Supplements to the Orchid Flora of Taiwan (IV): Four Additions to the Genus *Gastrodia*

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ABSTRACT: Four *Gastrodia* species were recently recognized from Taiwan, including two new species (*G. flexistyla* and *G. uraiensis*) and two newly recorded species (*G. nipponica* and *G. callosa*). Descriptions, illustrations and specimen lists of these species are presented.

KEY WORDS: *Gastrodia flexistyla*, *Gastrodia uraiensis*, *Gastrodia callosa*, *Gastrodia nipponica*, Orchidaceae, Taiwan, taxonomy.

INTRODUCTION

Gastrodia (Orchidaceae: Gastrodieae, Epidendroideae) is an obligate holomycotrophic genus of more than 50 species mainly distributed in Asia and Oceania. In Taiwan, 10 species have been reported (Chung and Hsu, 2006; Chen et al., 2009). During our recent field survey, a number of *Gastrodia* materials were collected throughout the island and some were not known from Taiwan previously. In this paper, we describe two new species, *Gastrodia flexistyla* T.C. Hsu & C.M. Kuo and *G. uraiensis* T.C. Hsu & C.M. Kuo, from northern Taiwan. Two newly recorded species, *Gastrodia callosa* J.J. Sm. and *G. nipponica* (Honda) Tuyama, which have been briefly reported by Chung (2008), are also presented here with detailed morphological descriptions, illustrations and specimen lists.

TAXONOMIC TREATMENTS

Gastrodia flexistyla T.C. Hsu & C.M. Kuo *sp. nov.* — Type: TAIWAN. Taipei City: Beitou District, Chongchengshan, 700-800 m alt., 24 Mar 2008, *T.C. Hsu 1300* (holotype TAI, isotype TAIF), here designated. 摺柱赤箭 Fig. 1

Gastrodia nipponica (Honda) Tuyama affinis, sed columna 3-lobata, lobo medio incurvo differt.

Roots few, slender, mostly extending from apex of rhizome. Rhizome tuberous, fusiform or cylindrical, 2-5 cm long, 4-11 mm in diameter, yellowish brown, covered with numerous scales and root-hair-like unicellular hairs. Scales lanceolate, pale yellowish brown, 1-3 mm long. Inflorescence erect, 3-6 cm long, 2-4 mm in diameter, pale brown under ground and dark brown over ground, 3-5 noded, with tubular, membranous sheaths; rachis often less than 2 cm long. Bracts broad ovate to ovate, brownish, 4-8 mm long, 3-5 mm wide. Pedicel and ovary 10-15 mm long. Flowers 1-3(-4), bell-shaped, slightly nodding, resupinate, ca. 18-23 mm long, 11-13 mm in diameter. Sepals and petals united and forming a 5-lobed perianth tube. Sepals subsimilar, fleshy, 19-24 mm long, connate ca. 3/4 their lengths with petals, lateral ones connate ca. 2/3 with each other, outer surface pale brownish, indistinctly verruculose, margins entire; free portion of dorsal sepal ovate-rectangular, apex retuse, 6-7 mm long, 6-7 mm wide; free portions of lateral sepals ovate, 6-7 mm long, 7-8 mm wide, apex obtuse. Free portions of petals pale brown, ovate, ca. 4 mm long, 2.5 mm wide, base contracted and thickened, margin entire or slightly scabrous. Lip adnate to column foot, greenish white tinged brown at apex, 6-7 mm long, 4-5 mm wide; hypochile with 2 greenish, globose calli; epichile rhombate-ovate, contracted at base, margin slightly scabrous or undulate, thickened and distinctly 6 ridged on the disc, the central two ridges extending toward the ligulate apex. Column 3-lobed, lateral lobes erect, 6-7 mm long, central lobe strongly incurved; column foot well developed; rostellum abscent. Anther hemispheric, ca. 1mm in diameter, pollinia 2, viscidium minute. Capsule cylindrical, 2-3.5 cm long, pedicel elongating to 20-40 cm long in fruit. Seeds fusiform, 1.5-2 mm long.

Distribution and Ecology: *Gastrodia flexistyla* is endemic to Taiwan. Its population is so far found under secondary forests and bamboo forests of Yangmingshan area, Taipei City. Flowering is observed from late March to early April and fruiting from April to early May.

Etymology: The specific epithet of *Gastrodia flexistyla* is derived from its strongly incurved column, which is quite peculiar in the genus *Gastrodia*.

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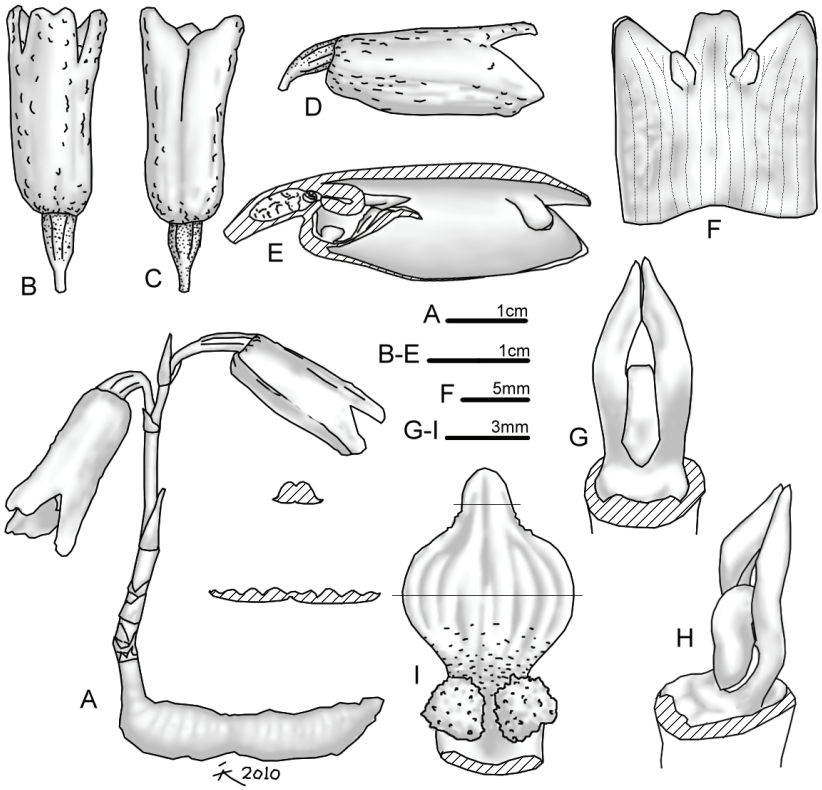


Fig. 1. ***Gastrodia flexistyla*** **T.C. Hsu & C.M. Kuo. A: Habit. B-E: Flower (B, upper view; C, lower view; D, side view; E, longitudinal section). F: Expanded perianth tube. G-H: Column (G, lower view; H, side view). I: Lip.**

Notes: The most remarkable character of *Gastrodia flexistyla* is the trilobed column with a strongly incurved central lobe. This unusual structure leads the anther to directly contact with stigma and thus facilitate self-pollination. In other respects, this new species shows a close relationship to *G. nipponica* (Honda) Tuyama.

Additional specimens examined (paratypes): TAIWAN. Taipei City: Beitou District, Chongchengshan, *T.C. Hsu 777, 1292, 1304* (TAIF).

Gastrodia uraiensis T.C. Hsu & C.M. Kuo *sp. nov.* — Type: TAIWAN. Taipei County, Wulai Township, Wulai village, under *Phyllostachys makinoi* Hayata plantation, ca. 400 m alt., 15 Feb 2007, *T.C. Hsu 715* (holotype TAI, isotype TAIF), here designated.

烏來赤箭 Fig. 2

Inflorescentia 1-4 cm longa; floribus 1-4; sepala cum petilis connata; floris tubus 9-13 mm longus, 7-9 mm latus; labium 6-7 mm longum, 3-4 mm latum, baci callis semiglobosis verrucosis donato; columna tereta, 6-7 mm longa, 2 mm crassa.

Roots few, slender, mostly extending from apex of rhizome. Rhizome tuberous, conical or ellipsoid, 2-6 cm long, 4-8 mm in diameter, yellowish brown, covered with numerous scales and root-hair-like unicellular hairs. Scales lanceolate, pale yellowish brown, 2-4 mm long. Inflorescence erect, dark brown, 1-4 cm long, 1.5-2 mm in diameter, basally 3-4 noded, with tubular, membranous sheaths. Bracts ovate, up to 3.5 mm long, 3 mm wide. Pedicel and ovary 6-10 mm long. Flowers 1-3(-5), bell-shaped, slightly nodding, resupinate, ca. 7-9 mm in diameter. Sepals and petals united and forming a 5-lobed perianth tube. Sepals subsimilar, fleshy, 9-13 mm long, connate ca. 2/3 their length with petals, lateral ones connate ca. 3/5 their length with each other, outer surface dark reddish brown, verruculose, margins entire; free portion of dorsal sepal straight, ovate-triangular, retuse, ca. 5 mm long, 4 mm wide; free portions of lateral sepals spreading, obtuse at apex. Free portions of petals ovate or ellipse, ca. 3 mm long, 1.5 mm wide. Lip adnate to column foot, 6-7 mm long, hypochile with 2 reddish, globose, nectared calli; epichile red-brownish, ovate-triangular, base contracted, with 4 indistinct ridges elevated on upper portion, and 2 ridges extending to the ligulate apex. Column straight, terete, 6-7 mm long, ca. 2 mm wide, white tinged with reddish brown at base; column foot well developed; lateral wings (stelidia) narrow, reddish, the edges parallel to column, base slightly angled, apex acute; rostellum small; stigma

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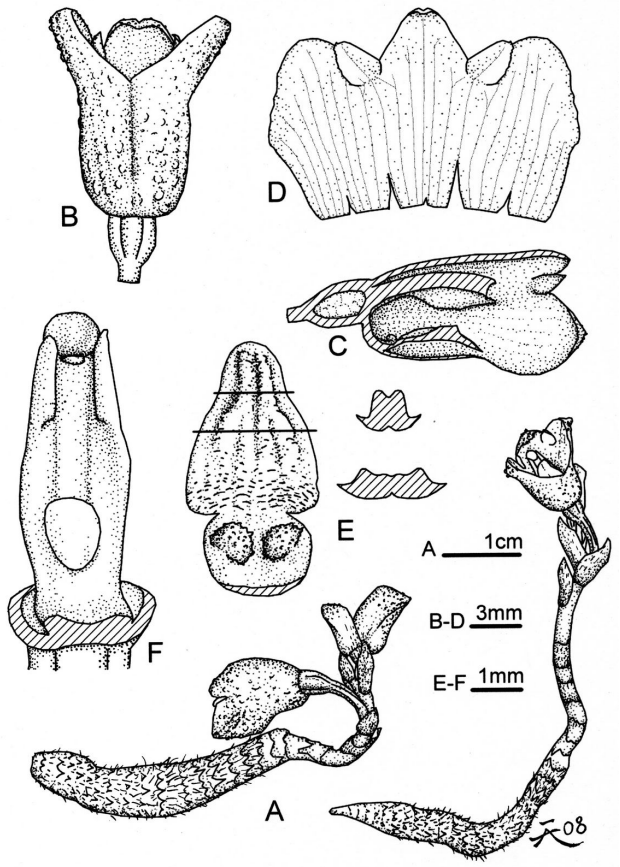


Fig. 2. *Gastrodia uraiensis* T.C. Hsu & C.M. Kuo. A: Habits. B: Flower, lower view. C: Flower, longitudinal section. D: Expanded perianth tube. E: Lip. F: Column, lower view.

located at base. Anther hemispheric, ca. 1 mm in diameter, pollinia 2. Capsule cylindrical, ca. 3 cm long, pedicel elongating to 37 cm long in fruit. Seeds fusiform, 1.2-2.0 mm long.

Distribution and ecology: *Gastrodia uraiensis* is endemic to Taiwan. Populations locate under broad leaved forests, bamboo forests or secondary forests at low altitude mountainous regions. Flowering is mainly observed in February and fruiting from May to April.

Etymology: The specific epithet is derived from "Urai", the former name of Wulai village, the type locality of *G. uraiensis*.

Notes: Morphology of this new species is somewhat similar to *Gastrodia fontinalis* T.P. Lin, which's type specimen was also collected around Wulai region (Lin, 1987). Comparing to the published descriptions and illustrations (Lin, 1987; Leou, 2000), however, *G. uraiensis* could be separated from *G. fontinalis* by having a shorter inflorescence (1-4 cm vs. 7-12 cm), a shorter perianth tube (9-13 mm vs. 15-17 mm), and different lip characters. In *G. uraiensis*, there are four ridges elevated from central portion of the disc and united into two higher ridges toward apex, while in *G. fontinalis*, it has 6-8 ridges throughout the disc, and only the central two extending to the ligulate apex.

Additional specimens examined (paratypes): TAIWAN. Taipei County: Chungho City, Hongludi, ca. 100 m alt., *T.C. Hsu 1250* (TAIF); Wulai Township, Wulai village, ca. 400 m alt., *T.C. Hsu 465, 768* (TAIF); Wulai Township, Pataoerhshan, ca. 600 m alt., *T.C. Hsu 1221* (TAIF); Wulai Township, Chongzhi, 400-500 m alt., *T.C. Hsu 716*, *781* (TAIF); Wulai Township, Dadaoshan, ca. 500 m alt., *T.C. Hsu 466, 467, 759, 1316* (TAIF); Wulai Township, Dabaokeshan, 500-600 m alt., *T.C. Hsu 763* (TAIF); Wulai Township, Neidon Forest Recreation Area, ca. 600 m alt., *T.C. Hsu 1252* (TAIF). Ilan County: Jiaosi Township, Wufongchi, ca. 200 m alt., *T.C. Hsu 427, 717, 1247, 1291* (TAIF).

Gastrodia callosa J.J. Sm., Repert. Spec. Nov. Regni Veg. 29: 248. 1931; Comber, Orch. Java 85. 1990; Chung, Orch. Taiwan 9, pl. 2008. ─Type: Java, *Leeuwen 11567* (holotype BO). 緋赤箭 Fig. 3

Roots few, slender, often extending from apex of rhizome. Rhizome tuberous, fusiform, 2-8 cm long, 3-10 mm in diameter, yellowish brown, covered with numerous scales and unicellular hairs. Scales verticillate, lanceolate, pale yellowish brown, 1-2 mm long. Inflorescence erect, 1-5 cm long, 2-3 mm in diameter, pale brownish, peduncle 3-4 noded, with tubular, membranous sheaths; rachis often less than 5 mm long. Bracts membranous, ovate to ovate-oblong, pale brownish, 2-4 mm long, 1-3 mm wide. Pedicel and ovary 6-8 mm long, ovary 2-3 mm in diameter. Flowers 1-3(-5), bell-shaped, ellipse in dorsal view, not widely opening, ca. 7-9 mm in diameter. Sepals and petals united and forming a 5-lobed perianth tube. Sepals flesh, subsimilar in shape, 9-13 mm long, connate ca. 3/5 their lengths with petals, lateral ones connate more than 3/4 with each other, outer surface flesh-colored, verruculose, apex slightly incurved; free portion ovate, 4-5 mm long, 4-4.5 mm wide; dorsal sepal whitish abaxially; lateral sepals reddish abaxially. Free portions of petals flesh-colored outside and pale orange inside, ovate, ca. 1.5 mm long, 1.5 mm wide, apex acute. Lip free from floral tube, orange-brown, pale greenish blue on upper portion and reddish at apex, 4.5-5.5 mm long, 3.5-4.5 mm wide, hypochile with two brownish, globose, nectared calli, ca. 1 mm in diameter; epichile ovate-triangular, with 2 distinct ridges in middle, the ridges higher toward apex. Column white tinged with dark-red in margin, straight, 4-4.5 mm long, ca. 1.8 mm wide, with a pair of lateral wings (stelidia); lateral wings reddish, the edges parallel to column, with long narrow tips superior to anther; column foot present; rostellum well-developed; stigma located near base. Anther hemispheric, 0.8-1 mm in diameter, pollinia 2. Capsule ellipsoid, 1.5-2 cm long; pedicel elongating to 10-30 cm long in fruit.

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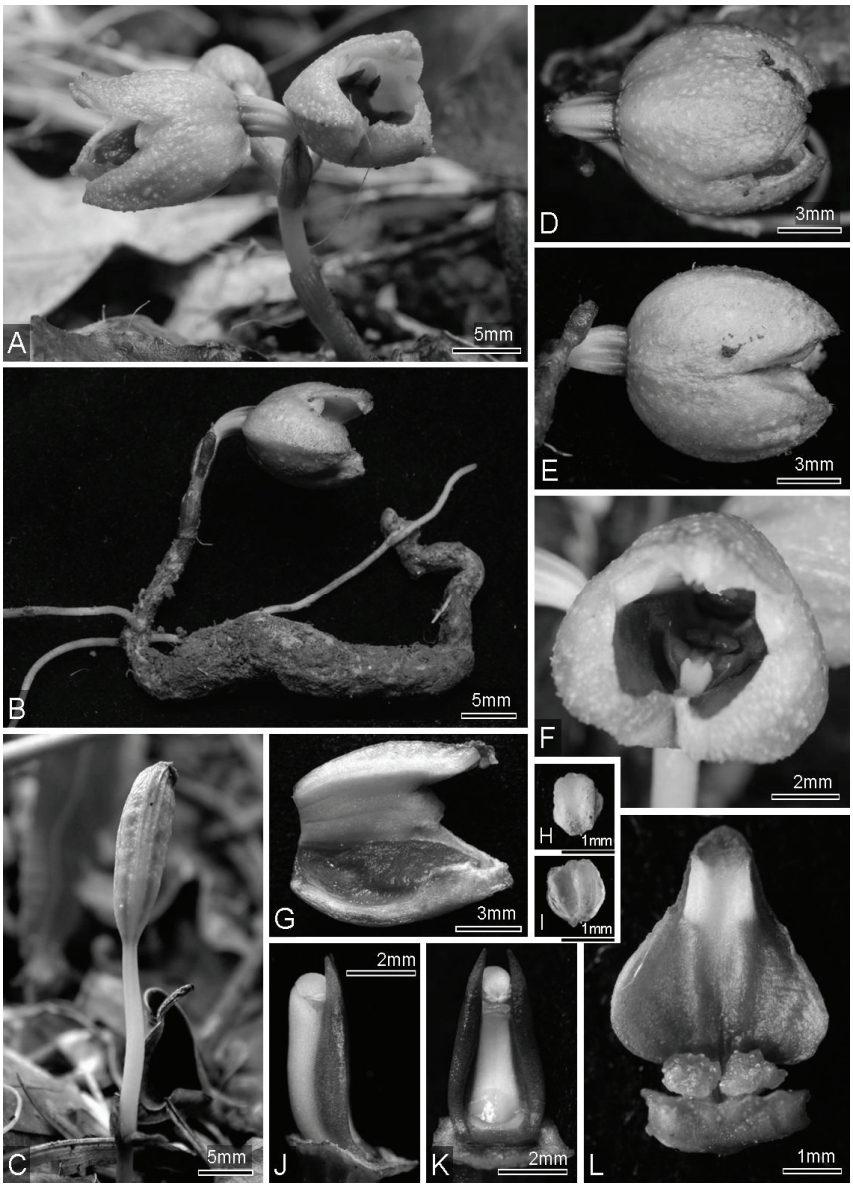


Fig. 3. *Gastrodia callosa* J. J. Sm. A-C: Habit. D-F: Flower (D, upper view; E, lower view; F, front view). G: Perianth tube, longitudinal section. H-I: Anther cap (H, upper view; I, lower view). J-K: Column (J, side view; K, lower view). L: Lip.

Distribution and ecology: *Gastrodia callosa* is so far known from Java and Taiwan (Lanyu). Populations in Taiwan are found on the floors of rain forests. Flowering is observed from late June to July and fruiting from July to August.

Notes: *Gastrodia callosa* is remarkable for its flesh-colored flowers, thickened floral tubes, and large red callus on the inner surfaces of lateral sepals. We have only confirmed its population in Lanyu, an islet located southeastern of Taiwan, but it could also occur in southern Taiwan since some fruiting individuals with habits similar to *G. callosa* were also observed from Pingtung County (C.-R. Yeh, pers. comm.).

Additional specimens examined: TAIWAN. Taitung County: Lanyu Township, Tienchih trail, ca. 150 m alt., 29 Jun 2008, *T.C. Hsu 1433* (TAIF).

Gastrodia nipponica (Honda) Tuyama, Bot. Mag. (Tokyo) 53: 4. 1939; Tuyama, Iconogr. Pl. Asiae Orient. 3(3): 249-252, tab. 90. 1940; Garay & Sweet, Orch. S. Ryukyu Isl. 61, f. 3a-3b. 1974; Hashimoto et al., Jap. Indig. Orch. Col. 80, pl. 1991; Chung, Orch. Taiwan 10, pl. 2008. ─ *Didymoplexis nipponica* Honda, Bot. Mag. (Tokyo) 46: 168. 1931. ─TYPE: Japan, Iwatamura, *Kashiyama 5* (holotype TI n.v.).
日本赤箭 Fig. 4

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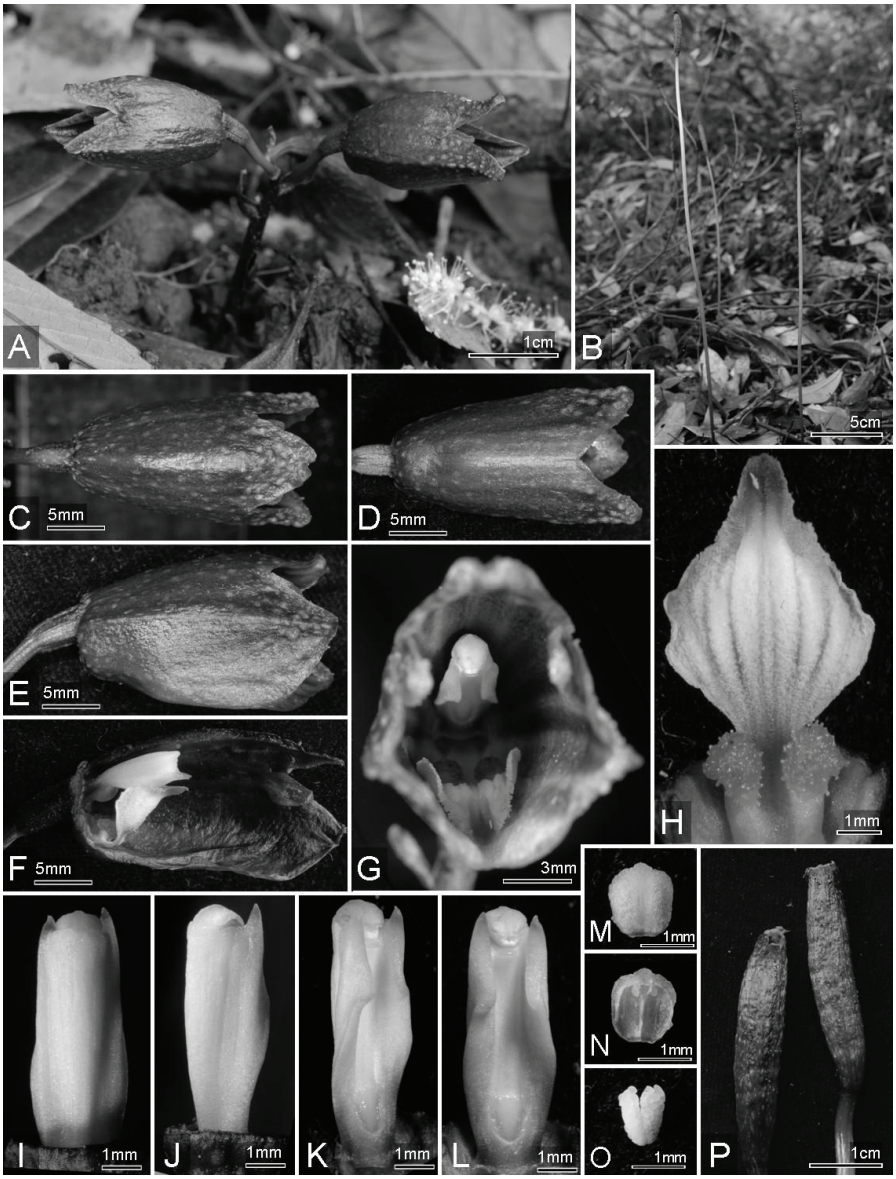


Fig. 4. *Gastrodia nipponica* (Honda) Tuyama. A-B: Habits. C-G: Flower (C, upper view; D, lower view; E, side view; F, side view, partial floral tube removed; G, front view). H: Lip. I-L: Column (I, upper view; J, side view; K, oblique lower view; L, lower view. M-N: Anther cap (M, upper view; N, lower view). O: Pollinia (upper view). P: Fruits.

Roots few, slender or occasionally thickened, mostly extending from apex of rhizome. Rhizome tuberous, fusiform or cylindrical, 2-7 cm long, 3-10 mm in diameter, annulate, covered with numerous scales and unicellular hairs. Inflorescence erect, pale brown, 3-8 cm long, 2-3.5 mm in diameter, 3-4 noded, with tubular, membranous sheaths. Bracts up to 3.5 mm long, 3 mm wide. Pedicel and ovary to 15 mm long. Flowers 1-3(-4), tubular, slightly nodding, resupinate, 18-24 mm long, 11-13 mm in diameter. Sepals and petals united and forming a 5-lobed perianth tube. Sepals subsimilar, fleshy, 18-24 mm long, connate ca. 3/4 their length with petals, lateral ones connate ca. 2/3 with each other, outer surface dark brown, verruculose, margins entire; free portion of dorsal sepal straight, ovate-triangular, retuse, ca. 7 mm long, 6 mm wide; free portions of lateral sepals spreading, obtuse at apex. Free portions of petals ovate or ellipse, to 4 mm long, 3.5 mm wide. Lip adnate to column foot, 7-8 mm long, hypochile with2 greenish, globose calli; epichile pale-yellowish white, ovate-orbicular, base contracted, disc 4-6 ridged, the central two ridges higher near apex and extending toward apex, margin slightly undulate; the apex portion ligulate, reddish, ca. 1.2 mm wide. Column straight,

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semicylindrical, ca. 8 mm long, ca. 2.5 mm wide, white tinged with reddish brown at base; column foot well developed; lateral wings (stelidia) distinct, narrow, the edges parallel to column, base slightly angled, apex acute; rostellum small; stigma located at base. Anther hemispheric, 1.1-1.3 mm in diameter, pollinia 2. Capsule cylindrical, 2.5-3.5 cm long, pedicel elongating to 37 cm long in fruit. Seeds fusiform, 1.8-2.5 mm long.

Distribution and ecology: *Gastrodia nipponica* distributes in Japan and Taiwan. In Taiwan, populations are found in broadleaved forests at 500-1200m in northern mountainous regions. Flowering is observed from middle May to early April; fruiting from April to May.

Notes: *Gastrodia nipponica* is characterized by having an remarkably elongated perianth tube to 18-24 mm long and 11-13 mm in diameter. Its lip and column, however, are still approximate to related species such as *Gastrodia fontinalis* T.P. Lin and *G. abscondita* J.J. Sm. in size and shape.

Additional specimens examined: TAIWAN. Taipei County: Wulai Township, Dadaoshan, 500-600 m alt., *T.C. Hsu 732, 1319* (TAIF); Wulai Township, Pataoerhshan, 600-900 m alt., *T.C. Hsu 783, 784, 794, 1315, 1331* (TAIF). Taoyuan County: Fushing Township, along the trail from Shaowulai to Peichiatienshan, 1100-1200 m alt., *T.C. Hsu 502, 735, 1333* (TAIF).

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臺灣蘭科植物補註(四)：赤箭屬四新增種

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摘要：本文記述臺灣近年新發現之四種赤箭屬(蘭科)植物：新種摺柱赤箭 (*Gastrodia flexistyla*)、烏來赤箭 (*G. uraiensis*) 及新紀錄種緋赤箭 (*G. callosa*)、日本赤箭 (*G. nipponica*)；並提供形態描述，圖片及標本資訊。

關鍵詞：摺柱赤箭、烏來赤箭、緋赤箭、日本赤箭、蘭科、臺灣、分類學。

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