NOTE

New Additions of the Bladderworts (Lentibulariaceae) in Taiwan

Tian-Chuan HSU¹, Zhi-Hao CHEN² and Yi-Shan CHAO³*

¹. Herbarium of Taiwan Forestry Research Institute, No. 53, Nanhai Rd., Taipei 100, Taiwan.
². Observer Ecological Consultant Co., Ltd., Taipei 10088, Taiwan.
³. Department of Biomedical Science and Environmental Biology, Kaohsiung Medical University, Kaohsiung 80761, Taiwan.

* Corresponding author Email: pteridaceae@gmail.com

(Manuscript received 5 May 2016; accepted 18 November 2016; online published 20 February 2017)

ABSTRACT: Wild populations of three bladderworts (Utricularia, Lentibulariaceae) were newly recognized in Taiwan. Utricularia heterosepala is newly recorded in Hualien, and two naturalized species, U. smithiana and U. tricolor, are found in northern Taiwan. Morphology, ecology and conservation status of these species are described. A renewed key for all Utricularia species ever recorded in Taiwan and Kinmen is also presented.

KEY WORDS: Lentibulariaceae, Naturalized species, New record, Taiwan, Utricularia.

INTRODUCTION

The bladderwort genus Utricularia L. is the largest genus of the carnivorous family Lentibulariaceae comprising ca. 235 cosmopolitan species (Fleischmann, 2015) characterized by the absence of roots and the presence of small bladder-like traps that actively capture and digest small organisms. In Taiwan, seven species (U. aurea Lour., U. australis Br., U. bifida L., U. caerulea L., U. gibba L., U. striatula Sm. and U. uliginosa Vahl) were confirmed in the latest taxonomic treatments (Chao, 2003; Li et al., 2011), and two more species, U. gramimifolia Vahl and U. livida E.Mey., were found naturalized in northern Taiwan (Lin, 2009; Liu et al., 2011). In addition, U. minor L. and U. inflata are considered as doubtfully recorded in Taiwan (Chao, 2003), and U. minutissima Vahl was recently recorded in Kinmen (Lu, 2011) but has not been found in the geographic range of Taiwan.

During our recent field investigation, three uncertain bladderworts were discovered from northern and eastern Taiwan. The species found in Hualien by the second author in 2014 was at first identified as U. uliginosa, a very rare species in Taiwan which’s wild population has not been reported since 1960s (Chao, 2003). However, after a detailed specimen and literature examination, this Hualien bladderwort is confirmed as U. heterosepala A.St.-Hil., after consulting the monograph of Utricularia (Taylor, 1989). Since both species have been traded in horticulture markets in Taiwan, and all their wild populations occur in easily accessible area around the Taipei metropolis, they are presumed as naturalized species.

Herein, morphological description, color plates and brief notes on ecology and taxonomy of U. heterosepala, U. smithiana and U. tricolor are presented. Their conservation status based on IUCN Red List categories (IUCN, 2012) are evaluated as well. A revised key of all Utricularia species ever recorded in Taiwan is provided to contribute to their identification. Altogether nine native species, four naturalized species, two doubted species are so far recorded in Taiwan and Kinmen. Including U. heterosepala, six among the nine native Utricularia species in Taiwan are of conservation concerns (Wang et al., 2012), and protection measures are thus urgently needed. On the other hand, for those naturalized species, careful monitoring of their population expansion is also necessary considering the cases that alien bladderworts could reproduce rapidly and pose a threat to local aquatic vegetation (Urban et al., 2006; GISD, 2006).

Key to the Utricularia species recorded in Taiwan

1a. Leaves divided into narrowly linear or capillary segments..................2
1b. Leaves simple, entire .................................................................6
2a. Leaves palmately or dichotomously divided into 2–11 ultimate segments, with few or no traps .........................................................3
2b. Leaves pinnately divided into numerous ultimate segments, with many traps .................................................................................4
3a. Turions never developed; ultimate segments capillary; scale 0–1; seeds lenticular, obviously winged .................................................U. gibba
3b. Turions developed in winter; ultimate segments flattened; scale 2–4; seeds prismatic, scarcely winged ...........................................U. minor
4a. Leaves unequally bifid; floats many, floating ................................U. inflata
Fig. 1–2.
basifixed, narrowly ovate-deltoid, apex acute, 2–3 mm thick, glabrous.
Inflorescence erect, solitary, 2–8 cm long, 0.3–0.5 mm appendages 2, dorsal, subulate, stalked glandular.
and stolons, globose, stalked, 0.7–2.0 mm long; oblanceolate, apex rounded, 3-veined.
node, 5–15 × 1.5–2.5 mm, petiolate; lamina obovate or branched.

**TAXONOMIC TREATMENTS**

**Utricularia heterosepala**

**Type:**

Rhizoids

**Perrenials or annuals,** terrestrial, subaquatic.
**Rhizoids** capillary, up to 2 cm long. **Stolons** very numerous, capillary, 0.2–0.3 mm thick, frequently branched. **Leaves** very numerous, solitary at each stolon node, 5–15 × 1.5–2.5 mm, petiolate; lamina obovate or oblancoate, apex rounded, 3-veined. **Traps** on leaves and stolons, globose, stalked, 0.7–2.0 mm long; appendages 2, dorsal, subulate, stalked glandular. **Inflorescence** erect, solitary, 2–8 cm long, 0.3–0.5 mm thick, glabrous. **Scales** 1–3, similar to the bracts. **Bracteoles** basifixed, narrowly ovate-deltoid, apex acute, 2–3 mm long. **Bracteoles always absent. Flowers** 2–8, laxly arranged; pedicels erect, 3–6 mm long. **Calyx** lobes unequal, narrowly ovate, the upper lobe 2.5–4.0 mm long, apex acute; the lower lobe constantly larger, up to 6 mm long in fruit, apex acute or minutely bidentate. **Corolla** 6–11 mm long, pale blue or violet, upper lip slightly constricted below middle; the superior part oblong, apex rounded or truncate; the inferior part broadly ovate; lower lip limb suborbicular, galeate, apex rounded or emarginate, base with a prominent swelling; palate with a ciliate marginal rim; spur subulate, apex acute, curved, longer than and widely diverging from the lower lip. **Filaments** ca. 1 mm long, straight; anther thecae distinct. **Ovary** ovoid; style short but distinct. **Capsule** ovoid, 2–3 mm long. **Seeds** globose or depressed globose, ca. 0.4 mm in diam., with isodiametric reticulations; anticallic walls of seed testa cells finely sinnate.

**Distribution:** *Utricularia heterosepala* is recorded in India (the Western Ghats), the Philippines (Luzon, Siibuyan and Palawan) and Taiwan (Hualien).


**Conservation status:** *U. heterosepala* is listed as **VU [D2]**. So far only 2 subpopulations of *U. heterosepala* are locates in Taiwan. Although numerous mature individuals exist in each subpopulation, and no immediate threat is so far observed, a careful monitoring of its population dynamics is still needed since the area of occupancy is very small (<1 km²) and easily disturbed by human activity and affected by climate change.

**Voucher specimens:** TAIWAN: Hualien County, Fengbin Township, Fengping (豐濱), T.-C.Hsu 7797, 7801 (TAIF).

**Note:** As listed in the key, *Utricularia heterosepala* is similar to *U. uliginosa* in gross outlines but significantly different in leaf shape, absence of bracteole, calyx structure and seed morphology. The finely sinnate anticallic walls of seed tests cells, noted by Taylor (1989) as a unique character in the genus, are also clearly observed from Taiwanese specimens (Fig. 2). *U. heterosepala* was thought as endemic to the Philippines (Taylor, 1989), but recently Fleischmann (2012) treated *U. janarthenamii* S.R.Yadav, Sardesai & S.P.Gaikwad, as synonym of *U. heterosepala* and thus extends its distribution range. Cleistogamous flowers are reported from the Indian population (Yadav et al., 2000; Sardesai and Yadav, 2008) but not observed in Taiwan so far.
**Taiwania**

Vol. 62, No. 1

Fig. 2. SEM micrographs of the seeds of *Utricularia heterosepala* (from T.-C.Hsu 7797). Note the finely sinuate anticlinal testa walls. Scale bars = 100 μm. Photographed by Y.-S.Chao.


*Type:* INDIA. “Malabar or Coorg.”, Herb. Wight s.n. (holotype: K)

史氏挖耳草 Fig. 3(A–D)

Perrenials, terrestrial or occasionally lithophytic, subaquatic. *Rhizoids* numerous, capillary, up to 3 cm long. *Stolons* very numerous, capillary, 0.2–0.4 mm thick, frequently branched. *Leaves* very numerous, solitary at each stolon node, 1.5–5 cm × 1–3 mm, petiolate; lamina linear, apex rounded, 0.5–1.0 mm long; appendages 2, dorsal, subulate, stalked glandular. *Traps* on leaves and stolons, globose, stalked, 0.5–1.0 mm long; appendages 2, dorsal, subulate, stalked glandular. *Inflorescence* erect or ascending, sometimes twining distally, solitary, simple, 10–20 cm long, 0.5–1.5 mm thick, glabrous. *Scales* few, similar to the bracts. *Bracts* basifixed, ovate, apex acute, ca. 2 mm long. *Bracteoles* basifixed, subulate, ca. 2 mm long. *Flowers* 1–6, laxly arranged; pedicels ascending, 5–15 mm long. *Calyx lobes* slightly unequal, ovate, 4–5 mm long, the upper lobe acute at apex; the lower lobe usually slightly smaller, obtuse or minutely bidentate at apex. *Corolla* 1.5–2 cm long, mauve, violat or bluish, upper lip slightly constricted near the base; the superior part obovate-oblong, apex retuse; the inferior part quadrate; lower lip limb suborbicular, galeate, apex rounded, base with a prominent swelling; palate with a ciliate marginal rim; spur subulate, apex acute, curved, about as long as and widely diverging from the lower lip. *Filaments* ca. 2 mm long, straight; anther thecae distinct. *Ovary* ovoid; style short. *Capsule* and seeds not seen.

**Distribution:** *Utricularia smithiana* is native in India and naturalized in Taiwan (New Taipei).

**Ecology:** *Utricularia smithiana* grows on semi-open wet grassy slope and roadside concrete cliffs with dripping water at the elevation of 300–600 m. Accompanied plants include *U. bifida*, *U. livida*, *Eriocaulon truncatum*, *E. sexangulare* L., *Drosera spatulata* Labill., *Dimeria ornithopoda*, *Eleocharis tetraqueta* Nees, *Eragrostis atrovirens* (Desf.) Trin. ex Steud. and *Ischaemum barbatum* Retz. Flowering is observed from April to July; no fruit set is observed.

**Conservation status:** NA. *Utricularia smithiana* is not native in Taiwan.

**Voucher specimens:** TAIWAN: New Taipei City: XiZhi District, Mt. Wuchih (五指山), T.-C.Hsu 2230 (TAIF); XiZhi District, Chepingliao (車坪寮), T.-C.Hsu 7080 (TAIF).

**Note:** The identification of above collections is somewhat difficult because capsules and seeds, which are very important in diagnosing *Utricularia* species (Taylor, 1989), are not observed in Taiwan so far. Even so, *U. smithiana* is adopted here since it is the only known species with a combination of long linear leaves with three longitudinal veins, sometimes twining inflorescences, and 1.5–2 mm long, mauve or violate corolla with spurs widely divergent from the lower lobes (Taylor, 1989; Fleischmann, 2012; 2015). This species is indeed displayed in flower and aquarium markets in Taiwan and also cultivated by some enthusiasts, although the plants are mostly labeled as *U. reticulata*, *U. graminifolia* or “*Utricularia sp.*” (Hsu, personal observation). Such confusion is possibly due to the lack of fruits and seeds in ornamental races and the great floral similarity among these species. However, even when lacking fruits and seeds, *U. reticulata* could still be distinguished from *U. smithiana* by its constantly 1-veined leaves and more aggressively twining inflorescences (Taylor, 1989), while *U. graminifolia* is also distinguished by its constantly erect inflorescence and slightly smaller flowers (Taylor, 1989; Li et al., 2011; Liu et al., 2011).


Type: BRAZIL. Rio de Janeiro, S. Joao de Barra, St.Hilaire s.n. (holotype: P photo!; isotype: MPU).

三色挖耳草 Fig. 3(E–H)

Perrenials, terrestrial, subaquatic. *Rhizoids* few, capillary. *Stolons* few, capillary, 0.4–0.6 mm thick,
Fig. 3. Naturalized bladderworts in Taiwan. **A–D**: *Utricularia smithiana* Wight (from T.-C.Hsu 2230). **A**: Habitat and habits. Note the slightly twining inflorescences. **B**: Leaves. **C**: Flower, front view. **D**: Flower, side view. **E–H**: *U. tricolor* A.St.-Hil. (from T.-C.Hsu 4719). **E**: Habitat and habits. **F**: Leaves. **G**: Flower, oblique front view. **H**: Flower, side view. Scale bars: **A–H** = 1 cm. Photographed by T.-C.Hsu.
sparsely branched. Leaves 1–3 rosulate at the base of peduncle, distinctly petiolate; petioles 1–4 cm long; lamina broadly obovate, suborbicular or subreniform, apex rounded, 0.8–1.3 × 0.8–1.5 cm, with numerous anastomosing veins. Traps on rhizoids and stolons, broadly ovoid, stalked, 1.5–2 mm long; appendages 2, dorsal, narrow-deltoid, acute, inner sides densely glandular hairy. Inflorescence erect or ascending, sometimes twining distally, solitary, 10–30 cm long. 0.3–1.5 mm thick, glabrous. Scales few, basifixed, ovate-deltoid apex acute, ca. 2 mm long. Bracts basifixed, deltoid to ovate-deltoid, apex acute, ca. 1.5 mm long. Bracteoles much narrower than bracts but as long. Flowers 1–4, laxly arranged; pedicels ascending. 0.5–1.5 cm long. Calyx lobes unequal, convex, the upper lobe broadly ovate to suborbicular, 5–6 mm long, apex rounded; the lower lobe much shorter, transversely elliptic, apex emarginate. Corolla 1–2 cm long, violet to lilac, marked with white and yellow at the base of the lower lip, minutely papillose and with sessile and stipitate glands; upper lip broadly ovate; lower lip limb transversely elliptic, base with a prominent bilobed swelling; apex rounded, entire or slightly 3-crenate; palatte papillate; spur narrowly conical, apex acute, slightly curved, about as long as or slightly longer than the lower lip. Filaments ca. 2 mm long, curved; anther thecae distinct. Ovary globose, glandular; style distinct. Capsule and seeds not seen.

**Distribution:** Utricularia tricolor is native in S America, including Argentina, Brazil, Bolivia, Colombia, Paraguay, Uruguay and Venezuela (Taylor, 1989), and it is naturalized in Taiwan (Keelung and New Taipei).

**Ecology:** Utricularia tricolor grows on wet roadside grassy slopes and on concrete ditch walls with dripping water. Accompanied plants include U. bifida, Drosera spatulata, Eriocaulon truncatum, E. sexangulare, Dimeria ornithopoda, Juncus prismatocarpus R. Br., Ischaemum barbatum and Emilia praetermissa Milne-Redh. Flowering is observed in September; no fruit set is observed.

**Conservation status:** NA. Utricularia tricolor is not native in Taiwan.

**Voucher specimens:** TAIWAN: Keelung City, Qidu District, Chifengiao (七星嶼), T.-C.Hsu 4719, 8130 (TAIF). New Taipei City: Xizhi District, Mt. Wuchi (五指山), T.-C.Hsu 8129 (TAIF).

**Notes:** Utricularia tricolor is easily distinguished from other species in Taiwan by its relatively very large, broadly obovate to subreniform leaves with 1–4 cm long petioles. The flowers are also large and quite attractive although rarely seen in field. This species is relatively easier cultivated and has long been traded in horticultural markets in Taiwan (Hsu, personal observation).

**ACKNOWLEDGEMENTS**

The authors thank Dr. Shih-Wen Chung for his kind assistant in field work and literature consulting.

**LITERATURE CITED**


