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NOTE

First record of the mycoheterotrophic orchid *Gastrodia fontinalis* (Orchidaceae) from Takeshima Island, the Ryukyu Islands, Japan

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ABSTRACT: We found *Gastrodia fontinalis* T. P. Lin in a bamboo forest from Takeshima Island, which is the northernmost island of the Ryukyu Islands in Japan. This species is apparently rare and was previously considered to be an endemic Taiwanese species. Because there are a few minor differences between the original description and our specimens collected in Takeshima Island, here we report *Gastrodia fontinalis* from Takeshima Island as the first record outside of Taiwan, with a description of the specimens from Takeshima Island.

KEY WORDS: *Gastrodia*, mycoheterotroph, new locality, Orchidaceae.

INTRODUCTION

The genus *Gastrodia* (Orchidaceae) is comprised of approximately 50 species of mycoheterotrophic orchids that are distributed throughout the temperate and tropical regions of Asia, Oceania, and Madagascar (Chung and Hsu 2006). The genus is characterized by either fleshy tubers or a coralloid underground stem, as well as the absence of leaves, the union of sepals and petals, and the production of two mealy pollinia lacking caudicles (Pridgeon *et al.*, 2005, Chen *et al.*, 2009, Cribb *et al.*, 2010, Hsu and Kuo, 2010, 2011).

Gastrodia shows extraordinary morphological diversity. Some species of section *Gastrodia* (sensu Schlechter, 1911), such as *G. elata* Blume, reach 60-100 cm in height during flowering. In contrast, many species of section *Codonanthus* (Schlechter 1911, Tuyama, 1967), represented by *G. verrucosa* Blume (the *G. verrucosa* group), have inflorescences that are only 3–15 cm long at flowering time; however, during fruiting, they are 30–40 cm long and have elongated pedicels (Chung and Hsu, 2006). Thus, as with most mycoheterotrophs, species belonging to section *Codonanthus* are rarely found during the flowering season, and therefore have not been studied in detail (Tuyama, 1982, Suetsugu *et al.*, 2012). Due to such difficulties in precise identification, adequate taxonomic studies of section *Codonanthus* have not been conducted. Recently, in Japan, we have conducted botanical surveys of mycoheterotrophs, which resulted in the discovery of many new taxa of section *Codonanthu*, *viz.* several new species [*G. takeshimensis* Suetsugu (Suetsugu, 2013) and *G. flexistyloides* (Suetsugu, 2014)], a new variety [*Gastrodia albida* T. C. Hsu & C.-M. Kuo var. *yakushimensis* Yahara & M. Nakajima (Yahara and Nakajima 2014)], new distributional records [*G. shimizuana* Tuyama (Suetsugu *et al.*, 2012) and *G. clausa* T. C. Hsu, S. W. Chung & C. M. Kuo (Suetsugu *et al.*, 2013)] and a new form [*Gastrodia confusa* Honda et Tuyama f. *viridis* Suetsugu (Suetsugu, 2012)].

In addition, other unknown species that belong to section *Codonanthus* have been reported on Takeshima Island, which is one of the northernmost islands of the Ryukyu Islands in Japan. This species was tentatively treated as *Gastrodia tokaraensis*, though the name has still not been validated (Yokota and Umata 2001). During the recent research trip to Takeshima Island, Suetsugu, one of the authors, had an opportunity to collect flowering individuals of this unknown *Gastrodia* in its natural habitat. Detailed morphological examination by additional sampling found that this unknown species can be considered *Gastrodia fontinalis* T.P. Lin (Fig. l), although there are a few minor differences between the original description and our specimens collected on Takeshima Island. Here we report its first known occurrence in Japan, with a description of the specimens from Takeshima Island.

TAXONOMIC TREATMENT

Gastrodia fontinalis T. P. Lin Native Orchids of Taiwan. 3: 129 (1987)

春赤箭 Fig.1

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Specimen examined: JAPAN. Ryukyu. Kagoshima Pref., Takeshima Island. 29 April 2012, K. Suetsugu Take-01 (KYO).

Terrestrial, mycoheterotrophic herb. Root, short, densely branching, mostly extending from the apex center of the rhizome system. Rhizome tuberous, fusiform or cylindrical, 6–18 cm long, 4–15 mm in diameter, dark brown, covered with numerous scales. Inflorescence erect, dark greenish brown, 11–24 cm long, 2.5–7 mm in diameter. Bracts ovate, 6–9 × 4–6 mm. Pedicel and ovary *ca.* 15 mm long. Flowers 1-16, bell-shaped, slightly nodding, resupinate, 17–21 mm long, 10–11 mm in diameter. Sepals and petals united forming a five-lobed perianth tube. Sepals sub-similar, fleshy, 17–21 mm long, connate *ca.* 2/3 the length of the petals, lateral ones connate *ca.* 3/5 their length with each other, outer surface pale brown, verrucose, margins entire; free portion of dorsal sepal straight, ovate-triangular, retuse, *ca.* 7 mm long, 8–9 mm wide; free portions of lateral sepals spreading, obtuse at apex. Free portions of petals ovate or ellipse, *ca.* 4.5 mm long, 4 mm wide. Lip adnate to column foot, 8 mm long, hypochile with 2 red, globose calli; epichile red-brownish, ovate-triangular, base contracted, with 6–8 ridges elevated on upper portion, with 2 ridges extending to the ligulate apex. Column straight, terete, 8–9 mm long, 2.5 mm wide, white tinged with pale green at base; column foot well developed; lateral wings (stelidia) narrow, brown, edges parallel to column, apex acute; rostellum small; stigma located at base. Anther hemispheric, 1.2 mm in diameter, pollinia 2. Capsule cylindrical, *ca.* 3 cm long, pedicel elongating to *ca.* 30 cm long in fruit. Seeds fusiform, *ca.* 2.0 mm long.

Distribution: To date, the distribution of *G. fontinalis* appears to be restricted to Takeshima Island, Japan. The populations, constituting of several hundred flowering individuals, were found in an area of less than 1 km^2 located in bamboo forests dominated by *Pleioblastus linearis* (Hack.) Nakai. Flowering was observed from late March to late April, and fruiting from late April to late May.

Notes: Compared with published descriptions and illustrations (Lin, 1987; Leou, 2000), the *G. fontinalis* specimens from Takeshima Island tended to be bigger than those from Taiwan, producing longer rhizomes (6–18 cm vs. 6–10 cm) and a greater number of flowers per inflorescence (1–16 vs. 2–8), as well as having taller inflorescences (11–22 cm vs. 7–12 cm) and longer perianth tubes (17–21 mm vs. 15–18 mm) with a greater diameter (10–11 mm vs. 8–10 mm). However, despite these differences there appeared to be no clear differences in coloration and morphology (other than size) between the two populations. In particular, there seemed to be no differences in the morphology of the lip and column, which are important characteristics used to classify *Gastrodia* species. Furthermore, given that plant size can be dramatically affected by the availability of resources, and that resource limitation is prevalent amongst mycoheterotrophic plants as a consequence of their parasitic nature (Leake, 1994), it would not be surprising to observe variability in plant size between different populations reflecting their different nutritional resources, such as the activity of their mycorrhizal fungi. It was also noted that there was sometimes an overlap between the size range of plants in the Taiwanese and Takeshima populations, which indicates that the differences between the two populations should be considered relatively minor and most likely represent an example of intraspecific variation.

Although previous studies of the Taiwanese *G. fontinalis* population have not involved detailed excavations of their rhizome system, the current study found that in agreement with the report of Umata and Yokota (2006), the population of *G. fontinalis* in Takeshima Island was often characterized by having a large rhizome network consisting of many rhizomes (Fig. 1G) which covers a surface area up to 0.4 m^2. Similar rhizome systems have never before been found in any species inhabiting Japan or the surrounding areas. Furthermore, the specimens in Takeshima Island were often found to produce a tight root mass complex beneath the rhizome network, approximately 5 cm in height and 4 cm in width, just like the root ball produced by *Monotropastrum globosum* H. Andres (Matsuda and Yamada, 2001; Fig. 1K, L). In general, the roots of the Takeshima island *G. fontinalis* specimens are densely branched, and were shorter (<5 cm) and wider (1.2–1.4 mm), zigzagging, and brittle (Umata and Yokota, 2006; Fig. 1 K, L), while the usual long, slender root morphology from the apex of rhizome can sometimes be found, especially before its mycorrhizal fungi inhabit the roots. Given that most species belonging to section *Codonanthus* produce a small number of straight, slender roots (Fig. 1M), mostly extending from the apex of the rhizome (e.g. Hsu and Kuo, 2010, 2011), the root morphology of the *G. fontinalis* specimens found in Takeshima Island can be considered unique, and it would therefore be of great interest to investigate whether the Taiwanese population of *G. fontinalis* also shares the same root morphology.

The detailed taxonomy of genus *Gastrodia* has yet to be completely resolved in Asia, and our ongoing surveys continue to reveal new species or new distributional records for this genus in southern Japan (Suetsugu, *et al.* 2012, 2013, Suetsugu, 2013, 2014). This indicates that there could still be many more undescribed species hidden in this area. However, to date our surveys have been limited in number and

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restricted to particular sites (Suetsugu, *et al.* 2012, 2013, Suetsugu, 2013, 2014), and more extensive and detailed botanical surveys are therefore required to establish the precise distribution and diversity of *Gastrodia* species in Ryukyu and Taiwan, and provide data which is critical for the conservation of section *Codonanthus* in these species-rich area..



Fig. 1. A: Flowering plants of *Gastrodia fontinalis.* B-C: Flower (B, front view; C side view). D: Expended and flattened perianth tube. F: Column and lip. G: Rhizome network (photographed after remove litter layer and top soil). H: lip. I-J: Column (I, upper view; J, lower view). K-L: Tight root mass complex (I, upper view; J, lower view). M: rhizome with non-branched root A: bar = 1.5 cm. G. bar = 5 cm. B-F, H-J: bar = 0.5 cm. K-M: bar = 1 cm.

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LITERATURE CITED

Chen, X., S. W. Gale and P. J. Cribb. 2009. *Gastrodia*. Flora of China 25: 201-205.

Chung, S. W. & T. C. Hsu. 2006. *Gastrodia shimizuana*, a new record of *Gastrodia* (Orchidaceae) in Taiwan. Taiwania **51:** 50-52.

Cribb, P., E. Fischer and D. Killmann. 2010. A revision of *Gastrodia* (Orchidaceae: Epidendroideae, Gastrodieae) in tropical Africa. Kew Bull. **65:** 315-321.

Hsu, T. C. and C. M. Kuo. 2010. Supplements to the orchid flora of Taiwan (IV): Four additions to the genus *Gastrodia*. Taiwania **55:** 243-248.

Hsu, T. C. and C. M. Kuo. 2011. *Gastrodia albida* (Orchidaceae), a new species from Taiwan. Ann. Bot. Fenn. **48:** 272-275.

Hsu, T. C., S. W. Chung and C. M. Kuo. 2012. Supplements to the orchid flora of Taiwan (vi). Taiwania **57:** 271-277.

Leake, J. R. 1994. Tansley Review No. 69. The biology of myco-heterotrophic ('saprophytic') plants. New Phytol. **127**: 171–216.

Leou, C. S. 2000. *Gastrodia*. In: Huang, T. C. et al. (eds.), Flora of Taiwan **5:** 890-896. Department of Botany, National Taiwan University, Taipei, Taiwan.

Lin, T.P. 1987. Native Orchids of Taiwan 3. Southern Materials Center, Taipei, Taiwan. 300pp.

Matsuda, Y. and A. Yamada. 2003. Mycorrhizal morphology of *Monotropastrum humile* collected from six different forests in central Japan Mycologia, **95:** 993–997.

Pedersen H. A., S. Watthana, S. Suddee and S. Sasirat. 2004. Breeding system, post-pollination growth, and seed dispersal in *Gastrodia exilis* (Orchidaceae). Nat. Hist. Bull. Siam Soc. **52:** 9-26.

Pridgeon, A. M., P. J. Cribb, M. W. Chase and F. N. Rasmussen. 2005. *Gastrodia*. Genera Orchidacearum **4:** 672.

Schlechter, R. 1911. Die Polychondreae (Neottiinae Pfitz.) und ihre systematische Einteilung. Bot. Jahrb. Syst. **45:** 375-410.

Suetsugu, K. 2012. A new form of *Gastrodia confusa*. J. Phytogeogr. Taxon. **59:** 125-126.

Suetsugu, K. 2013. *Gastrodia takeshimensis* (Orchidaceae), a new mycoheterotrophic species from Japan. Ann. Bot. Fenn. **50:** 375–378.

Suetsugu, K. 2014. *Gastrodia flexistyloides* (Orchidaceae), a new mycoheterotrophic plant with cleistogamous flower from Japan. Phytotaxa **175:** 270–274.

Suetsugu, K., M. Nakama, T. Watanabe, H. Watanabe and M. Yokota. 2012. The northernmost locality of *Gastrodia shimizuana* (Orchidaceae). J. Jpn. Bot. **87:** 62-64.

Suetsugu, K., M. Nakama, T. Watanabe, H. Watanabe, T. Yamamoto and M. Yokota. 2013. First record of the mycoheterotrophic plant *Gastrodia clausa* (Orchidaceae) from Okinawa Island, Ryukyu Islands, Japan. Acta Phytotax. Geobot. **64:** 123–126.

Tuyama, T. 1967. Notes on *Gastrodia* of Japan (4). J. Jpn. Bot. **42:** 230-236.

Tuyama, T. 1982. A new *Gastrodia* from the Ryukyus. Acta Phytotax. Geobot. **33:** 380-382.

Umata, H. and M. Yokota. 2006. Comparative characterization of two closely related achlorophyllous orchids, *Gastrodia nipponica* and *G. tokaraensis*. Res. Bull. Kagoshima Univ. For. **34:** 57- 67.

Yokota, M. and H. Umata. 2001. A new species of the genus *Gastrodia* (Orchidaceae) from the Northern Ryukyus. Proceedings of the Annual Meeting of the Botanical Society of Japan. **65:** 192.

Yahara, T. and M. Nakajima. In press *Gastrodia albida* var. *yakushimensis* (Orchidaceae), a new variety from Yaku Island, Japan. Acta Phytotax. Geobot.

日本新紀錄植物：春赤箭（蘭科）

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摘要：本文發表一種日本蘭科新記錄植物－春赤箭 (*Gastrodia fontinalis* T. P. Lin)。這個種是明顯的稀有而被認定為之前被找到的台灣固有種。因為在台灣的春赤箭和我們發現的竹島來的春赤箭中有一些差異，我們連同該種的簡介和從竹島來的春赤箭 (第一次在台灣外發現) 上報。

關鍵詞：蘭科、春赤箭、新紀錄。

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