

# Notes on *Limnophila* (Scrophulariaceae) of Taiwan

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**Abstract.** Four species of the genus *Limnophila* (Scrophulariaceae) of Taiwan are studied; two new species, *Limnophila aromaticoides* Yang & Yen and *L. taoyuanensis* Yang & Yen are described; *L. heterophylla* (Roxb.) Benth. is confirmed; *L. sessiliflora* (Vahl) Bl. is supplemented with diagnosis. Their descriptions are given, and the line drawings are provided in this paper.

**Keywords:** *Limnophila*; Species; Taiwan.

## Introduction

In the course of studying *Limnophila* of Taiwan, two new species have been found. A species of uncertain status since 1987 is confirmed. In addition, a species is supplemented with diagnosis. The key to the species in Taiwan and their descriptions are given as follows.

## Key to the Species of *Limnophila* in Taiwan

1. Plants with simple to lacerate leaves.
  2. Leaves petiolate ..... *L. rugosa*
  2. Leaves sessile or subsessile.
    3. Flowers sessile ..... *L. heterophylla*
    3. Flowers pedicellate.
      4. Submerged leaves rarely present, opposite to 3-verticillate; corolla pink; fruit ellipsoid.....  
..... *L. aromatica*
      4. Submerged leaves always present, (2-)3-8-(10)-verticillate; corolla white or rarely pinkish at top of corolla tube; fruit orbicular .....  
..... *L. aromaticoides*
1. Plants with finely divided leaves wholly or partly.
  5. Segments of divided leaves capillary; cleistogamous flowers absent ..... *L. taoyuanensis*
  5. Segments of divided leaves flattened; cleistogamous flowers present.
    6. Calyx glabrous or glandular.
      7. Capsule globular, sessile; aerial flowers with corolla tube more than 5 mm long .....  
..... *L. heterophylla*
      7. Capsule ellipsoid, stipitate; aerial flowers with corolla less than 3 mm long .*L. trichophylla*\*
    6. Calyx sparsely hirsute ..... *L. sessiliflora*

\*This species will be discussed in the near future. The diagnostic characters used in the key tentatively follow Li's description in 1978.

### 1. *Limnophila aromaticoides* Yang & Yen, sp. nov.

(Figures 1, 2, 6A, 7A-D)

*Herba aquatica.* Caules crassi, usque 30 cm longi, superne erecti, glabri vel minute glanduliferi, inferne glabri. Folia superne opposita vel 3-5-verticillata, anguste lanceolata, serrato-dentata, sessilia, subamplexicaulia, inferne 3-8-verticillata, oblongo-lanceolata vel linearilanceolata. Flores solitarii vel in racemos terminales et axillares, pedicellis 1-15 mm longis. Calyx 5-6.5 mm longus, minute glandulifer, lobis linearilanceolatis, 2.5-4.0 mm longis, acuminatis. Corolla 5-10 mm longa, extus glabra, intus villosa, pallide caerulea. Capsula 5 mm longa, compressi-globosa.—TYPE: Monghu, Hsichih, Taipei Co., Yen s. n. in 1994 (holotype: TAIF; isotypes: TAI, HAST).

*Herbaceous aquatic plants.* Stems erect above, simple to branched, 10-30 cm tall, glabrous to minutely glandular. Emerged leaves mostly opposite, rarely 3-5-verticillate, chartaceous, elliptic to oblong-lanceolate, 5-35 mm long, 4-10 mm wide, acute or obtuse at apex, attenuate at base, sessile, occasionally semi-amplexicaul, crenate-serrate, glabrous to sub-glandular on veins beneath, punctate, pinnate-veined; submerged leaves (2) 3-8(10)-verticillate, membranous, oblong-lanceolate or linear-lanceolate, 10-40 mm long, 3-10 mm wide, acute at apex, serrate-dentate, sessile, semi-amplexicaul, glabrous. Bracts lanceolate to oblong-lanceolate, 3-10 mm long, 2-3 mm wide; bracteoles 2, oblong-lanceolate, 0.8-2.0 mm long, ca. 0.8 mm wide, somewhat ciliate, obtuse at apex. Flowers solitary in axils or in racemes; pedicellate, rarely sessile to subsessile, pedicels slender, 1-15 mm long, glabrous to densely fine-glandular, calyx 5-6.5 mm long, 2-3 mm wide, patently glandular, striate at maturity, lobes narrowly lanceolate, 2.5-4.0 mm long, ca. 1.5 mm wide, as long as or slightly longer than

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**Figure 1.** *Limnophila aromaticoides* Yang & Yen. A, Habit with emerged leaves; B, Habit with submerged leaves; C, Corolla; D, Calyx and pistil; E, Stamens; F, Capsule; G, Seed. Scale bar = 1 cm.

the mature capsule, acuminate, sub-reflexed at maturity; corolla white or rarely pinkish at top of tube, 5–10 mm long, finely and sparsely glandular, upper lip orbicular, emarginate, lower lip 3-lobed, lobes orbicular; stamens didynamous, posterior filaments 1–1.5 mm long, villous, anterior filaments 3.0–4.0 mm long, glabrous. Capsules compressed orbicularly ellipsoid, 5 mm long, 4 mm wide, green to brown. Flowering Apr–Nov.

*Distribution.* In Taiwan, found mainly in the northern (Keelung River Basin and Neishuanghsih Basin) and northeastern parts (Tungshan River Basin) (Figures 7A–D). A small colony found in Kaohsiung in southern Taiwan (Figure 6A). Mostly growing in ponds, rice fields or ditches. This species is possibly also distributed in Japan because several specimens of the area at TAI are very similar to it.

*Additional specimens examined.* TAIPEI CITY: Taipei, *Simada 885c* (TAI), *Masamune s. n.* (TAI), *Sasaki s. n.* (TAI), *Chuang 3048* (TAI); Shihting, *Yen s. n.* in 1991 (NSYSU); Nankang, *Yen s. n.* in 1989 (NSYSU); Neihu, *Yen s. n.* in 1991 (NSYSU); Wanlee, *Yen s. n.* in 1995 (NSYSU); Neishuanghsih, *Yen s. n.* in 1994 (NSYSU); Hsichih, *Peng 13530* (HAST); *Peng 13552* (HAST); Yangmingshan, *Chen & Liu 19* (HAST); KEELUNG HSIEN: Badu, *Yen s. n.* in 1992 (NSYSU). TAOYUAN HSIEN: Taoyuan, *Suzuki 5825* (TAI), *Sasaki s. n.* (TAI), *Huang 3525* (TAI), *Suzuki ST20574* (TAI); Lungtan, *Yen s. n.* in 1988 (NSYSU); *Yen s. n.* in 1988 (HAST); Yangmei, *Yen s. n.* in 1988 (NSYSU); Pa-tei, *Huang 4606* (HAST); *Chuang 4620* (HAST). ILAN HSIEN: Tungshan, *Yen s. n.* in 1991 (NSYSU). KAOHSIUNG HSIEN: Fengshan, *Yen s. n.* in 1992 (NSYSU).

*Note.* The species is very similar to *Limnophila aromatica* (Lam.) Merr. In Taiwan, collections of the species were previously misidentified as it. However, the new species can be distinguished by its verticillate submerged leaves, white corolla, which is occasionally pinkish at top, and orbicularly ellipsoid capsule. In comparison, *L. aromatica* can be diagnosed by the character combination of submerged leaves mostly lacking corolla (occasionally with 2–3 submerged leaves), corolla pink or purple and capsule ellipsoidal.

## 2. *Limnophila taoyuanensis* Yang & Yen, sp. nov. (Figures 2, 3, 6B & C, 7A, 7C)

*Herba aquatica.* Caules usque ad 10 cm longi, basi glabri, superne erecti, sub-pilosi ad glabri. Folia verticillata, 2–3-fidis vel lobatis, glabra, laciniis linearibus ad filiformibus, 0.3–0.5 mm latis, apice acuta. Flores axillares, solitarii, pedicellis 2.5 mm longis. Calyx 3.5–5.5 mm longus, extus glabra, apice 5-lobatus, lobis lanceolato-ovatus, 2–3.5 mm longis, apice breviter acutis. Corolla extus glabra, limbo 2-labiato, labio superiore orbiculato. Stamina 4, filamentis glabri.—TYPE: Pachangli, Lungtan, Taoyuan, *Yen s. n.* in 1987 (holotype: TAIF; isotype: TAI, HAST).

*Aquatic plants.* Emerged stems erect, branched, 1–1.5 mm in diameter, slightly pilose to glabrous, violet; submerged stems branched, 1–1.2 mm in diameter, green. Emerged leaves 5–6-verticillate, deeply dissected, segments obtuse to rounded at apex, the leaves at blooming entire, elliptic to lanceolate; submerged leaves mostly 6–8-verticillate, finely divided, 5–25 mm long, segments opposite, filiform to capillary, 0.2–0.4 mm wide, obtuse to rounded at apex. Bracteoles usually absent. Aerial flowers solitary, axillary, sessile or subsessile; calyx 3.5–5.5 mm long, glabrous outside, lobes lanceolate-ovate, 2–3.5 mm long, short, acuminate, glabrous outside; corolla-tube white at top and yellow at base, 8–11 mm long, glabrous outside, villous inside laterally, upper lip white or light pink with two pink dots, orbicular, emarginate, lower lip white, 3-lobed, lobes broadly ovate; stamens usually with anthers contiguous, posterior filaments about 1 mm long, glabrous; style 1.5–3 mm long; cleistogamous absent. Capsule unknown. Flowering May–Oct.

*Distribution.* Endemic. Previously several small colonies found in northern and southern Taiwan, but now nearly extinct in the field because of destruction of habitats (Figures 7A & C). Currently, only a few plants cultivated at Fushan Botanical Garden in Ilan.

*Additional specimens examined.* TAOYUAN HSIEN: Lung-tan, *Kao 10743* (TAI); Pachangli, *Peng 11132* (HAST); Pa-tei, *Chuang 4607* (HAST). NANTOU HSIEN: Chu-shan, *Huang 5669* (TAI). CHIAYI HSIEN: Da-pu, *Yen s. n.* in 1992 (NSYSU).

*Note.* This species is close to *Limnophila stipitata* (Hayata) Makino & Nemoto, but differs from it by having deeply dissected emergent leaves at the sterile stage and at anthesis producing entire emergent leaves, and finely divided submerged leaves with only filiform to capillary segments and sessile to sub-sessile flowers. On the other hand, *L. stipitata* has slightly dissected emergent leaves at the sterile stage and at anthesis producing crenate-serrate to variously lacerate emergent leaves, and finely divided submerged leaves with flattened segments, and flowers with 0–15 mm long pedicels.

## 3. *Limnophila heterophylla* (Roxb.) Benth., Scroph. Ind. 25. 1835; Philcox in Kew Bull. 24(1): 124. 1970; Yamazaki in Journ. Fac. Sci. Univ. Tokyo III 13: 586. 1985. (Figures 5, 6D, 7A, 7E) *Columnnea heterophylla* Roxb., Fl. Ind. ed. Carey, 3: 97. 1832.

*Aquatic plants.* Emerged stems up to 20 cm tall, 2–3 mm in diameter, branched, glabrous; submerged stems branched, stipitate, glandular to subglabrous, 3–3.5 mm in diameter. Emerged leaves verticillate below, opposite to alternate above, oblong, 5–16 mm long, 2–4 mm wide, sessile, semi-amplexicaul, serrulate, glabrous; submerged leaves 6–10-verticillate, finely divided, segments opposite, flattened, 0.8–1.0 mm wide, obtuse to rounded at apex. Bracteoles usually absent. Aerial flowers axillary, solitary or in terminal spikes; calyx campanulate, 3–4 mm long,



**Figure 2.** *Limnophila taoyuanensis* Yang & Yen. A, Habit with emerged stems and leaves; B, Emerged leaf; C, Stem and glandular hairs; D, Flower and a hair of corolla; E, Corolla and hairs inside; F, Calyx and pistil; G, Stamens; H, Sections of ovary. Scale bar = 1 cm.

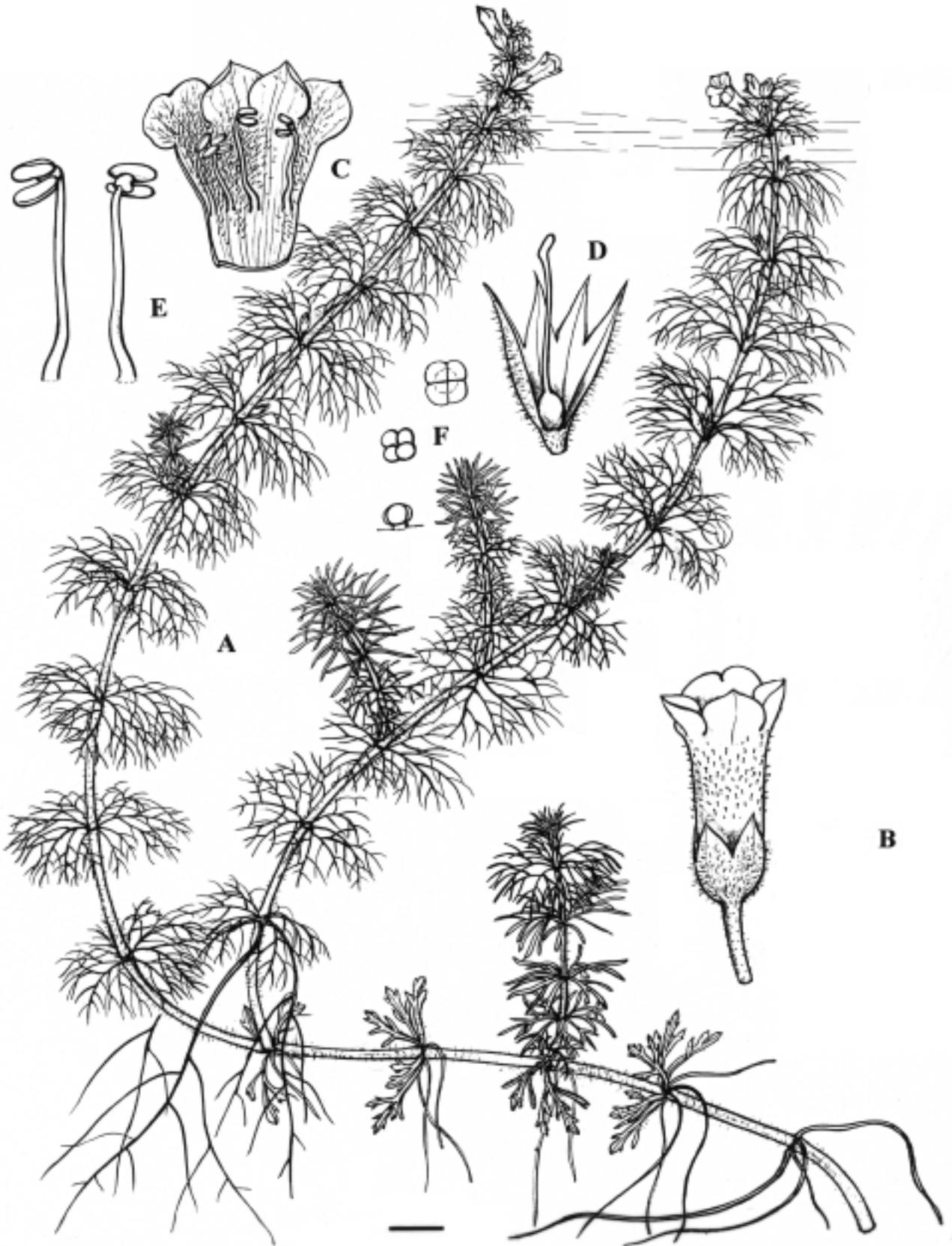
minutely glandular, lobes broadly ovate, half as long as the calyx-tube; corolla 5–6 mm long, violet, glabrous outside, villous inside laterally, upper lip circular, emarginate, lower lip 3-lobed, lobes broadly ovate; stamens usually with anthers contiguous, filaments glabrous, posterior ones ca. 1 mm long, anterior ones ca. 3 mm long; style ca. 3 mm long; cleistogamous flowers sessile; corolla smaller; calyx minutely glandular to glabrous. Capsules compressed globular, ca. 2.5 mm long and across. Flowering May–Oct.

*Distribution.* Widely distributed throughout eastern Asia. In Taiwan, found only at a small pond and very endangered (Figures 7A, 7E), but now nearly extinct in

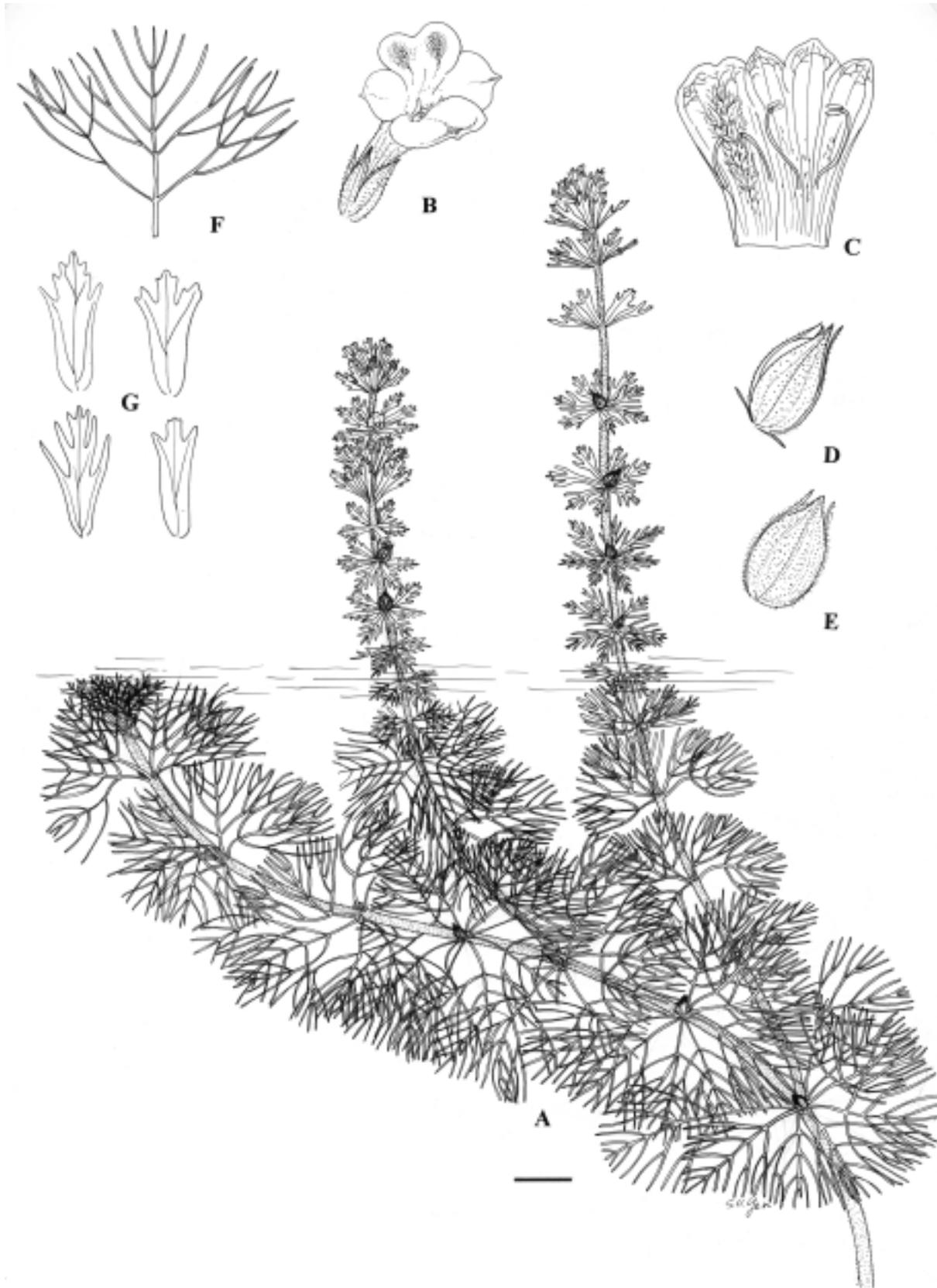
the field because of habitat destruction. Currently, only a few plants cultivated in the laboratory of the authors.

*Specimens examined.* KAOHSIUNG HSIEN: Meinung, Chung-cheng Lake, *Yen s. n.* in 1995 (NSYSU). PINGTUNG HSIEN: Bankinsing, *Henry 1849* (NY).

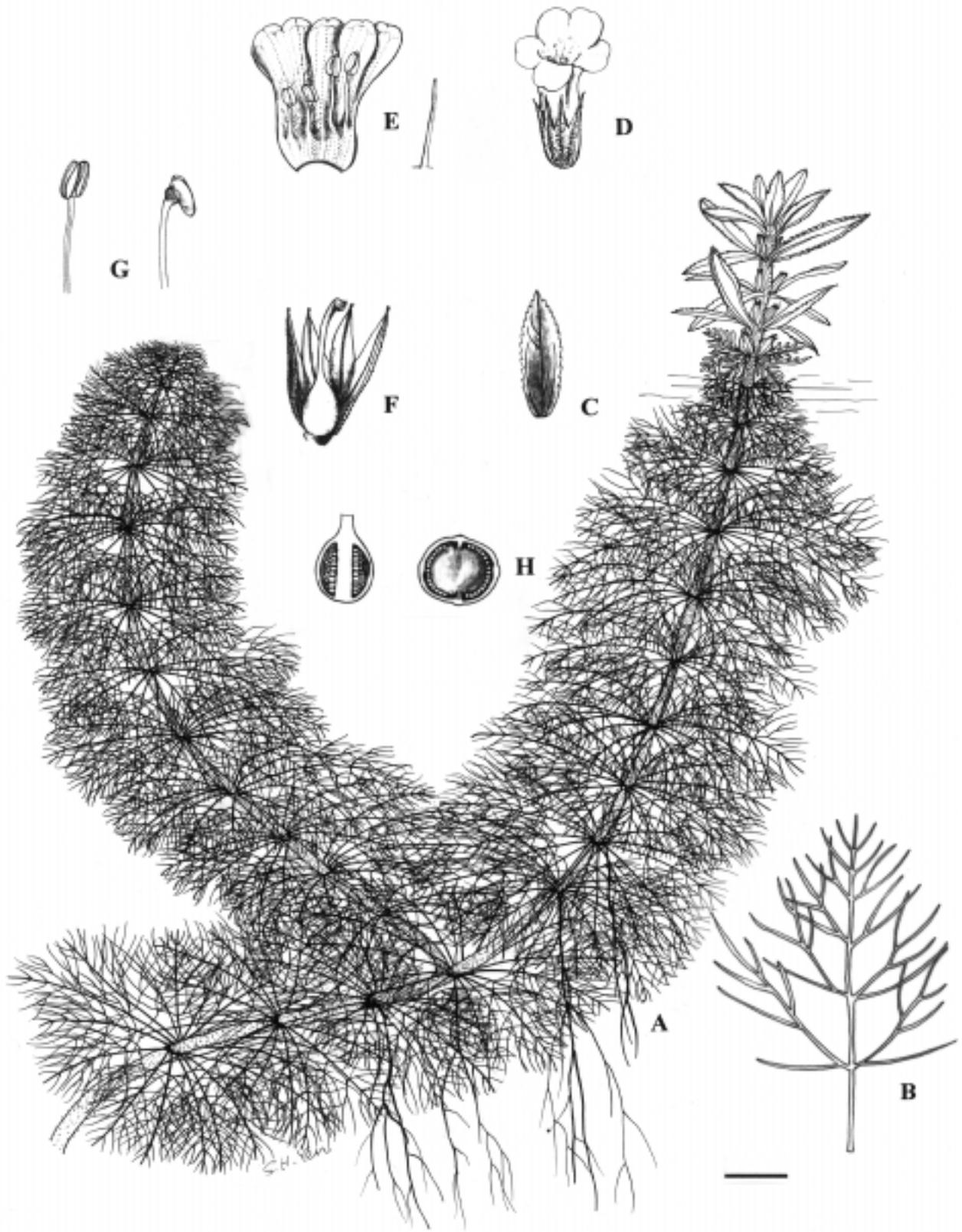
*Note.* Philcox (1970) included Taiwan in the range of distribution of *L. heterophylla* based on *Henry 1849* (K). Probably neglected by Li, the species was not included in the flora of Taiwan in 1978. Because no specimens of this species were available in the Taiwan herbaria, it was treated as an uncertain species by Yang (1987). In 1991, the first author examined a sheet of Henry's collection at NY and agreed with Philcox's opinion. In addition, Yen



**Figure 3.** *Limnophila taoyuanensis* Yang & Yen. A, Habit with emerged and submerged leaves; B, Leaf and flower; C, Corolla; D, Calyx and pistil; E, Stamens; F, Glandular hairs. Scale bar = 1 cm.



**Figure 4.** *Limnophila sessiliflora* Bl. A, Habit; B, Flower; C, Corolla; D, Capsule with bracteoles on submerged stem; E, Capsule without bracteoles on emergent stem; F, Submerged leaf; G, Emerged leaves. Scale bar = 1 cm.



**Figure 5.** *Limnophila heterophylla* (Roxb.) Benth. A, Habit; B, Submerged leaves; C, Emerged leaf; D, Flower; E, Corolla; F, Calyx and pistil; G, Stamens; H, Sections of ovary. Scale bar = 1 cm.

made a collection of this species from a pond near Chung-cheng Lake, Meinung, Kaohsiung, in 1995. This species is therefore confirmed for Taiwan.

4. *Limnophila sessiliflora* (Vahl) Bl., Bijdr. 749. 1826; Philcox in Kew Bull. 24(1): 112. 1970; Yamazaki in Journ. Fac. Sci. Univ. Tokyo III 13: 579. 1985.

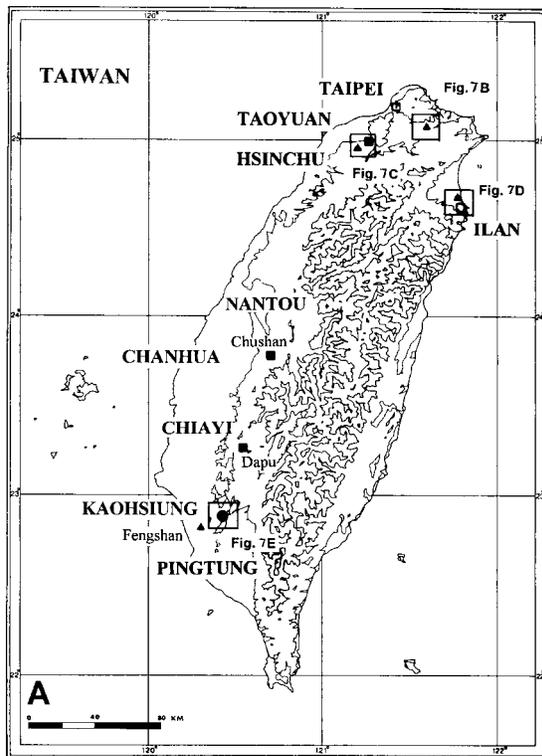
(Figures 4, 6E, 7A, 7D)

*Hottonia sessiliflora* Vahl, Symb. Bot. 2: 36. 1791.

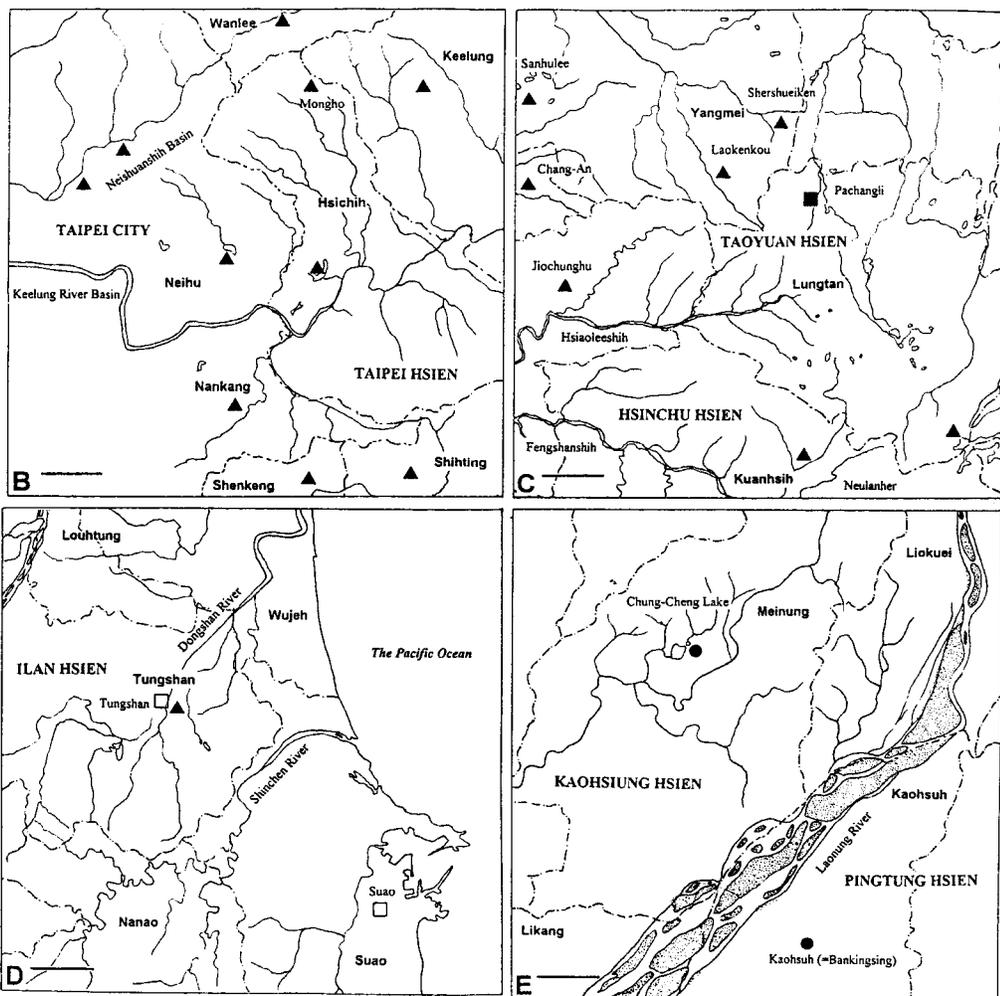
*Aquatic plants.* Emerged stems 2–3 mm in diameter, branched, pubescent to somewhat glabrous, green to pink; submerged stems branched, sparsely pubescent to somewhat glabrous, green to reddish. Emerged leaves 5–8-verticillate, elliptic to lanceolate, 10–20 mm long, slightly dissected on sterile stems, crenate-serrate to variously lacinate on flowering stems, segments obtuse to rounded at apex, dark green; submerged leaves 6–10(-more)-verticillate, rhomboid, ovate, elliptic to broadly lanceolate, 5–40 mm long, segments opposite, flattened, 0.8–1.0 mm



**Figure 6.** Habit of *Limnophila* species. A, *Limnophila aromaticoides* Yang & Yen, flowering; B, *Limnophila taoyuanensis* Yang & Yen, flowering; C, *Limnophila taoyuanensis* Yang & Yen, emerged plants; D, *Limnophila heterophylla* (Roxb.) Benth., flowering; E, *Limnophila sessiliflora* (Vahl) Bl., native colony in Ilan Hsien; F, *Limnophila sessiliflora* (Vahl) Bl. from S.E. Asia, naturalized colony in Chang-Hua Hsien.



**Figure 7.** Distribution map of some *Limnophila* species in Taiwan. A, General distribution of each species on the island; B, Distribution in Taipei Hsien; C, Distribution in Taoyuan and Hsinchu; D, Distribution in Ilan Hsien; E, Distribution in Kaohsiung and Pingtung. *L. aromaticoides* (solid triangles), *L. taoyuanensis* (solid squares), *L. heterophylla* (solid circles), *L. sessiliflora* (empty squares). Scale bar = 1 km.



wide, rounded to obtuse at apex. Bracteoles usually absent. Aerial flowers solitary, axillary, sessile or subsessile; calyx 4–7 mm long, densely to sparsely pubescent, not striate at maturity, lobes ovate, 2–3.5 mm long, acuminate; corolla 5–8 mm long, blue, violet to purple, glabrous outside, villous inside laterally, upper lip white or light pink with 2 blue dots, orbicular, emarginate, lower lip white, 3-lobed, lobes broadly ovate; stamens usually with anthers contiguous, filaments glabrous, posterior ones about 1 mm long, anterior ones about 3 mm long; style about 3 mm long; cleistogamous flowers sessile, rarely subsessile after fruiting; corolla smaller and reduced; calyx sparsely pubescent to glabrous; bracteoles linear, rarely present. Capsules compressed ellipsoid, 3.5–5.5 mm long, pale green-brown when submerged, dark brown when emerged. Flowering Apr–Nov.

*Distribution.* Widely distributed in eastern Asia; found only at a few localities in the northern and northeastern parts of Taiwan (Figures 7A, 7D), at low altitudes. Mostly growing along ditches or in ponds.

*Specimens examined.* TAIPEI HSIEN: Tang-shui, *Yen s. n.* in 1993 (NSYSU); ILAN HSIEN: Su-ao, *Shimada s. n.* in 1932 (TAI), *Yang s. n.* in 1976 (TAIF); Tungshan, *Yen s. n.* in 1994 (NSYSU).

*Note.* In 1906, Matsumura and Hayata listed *Limnophila sessiliflora* for Taiwan based on Henry's collections from Bankingsing. However, Li (1978) assumed that they misidentified the specimens and excluded the species from the flora of Taiwan. In fact, the misidentification was implied in the Philcox' worldwide revision of *Limnophila* as early as 1970. He examined all Henry's specimens of the genus collected from the location and did not indicate any of them belonging to the species.

As to the real *L. sessiliflora*, a collection of its flowering materials with submerged leaves was made by Shimada at Su-ao, Ilan, in 1932. The specimen was distributed as *L. indica* (L.) Druce and filed under *L. trichophylla* (Komarov) Komarov at TAI. In 1976, a specimen of *L. sessiliflora* from Su-ao, I-lan Hsien, was collected by the first author, but was neglected until the

authors re-examined it in 1986. The species was listed in the aquatic flora of the island by Yang (1987), but was not described. Since then, the second author has confirmed several distributional locations of the species in the northern and northeastern parts of Taiwan.

The species is often described as having no bracteoles between the calyces by some authors such as Philcox (1970) and Yamazaki (1985). However, in Taiwanese materials, the present authors found that the majority of submerged cleistogamous flowers bore two identical bracteoles and even produced very short pedicels.

Several naturalized colonies of *Limnophila sessiliflora*, which were introduced from S.E. Asia, are found in Chang-hua Hsien of central Taiwan (*Yen, s. n.*, in 1988, NSYSU). The plants of the naturalized colonies could be distinguished from the native ones by their larger size, paler corolla, and infertile capsule (Figure 5F).

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## 臺灣產石龍尾屬（玄參科）註

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本文研究臺灣產石龍尾屬（玄參科）之部份種類。其中發現二新種：擬紫蘇草 *Limnophila aromaticoides* Yen & Yang 及桃園石龍尾 *L. taoyuanensis* Yen & Yang。異葉石龍尾 *L. heterophylla* (Roxb.) Benth. 確認分布於臺灣；無柄花石龍尾 *L. sessiliflora* (Vahl) Bl. 則為本島之首次描述記錄。本文並提供各種類之描述與繪圖。

關鍵詞：種；石龍尾屬；臺灣。