

Notes on the Flora of Taiwan (21) --- The Genus *Asarum* L. (Aristolochiaceae)⁽¹⁾

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ABSTRACT: The genus *Asarum* of Taiwan is revised on the bases of morphology, pollen features and karyotype analysis. Six species including two new ones are recognized, *i.e.* *A. caudigerum* Hance, *A. crassusepalum* S. F. Huang, T. H. Hsieh & T. C. Huang, *sp. nov.*, *A. epigynum* Hayata, *A. hypogynum* Hayata, *A. macranthum* Hook.f. and *A. taipingshanianum* S. F. Huang, T. H. Hsieh & T. C. Huang, *sp. nov.* These six species can also be identified by using the pollen features alone. The pollen grains are characterized by inaperturate or 4-6-colpoidate. The chromosome number is $2n=24$ except *A. epigynum* with $2n=12$. The evidences from different karyotypes and their geographical distribution data make it possible to reconfirm that the center of origin for this genus is South West China. It is also suggested that the plants of *Asarum* of Taiwan are derived from South China since their karyotypes are within the range of the South China.

KEYWORDS: Revision, *Asarum*, Taiwan.

INTRODUCTION

Asarum s.l. comprises about 90 species distributing in northern temperate areas with the center of distribution in China and Japan (Cheng and Yang, 1983, 1988).

In Taiwan, Hooker (1888) first described *A. macranthum* based on the specimen collected at Keelung by Ford. But Henry (1896), following Maximowicz's treatment, named it as *A. thunbergii* A.Br.. Matsumura and Hayata (1906), and Kawakami (1910) adopted Hooker's treatment. Later, Hayata (1915) described seven new species and two new varieties and adopted the name *A. macranthum*. Such treatments were followed only with slight modifications by the later botanists (Hayata, 1917; Sasaki, 1928; Masamune, 1936; Liu *et al.*, 1976). The detailed chronological studies is shown in the Table 1.

Sasaki (1928) accepted Hayata's treatment (1915), but excluded *A. hypogynum* in his later work (Sasaki, 1930). Wu and her colleague (Wu *et al.* 1974), studying medicinal effects of Taiwan's *Asarum s.l.*, emphasized anatomical studies on stems and roots, and presented line drawings of five species. But the identities of plants they used were later corrected by Maekawa (1978). Liu and Lai (1976) revised this genus, mainly following

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Table 1: Chronological studies of *Asarum* in Taiwan.

Taxa \ Author	Hooker (1888)	Henry (1896)	Matsumura & Hayata (1906)	Kawakami (1910)	Hayata (1915)	Sasaki (1928)	Sasaki (1930)	Masamune (1936)	Maekawa (1936)
<i>A. albomaculatum</i>					+	+	+	+	
<i>A. crassusepalum</i>									
<i>A. epigynum</i>					+	+		+	
<i>A. grandiflorum</i>					+	+	+	+	
<i>A. grandiflorum</i> var. <i>colocasiifolium</i>					+	+	+	+	
<i>A. hayatanum</i>									+
<i>A. hypogynum</i>					+	+		+	
<i>A. infrapurpureum</i>					+	+	+	+	
<i>A. leptophyllum</i>					+	+	+	+	
<i>A. leptophyllum</i> var. <i>triangulare</i>					+	+	+	+	
<i>A. macranthum</i>	+	\$	+	+	+	+	+	+	
<i>A. taipingshanianum</i>									
<i>A. taitonense</i>					+	+	+	+	
<i>A. taiwanense</i>									

\$: treated as *Asarum thunbergii*.

(): the publication dates in brackets.

Table 1: continued.

Taxa \ Author	Masamune (1954)	Liu & Lai (1976)	Maekawa (1978)	Cheng & Yang (1983,1988)	Ying (1990,1991)	Present authors (1995)
<i>A. albomaculatum</i>	1	+	+	?		as <i>A. macranthum</i>
<i>A. crassupetalum</i>						+
<i>A. epigynum</i>	+	+	2	+		+
<i>A. grandiflorum</i>						as <i>A. hypogynum</i>
<i>A. grandiflorum</i> var. <i>colocasiifolium</i>						as <i>A. hypogynum</i>
<i>A. hayatanum</i>	1	+	1	?		as <i>A. hypogynum</i>
<i>A. hypogynum</i>	1	+		?		+
<i>A. infrapurpureum</i>	1	+		+		as <i>A. macranthum</i>
<i>A. leptophyllum</i>	+	+	+	3	4	3
<i>A. leptophyllum</i> var. <i>triangulare</i>				3	4	3
<i>A. macranthum</i>	1	+	1	+		+
<i>A. taipingshanianum</i>						+
<i>A. taitonense</i>	1	+	?	+		as <i>A. macranthum</i>
<i>A. taiwanense</i>					+	as <i>A. epigynum</i>

1: transferred to genus *Heterotropa*; 2: transferred to genus *Geotaenium*.3: treated as *Asarum caudigerum*; 4: treated as variety of *Asarum caudigerum*;

?: mentioned but not treated; (): the publication dates in brackets.

Hayata's treatment, for the Flora of Taiwan. But the specimens they cited were also doubted by Maekawa (1978). In his work, Maekawa (1978) recognized five species, *i.e.* *Geotae-nium epigynum* (Hayata) Maekawa, *Asarum leptophyllum* Hayata, *Heterotropa albomaculata* (Hayata) Maekawa, *H. hayatana* Maekawa and *H. macrantha* (Hook.f.) Maekawa, and left one doubtful species, namely, *Heterotropa taitonensis* (Hayata) Maekawa, for future study. Cheng and Yang (1983, 1988), revising *Asarum* of China, treated five species, *i.e.* *A. caudigerum* Hance, *A. epigynum* Hayata, *A. infrapurpureum* Hayata, *A. macranthum* Hayata, *A. taitonense* Hayata, and left *A. albomaculatum* Hayata, *A. hayatana* Hayata, and *A. hypogynum* Hayata as uncertain species. Ying (1990, 1991) published a new species, *A. taiwanense*, and treated *A. leptophyllum* as a variety of *A. caudigerum*. Thus the infrageneric classification in Taiwan is rather confused, therefore a new revision is desirable.

MATERIALS AND METHODS

The morphological study is based on the herbarium specimens. The specimens were compared with published descriptions. The data of distributions, habitats, altitudes and phenology are obtained from the field notes of the collections.

All cited specimens have been examined for this study except those marked "n.v.". Herbarium specimens were studied from the following herbaria:

HAST: Herbarium, Institute of Botany, Academia Sinica, Taipei, Taiwan.

NTUF: Herbarium, Department of Forestry, National Taiwan University, Taipei, Taiwan.

TAI: Herbarium, Department of Botany, National Taiwan University, Taipei, Taiwan.

TAIF: Herbarium, Division of Forestry Biology, Taiwan Forestry Research Institute, Taipei, Taiwan.

TI: Herbarium, Botanical Gardens, University of Tokyo, 3-7-1 Hakusan, Bunkyo-ku, Tokyo 112, Japan.

TNS: Herbarium, Botany Department, National Science Museum, 3-23-1 Shinjuku-ku Tokyo 169, Japan.

TNU: Herbarium, Department of Biology, National Taiwan Normal University, Taipei, Taiwan.

The voucher specimens for pollen and chromosome studies are also kept in TAI-Herbarium.

Pollen features

Pollen grains were prepared by the method proposed by Erdtman (1952). The acetolyzed grains were dehydrated in an ethanol series and dry with critical point drying. Dried grains were coated with gold and then examined with SEM, Hitachi SM 2400.

Karyotype analysis

The root tips had been held in a solution of 0.002 M 8-hydroxyquinoline for 3-4 hours at a temperature of 18-20°C, then fixed in 1:3 acetic ethanol for overnight, and hydrolysed in pectinase and squashed in acetic orcein. Chromosome study was done with aid of Leitz DM RB.

RESULTS

1. Indefinite roots

Indefinite roots are less than 1 mm thick in diameter, much slender than persisting rhizome and abundantly scattering from it in *A. caudigerum* and *A. epigynum*. The indefinite roots are more than 1 mm thick, emerging only from the rhizome nodes or/and sparsely spreading along it in the other species.

2. Stems and rhizomes

Stems and rhizomes are hardly to distinguish in this genus. We, therefore, use rhizomes as collective term to describe them. Rhizomes are elongate and the vegetative branches are far apart in *A. crassusepalum*, and *A. taipingshanianum*, and moderate in the other species. They are hairy in *A. caudigerum* and *A. epigynum*, and glabrous in the other species.

3. Cataphylls

Cataphylls, the organs to protect young bud, are leafy or scaly, sessile, membranous, hyaline and located in the lower part of annual vegetative or flowering branches. They are caducous and left distinctive scars. The cataphylls of the flowering branches are broadly ovate in *A. macranthum*, oblong in *A. epigynum*, and ovate in the other species. They are hairy at margin, glabrous in the upper surface, hairy in the lower surface in *A. epigynum*, hairy along veins in *A. caudigerum* and *A. hypogynum*, and glabrous in the other species. The upper one is about 4 mm long in *A. epigynum*, and about 10 mm long in the other species.

4. Leaves

Leaves are petiolate; petioles grooved or flat and thickened at margin, hairy when young and gradually deciduous; blades ovate in *A. epigynum*, oblong-triangular in the other species, cordate at base with 2 lobes, usually larger than 12 cm long in *A. hypogynum*, smaller in the other species; when young, gland-dotted beneath and gradually deciduous, hairy throughout beneath in *A. caudigerum* and *A. epigynum*, and hairy along main veins beneath in the other species, hairs gradually deciduous; white maculate in the upper surface, palish green, purple, or purple along veins in the lower surface.

5. Flowering branches

Four types of flowering branches are recognized, which are described as follows:

A. Caudigerum type: The flowering branch is composed of 3 cataphylls at lower part, two nearly opposite leaves at upper part, and a flower appearing from the base of the leaves. This type includes *A. caudigerum*.

B. Epigynum type: The flowering branch is composed of 2 or 3 cataphylls (usually caducous) at lower part, one leaf or two to three alternate leaves (when fully developed) at upper part, and flower(s) appearing from the base of each leaf. This type includes *A. epigynum*.

C. Hypogynum type: The flowering branch is composed of 2 or more cataphylls (sometimes caducous) at lower part, and a flower in the upper part without a leaf. This type includes *A. hypogynum* and population of *A. macranthum* around Tawushan.

D. *Macranthum* type: The flowering branch is composed of 2 or 3 cataphylls at lower part, one leaf at upper part, and a flower appears from the base of the leaf. This type includes *A. crassusepalum*, *A. macranthum*, *A. taipingshanianum*. Two subtypes recognized as below:

i. Flower appearing from a leaf which is much longer than the flower: This subtype includes *A. macranthum* (includes *A. albomaculatum*, *A. infrapurpureum*, and *A. taitoense*).

ii. Flower appearing from a young leaf which is much shorter or subequal to the flower: this subtype includes *A. crassusepalum*, *A. taipingshanianum* and populations of *A. macranthum* around Taipingshan, and Tawushan.

6. Flowers

Flowers are greenish or purplish outside. Perianth is composed of 3 sepals which are free in *A. caudigerum* and united at basal part in the other species. Calyx tube often constricted at upper end forming an orifice. Between orifice and perianth-lobes inside is green in *A. hypogynum*, white in *A. macranthum*, purple or yellowish in the other species. Calyx tube hairy outside in *A. caudigerum* and *A. epigynum*, and glabrous in the other species. Inside the tube, the ridges is absent in *A. caudigerum* and *A. epigynum*, and present in the other species; orifice-rim is absent in *A. caudigerum* and *A. epigynum*, and present in the other species. Appendages between orifice and calyx-lobes are absent in *A. caudigerum*, *A. epigynum* and *A. taipingshanianum*, lined in *A. crassusepalum*, and lamellate in *A. hypogynum* and *A. macranthum*. Calyx lobes are 3 in number, hairy outside in *A. caudigerum* and *A. epigynum*, glabrous in the other species; tailed at apex in *A. caudigerum*, obtuse to rounded in the others; hairy inside in all species except *A. crassusepalum* and *A. hypogynum* which only bearing glands. Petals are absent or sometimes vestigial in *A. macranthum*. Stamens are 12 in two whorls through this genus, sometimes 9 or 10 in *A. caudigerum*; longer or equal to the pistil in flower's position in *A. caudigerum* and *A. epigynum*, and much shorter than pistil in flower's position in the others; filaments are longer than anther in *A. caudigerum*, and much shorter in the others. Pistil is 6-carpeled, rarely 7-carpeled; ovaries are inferior in *A. caudigerum* and *A. epigynum*, superior to half-inferior in the others. Styles are fused to the top in *A. caudigerum* and *A. epigynum*, and free in the others; 2-lobed at the apex in Taiwan's species except *A. caudigerum* and *A. epigynum*, where the stigma crowned. Style dilated at apex to form reflexed stigma in *A. epigynum* and some populations of *A. macranthum*. Character of stigma are so variable that it should be careful in using it as a taxonomic character, otherwise it will be over weighted. Stigmas are strictly terminal in *A. caudigerum* and *A. epigynum*; sometimes in *A. hypogynum* and *A. macranthum*; stigma are subterminal or lateral in the others.

7. Pollen features

The pollen grains of *Asarum hayatatum* (= *A. hypogynum*) was described by Ikuse (1956) as 4-6-colpoidate with supratectum. Later, Huang (1970) described *A. leptophyllum* (= *A. caudigerum*) as inaperturate with supratectum. Our observations (Table 2; Fig. 1-18) are combined as follows: Pollen grains are inaperturate or 4-6-colpoidate; spherical to oblate in equatorial view, circular in polar view; exine tectate or semitectate; tectum perforate, reticulate, rugulate, rugulato-reticulate, rugulato-perforate or perforated subunits (Walker, 1976) with supratectum of small sized granules or large sized warts.

A pollen key is given below to distinguish each species in Taiwan

Key to the species of *Asarum*
(Based on pollen features)

1. Pollen grains inaperturate with many large supratectate warts
 2. Exine reticulate *A. caudigerum*
 2. Exine rugulato-reticulate *A. epigynum*
1. Pollen grains 4-6-colpoidate
 3. Exine with large supratectate warts; tectum reticulate, perforate or rugulato-perforate *A. macranthum*
 3. Exine with small supratectate granules on tectum or small granules on foot layer
 4. Tectum with perforated subunits *A. hypogynum*
 4. Tectum rugulate
 5. Exine loosely broken rugulate with granules on foot layer, columellar and tectum *A. crassusepalum*
 5. Exine compactly rugulate with granules on tectum *A. taipingshanianum*

Table 2: Comparisons of pollen grains of *Asarum* in Taiwan.

Character Taxa	Colpoid	Morphology of exine ornamentation	Locality	Voucher specimen	Figure
<i>A. caudigerum</i>	0	tectum reticulate with large supratectate warts	Hsitou	T.C.Huang et al. 16312	1,2
<i>A. epigynum</i>	0	tectum rugulato-reticulate with large supratectate warts	Nanjenshan	S.P.Li s.n.	3,4
<i>A. hypogynum</i>	4-5	tectum with perforated subunits bearing small supratectate warts	Hsitou	T.C.Huang et al. 16314	5,6
<i>A. macranthum</i>	4-6	tectum reticulate with large supratectate warts	Taipingshan	S.F.Huang 4963	7,8
<i>A. macranthum</i>	4-6	tectum perforate with large supratectate warts	Taipingshan	S.F.Huang 4999	9,10
<i>A. macranthum</i>	4-6	tectum rugulato-perforate with large supratectate warts	Tatunshan	S.F.Huang 5338	11,12
<i>A. macranthum</i>	4-6	tectum loosely broken rugulate with median supratectate warts	Hsiaokuehu	T.H.Hsieh 1106	13,14
<i>A. crassusepalum</i>	4-6	tectum incomplete reticulate with small granules on supratectum and foot layer	Yuanyanghu	T.H.Hsieh 1391	15,16
<i>A. taipingshanianum</i>	4-6	tectum compactly rugulate with small supratectate granules	Taipingshan	S.F.Huang 4965	17,18

8. Karyotype analysis

Some species of *Asarum* in Taiwan, i.e. *A. leptophyllum* (= *A. caudigerum*), *A. epigynum*, *A. macranthum*, *A. taitoense* (= *A. macranthum*), *A. hayatanum* (= *A. hypogynum*), *A. infrapurpureum* (= *A. macranthum*) were cytologically studied by Ono (1960), Sugawara (1982), Sugawara and Ogisu (1992). We examined chromosomes of all the species of *Asarum* (Figs. 19-30). The chromosome number is $2n=24$ for all species except *A. epigynum* with $2n=12$. So far three groups of chromosome sets are recognized from karyotype analysis.

Group 1: This group is composed of *A. epigynum*. The chromosome number is $2n=12$. One pair of chromosomes are metacentric and the other five pairs are subtelocentric.

Group 2: This group is composed of *A. caudigerum*. The chromosome number is $2n=24$. Four pairs of chromosomes are metacentric, and the other eight pairs are submetacentric.

Group 3: This group is composed of *A. crassusepalum*, *A. hypogynum*, *A. macranthum* and *A. taipingshanianum*. The chromosome number is $2n=24$. Eleven pairs of chromosomes are metacentric and one pair are subtelocentric. Satellites were observed on the subtelocentric pairs by Sugawara and Ogisu (1992) but obscure or absent in our observation.

9. Distribution in Taiwan (Fig 31)

Plants of Taiwan *Asarum* tend to differentiate locally due to self-compatibility. On the consequence, the plants in each place are slightly different, or if the difference is distinct, then the plants distribute in very restricted areas.

Asarum epigynum is restricted in the southern Taiwan from Tawushan to Nanjenshan, indicating its subtropical characteristics which could be considered advance since the genus is a temperate one. *Asarum caudigerum* inhabits central Taiwan especially around Hsitou to Alishan where *A. hypogynum* is also housed. *Asarum crassusepalum* is restricted to Yuangyang Lake, a place in the border of Hsueshan Mountain Ridge and Central Mountain Ridge. *Asarum macranthum* is a complex species containing three main populations; 'macranthum' population mainly inhabits Tatum Mountain Ridge to Hsueshan Mountain Ridge and dispersed to North Central Mountain Ridge, especially around Taipingshan, where the plants are hard to segregate to 'macranthum' or 'albomaculatum' population; 'albomaculatum' population inhabits North Central Mountain Ridge to Alishan Mountain Ridge; and 'tawushanianum' population inhabits South Central Mountain Ridge with the southern end at Jinshuiying. Taipingshan is the place where the differentiation is so strong that a new species, *A. taipingshanianum*, is segregated.

DISCUSSION

Asarum s.l. once was splitted into several genera, such as *Asarum s.s.*, *Asiasarum*, *Geotaenum*, *Heterotropa*, *Hexastylis*, and *Japonasarum*. Recently, Cheng and Yang (1983, 1988) considered them as one genus with two subgenera and several sections. The pollen features of Taiwan *Asarum s.l.* show two groups, inaperturate and 4-6-colpoidate, which support the division of two main groups in *Asarum s.l.*. Sugawara (1987) also support the division of two groups when comparing the placental vasculatures. The system of Cheng and Yang (1988) is adopted here.

Walker (1976) mentioned that the pollen grains of the genus *Asarum* are characterized by verrucate supratectum. But in Taiwan, *A. crassusepalum*, *A. hypogynum*, and *A. taipingshanianum* only coated with very few and tiny supratectate granules which could not be detected in light microscope. Studies for more species of *Asarum* are needed to elucidate the variation of the pollen features of this genus. *A. hypogynum* has similar pollen feature as *Thottea* in having many subunits (reticulato-perforate ornamentation in our sense) in exine surface, which suggest some relationships among these genera. *A. macranthum* is a complex species which also shows a wide range of variation in pollen features. A population study of *A. macranthum* is urgent.

Synthesizing the cytological data of Gregory (1956), Ono (1960), Sugawara (1981, 1982), Sugawara and Ogisu (1986, 1992), seven types of karyotype are recognized as follows:

- Type A: Chromosome number is $2n=26$ and the chromosome set contains one pairs of subtelocentric chromosomes.
- Type B: Chromosome number is $2n=26$ and the chromosome set contains two pairs of subtelocentric chromosomes.
- Type C: Chromosome number is $2n=26$ (or 39) and the chromosome set contains three pairs of subtelocentric chromosomes.
- Type D: Chromosome number is $2n=26$ and the chromosome set contains 11 pairs of subtelocentric chromosomes.
- Type E: Chromosome number is $2n=24$ and the chromosome set contains no subtelocentric chromosome.
- Type F: Chromosome number is $2n=24$ (or 48) and the chromosome set contains one pair of subtelocentric chromosomes which are usually satellite.
- Type G: Chromosome number is $2n=12$ and the chromosome set contains five pairs of subtelocentric chromosomes.

After we correlated the data of karyotypes with the taxonomic treatments of Cheng and Yang (1988) and Ohwi (1970), and geographic distribution of Ma (1990) as Table 3, we

Table 3: The correlation of karyotypes and infrageneric distributions of *Asarum*. (Types of karyotype see the contents; taxa and area from Cheng & Yang, 1988; Ohwi, 1970; and Ma, 1990)

TAXA \ AREA	1	2	3	4	5	6	7	8	9	10	11	12	13	14
subgenus <i>Asarum</i>														
section <i>Asarum</i>			A	AF	AEF	E	(E)	E	E	A		(B)	(B)	B
section <i>Brevituba</i>			(D)	(D)	D	(G)	(D)	G						
subgenus <i>Heterotropa</i>														
section <i>Asiasarum</i>	C	C	C	C						C	C	C		
section <i>Longiflorum</i>			(C)	C	(C)		C							
section <i>Heterotropa</i>			CF	C	CF			F	(F)	F				
section <i>Hexastylis</i>														C

1: North East China; 2: North China; 3: Central China; 4: South West China; 5: South China; 6: East Himalaya; 7: Vietnam; 8: Taiwan; 9: Ryukyus; 10: Japan; 11: Korea; 12: Russia; 13: Europe; 14: N. America. (): Possible karvotvde. only chromosome numbers are known.

found the diversity of the karyotypes were high in the Central, South West and South China, especially in South West China where it might be the center of origin for this genus as suggested by Ma (1990).

Since The karyotypes of Taiwan's species are included within the range of South China, we suggest that the plants of Taiwan's *Asarum* are derived from there.

TAXONOMIC TREATMENTS

Asarum L., Sp. Pl. 422. 1753; Liu and Lai in Fl. Taiwan **2**: 576. 1976; Cheng and Yang in J. Arn Arb. **64**: 565. 1983; Cheng and Yang in Fl. Reip. Pop. Sin. **24**: 161. 1988.

Perennial herb. Rhizomes short or elongate, creeping or ascending, hairy or glabrous. Indefinite roots many along rhizome. Cataphylls leafy or scaly, sessile, membranous, hyaline, caducous, in the lower part of annual vegetative branch or flowering branch. Leaves petiolate; petioles long, grooved or flat and thickened at margin, hairy when young and gradually deciduous; blades ovate or triangular, cordate at base, usually albo-maculate above, palish green or purple beneath. Flower solitary, pedicellate; sepals 3, free at base or not; calyx tube ridged inside or not, constricted above forming orifice; orifice with rim appendage or not; appendage present or not between orifice and calyx lobes; calyx lobes 3; stamens 12 in two whorls; filaments longer or shorter than connective; ovaries 6, inferior or superior, fused; styles 6, fused or free, bi-lobed at apex or not; stigma terminal or lateral. Fruit a capsule, with persistent calyx. Seeds many, ovate.

Key to the species

1. Rhizomes hairy; indefinite roots slender, less than 1 mm thick in diameter, spreading along the stem; calyx tube without orifice-rim; styles fused at least to the middle part.
 2. Flowering branch with 2 nearly opposite leaves; leaves usually triangular; calyx lobes tailed at apex; filaments longer than the anthers.....1. *A. caudigerum*
 2. Flowering branch with 1 or 2 alternate leaves; leaves usually ovate; calyx lobes rounded at apex; filaments shorter than the anthers.....3. *A. epigynum*
1. Rhizomes glabrous; indefinite roots tough, more than 1 mm thick in diameter; calyx tube with orifice-rim; styles free.
 3. Leaf blade usually more than 12 cm long; flower with many cataphylls directly below; calyx lobe purple and green, without hairs inside.....4. *A. hypogynum*
 3. Leaf blade usually less than 10 cm long, if more than 12 cm long then flower without cataphylls directly below.
 4. Annual vegetative branches close together; flower with lamellate appendage between orifice and calyx lobes.....5. *A. macranthum*
 4. Annual vegetative branches far apart; flower without or with lined appendage between orifice and calyx lobe.
 5. Flower with lined appendage between orifice and calyx lobes; calyx lobes rugose without hairs inside.....2. *A. crassusepalum*
 5. Flower without appendage between orifice and calyx lobes; calyx lobes smooth with hairs inside6. *A. taipingshanianum*

1. *Asarum caudigerum* Hance in J. Bot. **19**: 142. 1881; Cheng & Yang in J. Arn. Arb. **64**: 568. 1983; Cheng & Yang in Fl. Reip. Pop. Sin. **24**: 165. 1988. 薄葉細辛. **Fig. 1, 2, 19, 31.**

Asarum leptophyllum Hayata, Icon. Pl. Form. **5**: 147. 1915; Wu et al. in Pei-I-Shue-Pao (J. Taipei Med. College) **6**: 26. pl. 6. 1974; Liu & Lai in Fl. Taiwan **2**: 579. pl. 413. 1976; Mackawa in J. Jap. Bot. **53**: 290. 1978.

Asarum leptophyllum Hayata var. *triangulare* Hayata, Icon. Pl. Form. **5**: 148. 1915.

Asarum caudigerum Hance var. *leptophyllum* (Hayata) Ying in Mem. Coll. Agr., NTU. **30(2)**: 64. 1990.

Asarum caudigerum Hance var. *triangulare* (Hayata) Ying in Mem. Coll. Agr., NTU. **31(1)**: 33. 1991.

Indefinite roots hairy, spreading along rhizome and much narrower than it. Rhizome suberect, striate, hairy. Leaves petiolate; petiole densely hairy; blades triangular, rarely ovate, densely hairy and gradually deciduous, acuminate at apex, cordate and 2-lobed at base, 6.5-10 cm long, 6.5-8.5 cm broad, lobes 2.5-3.5 cm long, 2.8-4.5 cm broad. Flowering branch with 3 cataphylls at base, the upper one ovate, 10 mm long, hairy at margin and along veins beneath, glabrous above; flower emerging from the middle of the a 2 nearly opposite leaves in the outer appearance, hairy outside; calyx lobes 3, with abundant short hairs at upper part inside, less at lower part, tailed at apex; stamens 10-12, longer than pistil in flower position; filament longer than anther; ovary inferior; style connate; stigma 6, terminal.

Habitat: Forest margin, under forest.

Altitude: 300-2,000m.

Distribution: Southern China, Ryukyus, Taiwan; Taiwan in the central part.

Flowering: January, March, May, June, December.

Specimens examined:

CHIAYI: Alishan, Ito & Hayata s.n. Mar. 1914 (Type of *Asarum leptophyllum* var. *triangulare*, TAIF!), S. Sasaki s.n. Mar. 1911 (TAI), S. Sasaki s.n. Jan. 20, 1915 (TNS); Chunglun, Yeng & Kao 10697 (TAI); Chiaoliping, Ito & Hayata s.n. Mar. 27, 1914 (Type of *Asarum leptophyllum*, TAIF!). **HSINCHU:** Mt. Pa-u, M.T.Kao s.n. (TAI). **HUALIEN:** Chinshuishan, T.C.Huang et al. 12957 (TAI), W.H.Hu 1239 (HAST); Lanshan, T.S.Chan et al. s.n. Oct. 26, 1986 (HAST). **NANTOU:** Hsitou, T.C.Huang et al. 1631 (TAI), M.J.Lai 2445 (NTUF); Lienhuachih, Kuan 51 (TAI); Meiyuan, Masamune s.n. Mar. 27, 1944 (TAI); Chingshuikou, Liu & Kao s.n. Feb. 18, 1959 (NTUF).

2. *Asarum crassusepalum* S.F.Huang, T.H.Hsieh & T.C.Huang, *sp. nov.* 鴛鴦湖細辛. **Fig. 15, 16, 20, 26, 31, 32.**

Affine speciei *Asaro taipingshaniano*, sed sepalo crasso glabro glandeque interno differt.

Indefinite roots quite few, glabrous, as thick as rhizome. Rhizome glabrous, striate, elongate, the annual vegetative branch with 2 cataphylls at base, the upper one membranous, hyaline, sessile, oblong, glabrous at both surfaces, hairy at margin, obtuse at apex. Leaves

gland-dotted and shortly hairy above when young and gradually deciduous, glabrous beneath; petiole hairy above, grooved; blade triangular-oblong to triangular-ovate, acute to acuminate at apex, cordate and 2-lobed at base, 3.7 cm long, 2.3-2.9 cm broad, lobes 1 cm long, 1.4-1.7 cm broad, green and albo-maculate above, purple beneath. Flowering branch with 2 cataphylls at base, the upper one ovate, glabrous at both surfaces, hairy at margin; flower emerging from the branch or from a young leaf, 7 mm in diameter; pedicels glabrous, 4 mm long; calyx tube glabrous outside, reticulate-ridged inside, with orifice at the upper end of ridge; line scars present between the orifice and calyx lobes; calyx lobes 3, irregular thickened, glabrous with glands inside; stamens 12, filaments much shorter than anthers; ovary fused; style 6, free, slightly 2-lobed at apex; stigma orbicular, lateral. Fruit unknown.

Habitat: In the forest floor.

Altitude: 1,600-1,700m.

Distribution: Endemic; around Yuanyang Lake in Hsinchu County.

Flowering: February, April.

Specimens examined:

HSINCHU: Yuanyanghu, T. H. Hsieh 1391 (Holotype, TAI), Y. F. Wang 923 (TAI), M. H. Chen 177 (HAST), C. C. Liao 897 (HAST), C. I. Peng 15156 (HAST).

Note: The species is similar to *Asarum taipingshanianum* but differs from it by the thickened sepals which is glabrous and bears glands only inside, and by the pollen grain with incomplete reticulate ornamentation.

3. *Asarum epigynum* Hayata, Icon. Pl. Form. **5**: 140. 1915; Masamune in Trans. Nat. Hist. Soc. Form. **30**: 36. 1940; Liu & Lai in Fl. Taiwan **2**: 577. 1976; Maekawa in J. Jap. Bot. **52**: 221. 1977; Cheng & Yang in J. Arn. Arb. **64**: 571. 1983; Cheng & Yang in Fl. Reip. Pop. Sin. **24**: 175. pl. 38, 1-5. 1988. 上花細辛. Fig. 3, 4, 21, 27, 33.

Geotaenium epigynum (Hayata) Maekawa in Proceed. Seventh Pacific Sci. Congr. (New Zeal.) **5**: 217. 1953; Maekawa in J. Jap. Bot. 291. 1978.

Asarum taiwanense Ying in Mem. Coll. Agr., NTU. **30(2)**: 54. pl. 1. 1990.

Indefinite roots spreading on rhizome, much narrower than rhizome in diameter. rhizome striate, hairy; annual vegetative branch densely hirsute. Leaves densely hirsute when young and gradually deciduous, petioles grooved; blade ovate or triangular-ovate, acuminate at apex, cordate and 2-lobed at base, 5.7-8 cm long (from tip to the attachment of petiole), 3.6-5.2 cm broad, lobes 1-2 cm long, 1.5-2.5 cm broad. Flowering branch with 3 short and deciduous cataphylls at base, the upper one oblong, 4 mm long, hairy beneath. Flower emerging from the base of a leaf, densely hirsute when young; calyx hairy outside, without orifice and ridge inside, tube hairy inside, lobes 3, rounded at apex, hairy inside, smooth; stamens 12, longer than pistil in flower position; ovary and style fused; stigma 6, terminal. Seed ovate, greyish white, 4 mm long.

Habitat: In the shady forest floor.

Altitude: 250-1,150m.

Distribution: Hainan and Taiwan; Taiwan in the southern part.

Flowering: March.

Specimens examined:

WITHOUT LOCALITY: *T.Soma* s.n. (Type, TI!). **PINGTUNG:** Chunjih Hsiang, Cha-chayalaishan protection area, 28 forest compartment, C.C. Liao et al. 195 (HAST); Kao-shihfu, Yang & Chen s.n. Oct. 4, 1994 (TAI), *T.Soma* s.n. Jan. 3, 1912 (TI); Nanjenshan, C.I. Peng 7797 (HAST), Sasaki s.n. March 27, 1932 (TAI), K.H. Wang 849 (TAI), S.P. Li s.n. 1995 (TAI), W.T. Chao 41 3 (TNU); Shouka, C.S. Kuo 15473 (HAST), M.T. Kao 9517 (TAI); W.T. Son s.n. July 1989 (HAST), S.S. Ying s.n. March 24, 1987 (Type of *Asarum taiwanense*, NTUF!); Shouka-Tsaopu, T.C. Huang & S.F. Huang 14067 (TAI); Wuweshan, Sasaki s.n. Dec. 30, 1918 (TNS); E. Matuda s.n. Dec. 30, 1918 (TI). **TAITUNG:** Taririku, S. Sasaki s.n. Feb. 25, 1925 (TAI).

Note: Plants of Taiwan are slightly different from those of Hainan, when you compare with the description and figures made by Cheng and Yang (1988), in the cataphylls of flowering branch being smaller, 4 (against 8) mm long, and flowering branch bearing one or two to three alternate (against two nearly opposite) leaves. The flowering branch consisting of two nearly opposite leaves seems to be the rule of the subgenus *Asarum* in view of the published figures. If it is true, *A. epigynum* in Taiwan represents a highly specialized one in the subgenus *Asarum*.

4. *Asarum hypogynum* Hayata, Icon. Pl. Form. 5: 144. f. 53. 1915; Liu & Lai in Fl. Taiwan 2: 578. 1976. 下花細辛. Fig. 5, 6, 22, 28, 31, 34.

Asarum grandiflorum Hayata, Icon. Pl. Form. 5: 141. f. 52. 1915, non Klotsch 1859.

Asarum grandiflorum Hayata var. *colocasiifolium* Hayata, Icon. Pl. Form. 5: 144. 1915.

Asarum hayatana Maekawa [in J. Jap. Bot. 12: 35. 1936, *pro syn.*] Maekawa ex Masamune in Sci. Rep. Kanzawa Univ. 2: 77. 1954; Liu & Lai in Fl. Taiwan 2: 578. 1976, p.p..

Heterotropa hayatana Maekawa in J. Jap. Bot. 12: 34. 1936, new name for *Asarum grandiflorum* Hayata non Klotsch 1859; Maekawa in J. Jap. Bot. 53: 296. f. 7. 1978.

Heterotropa hayatana Maekawa f. *colocasiifolia* (Hayata) Maekawa ex Nemoto, Fl. Jap. Suppl. 160. 1936.

Heterotropa hypogyna (Hayata) Maekawa ex Nemoto, Fl. Jap. Suppl. 161. 1936; Masamune, List Vasc. Pl. Taiwan 49. 1954.

Indefinite roots many, narrower than the rhizome, young ones hairy and gradually deciduous. Rhizomes striate, glabrous; annual vegetative branch with 2-3 prophylls scars at lower part, prophylls 4 mm long, sparsely hairy. Leaves long petiolate; petioles hairy when young and gradually deciduous, grooved; blade triangular, hairy along veins beneath when young and gradually deciduous, glabrous above, green and albomaculate above, palish green and scatterly small gland-dotted beneath, acuminate to caudex at apex, cordate and 2-lobed at base, 13-19.5 cm long, 6.6-20 cm broad, lobes 3-9 cm long, 2.8-9.5 cm broad. Flowering branch with prophylls' scars at the base of pedicel; the upper cataphyll

membranous, hyaline, ovate, hairy at margin, gland-dotted beneath; flowers glabrous outside; calyx tube reticulate-ridged inside, glabrous, with orifice-rim large and rugose above the ridge, with lamellate appendage between orifice and calyx-lobes; lobes 3, glabrous inside, with abundant short glands, rough at surface; stamens 12, shorter than the pistil; ovary fused; styles 6, free; stigma terminal, or subterminal, orbicular to slightly oblong. Seed ovate brownish white, gland-dotted, 3.8 mm long.

Habitat: In the forest floor.

Altitude: 1,000-2,000m.

Distribution: Endemic, in central part of Taiwan.

Flowering: January, February, July, October, December

Specimens examined:

CHIAYI: Taroyen, *B.Hayata s.n.* Jan. 20, 1912 (Type of *Asarum hypogynum*, TI!); Erwanping, *B.Hayata s.n.* Apr 4, 1914 (Type of *Asarum grandiflorum* Hayata, TI!); Chuchi, Tatungshan, *H.F.Yen 7113* (HAST); Fenchihu, *B.Hayata s.n.* March 1907 (TAI), *T.C.Huang & S.F.Huang 15947* (TAI), *K.H.Wang 857* (TAI), **NANTOU:** Hsitou, *T.C.Huang et al. 16314* (TAI), *Kao 3036* (TAI, HAST); Hsitou to Fenghuangshan, *C.C.Hsu 6102* (TAI), *6159* (TAI); Fenghuangshan, *Y.K.Chen 264* (HAST); Sunlinksea, *S.J.Hsiao s.n.* Jan. 23, 1987 (HAST), *C.C.Liao et al. 946* (HAST).

Note: According to Hayata(1915), *Asarum grandiflorum* (= *A. hayatatum*) was different from *A. hypogynum* by bigger flower and, especially, terminal and decurrent stigma. Maekawa (1978) mentioned that the stigma of *A. hayatatum* was terminal and orbicular. In this study, no decurrent stigmas were ever found while the terminal stigma and subterminal stigma were examined. We treat them as conspecies.

5. ***Asarum macranthum*** Hook. f. in Bot. Mag. **114: pl. 7022.** 1888; Hayata, Icon. Pl. Form. **5: 149.** 1915; Liu & Lai in Fl. Taiwan **2: 579.** 1976; Cheng & Yang in J. Arn. Arb. **64: 585.** 1983. 大花細辛. **Fig. 7, 8, 9, 10, 11, 12, 13, 14, 23, 29, 31, 35.**

Asarum thunbergii auct. non A.Br.: Henry, List. Pl. Form. **77.** 1896.

Asarum albomaculatum Hayata, Icon. Pl. Form. **5: 139. f. 51.** 1915; Liu & Lai in Fl. Taiwan **2: 577.** 1976.

Asarum infrapurpleum Hayata, Icon. Pl. Form. **5: 146.** 1915; Liu & Lai in Fl. Taiwan **2: 579.** 1976.

Asarum taitonense Hayata, Icon. Pl. Form. **5: 148.** 1915; Wu et al. in Pei-I-Hsueh-Pao(J. Taipei Med. College) **6: 30. pl. 10.** 1974; Liu & Lai in Fl. Taiwan **2: 581.** 1976, *p.p.*; Cheng & Yang in J. Arn. Arb. **64: 383.** 1983.

Heterotropa albomaculata (Hayata) Maekawa ex Nemoto, Fl. Jap. Suppl. **156.** 1936; Maekawa in J. Jap. Bot. **53: 297. f.1.** 1978.

Heterotropa infrapurea (Hayata) Maekawa ex Nemoto, Fl. Jap. Suppl. **161.** 1936.

Heterotropa macrantha (Hook. f.) Maekawa ex Nemoto, Fl. Jap. Suppl. **162.** 1936; Maekawa in J. Jap. Bot. **53: 294. f. 3, 4.** 1978.

Heterotropa taitonensis (Hayata) Maekawa ex Nemoto, Fl. Jap. Suppl. **165.** 1936.

Asarum hayatatum auct. non (Maekawa) Maekawa ex Masamune: Wu et al. in Pei-I-Hsueh-Pao (J. Taipei Med. College) **6: 27. pl. 7.** 1974.

Asarum hypogynum auct. non Hayata: Wu *et al.* in Pei-I-Hsueh-Pao (J. Taipei Med. College) 6: 28. pl. 8. 1974.

Indefinite roots many, narrower than rhizomes in diameter. Rhizomes glabrous, striate. Leaves petiolate; petioles grooved or flat and thickened at margin; blade oblong-triangular, acuminate at apex, cordate and 2-lobed at base, hairy at margin, green, albo-maculate, sparsely hairy above, palish green, purplish along veins or purple throughout beneath, gland-dotted beneath or not. Flowering branch with 2-3 cataphylls and/or many scars at base, the upper one broadly ovate, hairy at margin; flower emerging from a much larger leaf or a young one, glabrous outside; calyx tube glabrous inside, reticulate-ridged, with orifice-rim large or small; lamellae white and distinct between orifice and calyx lobes; calyx lobes 3, wavy at margin, densely hairy inside; stamens 12, shorter than pistil; ovary 6, fused, superior to half superior; style 6, free, 2-lobed at apex, lobes separate or connate, dilated at the base of the lobes or not; stigma oblong to orbicular, reflexed or not, terminal, subterminal or lateral. Seed ovate, brownish white, 3.5 mm long.

Habitat: In the forest floor.

Altitude: 0-2,800m.

Distribution: Endemic, throughout the islands.

Flowering: January, March, April, May.

Specimens examined:

CHIAYI: Erwanping, Alishan, *B.Hayata* s.n. Apr. 1914 (TAI), *Ito & Hayata*, s.n. Apr. 1914 (Type of *Asarum albomaculatum*, TI!, TAIF!). **HSINCHU:** Tentana, *R.Kanehira et al.* s.n. Apr. 1918 (TAI); Wuchihshan, *C.I.Peng* 12942 (HAST). **HUALIEN:** Chingshuishan, *Shimizu & Kao* 11883 (TAI); inter Kiraiki et Higasino, *Kudo & Mori* s.n. July 10, 1930 (TAI); Hsiulin Hsiang, Kuailin to Wuchiapengshan, *C.C.Liao et al.* 1411 (HAST); Meifeng Farm, *Leu & Yen* 440 (HAST). **ILAN:** Taipingshan, *S.F.Huang* 4963 (TAI), *S.F.Huang* 4973 (TAI), *S.F.Huang* 4999 (TAI), *S.Suzuki* s.n. Aug. 4, 1928 (TAI), Tairei, *S.Suzuki* 4076 (TAI); Mururoahu, *S.Suzuki* s.n. Aug. 9, 1928 (TAI); Chialoshan, *S.Suzuki* 767 (TAI); Sakahen to Tencho, *S.Suzuki* 1774 (TAI); Shenmihu, *S.F.Huang et al.* 5200 (TAI). **MIAOLI:** Chungshueshan, *Kuo & Kao* s.n. May 21, 1958 (NTUF); Kuanwu to Kuaishan, *C.I.Peng* 9439 (HAST). **PINGTUNG:** Tawushan, Tiishuichang to Kueiku, *T. Namba et al.* 751 (TI), from Peitawushan hiking entrance to Kuaiku mountain lodge, *J.C.Wang et al.* 9057 (TAI,TNU), Tawushan, *E. Matuda* s.n. Jan 4, 1921 (TAI), *T.C.Huang et al.* 13628A (TAI); Hsiaokuehu, *T.H.Hsieh*, 1106 (TAI); Bayouchih, *S.F.Huang* 3363 (TAI); Arikobanti, *E.Matuda* s.n. Jan. 2, 1917 (TAI); Wutai, *C.H.Liu et al.* 385 (HAST); Shuitiliao to Tahanshan, *W.P.Leu* 601 (HAST). **TAICHUNG:** Ssuyuan-yiako, *Yang & Hsieh* 4072 (TAI). **TAIPEI:** Lupei, *C.F.Hsieh et al.* 688 (TAI); Tatunshan, *S.F.Huang* 5338 to 5342 (TAI), *S.Suzuki*, s.n. Apr. 27, 1932 (TAI); Hsiaokuan-yinshan, *H.Shimada* s.n. Apr. 21, 1935 (TAI); Chutsuhu, *S.Suzuki* 4349 (TAI); Chihshingshan, *S.F.Huang* 4257 (TAI); Chyakonkei, *S.Sasaki* s.n. Mar. 27, 1920 (TAI); Wenshan, *W.T.Chao et al.* s.n. Apr. 18, 1992 (TAI); Huangtidien, *S.F.Huang* 5359 to 5367 (TAI), *Yu et al.* 186 (TAI); Kuanyinshan, Fukuyama et al. 49 (TAI); Yinhetung, *C.C.Hsu et al.* 4321 (TAI); Tarana, *T.Suzuki* 17872 (TAI). **TAITUNG:** Shenshan to Wushan, *T.Hosokawa* 5295 (TAI); Matuyama, Tipon-goe, *S.Suzuki* s.n. Aug. 30, 1932 (TAI); Kueihu, *C.C.Hsu* 3355 (TAI); Shichiseitozan, *Kawakami & Sasaki* s.n. Mar. 1911 (Type of *Asarum infrapurpleum*, TI!, TAIF!); Tatunshan, *U. Faurie* s.n. June 1903 (Type of *Asarum taitonense* Hayata, TI!, TAIF!). **TAOYUAN:** Lalashan, *M.C.Chien* 39 (TAI); Paling to Tamanshan, *Hu & Yang* 740 (TAI); Battoru, *S.Sasaki* s.n. May 2, 1934 (TAI).

Note: This species is rather variable. The local differentiation of this species is usually stable that lead some taxonomists to separate this species into several small ones. Owing to the local differentiation, the following populations can be grouped; an infraspecific rank is not given because the delimitation is difficult for the groups of plants with continuous variations of characters.

'macranthum' population: This population includes *Asarum macranthum*, *A. infrapureum*, and *A. taitonense* distributing in northern part of Taiwan. When inhabiting the low altitude, the stigma is oblong, terminal or subterminal, and reflexed at one end because of dilation of the style at the upper part, the lobes of the style are separated, the filaments are emarginate at apex (*A. macranthum*). When inhabiting the medium altitude, the stigma is oblong, subterminal, and reflexed at one end, the lobes of the style are connate and may be separated when merged with alcohol, the filaments are rounded at apex (*A. infrapureum*). When inhabiting the higher altitude, the plants become smaller in every parts, the stigma is oblong, lateral, and also reflexed at one end, the lobes of style are connate, the filaments are rounded at apex (*A. taitonense*). In this population, the leaves are green and albomaculate above, palish green or purplish along veins (never purple throughout) beneath; the venation is rather distinctive. The flower always appears from the base of a much larger leaf. The vegetative branches are very close together.

'albomaculatum' population: This population includes *Asarum albomaculatum* distributing in high altitude of north to central part of Central Taiwan Mountain Ridge and Alishan Mountain Ridge. The stigma is orbicular or slightly oblong, lateral, but never reflexed at one end for shortage of dilation of the style at upper part, the lobes of the style are connate, the filaments are rounded at apex. In this population, The leaves are green and albomaculate above, purple beneath, the venation is not so distinctive. The flower usually appears from the base of a mature or young leaf. The vegetative branches are close together or a little far apart.

'tawushanianum' population: This population distributes in high altitude of the southern Central Taiwan Mountain Ridge. The stigma is oblong or suborbicular, lateral or terminal, never reflexed at one end, the lobes of the style are connate or separated, the filaments are rounded at apex. The leaves of this population are green and albo-maculate above, palish green or purple beneath, triangular in shape with acuminate to caudex tip, the venation is not so distinctive. The vegetative branches are a little far apart. The flower appears from a young leaf or from branch directly. This population is similar to 'albomaculatum' and sometimes similar to *A. hypogynum* in outer appearance.

The morphology are most variable in the population around the area of Taipingshan. The stigma is oblong or slightly oblong, lateral or subterminal, reflexed at one end or not (the stigma's type of 'macranthum' and 'albomaculatum' in one flower are examined), the lobes of the style connate, the connective are rounded at apex. The leaves are green and albomaculate above, purple or palish green beneath, the venation is not so distinctive. The vegetative branches usually close together. The flower appears from a young leaf.

The population around Shenmi Lake, Ilan County, are morphologically identical to 'macranthum' except the pistil like 'albomaculatum'.

The comparisons are summerized in Table 4.

Table 4: The characters among three major populations in *Asarum macranthum*.

CHARACTER	MACRANTHUM	ALBOMACULATUM	TAWUSHANIANUM
Leaves			
above	green and albomaculate	"	"
beneath	palish green or purplish along veins	purple throughout	palish green or purplish throughout
venation	distinctive	not distinctive	not distinctive
Vegetative branches	close together	close together or a little far apart	a little far apart
Flowers			
position	at the base of a mature leaf	at the base of a mature or young leaf	at the base of a young leaf or from rhizome
style	dilated at apex	not dilated	not dilated
lobes	separated or connate	connate	connate
stigma	reflexed	not reflexed	not reflexed
	terminal	lateral	terminal
	sublateral		sublateral
	lateral		lateral
shape	oblong	suborbicular to oblong	oblong to suborbicular

6. *Asarum taipingshanianum* S.F.Huang, T.H.Hsieh & T.C.Huang, *sp. nov.* 太平山細辛.
Fig. 17, 18, 24, 30, 31, 36.

Affine *A. macrantho*, sed rhizomatibus longis et appendicibus inter orificis sepalaque absentibus differt.

Indefinite roots quite few, as wide as rhizome in diameter. Rhizomes elongate, striate, glabrous; annual vegetative branch with 3 cataphylls, scars at base. Leaves small, gland-dotted, hairy along main veins and at margins when young and gradually deciduous; petioles grooved; blades triangular-oblong, obtuse at apex, cordate and 2-lobed at base, green, albomaculate, and spreading shortly hairy above denser along veins, palish green or purple beneath, 3.2-5.3 cm long, 2.1-4.7 cm broad, lobes 1-2 cm long, 1.3-2.3 cm broad. Flowering branch with 3 cataphylls at base, the upper one 10 mm long, ovate, membranous, hyaline, hairy at margin, acute at apex; flower emerging from the base of a young leaf; calyx tube glabrous outside, shallowly ridged inside, with orifice-rim at the end of the ridge; lamellae between calyx lobes and orifice absent; calyx lobes hairy inside, glabrous outside; stamens 12, filament much shorter than anther; ovary fused; style 6, free, emarginate at apex, stigma oblong, lateral. Fruit unknown.

Habitat: In the shaded forest floor.

Altitude: 1,900m.

Distribution: Endemic; Taiwan around Taipingshan.

Flowering: January.

Specimens examined:

ILAN: Taipingshan, *S.F.Huang* 4965 (Holotype and isotypes, TAI), *S.F.Huang & T.H.Hsieh* 5372 to 5374 (TAI); Chilanshan, *C.M.Kuo* 8187 (TAI).

Note: This species differs from *A. macranthum* by long rhizome and absence of appendages between orifice and calyx lobes. The pollen grains are also different by the tiny supratectate granules and the striate ornament in exine.

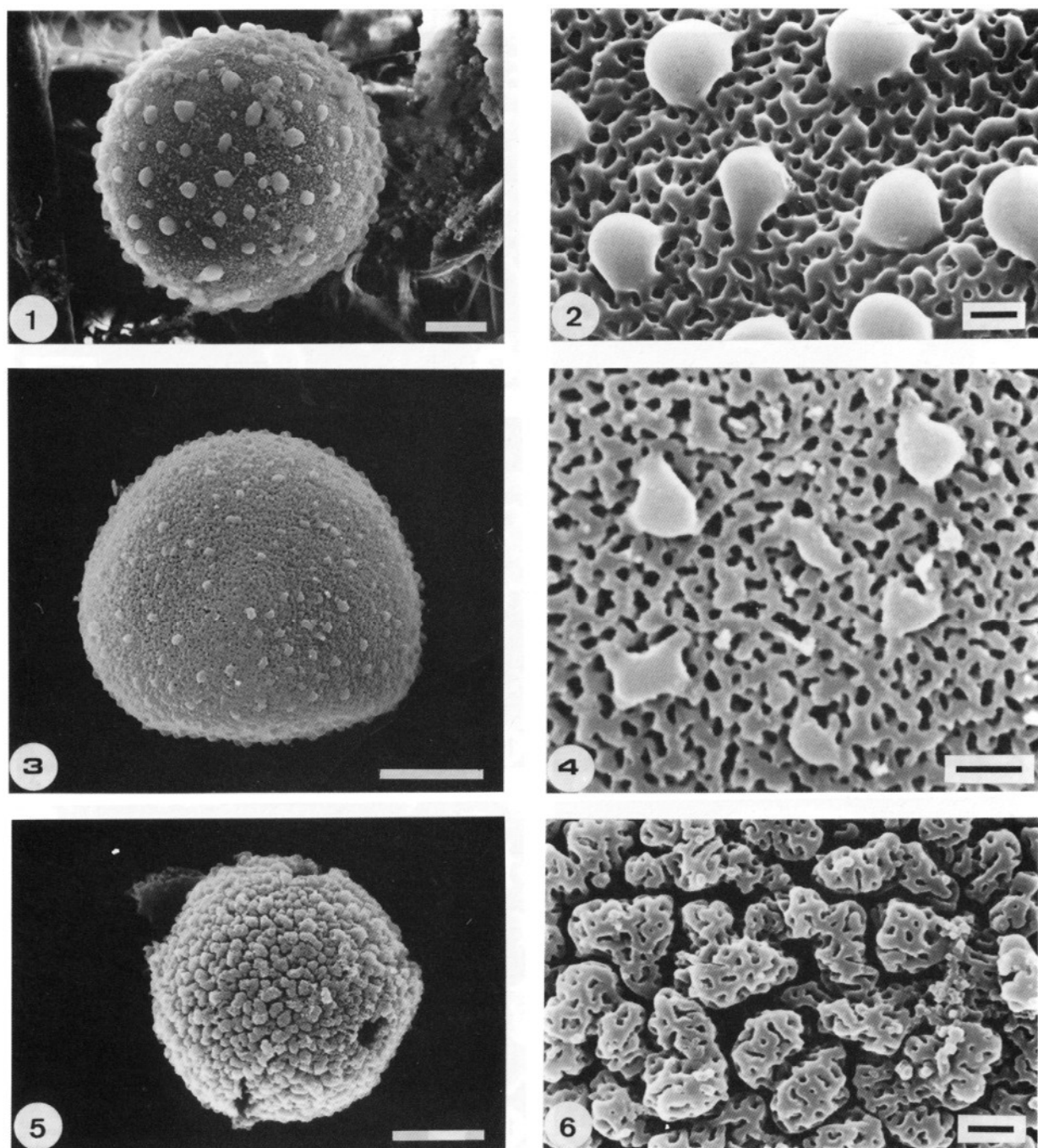
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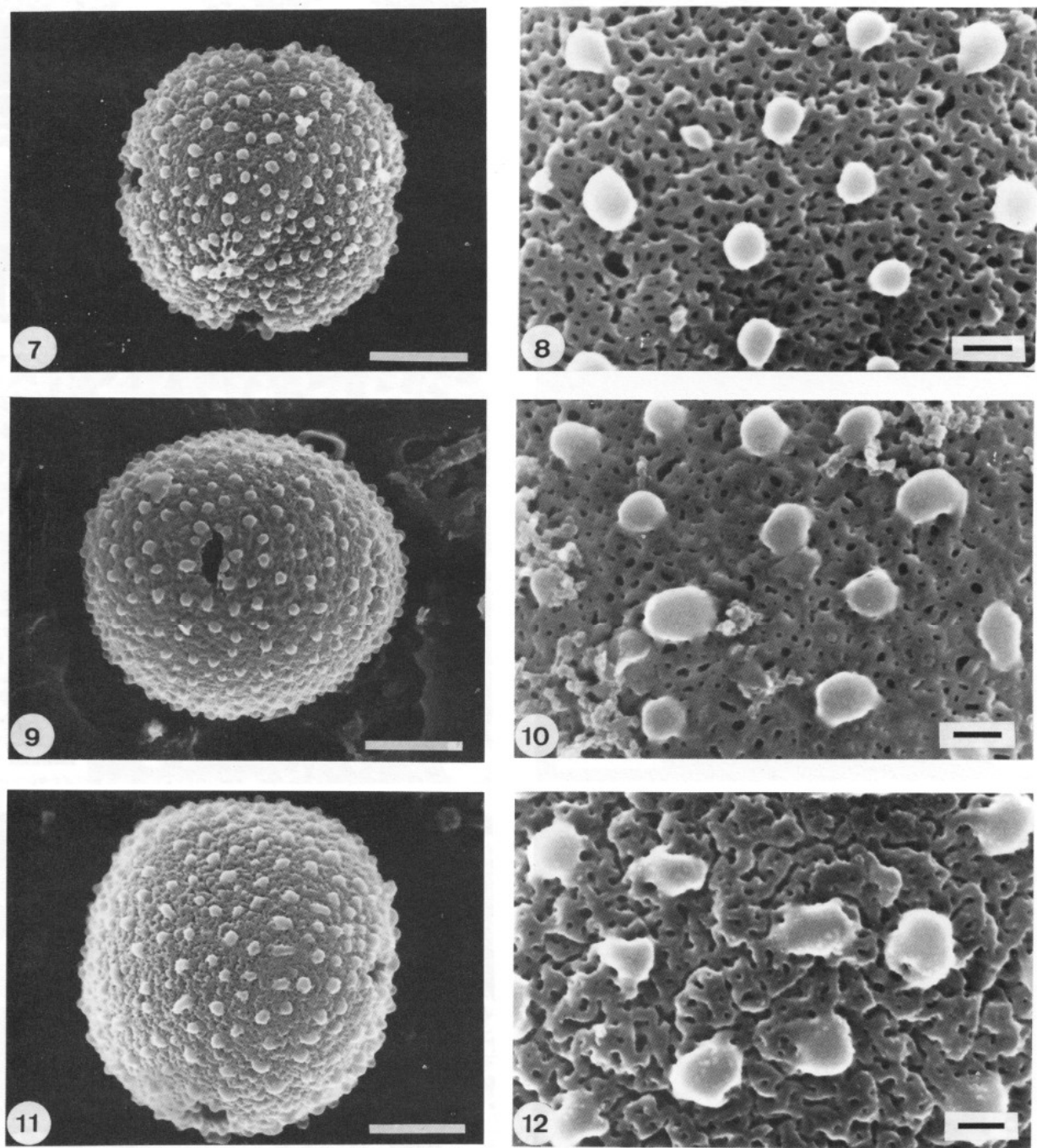


Figures 1-6: SEM micrographs of pollen grains of *Asarum* (White scale bar = 10 μ m, black scale bar = 1 μ m).

Figures 1-2: *A. caudigerum* Hance (T.C.Huang *et al.* 16312)

Figures 3-4: *A. epigynum* Hayata (S.P.Li s.n. 1995)

Figures 5-6: *A. hypogynum* Hayata (T.C.Huang *et al.* 16314)

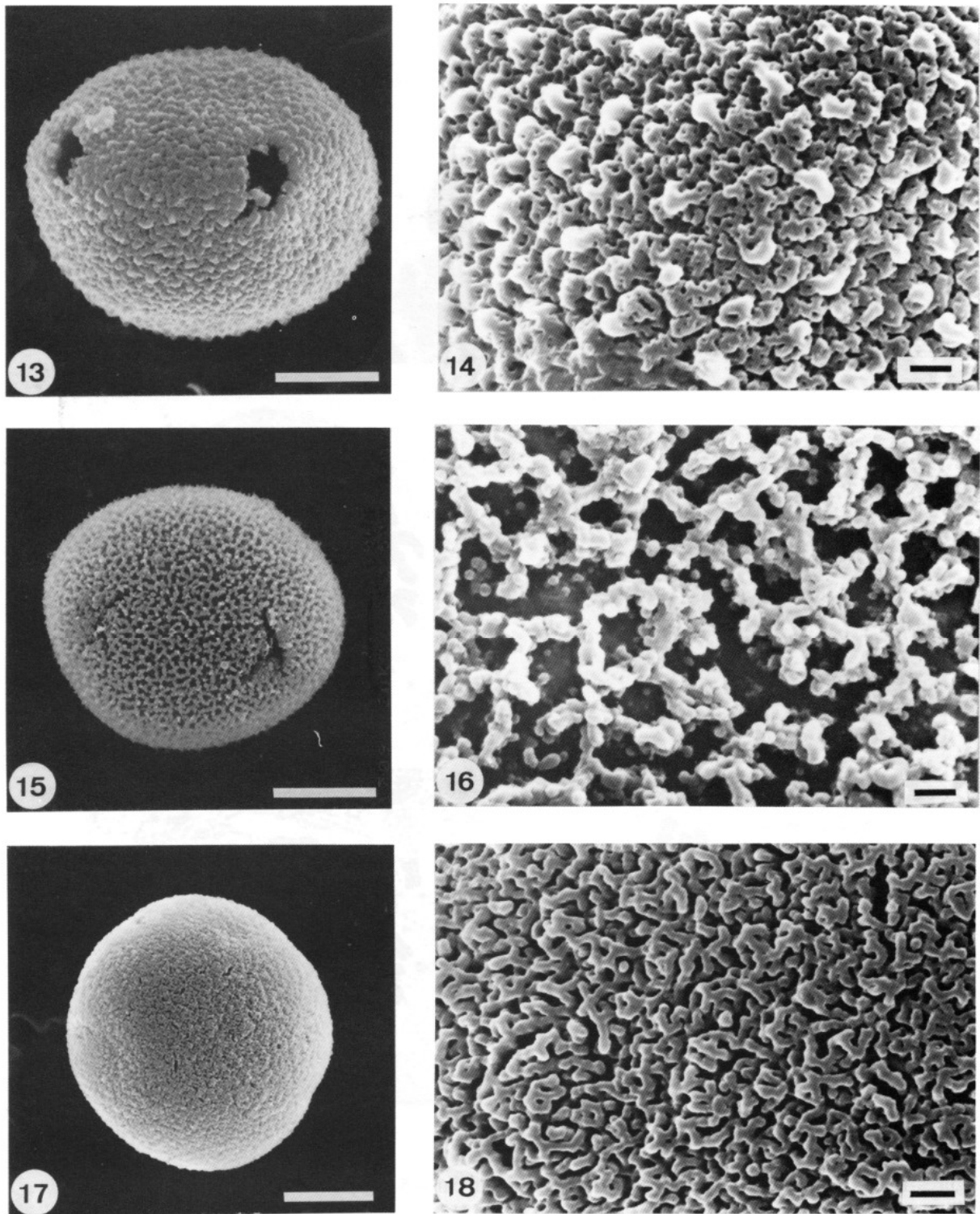


Figures 7-12: SEM micrographs of pollen grains of *Asarum macranthum* Hook. f. (White scale bar = 10 μm , black scale bar = 1 μm).

Figures 7-8: (S.F.Huang 4963)

Figures 9-10: (S.F.Huang 4999)

Figures 11-12: (S.F.Huang 5338)

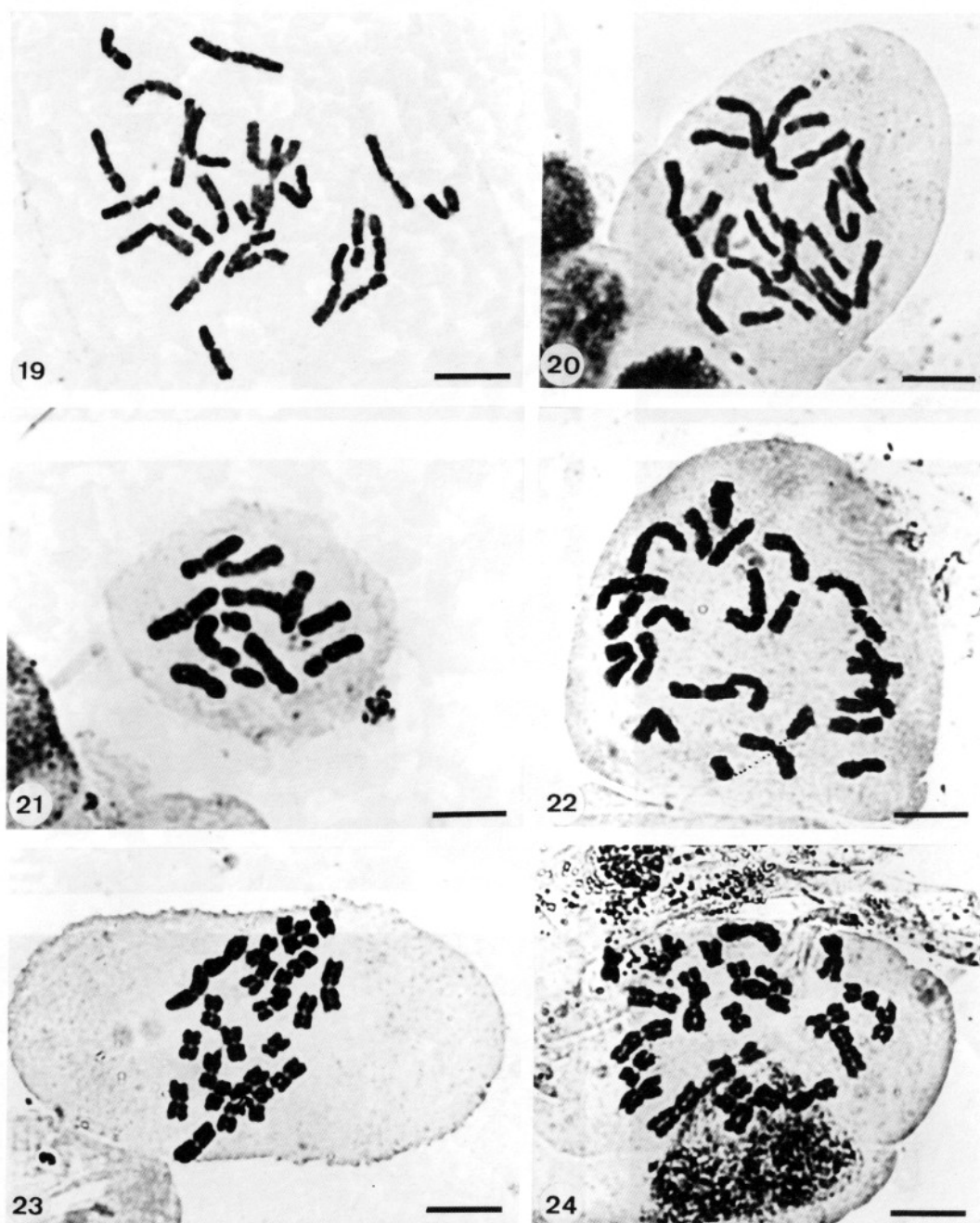


Figures 13-18: EM micrographs of pollen grains of *Asarum* (White scale bar= 10 μ m, black scale bar= 1 μ m).

Figures 13-14: *A. macranthum* Hook. f. (T.H. Hsieh 1106)

Figures 15-16: *A. crassusepalum* S.F. Huang, T.H. Hsieh & T.C. Huang (T.H.Hsieh 1391)

Figures 17-18: *A. taipingshanianum* S.F. Huang, T.H. Hsieh & T.C. Huang (S.F. Huang 4965)



Figures 19-24: Somatic chromosomes in root-tips. (Scale bar = 5 μ m)

Figure 19: *A. caudigerum* Hance (T.C.Huang et al. 16312)

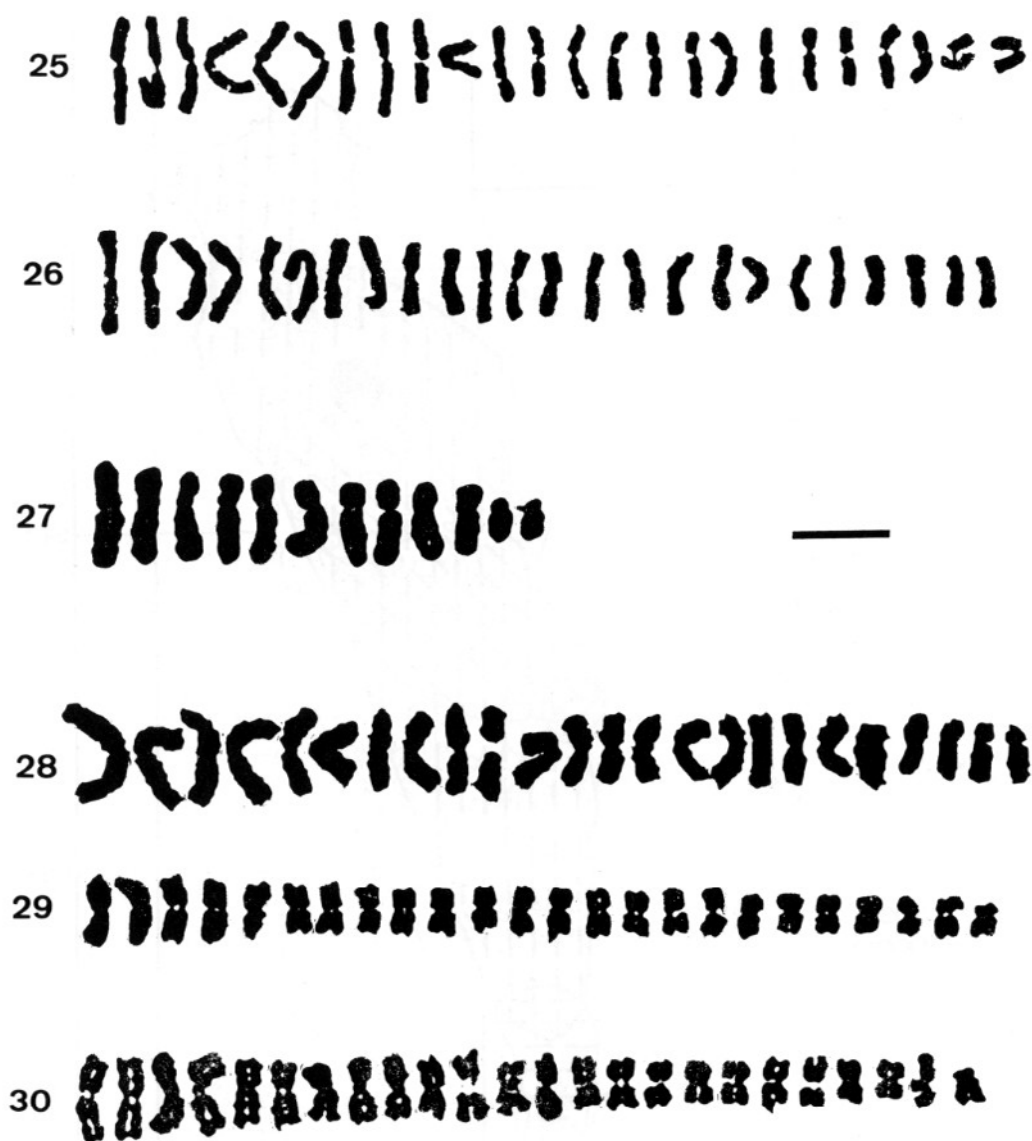
Figure 20: *A. crassusepalum* S.F.Huang, T.H.Hsieh & T.C.Huang (T.H.Hsieh 1391)

Figure 21: *A. epigynum* Hay. (S. P. Li, s. n. 1995)

Figure 22: *A. hypogynum* Hayata (T.C.Huang et al. 16314)

Figure 23: *A. macranthum* Hook. f. (S.F.Huang 5363)

Figure 24: *A. taipingshanum* S. F. Huang, T. H. Hsieh & T. C. Huang (S.F.Huang & T.H. Hsieh 5372)



Figures 25-30: Karyotypes of *Asarum* (Scale bar = 5 μ m).

Figure 25: *A. caudigerum* Hance (T.C.Huang *et al.* 16312)

Figure 26: *A. crassusepalum* S.F.Huang, T.H.Hsieh & T.C.Huang (T.H.Hsieh 1391)

Figure 27: *A. epigynum* Hay. (S.P.Li, s. n. 1995)

Figure 28: *A. hypogynum* Hayata (T.C.Huang *et al.* 16314)

Figure 29: *A. macranthum* Hook. f. (S.F.Huang 5363)

Figure 30: *A. taipingshanum* S. F. Huang, T. H. Hsieh & T. C. Huang (S.F.Huang & T.H. Hsieh 5372)

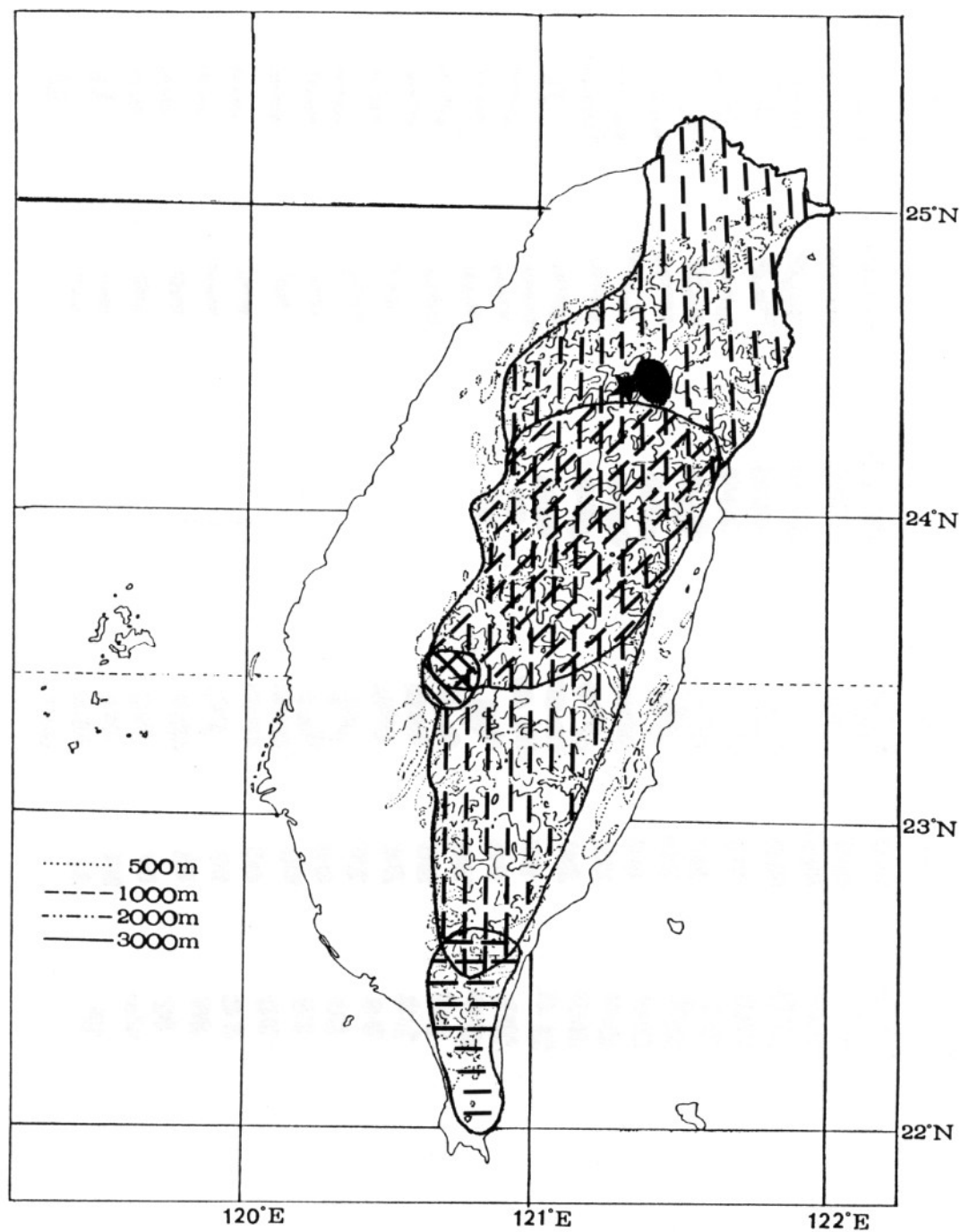


Figure 31: Distribution of *Asarum* in Taiwan.

● *A. taipingshanianum* S.F. Huang, T.H. Hsieh & T.C. Huang; ★ *A. crassusepalum* S.F. Huang, T.H. Hsieh & T.C. Huang; ▮ *A. macranthum* Hook. f.; ▮ *A. epigynum* Hayata; ▮ *A. caudigerum* Hance; ⊗ *A. hypogynum* Hayata.

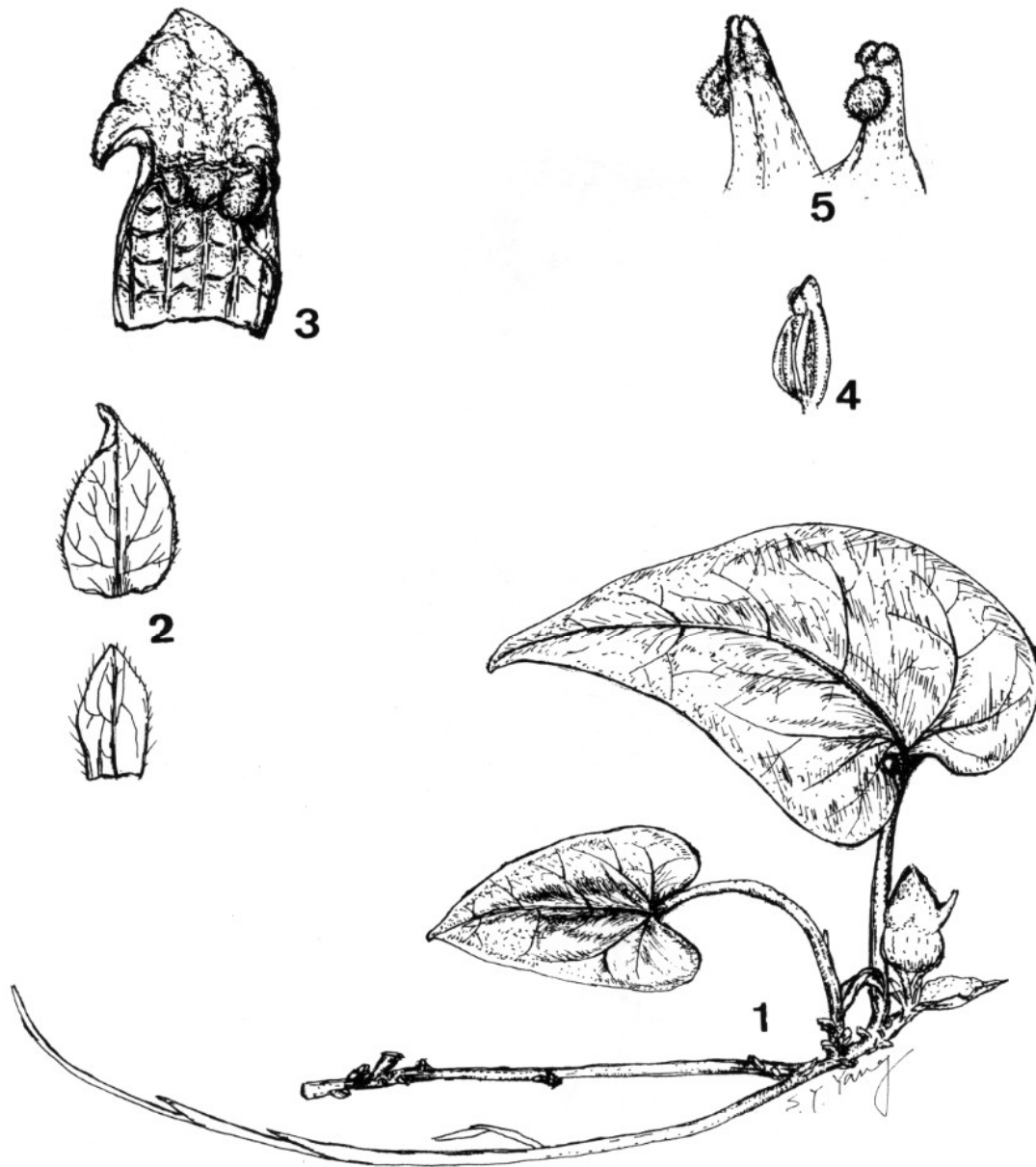


Figure 32: *Asarum crassusepalum* S.F.Huang, T.H.Hsieh & T.C.Huang (T.H.Hsieh 1391).
1. habit x1; 2. cataphylls x2; 3. dissected calyx x4; 4. stamen x8; 5. styles and stigmas x4.

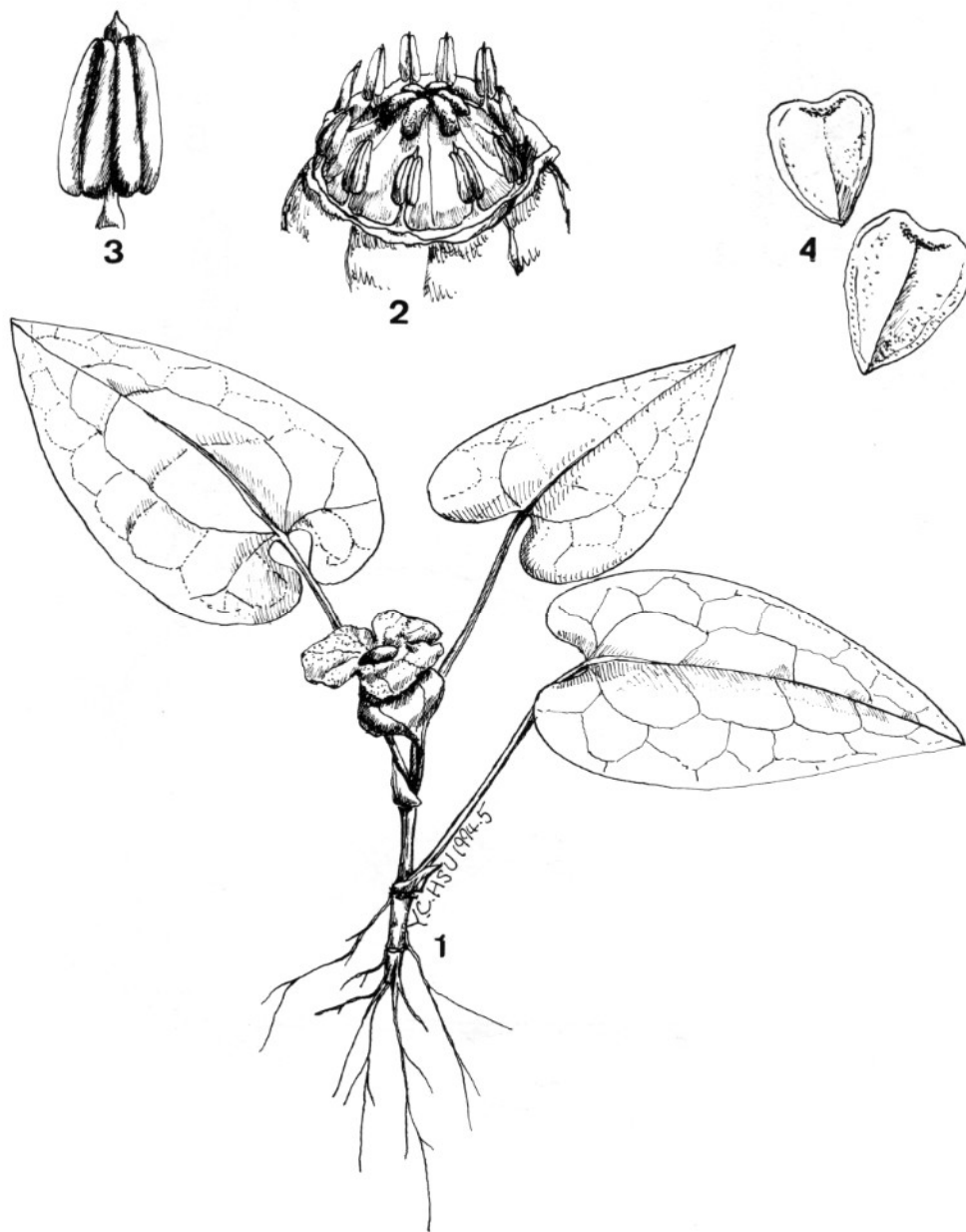


Figure 33: *Asarum epigynum* Hayata (M.T.Kao 9517).

1. Habit; 2. flower without calyx lobes; 3. stamen; 4. seed.

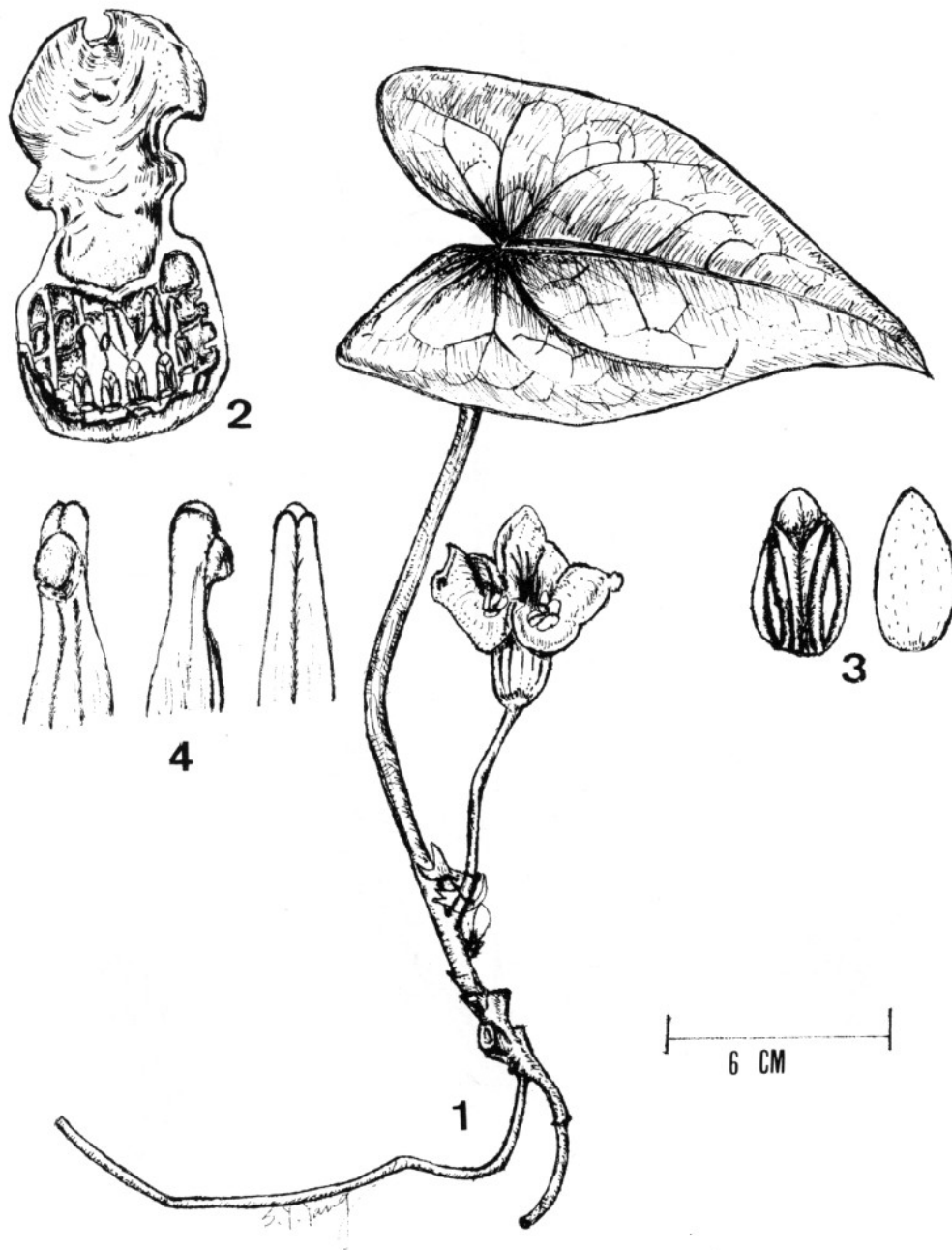


Figure 34: *Asarum hypogynum* Hayata (T.C.Huang & S.F.Huang 15947)

1. habit x0.5; 2. dissected flower x2; 3. different views of stamen x8; 4. different views of style and stigma x6.

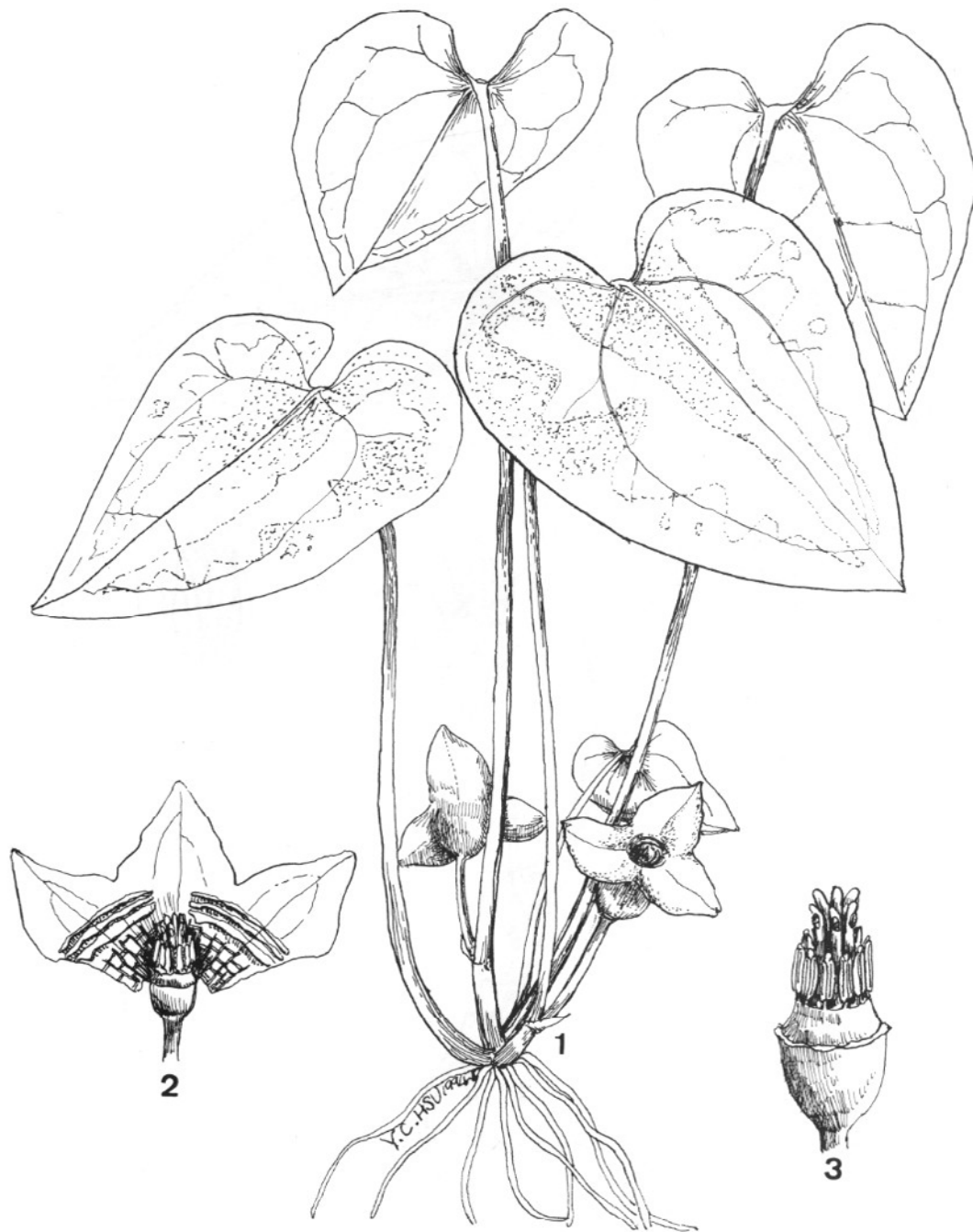


Figure 35: *Asarum macranthum* Hook. (S. F. Huang 5200).
1. habit; 2. dissected flower; 3. flower without calyx lobes.

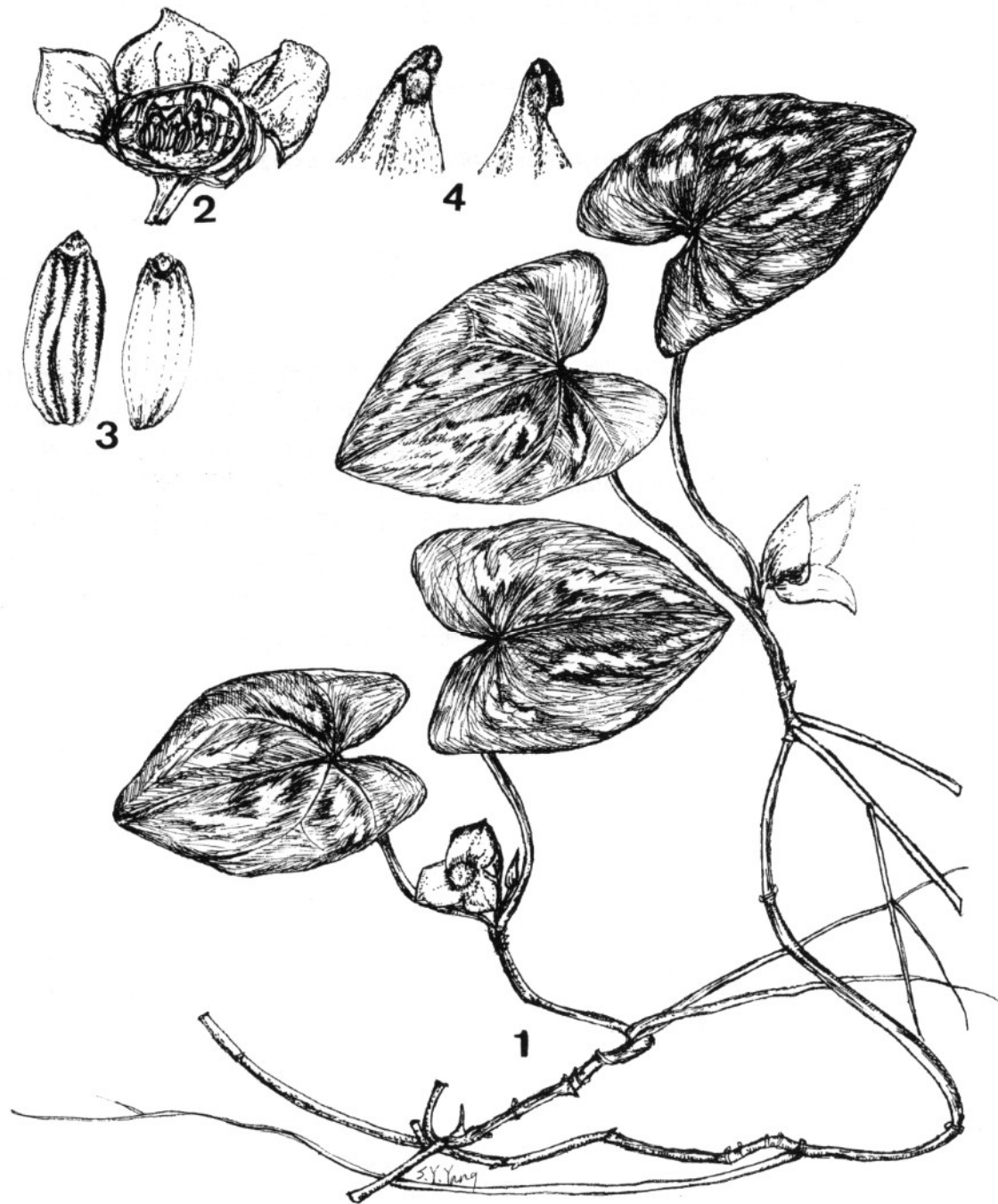


Figure 36. *Asarum taipingshanianum* S.F. Huang, T.H.Hsieh & T.C. Huang (S.F.Huang 4965)
1. habit x1; 2. dissected flower x1.5; 3. different views of stamen x16; 4. different views of style and stigma x16.

台灣植物誌之觀察(21)——台灣細辛屬(馬兜鈴科)⁽¹⁾

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摘 要

本文以植物外部形態, 花粉形態, 染色體數目及其核型作為分類特徵, 訂正台灣之細辛屬 (*Asarum*) 植物。總共確認六種, 包括二種新種。其種類為薄葉細辛 (*A. caudigerum*), 鴛鴦湖細辛 (*A. crassusepalum*), 上花細辛 (*A. epigynum*), 下花細辛 (*A. hypogynum*), 大花細辛 (*A. macranthum*), 及太平山細辛 (*A. taipingshanianum*)。其花粉粒無孔, 或具4-6孔。染色體除上花細辛為 $2n=12$ 外, 其餘種類皆為 $2n=24$ 。本文將本屬已發表之染色體核型分為七型, 而以大陸西南地區之染色體型最繁雜, 故支持馬金雙於1990年提出大陸西南地區可能為本屬之起源中心說法。由於台灣細辛屬植物之染色體核型包含於華南地區者, 本文認為台灣之細辛植物乃由華南地區分化而來。

關鍵詞：訂正，細辛屬，台灣。

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