

Conservation status of the unique population of *Wenchengia alternifolia*, an enigmatic plant endemic to Hainan Island, China

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Abstract *Wenchengia alternifolia* (Lamiaceae) is a plant species endemic to Hainan Island, China. Since the 1930s it was known from only four collections and was believed to be extinct until a remnant population was rediscovered in 2010. We conducted further field surveys during 2010–2012 but located only one population, with 66 individuals. *W. alternifolia* is restricted to the c. 1,500 m² Shuangximu Valley, in a harsh microenvironment surrounded by plantations. As the population comprises < 50 mature individuals, we propose that *W. alternifolia* be categorized as Critically Endangered on the IUCN Red List, based on criterion D. We recommend that the remnant population and its habitat need urgent protection and monitoring and that ex situ conservation, for future reintroduction, should be implemented.

Keywords China, conservation strategy, endemic species, ex situ conservation, habitat destruction, rediscovery, *Wenchengia alternifolia*

Hainan, the second largest island of China, with an area of c. 33,900 km² (Fig. 1), harbours c. 4,800 taxa of vascular plants (Xing et al., 2012) and the best-preserved tropical forest in China (Deng et al., 2008). However, the island has been experiencing extensive deforestation, posing major threats to its biodiversity (Francisco-Ortega et al., 2010).

Wenchengia (Lamiaceae) is one of the seven monotypic genera endemic to the island (Francisco-Ortega et al., 2010). *Wenchengia alternifolia* C. Y. Wu & S. Chow was described on the basis of two collections made in the 1930s (Wu & Chow, 1965). Since its description, *W. alternifolia* has been

known only from the two original and two further collections and was considered to be one of the most enigmatic genera in the mint family (Cantino & Abu-Asab, 1993). It was believed to be extinct (Harley et al., 2004) until a remnant population was rediscovered in 2010 (Li et al., 2012). The genus is characterized by alternate leaves, racemose inflorescences, and a unique type of nutlet attachment, described as vascular funicles, and slender stalks (Li & Hedge, 1994; Li et al., 2012). Because these traits are rare or unique in the mint family, Wu & Chow (1965) established a monotypic subfamily, Wenchengioideae, to accommodate the genus. However, a recent phylogenetic investigation suggested that *Wenchengia* is an early and relictual lineage in the Scutellarioideae (Li et al., 2012). Its limited distribution and isolated phylogenetic position make this species a high conservation priority. However, *W. alternifolia* is not yet included on the IUCN Red List (IUCN, 2013) or the List of National Protected Key Wild Plants (First Batch) (4 August 1999), and is categorized as Vulnerable on the China Species Red List (Wang & Xie, 2004). To improve the protection of this species, this study aimed to provide detailed information about its habitat, evaluate the major threats to its survival and propose appropriate conservation strategies.

The rediscovered population lies in the stony Shuangximu Valley of the Nanlin State Forestry Center, Xinglong Town, Wanning City (Fig. 1; Plate 1a), Hainan Province, China. With an area of c. 1,500 m² and an altitude of c. 100–300 m, the valley is surrounded mainly by areca, rubber and pineapple plantations (Plate 1b). Several mountain streams flow into the valley and flood periodically during the July–November rainy season. The population of *W. alternifolia* is in two adjacent sites near a waterfall and a c. 80 m² pond below the waterfall. The individuals above the waterfall are growing in the shade of a small dense forest (c. 300 m²; Plate 1a) and are accompanied mostly by *Adina pilulifera* (Lam.) Franch. ex Drake and *Phyllanthus hainanensis* Merr. The individuals beneath the waterfall are scattered amongst huge boulders (Plate 1c) and grow out from moist cracks in stones and cliffs (Plate 1d).

In the hope of discovering further populations of *W. alternifolia* we examined the label data from all four known herbarium specimens: How 7368, 20 September 1935, and Liu 28220, 17 November 1936, deposited in IBSC

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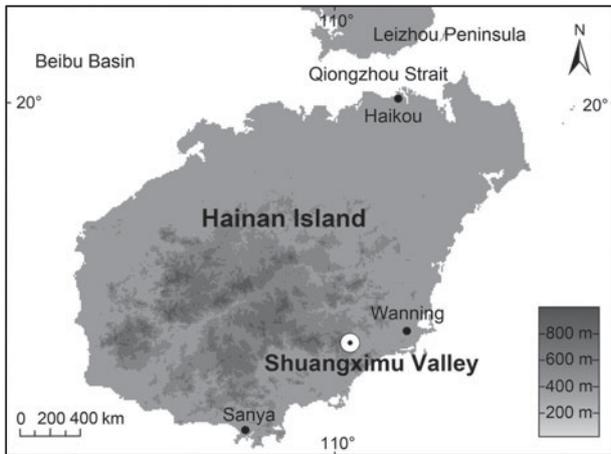


FIG. 1 Hainan Island, showing the location of Shuangximu Valley, where *Wenchengia alternifolia* was rediscovered in 2010. The degree of shading indicates altitude.

and A (herbarium abbreviations follow Index Herbariorum, 2014), Deng 3079, 7 November 1956, deposited in IBSC, and Hu 9017, 10 July 1996, deposited in MO. The labels of How 7368 and Deng 3079 indicate they were both collected from ‘Shuangximu Valley near Xinglong Town’, the same locality as the surviving population. Our attempt to locate the precise localities of Liu 28220 (recorded as ‘Nanniuling valley in Baoting County’) and Hu 9017 (simply documented as ‘from Hainan Island’) was unsuccessful. The rediscovered Shuangximu Valley population is thus probably the only one remaining.

Within this remnant population we counted 45 reproductive plants, 14 non-reproductive plants and seven seedlings (a total of 66 individuals). Reproductive plants mostly exhibit a clumped structure, each clump (‘individual’) consisting of 3–25 slender, leafy shoots (Plate 1c). Most of the shoots are prostrate or ascending, terminating in

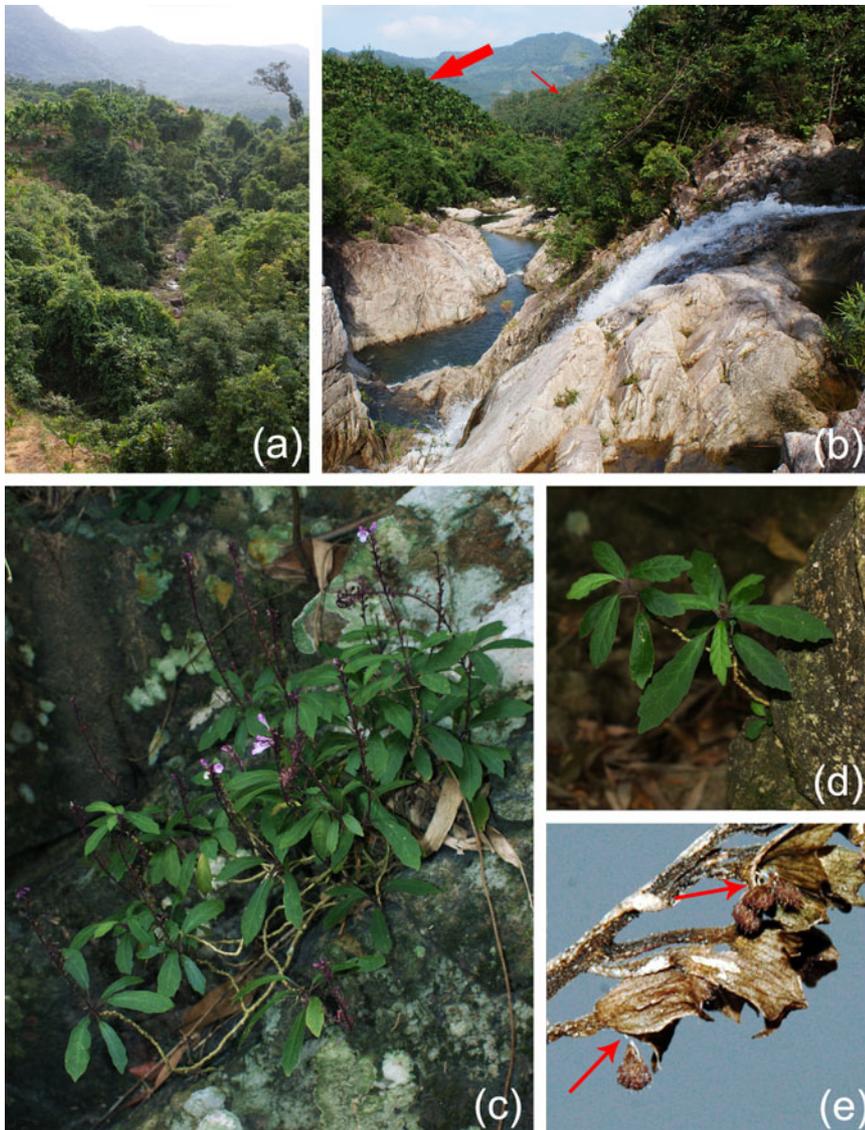


PLATE 1 (a) The rediscovered population of *Wenchengia alternifolia* in Shuangximu Valley, isolated among tropical crops, (b) the habitat (completely surrounded by areca plantations, arrowed), (c) a reproductive individual of *W. alternifolia*, (d) a non-reproductive individual growing in a moist stone crack, and (e) part of a dried infructescence with nutlets (arrowed) attached by flexible funicles.

inflorescences and fruits (Li et al., 2012). The mean number of fruits (each fruit comprising four dry nutlets) is 17 per infructescence. A reproductive plant (clump) can generate a mean of c. 380 mature nutlets, suggesting seed output may not be limiting population viability. Non-reproductive plants usually contain 2–5 short, vegetative shoots (Plate 1d), and seedlings are distinguishable by their single purple stem with several purple leaves. In harsh habitats some plant species display a low rate of seed germination (Choi et al., 2012), and the low proportion of both juveniles and seedlings of *W. alternifolia* could be a consequence of the species' stony habitat.

Plants in wetland and coastal areas frequently depend on water for dispersal (Cadée, 2005; Choi et al., 2012). That *W. alternifolia* grows in cracks and cliffs suggests that fruit dispersal may depend on water flow. The mature nutlets are apically tuberculate and pubescent, and usually hang out of the calyx by means of vascular funicles (Plate 1e). When the dry nutlets fall into water, small air bubbles form among the pubescence, allowing the nutlet to float. We found that *W. alternifolia* fruits from September to November, coinciding with the rainy season on Hainan Island. It is likely that rains or flooding detach the nutlets from the calyx, which then lodge in cracks.

On Hainan Island extensive change in land use, mainly from the expansion of plantations and rapid development of urbanization, mining and tourism (Guo et al., 2006), has resulted in a dramatic transformation of once-contiguous forests into small isolated fragments. In the 1950s c. 25.5% of Hainan was forest but by 1998 this had decreased to 8.7% (Compilation Group of China's Biodiversity, 1998). The labels of How 7368 and Liu 28220 indicate that the collecting localities of *W. alternifolia* in the 1930s included 'on the roadside of Xinglong Town' and 'under dense rainforest', suggesting that *W. alternifolia* and its habitat were more common in the 1930s. Habitat destruction can be a major threat to plant species (Ali & Qaiser, 2011; Fenu et al., 2011; Martinell et al., 2011; Choi et al., 2012), and changes in land use could have eradicated most *W. alternifolia* populations. Our observations during 2010–2012 indicate that even in its last refuge the growth of *W. alternifolia* appears to be constrained by the harshness of its habitat and persistent disturbance from agriculture. Because of the small size of the population, we propose that *W. alternifolia* is categorized as Critically Endangered on the IUCN Red List, based on criterion D (population size estimated at < 50 mature individuals; IUCN, 2001).

For narrow endemic species any disturbance of the population (Bernardos et al., 2006) or destruction of the habitat (Ali & Qaiser, 2011; Fenu et al., 2011; Martinell et al., 2011; Choi et al., 2012) could trigger extinction. Given the very small population size and harsh habitat of *W. alternifolia*, this species is extremely vulnerable to any disturbance. Strict protection of the two adjacent sites in

Shuangximu Valley is required, along with protection from disturbance by agriculture and restoration of remnant forest in the valley. Five plants of *W. alternifolia* were transplanted to a greenhouse in South China Botanical Garden, Chinese Academy of Sciences, in April 2010, where they are growing well and flowering regularly, indicating that ex situ conservation could help rescue this species, and we are currently studying the population genetics of *W. alternifolia* as an aid to its future conservation.

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Biographical sketches

BO LI'S research focuses on the systematics and biogeography of various genera of Lamiales, including *Osmanthus*, *Premna* and *Wenchengia*, as well as conservation of *W. alternifolia*. ZHIYONG ZHANG is a botanist with an interest in conservation of the subtropical evergreen forests of China. DIANXIANG ZHANG is a botanist with broad interests in plant reproductive biology, taxonomy and the conservation biology of tropical angiosperms. He is organizing a project on the survey and conservation of the biodiversity of the coast and islands of southern China.