

## Revision of *Torenia* L. (Scrophulariaceae) in Taiwan

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**ABSTRACT:** The genus *Torenia* L. (Scrophulariaceae) in Taiwan is revised based on comparative morphological and palynological studies. Four species, *i. e.*, *Torenia benthamiana* Hance, *T. concolor* Lindl., *T. flava* Buch.-Ham. ex Benth., and *T. violacea* (Azaola ex Blanco) Pennell are recognized in this paper. SEM micrographs of pollen grains, chromosome counts, a key to species, species descriptions, and taxonomic notes are provided.

**KEY WORDS:** *Torenia*, Scrophulariaceae, Pollen grains, Revision, Taiwan.

### INTRODUCTION

The genus *Torenia* L. (Scrophulariaceae) consists of about 30 species that are distributed in tropical regions of Asia and Africa (Li, 1978; Chin, 1979). According to Li (1978), there are three taxa, *i. e.*, *Torenia concolor* Lindl. var. *formosana* Yamazaki, *T. flava* Buch.-Ham. ex Benth., and *T. violacea* (Azaola ex Blanco) Pennell and two uncertain taxa, *T. arisanensis* Sasaki and *T. nantonensis* Hayata in Taiwan. Li (1978) mentioned that Yamazaki (1955) suggested *T. nantoensis* as a synonymy of *T. hirsuta* Willd based on a fragmentary fruiting isotype, but he assumed that *T. nantoensis* was more probably referable to *T. violacea*. Liu (1998) treated *T. nantoensis* as a synonymy of *T. violacea* in the second edition of Flora of Taiwan, but Chin (1979) and Hong *et al.* (1998) accepted Yamazaki's opinion and treated *T. nantoensis* as a synonymy of *T. benthamiana*. *Torenia arisanensis* was not treated by Chin (1979) and Hong *et al.* (1998), but by Liu (1998), it was treated as a synonymy of *T. concolor*. The native species *Torenia violacea* and the cultivated species *T. fournieri* Linden. ex Fourn. are very similar in habit. However, the former has small corolla (1.5-2.2 cm long), but the latter has large corolla (2.5-4.0 cm long). Thus the infrageneric classification of *Torenia* in Taiwan is rather confused, and a new revision is desirable.

### MATERIALS AND METHODS

Pollen grains were prepared by the procedures outlined by Erdtman (1952), and the pollen morphological description follows that of Huang (1972). The acetolyzed grains were dehydrated in an ethanol series and were dried using critical point drying. Dried grains were coated with gold and examined by SEM.

Root tips for chromosome counts were cut from living plants. After being pretreated with 0.002 M 8-hydroxyquinoline for 3-4 hours at a temperature of 18- 20°C, the root tips were fixed in a mixture of absolute alcohol and glacial acetic acid (3:1/v:v), then macerated with 1% pectinase, stained with acetic orcein, squashed, and observed using a Nikon microscope.

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Fig. 1. Habit and flower of *Torenia benthamiana* Hance.

## RESULTS

### External morphology

In habit, *Torenia benthamiana* (Fig. 1) and *T. concolor* are perennial prostrate herbs with diffusely branched stems; *T. flava* and *T. violacea* are annual herbs with erect or decumbent stems.

The plant of *T. benthamiana* covered with strigose hairs is different to the others. The yellow corolla of *T. flava* is very distinct, while the others have bluish or purple corolla.

*Torenia violacea* and *T. fournieri* Linden. ex Fourn. are very similar in habit. However, the former has small corolla (1.5-2.2 cm long) and is a native species which is distributed from central to southern Taiwan, while the latter has large corolla (2.5-4.0 cm long) and is cultivated in Taiwan.

### Pollen grains

The pollen grains can be used to distinguish four species of *Torenia* in Taiwan. The pollen grains of *T. benthamiana* has 3- or 4-colpate, isopolar, prolate spheroidal to subprolate in equatorial view, circular in polar view; sexine elevated reticulate with microperforation and granule in lumina (Figs. 2A-D).

The pollen grains of *T. concolor* has 3-colpate, isopolar, prolate-spheroidal to subprolate in equatorial view, circular in polar view; sexine elevated rugulate to reticulate with microperforation and granules in lumina. (Figs. 2E-G).

The pollen grains of *T. flava* has 3- or percolpate, prolate to subprolate in equatorial view, circular in polar view; sexine elevated rugulate to reticulate with micorperforation and few granules in lumina (Figs. 2H-J).

The pollen grains of *T. violacea* has 3-colpate, prolate-spheroidal to subprolate in equatorial view, semi-angular in polar view; sexine reticulate with perforation surface (Figs. 3A-C)

The pollen grains of *T. fournieri* has 3-colpate, spheroidal to prolate-spheroidal in equatorial view, inter-semi-angular in polar view; sexine elevated rugulato-reticulate with microperforation and granules in lumina (Figs. 3E-F).



The pollen morphology shows that *T. violacea* and *T. frounieri* are different species and is a good character for recognizing taxa at specific rank in this genus in Taiwan.

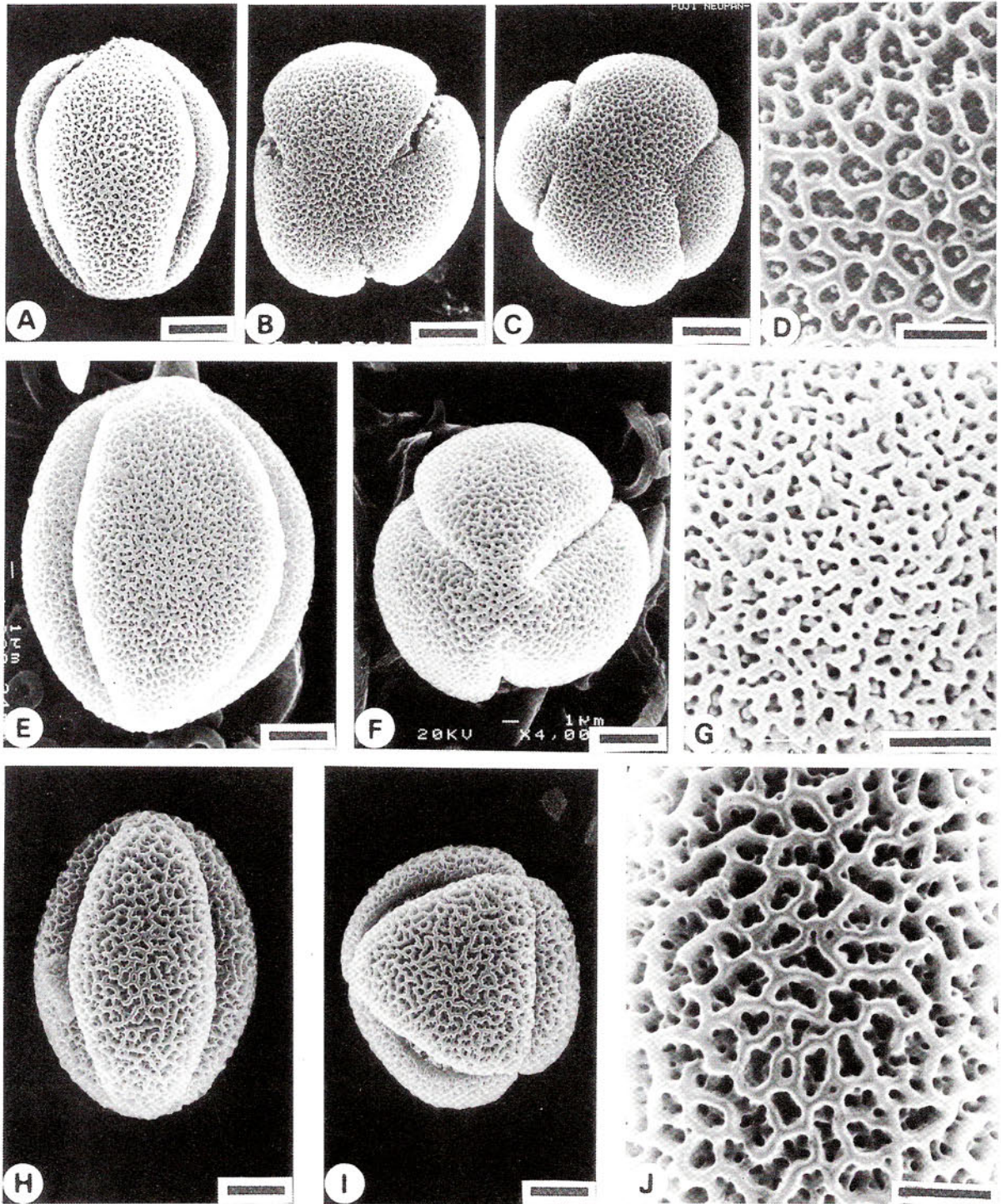


Fig. 2. SEM micrographs of pollen grains of *Torenia* in Taiwan. *T. benthamiana* Hance (A-D), *T. concolor* Lindl. (E-G), and *T. flava* Buch.-Ham. ex Benth. (H-J). Scale bars = 5 µm, except 2 µm in D, G, and J.



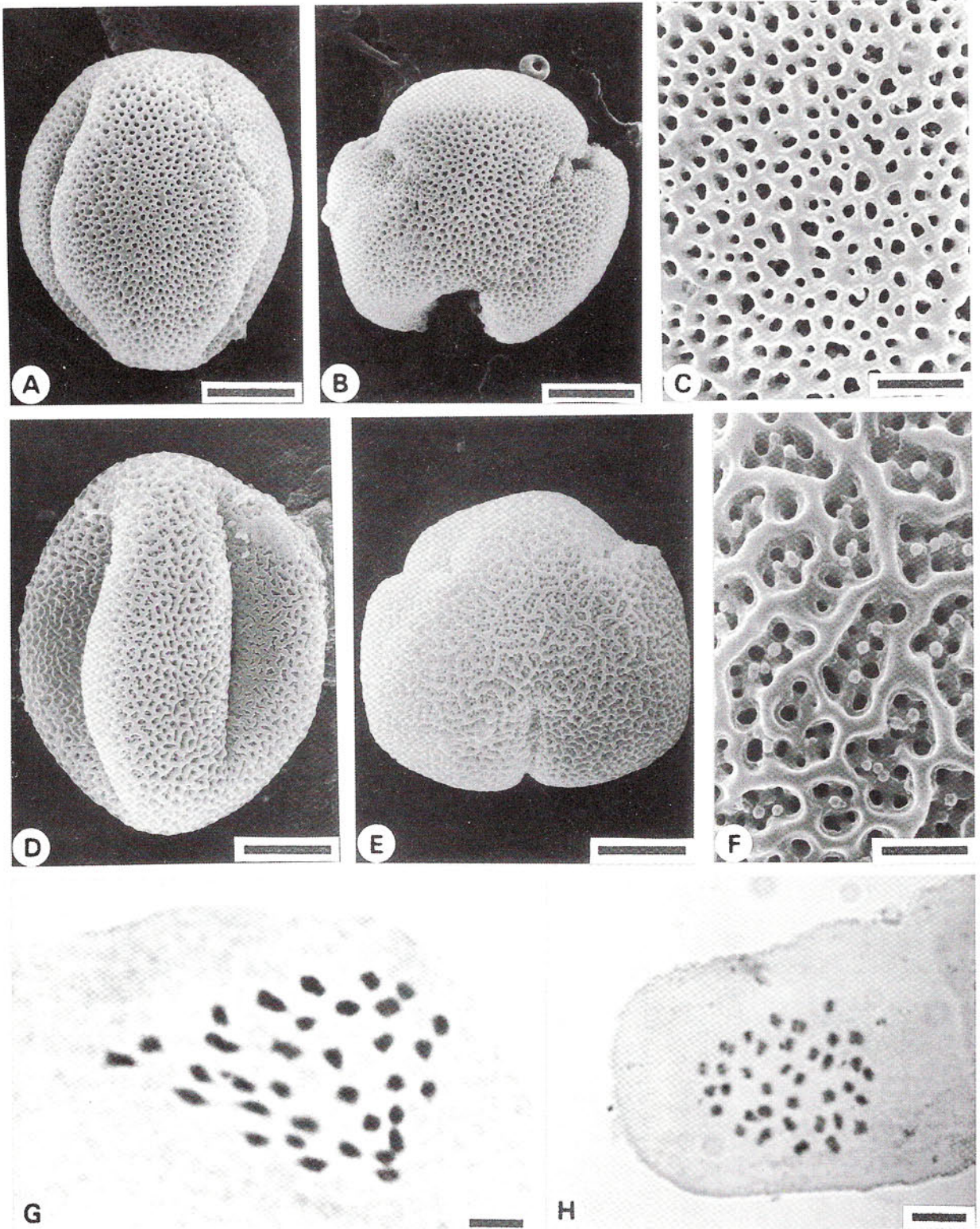


Fig. 3. SEM micrographs of pollen grains (A-F) and somatic chromosome numbers (G & H) of *Torenia* in Taiwan. *T. violacea* (Azaola ex Blanco) Pennell (A-C), *T. fournieri* Linden. ex Fourn. (D-F), *T. concolor* Lindl. (G), and *T. benthamiana* Hance (H). Scale bars = 5 μm, except 1.5 μm in C and F.



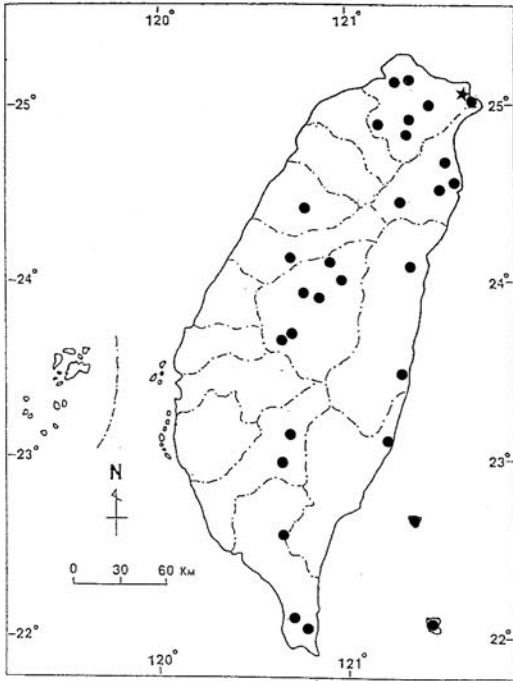


Fig. 4. Distribution of *Torenia benthamiana* Hance(\*) and *T. concolor* Lindl.(•) in Taiwan.

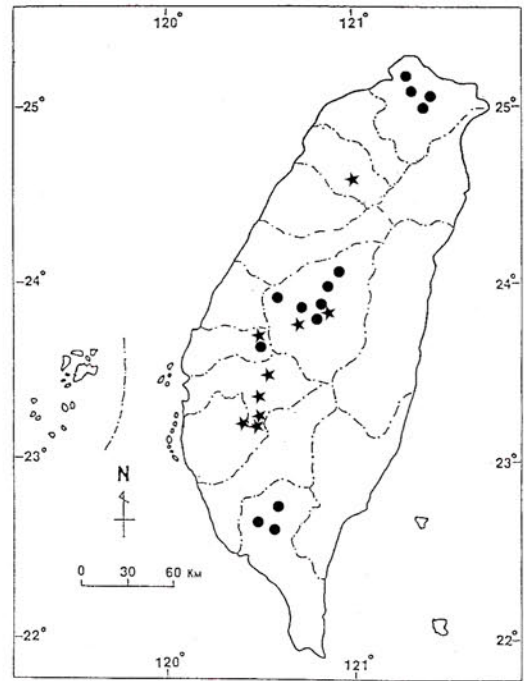


Fig. 5. Distribution of *Torenia flava* Buch.-Ham. ex Benth.(•) and *T. violacea* (Azaola ex Blanco) Pennell (\*) in Taiwan.

**Chromosome number**

Since the fresh material was lacking for *T. fulva* and *T. violacea*, the chromosome number of *T. concolor*  $2n = 34$  (Fig. 3G) and *T. benthamiana*  $2n = 36$  (Fig. 3H) is published here.

**Distribution**

*Torenia benthamiana* (Fig. 4) occurs at low elevations in northern Taiwan. *T. concolor* (Fig. 4) is distributed throughout the island from lowland to medium elevations. *T. flava* and *T. violacea* (Fig. 5) occur at low elevations in western Taiwan.

**Key to species**

- 1. Perennial herb; stem prostrate, diffusely branched
  - 2. Plant covered with strigose hairs; corolla 12-15 mm long ..... *T. benthamiana*
  - 2. Plant glabrous or sparsely pubescent; corolla 25-40 mm long ..... *T. concolor*
- 1. Annual herb; stems erect or decumbent
  - 3. Corolla yellow, 10-12mm long ..... *T. flava*
  - 3. Corolla bluish purple, 15-22 mm long ..... *T. violacea*

**TAXONOMIC TREATMENT**

***Torenia benthamiana* Hance**, Ann. Sci. Nat., Bot., ser. 4: 18: 226. 1862; Chin, Fl. Reip. Popu. Sin. 67(2): 154. 1979; Hong *et al.*, Fl. China 18: 38. 1998.

*Torenia nantoensis* Hayata, Ic. Pl. Formosa. 9: 81. 1920.  
*Torenia hirsuta* auct. non Lamarck: Dunn et Tutch. Kew Bull. Add. Ser. 10: 188. 1912; Yamazaki, J. Jap. Bot. 30: 364. 1955.

Perennial prostrate herbs. Stems slender, diffusely branched, densely white hirsute, usually rooting. Leaves membranous; petioles 5-10 mm long; blades ovate to ovate-cordate, 15-25 mm long, 10-20 mm wide, apex obtuse, base obtuse to truncate, with 5-8 pairs of depressed mucronate teeth on margin, covered with hirsuteness. Inflorescence solitary in upper leaf axils or in a 3-flowered fascicles. Pedicels 10 mm long in flower, 20-30 mm long in fruit. Calyx tubular, 10 mm long in flower, 15-20 mm long in fruit, 5-ribbed. Corolla bilabiate, dark bluish purple, 12-15 mm long, upper lip orbiculate, ca. 5 mm long, lower lip 3-lobed, lobes orbiculate, ca. 4 mm long. Stamens 4, didynamous, anterior filaments with a filiform appendage near base. Capsule narrowly ellipsoid, ca. 10 mm long, enclosed by the persistent calyx.

Distributed in S. China. Taiwan, in sunny grassland at low elevations on northern part.

**Specimens examined:** Taipei: Yenliao, *T. C. Huang* 8463 (TAI).

Notes: This species differs from *T. concolor* by densely white hirsute plant and small corolla (12-15 mm long). It is restricted in the northern Taiwan and rare.

**Torenia concolor Lindl.**, Bot. Reg. 32: tab. 62. 1846; Liu, Fl. Taiwan 2<sup>nd</sup> ed. 4: 629. 1998. excl. syn. *T. arisanensis* Sasaki.

*Torenia concolor* Lindl. var. *formosana* Yamazaki, J. Jap. Bot. 30: 363. 1955; Yamazaki, Fl. Jap. 3a: 341. 1993; Li, Fl. Taiwan 4: 598. 1978.

Perennial prostrate herbs. Stems slender, diffusely branched, 15-60 cm long, sparsely pubescent when young, glabrous when mature except nodes. Leaves membranous; petioles 4-10 mm long; blades ovate-cordate to triangular-ovate, 10-40 mm long, 8-25 mm wide, apex acute to acuminate, base truncate, margins sparsely crenate-serrate, upper surface loosely pubescent, lower surface loosely pubescent on nerves. Flower solitary in upper leaf axils. Pedicels 15-40 mm long, glabrous or sparsely pubescent. Calyx narrowed-tubular, 15-20 mm long in flower, 25-40 mm long in fruit, prominently 5-winged, bilobed. Corolla bilabiate, dark blue, 25-40 mm long, upper lip orbiculate, ca. 10 mm long, lower lip 3-lobed, lobes orbiculate, ca. 10 mm long. Stamens 4, didynamous, anterior filaments with a filiform appendage near base. Capsules linear-oblong, 10-15 mm long, enclosed by the persistent calyx.

Distributed in the Ryukyus, S. China, Indochina, and India. Taiwan, common and widespread throughout the island.

**Specimens examined:** Taipei: Shihting, *J. C. Wang* 4351 (TAI); Chishingshan, *S. C. Chen* 29 (TAI); Yenliao, *J. C. Wang* 3149 (TAI); Muchihshan, *L. Y. Lin* 6 (TAI); Wulai, *W. S. Tang* 1003 (TAI), *C. S. Kuoh* 1392 (TAI); Sanhsia, *J. C. Wang* 3288 (TAI); Tatunshan, *S. Sasaki s. n.* Jun 1928 (TAI); Yangmingshan, *C. Hsu* 3178 (TAI); Shinten, *Y. Shimada* 11182 (TAI); enroute from Auti to Yenliao, *T. Y. Yang* 1873 (TAI). **Miaoli:** Tahu, *Y. C. Chen* 96 (TAI). **Taichung:** Pahsienshan, *T. I. Chuang* 2711 (TAI). **Nantou:** Lushan, *S. F. Huang* 3497 (TAI), *C. Hsu & M. T. Kao* 11537 (TAI); Sanlinchih, *S. H. Lin* 12 (TAI), *W. S. Tang* 495 (TAI), *S. F. Huang* 35 (TAI); Lienhuachi, *M. T. Kao* 4044 (TAI); Chitou, *T. C. Huang* 1160 (TAI); Meiyenshan, *M. T. Kao* 6652 (TAI); Sun-Moon Lake, *C. T. Moo* 2287 (TAI). **Kaohsiung:** *T. C. Huang* 13818 (TAI); Sanping, *T. C. Huang* 4903 (TAI), *C. T. Moo* 2163 (TAI), *H. J. Chang* 2075 (TAI); Chuyunshan forest logging trail, *T. H. Hsieh* 3750 (NTNTC). **Pingtung:** Nanjenshan, *C. M. Kuo* 12772 (TAI); enroute to Tawushan, *T. C. Huang* 13569 (TAI); Lilungshan, *T. H. Hsieh* 2075 (NTNTC). **Taitung:** Sanshientai, *T. L. Liu* 14 (TAI); Lanyu, *C. Hsu* 4965 (TAI), *M. T. Kao* 8715 (TAI), *T. H. Hsieh* 2019 (NTNTC); Lutao, *T. C. Huang* 6968 (TAI). **Hualien:** Luanshan, *C. S. Kuo* 6969 (TAI); Fengping, *T. C. Huang & S. F. Huang* 14133 (TAI). **Ilan:** Bonbon, *M. T. Kao* 5922 (TAI); Suao, *S. F. Huang* 5050 (TAI); Chiaoichi, *T. C. Huang et al.* 13130 (TAI); Taipingshan, *T. Y. Chiang* 572 (TAI).



***Torenia flava* Buch.-Ham. ex Benth.**, Scroph. Ind. 38. 1835; Matsumura et Hayata, Enum. Pl. Formosa. 278. 1906; Li, Fl. Taiwan 4: 598; Liu, Fl. Taiwan. 2<sup>nd</sup> ed. 4: 629. 1998.

*Torenia hukutensis* Hayata, Ic. Pl. Formosa. 9: 81. 1920.

*Torenia fordii* auct. non Hook. f.: Matsumura et Hayata, Enum. Pl. Formosa. 278. 1906.

Annual herbs. Stems erect or decumbent, 15-40 cm tall, simple or branched, glabrous or sparsely pubescent. Leaves membranous; petioles 5-15 mm long; blade ovate to oblong, 20-50 mm long, 8-25 mm wide, apex acute or obtuse, base cordate to truncate, margins serrate, sparsely pubescent. Flowers in a terminal, loosely flowered raceme. Pedicels 5-7 mm long. Bract linear-lanceolate, 4-8 mm long, pubescent. Calyx 5-ribbed, narrowed-tubular, 5-10 mm long and 2-3 mm long wide in flower, 12-20 mm in fruit. Corolla bilabiate, yellow with purple spots in throat, 10-12 mm long, upper lip orbiculate, ca. 3 mm long, lower lip 3-lobed, lobes orbiculate, ca. 2 mm long. Stamens 4, didynamous, anterior filaments with a filiform appendage near base. Capsules linear-oblong, ca. 8-15 mm long, enclosed by the persistent calyx.

Distributed in S. China, Malaysia, Indochina, and India. Taiwan, widely distributed at lower elevation in western part.

**Specimens examined:** **Taipei**, Peitou, *S. Sasaki* s. n. Oct. 1914 (TAI), *N. Murakami* 182 (TAI); Toutingli, *C. M. Kuo* 10095 (TAI); Hsiengiyen, *S. F. Huang & K. C. Yang* 434 (TAI); Tatunshan, *S. Sasaki* s. n. Aug. 1928 (TAI); Sirin, *Y. Shimada* 11168 (TAI); Nankangshan, *C. I. Peng* 9037 (HAST); Nankang, *C. I. Peng* 7488 (HAST). **Nantou**: Tsaotun, *C. H. Chen* 448 (HAST); Puli, *T. C. Huang & S. F. Huang* 13481 (TAI), *C. Hsu* 4616 (TAI); Sun Moon Lake, *M. T. Kao* 10332 (TAI), *Y. Kudo & S. Sasaki* s. n. Sep. 1929 (TAI); Lienhuachi, *T. Shimizu* s. n. Aug. 1963 (HAST), *S. Sasaki* s. n. Aug. 1928 (TAI); Kuantaochi, *C. F. Hsieh* 1478 (TAI); Nenkao experimental Station, *T. C. Huang & M. T. Kao* 6071 (TAI); Hsinsheng, *K. Mori & S. Sasaki* s. n. Jul. 1926 (TAI); Shuishhe, *S. Sasaki* s. n. Sep. 1929 (TAI). **Yinlin**: Kunkeng Farm, *H. F. Yen* 8189 (HAST); Kunkeng, *H. F. Yen* 9547 (HAST). **Pingtung**: Litingshan, *T. C. Huang et al.* 16151 (TAI); en route from Talai Bridge to old Talai, *T. Y. Liu* 776 (HAST); Pingtung city, *W. P. Leu* 545 (HAST).

***Torenia violacea* (Azaola ex Blanco) Pennell**, J. Arnold Arbor. 24: 255. 1943; Li, Fl. Taiwan 4: 600. 1978; Liu, Fl. Taiwan 2<sup>nd</sup> ed. 4: 631. 1978. excl. *syn. T. nantoensis* Hayata.

*Mimulus violacea* Azaola ex Blanco, Fl. Filip. 2<sup>nd</sup> ed. 357. 1845.

Annual herbs. Stems erect or decumbent, simple or branched, 10-35 cm tall, sparsely pubescent. Leaves membranous; petioles 5-20 mm long; blades ovate to oblong-ovate, 20-40 mm long, 10-25 mm wide, apex acute, base truncate, margins serrate, sparsely pubescent. Flower solitary, axillary, or in a terminal few-flowered subumbell or raceme. Pedicels 15 mm long in flower, 30 mm long in fruit. Bract linear, 1-3 mm long. Calyx 5-winged, elliptic, 10-17 mm long in flower, 15-20 mm long in fruit, wing 2.5 mm wide in fruit, pubescent. Corolla bilabiate, bluish purple, 15-22 mm long, upper lip orbiculate, ca. 5 mm long, lower lip 3-lobed, lobes orbiculate, ca. 4 mm long. Stamens 4, didynamous, anterior filaments without a filiform appendage. Capsules oblong, ca. 8-12 mm long, enclosed by the persistent calyx.

Distributed in Central and S. China, Malaysia, India, and Papua New Guinea. Taiwan, in roadsides at low elevation.

**Specimens examined:** **Hsinchu:** Taoshan village, *C. I. Peng* 8395 (HAST). **Nantou:** Gigi, *C. F. Hsieh* 1367 (TAI); Puli, *S. Sasaki s. n.* 1929 (TAI). **Yinlin:** Kunkeng Farm, *H. F. Yen* 9545 (HAST). **Chiayi:** Chishinliao, *H. F. Yen & M. T. Kao* 10728 (TAI); Chonglun, *H. F. Yen & M. T. Kao* 10696 (TAI); Houtapu, *S. Sasaki s. n.* Oct. 1929 (TAI); Kuangyin waterfall, *T. C. Huang et al.* 16158 (TAI), *W. P. Leu* 1603 (HAST); Tapu, *H. F. Yen* 6602 (HAST). **Tainan:** Chiayi Farm, *T. C. Huang & S. F. Huang* 14196 (TAI); Kuantzuling, *L. Mori s. n.* Oct. 1942 (TAI). **Kaohsiung:** Chuyunshan forest logging trail, *T. H. Hsieh* 2117 (NTNTC).

### Excluded species

**Torenia arisanensis** Sasaki, *Trans. Nat. Hist. Soc. Formosa*. 21: 222. 1931.

According to the type specimen (*S. Sasaki s. n.* Oct. 1928, Alishan, 2270m, TAI !) and original description, this species belongs to *Mimulus tenellus* Bunge var. *japonicus* (Miq.) Hand.-Mazz.

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## 台灣產倒地蜈蚣屬 (玄參科) 訂正

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## 摘 要

根據外部形態和花粉等特徵，將省產倒地蜈蚣屬 (玄參科) 訂正為四個種，分別為毛葉蝴蝶草 (*Torenia benthamiana* Hance)，倒地蜈蚣 (*T. concolor* Lindl.)，母丁香 (*T. flava* Buch.-Ham. ex Benth.)，和紫萼蝴蝶草 (*T. violacea* (Azaola ex Blanco) Pennell)。本文確認毛葉蝴蝶草產於台灣。至於 *Torenia arisanensis* Sasaki 此學名應併入尼泊爾溝酸漿 (*Mimulus tenellus* Bunge var. *japonicus* (Miq.) Hand.-Mazz) 之異名下。本文並提供檢索表、特徵描述、花粉、和部份種類的染色體數目等特徵。

關鍵詞：倒地蜈蚣屬、玄參科、花粉、訂正、台灣。

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