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# *Phymatosorus longissimus* (Bl.) Pic. Serm. (Polypodiaceae): Rediscovered in Taiwan

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**ABSTRACT:** The fern, *Phymatosorus longissimus* (Bl.) Pic. Serm., was believed to be locally extinct in Taiwan. However, we recently rediscovered this species in Mudan, Pingtung County and Lanyu Island, Taitung County of Taiwan. The species has currently been found in wetlands neighboring cultivated fields. These habitats are prone to the disturbance of human activities, which may lead to another future extinction of the species in Taiwan. Based on the IUCN criteria, we proposed *Phymatosorus longissimus* (Bl.) Pic. Serm. to be a critically endangered species in Taiwan. We also discussed the taxonomy and the distribution of this species.

**KEY WORDS:** ***Phymatosorus longissimus*, *Phymatosorus suisha-stagnale*, Polypodiaceae, rare species, Taiwan.**

## INTRODUCTION

The first discovery of *Phymatosorus longissimus* (Bl.) Pic. Serm. (Polypodiaceae, Pteridophyta) in Taiwan was from the floating island in Suisha Lake (now known as the Sun-Moon Lake of Nantou County, Taiwan). That plant was given the name *Polypodium suisha-stagnale* Hayata; it was believed to be closely related to *Polypodium longissimus* Bl., just with thinner texture and deeper sunken sori (Hayata, 1916). The name *P. suisha-stangnale* was later transferred to the genus *Phymatosorus*, but was still recognized as a distinct species (Pichi Sermolli, 1973). However, later studies treated it as a synonym of *Phymatosorus longissimus* (Bl.) Pic. Serm. [under the name *Phymatodes longissimus* (Bl.) J. Sm. or *Microsorum rubidum* (J. Sm.) Copel. (misspelled as *Microsorium rubidum* (Kunze) Copel.)] (DeVol and Kuo, 1975; Shieh et al., 1994). The genus status of *Phymatosorus* is doubtful. Some taxonomists placed it in the genus *Microsorum*, but the molecular phylogeny shows *Microsorum* being polyphyletic (Smith et al., 2006). We followed Kramer's scheme (Kramer and Green, 1990), which placed this taxon under the genus *Phymatosorus* of the family Polypodiaceae.

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Collections in Sun-Moon Lake region were few during 1929 to 1934 (Sasaki, 1930; DeVol and Kuo, 1975). After 1934, the floating island disappeared and no more collections were made around the Sun-Moon Lake. In 1959, the fern was found again in the nearby Chingshuikuo area of Nantou County (DeVol and Kuo, 1975); however, this habitat was destroyed and no voucher specimens were collected from these areas for the following 50 years (Tseng-Chieng Huang per. comm.). In 1981, the species was found again in Loshan area of Hualian County by Mr. Chin-Wen Tsai (National Taiwan University Herbarium, TAI). Later, the species was suggested to be locally extinct in Taiwan according to the extinct species definition of Groombridge (Kuo, 1998).

## REDISCOVERY

The first author and Mr. Chun-Yih Lin rediscovered this species in Mudan, Pingtung County in autumn 2002. The population in Mudan, Pingtung County was found mostly in wetlands at the shore of streams, where the rhizomes formed a dense submerged mat. The site was located in the low-hills in the understory of secondary forest - the habitat was approximately 20×40 $m^2$ where *P. longissimus* was one of the dominating herb species. We found no more populations in the neighboring area.

The species was also rediscovered in Lanyu Island by Mr. Wei-Chao Leong and Mr. Shin-Ming Ku in autumn 2002; they found the plant growing on the

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ridge side near taro paddies. A small native population in wetland near the taro paddies of Lanyu was also found by Knapp Ralf in autumn 2005. However, these populations in Lanyu Island disappeared when revisited in 2006 - the species might have become extinct again in Lanyu.

Specimens were collected from each sites and deposited in the Herbarium of National Sun Yat-sen University (SYSU). Fresh planting materials were transplanted to the greenhouses of SYSU and National Taiwan University (NTU).

## TAXONOMY TREATMENTS

***Phymatosorus longissimus*** (Bl.) Pic. Serm., *Webbia* 28 (2): 459. 1973; *Polypodium longissimum* Bl., Enum. Pl. Javae 2: 127. 1828; *Phymatodes longissima* (Bl.) J. Sm., Cult. Ferns 10. 1857; DeVol & Kuo, Fl. Taiwan 1: 199. pl. 69. 1975. Figs. 1-3

*Drynaria rubida* J. Sm., J. Bot. (Hook.) 3: 397. 1841; *Microsorum rubidum* (J. Sm.) Copel., Gen. Fil. (Ann. Cryptog. Phytopathol. 5) 197. 1947; Shieh et al., Fl. Taiwan 2nd ed. 1: 502. 1994. *Polypodium suisha-stagnale* Hayata, Icon. Pl. Formos. 6: 160. 1916; *Phymatosorus suisha-stagnalis* (Hayata) Pic. Serm., Webbia 28(2): 460. 1973.

Rhizome 4-8 mm wide, long creeping, approaching to 2 or more meters long, not white waxy. Scales ovate or triangular, 3-5 by 1-2 mm, margin entire but sometimes with glandular hairs, apex acute, thinly clathrate, pseudopeltately attached, sparsely distributed on rhizome and densely on the tip of the rhizome and basal stipe. Fronds deeply pinnatifid, herbaceous; *stipe* 10-80 cm long, green; *lamina* elliptic, 30-120 cm long, 30-100 cm wide, the ratio of length divided by width 1.5 to 5; with a rachis wing 0.1-1 cm; *lobes* 10-30 at each side, longest lobes located at the lower 1/3 of lamina, 7-40 by 0.7-3.5 cm, the ratio of length divided by width 8-12, base narrowly angustate, decurrent to a rachis wing, apex acute to acuminate, or rounded; margin entire. Sori round, deeply sunken, visible as protrusions on the upper surface, 3-5 mm in diameter; sori usually distributed on the whole surface except lower portion of the lamina.

Examined specimens: TAIWAN: Nantou Co.: Sun-Moon Lake, *Hayata s. n.* Apr. 20 1916 (TAIF); same loc., *S. Sasaki, s. n.* Sep. 12 1929 (TAIF); same loc., *Kudo et Sasaki s. n.* Sep. 19 1929 (TAI); same loc., *Kudo et Sasaki s. n.* Sep. 22 1929 (TAI); same loc., *S. Sasaki, s. n.* Sep. 1934 (TAI); same loc., *S. Sasaki s. n.* Dec. 15 1930 (TAI); Chingshuikou, *Huang, T. C. et al. 1100* (TAI, HAST). Pingtung Co. Mudan. *Liu, Y. C. 3165* (SYSU). Hualian Co. Loshan. *Tsai 37* (TAI). Taitung Co. Lanyu. *Leong, W. C. 3329* (HAST).

Distribution: China (Yunnan and Hainan); Vietnam; Thailand; India; Philippine; Indonesia; Malaya; S. Japan (Amami Islands and southwards); and Pacific Islands. Taiwan, recently rediscovered only at Mudan, Pingtung Co. (N 22º 09', E 120º 48'; elevation ca. 260 m.) and Lanyu Island, Taitung Co. (N 22º 02', E, 121º 32'; elevation ca. 70 m). Taiwan locates on the north limitation of this species (Fig. 1).

## DISCUSSION

### Leaf texture variance

Blume (1828) described the frond texture of *P. longissimus* as membranous in his protologue. Nooteboom (1997) treated this name on the type specimen collected by Blume (Lectotype: *Blumea 35*. L.) as the synonym of *Microsorum rubidum* (Kunze) Copel. However, *Polypodium suisha-stagnale* has a thinner frond texture and deeper sunken sori than *Polypodium longissimus* Blume (Hayata, 1916).

We examined the specimen of *P. suisha-stagnale* collected by Hayata in the Sun-Moon Lake (*Hayata, s. n.* 1916 Sep. 20, TAIF), as well as other specimens collected by others from the Sun-Moon Lake and the neighboring area. We found all of these specimens resembling the type specimen of *M. rubidium* (*Cuming 241*, photograph from National Herbarium Nederland website), which has thicker and narrower pinnae. The material from Mudan has much thinner and broader pinnae, matching the description of *P. longissimus* and lectotype specimen (*Blume 35*, photograph from National Herbarium Nederland website).

To study the variations between different habitats, the fresh planting materials from greenhouses were examined. After a few months, the plants grew in the semi-shaded greenhouse showed larger and thinner laminae and boarder pinnae; the plants grew in sunny outdoor environment on the campus of NTU had thicker laminae and narrower pinnae. These morphological variations can be found as well in the wild populations of this species in Taiwan. The plants found in the wetland under a secondary forest in Mudan showed thinner laminae; and plants found near the sunny taro paddy of Lanyu Island showed thicker laminae. Transplanting demonstrated that the textures of lamina, pinnae sizes, degree of sori sunken into the lamina were variable depending on environmental conditions. These findings support the combination of *P. suisha-stagnale* into *P.*

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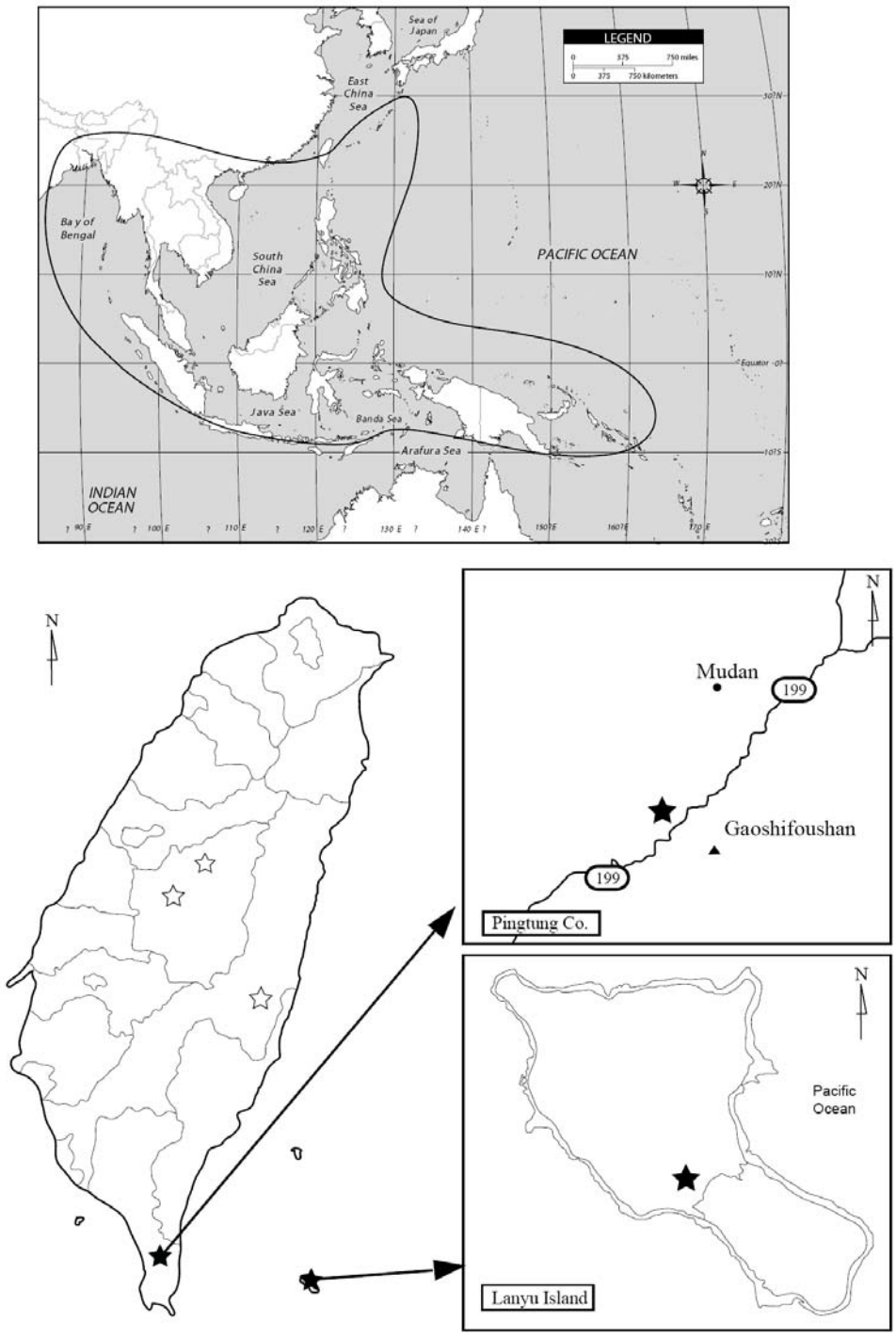



Fig. 1. Distribution map of *Phymatosorus longissimus* (Bl.) Pic. Serm. ★: New distribution. ☆: Historic collected location.

*longissimus.* The habitat descriptions of *P. longissimus* are different in some references (Kuo and Wang, 1985; Fraser-Jenkins, 1997; Iwatsuki, 1995; Lu, 2000), which suggested the species can adapt to various environments.

**Evaluation of endangered status**

*P. longissimus* was mainly found in Malaysiana and is not rare in that region. But in Japan, Taiwan and China (Hainan Island), this species was rare and endangered. In Japan, it was only found in Okinawa

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Fig. 2. Natural population of *Phymatosorus longissimus* in Mudan, Pingtung Co.



Fig. 3. Plants of *Phymatosorus longissimus* in Mudan, Pingtung Co.

Islands (Iwatsuki, 1995) and was classified by Japan Integrated Biodiversity Information System as vulnerable (VU) (30 Sep. 2006; seen in the web, http://www.biodic.go.jp/english/rdb/rdb_f.html). Dong et al. (2003) also classified it as a vulnerable species in Hainan, China; they suggested the reason caused endangered was the north limitation of distribution of this species.

*P. longissimus* has high spore germination rate and proceeding young sporophytes successfully in Taiwan (Chiou et al. unpublished data). However, in Taiwan, *P. longissimus* has currently been found in wet places, which are easily disturbed or even destroyed by human activities. Besides, the invasive species, *Mikania* sp. favors the same habitats and competes strongly for space. Previous populations of the species have disappeared in the Sun-Moon Lake, Chingshuikuo, Loshan and Lanyu Island. We suggested that, unless steps are taken to conserve the habitat, the species would soon be extinct again in Taiwan.

According to the distribution information and field observation for more than five years, authors evaluate this threatened species by recent categories and criteria (IUCN 2001) as Critically Endangered (CR), A1d; B2ac (ii+iii); C2a (ii) in Taiwan.

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# 水社擬茀蕨在臺灣的再發現

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## 摘　　要

水社擬茀蕨過去在臺灣被視為已經滅絕，但是最近我們在屏東縣牡丹鄉以及臺東縣蘭嶼鄉重新發現了此一物種。該種目前均發現於鄰近農耕地旁的溼地，相信極容易受到人為的干擾而再次滅絕。我們依循 IUCN 受威脅等級及準則，評估水社擬茀蕨在臺灣的稀有等級為嚴重瀕臨滅絕。

關鍵詞：水社擬茀蕨、水龍骨科、稀有種、臺灣。

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