

Phryma leptostachya (Phrymaceae), a new family record in Taiwan

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Abstract. A newly recorded family, Phrymaceae, and species, *Phryma leptostachya* L., from Taiwan are described and illustrated. *Phryma leptostachya* was found near Chienshih Hsiang, in Hsinchu Hsien. The flowers of *Phryma* have unusually long hooked tips on the calyx and single-seeded fruit enclosed by the persistent calyx, which accounts for its isolated taxonomic position and recognition as an independent family, Phrymaceae. It is easily distinguished from the other related families, Scrophulariaceae, Lamiaceae, and Verbenaceae, respectively, in Taiwan.

Keywords: Floral anatomy; New record; *Phryma*; Phrymaceae; *Phryma leptostachya*; Pollen; Taiwan.

Introduction

Recently, the species *Phryma leptostachya* L. was found in our botanical survey at Syakaro, Chienshih Hsiang, Hsinchu Hsien in northern Taiwan. This species, the genus *Phryma*, and the family Phrymaceae all together were not recorded in the recent second edition of Flora of Taiwan (Hsieh et al., 2003).

Several authors keep *Phryma leptostachya* in the family Verbenaceae (Cronquist, 1981; Reveal, 2000; USDA, NRCS, 2004) and some authors segregate the plant into its own family, the Phrymaceae (Ohwi, 1965; APG, 1998; Reveal, 2000). This family includes a single genus, *Phryma*, adjunctly distributed in East Asia and eastern North America (Hara, 1962). The genus *Phryma* has either one or two taxa, depending on whether East Asian and eastern North American populations are considered separate taxa or not (Beardsley and Oldstead, 2002). Some Japanese taxonomists even published more names for the variation of this species (cf. Species Description). *Phryma leptostachya* has flowers with unusually long hooked tips on the calyx and a single-seeded fruit, which accounts for its isolated taxonomic position. However, Beardsley and Oldstead (2002) have treated *Phryma*, *Mimulus* (Scrophulariaceae), and some other small genera as comprising a monophyletic group, under the name Phrymaceae, based on molecular data.

Phrymaceae is reported here as new to the Flora of Taiwan with the description of the species *Phryma leptostachya* based on our collections. Anatomical characters were described and a line drawing and distribution maps were provided.

Materials and Methods

Fresh buds and flowers of *Phryma leptostachya* were collected at Syakaro, Chienshih Hsiang, Hsinchu County in northern Taiwan. These were preserved in F.A.A. (18: 1:1 of ethanol [50%], glacial acetic acid, formalin) immediately, and then transferred into 70% ethanol for storage and further work. Voucher specimens were saved in the Herbarium of National Cheng-Kung University (NCKU).

Light Microscopy

Samples were dissected and gradually dehydrated in an alcohol/xylene series, slowly infiltrated/embedded in paraffin, and then sectioned on a microtome. Sections (10 μ m) were stained with hematoxylin, and examined/imaged on a Zeiss compound microscope.

Scanning Election Microscopy

Samples were fixed in F.A.A. (18: 1:1 of ethanol [50%], glacial acetic acid, formalin). After dehydration in an alcohol-acetone series, samples were critical point dried, sputter coated with platinum, and observed under the scanning electron microscope (Hitachi S-4200, Tokyo) with an accelerating voltage of 15 kV.

Species Description

Phryma leptostachya L., Sp. Pl. 601. 1735; Makino, Makino's New Illustrated Flora of Japan. 578. f. 2310. 1979. 蠅毒草 Figures 1, 2, 3

Phryma leptostachya var. *confertifolia* Fernald, Rhodora 37(444): 442. pl. 402. fig. 1. 1935.

Phryma leptostachya var. *asiatica* H. Hara, Enum. Spermatoph. Jap. 1: 297. 1948.

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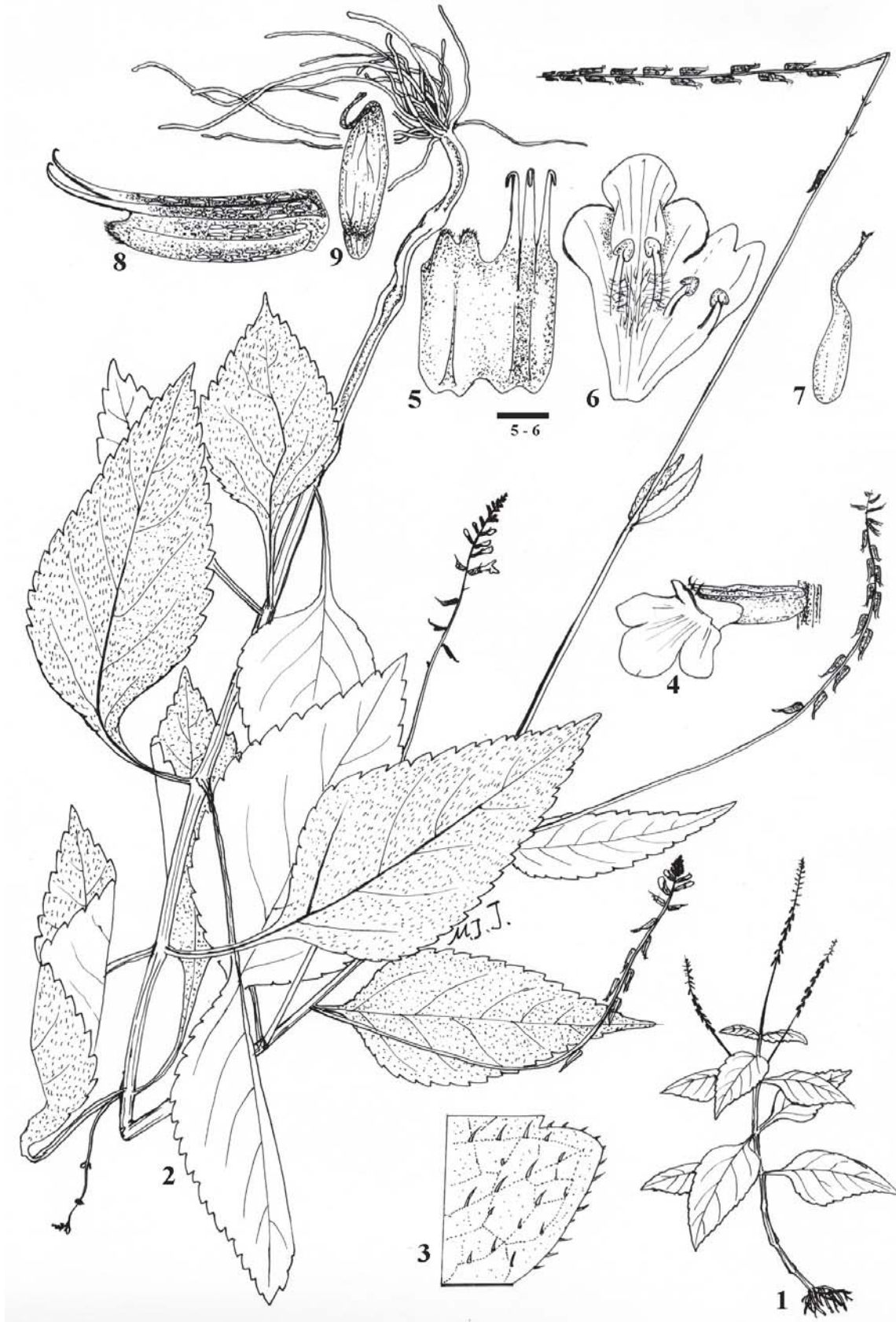


Figure 1. *Phryma leptostachya* L. 1, Habit. 2, Flowering plant. 3, Portion of an abaxial leaf surface, showing pubescence. 4, Flower. 5, Calyx dissected. 6, Flower dissected to show corolla and stamen. 7, Pistil. 8, Lateral view of persistent calyx. 9, Achene. Scale bar = 1 mm for Figure 1: 5-6.

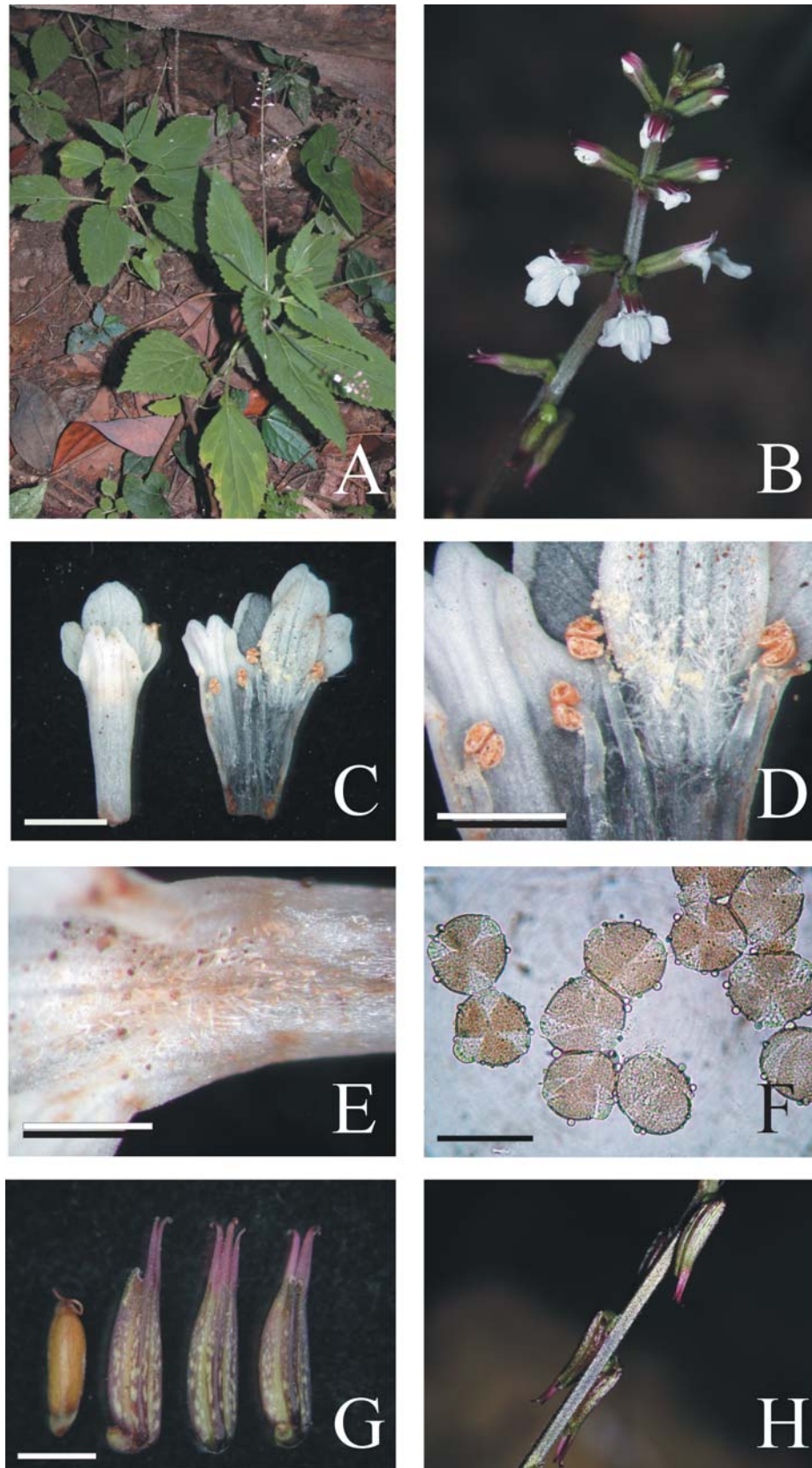


Figure 2. *Phryma leptostachya*. A, Habit. B, Inflorescence with buds, flowers and persistent calyx. C, Corolla tube and the dissected corolla (Scale bar = 2 mm). D, Flower, dissected to show didynamous stamens and pubescent throat (Scale bar = 0.5 mm). E, Lower corolla lip, showing the hairy concave place (Scale bar = 0.5 mm). F, Tricolpate pollen (Scale bar = 0.05 mm). G, Achene and lateral view, adaxial view and abaxial view of persistent calyx showing from left to right (Scale bar = 3 mm). H, Infructescence and drooping fruits.

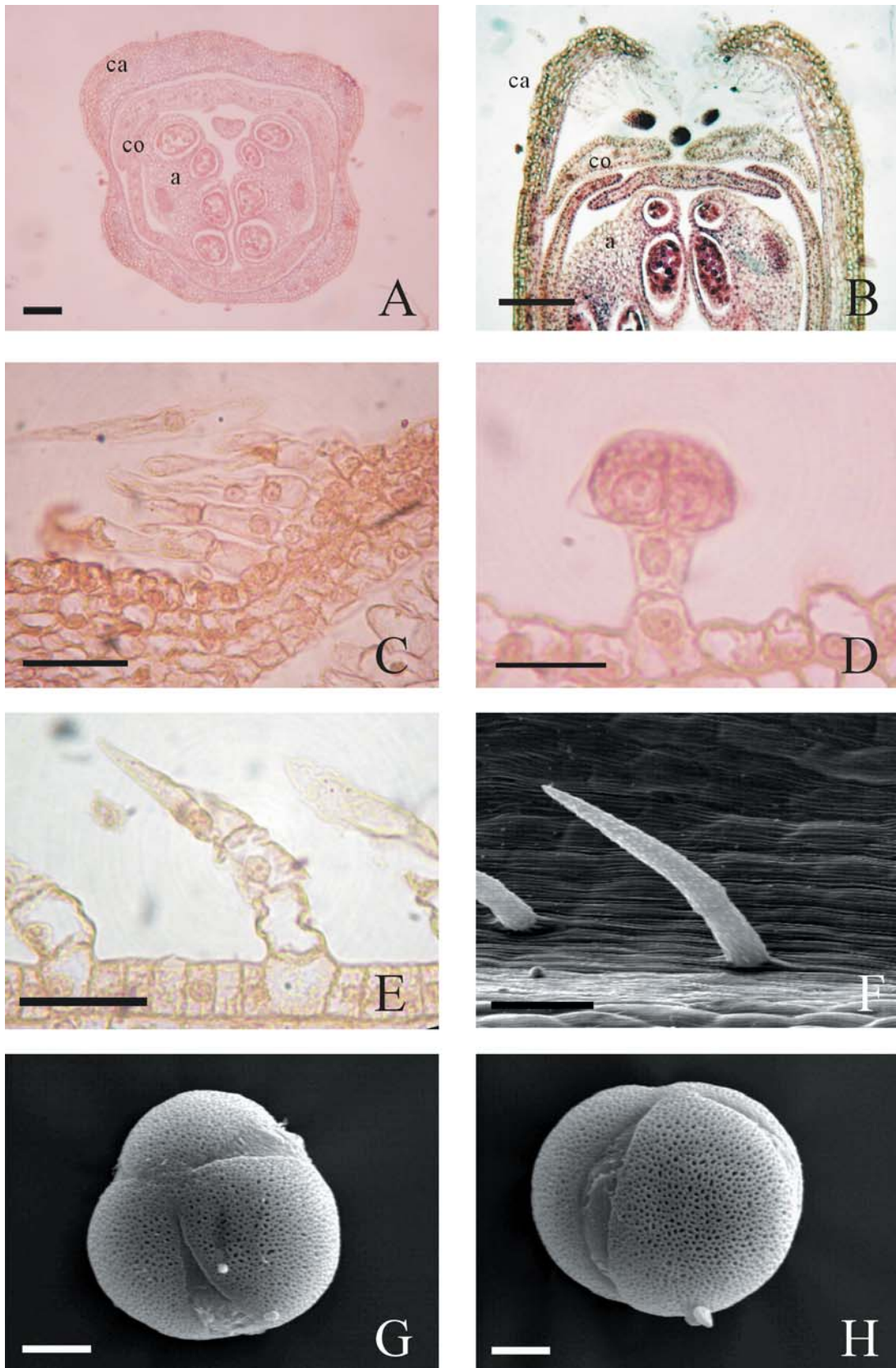


Figure 3. Floral anatomy and pollen of *Phryma leptostachya*. (A-E, LM photographs; F-H, SEM micrographs. A, B: bar = 100 μm ; C-F: bar = 30 μm ; G, H: bar = 5 μm) A-B, Cross section and longitudinal section showing floral structure, ca = calyx, co = corolla tube, and a = anther. C, Hairs at edge of calyx. D, Glandular hair on calyx. E-F, Part of hairy concave place (Figure 2E), showing multicellular hair. G-H, Polar view and equatorial view of pollen, showing tricolpate and microreticulate sculpture of the pollen wall.

Phryma leptostachya subsp. *asiatica* (H. Hara) Kitam.,
Acta Phytotax. Geobot. 17: 7. 1957.

Phryma oblongifolia Koidz., Bot. Mag. Tokyo 43: 400. 1929.

Phryma leptostachya var. *oblongifolia* (Koidz.) Honda,
Bot. Mag. Tokyo 50: 608. 1936.

Herbs, to 96 cm tall, simple or branch, erect; stems 4-angled and nodes swollen on older parts. Leaves opposite and decussate, cauline, herbaceous, pubescent. Blades to 13 cm long, 5.5 cm wide, lanceolate, ovate, or rhomboid, apex acuminate, base attenuate and decurrent on petiole to form wing, margin coarse crenate-serrate, lower surface pubescent on veins; basal blades usually smaller. Inflorescence in terminal and axillary racemes to 40 cm long; rachis greenish to purplish, bracteoles linear, to 1.5 mm long. Stipe articulate, short. Calyx persistent, zygomorphic, tubular, perpendicular to the stem, 2.7-5.5 mm long at anthesis, with five ridges the three adaxial lobes linear, purple, hooked at apex, the two abaxial lobes short subulate with a pubescent margin. Persistent fruiting calyx brown with light spots, directed abaxially and parallel to the stem, 6-8.4 mm long. Corolla bilabiate, whitish, to 6 mm long. Upper lip shallowly 2-lobed, lower lip 3-lobed, pubescent at abaxial concave place and at the apex of throat. Stamens 4, didynamous, adnate near apex of corolla tube, included; filaments white, glabrous; pollen grains tricolpate. Pistil 1, style curved, persistent; sigma bilamellate. Achene glabrous, 4.4-5.3 mm long, 1.2-1.5 mm wide.

Specimens examined. **TAIWAN.** HSINCHU: Shyakaro, 21 Jul 2003, M. J. Jung & K. C. Hung w072108, M. J. Jung, K. C. Hung, J. U. Lin & S. C. Wang w072806, w072807, w072808, w072809, w072810, w072811, w072812, w072813 (NCKU).

Habitat and Distribution (Figure 4). This species is found in the northern part of Taiwan (Chienshih Hsiang, Hsinchu Hsien; longitude 121°15' E and latitude 24°35' N), at 1,300-1,500 m elevation, on slopes and trailsides in disturbed temperate broad-leaved forest.

Floral anatomy. In a longitudinal section of the bud, the lower lobe of the calyx overlaps the upper lobe, and the upper lip of the corolla overlaps the lower lip (Figure 3B). There were multicellular hairs on the margin of calyx (Figure 3B-C). In a cross section, glandular hairs were sparse on the outside surface of the calyx (Figure 3A, D). There is a concave place on the lower corolla lip, and the outside of it is hairy (Figure 2E, 3E-F).

Pollen morphology. Pollen grains were tricolpate (Figure 2F, 3G). The pollen wall has microreticulate sculpture (Figure 3G-H). In contrast to a previous report (Todd et al., 1992), the pollen we observed had longer equatorial and polar axes; however, the P/E ratio was not conspicuously different (Table 1).

Notes. The relative position of calyx and corolla lips in bud noted above, were similar to that seen in the genera *Mazus* and *Mimulus*. The drooping fruits and tiny whitish flowers with the distinctive calyx are diagnostic.

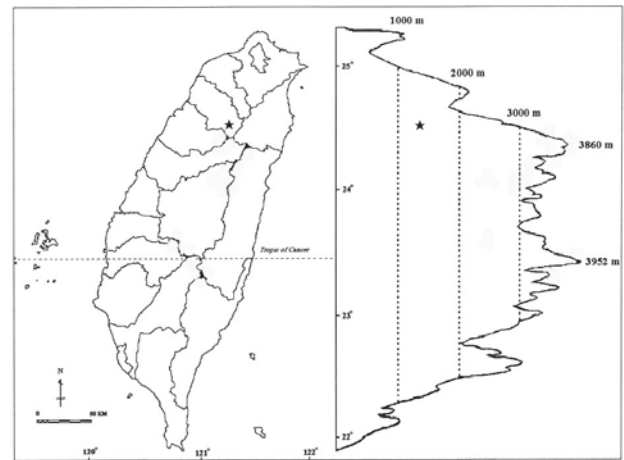


Figure 4. Distribution map of *Phryma leptostachya* in Taiwan.

Table 1. Comparison of size (in μm) and P/E ratio of pollen in *Phryma leptostachya*.

	Polar axis			Equatorial axis			P/E ratio
	Mean	Range	s. d.	Mean	Range	s. d.	
Taiwan	29.1	26.5-31	1.4	33.7	30.5-38	2.4	0.86
Ohio ^a	29	26-31	1.9	30	26-31	1.6	0.96
Québec ^a	27	22-33	3.0	32	29-35	2.1	0.85
China 1 ^a	23	22-26	1.4	29	26-31	2.2	0.79
China 2 ^a	24	22-26	1.5	29	26-31	1.9	0.82
China 3 ^{a, b}	23	20-26	1.7	25	22-26	1.9	0.92
Japan ^a	28	26-31	2.0	31	29-33	1.6	0.91

^aCited from Todd et al., 1992.

^bMeasurements taken from acetolyzed pollen in the same study (Todd et al., 1992).

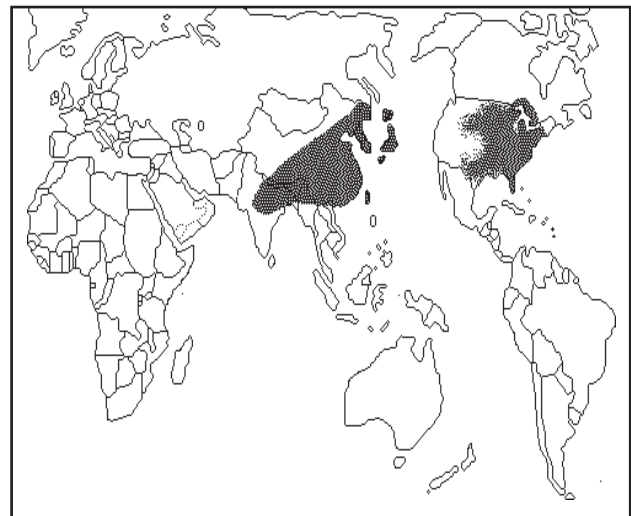


Figure 5. Global distribution of family Phrymaceae, include East Asia (Himalayas to China, Korea, Japan, Taiwan), and eastern North America.

The whitish corolla and the indumenta on the outside of lower corolla lip, and brown persistent calyx with light spots, are not mentioned in previous studies. Furthermore, the pollen sizes of our collection were larger than in other reports. Hara (1966) mentioned that Japanese and North American races of *Phryma leptostachya* differ in shape of leaves, in pubescence of rachises and calyces, and size of corollae. The population of *P. leptostachya* in the Himalayas has hairy stems and rachises, and fewer exerted corolla than the Japanese ones (Hara, 1966). The hairs on throat of corolla of *P. leptostachya* were described by Holm (1913). We tentatively treated this widespread and variable taxon as a single species. In Asia, with the new collecting site of *Phryma leptostachya*, the known distribution of the family, Phrymaceae, extends southeastward to Taiwan (Figure 5).

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蠅毒草（蠅毒草科）台灣新記錄

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本文描述最近發現於新竹縣尖石鄉之一台灣新記錄科植物—蠅毒草（*Phryma leptostachya* L.）。蠅毒草屬植物，其花萼先端具尖鉤，果實只具單一種子並由宿存萼包住。此等分類學特徵被認為獨特，故學者另立為一科。在台灣很容易和相近的玄參科、唇形科及馬鞭草科等鑑別。

關鍵詞：蠅毒草科；蠅毒草屬；蠅毒草；新記錄；花部解剖；花粉；台灣。