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REVIEW ARTICLE

A Revision of the Genus *Polygala* L. (Polygalaceae) in Taiwan

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ABSTRACT: Based on the morphological characteristic and comparing the type specimen, we clarify the taxonomic chaos of the genus *Polygala* in Taiwan. We reexamine the genus *Polygala* and reconfirm the existence of *P. chinensis* and *P. polifolia* in Taiwan. A key to the taxa, synonyms for each taxon and taxonomic description are presented. The line drawing illustration, habitat and photographs of *P. chinensis* also provided.

KEY WORDS: *Polygala* L., *Polygala chinensis*, *Polygala polifolia*, taxonomy.

INTRODUCTION

The Polygalaceae is a cosmopolitan family comprising with 21 genera and 800–1000 species having its centre of diversity in tropical and subtropical areas (Eriksen and Persson, 2007). The modified perianths superficially resemblance to the papilionaceous flower of the Leguminosae is attributed to the Fabales in APG system (APG III, Heywood et al., 2007). The *Polygala* L. is the largest genus in this family which has about 325 species with cosmopolitan distribution except for the Arctic, Antarctica and New Zealand (Heywood et al., 2007). Five taxa were recognized by previous workers in the Flora of Taiwan (Huang, 1977, 1993; Yang and Liu, 2002).

In order to publish Flora of Lanyu, we had conducted the field collections in Lanyu and examined the specimens of the Lanyu Island from several herbaria. During the field survey in these years, we had collected two species belonging to *Polygala* plants. One of them is *P. japonica*, the other plant which has elliptic leave and keel with deer horn-like appendage, and we could not identify with reference of the Flora of Taiwan. However, we did find it as *P. chinensis* in the Flora of China (Chen et al., 2008).

Besides, during checking both editions of Flora of Taiwan (Huang, 1977, 1993) and Manual of Taiwan Vascular Plant Vol. 6 (Yang and Liu, 2002), we realized that they placed this plant in the name of *P. arvensis*, *P. polifolia* and *P. golmerata* in Taiwan. Thus the revision of *Polygala* L. would be required.

In this paper we reconfirm both *P. polifolia* and *P. chinensis* in Taiwan, thus a total of 6 species of the genus *Polygala* in Taiwan. Moreover, the key to the taxa, synonyms for each taxon and taxonomic description are presented, we also provided the line drawing illustration, habitat and morphology photographs of *P. chinensis*.

TAXONOMIC TREATMENT

Polygala L., Sp. Pl. 2: 701. 1753.

Annual or perennial herbs, or shrubs, small trees (all species in Taiwan are herbs). Leave simple, alternate, estipulate, petiolate; leaves entire, glabrous or pilose. Racemes terminal or axillary. Flower bisexual, zygomorphic. Sepals 5, free, unequal, persistent or caducous; outer sepal 3, inner sepal 2, always petaloid. Petals 3, unequal, connate at base; lateral petal 2, lowest petal keel boat shaped, enclosing stamens and style, apex always with highly divided, fimbriated appendage. Stamens 8, monadelphous, filaments united at least at base, forming an open staminal sheath, adnate with petals; anthers with stalk or sessile, dehiscent from terminal pores. Ovary 2-loculed, ovule 1 per locule; style simple, sometime curved; stigma 1, rare 2. Fruit capsules, always winged, loculicidal dehiscent. Seed 2, ovoid or globose, pilose, with an aril.

About 325 species, cosmopolitan except for the Arctic, Antarctica and New Zealand, 6 species in Taiwan (including 1 endemic species).

Key to the species of *Polygala* L. in Taiwan

1a. Racemes terminal 2
1b. Racemes axillary 3
2a. Leaves petiolate, ovate; flowers purplish-red, sepals caducous after anthesis, keel without apical appendage .... 6. ***P. tatarinowii***
2b. Leaves subsessile, linear; flowers white, sepals persistent after anthesis, keel with 4–6-lobes fimbriated appendage ..... 4. ***P. paniculata***

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3a. Sepals caducous after anthesis; keel apical appendage yellow, leaves blades large, 4–10 cm long ..…….....…. 1. ***P. arcuata***
3b. Sepals persistent after anthesis; keel apical appendage violet-red or bluish-purple, leaves blades < 5 cm long …….……..…. 4
4a. Keel with 2 groups of brush-like appendages; the two central anthers on separate filaments, the lateral anthers sessile on two bundles of three anthers ……..…….…… 5. ***P. polifolia***
4b. Keel with bipinnate to tripinnate deer horn-like appendages; filaments connected more or less ….…..……..... 5
5a. Flower sessile; filaments united in lower 1/2 forming an open staminal sheath and with upper 1/2 free each other, anther with filament ……..…… 2. ***P. chinensis***
5b. Flower pedicellate; filaments nearly completely connected, anther sessile……..…….. 3. ***P. japonica***

1. *Polygala arcuata* Hayata in J. Coll. Sci. Univ. Tokyo **25(19)**:54. 1908; Huang in Fl. Taiwan **3**: 557. 1977, Fl. Taiwan **3** (2nd ed.): 571. 1993. TYPE: TAIWAN. Taichung, Kashigatani, *G. Nakahara s.n.*, Feb. 1907 (Isotype: TAIF!) 巨葉花遠志

Polygala crassiuscula Hayata, Icon. Pl. Formos. **3**: 32. 1913. TYPE: TAIWAN. Chiayi, Alisan, *S. Sasaki s.n.*, Jan. 1911.

Distribution: Endemic to Taiwan, distributed in the southern and central parts of the island.

Specimens examined: **TAIWAN**: TAICHUNG City: Hoping Dist., Lileng Logging Trail, *Y.H. Chang 20080111-011* (TAIF); Pahsienshan, *C.M. Wang & S.W. Chung 609* (TAIF). NANTOU Co.: Renai Township, Mt. Hsiaochushan, *F.C. Kuo & S.Y. Lu 3* (TAIF). PINGTUNG Co.: Chunri Township, Chinshuiying, *C.F. Chen 3135* (TAIF); Taiwu Township, Mt. Peitawushan, *T.C. Huang et al. 13593* (TAI). TAITUNG Co.: Daren Township (Taririkusya), *S. Sasaki s.n.,* 10 Feb. 1925 (TAI).

2. *Polygala chinensis* L., Sp. Pl. **2**: 704. 1753; Chen in Fl. China **11**: 154. 2008. TYPE: INDIA. *C. Linnaeus s.n.,* s.d. (Lectotype: LINN!, designated by Fawcett & Rendle, Fl. Jamaica 4: 244. 1920) 華南遠志 Fig. 1, 2.A–F

Polygala glomerata Lour., Fl. Cochinch. **2**: 426. 1790; Henry, List Pl. Formos. 18. 1896; Huang in Fl. Taiwan **3** (2nd ed.): 573, *pl*. 296. 1993, *pro parte*. TYPE: CHINA. Guangdong (Canton) *J. de Louriero. s.n.,* s.d. (holotype: P!)

Annual to perennial herbs, erect, 15–35 cm tall. Stems woody at base, simple or 2–5 branches, with crisped puberulous. Petioles 1 mm long, puberulous. Leaves alternate, chartaceous, ovate to elliptic, lanceolate, rarely obovate, 2–5 (–6) cm long, 0.6–1.5 cm wide, entire, slightly recurve, acute to obtuse and mucronulate at apex, acute at base, midrib raised abaxially, impressed adaxially, lateral veins indistinct, 3–4 pairs, obscure at lower surface. Racemes supra-axillary, 5–8 mm long; flowers 3–15, pale pink; bracts 3, caducous, 0.5 mm long, lanceolate, ciliate; pedicle 0.5–0.8 mm long, glabrescent. Sepals 5, persistent, outer sepals 3, unequal, ovate, ciliate; upper sepal bigger than lateral one, 3–3.5 mm long; inner sepals 2, equal, obliquely oblong or ovate, caudate at apex, 6 mm long, 2.5 mm wide, 4–5 nerved, indistinct. Petals 3, connate at base; lateral petals obovate, 3 mm long, each with tuft of hair at base; keel cucullate, 4 mm long, longer than lateral petals, white or purple, near apex with 2 groups of bipinnate to tripinnate deer horn-like appendages, violet-red. Stamens 8, base 1/2 unite, forming an open staminal sheath, filaments separated, 1–1.5 mm long; anther goblet-like, yellow. Ovary suborbicular; style 3–4 mm long, curved, strongly reflexed apically. Capsules flat-reniform, *ca.* 4 mm long, 4 mm wide, minutely winged and ciliate at margin. Seeds 2, black, ovate, *ca.* 3 mm long, 2.5 mm in diam., densely white pilose; arils white to translucent, 3 lobed, unequally.

Distribution: Ceylon, India, the Philippines, Vietnam, Southwest China and Taiwan. In Taiwan, it distributed at low altitude in western Taiwan and only one locality, i.e. Island Lanyu in eastern area. In Lanyu found at the altitude about 150 m of open grassy slopes in Mt. Hsiangaishan, Yehyo Village only.

Specimens examined: **TAIWAN:** MIAOLI Co.: Zhuolan Township, *C.F. Chen 3230* (TAIF), *C.M. Wang & P.F. Lu 12376* (TNM). TAICHUNG City: Longjing Dist., Mt. Tatushan, Wangkaoliao, *C.I. Huang 3262* (HAST); Hoping Dist., on the way of Mt. Tungmaoshan, *C.M. Wang 12478* (TNM); Tungshih Dist., Tungshih Forestry Farm, *C.M. Wang & K.C, Chang 11294* (TNM). NANTOU Co.: Yuchi Township, Lienhuachih, *S. Sasaki s. n.,* Oct. 1929 (TAI), Sun-Moon Lake, *T.W. Hsu 9663* (TAI). KAOHSIUNG City: Sanmin Dist., *Y.H. Tzeng 156* (TAIF). TAITUNG Co.: Lanyu Township, Yehyo Village, on the way of Mt. Hsiangaishan, *T.Y.A. Yang et al. 19003* (TNM). **CHINA:** GUANGDONG: Guangdong (Canton), *S.K. Lau 1329* (BM)*, 4226* (BM)*, 4559* (BM). HAINAN: Hainan, *F.C. How s.n.*, Oct. 1935 (BM). **PHILIPPINES:** LUZON: Luzon, *Ramos M. & Edano G. s.n.,* Nov. 1918 (K). Mindanao, *M. Ramos & G. Edano s.n.,* Jun. 1920 (K).

Note: The name of *Polygala chinensis* had been rejected and adapted as *P. glomerata* for this species by Burtt (1973). This opinion had been adapted in Flora of Taiwan Volume 3 (2nd ed.) (Huang, 1993), but in the notes, he mentioned that *P. glomerata* is used for conditional, until the type of *P. chinensis* is clarified. However, the specimen of *P. chinensis* named by Linnaeus was deposited at the LINN Herbarium (sheet 882.26!), and it was the only one specimen mentioned by Linnaeus himself. Moreover, Merrill (1935) and Adema (1966) had regarding it should be the type specimen of *P. chinensis*. After checking both type specimens of *P. chinensis* at LINN and *P. glomerata* (Fig. 3) at P by us, we do agree Van der Meijden's (1988) opinion to conserve *P. chinensis* and to adjust the *P. glomerata* as a synonym of *P. chinensis*.

3. *Polygala japonica* Houtt., Handleid **10**: 89. *pl. 62. f. 1*. 1779; Huang in Fl. Taiwan **3**: 558. *pl. 726*. 1977, Fl. Taiwan **3** (2nd ed.): 573. *pl. 295.* 1993. 瓜子金

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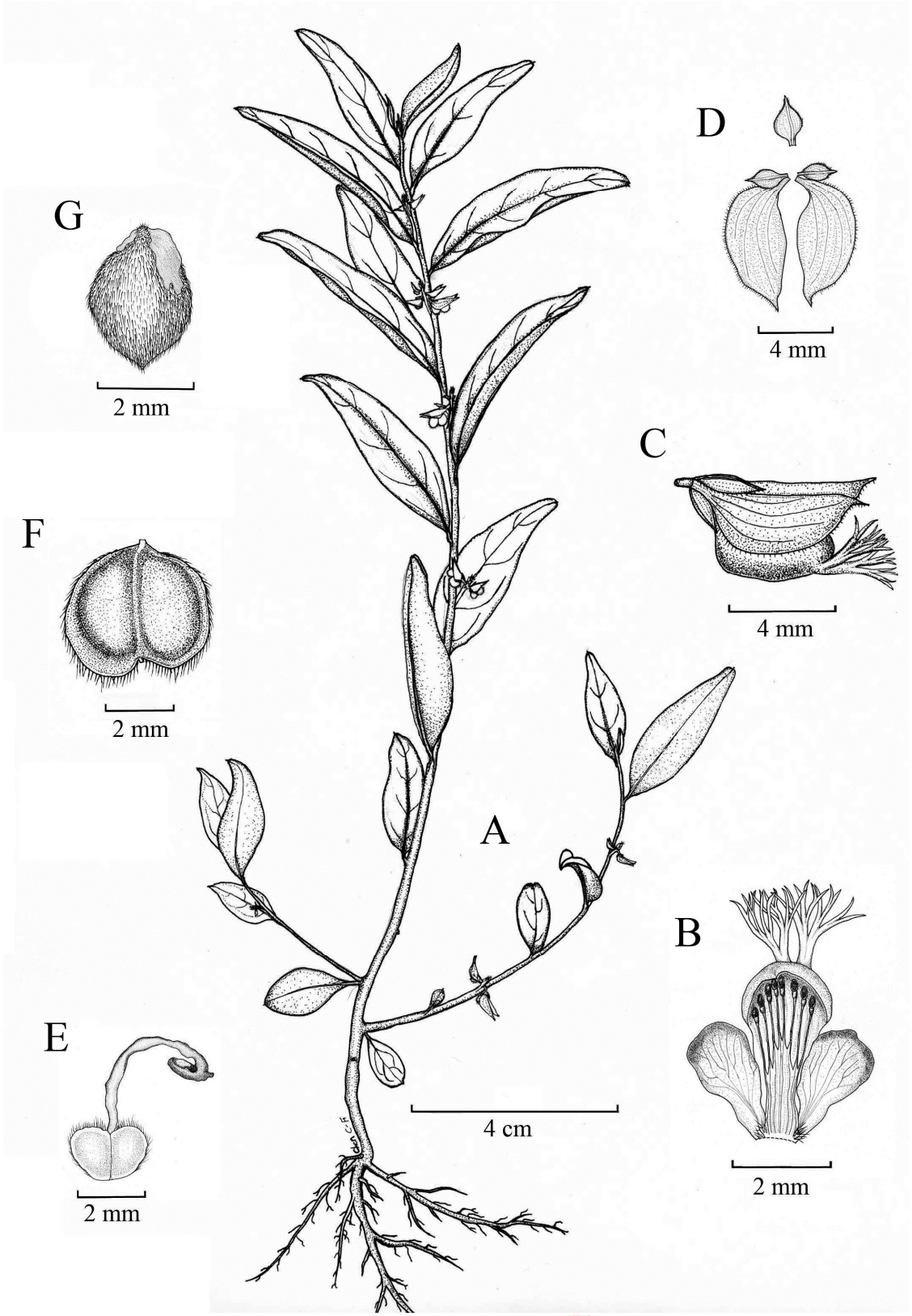


Fig. 1. The linedraw of *Polygala chinensis* L. A: Habit. B: Showing the keel appendage and staminal sheath. C: Flower. D: Sepal. E: Pistil. F: Fruit. G: Seed.

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Distribution: India, China, Japan, the Ryukyus, the Philippines, Moluccas, New Guinea, Micronesia and Taiwan. In Taiwan, this species has wide distribution from the low to high altitudes and throughout the island in many different habits. In Island Lanyu, it was found on open grassy land in western and southern parts.

Specimens examined: **TAIWAN**. TAIPEI City: Shihlin Dist., Palaka, *P.F. Lu 5681* (TAIF). NEW TAIPEI City: Tamsui Dist., *T. Kawakami & Y. Shimada 5723* (TAIF), Wulai Dist., *S.W. Chung 9127* (TAIF). HSINCHU Co.: Wufeng Township, Guanwu, *S.W. Chung 2356* (TAIF). TAICHUNG City: Hopin Dist., Tahsuehshan Forest Recreation Area, *J.C. Wang 12024* (TAIF). NANTOU Co.: Hsinyi Township, Tatachia, *Y.P. Cheng 2292* (TAIF). CHIAYI Co.: Alishan Township, *S. Sasaki s.n.*, May 1913 (TAIF). KAOHSIUNG City: Taoyuan Dist. Tienchih, *H.L. Chiang 620* (TAIF). ILAN Co.: Datung Township, Nanhutashan, *T.T. Chen et al. 10649* (TAIF). HUALIEN Co.: Xiulin Township, Zhuilu Historic Trail, *C.F. Chen 3622* (TAIF). TAITUNG Co.: Lanyu Township, *T.H. Hsieh & Y.C. Hsu 1355* (TAI); Hongtou Village, Meadow Chingching Grassland, *T.Y.A. Yang & C.F. Chen 23122* (TNM). KINMEN Co.: Taiwushan, *C.Y. Chen 5* (TAIF). LIANCHLANG Co.: Beikan, *Y.P. Cheng* 3707 (TAIF).

4. *Polygala paniculata* L., Syst. Nat. (ed. 10) 1154. 1759; Huang in Fl. Taiwan 3: 558. 1977, Fl. Taiwan **3** (2nd ed.): 573. 1993. TYPE: *Browne s.n.* s.d., Herb. Linn. No. 882.9 (Lectotype: LINN photo!, designated by Fawcett & Rendle, Fl. Jamaica 4: 242. 1920) 圓錐花遠志

Distribution: Widely distributed in the tropics. Introduced and naturalized at low altitude in northern and central Taiwan.

Specimens examined: **TAIWNA.** TAIPEI City: Datung Dist., Mt. Taluntou, *P.F. Lu 18551* (TAIF). NEW TAIPEI City: Gongliao Dist., Santiaochiao, *F.C. Kuo 25* (TAIF); Hsintien Dist. Ankkang Farm, *H.Y. Chen 1386* (TAIF); Wulai Dist., Wulai to Hsiaoyi, *S.W. Chung 4697* (TAIF). NANTOU Co.: Yuchi Township, Lienhuachi, *C.F. Chen 3729A* (TAIF). ILAN Co.: Chiaohsi Township, Paoma Historic trail, *P.F. Lu 732* (TAIF); Toucheng Township, Toucheng Farm, *P.F. Lu 6686* (TAIF). HUALIEN Co.: Xiulin Township, Tailuko (Tarokokyo), *T. Nishimura s.n.*, 9 Jul. 1929 (TAI).

5. *Polygala polifolia* C. Presl, Rel. Haenk. **2**: 101. 1835; Yamazaki in J. Jap. Bot. 48(5): 142. 1973; Huang in Fl. Taiwan 3: 558. 1977 (in part.); Chen in Fl. China 11: 152. 2008. TYPE: PHILIPPINES: Luzon, *T. Haenke s.n.*, 1792 (Holotype: MO photo!)
無柄花瓜子金 Fig. 2.G–J

Polygala arvensis auct. non Willd. 1802.: Yang & Liu, Manu. Taiwan Vasc. Pl. 6: 271. 2002.
Polygala glaucoides var. *hirsutula auct. non* (Arn.) Trimen.: Odashima in Trop. Agr. 7: 81. 1935.
Polygala shimadai Masam. in J. Soc. Trop. Agric. 3: 114, *f.* 15. 1931. TYPE: TAIWAN, Hsinchu Co., Hukou (Koko), *Y. Shimada 1191* (Holotype: TAI!)

Annual to perennial herbs, 5–20 cm tall. Erect or ascending, stem simple or 2–5 branches, cover with crisped-puberulous. Petioles very short *ca.* 0.5 mm, puberulous. Leaves alternate, chartaceous, green, glabrescent, obovate, elliptic, oblong, elliptic-lanceolate, 9–12 mm long, 4–5.5 mm wide, midrib slightly impressed on the surface and depressed beneath, lateral veins indistinct or absent, entire, obtuse to round at base, obtuse to round and mucronulate at apex. Racemes extra-axillary, up to 10 mm long; flowers 6–10, density, pale violet or lavender; bracts 3, caducous, unequal, 0.3–0.5 mm long, subulate, ciliate; pedicle shorter, 0.3–0.6 mm long, pubescent. Sepals 5, persistent, outer sepals 3, subulate, midrib 1, upper sepal bigger than lateral one, 1–1.5 mm long, inner sepals 2, equal, obliquely oblong or elliptic, 3 mm long, 2 mm wide, reticulate vein, 3-nerved, ciliate. Petals 3, connate at base; lateral petals broad rhombic, glabrous, undulate at margin; keel cucullate, longer than lateral petals, purple at apex, with 2 groups of brush-like appendages, bluish-purple. Stamens 8, base 1/3 unite, forming an open staminal sheath, split halfway, the two central anthers on separate filaments, the lateral anthers sessile on two bundles of three anthers; anthers goblet-like, yellow. Ovary suborbicular; style 2 mm long, toward stigma gradually curved and thickened. Capsules flat-reniform, *ca.* 2 mm long, 2 wide, minutely winged and ciliate at margin. Seeds 2, black, ovate-oblong, *ca.* 0.8–1.3 mm long, 2 mm in diam., densely white pilose; arils white to translucent, 3 lobed.

Distribution: India, Bangladesh, Sri Lanka, Pakistan, Cambodia, Laos, Thailand, Vietnam, Malaysia, the Philippines, Indonesia, New Guinea, Southwest China and Taiwan. In Taiwan, the species growing in grasslands on slopes along the seashore or wet grassland of hillside at low altitude and only found in the main island.

Specimen examined: **TAIWAN**. TAIPEI City: Peitou Dist., Mt. Chihsingshan, *T. Suzuki 20575* (TAI), Mt. Chihsingshan to Peitou, *Y. Simada 5761* (HAST). NEW TAIPEI City: Wulai Dist., Hsiaoi to Tunghou, *Y.K. Chen 299* (HAST). TAOYUAN Co.: Taoyuan, *T. Kawakami s.n.,* 17 Oct. 1914 (TAIF), *S. Sasaki 11773* (TAI); Chungli City, *T. Kawakami s.n.,* Aug. 1914 (TAIF), Jenmei, *C.M. Kuo 6345* (TAI, TAIF); Bade City, *T. Suzuki 21374* (TAI). HSINCHU Co.: Siangshan Dist., Siangshan (Kozan), *Y. Shimada 5091* (HAST); Hukon Township, Hukou, *Y. Simada 1191A* (HAST), *1191C* (TAI); Hsinchu, *S. Sasaki s.n.*, 10 May 1927 (TAI), *S. Sasaki s.n.*, 15 Aug. 1927 (TAI), *Y. Shimada 1190* (HAST); Chupei City, Temple Lienhuashih, *T.C. Huang & W.Y. Huang 14521* (TAI), *C.I Peng 7233* (HAST), *8599* (HAST), *9490* (HAST), *11192* (HAST), *C. I Peng & W.P. Leu 13148* (HAST), *C.I Peng & M.H. Chen 12219* (HAST). PINGTUNG Co.: Manzhou Township, Hsuhai, *T.C. Hsu 1450* (TAIF), Chufenkou grassland, *C.F. Chen 2666* (TNM), Pond Nanjenhu, *S.W. Chung 4063* (TAIF), *W.C. Leong 1057* (HAST), *T.Y.A. Yang et al. 23112* (TNM), Chialoushui, *T.C. Huang & W.Y. Huang 14538* (TAI). **JAPAN. ISLANDS RYUKYUS**: Ryukyu, *F. Miyoshi 4256* (K). **PHILIPPINES. LUZON:** Luzon, *Ramos M. s.n.*, Oct. 1909 (K), *Fénix E. s.n.,* Nov. 1917 (K). Philippines, *Loher s.n.,* 1906 (K).

Note: The species *Polygala polifolia* does not distribute in Lanyu Island. When we treated the Lanyu

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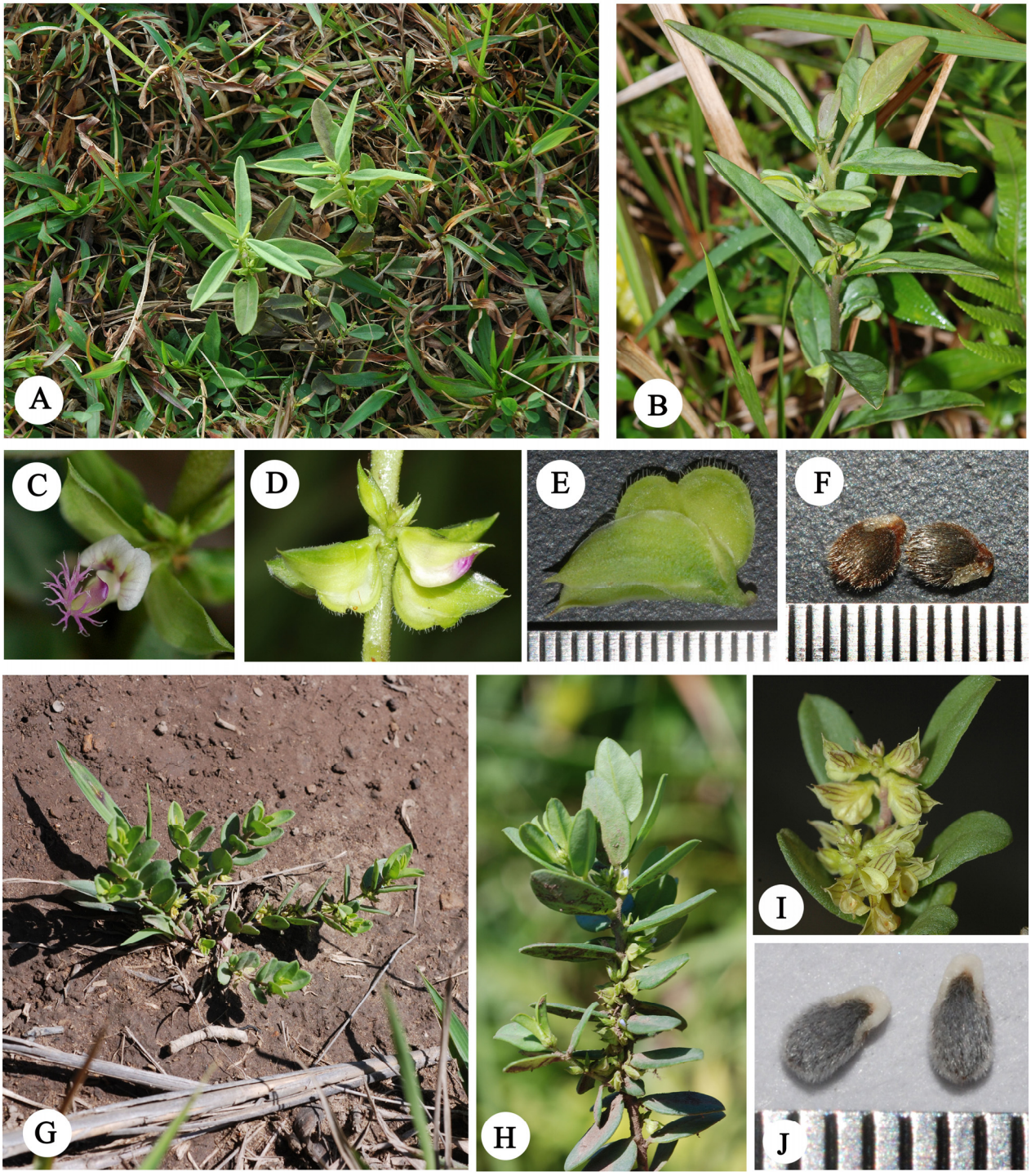


Fig. 2. A–F: *Polygala chinensis* L. A, B: Habit. C: Flower. D: Inflorescence. E: Fruit. F: Seeds; G–J: *Polygala polifolia* Presl. G: Habit. H: Branch. I: Fruit branch. J: Seeds. Scale bar= 0.05 mm.

Flora on *Polygala* species, we did find no one used this scientific name in Taiwan, only the 1st edition of Flora of Taiwan (Huang, 1977). However, this species had been changed into *P. glomerata* in Flora of Taiwan 2nd ed. (Huang, 1993) and *P. polifolia* as its synonym. After checking many specimens of *P. arvensis, P. chinensis, P. glomerata, P. polifolia* at different herbaria, then we clarified as follow: 1. *Polygala glomerata* is a synonym

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Fig. 3. Holotype of *Polygala glomerata* Lour. (P 00150864). Scale bar= 1 cm

of *P. chinensis*, and the species is also a new record to Taiwan as above mentioned. 2. *Polygala polifolia* is not the same species of *P. glomerata*, e.g. the treatment of the 2nd edition of Flora of Taiwan (Huang, 1993). Moreover, it has been treated as synonym of *P. arvensis* in Manual of Taiwan Vascular Plant (Yang and Liu, 2002). 3. We have checked several specimens of *P. arvensis* collected in India, and found the flowers colour of this species is yellow. Even the leave characters between these two species, *P. arvensis* and *P. polifolia* are very similar to each other, however, the flower colour is distinct different. In addition, Chandrabose & Nair (1981) mentions that the filament of *P. arvensis* is free each other and united in lower 1/2 forming an open stamina sheath. Therefore, we considered *P. arvensis* is not the taxon which we found in Taiwan, and the species should be the taxon of *P. polifolia*.

6. *Polygala tatarinowii* Regel in Bull. Soc. Nat. Mosc. **34(2)**: 523. 1861; Huang in Fl. Taiwan 3: 560, *pl.* 727. 1977, Fl. Taiwan **3** (2nd ed.): 576, *pl.* 296. 1993. TYPE: CHINA, near Beijing (Peking), *A.A.*

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Tatarinow 957 (Holotype: LE!)

Distribution: India, Japan, Kashmir, mainland China, N. Myanmar, Philippines and Taiwan. Taiwan, at low to middle altitude.

Specimen examined: **TAIWAN.** HSINCHU Co.: *Y. Simada s.n.*, 6 Apr. 1918 (TAIF). NANTOU Co.: Renai Township, Nengkao cross-ridge historic trail, *P.F. Lu 18659* (TAIF); Sinyi Township, Tanta logging trail, *S.S Li 152* (TAIF). CHIAYI Co.: Alishan Township, Nanhsi logging trail 5 Km, *P.H. Li 3465* (TAIF). ILAN Co.: Datong Township, *S. Sasaki s.n.*, Oct. 1928 (TAIF). HUALIEN Co.: Xiulin Township, Hopping logging trail, *S.W. Chung & T.C. Hsu 8115* (TAIF). TAITUNG Co.: Haiduan Township, Tienlung ancient trail, *P.F. Lu 10563* (TAIF).

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台灣遠志屬植物分類之訂正

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摘要：本文回顧形態特徵及重新比對模式標本，澄清台灣產遠志科植物學名混淆情形，確認華南遠志及無柄花瓜子金台灣均有分布。本文提供台灣產遠志屬檢索、各分類群分類處理及形態描述，並提供華南遠志手繪圖、生育地及形態照片。

關鍵詞：遠志屬、華南遠志、無柄花瓜子金、分類。

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