

---

# *Fallopia multiflora* var. *angulata*, a New Combination in the Polygonaceae from China

Yan Hanjing,<sup>1,2</sup> Fang Zhijian,<sup>2</sup> Zhang Hongyi,<sup>2</sup> and Yu Shixiao<sup>1\*</sup>

<sup>1</sup>School of Life Sciences/State Key Laboratory of Biocontrol, Sun Yat-sen University, Guangzhou 510275, People's Republic of China

<sup>2</sup>School of Traditional Chinese Medicine, Guangdong Pharmaceutical University, Guangzhou 510006, People's Republic of China

\*Author for correspondence: lssysx@mail.sysu.edu.cn

---

**ABSTRACT.** Taxonomic evaluation of *Polygonum multiflorum* Thunb. var. *angulatum* S. Y. Liu (Polygonaceae) reveals that a new combination in *Fallopia* Adans. is necessary, and the name *F. multiflora* (Thunb.) Haraldson var. *angulata* (S. Y. Liu) H. J. Yan, Z. J. Fang & Shi Xiao Yu is proposed. The new variety differs from the typical one by its square branchlets with longitudinal ridges that are densely papillate and by its root tubers with a greater abundance of fibers and abnormal vascular strands evident in anatomical cross section.

**Key words:** China, *Fallopia*, Guangxi, Polygonaceae.

In *The Polygonaceae of Eastern Asia*, Steward (1930) divided the family into three genera (*Antenoron* Raf., *Polygonum* L., and *Koenigia* L.), and *P. multiflorum* Thunb. was placed in *Polygonum* sect. *Tiniaria* Meisn. Liu (1959) later moved *P. multiflorum* along with *P. ciliinerve* (Nakai) Ohwi from section *Tiniaria* to section *Pleuropterus* (Turcz.) Haraldson within the genus. Based on its stems with a twining habit, *Fallopia* Adans. was later recognized as an independent genus (Haraldson, 1978), and *P. multiflorum* was transferred to the genus *Fallopia*, a taxonomic opinion that was subsequently recognized by Li (1998; Li et al., 2003) in the *Flora Reipublicae Popularis Sinicae*. *Fallopia multiflora* (Thunb.) Haraldson is a well-known herbal medicine in China, and its roots are called He Shou Wu in Chinese. This species has often been used as a tonic and an anti-aging herb in Chinese traditional medicine. Liu (1991) described *P. multiflorum* var. *angulatum* S. Y. Liu from Guangxi. This variety differs from the typical variety in its square branchlets with longitudinal ridges that are densely covered by papillate bodies; the immature leaf that is purple adaxially along the vein and abaxially, turning green at maturity; the larger flower (3–3.5 mm diam. at anthesis vs. 2–3 mm diam. in variety *multiflorum*); and the elliptic tepals that are unequal in size, with

the outer three larger and winged on the abaxial surface, and the apex of the wings retuse (vs. apex entire in variety *multiflorum*). However, *P. multiflorum* var. *angulatum* was considered only a cultivated variant of *F. multiflora* in the *Flora of China* treatment of the Polygonaceae (Li, 1998).

We examined the bioactive components of *Polygonum multiflorum* Thunb. [ $\equiv$  *Fallopia multiflora* (Thunb.) Haraldson var. *multiflora*] collected from seven provinces in China and compared these to two accessions of *P. multiflorum* var. *angulatum* from Tianyang County, Guangxi (Table 1). The bioactive components of variety *angulatum* differed remarkably from those of the typical variety (Fu et al., 2006; Yan et al., 2007). Our further investigation of their respective anatomies, morphologies, and ITS sequence data (Yan, unpublished data) supports *P. multiflorum* var. *angulatum* as distinct and its transfer to *Fallopia* is proposed here at the varietal level.

**1. *Fallopia multiflora*** (Thunb.) Haraldson, Symb. Bot. Upsal. 22(2): 77. 1978. Basionym: *Polygonum multiflorum* Thunb., Syst. Veg. (ed. 14) 379. 1784. TYPE: China. Yunnan: *Ducloux 485* (holotype, BS [fide Steward, 1930] not seen).

**1a. *Fallopia multiflora* var. *multiflora*.**

**1b. *Fallopia multiflora* var. *angulata*** (S. Y. Liu) H. J. Yan, Z. J. Fang & Shi Xiao Yu, comb. nov. Basionym: *Polygonum multiflorum* Thunb. var. *angulatum* S. Y. Liu, Acta Bot. Yunnan. 13(4): 390. 1991. TYPE: China. Guangxi: Lingyun, 23 Oct. 1989, S. Y. Liu *L89015* (holotype, KUN).

**1c. *Fallopia multiflora* var. *ciliinervis*** (Nakai) Yonekura & H. Ohashi, J. Jap. Bot. 72(3): 158. 1997. Basionym: *Pleuropterus ciliinervis* Nakai, Repert. Spec. Nov. Regni Veg. 13(363–367): 267–268. 1914. *Fallopia multiflora* var. *ciliinerve* (Nakai) A. J. Li, Fl. Reipubl. Popularis

Table 1. Voucher collections from China for *Fallopia multiflora*. Vouchers are deposited at GDMP.

Taxon	Voucher	Locality
<i>Fallopia multiflora</i>	<i>H. J. Yan Y05JL</i>	Guangdong, Deqing
	<i>H. J. Yan Y05JG</i>	Guangdong, Deqing
	<i>H. J. Yan Y05SB</i>	Guizhou, Shibing
	<i>H. J. Yan Y05EMS</i>	Sichuan, Mt. Emei
	<i>H. J. Yan Y05JY</i>	Henan, Jiyuan
	<i>H. J. Yan Y05ES</i>	Hubei, Enshi
	<i>H. J. Yan Y05JGS</i>	Jiangxi, Mt. Jinggang
	<i>H. J. Yan Y05JX</i>	Guangxi, Jingxi
<i>Fallopia multiflora</i> var. <i>angulata</i>	<i>H. J. Yan Y05GZ</i>	Guangdong, Guangzhou
	<i>S. Y. Liu Y05TY</i>	Guangxi, Tianyang
<i>Polygonum multiflora</i> var. <i>angulata</i>	<i>S. Y. Liu L89015</i> (KUN)	Guangxi, Tianyang

Sin. 25(1): 103. 1998, nom. illeg. superfl. TYPE: China. Liaoning: thickets in valleys, mtn. slopes, 13 July 1897, *V. Komarov 563* (holotype, GH).

**1d. *Fallopia multiflora* var. *hypoleuca*** (Nakai ex Ohwi) Yonek. & H. Ohashi, *J. Jap. Bot.* 72(3): 158. 1997. Basionym: *Polygonum hypoleucum* Nakai ex Ohwi, *Acta Phytotax. Geobot.* 7(3): 130. 1938. TYPE: Taiwan. Taipei: Hokuto, 1 Dec. 1913, *Urbain Faurie 762* (isotype, HAST).

To distinguish the varieties of *Fallopia multiflora* in China, a revised identification key is provided (based on Li et al., 2003).

A REVISED KEY TO *FALLOPIA MULTIFLORA* IN CHINA

- 1a. Branchlets square in cross section .... variety *angulata*
- 1b. Branchlets circular.
  - 2a. Leaf blades abaxially glabrous.
    - 3a. Bracts triangular to ovate ..... variety *multiflora*
    - 3b. Bracts oblique, funnellform ..... variety *hypoleuca*
  - 2b. Leaf blade abaxially papillate along veins, but otherwise glabrate ..... variety *ciliinervis*

METHODOLOGY

**Anatomy.** Both handmade cross sections and microtome sections were made from root tubers at 1 cm diam. Transverse sections 8–12 μm thick were serially cut, and then dehydrated through an ethanol series. The sections were stained with safranin-fast green FCF, mounted on microscope slides, and embedded in Paraplast Plus medium (Zhengzhou Baisite Test Instruments Sales Co., Zhengzhou, China).

**Stem cuticle ultrastructure.** Stems were sampled from the approximate middle fourth to fifth internodes and cut into small tissue blocks, which were fixed in 2.5% glutaraldehyde at 4°C for 6 hours, then rinsed with 0.1 M phosphate buffer (pH 7.2) six times, and

dehydrated through an ethanol series toward supercritical point drying. Stem samples were sputter-coated with gold and examined with a Hitachi S-520 scanning electron microscope (Hitachi Ltd., Tokyo, Japan).

RESULTS

**Stem morphology.** Epidermal cells were rectangular, with their long axes parallel to the stem axis in *Fallopia multiflora* and *F. multiflora* var. *angulata*. Epidermal cuticles were striated in *F. multiflora* and *F. multiflora* var. *angulata*, and there were no obvious morphological differences in the ornamentation. Only in *F. multiflora* var. *angulata* was a twisting of the epidermal cells noted, with papillate ridges evident (Fig. 1A, B).

**Root tuber anatomy.** Transverse sections were similar among the samples for *Fallopia multiflora* with several layers of cork cells noted, filled with brown contents. The tuber cortex in *F. multiflora*, scattered with four to 11 abnormal vascular bundles in *F. multiflora* with fewer vessels evident, was broader than the cork. The vascular cylinder in *F. multiflora*, in the central portion of the root, has a ring-shaped cambium, with fewer vessels in the xylem and a few wood fibers noted to surround the vessels (Fig. 1C, D).

Cellular ultrastructure of *Fallopia multiflora* var. *angulata* differed in that the vascular bundle fibers occurred in the outer part of the cortex, and many more abnormal vascular bundles appeared to be scattered in the cortex. Also, pericycle fibers were grouped in bundles in *F. multiflora* var. *angulata*, with wood fibers surrounding the vessels (Fig. 1E, F).

DISCUSSION

Based on our field observations and an earlier study (Liu, 1991), significant morphological differ-

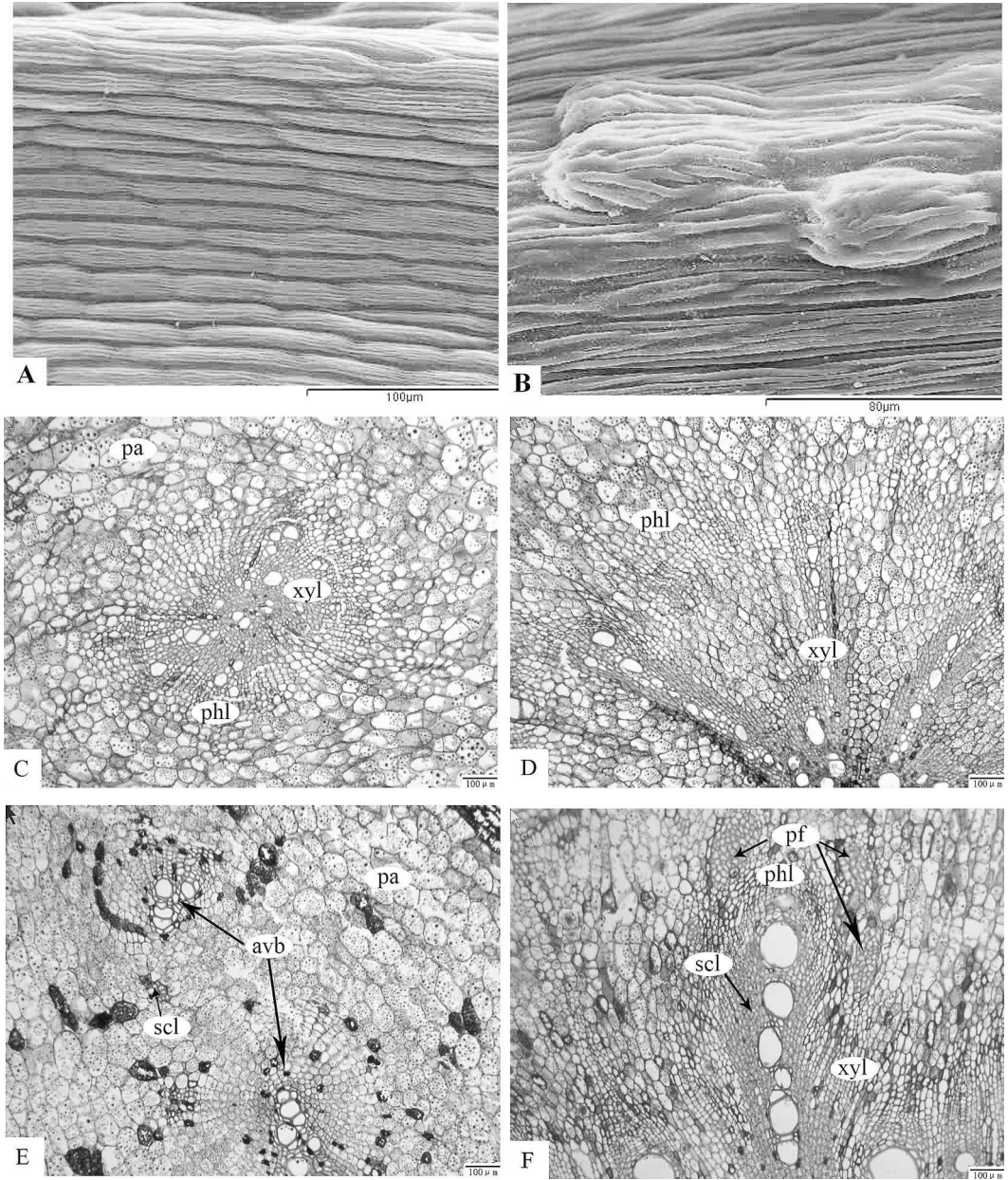


Figure 1. A, B. SEM micrographs of plant stems showing cuticular ornamentation. —A. *Fallopia multiflora* (Thunb.) Haraldson, H. J. Yan Y05JG sample from Deqing, Guangdong. —B. *Fallopia multiflora* var. *angulata* (S. Y. Liu) H. J. Yan, Z. J. Fang & Shi Xiao Yu, S. Y. Liu Y05TY from Tiangyang, Guangxi. C–F. Light micrographs of root tuber transverse sections. C, D. *Fallopia multiflora* (Thunb.) Haraldson, H. J. Yan Y05JG sample from Deqing, Guangdong. —C. Cortex showing abnormal vascular bundles. —D. Normal vascular tissue. E, F. *Fallopia multiflora* var. *angulata* (S. Y. Liu) H. J. Yan, Z. J. Fang & Shi Xiao Yu, S. Y. Liu Y05TY from Tiangyang, Guangxi. —E. Cortex showing abnormal vascular bundles. —F. Normal vascular tissue. Abbreviations: avb, abnormal vascular bundles; pa, parenchyma; pf, pericycle fibers; phl, phloem; scl, sclerenchymatous fibers; xyl, xylem.

ences exist between *Fallopia multiflora* var. *angulata* and the typical variety of *F. multiflora*. The former has many more cortical fibers in the root tubers, including pericycle fibers and wood fibers, as well as

abnormal vascular strands evident in transverse sections. These characters have remained stable even when the cultivated samples were transplanted for more than 10 years (these are maintained at Guangxi

Traditional Chinese Medical University and Guangdong Pharmaceutical University).

Crude extracts from the roots of *Fallopia multiflora* contain phospholipids, anthraquinones, and bianthraquinonyl glucosides, and these compounds exhibit prominent effects on many clinical therapies, particularly in cardiovascular diseases (Chang, 2000; Chan et al., 2002). We have examined the nature and concentration of 2,3,5,4'-tetrahydroxystilbene-2-O- $\beta$ -D-glucoside and anthraquinones by high-performance liquid chromatography (Fu et al., 2006; Yan et al., 2007). The content of 2,3,5,4'-tetrahydroxystilbene-2-O- $\beta$ -D-glucoside from samples of variety *angulatum* collected from Tianyang were only 0.0688%, much lower than 1% (a minimal effective level established by the China Pharmacopoeia Committee [2005]). The content of emodin physcion from these samples was also very low, with very little chrysophanol and rhein detected. The levels of these compounds from *F. multiflora* var. *angulata* were significantly lower than those sampled from *F. multiflora*.

*Acknowledgments.* We thank Si He (MO) and Yun-Heng Ji (KUN) for helpful comments and Jiang Wang (Sun Yat-sen University), Ji-Zhu Liu (Guangdong Pharmaceutical University), and Shou-Yang Liu (Guangxi Traditional Chinese Medical University) for assistance in collecting samples. Financial support was provided by a grant to Shi-Xiao Yu from the Science Foundation of Guangdong Province (No. 04105514).

#### Literature Cited

- Chan, Y. C., F. C. Cheng & M. F. Wang. 2002. Beneficial effects of different *Polygonum multiflorum* Thunb. extracts on memory and hippocampus morphology. *J. Nutritional Sci. & Vitaminology* 48: 491–497.
- Chang, S. C. 2000. Effects of *Polygonum multiflorum* Thunb. Extract on Learning, Memory and Antioxidative Abilities in Mice. Master's Thesis, Providence University, Taichung, Taiwan.
- China Pharmacopoeia Committee. 2005. *Radix Polygoni multiflori*. P. 123 in Chinese Pharmacopoeia, Vol. 1. Chemical Industry Press, Beijing.
- Fu, J., H. J. Yan, C. Q. Liang & J. Z. Liang. 2006. The quality evaluation for *Radix Polygoni Multiflori* from different areas. *J. Guangdong Coll. Pharm.* 22: 178–180.
- Haraldson, K. 1978. Anatomy and taxonomy in Polygonaceae subfam. Polygonoideae Meisn., emend. Jaretsky. *Symb. Bot. Upsal.* 22(2): 77.
- Li, A. R. 1998. *Fallopia* Adans. Pp. 96–105 in A. R. Li, Z. J. Gao, Z. M. Mao & Y. L. Liu (editors), *Flora Reipublicae Popularis Sinicae*, Vol. 25(1). Science Press, Beijing.
- Li, A. R., B. J. Bao, A. E. Grabovskaya-Borodina, S. P. Hong, J. McNeill, S. L. Mosyakin, H. Ohba & C. W. Park. 2003. Polygonaceae. Pp. 277–350 in Z. Y. Wu, P. H. Raven & D. Y. Hong (editors), *Flora of China*, Vol. 5 (Ulmaceae through Basellaceae). Science Press, Beijing, and Missouri Botanical Garden Press, St. Louis.
- Liu, S. E. 1959. Polygonaceae. Pp. 39–42 in *Key of Plants of Northeastern China*. Science Press, Beijing.
- Liu, S. Y. 1991. A new variety of *Polygonum multiflorum*. *Acta Bot. Yunnan.* 13: 390.
- Steward, A. N. 1930. The Polygoneae of Eastern Asia. *Contr. Gray Herb.* 5(88): 1–129.
- Yan, H. J., J. Fu, C. Q. Liang & J. Z. Liang. 2007. Determination of anthraquinone in *Radix Polygoni Multiflori* from different areas. *Chin. Patent Med.* 29: 91–94.