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Notes on *Strobilanthes* (Acanthaceae) with paniculate inflorescence group in Thailand

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Abstract. Six species of *Strobilanthes* Blume with paniculate inflorescence are enumerated for Thai Flora namely *S. microcarpa* T. Anderson, *S. pedunculosa* Miq., *S. peninsularis* Terao, *S. tenuiflora* J.R.I. Wood, *S. trichantha* J.R.I. Wood and *S. violifolia* T. Anderson. Certainly, *S. pedunculosa* is a new record from Thailand. The distribution, ecology and phenology of each species are provided. A key to the species, vernacular names as well as taxonomic notes are presented.

Keywords: floristic region, identification key, morphology, new record

Introduction

Strobilanthes Blume (Acanthaceae) comprises *ca*. 452 species distributed in tropical and subtropical Asia (Mabberley, 2008; Christenhusz *et al*., 2017; Tripp *et al.*, 2021; POWO, 2023). Its species occur in a wide variety of habitats from tropical rainforests to high elevation grasslands. Besides its diverse species number and habitats, this genus is also one of the most variable features of the family Acanthaceae. Especially in the inflorescence characters in which the flowers are arranged into capitate, spike and paniculate. In addition, three groups of species delimited based on inflorescence types are proposed. In general, the *Strobilanthes* species with capitate or spike inflorescences are common whereas the species with paniculate inflorescence are rare. Indeed, the paniculate type is characterised by the arrangement of pedicellate flowers on the inflorescence axes to form the open panicle (Bremekamp, 1944; Wood & Scotland, 2003).

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During the preparation of the account of *Strobilanthes* for the Flora of Thailand many herbarium specimens were consulted and the field surveys were made. Six species of *Strobilanthes* with paniculate inflorescence are native in Thailand such as *S. microcarpa* T. Anderson, *S. pedunculosa* Miq., *S. peninsularis* Terao, *S. tenuiflora* J.R.I. Wood, *S. trichantha* J.R.I. Wood and *S. violifolia* T. Anderson. We also found that *S. pedunculosa* is newly recorded in Thailand. Additionally, one species, *S. hamiltoniana* (Steud.) Bosser & Heine is cultivated as an ornamental plant. Furthermore, the morphology is examined and the key to the species of *Strobilanthes* with paniculate inflorescence in Thailand is constructed. The distribution map of the native species is illustrated.

Material and Methods

The herbarium specimens including type collections were consulted form Thai and abroad herbaria: A, AAU, BCU, BK, BKF, BM, C, CAL, CMU, CMUB, E, G, GZU, K, KKU, K-W, KYO, L, M, P, PSU, QBG and SING. The specimens at A, C, CAL, G, GZU, M, P and SING were investigated based on digital images which are directly obtainable on each herbarium website and on the JSTOR (https://plants.jstor.org/) and GBIF (https://gbif.org) websites. The herbarium acronyms cited follow Thiers (2021). Extensive field surveys and plant collections were made and the herbarium specimens were deposited at KKU. The colour of the corolla and anther was observed from living materials. The taxonomic literature of *Strobilanthes* were examined such as Hosseus (1907), Craib (1913, 1914), Benoist (1935), Imlay (1938, 1939), Bremekamp (1944, 1953, 1961, 1965, 1966, 1969), Terao (1980, 1981, 1983), Hansen (1985), Wood (1994), Bennett & Scotland (2003), Wood & Scotland (2003, 2009), Hu *et al.* (2011), Albertson & Wood (2012), The Forest Herbarium (2014), Newman *et al.* (2007, 2017), Wood *et al.* (2022) and Kladwong & Chantaranothai (2022). The morphology of inflorescence concept in delimiting groups of the *Strobilanthes* species is followed Bremekamp (1944) and Wood & Scotland (2003).

Taxonomic treatments

A key to the species of *Strobilanthes* with paniculate inflorescence group in Thailand is constructed as follows:

Key to the species

1. Leaves hairy; stems hairy to glabrescent; capsule 2-seeded or 8–20-seeded
   2. Bracts linear or liner-oblanceolate; capsule oblongoid, 8–20-seeded **6. S. violifolia**
   2. Bracts ovate or oblong or elliptic-oblong to oblong-linear; capsule ellipsoid, 2-seeded
      3. Bracteoles absent; rachis hairy; corolla hairy outside **1. S. microcarpa**
      3. Bracteoles present; rachis glabrous; corolla glabrous outside **3. S. peninsularis**
1. Leaves glabrous or subglabrous; stems glabrous; capsule 4-seeded
   4. Calyx truncate or emarginate at apex; corolla glabrous outside
      5. Inflorescence axis very fine and dense branching; bracts subulate; corolla white; anthers reddish or purplish-red **4. S. tenuiflora**
      5. Inflorescence axis not as above; bracts obovate and concave; corolla pink; anthers white **S. hamiltoniana**
   4. Calyx acute at apex; corolla hairy outside
      6. Leaves elliptic to elliptic-oblong; leaf base attenuate; capsule glandular-hairy **5. S. trichantha**
      6. Leaves ovate to ovate-lanceolate or broadly ovate to suborbicular; leaf base rounded or subcordate or cuneate; capsule glabrous **2. S. pedunculosa**

1. Strobilanthes microcarpa T. Anderson, J. Linn. Soc., Bot. 9: 482. 1867. Type: Myanmar [Burma], Tenasserim, *Helfer 6113* (lectotype K [K000883036!], designated by Terao (1983)).— *Semnostachya glandulosa* Bremek., Dansk Bot. Ark. 23: 203. 1965. Type: Thailand, Kanchanaburi, Sai Yok, 4 Jul. 1961, *Larsen 8489* (holotype U [U0000110!]; isotypes C [C10005206, C10005207], E [E00051396!]). Figs. 1–2.

Thailand.— NORTHERN: Tak [Tha Song Yang, Mae Sot to Mae Sariang road no. 105, near Mo Bo Waterfall, 200 m alt., 22 Nov. 2005, *Pooma et al. 5805* (BKF)]; SOUTH-WESTERN: Kanchanaburi [Sai Yok, 4 Jul. 1961, *Larsen 8489* (C-2 sheets, E, U); Sangkhla Buri, Thung Yai Naresuan WS, Laiwo, 250 m alt., 14 Jan. 1994, *Maxwell 94-52* (BKF, CMUB, L); Thong Pha Phum, Tha Khanun temple, 300 m alt., 21 Jan. 1926, *Kerr 10281* (BK, BM, K); ibid., 150 m alt., 18 Dec. 2009, *Pooma et al. 7452* (BKF-2 sheets); ibid., 22 Jan. 2022, *Kladwong et al. 453* (KKU)].

Distribution.— Myanmar.

Ecology and Phenology.— On rugged limestone rocks in mixed deciduous forest with bamboo, 150–300 m alt. Flowering and fruiting: July–January.

Vernacular.— Hom thong pha phum (ฮ่อมทองผาภูมิ).

Notes.— *Strobilanthes microcarpa* is similar to *S. peninsularis* in having ellipsoid fruits, which is 5–8 mm long and 2 seeds. In addition, they also have pustules on stems and ovate-elliptic leaves. *Strobilanthes microcarpa* differs based on its hairy rachis and corolla outside vs glabrous in *S. peninsularis*. Furthermore, *S. microcarpa* lacks bracteoles vs present in *S. peninsularis*.

The collection at C was proposed as the holotype of *S. glandulosa* by Wood & Scotland (2003). However, the investigation of the protologue indicated that the specimen at U was mentioned as the type specimen of this species (Bremekamp, 1965). Moreover, we found that this specimen has the original label as "*Semnostachya glandulosa sp. nov.*". Therefore, we conclude that the sheet U0000110 at U is the holotype of *S. glandulosa*.

2. Strobilanthes pedunculosa Miq., Fl. Ned. Ind. 2: 803. 1858.— *Lissospermum pedunculosum* (Miq.) Bremek., Verh. Kon. Ned. Akad. Wetensch., Afd. Natuurk., Sect. 2, 41(1): 302. 1944. Type: Indonesia, West Java, Cibodas Botanical Garden, *Junghuhn s.n.* (lectotype U [U0000069!], designated by Bennett & Scotland (2003)). Figs. 1 & 3.

Thailand.— SOUTH-WESTERN: Kanchanaburi [Sangkhla Buri, Thung Yai Naresuan WS, 400 m alt., 23 Jan. 2000, *Maxwell 00-17* (BKF, CMUB)].

Distribution.— Myanmar, Indonesia.

Ecology and Phenology.— On rugged limestone rocks in shaded places of mixed evergreen and deciduous forests with bamboo, 400 m alt. Fruiting: January.

Vernacular.— Hom thung yai (ฮ่อมทุ่งใหญ่).

Notes.— *Strobilanthes pedunculosa* resembles *S. trichantha* in having axillary paniculate inflorescence, leaf-like bracts and equal or subequal calyx lobes. It can be distinguished based on ovate to ovate-lanceolate or broadly ovate to suborbicular leaves and rounded or subcordate or cuneate at base vs elliptic to elliptic-oblong leaves and attenuate base. In addition, *S. pedunculosa* has a glabrous capsule vs glandular-hairy in *S. trichantha*.

Strobilanthes pedunculosa is known to distribute in Indonesia (Java and Sumatra) and Myanmar (Dawei) (Wood *et al.*, 2022). Nevertheless, this species is the first record for Thailand where it occurs in south-western floristic region.

3. Strobilanthes peninsularis Terao, Acta Phytotax. Geobot. 34(4–6): 123. 1983. Type: Malaysia, Pulau Langawi, Batu, 19 Nov. 1941, *Corner 37827* (holotype L [L-2833851!]; isotypes A [A00286746], K [K001495195!], L [L-2833852!], SING [SING0194683, SING0027250]). Fig. 1.

Thailand.— PENINSULAR: Nakhon Si Thammarat [Thung Song, 13 Feb. 1929, *Put 2370* (BK, BM, K)].

Distribution.— Malaysia.

Ecology and Phenology.— On limestone rocks. Flowering and fruiting: February.

Vernacular.— Hom si nakhon (ฮ่อมศรีนคร).

Notes.— *Strobilanthes peninsularis* is known to occur in Thailand only based on *Put 2370* from Thung Song, Nakhon Si Thammarat province (Terao, 1983). Fieldwork and specimen collections are needed to obtain a better understanding of this species distribution.

4. Strobilanthes tenuiflora J.R.I. Wood, Kew Bull. 58(3): 691. 2003. Type: Thailand, Chiang Mai, Doi Inthanon [Doi Ang Ka], east slope, Mae [Me] Ka Pak above waterfall,

22 Oct. 1929, *Garrett 488* (holotype K!; isotypes KYO!, L [L-2834234!, L-0822636!]). Figs. 1 & 4.

Thailand.— NORTHERN: Chiang Mai [Doi Inthanon NP, Mae Ka Pak, above waterfall, 1,480 m alt., 22 Oct. 1929, *Garrett 488* (K, KYO, L-2 sheets); ibid., Mae Pan waterfall, 1,100 m alt., 18 Oct. 1979, *Shimizu et al. 18945* (BKF, K); ibid., 1,000 m alt., 5 Oct. 1999, *Suksathan 2337* (QBG); ibid., 5 Oct. 2019, *Kladwong et al. 359* (KKU); ibid., Siri Phum waterfall, 1,380 m alt., 19 Sept. 2008, *Middleton et al. 4512* (BKF, E); Wachirathan waterfall, 1,000 m alt., 18 Dec. 1978, *Santisuk 1614* (BKF); ibid., 800 m alt., 9 Jan. 1983, *Koyama et al. 32190* (AAU, BKF-2 sheets, K); ibid., 600–700 m alt., 6 Dec. 1984, *Koyama et al. 39943* (AAU, BKF, KYO, L); ibid., 1,400 m alt., 10 Dec. 1984, *Koyama & Nantasan 40076* (AAU, BKF, KYO, L); Mae On, Mae Kampong waterfall, 1,200 m alt., 20 Sept. 2004, *Maxwell 04-491* (BKF, CMUB); ibid., Huai Kaeo, trail along Mae Kampong waterfall, 1,100 m alt., 7 Sept. 2011, *Pooma et al. 7780* (AAU, BKF, E, L)]; Kamphaeng Phet [Mae Wong NP, Khlong Lan, 1,320 m alt., 2 Nov. 1997, *van de Bult 52* (BKF, CMUB); ibid., Chong Yen, 1,300 m alt., 24 Oct. 2001, *Watthana 1472* (QBG)]; SOUTH-WESTERN: Kanchanaburi [Wang Ka, 200 m alt., 26 Jan. 1926, *Kerr 10309* (BK, BM, K); ibid., 600 m alt., 30 Jan. 1926, *Kerr 10346* (BK, BM, K); ibid., 200 m alt., 7 Feb. 1926, *Kerr 10451* (BK, BM, K)].

Distribution.— China.

Ecology and Phenology.— Near waterfall or stream in shaded to partly open of evergreen forest or in seasonal hardwood forest with bamboo, limestone or granite bedrock, 200–1,480 m alt. Flowering and fruiting: October–January.

Vernacular.— Hom dok bang (ฮ่อมดอกบาง).

Notes.— *Strobilanthes tenuiflora* resembles *S. hamiltoniana*, a native species in India and upper Myanmar (Wood *et al*., 2022) in having open paniculate inflorescence at the terminal of branches. Moreover, they have dark green and glabrous stems and the stems are swollen above the node. Additionally, they also have glabrous or subglabrous leaves. *Strobilanthes tenuiflora* is distinguished based on its much branching in the inflorescence with dense and very fine branches vs less branching and not fine branches in *S. hamiltoniana*. Furthermore, the bract of *S. tenuiflora* is subulate vs obovate and concave in *S. hamiltoniana*. The anther of *S. tenuiflora* is reddish or purplish-red vs white in *S. hamiltoniana*.

Strobilanthes tenuiflora was proposed as endemic to Thailand with few collections in the protologue (Wood & Scotland, 2003) and it was known to occur in Yunnan, China (Hu *et al.*, 2011). During the investigation of herbarium specimens, we found some collections which are pointed the new localities of this species in Thailand.

5. Strobilanthes trichantha J.R.I. Wood, Kew Bull. 64(1): 34. 2009. Type: Thailand, Chiang Mai, Mae Chaem, Doi Inthanon NP, 1,700 m alt., 24 Dec. 1996, *Hara A175* (holotype CMUB!). Fig. 1.

Thailand.— NORTHERN: Chiang Mai [Doi Inthanon NP, 1,600–1,650 m alt., 25 Jul. 1988, *Tamura 60250* (BKF); ibid.,

Koyama 61049 (AAU, BKF, QBG); ibid., 1,650 m alt., 28 Jul. 1988, *Phengklai et al. 7203* (BKF, K, L); ibid., 1,700 m alt., 30 Jul. 1988, *Fukuoka 62352* (BKF); ibid., 1,700 m alt., 24 Dec. 1996, *Hara A175* (CMUB); ibid., 21 Oct. 1988, *B.O.T. 111* (BCU); ibid., Mae Pan waterfall, 1,700 m alt., 24 Feb. 1989, *Maxwell 89-252* (AAU, BKF, CMU); Mae Wang, Mae Win, Pha Ngaem, 1,700 m alt., 10 Mar. 2005, *Maxwell 05-205* (BKF, CMUB, L)]; Lamphun [Thung Hua Chang, 600 m alt., 27 Feb. 2000, *Maxwell 00-112* (BKF)]; SOUTH-WESTERN: Kanchanaburi [Sangkhla Buri, Thung Yai Naresuan WS, Laiwo, 650 m alt., 22 Mar. 2004, *Webb 15* (CMUB)].

Distribution.— Endemic in Thailand.

Ecology and Phenology.— In evergreen hardwood forest, near small streams, rugged limestone or granite bedrock, 600–1,700 m alt. Flowering and fruiting: July–March.

Vernacular.— Hom cho mani (ฮ่อมช่อมณี).

Notes.— Three collections from Chiang Mai province were cited in the protologue of *S. trichantha* (Wood & Scotland, 2009). On examination, we found that this endemic species also occurs in Lamphun and Kanchanaburi provinces.

6. Strobilanthes violifolia T. Anderson, J. Linn. Soc., Bot. 9: 485. 1867.— *Pteracanthus violifolius* (T. Anderson) Bremek., Verh. Kon. Ned. Akad. Wetensch., Afd. Natuurk., Sect. 2, 41(1): 199. 1944. Type: India, Sikkim, Ratong to Yoksum, *Anderson 1051* (lectotype CAL [CAL0000019841], designated by Albertson & Wood (2012)).— *Echinacanthus parviflorus* T. Anderson, J. Linn. Soc., Bot. 9: 459. 1867.— *Clarkeasia parviflora* (T. Anderson) J.R.I. Wood, Edinburgh J. Bot. 51(2): 189. 1994. Type: India, Meghalaya (Khasia), *Griffith s.n.* (lectotype K [K000882651!], designated by Wood (1994)).— *E. siamensis* J.B. Imlay, Bull. Misc. Inform. Kew 1939(3): 114. 1939. Type: Thailand, Nan, Doi Phu Kha [Doi Pu Ka], 27 Feb. 1921, *Kerr 4944* (holotype ABD [ABDUH:2/839, *n.v.*]; isotypes BK [257603!], BM [BM000950015!], K [K000882649!, K000882650!]). Fig. 1.

Thailand.— NORTHERN: Nan [Doi Phu Kha NP, 600 m alt., 27 Feb. 1921, *Kerr 4944* (BK, BM, K)]; SOUTH-WESTERN: Kanchanaburi [Thong Pha Phum, Pilok, 650 m alt., 10 Feb. 1969, *Chermsirivathana 1585* (BK, K, L)].

Distribution.— Nepal, Bhutan, India.

Ecology and Phenology.— Near stream in evergreen forest, 600 m alt. Flowering and fruiting: February.

Vernacular.— Hom bai phai (ฮ่อมใบพาย).

Notes.— *Strobilanthes violifolia* is distinguished in having 8–20 seeds per capsule vs 2 seeds in *S. microcarpa* and *S. peninsularis*, and 4 seeds in *S. hamiltoniana*, *S. pedunculosa*, *S. tenuiflora* and *S. trichantha*.

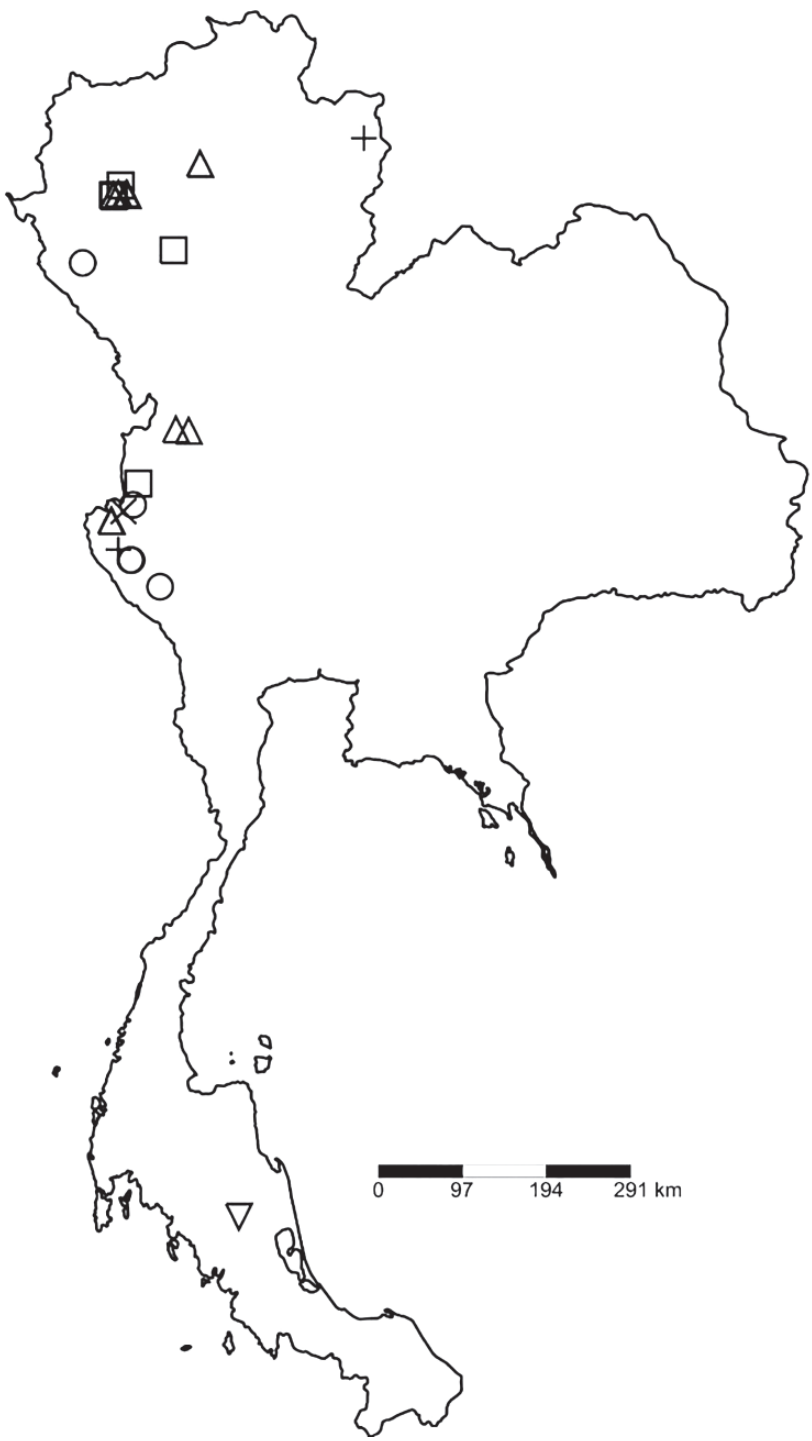

Figure 1. Distribution map of *Strobilanthes microcarpa* (○), *S. pedunculosa* (×), *S. peninsularis* (▽), *S. tenuiflora* (△), *S. trichantha* (□) and *S. violifolia* (+) in Thailand.

FIGURE 2. *Strobilanthes microcarpa*: A. habitat; B. stem and inflorescences; C. flower; D. infructescence.

FIGURE 3. Photographs of dried specimen of *S. pedunculosa* from Thailand: A. stem, leaves and infructescences from *Maxwell 00-17* (BKF); B. calyx, fruits and seeds from *Maxwell 00-17* (CMUB).

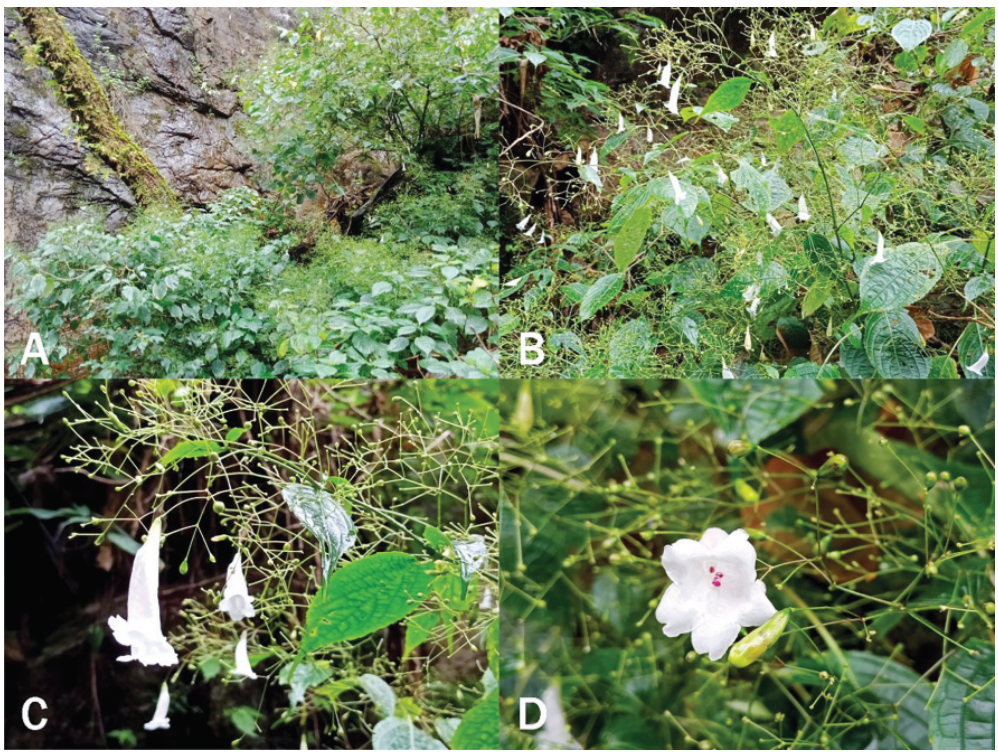

FIGURE 4. *Strobilanthes tenuiflora*: A. habitat; B. stem and inflorescences; C.–D. flowers. Photos by P. Kochaiphat.

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