

Revision of the Genus *Swertia* L. (Gentianaceae) in Taiwan

Jenn-Che Wang^(1,2) and Chang-Tze Lu⁽¹⁾

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ABSTRACT: The genus *Swertia* (Gentianaceae) in Taiwan is revised based on morphological study. Four species, namely *S. arisanensis* Hayata, *S. macrosperma* (C. B. Clarke) C. B. Clarke (*syn. S. randaiensis* Hayata), *S. shintenensis* Hayata, and *S. tozanensis* Hayata, are recognized. By detailed comparison of type specimens and field investigation, *S. matsudae* Satake, which was previously treated as distinct, is now reduced to the synonymy under *S. tozanensis* Hayata. Nectaries on corolla-lobes are the most important characters in separating the Taiwanese taxa. Habit, calyx-lobe, seed number per capsule, and seed morphology also display interspecific variation and provide valuable taxonomic significance. A key to the taxa along with descriptions, illustrations, and taxonomic notes are provided.

KEY WORDS: Gentianaceae, Revision, *Swertia*, Taiwan, Taxonomy.

INTRODUCTION

The genus *Swertia* comprises about 150 species distributed most in Asia and Africa (Ho and Pringle, 1995). In Taiwan, early Japanese taxonomists described five endemic taxa of which Hayata (1908, 1911, 1916) published four and one by Satake (1941). These early taxonomic treatments were most adopted by Liu and Kuo (1970, 1974) and the Flora of Taiwan (Liu and Kuo, 1978). Ho *et al.* (1988) and Ho and Pringle (1995) in their taxonomic treatments of Chinese Gentianaceae also reported five taxa in Taiwan. However, they reduced *S. randaiensis* Hayata to synonymy under *S. macrosperma* (C. B. Clarke) C. B. Clarke, a species widely distributed in Mainland China, Himalayas, and India. A more recent revision in Taiwan was by Ying (1989). He also recognized five taxa but his nomenclatural treatment was quite different from others. He reduced *S. arisanensis* Hayata to the variety of *S. bimaculata* (Sieb. & Zucc.) Hook. & Thoms. *et* C. B. Clarke (*S. bimaculata* var. *arisanensis* (Hayata) S. S. Ying), and *S. shintenensis* Hayata to the synonymy under *S. kuroiwai* Makino. In the present paper, we attempt to resolve the above disagreement by a more extensively morphological study. As a result, four species are recognized in Taiwan.

TAXONOMIC CHARACTERS

All the previous studies (Satake, 1947; Liu and Kuo, 1970, 1974, 1978; Ho *et al.*, 1988; Ho and Pringle, 1995; Ying, 1989) have shown that the morphology and position of nectaries (corolla maculae) were the most important characters for the taxonomy of this genus.

1. Department of Biology, National Taiwan Normal University, Taipei 117, Taiwan, Republic of China.

2. Corresponding author.

Besides, number of floral parts, plant size, and leaf shape were also considered to be important for the identification of Taiwanese species. Moreover, Ho *et al.* (1988) and Yuan (1993) suggested that seed morphology may be a new taxonomic character, although it is not always congruent with the gross morphology. The taxonomic characters used for the present revision are concisely described as follows.

Habit

Liu and Kuo (1978) and Ying (1989) described the Taiwanese *Swertia* as being either annual, biennial or perennial herbs. However, we find only two types, annual and biennial (monocarpic). Biennial plants bear rosette of few radical leaves in the first year then a terminal inflorescence in the second year. The radical leaves live at least one year. They are usually persistent at anthesis until the plant die so are relatively long-lived. By contrast, annual plants grow, branch, and flower quickly after germination. Their radical leaves are short-lived and wither at anthesis. In general, biennial plants are more robust than annuals and usually produce thick fleshy roots instead of hard fibrous roots as in annuals. The size of annual plants varies greatly according to the habitat and germination season. Sometimes the plant may grow up to 1m tall especially when it inhabits in the tall grassland and/or germinates early.

Except *S. shintenensis*, all the Taiwanese *Swertia* are annual herbs. *Swertia shintenensis* was described as being annual (Liu and Kuo, 1970, 1974, 1978; Ho *et al.*, 1988; Ho and Pringle, 1995) or perennial (Ying, 1989). But the species bears rosette of long-lived radical leaves then flowers in late autumn or early winter of the next year. So it is actually a biennial species. *Swertia tozanensis* was described as being biennial or perennial (Ying, 1989, as *S. matsudae*) and *S. macrosperma* in Taiwan was described as being perennial (Liu and Kuo, 1970, 1974, 1978; Ying, 1989). However, based on our field observation, both species produce fibrous roots and soon wither radical leaves so are actually annual species.

Calyx-lobe

The calyx of *Swertia* has long been considered to be important in the classification of the genus (Ho *et al.*, 1988; Ying, 1989; Ho and Pringle, 1995). It displays great diversity in shape, relative length to corolla-lobe, curvature, and hairiness. All the annual species in Taiwan always bear a fimbriate ring at the throat of calyx-tube (Figs. 1-A, C, D) while the biennial species, *S. shintenensis*, does not (glabrous) (Fig. 1-B).

Shape of calyx-lobe is a good character in identifying Taiwanese species. Based on the lobe length, the character can be easily divided into short and long types. In *S. shintenensis* the calyx-lobe is ovate-triangular and shorter than the tube (Fig. 1-B) so is short type; In all other species, the calyx-lobe is narrower and much longer than the tube. In the long type, every species has its distinct shape of calyx-lobe: *S. arisanensis* is narrowly triangular (Fig. 1-A); *S. macrosperma* is lanceolate (Fig. 1-C); *S. tozanensis* is spatulate (Fig. 1-D).

The curvature of calyx-lobe is also distinguishable. The calyx-lobes of *S. tozanensis* is recurved which is a unique and diagnostic character in identifying *S. tozanensis* (Fig. 1-D). Those of the other three species are straight, never recurved (Figs. 1-A, B, C).

The relative length of calyx-lobe to corolla-lobe also provides classification value. Among the Taiwanese species, calyx-lobe is often shorter than corolla-lobe (Figs. 2-B, C, D) except *S. arisanensis* of which calyx-lobe is longer than corolla-lobe (Fig. 2-A).

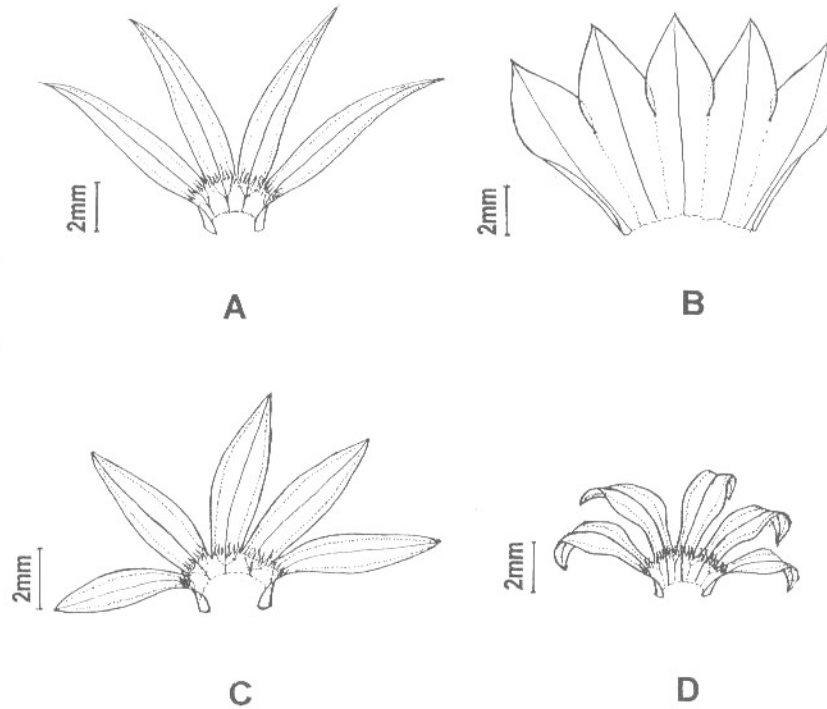


Fig. 1. Calyx-lobes of *Swertia* in Taiwan. A, *S. arisanensis*; B, *S. shintenensis*; C, *S. macrosperma*; D, *S. tozanensis*.

Corolla

Corolla of the genus is usually deeply 4- or 5-lobed with very short corolla-tube. In Taiwan, *S. arisanensis* is the only species with steady 4-merous flowers. Other species often bear 4- and 5-merous flowers even in the same individual. The 4-merous flowers are found more frequently in dwarf plants that usually resulted from late germination of seed. The character could be hardly applied in discriminating species as those done by Liu and Kuo (1974, 1978).

Coloration of corolla-lobe provides another obvious character. The first type, found in *S. shintenensis* and *S. tozanensis*, is yellowish with dark spots on upper half of corolla-lobe (Figs. 3-B, D). The second one, found in *S. arisanensis* and *S. macrosperma*, is white and without dark spots on upper half (Figs. 3-A, C).

Nectaries (corolla maculae)

The nectaries on corolla-lobes of *Swertia* are well developed and show great diversity so that are the most important and reliable characters in discriminating species. This item can be described in the following categories.

Number of nectaries per corolla-lobe can be either one or two. Both *S. arisanensis* (Fig. 3-A) and *S. shintenensis* (Fig. 3-B) have one nectary per corolla-lobe and the other two species, *S. macrosperma* and *S. tozanensis*, have two (Figs. 3-C, D).

Nectaries morphology can be divided into two types. The first type, found in *S. arisanensis* and *S. macrosperma*, is well developed, covered with scales and fimbriae on the margin. Nectaries of *S. arisanensis* are pocket-shaped, with an orbicular scale and many ciliate fimbriae along apex margin (Fig. 3-A); Those of *S. macrosperma* are tubular with narrow scale and few long fimbriae on the margin (Fig. 3-C); The second one is much

reduced, naked spotlike gland patches, without scale or fimbriae. This type may be either superficial (*S. tozanensis*, Fig. 3-D) or sunken (*S. shintenensis*, Fig. 3-B).

Position of nectary on the corolla-lobe can be divided into two states. The first type, found in *S. arisanensis* and *S. macrosperma*, has nectaries near the base of corolla-lobe (Figs. 3-A, C); The second one, found in other two species, has nectaries at the middle of corolla-lobe (Figs. 3-B, D).

A key based on the characters of the nectaries is given below to distinguish each species in Taiwan.

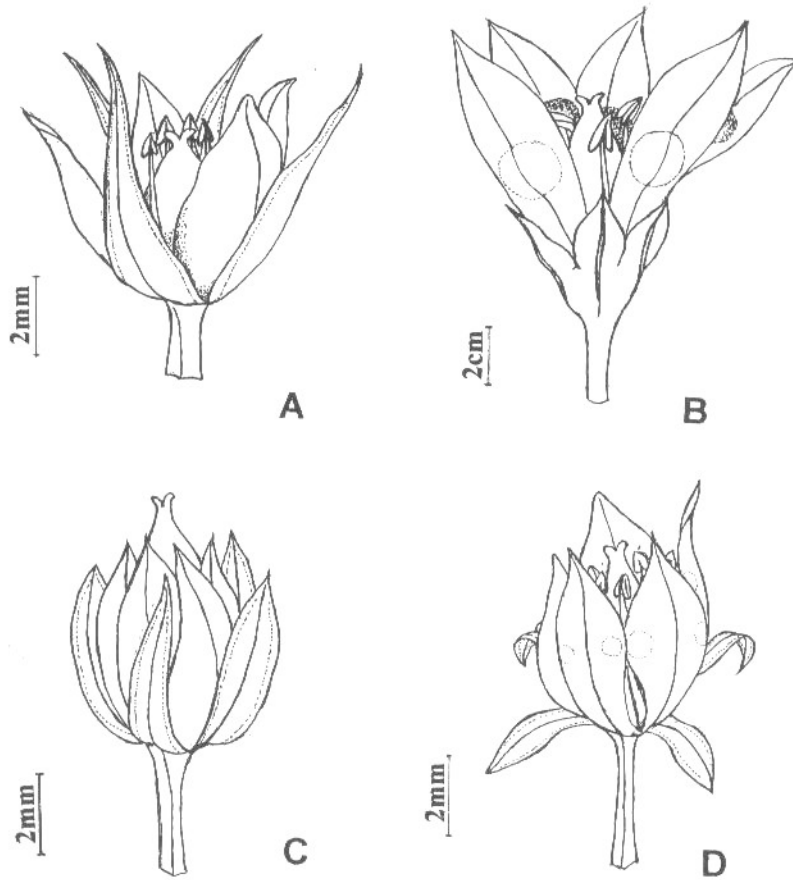


Fig. 2. Flowers of *Swertia* in Taiwan, notice the relative length of calyx-lobes to corolla-lobes. A, *S. arisanensis*; B, *S. shintenensis*; C, *S. macrosperma*; D, *S. tozanensis*.

Key to the Taiwanese species based on the characters of nectaries

- 1. Nectaries cupular or pocket-shaped, near the base of corolla-lobe.
 - 2. Nectary 1 per corolla-lobe, pocket-shaped, with an orbicular scale and many short fimbriae *S. arisanensis*
 - 2. Nectaries 2 per corolla-lobe, cupular, with few long fimbriae *S. macrosperma*
- 1. Nectaries reduced to a gland patch, naked, near the middle of corolla-lobe
 - 2. Nectary 1 per corolla-lobe, sunken, oblong *S. shintenensis*
 - 2. Nectaries 2 per corolla-lobe, superficial, orbicular *S. tozanensis*

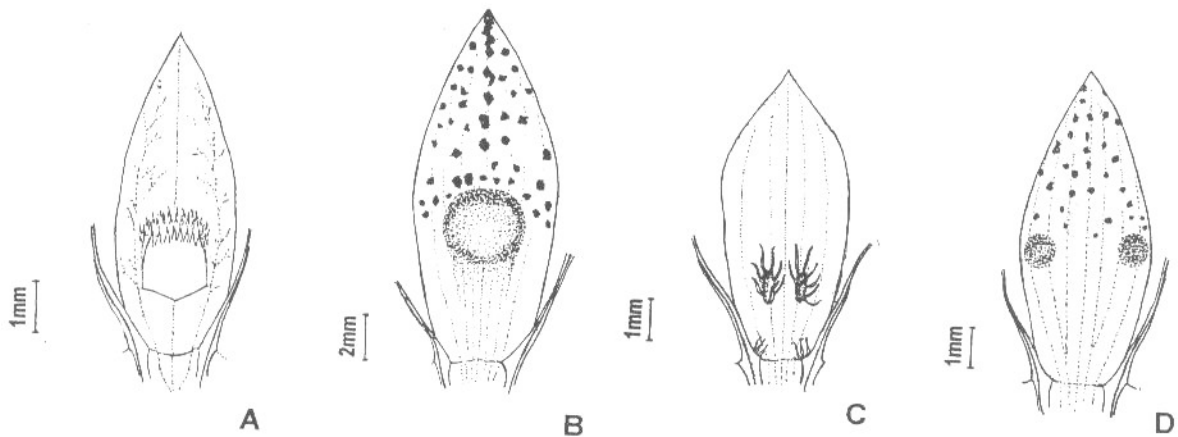


Fig. 3. Corolla-lobe of *Swertia* in Taiwan, notice the nectaries. A, *S. arisanensis*; B, *S. shintenensis*; C, *S. macrosperma*; D, *S. tozanensis*.

Seeds

Seed size and number per capsule are conspicuous characters. Among the Taiwanese species, *Swertia macrosperma* can be easily identified by its largest seed and few (only 3 to 4) seeds per capsule. Other Taiwanese species bears much smaller and numerous seeds.

Seed morphology under the light microscope has been suggested as reliable and steady characters in the classification of the genus (Ho *et al.*, 1988). Using scanning electron microscopy, Yuan (1993) observed the seedcoats of 46 species of Gentianaceae and revealed a high diversity of seed micromorphology. However, he concluded that in *Swertia* seed micromorphology is not always congruent with the gross morphology, perhaps since only limited number of species (four species) were studied. He suggested that checking more species is necessary before any valid conclusion can be drawn (Yuan, 1993). Nevertheless, micromorphological studies on the seedcoat of the genus in Taiwan are lacking, except that a few general taxonomic revisions (e.g., Satake, 1947; Liu and Kuo, 1974, 1978; Ying, 1989) have briefly described seed feature observed under magnifying glass or light microscope.

We observed the seed micromorphology of all four species in Taiwan under the scanning electron microscope. The seedcoats of Taiwanese *Swertia* may be classified into the following three types based on the curvature of the outer periclinal wall (so-called the primary sculpture).

1. Undulate type: the outer surface of seedcoats slightly rises up to form irregular undulate curvature as in *S. macrosperma* (Figs. 4-C, D).
2. Pitted type: the seedcoats have irregular pits on their surface as in *S. tozanensis* (Figs. 4-G, H).
3. Echininate type: the epidermal cells of the seedcoats protrude to form irregular echinate projections as in *S. arisanensis* (Figs. 4-A, B) and *S. shintenensis* (Figs. 4-E, F).

TAXONOMIC TREATMENT

SWERTIA L.

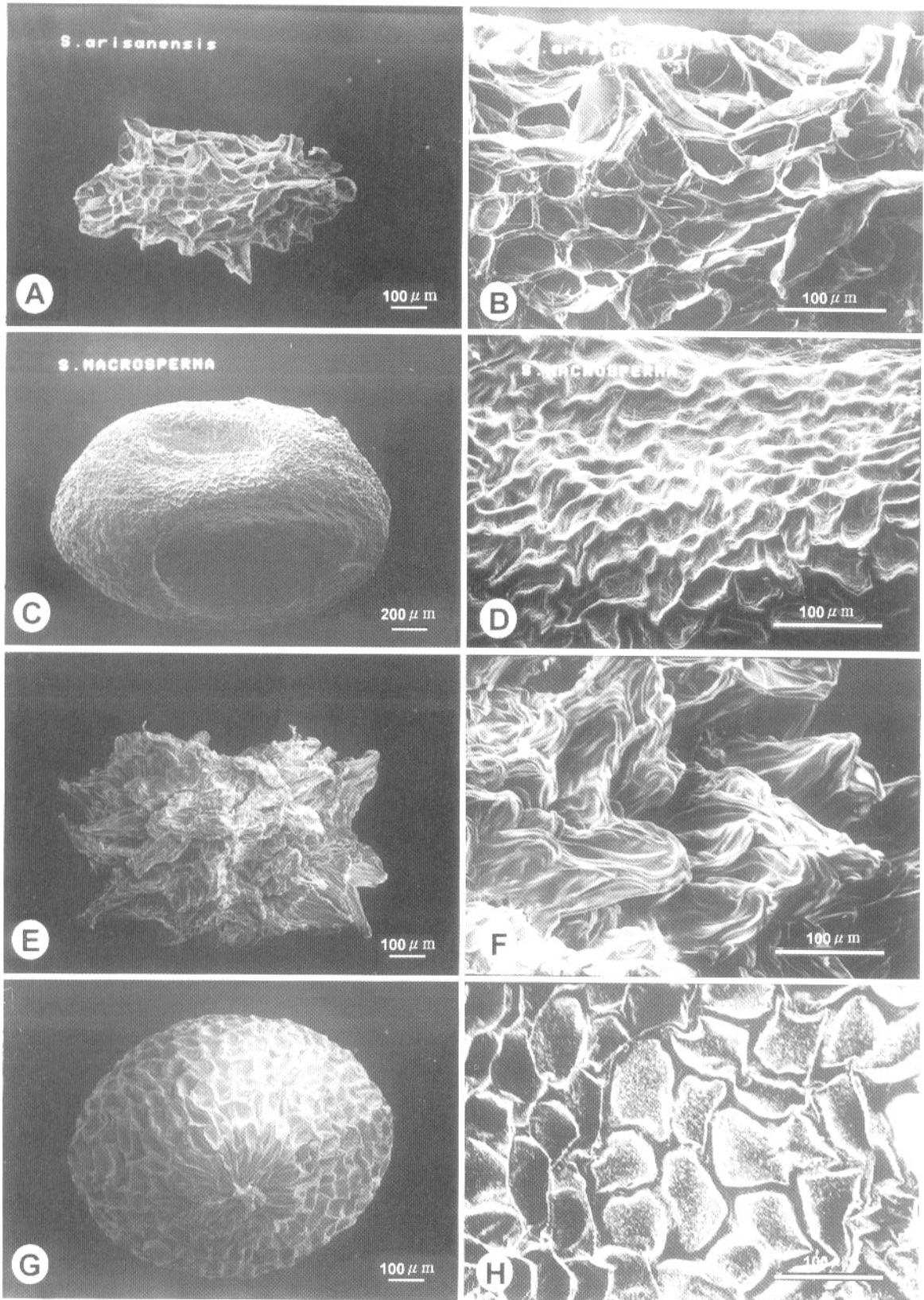


Fig. 4. Seeds and seedcoats of *Swertia* in Taiwan. A & B, *S. arisanensis*; C & D, *S. macrosperma*; E & F, *S. shintenensis*; G & H, *S. tozanensis*.

Annual or biennial herbs. Stem erect, terete, striate or angled, simple or branched. Leaves opposite, margin entire, usually with radical leaves, large or small and persistent or withered at anthesis. Inflorescences cymose, usually grouped into simple or paniculate thyrses. Flowers blue, purplish or greenish-yellow to white, 4- or 5-merous. Calyx and corolla rotate, persistent in fruit, lobed nearly to base, tubes less than 3 mm. Nectaries (corolla maculae) 1 or 2 per corolla-lobe, with fimbriate margin or represented by naked spot-like gland patches. Stamens inserted at base of corolla tube. Ovary 1-celled. Style short to elongate. Fruit a 2-valved capsule, with few to many seeds.

About 150 species, worldwide, mainly in Asia and Africa, few in North America and Europe. Four species in Taiwan.

Key to Species

1. Biennials; flowers larger than 3 cm in diameter; calyx lobes ovate-triangular, without fimbriate ring at the throat of calyx-tube 3. *S. shintenensis*
1. Annuals; flowers less than 1.5 cm in diameter; calyx-lobes lanceolate or linear-lanceolate, with a fimbriate ring at the throat of calyx-tube
 2. Calyx lobes much longer than corolla-lobes; nectaries 1 per corolla-lobe; leaf blade rounded at base 1. *S. arisanensis*
 2. Calyx lobes shorter or equal to corolla-lobes; nectaries 2 per corolla-lobe; leaf blade narrowed at base
 3. Nectaries with few fimbriae; calyx lobes incurved or straight; corolla white, without spots; seeds 3 or 4 per capsule 2. *S. macrosperma*
 3. Nectaries reduced to a naked gland patch; calyx lobes recurved; corolla pale yellow, with dark spots on the upper portion; seeds many per capsule 4. *S. tozanensis*

1. *Swertia arisanensis* Hayata in J. Coll. Sci. Univ. Tokyo 30(1): 203. 1911 (Mat. Fl. Form.); Hayata, Icon. Pl. Form. 2: 122. *pl.* 27. 1912; Satake in J. Jap. Bot. 21: 23. 1947; T. S. Liu & C. C. Kuo in Ann. Taiwan Mus. 13:122. *fig.* 15. 1970; T. S. Liu & C. C. Kuo in Bull. Exp. Forest Natl. Taiwan Univ. 144: 202. *pl.* 19. 1974; T. S. Liu & C. C. Kuo in Fl. Taiwan 4: 184. *pl.* 957. 1978; Ho *et al.* in Fl. Reipubl. Popularis Sin. 62: 388. 1988; Ho & Pingle in Fl. China 16: 116. 1995.

阿里山當藥

Swertia alata Hayata in J. Coll. Sci. Univ. Tokyo 25(19): 168. 1908 (Fl. Mont. Form.), *non* Royle.

— Type: Formosa. Arizan, in montibus Morrison, Oct. 1906. *G. Nakahara s. n.* (holotype: TI!).

Swertia bimaculata (Sieb. et Zucc.) Hook. et Thoms. ex C. B. Clarke var. *arisanensis* (Hayata) S. S.

Ying in Quart. J. Exp. Forest Natl. Taiwan Univ. 3(2): 100. 1989. *syn. nov.*

Annuals 30-90 cm tall. Stems erect, subquadrangular, narrowly winged, branched. Basal leaves withered at anthesis. Stem leaves sessile or subsessile, rhombic-oblong to lanceolate, 4-11 cm long, 1.2-3 cm wide, thin herbaceous, base rounded and clasping, apex acute, veins 3, prominently elevated beneath; uppermost leaves smaller, lanceolate, apex acuminate. Inflorescences panicles of cymes, spreading branched. Flowers 4-merous. Pedicel erect, 0.5-1.5 cm long, narrowly winged. Calyx lobes lanceolate, 5-10 mm long, apex acuminate, inside of the base with short fimbriae, veins 3. Corolla white or pale green, lobes lanceolate, 6-9 mm long, apex acuminate. Nectaries 1 per corolla-lobe, near the base of corolla-lobe, pocket-shaped, with an orbicular scale and many ciliate fimbriae along apex margins of pocket. Filaments ca. 3 mm, lower part flat; anthers ellipsoid, ca. 1 mm. Ovary ovoid, 5-6 mm; style short. Capsules ovoid-ellipsoid. ca. 1 cm. Seeds brown, ovoid, 0.5-1 mm; seed coat rugose.

Endemic to Taiwan, widespread but scarce at low to medium altitudes from 1000 to 1700 m throughout the island.

Specimens examined: **Ilan:** Nanhutashan, Oct. 1928, *Sasaki s. n.* (TAI). **Hsinchu:** Tuchang to Kuanwu, elev. ca. 1280m, July 18, 1986. *Peng 9379* (HAST). **Nantou:** Chilaichushan, Aug. 6, 1919. *Sasaki s. n.* (TAI). **Taichung:** Wushe, Oct. 12, 1930. *Sasaki s. n.* (TAI). **Chiayi:** Mt. Alishan, *Feung & Kao 4939* (TAI). **Taitung:** Tawushan, Jan. 1, 1917. *Matuda s. n.* (TAI). **Hualien:** Tailuko, Oct. 28, 1935. *Sasaki s. n.* (TAI), et *Susuki 1833* (TAI).

Ying (1989) reduced this species to a variety under *S. bimaculata* (Sieb. et. Zucc.) Hook. et Thoms ex C. B. Clarke. He wrote "the variety very close to typical phase, but differs from it by the corolla-lobed; corolla-lobed usually only one macula instead of the 2 macula of typical phase." However, these two taxa are quite different not only in the number of nectaries but also in floral parts, calyx-lobe, nectary morphology, and seed (see table 1, a comparison between them). Actually, they are so different as to belong to different series based on the system of Ho *et al.* (1988). Therefore, we consider Ying's treatment as unwarranted and retain the taxon at species level.

Table 1. A comparison between *Swertia arisanensis* and *S. bimaculata*.

	<i>Swertia arisanensis</i>	<i>Swertia bimaculata</i>
Floral parts	4-merous.	5-merous.
Calyx-lobe	lanceolate, straight, longer than corolla-lobe.	narrowly oblanceolate or elliptic, recurved, shorter than corolla-lobe.
Nectaries	1, pocket-shaped, with an orbicular scale, near the base of corolla-lobe.	2, gland patch-like, naked, at the middle of corolla-lobe.
Seeds	ellipsoid, rugose.	spheroid, reticulate.

2. *Swertia macrosperma* (C. B. Clarke) C. B. Clarke in J. D. Hooker, Fl. Brit. India. 4: 123. 1883; Ho *et al.* in Fl. Reipubl. Popularis Sin. 62:397. *pl.* 65: 1-3. 1988; Ho & Pringle in Fl. China 16: 118. 1995.

Fig. 5 大籽當藥

Ophelia macrosperma C. B. Clarke in J. Linn. Soc. Bot. 14: 488. 1875.

Swertia randaiensis Hayata in J. Coll. Sci. Univ. Tokyo 25(19): 203. 1911 (Mat. Fl. Form.); Hayata, Icon. Pl. Form. 2: 122. *pl.* 28. 1912; Satake in J. Jap. Bot. 21: 27, 1947; T. S. Liu & C. C. Kuo in Ann. Taiwan Mus. 13:125. *fig.* 18. 1970; T. S. Liu & C. C. Kuo in Bull. Exp. Forest Natl. Taiwan Univ. 114: 205. *pl.* 22. 1974; T. S. Liu & C. C. Kuo in Fl. Taiwan 4:187. *pl.* 960. 1978; S. S. Ying in Quart. J. Exp. Forest Natl. Taiwan Univ. 3(2): 102. 1989. — Type: Formosa. Randaizan, Aug. 1908, *B. Hayata et U. Mori* (No. 7114) (holotype: TI!).

Swertia tozanensis auct. non Hayata: T. S. Liu & C. C. Kuo in Ann. Taiwan Mus. 13:129. *fig.* 19. 1970; T. S. Liu & C. C. Kuo in Bull. Exp. Forest Natl. Taiwan Univ. 114: 206. *pl.* 23. 1974; T. S. Liu & C. C. Kuo in Fl. Taiwan 4: 191. 1978; S. S. Ying in Quart. J. Exp. Forest Natl. Taiwan Univ. 3(2): 103. 1989; Ho & Pringle in Fl. China 16: 119. 1995.

Annuals to 100cm tall. Stems erect, often purplish, subquadrangular, narrowly winged, branched. Basal and lower leaves withered at anthesis, short-petiolate; leaf blade spatulate, base narrowed, margin entire, apex obtuse, veins 1-3. Middle leaves sessile, lanceolate, oblong, ovate, 1-5 cm long, 0.5-2 cm wide, base obtuse, apex acute, veins 3-5. Inflorescences panicles of cymes, many flowered, spreading branched. Flowers 5- or 4-merous. Pedicel erect, 5-15 mm long, slender. Calyx tube short, loosely ciliate-fimbriate inside at the throat;

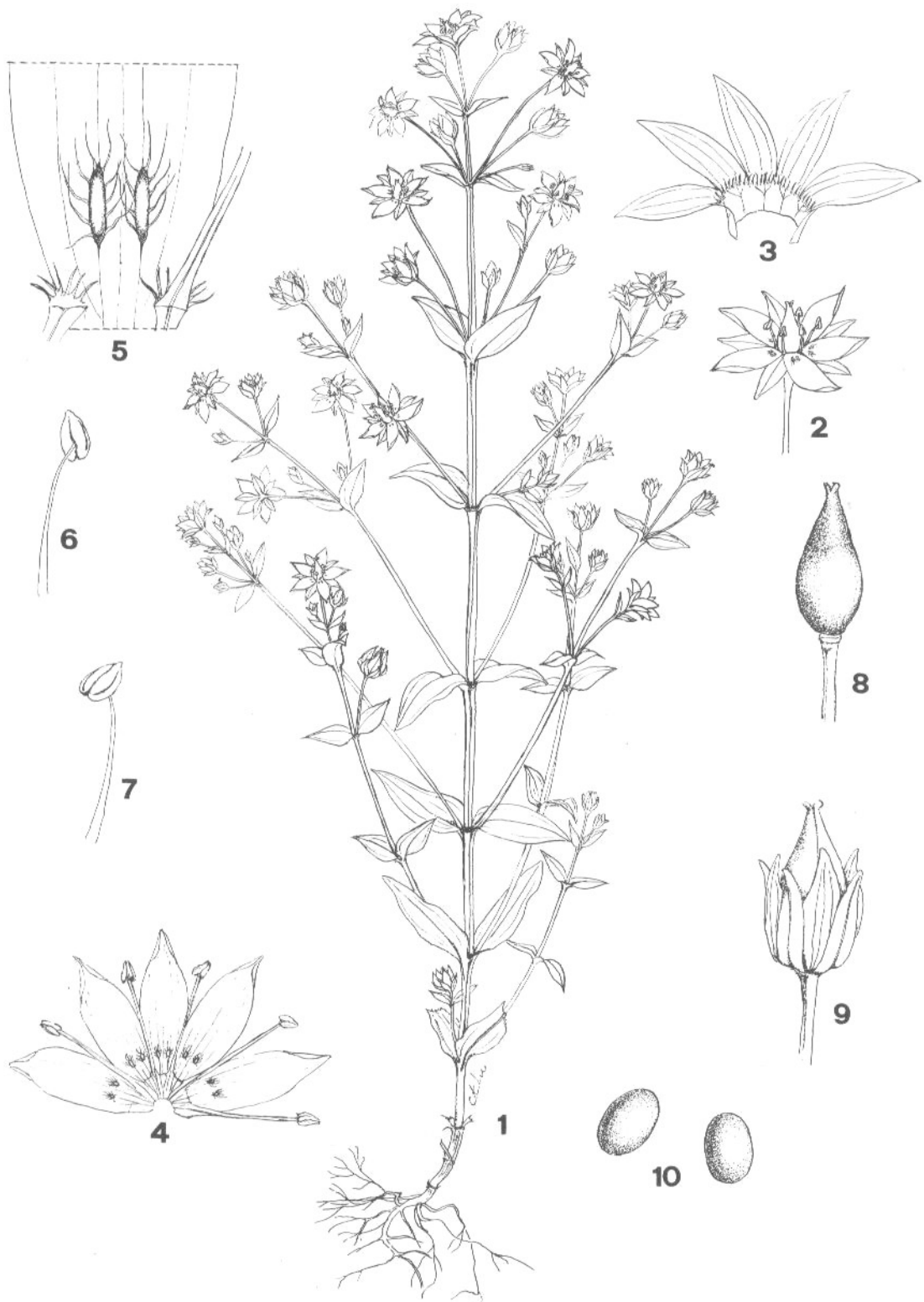


Fig. 5. *Swertia macrosperma* (C. B. Clarke) C. B. Clarke. 1, Habit; 2, Flower; 3, Calyx; 4, Corolla with stamens and nectaries; 5, Part of corolla-lobe with nectaries; 6 & 7, Stamens; 8, Pistil; 9, Fruit; 10, Seeds.

lobes ovate-elliptic, 2.5-4 mm long, apex acute, mid-vein distinct. Corolla white or tinged blue, 5-8 mm in diameter, tube ca. 0.5 mm; lobes oblong, 4-8 mm long, apex obtuse. Nectaries 2 per corolla-lobe, near the base of corolla-lobes, cupular, with a narrow scale and few long fimbriae. Filaments 4-5 mm; anthers ellipsoid, ca. 1.5 mm. Ovary ellipsoid-ovoid, ca. 3 mm; style indistinct. Capsule ovoid, 7-8 mm. Seeds 3-4 per capsule, brown, ellipsoid to subglobose, 1.5-2 mm; seed coat smooth.

India, Bhutan, Nepal, Sikkim, Burma, south-western China, and Taiwan. Taiwan, at medium to high altitudes from 1400 to 3900m.

Specimens examined: **Hsinchu:** Tapachienshan Mt.- hiking entrance to "99 Lodge", elev. ca. 2150-2500m, Sept. 6, 1993. *Huang 50* (HAST). **Nantou:** Tatachia saddle to Paiyun Lodge, elev. ca. 2800-3500m, Sept. 6, 1991. *Peng 14365* (HAST); Paiyun Lodge to Yushan main peak, elev. ca. 3800m, Sept. 7, 1991. *Peng 14376* (HAST); Tienchih to Kuailin, elev. ca. 2160-2860m, Oct. 14, 1992. *Ho et al. 633* (HAST); Tungpushanchuang to Tatachianpu, elev. ca. 2500-2900m, Aug. 7, 1991. *Leu 1117* (HAST); on the way from Tzuchung to Tatachia mountain saddle, elev. ca. 2150-2250m, Aug. 8, 1995. *Chen 1220* (TNU); Tsui-feng, elev. ca. 2300m, June 30, 1996. *Wang 10166* (TNU). **Taichung:** Nanhushanchuang to Yunlingshanchuang, elev. ca. 2550-3300m, Sept. 10, 1991. *Hsu 797* (HAST); Wuling, elev. ca. 2500-3200m, Aug. 24, 1988. *Peng 12034* (HAST); on the way from Chika Lodge to Sanliuchiu Lodge, elev. ca. 2400-3100m, Aug. 22, 1995. *Chen 1331* (TNU); **Chiayi:** Tatachianpu to Paiyunshanchuang, elev. ca. 2700-3500m, Aug. 9, 1989. *Leu 200* (HAST); same loc., elev. ca. 2800-3000m, Aug. 10, 1989. *Hu 1291* (HAST); Paiyun Lodge to Tatachianpu, elev. ca. 3200m, Aug. 12, 1989. *Hu 1320* (HAST); Tatachianpu, elev. ca. 2600m, July 2, 1989. *Wang 5481* (TNU); Mt. Alishan, Mar. 17, 1932. *Sasaki s. n.* (TAI). **Hualien:** Chilaishan, en route from Sunghsuehlou, elev. ca. 2910-3000m, July 19, 1994. *Shen 23* (HAST).

3. **Swertia shintenensis** Hayata, Icon. Pl. Form. 6: 31. 1916; Maekawa in J. Jap. Bot. 12: 158, 1936; Ho *et al.* in Fl. Reipubl. Popularis Sin. 62: 381. *pl. 62: 1-4*. 1988; Ho & Pingle in Fl. China 16: 114. 1995. — Type: Formosa. In monte Shinten, 2400 ped. alt., Nov. 1914, *U. Faurie 1256* (holotype: TI!).

Fig. 6 新店當藥

Swertia kuroiwai Makino var. *shintenensis* (Hayata) Satake in J. Jap. Bot. 20: 341. 1944; T. S. Liu & C. C. Kuo in Ann. Taiwan Mus. 13:122. *fig. 16*. 1970; T. S. Liu & C. C. Kuo in Bull. Exp. Forest Natl. Taiwan Univ. 114: 203. *pl. 20*. 1974; T. S. Liu & C. C. Kuo in Fl. Taiwan 4:184. *pl. 958*. 1978. *Swertia kuroiwai* auct. non Makino: S. S. Ying in Quart. J. Exp. Forest Natl. Taiwan Univ. 3(2): 101. *pl. 3*. 1989.

Biennials 45-100 cm tall. Stems erect, simple, terete. Basal leaves persistent at anthesis, with petiole flattened, 2-3.5 cm long; leaf blade elliptic to obovate, variable in size, to 23 cm long and 10 cm wide, base cuneate and decurrent into wings of petiole, apex acute; veins distinct, pinnate, midrib elevated beneath. Stem leaves sessile, ovate, to 10 cm long and 8 cm wide, base cordate and subamplexicaul, apex acute. Inflorescences many-flowered thyrses, lax, spreading. Flowers 4- or 5- merous, nodding. Pedicel 1.5-3.5 cm, slightly thickened at apex. Calyx tube 2-3.5 mm, lobes ovate to triangular, 3-4.5 mm, margin narrowly membranous, apex acute. Corolla pale yellow or yellow green, 3-4 cm in diameter, tube 3-4.5 mm; lobes narrowly elliptic to oblanceolate, 1.5-2 cm, with purple spots on the upper portion, apex acute. Nectaries 1 per corolla-lobe, at the middle of corolla-lobes, suborbicular, reduced to a naked gland patch. Filaments slightly flattened, 5.5-6.5 mm; anthers yellow, narrowly ellipsoid, ca. 4 mm. Ovary laterally compressed, style indistinct. Capsules ovoid to ellipsoid, 1.7-2 cm. Seeds brown, ellipsoid, ca. 0.5 mm; seed coat warty.



Fig. 6. *Swertia shintenensis* Hayata. 1, Habit; 2, Calyx; 3, Corolla with stamens and nectaries; 4, Corolla-lobe with nectary; 5 & 6, Stamens; 7, Pistil; 8, Seeds.

Japan and Taiwan. Taiwan, under broad-leaved forest at low altitudes from 500 to 900m around Taipei.

Specimens examined: Taipei: Leikungpo, Hsiaocketou, elev. ca. 350-450m, Jan. 18, 1989. *Peng 12285* (HAST); Huangtien mountain hiking trail loop, elev. ca. 630m, Feb. 5, 1995. *Wang 709* (HAST); Mucha, *Suzuki 13850* (TAI); Mt. Er-ko-shan, elev. ca. 400m, Nov. 17, 1995. *Chen 22* (TNU), same loc., Nov. 17, 1995. *Wang 9716* (TNU); Uraishan, Dec. 9, 1992. *Chen 133* (TNU), same loc., Oct. 6, 1988. *Kao 3* (TNU), et Oct. 31, 1988. *Kao 31* (TNU).

The status of *Swertia shintenensis* Hayata has long been confused since Hayata (1916) first described this taxon at species rank. Satake (1944) and Liu & Kuo (1970, 1974, 1978) treated it as a variety of *S. kuroiwai* Makino. Ying (1989) even reduced it to the synonymy of the later. However, Maekawa (1936), Ho *et al.* (1988) and Ho & Pringle (1995) retained it to distinct species. In his detailed study on *S. tashiroi* (Maxim.) Makino and its allies, Maekawa (1936) pointed out many difference between *S. shintenensis* and *S. kuroiwai*. Compared to *S. kuroiwai* Makino of the Ryukyus (Makino, 1903; Maekawa, 1936; Walker, 1976), the Taiwanese *S. shintenensis* Hayata shows a broader corolla-lobe and a purple nectary at or below the middle of corolla-lobe. The two species are closely related but readily distinguishable.

4. ***Swertia tozanensis*** Hayata in J. Coll. Sci. Univ. Tokyo 30(1): 204. 1911. (Mat. Fl. Form.); Satake in J. Jap. Bot. 21: 25. 1947; Ho *et al.* in Fl. Reipubl. Popularis Sin. 62: 184. 1988. — Type: Formosa. Tozan, in montibus Morrison, Nov. 1906, *G. Nakahara*, s. n. (holotype: TI!).

Fig. 7 高山當藥

Swertia matsudae Hayata ex Satake in J. Jap. Bot. 17: 722. 1941; Satake in J. Jap. Bot. 21: 25. 1947; T. S. Liu & C. C. Kuo in Ann. Taiwan Mus. 13:125. fig. 17. 1970; T. S. Liu & C. C. Kuo in Bull. Exp. Forest Natl. Taiwan Univ. 114: 204. pl. 21. 1974; T. S. Liu & C. C. Kuo in Fl. Taiwan 4: 187. pl. 959. 1978; Ho *et al.* in Fl. Peipubl. Popularis Sin 62:384. 1988; S. S. Ying in Quart. J. Exp. Forest Natl. Taiwan Univ. 3(2): 103. 1989; Ho & Pringle in Fl. China 16: 115. 1995. — Type: Taiwan. in monte Nokozan, Aug. 1919, *E. Matuda*, s. n. (holotype: TI!). syn. nov.
Swertia matsudae Hayata in sched.

Annuals to 80 cm tall. Stems erect, subquadrangular, branched. Basal leaves petiolate, leaf blade rhombic-ovate, 1.5-3 cm long including petiole, 5-7 mm wide, apex obtuse, base narrowed, veins 3. Stem leaves sessile; leaf blade linear-lanceolate to lanceolate, 2-7 cm long, 3-7 mm wide, apex acute or obtuse, base narrowed, veins 3. Inflorescences panicles of cymes, lax, few-flowered. Flowers 5-merous, occasionally 4-merous. Pedicel 1-2.5 cm. Calyx lobes ovate-lanceolate to spatulate, spreading to recurved, 2-3.5 mm, apex obtuse to acute, veins 3. Corolla pale yellow, with dark spots on middle and upper portion, lobes oblong, 4-8 mm long, 2-3.5 mm wide, apex obtuse to acute. Nectaries 2 per corolla-lobe, at the middle of corolla-lobe, orbicular, reduced to a naked gland patch. Filaments ca. 3 mm; anthers ellipsoid, 1-1.5 mm. Ovary ovoid, 5-6 mm; style short. Capsules narrowly ovoid, 1-2 cm. Seeds many, dark brown, subglobose, 0.7-1 mm; seed coat alveolate.

Endemic to Taiwan, at high altitudes from 2200 to 3500m in central and southern parts.



Fig. 7. *Swertia tozanensis* Hayata. 1, Habit; 2, Calyx; 3, Corolla with stamens and nectaries; 4, Stamen; 5, Pistil; 6, Fruit; 7, Seeds.

Specimens examined: Nantou: Yushan, Sept. 6, 1985. *Peng 8580* (HAST); Kungang, elev. ca. 3000m, Aug. 2, 1986. *Peng 9590* (HAST); Tatachia saddle to Paiyun Lodge, elev. ca. 2800m, Sept. 6, 1991. *Peng 14330* (HAST); Tienchih to Kuailin, elev. ca. 2160-2860m, Oct. 14, 1992. *Ho 650* (HAST); Tungpushanchuang to Tatachiaanpu, elev. ca. 2500-2900m, Aug. 7, 1991. *Leu 1134* (HAST). Chiayi: Tatachia saddle to Paiyun Lodge, elev. ca. 3000m, Sept. 16, 1986. *Peng 9795* (HAST). KAOHSIUNG: Chinching Bridge to Kuanshan, elev. ca. 2820-3074m, Oct. 21, 1995. *Lin 139* (HAST). Hualien: Tayuling, elev. ca. 2550m, Sept. 10, 1991. *Peng 14492* (HAST); Chingshuishan, elev. ca. 2200-2400m, June 2, 1993. *Leu 1760* (HAST); same loc., elev. ca. 2000-2400m, July 14, 1995. *Chen 1162* (TNU); Hoping logging tract 41K-46K, elev. ca. 1900-2000m, July 27, 1993. *Wang 8582* (TNU) *et 8590* (TNU).

Since Hayata first published *S. tozanensis* in 1911, the species has long been problematic. Satake (1941) separated *S. matsudae* from *S. tozanensis* by its narrow leaves with acute tip, large flowers, and anastomosing veinlets on calyx-lobes. However, based on our field observation and examination of herbaria specimens, we found that plant size, flower size, and leaf shape are not good characters because they display great infraspecific variation which may possibly correlate with collecting season. When the plant is collected in the late growth season, it often displays smaller size, lax inflorescence with fewer flowers, and 4-merous instead of 5-merous flowers. *Swertia tozanensis* Hayata, based on the type specimen (holotype: *G. Nakahara*, *s. n.* Nov. 1906, TI!) collected in November, represents the extreme pattern mentioned above. On the other hand, *Swertia matsudae* Hayata ex Satake (holotype: *E. Matuda*, *s. n.* Aug. 1919, TI!) represents the normal pattern. However, their gross morphology, including the recurved spatulate calyx-lobes (a character unique among the Taiwanese species), two orbicular gland patch-like nectaries at the middle of corolla-lobes, and the morphology of seeds, are steadily consistent. Consequently, *Swertia matsudae* Hayata ex Satake should be treated as conspecific with *S. tozanensis* Hayata.

Most of later taxonomists adopted Satake's opinion and treated *S. matsudae* and *S. tozanensis* to be distinct (Liu & Kuo, 1974, 1978; Ying, 1989; Ho & Pringle, 1995). However, perhaps because of the unavailability of the type specimen, their descriptions about "*S. tozanensis*" are quite different from Hayata's original publication even in the diagnostic characters such as calyx-lobe, nectary, and seed. Judging from their illustration (Liu & Kuo, 1974, *pl.* 23) and/or descriptions, "the corolla-lobes with 2 ciliate glandular-maculas on both margins near the base." (Liu & Kuo, 1978), their "*S. tozanensis*" could be misapplied. Undoubtedly, It should be synonymous with *S. macrosperma*.

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台灣產當藥屬植物之訂正

王震哲^(1,2)、呂長澤⁽¹⁾

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摘 要

依據臺灣植物誌 (Liu & Kuo, 1978) 的記載, 台灣產當藥屬植物共有五個分類群, 然近年來陸續有台灣及大陸之學者重新對本屬植物予以分類處理, 各方之分類研究結果頗不一致, 顯示仍有深入研究之必要。本文針對台灣產之當藥屬植物進行詳盡的分類研究, 研究結果將臺灣產的本屬植物處理為四個分類群。其中將細葉當藥 (*S. matsudae* Satake) 併入高山當藥 (*S. tozanensis* Hayata) 處理為同種, 依循 Ho et al. (1988) 之意見將巒大當藥 (*S. randaiensis* Hayata) 併入大籽當藥 (*S. macrosperma* (C. B. Clarke) C. B. Clarke), 並將新店當藥 (*S. shintenensis* Hayata) 處理為種的階級。

研究結果顯示花冠裂片上的腺體形態及位置為區分台灣產當藥屬植物最主要的特徵, 另外, 植物的習性、萼片形態以及種子的數目及形態, 亦可作為有效的分類特徵。本文並提供種之檢索表, 各種之描述、繪圖及分類註釋。

關鍵詞: 龍膽科、訂正、當藥屬、臺灣、分類。

1. 國立台灣師範大學生物系, 台北市文山區117, 台灣, 中華民國。

2. 通信聯絡員。