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Sciaphila sugimotoi (Triuridaceae), a new mycoheterotrophic plant from Ishigaki Island, Japan

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Abstract

A new species of *Sciaphila* (Triuridaceae), *S. sugimotoi* Suetsugu & T. Nishioka, is described and illustrated from Ishigaki Island, Okinawa Prefecture, Japan. The new species is similar to *S. arfakiana* in having a stipitate globose to ellipsoid knob without hairs in apices of all male perianth segments. However, it is clearly distinguishable by its shorter pedicel, filament-connective not extended and thick stem. A key to the Japanese *Sciaphila* based on the whole flower characteristics and stylar characteristics, are provided for easy identification of these rare mycoheterotrophic plants.

Keywords: Distribution, mycoheterotrophic plants, new species, *Sciaphila,* taxonomy, Triuridaceae, Ryukyu

Introduction

The Triuridaceae is a family of fully mycoheterotrophic plants that grow in the deep shade of pantropical ever-wet forests throughout the subtropical and temperate regions of Argentina, Paraguay, and Japan (Maas-van de Kamer & Weustenfeld 1998, van de Meerendonk 1984). Recent molecular phylogenetic studies have shown that the Triuridaceae, which comprises approximately 50 species within 11 genera, constitute a single clade within the Pandanales (Davis *et al.* 2004, Mennes *et al.* 2013). Consisting of 30–40 species, the genus *Sciaphila* Blume (1826: 514) is the largest group within the family. Its center of distribution lies in Borneo and harbors eleven different species, five of which are putative endemics (van de Meerendonk 1984, Tsukaya & Okada 2013, Tsukaya & Suetsugu 2014).

Species within the genus *Sciaphila* are identified by several morphological features including the bisexual or unisexual nature of their flowers, the number and shape of their stamens and perianth segments, the shape of their apical perianth segments, and the shape and length of their styles (van de Meerendonk 1984, Tsukaya & Okada 2013, Tsukaya & Suetsugu 2014). Similar to many other groups of mycoheterotrophic plants, the genus *Sciaphila* is very small in size and generally occurs in small populations, which typically results in them only being observed when flowering. Consequently, few specimens of this genus have been described in detail. Key characteristics of the male flowers, which are crucial for their precise identification, have not been documented in some species particularly if individual specimens were too young at the time of collection (Tsukaya & Okada 2013, Tsukaya & Suetsugu 2014). Recent studies have reexamined the *Sciaphila* populations of various Asian countries, which have resulted in the discovery of several new species (Averyanov 2007, Xu *et al.* 2011, Suetsugu *et al.* 2016a) and new distribution records (Chantanaorrapint & Thaithong 2004, Ohashi *et al.* 2008), however, more extensive taxonomic studies are required in order to characterize the diversity of this group, for which the precise identification of individual species remains problematic.

A recent botanical survey conducted in September to October 2016 on Ishigaki Island, Ryukyu Islands located in Okinawa Prefecture in the southern part of Japan, resulted in the discovery of an unknown species of the genus *Sciaphila*. Detailed examination of the specimens' morphology and comparison to previously recorded species provided the convincing evidence that it is indeed a new species. The new species *Sciaphila sugimotoi* is described hereafter, along with two different keys for the accurate identification of all the *Sciaphila* species found in Japan.

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Taxonomic Treatment

Sciaphila sugimotoi Suetsugu & T. Nishioka, *sp. nov.* (Figs. 1–2)

Type:—JAPAN. Ryukyu. Okinawa Pref., Ishigaki City, Hirae, alt ca. 180m, 18 October 2016, *T. Sugimoto s.n.* (holotype KYO!; isotype OSA!).

Diagnosis:—*Sciaphila sugimotoi* is similar to *Sciaphila arfakiana* Beccari (1890: 337), but it differs by its shorter pedicel, its filament-connective not extended and its thick stem.

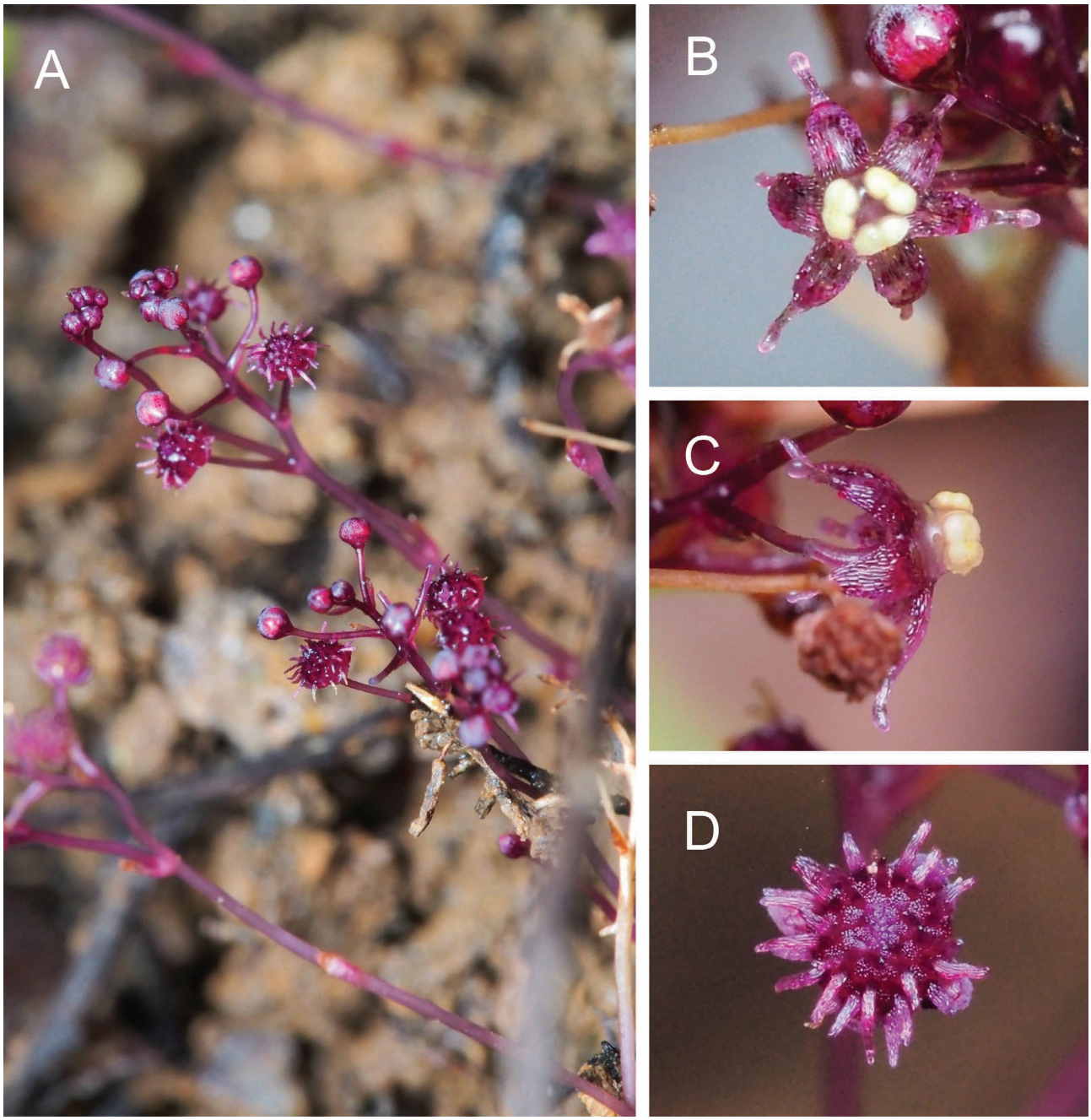

FIGURE 1. Habit (A) and microscopic images (B, C, D) of *Sciaphila sugimotoi*. A. Flowering plant. B–C. Male flower. D. Female flower. Photographed by Takaomi Sugimoto in the type locality.

Mycoheterotrophic, perennial herb. Plant erect, pinkish purple to reddish purple, non-branched or branched at the base, white underground. Roots filiform, hairy. Scale leaves acute, ca. 1.5 mm long. Inflorescences glabrous, ca. 5–7 cm tall, ca. 0.6–0.8 mm thick. Rachis, 1–4 cm long, ca. 10–35 flowers spirally arranged all around with male flowers generally on upper part. Pedicels ca. 1.5–4.0 mm long, longer than flower, patent at 30–60°, straight or slightly apically recurved; bracts minute, linear acute, ca.1–1.5 mm long, appressed to the pedicel. Male flowers ca. 1.5–2.0 mm across, perianth segments 6, connate at base, segments narrowly ovate, glabrous, apex acute with a globose knob at apex,

three segments slightly broader than alternating three acuminate segments. Stamens three, filament-connective not extended; filaments sessile. Anthers four-lobed. Female flowers ca. 1.0–1.5 mm across; perianth segments six, connate at base, more or less equal, ovate to triangular, apex acute without appendage. Carpels numerous, ca. 0.5 mm long, globose at apex; style subulate, acuminate, inserted laterally; fused along the side of carpel, ca. 0.5–0.8 mm long.

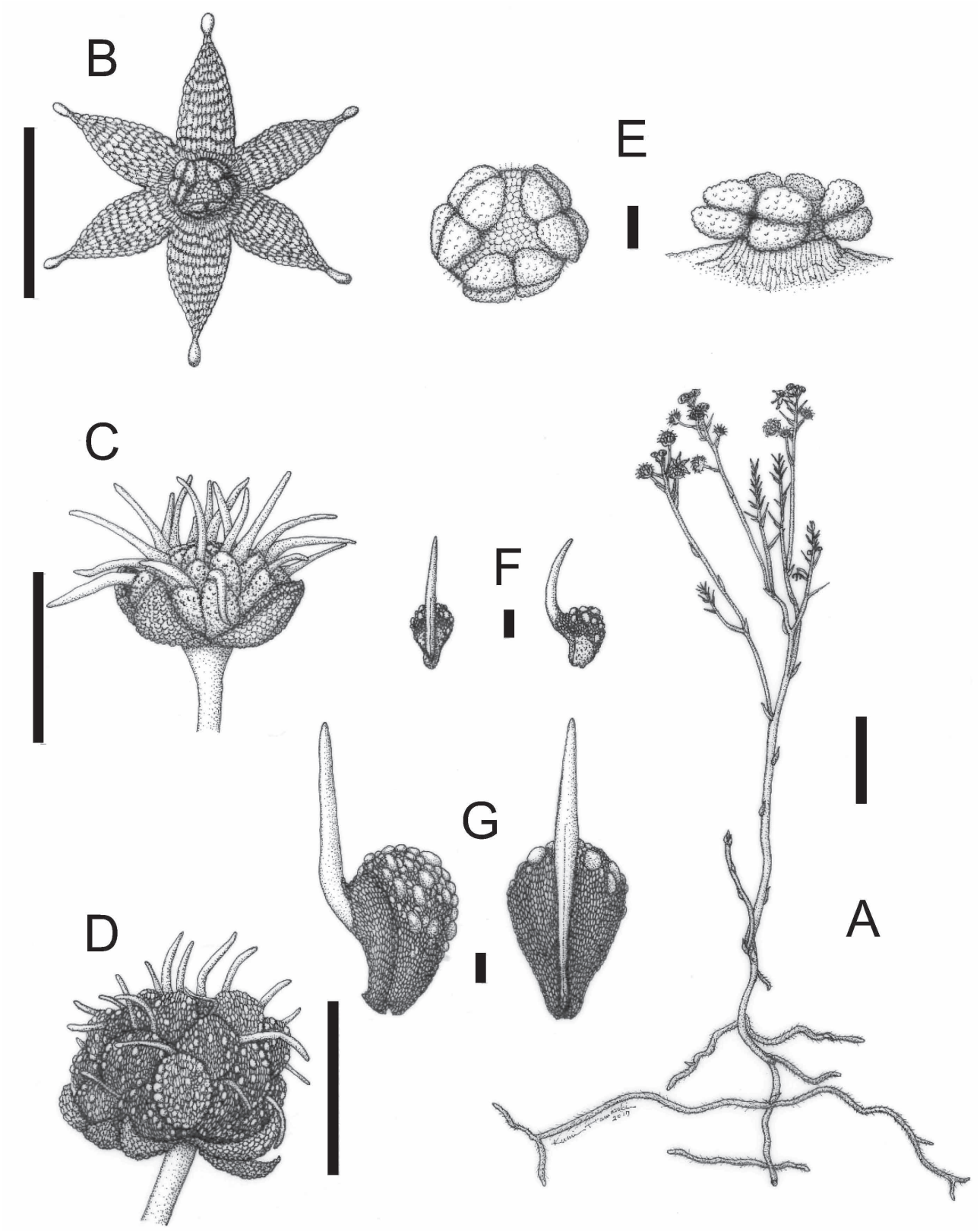

FIGURE 2. *Sciaphila sugimotoi* from type locality. A. Flower plants, B. Male flower, C. Female flower. D. Female flower at fruiting stage with persistent perianth segments. E. Anthers with floral disc. F. Immature carpel with stigma. G. Immature fruit. Bar = 1 cm (A), 1 mm (B–D) and 0.1 mm (E–G). Drawn by Kumi Hamasaki.

Distribution, phenology and conservation status:—To date, the distribution of *Sciaphila sugimotoi* appears to be restricted to two localities, separated by ca. 3 km, on central Ishigaki Island in the Ryukyu Islands (Okinawa Prefecture, Japan). The two known *S. sugimotoi* population occurs at an elevation of approximately 80–180 m within a humid evergreen broadleaf forest dominated by *Castanopsis sieboldii* (Makino 1910: 232) Hatusima (1971: 223) and *Distylium racemosum* Siebold & Zuccarini (1841: 179). *Sciaphila sugimotoi* flowers in mid-September to mid-October and each location consists of only dozens of flowering individuals. The two population of *S. sugimotoi* contains less than 50 flowering plants, and at present, we are not aware of any other locality where this species persists. Therefore, *S. sugimotoi* should be assigned a risk of extinction of "Critically Endangered" [CR B1ab(iii)+B2ab(iii)+D1] following the IUCN Red List (IUCN 2012). Since this mycoheterotrophic species is completely dependent on its unique relationship with its host fungi for survival (e.g. Suetsugu *et al.* 2014a), it would be necessary to conserve the entire ecosystem in order to protect these endangered plants.

Etymology:—The new species is named after Mr. Takaomi Sugimoto, who collected ample specimens of this new species for the comparative study.

Additional specimens examined:—JAPAN. Okinawa Pref., Ishigaki City, Miyaera, alt. ca. 80 m, 21 October 2016, *T. Sugimoto s.n.* (OSA); Hirae, alt ca. 160m, 30 September 2016, *T. Nishioka s.n.* (OSA).

Taxonomic note:—*Sciaphila sugimotoi* is similar to *S. arfakiana* Beccari (1890: 337) in having a stipitate globose to ellipsoid knob without hairs in apices of all male perianth segments. However, it is clearly distinguishable by its shorter pedicel (1.5–4.0 mm vs typically 7–9 mm), status of filament–connective (not extended vs. extended into a long appendage, ca. 1.3 mm long), thick stem, (0.6–0.8 mm vs 0.3–0.5 mm), shorter style (0.5–0.8 mm vs 1.0 mm). *Sciaphila sugimotoi* is also similar to the species that Hsieh *et al.* (2003) recorded as *S. ramosa* Fukuyama & Suzuki (1936: 410), due to the similarity of a stipitate globose to ellipsoid knob without hairs in apices of all male perianth segments. It should be noted that *S. ramosa sensu* Hsieh *et al.* (2003) should have different taxonomic identity from original *S. ramosa*, because of the number (6 for *S. ramosa sensu* Hsieh *et al.* (2003) vs 4–6 for original *S. ramosa*) and character (equal in shape and size without a knob at apex for *S. ramosa sensu* Hsieh *et al.* (2003) vs. three larger alternating with three smaller segments each with a stipulate globose knob at apex for original *S. ramosa*) of male perianth segments. Considering these facts, it is even possible that *S. ramosa sensu* Hsieh *et al.* (2003) is identical to *S. sugimotoi*. Further exploration is needed to elucidate the taxonomic identity of *S. ramosa sensu* Hsieh *et al.* (2003).

A. Key to the Species of *Sciaphila* in Japan based on total flower characteristics

1. Plants with bisexual and unisexual flowers ..... *S. tenella*
1. Plants with unisexual flowers 2
2. Male flowers located between female flowers ..... *S. multiflora*
2. Male flowers located on upper rachis above female flowers 3
3. Perianth of the male flower of equal segments 4
3. Perianth of the male flower of 6 segments, 3 larger alternating with 3 smaller 5
4. Male flowers ca. 6–7 mm across ..... *S. secundiflora*
4. Male flowers ca. 1.5 mm across ..... *S. ramosa*
5. A globose knob at apex with all 6 male perianth segments ..... *S. sugimotoi*
5. A globose knob at apex with 3 smaller male perianth segments 6
6. Style subulate with glabrous apex ..... *S. nana*
6. Style club-shaped with many papillae ..... *S. yakushimensis*

B. Key to the Species of *Sciaphila* in Japan based primarily on stylar characteristics

1. Female flowers with club-shaped style with many papillae at apex 2
1. Female flowers with subulate style with glabrous apex 5
2. Flowers male and bisexual; perianth bearded at apex ..... *S. tenella*
2. Flowers unisexual 3
3. Male flowers located between female flowers; perianth of male flowers with equal segments and bearded at apex ..... *S. multiflora*
3. Male flowers located on upper rachis above female lowers 4
4. Male flowers 6–7 mm across, female ones ca. 5 mm across, perianth segments of male flowers narrowly to linear triangular, equal, without appendages at apex; plants pink or brownish to reddish purple ..... *S. secundiflora*
4. Male and female flowers same sized, ca. 1.5 mm across, perianth segments of male flowers narrowly ovate, 3 slightly broader than alternating 3, narrower 3 with a globose knob at apex; plants blackish purple ..... *S. yakushimensis*
5. Inflorescences branched; perianth without appendages at apex; filaments not exceeding anthers; style ca. 0.3 mm long ..... *S. ramosa*
5. Inflorescence simple or branched; perianth dimorphic, 3 broader ones with alternating 3 narrower ones 6
6. Filament-connective exceeding anthers; a globose knob at apex with 3 smaller male perianth segments ..... *S. nana*
6. Filament-connective not exceeded; a globose knob at apex with all 6 male perianth segments a globose knob ..... *S. sugimotoi*

Discussion

Over the past decade there have been several investigations into the diversity of *Sciaphila* species in various Asian countries including Taiwan, Thailand, Vietnam, and the island of Hainan in China (Hsieh *et al.* 2003, Chantanaorrapint & Thaithong 2004, Averyanov 2007, Xu *et al.* 2011, Ohashi *et al.* 2008, Suetsugu *et al.* 2016). These studies have revealed several new species as well as new distributional records for known species and clearly indicate that there could be many more undescribed species hidden in other Asian countries.

Japan is known for its high diversity of *Sciaphila* species (Ohashi *et al.* 2008, Suetsugu *et al.* 2016a), as well as its richness of mycoheterotrophic plants in general (reviewed by Suetsugu 2015a). Indeed, many recent botanical surveys of the mycoheterotrophic plants in Japan have resulted in the discovery of many new taxa and new distributional records (Ohashi *et al.* 2008, Yagame *et al.* 2008, Yahara & Tsukaya 2008, Suetsugu 2012a, b, 2013, 2014, 2015a, b, 2016a, b, c, d, 2017a, b, Suetsugu & Ishida 2011, Suetsugu & Yagame 2014, Suetsugu & Fukunaga 2016, Suetsugu *et al.* 2012, 2013, 2014b, 2016a, b). Therefore, more extensive and detailed botanical surveys are required to establish the precise distribution and diversity of mycoheterotrophic plants in this region. Such surveys will provide the critical data needed for the conservation of these intriguing plants.

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