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Gastrodia flexistyloides (Orchidaceae), a new mycoheterotrophic plant with complete cleistogamy from Japan

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Abstract

A new species, *Gastrodia flexistyloides* (Orchidaceae: Epidendroideae, Gastrodieae) from Takeshima Island, Kagoshima Prefecture, Japan, is described and illustrated. In its trilobed column with a strongly incurved central lobe, this species shows a close affinity to *G. flexistyla* from Taiwan, but it is easily distinguished from *G. flexistyla* by several characteristics, including taller stature during the flowering period and completely cleistogamous flowers with a smaller and narrower perianth tube.

Introduction

The genus *Gastrodia* Brown (1810: 330; Gastrodieae, Epidendroideae) constitutes a group of mycoheterotrophic orchids distributed throughout the temperate and tropical regions of Asia, Oceania, and Madagascar (Chung & Hsu 2006, Tan *et al.* 2012). It contains approximately 50 species, which are characterized by their fleshy tuber or coralloid underground stem, as well as the absence of leaves, the union of sepals and petals, and two mealy pollinia lacking caudicles (Pridgeon *et al.* 2005, Meng *et al.* 2007, Chen *et al.* 2009, Cribb *et al.* 2010, Hsu & Kuo 2010, 2011, Hsu *et al.* 2012).

The genus shows considerable morphological diversity. For example, some species of section *Gastrodia* can reach 60–100 cm in height during flowering, while most species of section *Codonanthus* (Schlechter 1911, Tuyama 1967) produce inflorescences that are only 3–15 cm during flowering, but extend to 30–40 cm during the fruiting period as a consequence of their elongated pedicels (Chung & Hsu 2006).

Plants belonging to the latter group, including the new species described below, are rarely found during the flowering season, and as such have not been studied in detail. However, recent floral research in southern Japan has revealed several new species, as well as new distributional records for the genus, indicating that there may still be undiscovered species hidden in this area (Tuyama 1982, Suetsugu *et al.* 2012, 2013, Suetsugu 2013a). As expected, a new *Gastrodia* species, with significantly different floral morphology compared to other known species, was discovered during a research trip to Takeshima Island, Kagoshima Prefecture, Japan in March to April 2014.

Gastrodia flexistyloides Suetsugu, *sp. nov.* (Figs. 1–2)

Type:—JAPAN. Kyushu: Kagoshima Pref., Takashima Island, 25 March 2014, *K. Suetsugu s.n.* (holotype KYO; isotype TNS).

Diagnosis:—*Gastrodia flexistyloides* differs from its close relative *G. flexistyla* T.C. Hsu & C.M. Kuo (2010: 243), in that it has a larger inflorescence, a completely cleistogamous flower, and a smaller, narrower perianth tube.

Terrestrial, mycoheterotrophic herb. Roots few, slender or occasionally thickened, mostly extending from apex of the rhizome. Rhizome tuberous, fusiform or cylindrical, 2–8 cm long, 4–12 mm in diameter, pale brown, covered with numerous scales and unicellular hairs. Inflorescence erect, pale brown, 9–18 cm long, 3–5 mm in diameter, 3–4 nodes, with tubular, membranous sheaths. Bracts up to 8 mm long, 5 mm wide. Pedicel and ovary up to 15 mm long. Flowers 1–6, tubular, slightly upwards or downwards, resupinate, 15–18 mm long, 5–6 mm in diameter. Sepals and petals united

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forming a five-lobed perianth tube. Perianth tube enclosed or never opening. Sepals subsimilar, fleshy, 15–18 mm long, connate ca. 3/4 of their length with petals, lateral ones connate ca. 2/3 with each other, outer surface pale brown, verrucose; free portion of dorsal sepal ovate-rectangular, apex retuse, ca. 4.5 mm long, 4 mm wide; free portions of lateral sepals ovate, ca. 4.5 mm long, 4.5 mm wide, apex obtuse. Free portions of petals pale orange, ovate, ca. 4 mm long, 3 mm wide, base contracted and thickened, margin slightly scabrous. Lip adnate to column foot, pale green, ca. 8–9 mm long, 4–5 mm wide; hypochile with 2 greenish, globose calli; epichile rhombate-ovate, base contracted, 4–6 ridged on the disc, with two central ridges extending toward the apex, margin slightly undulate; apex portion ligulate, red, ca. 1.5 mm wide. Column 3-lobed, lateral lobes erect, ca. 6 mm long, central lobe strongly incurved; column foot well developed; rostellum absent. Anther hemispheric, ca. 1 mm in diameter, pollinia 2. Capsule cylindrical, 3–3.5 cm long, pedicel elongating to ca. 30 cm long in fruit. Seeds fusiform, ca. 2 mm long.

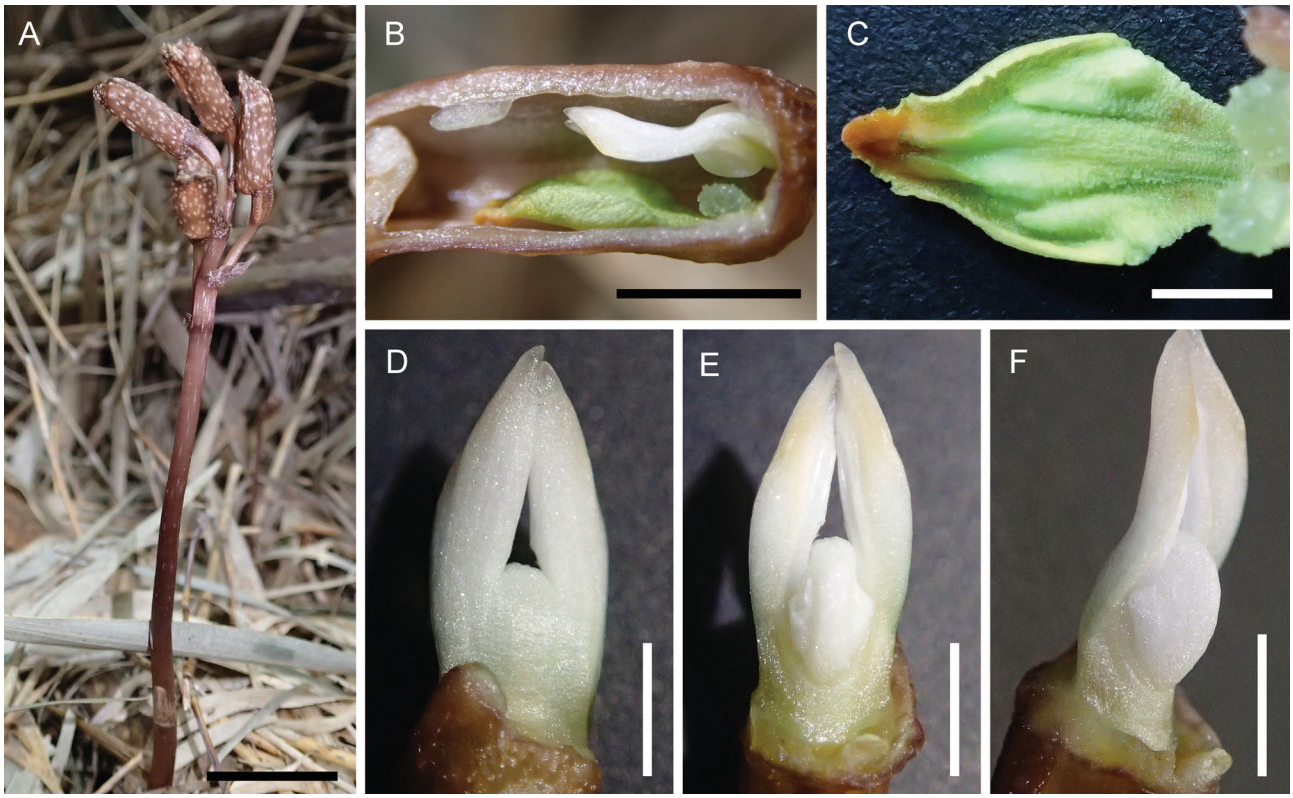

FIGURE 1. A. Flowering plants of *Gastrodia flexistyloides* (from the type locality; bar = 2 cm). B. Dissected flower. C. Lip. D–F. Column (D, front view; E, back view; F, lateral view). A. Bar = 2 cm. B. Bar = 5 mm. C–F. Bar = 2 mm.

Distribution:—To date, the distribution of *G. flexistyloides* appears to be restricted to Takashima Island. The population was located in a bamboo forest dominated by *Pleioblastus linearis* (Hack.) Nakai. Several hundred flowering individuals were found throughout the island. Flowering was observed from mid-March to early April, and fruiting from early April to early May.

Taxonomic notes:—The remarkable characteristic of *G. flexistyloides* is its trilobed column, which has a strongly incurved central lobe. In this respect, this species shows great similarity to *G. flexistyla* T.C. Hsu & C.M. Kuo (2010: 243) from Taiwan, although *G. flexistyloides* can be distinguished by its larger stature during flowering (9–18 cm vs. 3–6 cm), its floral character (cleistogamous vs. chasmogamous), smaller size (15–18 mm vs. 19–24 mm) and narrower perianth tube (5–6 mm vs. 11–13 mm), as well as the ratio of its petal to sepal length (ca 1:1 vs. 1:1.5–2 for *G. flexistyloides* and *G. flexistyla*, respectively).

The most significant difference between these two species is that all the individuals of *G. flexistyloides* have only cleistogamous flowers, while all observed individuals of *G. flexistyla* have opening flowers (Tian-Chuan Hsu, pers. comm.). Some orchids utilize both chasmogamous and cleistogamous flowers (e.g. CaraDonna & Ackerman 2012) and some specimens of such species that incidentally have only cleistogamous flowers were mistaken for new taxa (Pupulin and Bogarín 2011). However, such "new species" were always collected in the regions where only equivalent chasmogamous species exists (Pupulin and Bogarín 2011). *Gastrodia flexistyloides* is distinct from such examples because the hundreds of *G. flexistyloides* in the Takashima population only produce cleistogamous flowers (complete

cleistogamy). Because the morphological dissimilarities are clear and stable, I thus treat this taxon as an independent species rather than an infraspecific taxon of *G. flexistyla*. This notion is also based on biological species concept, which defines a species as members of populations that actually or potentially interbreed in nature, because complete cleistogamous conditions block gene flow with *G. flexistyla*. In fact, taxa with complete cleistogamy have often been recognized as species levels and a recent review documents ca. 70 such cases (Culley & Klooster 2007).

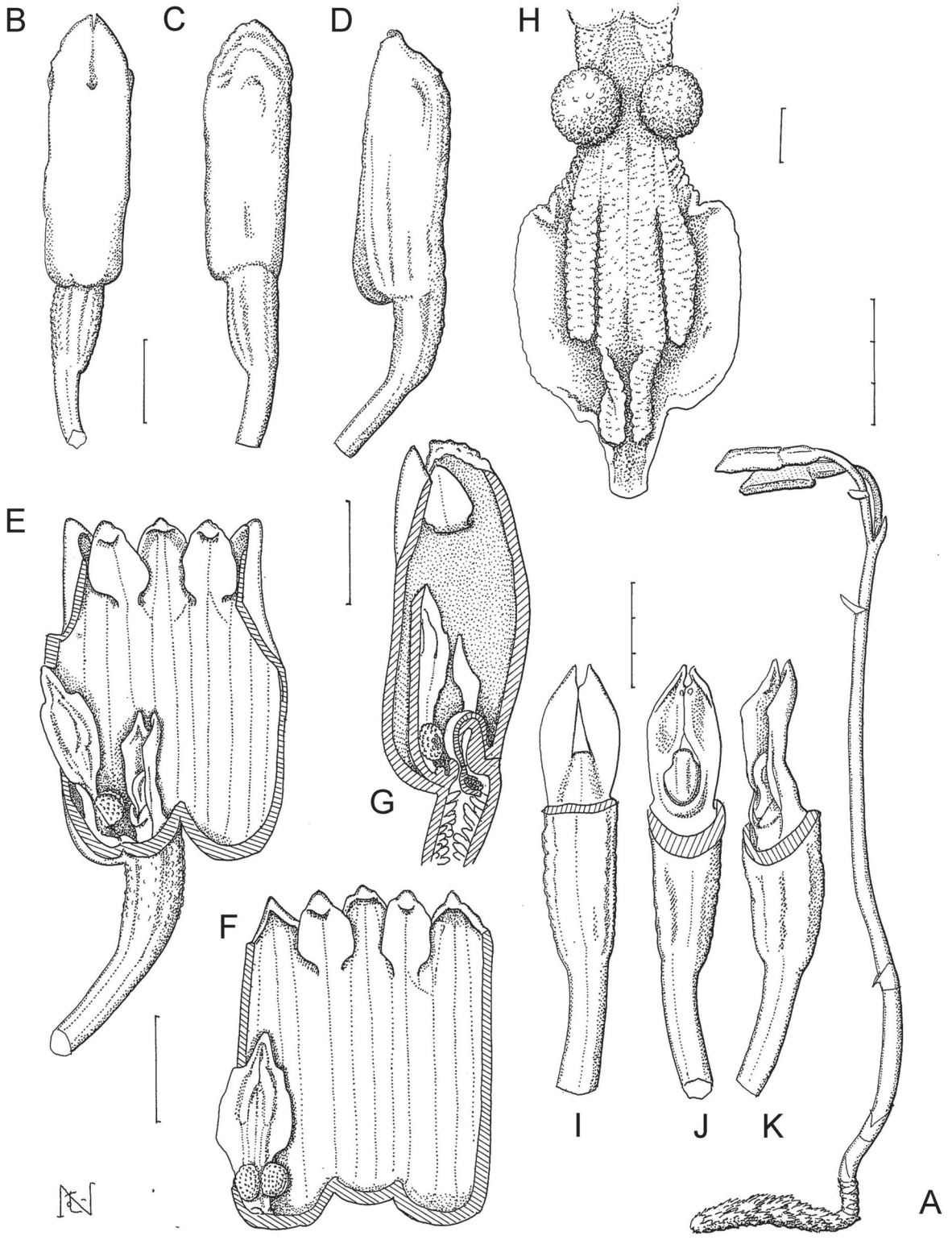

FIGURE 2. *Gastrodia flexistyloides* (from the holotype). A. Habit. B–D. Flower. (B, back view; C, front view; D, side view). E. Flattened flower. F. Flattened perianth tube with lip. G. Longitudinal section of the flower. H. Lip. I–K. Column (I, front view; J, back view; K, lateral view). A. Bar = 3 cm. B–G. Bar = 5 mm. I–K = 3 mm. H. Bar = 1 mm.

Gastrodia flexistyloides is also similar in appearance to *G. takeshimensis* Suetsugu (2013: 375), since both species have completely cleistogamous flowers and elongated corolla tubes. However, the two species differ greatly with regard to their lip and column morphology (Suetsugu 2013a). In addition, *G. flexistyloides* can also be distinguished from *G. takeshimensis* without dissection of the perianth tube as the perianth tube differs in colour (pale brown vs. dark brown for *G. flexistyloides* and *G. takeshimensis*, respectively). Furthermore, the flowering season of *G. flexistyloides* (mid-March to early April) is somewhat earlier than that of *G. takeshimensis* (late March to late April).

Reproductive biology:—*G. flexistyloides* adopts an autonomous self-pollination system. Reports of autonomous self-pollination are fairly common in Orchidaceae (e.g. Suetsugu 2013a, b, c, 2014). The usual mechanism of autonomous self-pollination involves the pollinia falling onto the stigma surface, allowing contact between the pollinia and stigma (e.g. Liu *et al.* 2006, Chen *et al.* 2012, Suetsugu 2013a, b, c, 2014, but also see Gamisch *et al.* 2013). However, the autogamous system of *G. flexistyloides* is notable because the central lobe of the column, which is strongly incurved, also contributes to the pollination process, allowing the anther to contact with stigma directly and thus facilitate self-pollination. So far, this selfing strategy has only been reported in *G. flexistyloides* and the closely related species *G. flexistyla.*

The flowers of *G. flexistyloides* remain closed throughout the flowering period (mid-March to early April). Although cleistogamous plants usually adopt a mixed pollination strategy, also bearing chasmogamous flowers for open pollination (reviewed by Culley & Klooster 2007), it was found that *G. flexistyloides* only produced cleistogamous flowers, which indicates that it is an obligate self-pollinating species. Complete cleistogamy is also known to occur in several *Gastrodia* species belonging to section *Codonanthus* (e.g. *G. clausa* T. C. Hsu, S. W. Chung & C. M. Kuo (2012: 271) and *G. takeshimensis*). In addition, *G. flexistyloides* also shares a common characteristic with section *Codonanthus*, producing pedicels that elongate considerably until the dehiscence of the capsules, a feature that is theorized to facilitate the wind dispersal of seeds in *Codonanthus* (Pedersen *et al.* 2004).

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