; blade triangular ovate, 7-10 cm long, 4-5 cm wide, acute to acuminate at apex. Spadix 3-4 cm long in male, appendage filiform, 40-60 cm long, long-exerted, upper portion bent downward and pendulous, lower portion gradually thickened to form a smooth long cylindrical enlargement then gradually narrowed toward floriferous part.

*Specimens examined.* TAIPEI: Yun-sen Waterfall, Wang *et al.* 9035 (TNU); Sanhsia, Hsiung-kung to Man-yue-yuan, on the floor of broadleaf forest, Wang, Sang & C. H. Chen 9460 (type, HAST, TNU); Province Road No. 7, Chihtuan to 67.5K, Wang 11504 (HAST). ILAN: Fushan Botanical Garden, 1992, Yang *s. n.* (TNU); Nanao



**Figure 12.** *Arisaema thunbergii* ssp. *autumnale* J. C. Wang, J. Murata & Ohashi ssp. nov.. 1 & 2, Habit and tuber; 3, Spadix with spathe; 4, Apex of cataphyll; 5, Male spadix; 6, Male flower from the upper part of spadix, front view and side view; 7, Male flower from the lower part of spadix, side and front view. (Wang 6747A)



Hsiang: en route from Shenmihu control station to Shenmihu, *Liu et al.* 147 (HAST, TNU). HUALIEN: Lanshan, *Peng* 9922 (HAST); Taroko National Park, en route from Yuehwangting to Yenhai Forest Trail, *Peng et al.* 12990 (HAST); Walami, *Lu & Horng* 1361 (TNU); Yenhai logging tract, *Wang* 6747A (TNU), *Wang et al.* 7640 (TNU).

*Distribution.* endemic to Taiwan, widespread but scarce at low altitudes of northern and eastern parts (Figure 7).

*Notes.* The taxon was recently found in northern and eastern Taiwan and previously misidentified as *Arisaema thunbergii* ssp. *urashima* of Japan (Wang, 1992). The gross morphology of the Taiwan plants is closely similar with those from Japan. However, by a detailed comparison, the Taiwanese taxon is different from that in Japan in the pollen morphology, flowering season, and shape and color of spathe. The palynological differences were described as above. The flowering season was considered to be important by Murata (1984), who used it as one character in discriminating the *Arisaema* section *Decipientia*. However, the flowering time may not be so important in the Taiwanese *Arisaema* because they flower one after another all year long, probably due to the warmer climate. However, the flowering season of *A. thunbergii* ssp. *autumnale* is quite different from that of *A. thunbergii* ssp. *urashima*, the former is exclusively in the autumn (from October to November) while the latter is in the spring (from April to May, Ohwi (1965)). Lastly, *A. thunbergii* ssp. *autumnale* is distinct from *A. thunbergii* ssp. *urashima* by the less expanded spathe-limb, and in having distinctly longitudinal striation on the both surfaces of spathe-blade as well as the inner surface of spathe-tube. Therefore, it is reasonable to treat them as distinct.

**IIIb. *Arisaema* subsect. *Tortuosa*** (Engler) J. Murata, J. Fac. Sci. Univ. Tokyo III 13: 471. 1984.

**5. *Arisaema heterophyllum*** Blume, Rumphia 1: 110. 1835; Nakai, Icon. Pl. Asiae Orient. tab. 79. 1939; Kitamura, Acta Phytotax. Geobot. 10: 189. 1941; Huang, J. Forest NTU 27: 8. 1960; Liu & Huang, Quart. J. Taiwan Mus. 16: 134. 1963; Liu & Huang in H. L. Li *et al.*, Fl. Taiwan 5: 805. 1978; Li in Wu & Li, Fl. Reipubl. Popularis Sin. 13(2): 157, pl. 30: 1-3. 1979. (Figure 13)

*Heteroarisaema heterophyllum* (Blume) Nakai, J. Jap. Bot. 25: 5. 1950.

*Arisaema takeoi* Hayata, Icon. Pl. Form., 5: 246. 1915; 8:132, fig. 59. 1919. —TYPE: Formosa. Inter Heirinbi et Shokei, 10 May 1916, *Hayata s.n.* (neotype: TI, chosen by H. Ohashi, 1981: 23; figured in Ohashi, Univ. Mus. Univ. Tokyo, Mater. Rep. 5, pl. 49. 1981)

Tuber depressed-globose, 1-6 cm in diameter. Pseudostem 25-60 cm long, much longer than petiole. Leaf solitary; petiole 5-15 cm long; lamina pedate; leaflets 11-19, narrowly elliptic to oblanceolate, cuneate at base, acuminate at apex, short-petiolate to sessile; terminal leaflet 4-15 cm long, 1-3.5 cm wide, much shorter than adja-

cent leaflets. Peduncle 15-22 cm long, longer than the petiole. Spathe green on both sides; tube cylindrical, not or slightly auriculate at the mouth, 4-10 cm long 1-2 cm in diameter; limb ovate or ovato-lanceolate, 5-11 cm long, 3-5 cm wide, acuminate at apex. Spadix mostly dioecious, 2.5-3.5 cm long in male, 4-5 cm long in female; appendage filiform, 15-25 cm long, erect, bent outward at tube mouth and then turned upward and long-exserted, basal part with few echinate sterile flower or not.

*Specimens examined.* KEELUNG: Dandan, 1944, *Masamune s. n.* (TAI); TAIPEI: Agyokusan, 1934, *Suzuki s. n.* (TAI); Chingtienkang to Tsuetsueku, *Wang* 5284 (TNU), 5332 (HAST, TNU); Chungshing Farm, *Lu* 57 (TNU); Ertsuping, *Wang et al.* 9205 (TNU); Hsiaokoutou, *Huang & Jeng* 10823 (TAI); Hsintien: en route from Hualin to mt.-hiking entrance of Tatungshan, *Liu et al.* 204 (HAST); Hualin to Tatungshan, *Liu et al.* 204 (TNU); Kungliao Hsiang: Chaohui Temple, near Yenliao, *Peng et al.* 14965 (HAST); Peichatienshan, *Lu* 412 (TNU); Tatungshan, *Deng* 928 (TNU); Tatunshan to Chingho, *Hsu* 5561 (TAI); Shihkuliao, *Yang* 1253 (TNU); Shinshan, *Chiang* 1561 (TAI); MIAOLI: Hsiaoping, *Hsu* 9322 (TAI); Hsihu Hsiang Public Cemetery, *Peng et al.* 13953 (HAST). ILAN: Mt. Oobi, 1938, *Masamune s. n.* (TAI); Nanao Hsiang: Chinyang Village, Shenmihu, *Chen et al.* 675 (HAST); Nan-ao to Hoping, *Wang* 6741 (TNU); Tanoorei, *Suzuki* 7401 (TAI); Taipingshan, *Suzuki* 174 (TAI); Shenmeihu *Huang et al.* 5204 (TAI); HUALIEN: Taroko National Park: Tsankuang Temple to a mt. ridge above the destroyed Eternal Spring Temple, *Peng et al.* 12307 (HAST); Tenhsian, *Huang* 9319 (TAI); Yenhai logging tract, *Wang* 6747 (TNU); Yuehwangting to Yenhai logging tract, *Wang et al.* 7670 (TNU).

*Distribution.* China, Korea, and Japan. Taiwan, in the northern parts at low altitude (Figure 6).

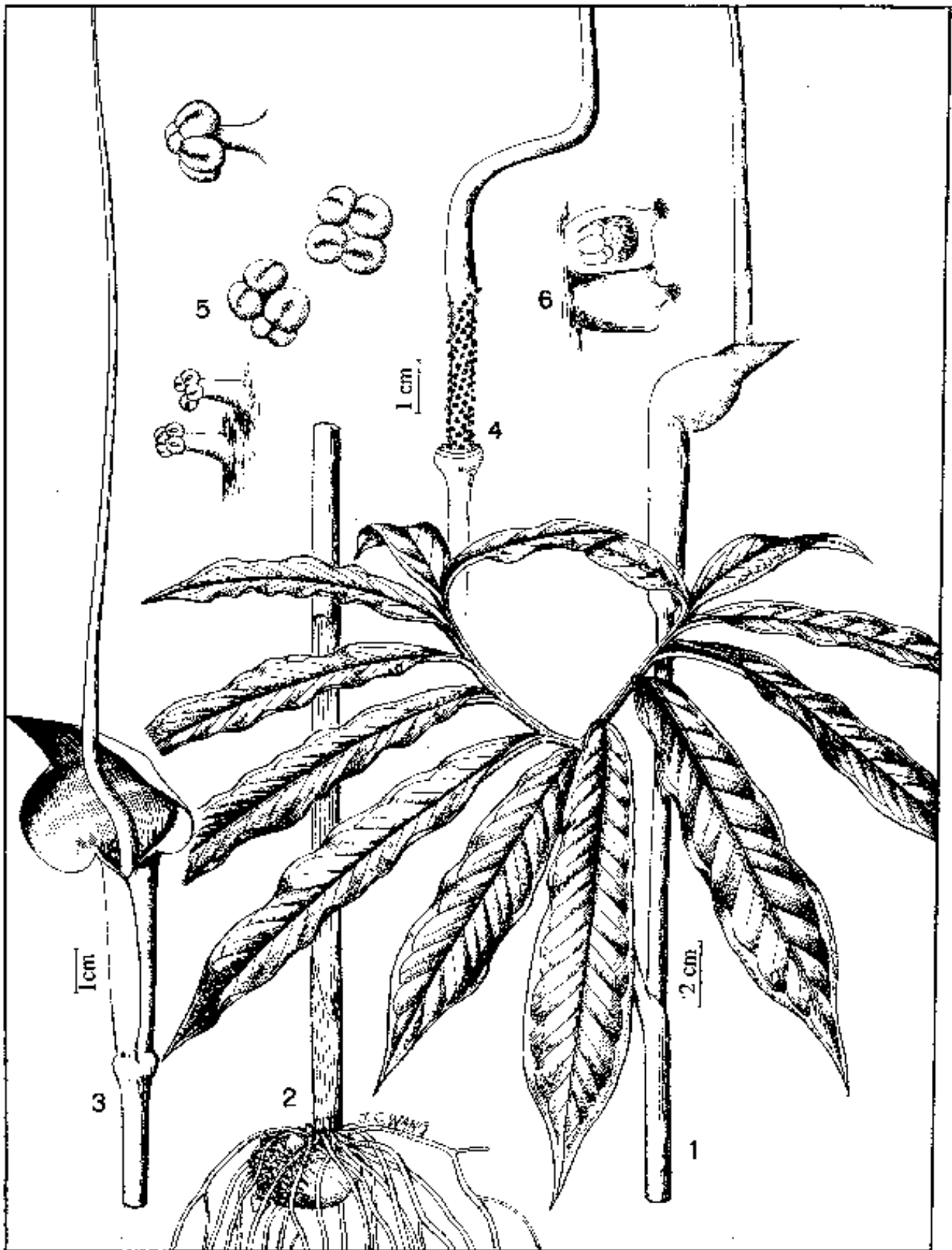
**IV. *Arisaema* sect. *Sinarisaema*** Nakai, J. Jap. Bot. 25: 6. 1950; Hara, Fl. East. Himalayas 2:324 et 347. 1971; Li in Wu & Li, Fl. Reipubl. Popularis Sin. 13(2): 186. 1979; J. Murata, J. Fac. Sci. Univ. Tokyo III 13: 475. 1984. —TYPE: *Arisaema formosanum* (Hayata) Hayata.

**6. *Arisaema consanguineum*** Schott, Bonplandia 7: 27. 1859; N. E. Brown, J. Linn. Soc. Bot. 36: 176. 1903; Hayata, Icon. Pl. Form. 5: 241. 1915; Huang, J. Forest NTU 27: 6. 1960; Huang, Taiwania 7: 102. 1960; Liu & Huang, Quart. J. Taiwan Mus. 16: 130. 1963; Liu & Huang in H. L. Li *et al.*, Fl. Taiwan 5: 801. 1978; Hara, Fl. East. Himalayas 394. 1966; Hara, Fl. East. Himalayas, ed. 2, 348, pl. 19: c, d, fig. 55: k. 1971.

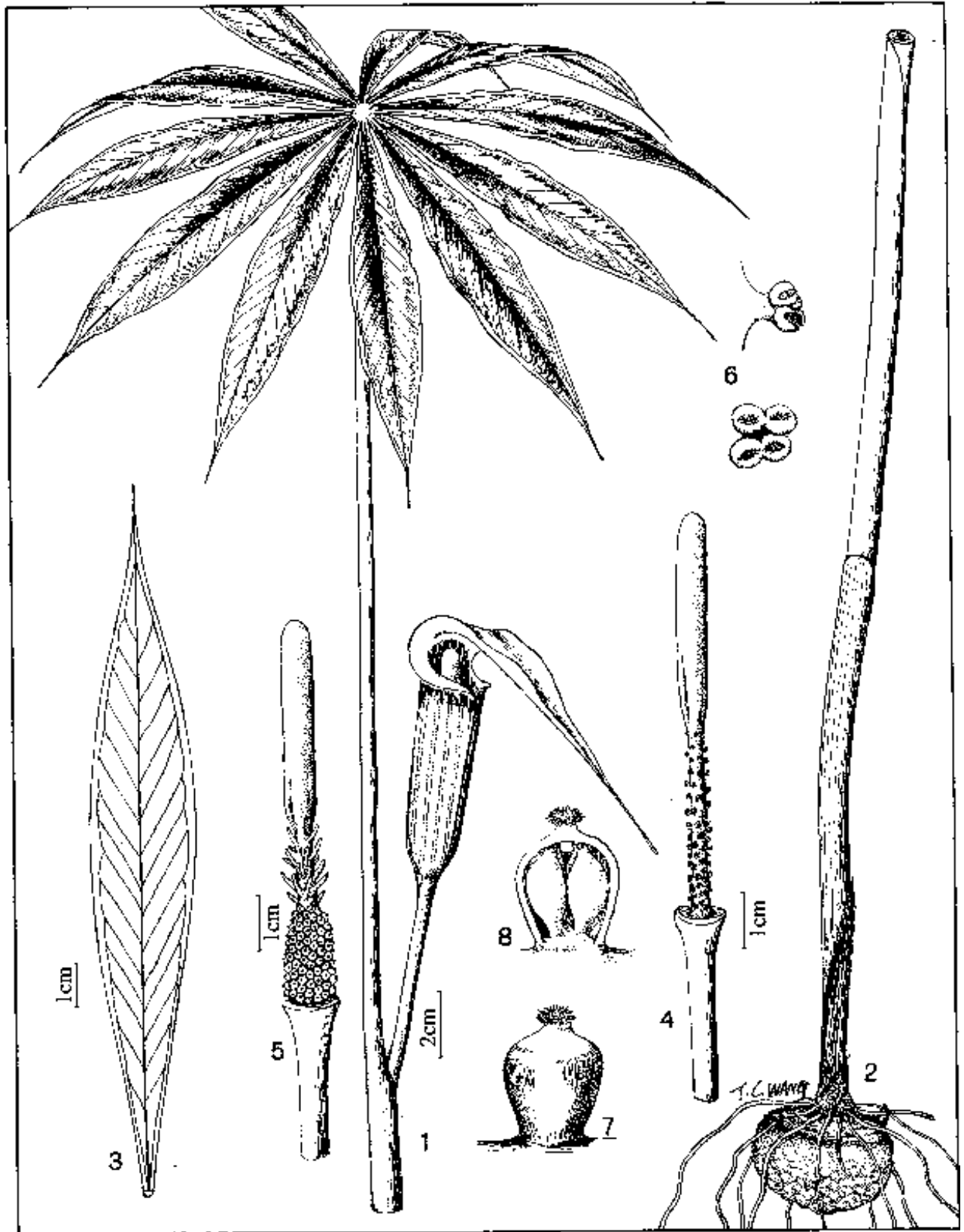
Figure 14

*Arisaema erubescens* var. *consanguineum* (Schott) Engl. in DC., Monogr. Phan. 2: 558. 1879.

*Arisaema kelung-insularis* Hayata, Icon. Pl. Form., 5: 246, fig. 88. 1915; Liu & Huang in H. L. Li *et al.*, Fl. Taiwan 5: 805. 1978; Li in Wu & Li, Fl. Reipubl. Popularis Sin. 13(2):188. 1979. —TYPE: Formosa. Ins. Kelung,



**Figure 13.** *Arisaema heterophyllum* Blume. 1 & 2, Habit and tuber; 3, Spadix with spathe; 4, Male spadix; 5, Male flowers; 6, Female flower, upper one showing longitudinal section and inner ovules. (1993, Huang s.n.)



**Figure 14.** *Arisaema consanguineum* Schott. 1 & 2, Habit and tuber; 3, Leaflet; 4, Male spadix; 5, Female spadix; 6, Male flowers; 7, Female flower; 8, Longitudinal section of ovary showing inner ovules. (Chen & Hung 1111)

May 1910, *Sasaki s.n.* (holotype: TI, figured in Ohashi, Univ. Mus. Univ. Tokyo, Mater. Rep. 5, pl. 19. 1981).

*Arisaema consanguineum* var. *kelung-insularis* (Hayata) Huang, *Taiwania* 7: 102, fig. 7. 1960; Liu & Huang, *Quart. J. Taiwan Mus.* 16: 132. 1963.

*Arisaema biradiatifoliatum* Kitamura, *Acta Phytotax. Geobot.* 10: 187. 1941; Li in Wu & Li, *Fl. Reipubl. Popularis Sin.* 13(2): 187. 1979. —TYPE: Formosa. Takao, Daikwanzan, 14 May 1939, *Okamoto s.n.* (holotype: KYO? n. v.)

*Arisaema erubescens* auct. non Schott: Li in Wu & Li, *Fl. Reipubl. Popularis Sin.* 13(2): 189. 1979.

*Arisaema japonica* auct. non Blume: N. E. Brown, *J. Linn. Soc. Bot.* 36: 178. 1903; Matsumura & Hayata, *J. Coll. Sc. Univ. Tokyo* 22: 456. 1906.

Tuber depressed globose, 2-7 cm in diameter. Pseudostem 30-80 cm long, white to pale green, sometimes mottled with purple-brown marks. Cataphylls three or four, greenish or reddish, sometimes with purple-brown marks. Leaf solitary or two; petiole 15-40 cm long, distinctly shorter than the pseudostem; lamina radiately 9-15-foliolate; leaflets narrowly elliptic to elliptic, 12-25 cm long, 1-6 cm wide, apex acuminate, base cuneate, green above, glaucous beneath. Peduncle 6-12-(15)cm long, distinctly shorter than the petiole. Spathe green or red with white lines along veins on the outer surface; tube cylindrical, auriculate at the mouth, 5-8.5 cm long, 1-2 cm in diameter, greenish to yellowish green, sometimes with purplish red stripes on inner surface; blade triangular ovate, 4-8 cm long, 2-4 cm wide, white, green or purplish red, often with pale veins on inner surface, long acuminate, sometimes with a prolonged filiform tail at apex. Spadix 6-10 cm long including appendage; appendage clavate, erect, 4-7 cm long, tip more than 2 mm thick, base with fine bristly projections usually abundant in the female spadix but scarce in the male; infructescence recurved downward.

*Specimens examined.* TAIPEI: Chisingshan, *Yang 1368* (TAI), *Tang 1249* (TAI); Chunghsing Farm, *Lu 53, 59* (TNU); Kabozan, *Fukuyama ST19241* (TAI); Tsaoshankou, near Chinkuashih, *Peng & Chen 10867* (HAST). TAOYUAN: Lalashan, *6th group 32* (TAI); Parlin to Lalashan, *Cheng 8* (TAI). MIAOLI: Kwanwu, *Huang 4751* (TAI); same loc., along the trail to the "Sacred Tree", *Peng et al. 14910* (HAST); 2 km of Kuanwu, *Peng et al. 14936* (HAST); Kuanwu to Chutung, *Wang et al. 9288* (HAST, TNU); Loshan to Kwanwu, *Wang & Yang 4721* (TNU). HSINCHU: Chienshih Hsiang: Yuanyanghu Natural Preserved Area, *Shen et al 739* (HAST), *Wang & Hsu 1311* (HAST), *Wang et al. 1055* (HAST); Wufeng Hsiang: Kuanwu, Talu forest road 20-26K, *Wang et al. 9218, 9221* (HAST, TNU); same loc., east branch line 7-10K, *Wang et al. 9258* (HAST, TNU), *9258A* (TNU). TAICHUNG: Anmashan, *Huang 8070, 8116, 8120* (TAI); Chihyuanshanchuang, *Tang 1251* (TAI); Nanhushi-Tochiatunshan-710 track road, *Wang et al. 3848* (TAI); Pilushi 11th watershed, *Wang 3096* (TAI).

NANTOU: Dandar logging tract, 1993, *Yang s.n.* (TNU); en route from Tungpu Hot Spring to Kuankao, *Peng 8024* (HAST); Kunyang to Yuanfeng, *Wang 5093* (TAI); Meifeng, 1993, *Yang s.n.* (TNU), *Peng 8334* (HAST); Hsinyi District: Shenmu Forest Trail, *Peng & Chen 11403* (HAST); Tsuifeng to Meifeng, *Tateishi et al. 17754* (TAI); Yushan National Park: en route from Lulin Lodge to Tatachia Saddle, *Peng & Chen 11457* (HAST); Wushe to Chienching, *Feung & Kao 4540* (TAI). CHIAYI: Alishan, *Huang 1765* (TAI), 1991, *Chang s.n.* (TNU), *Tateishi et al. 17806* (TAI); Alishan, Erhwanping, *Tateishi et al. 17920* (TAI); Alishan to Erhwanping, *Wang 6378* (TNU); En route to Yushan, *Huang et al. 14221, 14231, 14242* (TAI); Tataka, *Wang et al. 5483* (TNU). KAOHSIUNG: Chinching Bridge, *Wang 10397* (HAST); Taoyuan Hsiang: Tienchih, *Wang et al. 1152* (HAST), *Wang 10393* (HAST); Tashulinshan, 1919, *Matsuda s.n.* (TAIF). ILAN: Taipingshan, *Suzuki 187* (TAI), 1918, *Sasaki s.n.* (TAIF). HUALIEN: Yenhai logging tract, *Wang et al. 7668* (TNU); Yuli Wildlife Nature Reserve, *Deng 433-1, 433-3* (TNU). TAITUNG: Haituan District: between mt.-hiking entrance and the peak of Takuanshan, *Peng et al. 11737* (HAST).

*Distribution.* Northern India, Nepal, Sikkin, Burma, northern Thailand, and mainland China. Taiwan, from low to medium altitudes throughout the island (Figure 7).

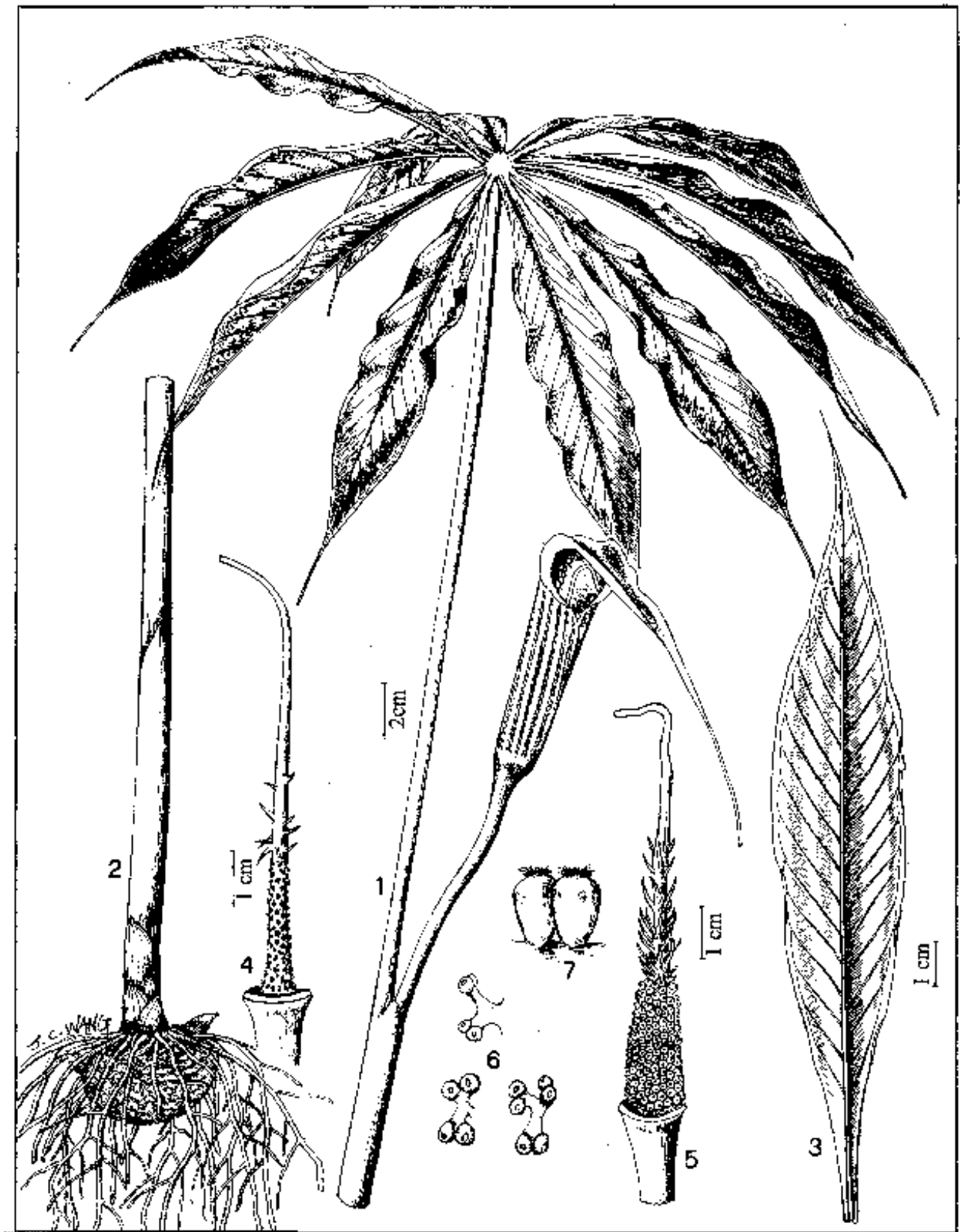
**7. *Arisaema formosanum*** (Hayata) Hayata, *Icon. Pl. Form.* 5: 243, fig. 87. 1915 ("*formosana*"); Huang, *J. Forest NTU* 27: 6, fig. 6, 7. 1960; Huang, *Taiwania* 7: 102, fig. 1, 3, 4. 1960; Liu & Huang, *Quart. J. Taiwan Mus.* 16: 133. 1963; Liu & Huang in H. L. Li *et al.*, *Fl. Taiwan* 5: 803, pl. 1527. 1978; Li in Wu & Li, *Fl. Reipubl. Popularis Sin.* 13(2):187. 1979. (Figure 15)

*Arisaema alienatum* var. *formosanum* Hayata, *J. Coll. Sci. Univ. Tokyo* 30:371. 1911 ("*formosana*").—TYPE: Formosa. Shinchiku, Okunghishan, Apr. 1907, *Kawakami & Watanabe s.n.* (holotype: TI, figured in Ohashi, Univ. Mus. Univ. Tokyo, Mater. Rep. 5, pl. 5. 1981).

*Arisaema formosanum* forma *stenophyllum* Hayata, *Icon. Pl. Form.* 5: 24. 1915 ("*formosana*" form. "*stenophylla*"); Huang, *J. Forest NTU* 27:8. 1960; Liu & Huang, *Quart. J. Taiwan Mus.* 16: 133. 1963; Liu & Huang in H. L. Li *et al.*, *Fl. Taiwan* 5: 803. 1978; Li in Wu & Li, *Fl. Reipubl. Popularis Sin.* 13(2):188. 1979. —TYPE: Formosa. Mt. Arisan, May 1913, *S. Sasaki 5* (holotype: TI, figured in Ohashi, Univ. Mus. Univ. Tokyo, Mater. Rep. 5, pl. 13. 1981)..

*Arisaema formosanum* var. *bicolorifolium* Huang, *Taiwania* 27: 30, fig. 1, pl. 1-5. 1982 ("*bicolorifolia*").—TYPE: Taiwan. Mt. Tiger, *Huang 8698* (holotype: TAI) *syn. nov.*

*Arisaema oblanceolatum* Kitamura, *Acta Phytotax. Geobot.* 10: 188. 1941 ("*oblanceolata*"); Li in Wu & Li, *Fl. Reipubl. Popularis Sin.* 13(2): 186. 1979. —TYPE: Formosa. Takao, Keinzan, 10 May 1939, *Okamoto s.n.* (holotype: KYO. n. v.)



**Figure 15.** *Arisaema formosanum* (Hayata) Hayata. 1 & 2, Habit and tuber; 3, Leaflet; 4, Male spadix; 5, Female spadix; 6, Male flowers; 7, Female flower. (Wang et al. 9220)

Tuber depressed globose, 1.5-4.5 cm in diameter. Pseudostem 10-60 cm long, white to pale green, sometimes mottled with purple-brown marks. Cataphylls three or four, greenish or reddish, sometimes with purple-brown marks. Leaf solitary, rare two; petiole 12-30 cm long, about equal or shorter than the pseudostem; lamina radiately 7-11-(15)-foliolate; leaflets narrowly elliptic to elliptic, 10-30 cm long, 0.8-7.5 cm wide, apex acuminate, base cuneate, green above, glaucous beneath. Peduncle 4-10-(15) cm long, distinctly shorter than petiole. Spathe green to reddish green, with white lines along veins, on the outer surface; tube cylindrical, auriculate at the mouth, 4-6 cm long, 1-1.8 cm in diameter, greenish to yellowish green, sometimes with purplish red stripes on inner surface; blade ovate, 4-7 cm long, 2-3.5 cm wide, green to purplish red, often with pale veins on inner surface, long acuminate with a prolonged filiform tail at the apex. Spadix 5-8 cm long including appendage; appendage filiform, (2)-3-4 cm long, less than 1.5 mm wide, base with fine bristly projections usually abundant in the female spadix but scarce in the male; infructescence recurved downward.

*Specimens examined.* TAIPEI: Chungsing Farm, Lu 58 (TNU); Erhtzuping, Wang et al. 9206 (TNU); Tsutzuhu, Nakamura 4354 (TAI); HSINCHU: Chienshih Hsiang: Yuanyanghu Natural Preserved Area, Shen et al. 585 (HAST). MIAOLI: Hushan, Huang 8695 (TAI); Taian Hsiang: Malapangshan, Liu et al. 93 (HAST); TAICHUNG: Anmashan, Huang 8118, 8119 (TAI); Pilushi 11th watershed, Wang 3095 (TAI); Shuanshan, 1983, Lin & Hsieh s.n. (TAIF); Wuling, en route from Wuling Farm to Chikashanchuang, Hsu & Moore 633 (HAST). NANTOU: Chitou, Lu 603 (HAST, TNU), Wang 15362 (HAST), Chuang & Kao 3174 (HAST); Chitou tract, Huang 1401, 1440 (TAI); Fenghuangshan, Peng & Chen 10517 (HAST); Hoshie tract, Huang 2187 (TAI); Hsinyi Hsiang: from Patungkuan to Tungpu, Chen 988 (HAST); Patungkuan, Huang 1588 (TNU); Tsuifeng, Hu 1550 (HAST); Tungpu to Kuankao, Huang 1589 (TNU); Tunyuan to Yunhai, Liao et al. 1289 (TNU); CHIAYI: Alishan, 1911, Kawakami & Sasaki s.n. (TAIF), Huang 1667, 1668, 1706 (TAI), Chann 5458 (TAI); Alishan to Erhwanping, Wang et al. 6379 (TNU); Alishan to Tzushan, Wang et al. 6428 (TNU); Chuchi Hsiang: Shihcho, Lungyunshanchuang, Wang et al. 725 (HAST); Erhwanping, 1914, Hayata s.n. (TAIF); Fenchihu, Huang & Huang 13978 (TAI), Huang 2602 (TAI); Fenchihu to Dardungshan, Wang et al. 7080, 7081 (TNU); Fenchihu to Tianchian, Wang et al. 6251 (TNU); Monlu cliff to Tungpu, Hsu 5389 (TAI); Mt. Morrison, Chuang et al. 4033 (HAST); Niitakayama, Kawakami & Mori 2330 (TAIF); KAOHSIUNG: Tengiy, Wang et al. 7482 (TNU); Tienchu to Yiakou, Southern E-W Highway, Huang et al. 8859 (TAI). PINGTUNG: Peitawushan, Wang et al. 9166 (TNU); ILAN: Chiliehting Ridge, Huang 7793, 7852 (TAI); Nanao Hsiang: Chinyang Nanao broad-leaved forest preserve, Peng et al. 13796 (HAST); Chinyang: border of Shenmihu Lake in "Nanao broad-leaved forest

preserve", Peng et al. 13814 (HAST); Taipingshan, Huang et al. 10792, 10807 (TAI); Yuanyang Lake, Wang 9292 (TNU); HUALIEN: Chingsuishan, 1983, Chiou & Ho s.n. (TAIF); Fuli Hsiang: Hsinkangshan, Shen et al. 650 (HAST); Mt. Tarokotaizan, Suzuki 10926 (TAI); Topoko, 1983, Chiou & Lin s.n. (TAIF); Taroko National Park: Yenhai Forest Trail, Peng et al. 12367 (HAST); Yenhai logging tract, Wang et al. 6794 (HAST, TNU), Wang et al. 7667 (HAST, TNU); Yuehwangting to Yenhai logging tract, Wang et al. 7639 (TNU); Yuli Wildlife Nature Reserve, Deng 433-2 (TNU); TAITUNG: Sinsuiei, 1932, Sasaki s.n. (TAI), Suzuki ST8027 (TAI); Southern cross island highway 155K, Hsiangyang to Liyuan, Wang 14204 (HAST).

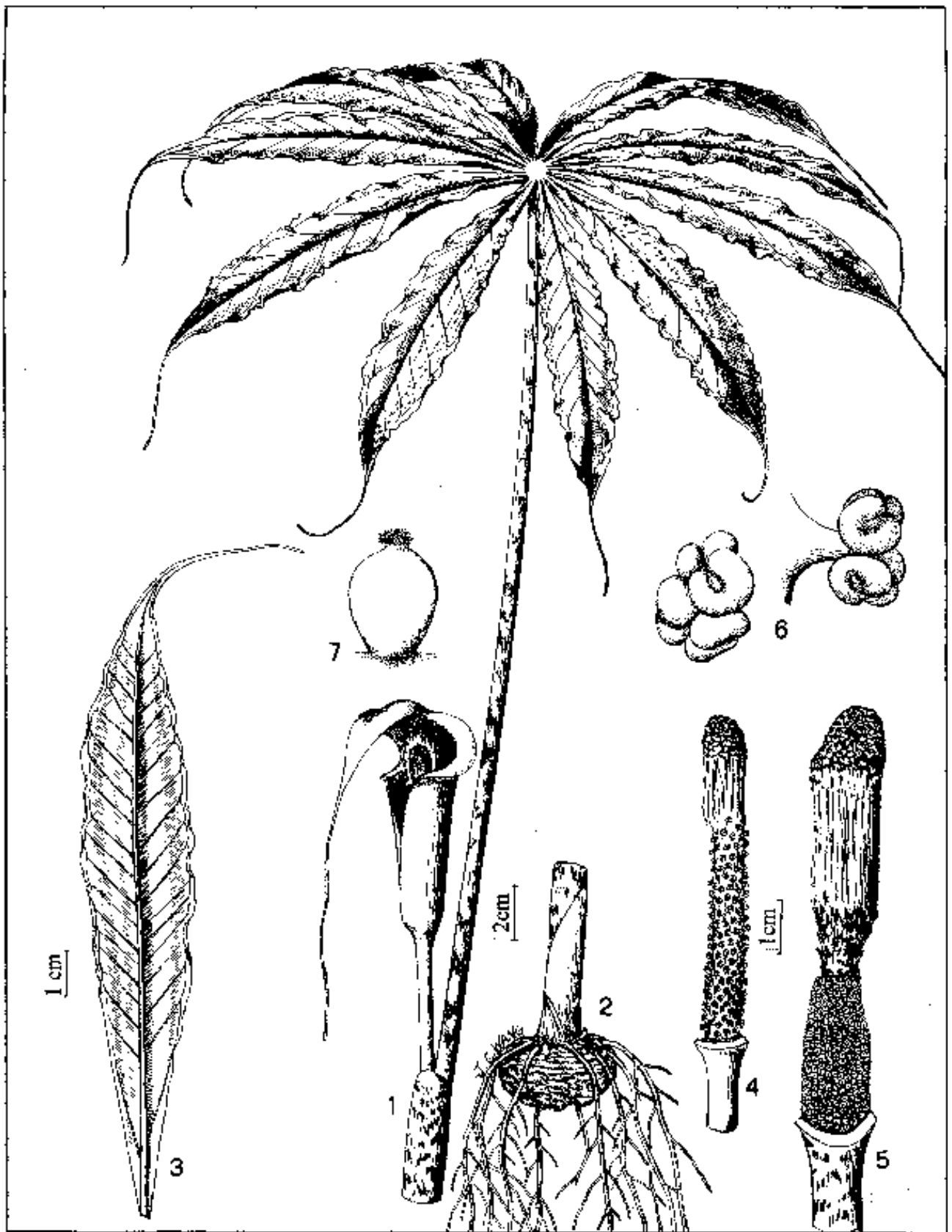
*Distribution.* Endemic to Taiwan, from low to medium altitudes throughout the island (Figure 7).

*Notes.* *A. consanguineum* and *A. formosanum* are very similar in morphology as well as habit. The two species often occur in the same locality (see Figure 7). Their typical forms are easily distinguished by the thickness of the spadix-appendage tip, the only character distinguishing them. In general, the former has a thicker spadix-appendage (typically more than 3 mm in diameter) while the latter has a slender one (typically less than 1.5 mm in diameter). However, both taxa show great variation in plant size, leaf shape, spathe color, and the thickness of spadix-appendage tip, all of which result in some infraspecific taxa. Also, some intermediate plants with 2-3 mm thick spadix-appendage tips were occasionally found. Murata (1985) pointed out that these species may be isolated seasonally and/or geographically. However, their flowering season changes continuously from species to species. During the transition period, hybridization, which may confuse the delimitation of species, possibly occurs. In this situation, any nomenclatural change and infraspecific classification await an extensive comparative study of both species.

**8. *Arisaema taiwanense*** J. Murata, J. Jap. Bot. 60: 353, fig. 1, 2, 3. 1985. —TYPE: Taiwan. Erhwanping, Apr. 19, 1985, Murata 17248 (holotype: TI, n.v.; isotype: TAI). (Figure 16)

*Arisaema consanguineum* auct. non Schott: Hayata, Icon. Pl. Form. 5: 241. 1915.

Tuber depressed globose, 2-6 cm in diameter. Pseudostem 2-30 cm long, white to pale green, usually mottled with purple-brown marks. Cataphylls greenish or reddish, often with purple-brown marks. Leaf solitary; petiole 10-40 cm long, usually longer than the pseudostem; lamina radiately 7-15-foliolate; leaflets oblanceolate, apex filiform-caudate, with a thread-like pendulous tail at tip, green above, glaucous beneath. Peduncle 5-15 cm long, distinctly shorter than the petiole. Spathe purplish red to dark purple, with fine green dots between veins on outer surface; tube obconical, gradually opening to the auriculate mouth, 2-6 cm long, 4-8 cm wide, white to pale yellowish green with purple stripes on inner surface; blade ovate to broadly ovate, 3-8 cm



**Figure 16.** *Arisaema taiwanense* J. Murata. 1 & 2, Habit and tuber; 3, Leaflet; 4, Male spadix; 5, Female spadix; 6, Male flowers; 7, Female flower. (Wang et al. 9377)

long, 4-8 cm wide, dark purple, scarcely with pale veins on inner surface, acute to acuminate with a prolonged filiform tail up to 40 cm long at apex. Spadix 3-10 cm long including appendage; appendage stipitate or sometimes sessile, thick cylindrical, 2-5 cm long, 0.5-1.5 cm wide, apex slightly enlarged, strongly to weakly rugose, base narrower, with fine bristly projections, usually abundant in the female spadix but scarce in the male; Inflorescence recurved downward.

*Specimens examined.* TAOYUAN: Lalashan, 1990, *Chiang s.n.* (TAI); HSINCHU: 8.7 km N of Kuanwu, *Peng et al. 14937* (HAST). TAICHUNG: Anmashan, *Huang 8114, 8115* (TAI); Chihyuanshanchuang, *Tang 1250* (TAI); Hoping Hsiang: Lishan, *Ho 328* (HAST); same loc., *Hsu 3849* (TAI); Pilushi 11th watershed, *Wang 3095* (TNU); NANTOU: Chiti, near Chitou, 1968, *Hsu s.n.* (TAI); Juiyenchu, *Lu et al. 1450* (TNU); CHIAYI: Alishan, 1914, *Hayata s.n.* (TAI), 1924, *Ishizaki s.n.* (TAI), *Wang 2303* (TAI), 1957, *Chuan & Kao s.n.* (TAI); Alishan highway, Shihcho, Tinghuti-Tadungshan-Furungshan, *Wang 18495* (HAST); Alishan to Erhwanping, *Tateishi et al. 17901* (TAI); Chihchung, *Wang et al. 5406* (TNU); Erhwanping, *Murata 17248* (isotype of *A. taiwanense* J. Murata, TAI!); Erhwanping to Shinmu, *Murata & Huang 17667* (TAI); Fenchiu to Dardungshan, *Wang et al. 7082* (HAST, TNU); KAOHSIUNG: Tengchih, *Huang et al. 13849, 13850* (TAI); ILAN: Ssuyuan Yakou, *Yang & Hsieh 4070* (TAI); Ssuyuan to Nanshan, *Lu 70* (HAST, TNU), 71, 224 (TNU); Taipingshan (Taiheizan), *Lin et al. 23* (TNU), *Suzuki 187* (TAI); Taipingshan, around Taipingshanchuang, *Lin et al. 23* (HAST).

*Distribution.* Endemic to Taiwan, throughout the island at medium altitudes, common (Figure 8).

#### 8a. *Arisaema taiwanense* var. *brevipedunculatum* J.

Murata, J. Jap. Bot. 60:356, fig. 3A. 1985. —TYPE: Taiwan. Peitawushan, Kuaikushanchuang - the base, May 5 1985, *Murata 17252* (holotype: TI. n.v.; isotype: TAI).

Pseudostem 2-10 cm long, greenish, without colored marks. Cataphylls greenish pale brown, without colored marks. Peduncle 1-5 cm long. Spathe tube 2-4 cm long, 3.5-6 cm wide; spathe-blade concave and arched, 3-5 cm long not including a thread-like tail. Spadix-appendage 2-4 cm long, 0.5-1.2 cm wide.

*Specimens examined.* PINGTUNG: Peitawushan, Kuaikushanchuang - the base, *Murata 17252* (isotype of *A. taiwanense* var. *brevipedunculata* J. Murata, TAI!), *Tateshi et al. 19562, 19564* (TAI); HUALIEN: Yuli Wildlife Nature Reserve, *Deng 444-1, 444-3* (TNU).

*Distribution.* Endemic to Taiwan, at medium altitudes of southern and eastern parts (Figure 8).

V. *Arisaema* sect. *Pedatisecta* Schott ex Engler in DC., Monogr. Phan. 541. 1879 *pro minor part.*; J. Murata, Kew Bull. 46(1): 127. 1991. Lectotype: *Arisaema japonicum* Blume, chosen by J. Murata 1991: 127.

9. *Arisaema ringens* (Thunb.) Schott, Melet. 17. 1832; N. E. Brown, J. Linn. Soc. Bot. 36: 179. 1903; Hayata, Icon. Pl. Form., 5: 246. 1915; 9: 147, fig. 54. 1920; Huang, J. Forest NTU 27: 8, fig. 8. 1960; Huang, Taiwania 7:101. 1960; Liu & Huang, Quart. J. Taiwan Mus. 16: 134. 1963; Liu & Huang in H. L. Li *et al.*, Fl. Taiwan 5: 805. 1978; Li in Wu & Li, Fl. Reipubl. Popularis Sin. 13(2): 155, pl. 29:4-6. 1979; Chang, J. Phytogeogr. Taxon. 32: 111. 1984. (Figure 17)

*Arum ringens* Thunb., Act. Soc. Linn. Lond. 2: 337. 1794. *Ringentiarum ringens* (Schott) Nakai, J. Jap. Bot. 25: 5. 1950.

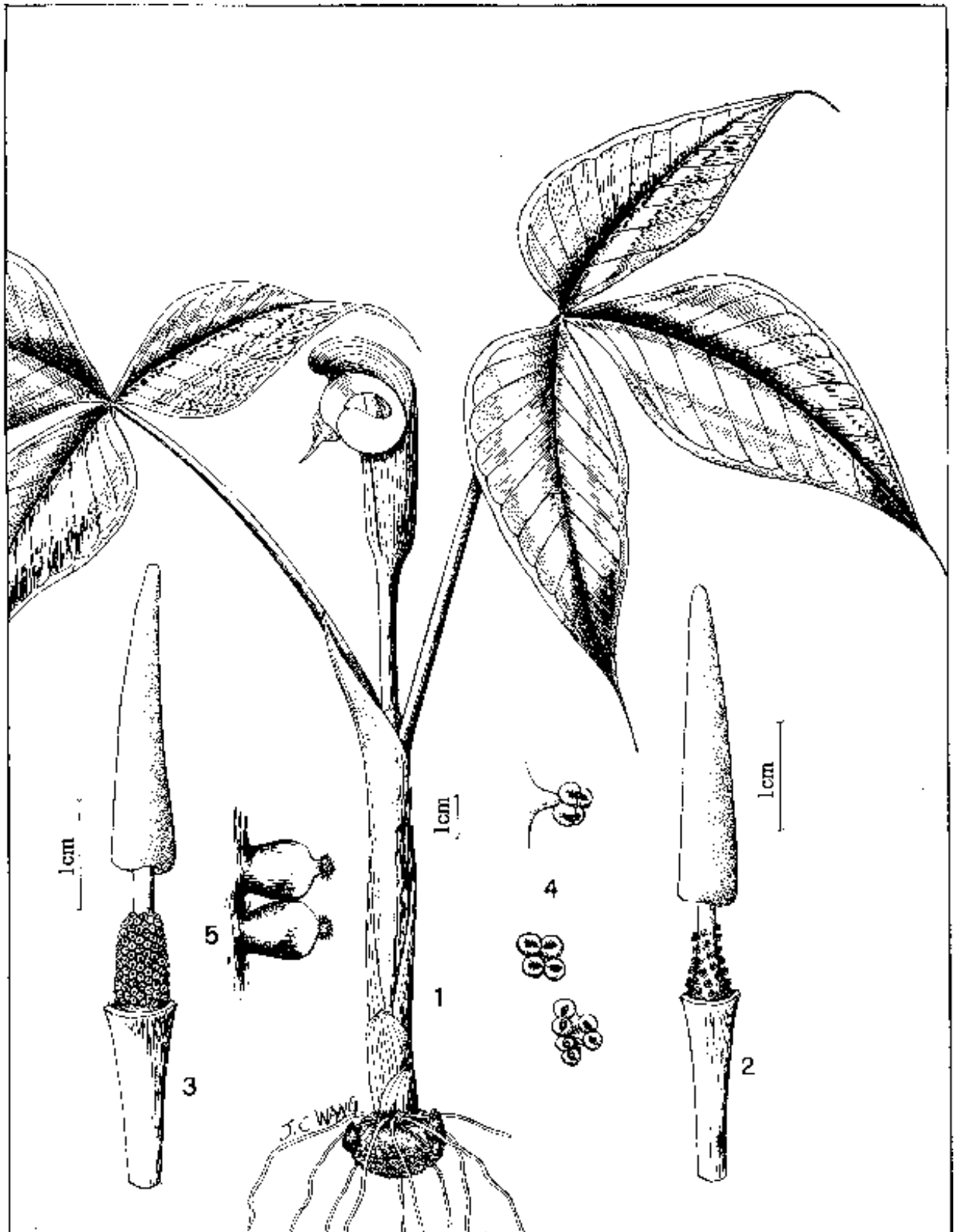
*Arisaema arisanense* Hayata, Icon. Pl. Form. 6:100. 1916; Huang, J. Forest NTU 27:6. 1960; Li in Wu & Li, Fl. Reipubl. Popularis Sin. 13(2): 156. 1979. —TYPE: Formosa. Arisan, 2500m alt., June 1914, *Faurie s.n.* (holotype: TI, figured in Ohashi, Univ. Mus. Univ. Tokyo, Mater. Rep. 5, pl. 8. 1981).

*Arisaema taihokense* Hosokawa, J. Jap. Bot. 12: 214, fig. 2, 3, 5: a-c. 1936; Li in Wu & Li, Fl. Reipubl. Popularis Sin. 13(2): 155. 1979.—TYPE: Taiwan. Taihoku, Koko, 1934, *Ohnuma s.n.* (holotype: TAI).

Tuber depressed globose, 2-5 cm in diameter. Pseudostem 4-30 cm long, white to pale green or sometimes brownish pale green. Cataphylls greenish to purplish. Leavestwo; petiole 10-35 cm long, usually longer or equal to pseudostem; lamina trifoliate; terminal leaflet ovate-lanceolate to rhomboid-elliptic; lateral leaflets obliquely ovate to lanceolate, apex filiform-caudate, usually with a thread-like tail at tip, green above, glaucous beneath. Peduncle 3-6 cm long, distinctly shorter than petiole. Spathe yellowish green to green; tube cylindrical, gradually opening to an auriculate mouth, 3-5.5 cm long, 1-2 cm in diameter, yellowish green to green on outer surface, purplish red with white to pale yellowish green striations on inner surface; blade concave and revolute, saccate, caudate at the apex. Spadix 3-8 cm long including appendage; appendage white, 2-6 cm long including a short stalk of 3-10 mm long, attenuate, base truncate, apex obtuse, without modified sterile flower. Inflorescence erect.

*Specimens examined.* KEELUNG: Campus of National Taiwan Coll. Marine Science and Technology, *Peng 6361* (HAST); Chingjenhu, *Liao et al. 1116* (HAST); Hopingtao, *Lu 604* (TNU); Insl. Keelung, *Masamune et al. 42* (TAI); Keelung, 1913, *Sasaki s.n.* (TAIF), *Kou & Kao 4509* (TAI); TAIPEI: Chihhankung, Hoshanyueh, *Wang 15307* (HAST); Chihshingshan to Erhtzuping, *Lin et al. 78* (TNU); Chinshan, 1993, *Wang s.n.* (TNU), *Lu 511, 512* (TNU); Chungshing Farm *Huang 13454, 13455* (TAI), *Lu 55, 56, 61, 62, 68* (TNU); en route from Hsintien to Pinglin, *Leu & Yang 24* (HAST); Homei, Meiyenshan, *Huang & Huang 13974* (TAI); Hsiaokoutou, *Huang & Jeng 10822* (TAI), 1991, *Chen et al. s.n.* (TNU), *Ou 2* (TNU); Hsiaokoutou to Shihging, *Wang 5280* (TNU); Huangtitian, *Kao 388, 389, 390* (TNU), *Wang et al. 700* (HAST); Koko, *Ohnuma s.n. 1934* (Holotype of *A. taihokense* Hosokawa, TAI!); Kuanyinshan, 1915,





**Figure 17.** *Arisaema ringens* (Thunb.) Schott. 1, Habit and tuber; 2, Male spadix; 3, Female spadix; 4, Male flowers; 5, Female flower. (Wang 6455)

*Shimada s.n.* (TAIF), 1931, *Mori s.n.* (TAI), *Huang 2007, 2015, 2355* (TAI), *Fukuyama s.n. 1940* (TAI); Manyuehyuan, *Wang 5675* (HAST, TNU); Maso (Wanli), *Kawakami & Shimada 4348* (TAIF); Mt. Sitisei, *Suzuki 3503* (TAI), *Suzuki 6747* (TAI); Nankang: en route from Chunghua Inst. of Technology to Nakangshan, *Peng & Chan 10425* (HAST); Nanpanliao, *Huang 10453* (TAI); Pei-Highway, *Huang 15930* (TAI); Peiyi highway (Province Road No.9) 53.5K, *Wang 15308, 15309, 15310* (HAST); Pichashan, *Yang 1196* (TAI); Pihu, *Tsou & Lin 652* (HAST); Pinglin Hsiang: Jenlipan, *Peng et al. 10585* (HAST); Sabosan, 1914, *Shimada s.n.* (TAIF); Sandiaoling, *Masamune 2643* (TAI); Shamaoshan, *Chung 705* (PPI); Sekitei, *Kawakami & Fuji 1914* (TAIF); Shantzuchia, 1934, *Sasaki s.n.* (TAI); Shihting Hsiang: Leikungpo, *Hsiaokotou, Peng & Hu 12286* (HAST); Sozan (Yangmingshan), 1929, *Suzuki s.n.* (TAI), *Hsu 5303* (TAI), *Chuang & Lin 4809* (HAST); Tatunshan, *Lu 15216* (TAIF), *Murata & Yang 17861* (TAI); Tsaoshan, *Hsu 10403* (TAI); Wulai, *Ruan 42* (HAST, TNU), 1972, *Chang s.n.* (TNU), 1981, *Chen s.n.* (PPI); Yangmingshan National Park, *Peng & Hsiao 10459* (HAST); Yangmingshan National Park: on the way from Erhtzuping to Hsiangtienchih, *Chen et al. 431* (HAST, TNU); Yangmingshan National Park: Tsutzuhu, *Leu 387* (HAST); Yehliu, *Wang et al. 7310* (TNU), *Lu 599* (TNU); Yinhotung, 1972, *Chien s.n.* (TNU), *Wang 6455* (HAST, TNU); TAOYUAN: Lalashan *Chen 13* (TAI); HSINCHU: Neiwan, 1916, *Sasaki s.n.* (TAIF). MIAOLI: Shihtan, *Peng et al. 13937* (HAST). ILAN: Insl. Kizan, 1932, *Masamune & Suzuki s.n.* (TAI); Nanao Hsiang: Wushihipi, *Wang et al. 675* (HAST); Taipingshan, 1918, *Sasaki s.n.* (TAIF); Taipingshan to Tuchang, *Suzuki 1140* (TAI); HUALIEN: Antong, *Kao 6147* (TAI); Dangi-Forest, Taroko, *Suzuki 9253, 9305* (TAI); TAITUNG: Is. Lanyu, 1935, *Hosokawa s.n.* (TAI), *Chang 6158, 11481, 11482* (PPI), *Yeh 768* (PPI); Is. Lanyu, Hurngtourshan, *Wang et al. 6100* (TNU), *Chung 572* (PPI).

**Distribution.** Mainland China, south Korea, Japan, and the Ryukyu Islands. Taiwan, in northern part and Lanyu Is. at low altitudes (Figure 8).

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## Literature Cited

- Engler, A. 1920. Araceae-Aroideae. In *Die Pflanzenreich IV*, 23F (Ht.73): 1–249.
- Erdtman, G. 1952. Pollen Morphology and Plant Taxonomy: Angiosperms. Almqvist and Wiksell, Stockholm.
- Hara, H. 1971. A revision of the Eastern Himalayan species of the genus *Arisaema* (Araceae). In Hara, H. (ed.), *Flora of Eastern Himalayas*, second report, pp. 321–354. Univ. Tokyo Press, Tokyo.
- Hayata, B. 1915. *Icones Plantarum Formosananarum*, Bureau Prod. Ind. Gov. Formosa, Taihoku (Taipei). **5**: 241–247.
- Hayata, B. 1916. *Icones Plantarum Formosananarum*, Bureau Prod. Ind. Gov. Formosa, Taihoku (Taipei). **6**: 100–101
- Hayata, B. 1920. *Icones Plantarum Formosananarum*, Bureau Prod. Ind. Gov. Formosa, Taihoku (Taipei). **9**: 146–149
- Hosokawa, T. 1936. A description of *Arisaema taihokensis* sp. nov. from Taiwan. *J. Jap. Bot.* **12**: 212–215.
- Hotta, M. 1971. Study of the family Araceae, general remarks. *Jap. J. Bot.* **20**: 269–310.
- Huang, T. C. 1960. Notes on the *Arisaema* of Taiwan. *Taiwania* **7**: 93–104.
- Huang, T. C. 1962. Chromosome study of *Arisaema* of Taiwan. *Proc. Iowa Acad. Sci.* **69**: 152–155.
- Huang, T. C. 1972. Pollen Flora of Taiwan. NTU Bot. Dept. Press. Taipei.
- Huang, T. C. 1982. A new *Arisaema* of Taiwan. *Taiwania* **27**: 30–34.
- Kitamura, S. 1941. Expositiones plantarum novarum Orientali-Asiaticarum 6. *Acta Phytotax. Geobot.* **10**: 172–192.
- Li, H. 1979. *Arisaema*. In C. Y. Wu & H. Li (eds.), *Flora Reipublicae Popularis Sinicae* **13**(2): 116–194. (in Chinese)
- Li, H. 1980. Himalayas-Hengduan Mountains—the centre of distribution and differentiation of the genus *Arisaema*. *Acta Bot. Yunnan.* **2**: 402–416.
- Liu, T. S. and T. C. Huang. 1978. *Arisaema*, In H. L. Li et al. (eds.), *Flora of Taiwan*. Vol. 5. pp. 802–806.
- Martius, K. F. P. von 1831. *Arisaema*. *Flora* **14**: 458–459.
- Murata, J. 1984. An attempt at an infrageneric classification of the genus *Arisaema* (Araceae). *J. Fac. Sci. Univ. Tokyo*, III, **13**: 431–482.
- Murata, J. 1985. *Arisaema taiwanense* J. Murata (Araceae), a new species from Taiwan. *J. Jap. Bot.* **60**: 353–360.
- Murata, J. 1990a. Present status of *Arisaema* systematics. *Bot. Mag. Tokyo* **103**: 371–382.
- Murata, J. 1990b. New or noteworthy chromosome records in *Arisaema* (Araceae) (2). *J. Jap. Bot.* **65**: 65–72.
- Murata, J. 1991. The systematic position of *Arisaema nepenthoides* and *A. wattii* (Araceae). *Kew Bull.* **46**(1): 119–128.
- Ohashi, H. 1981. Catalogue of the Type Specimens Preserved

- in the Herbarium of Department of Botany in the University Museum, University of Tokyo. Part 1 Araceae. University Museum, Univ. Tokyo Material Reports No. 5.
- Ohashi, H. and J. Murata. 1980. Taxonomy of the Japanese *Arisaema* (Araceae). J. Fac. Sci. Univ. Tokyo, Sect. III, **12** (6): 281–336.
- Ohashi, H., J. Murata, and M. Takahashi. 1983. Pollen morphology of the Japanese *Arisaema* (Araceae). Sci. Rep. Tohoku Univ. 4th ser. **38**: 219–251.
- Ohwi, J. 1965. *Arisaema*. In Flora of Japan. pp. 256–262. Smithsonian Inst., Washington.
- Wang, J. C. 1992. A new record of *Arisaema* (Araceae) in Taiwan. *Taiwania* **37**: 54–57.

## 台灣天南星屬之分類研究

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天南星屬植物全世界共約有150種，主要分布於亞洲之暖溫帶地區。台灣位於分布區之東緣，依據台灣植物誌之記載僅有六分類群，但近十年來陸續發現一些新紀錄及新種，顯示以往分類研究之不足，仍有深入調查之必要。本文針對台灣產天南星屬植物進行詳細之形態、花粉及染色體研究。依據研究結果將台灣地區之本屬植物區分為九種及一變種，其中包括一新種—宜蘭天南星 (*Arisaema ilanense* J. C. Wang) 及一新亞種—東台天南星 (*A. thunbergii* ssp. *autumnale* J. C. Wang, J. Murata & Ohashi)。另將以往併入毛筆天南星 (*A. grapsospadix* Hayata) 之線花南星 (*A. matsudai* Hayata) 處理為不同種。研究結果顯示地下莖類型、小葉排列方式、假莖與葉柄之相對長度以及花序頂端附屬物之形態為主要之分類特徵。花粉表面棘狀突起之長度及密度亦顯示有種間差異，可供分類參考。省產本屬植物之染色體除線花南星尚未檢定外，其餘均為 $2n=28$  (二倍體)，但在羽葉天南星、長行天南星及台灣天南星等種類另發現有 $2n=56$  (四倍體) 之種內異倍體 (intraspecific heteroploidy) 現象。本文並提供種之檢索表，各種之描述、繪圖、地理分布及分類註釋。

**關鍵詞：**天南星科；天南星屬；染色體；花粉；台灣；植物分類。