

Sciaphila lambirensis (Triuridaceae), a New Mycoheterotrophic Plant from Sarawak, Borneo, Malaysia

KENJI SUETSUGU

Department of Biology, Graduate School of Science, Kobe University, 1-1 Rokkodai, Nada-ku, Kobe, Hyogo 657-8501, Japan. kenji.suetsugu@gmail.com

Borneo is known to harbor the greatest species diversity of the mycoheterotrophic genus *Sciaphila* (Triuridaceae) and is home to 11 species, including five endemics. Here, another undescribed *Sciaphila* species, *S. lambirensis*, which was discovered during a botanical survey in Lambir Hills National Park (Sarawak, Borneo, Malaysia) is reported along with a detailed morphological account. *Sciaphila lambirensis* is similar to *S. brevistyla* in having six equal perianth segments with a swollen apex bearing long hairs in both staminate and carpellate flowers. However, it is easily distinguishable by the second arrangement of the flowers and the pedicel slightly recurved at its apex. A key to the species of *Sciaphila* in Borneo is provided.

Key words: Lambir Hills National Park, mycoheterotrophy, new species, taxonomy

The Triuridaceae Gardner are a group of fully mycoheterotrophic plants of deep shade in the understory of ever-wet forests in the tropics and subtropics worldwide, reaching their northernmost limits in Japan (van de Meerendonk 1984). The genus *Sciaphila* Blume, which contains ca. 40 species, is the largest group within the family (van de Meerendonk 1984).

In taxonomic studies of *Sciaphila*, species have been primarily discriminated on the basis of the following floral traits: bisexual or unisexual flowers, number and shape of stamens and perianth segments, shape of the apical perianth segments, and shape and length of the styles (van de Meerendonk 1984, Hsieh *et al.* 2003, Chantanaorrapint & Thaithong 2004, Averyanov 2007, Ohashi *et al.* 2008, Suetsugu *et al.* 2016, Suetsugu & Nishioka 2017). As with most other mycoheterotrophs, the plants are small, growing to a maximum height of 40 cm, are only recognizable during the reproductive season and usually occur in small populations. Consequently, the species have rarely been collected, and their morphological traits have rarely been described in detail.

Furthermore, key characters of the staminate flowers, which are crucial for precise identification, have not been documented for some species, especially if individual specimens were too young at the time of collection (Tsukaya & Okada 2013, Tsukaya & Suetsugu 2014). Given such difficulty of precise species identification, the taxonomy of *Sciaphila* remains to be revised.

Borneo is one of the most biodiverse regions of the world, particularly with respect to mycoheterotrophic plants, and harbors ca. 70 mycoheterotrophic species, which is greater than the number of mycoheterotrophs documented in the whole of tropical Africa (Merckx *et al.* 2013). Furthermore, the high rate of species endemism in Borneo is particularly pronounced in the Thismiaceae and Orchidaceae, with *Thismia* (11 species) and at least 17 mycoheterotrophic orchids being endemic to Borneo (reviewed by Merckx *et al.* 2013, Suetsugu *et al.* 2017). Borneo is also known for its great diversity in *Sciaphila*. Papua New Guinea was previously recognized as the center of diversity for *Sciaphila* because it harbored eight species (van de Meerendonk 1984).

However, studies by Tsukaya and Okada (2013) and Tsukaya and Suetsugu (2014) added four species endemic to Borneo. Consequently, these studies revealed that Borneo harbors at least 11 species, with five endemics. Because these four additional species were discovered during two limited surveys in two National Parks (Tsukaya & Okada 2013, Tsukaya & Suetsugu 2014), further botanical surveys in Borneo will enable us to discover additional species and provide critical data for conservation.

Lambir Hills National Park is located in the Malaysian state of Sarawak. After launching the Long-term Ecological Research of Tropical Rain Forests in Sarawak (LTER), which is a collaboration between the Forest Department of Sarawak and universities in both Japan and the United States, extensive studies have examined the flora, fauna, physiology, and ecosystems of the area (reviewed by Yamakura 1995, Ichie *et al.* 2009). During a botanical survey of the area in March 2013, I collected several species of *Sciaphila*, including two new species that were reported previously (Tsukaya & Suetsugu 2014). A thorough review of the literature, herbarium specimens in SAR, KYO and TI and online digitized plant collections, such as JSTOR Global Plants (<http://plants.jstor.org/>), allowed me to determine that the collections contained one undescribed species. Here, I describe *Sciaphila lambirensis* with a detailed morphological account. I also include a key to the species of *Sciaphila* in Borneo.

Taxonomic treatment

***Sciaphila lambirensis* Suetsugu, sp. nov.**—Figs. 1 & 2.

Sciaphila lambirensis is similar to *Sciaphila brevistyla* Tsukaya & H. Okada in having six equal perianth segments with a swollen apex bearing long hairs in both staminate and carpellate flowers, but differs in having a secund arrangement of the flowers and a long pedicel slightly recurved apically.

Typus. MALAYSIA. Sarawak: Miri Division, Miri District, Lambir Hills National Park, near the No. 3 Wa-

terfall in dipterocarp forest, 22 March 2013, *K. Suetsugu KSI99* (holo- dried plant on a herbarium sheet and liquid-preserved material in a bottle, labelled as the same specimen, SAR!; iso- dried plant on a herbarium sheet and liquid-preserved material in a bottle, KYO!; liquid-preserved material in a bottle, TNS!).

Herbs, monoecious, mycoheterotrophic, perennial. Stem erect, 5–10 cm tall, reddish purple, glabrous, unbranched at base; underground part white. Roots filiform, glabrous. Scale leaves ca. 15, linear, ca. 1 mm long, apex acute. Inflorescence racemose, rachis 3–6.5 cm, 0.3–0.7 mm in diam., reddish purple, 20–55-flowered; flowers secund. Pedicels 7–9 mm long, 0.1 mm in diam., patent at 70–100° from rachis, slightly recurved apically. Bracts linear, ca. 0.8 mm long, apex acute, appressed to pedicel. Staminate flowers ca. 0.5 mm across in nature, 1.3–1.4 mm across when flattened, perianth segments 6, more or less equal, connate at base, segments narrowly ovate, ca. 0.45 mm long, 0.22 mm wide, apex acute, swollen, long bearded. Stamens 3, sessile, filament connective not extended. Anthers ellipsoid, 0.15 mm wide, 2-lobed, opening transversally. Carpellate flowers 0.6–0.7 mm across in nature, ca. 1.5 mm across when flattened, perianth segments 6, more or less equal, connate at base, segments narrowly ovate to triangular, ca. 0.5 mm long, 0.25 mm wide, apex acute, swollen, long bearded. Carpels numerous, ellipsoid, ca. 0.3 mm long, apex rounded; style and stigma clavate, 0.3–0.4 mm long, inserted laterally, fused along side of carpel.

Distribution, phenology and preliminary conservation status. *Sciaphila lambirensis* is currently known only from a single population in a lowland dipterocarp forest in Lambir Hills National Park. *Sciaphila lambirensis* flowers in March. The population contained only ca. 10 mature plants, and at present we are not aware of any other localities where this species occurs. Therefore, *S. lambirensis* is classified as Critically Endangered (CR) under Criterion D (IUCN 2012).

Taxonomic note. *Sciaphila lambirensis* has unisexual flowers with six equal perianth seg-

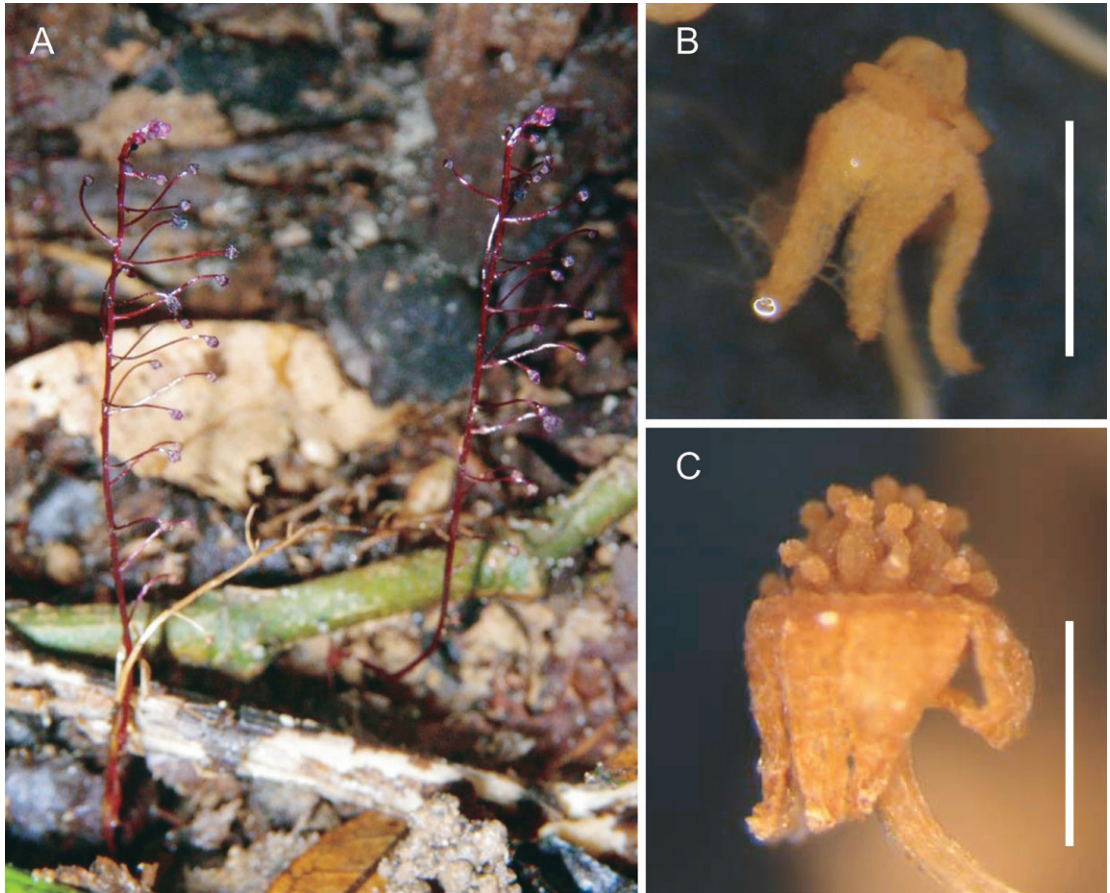


FIG. 1. *Sciaphila lambirensis* (from the holotype). A. Flowering plants of *Sciaphila lambirensis* in its type locality. B. Staminate flower. C. Carpellate flower. Scale bars. B–C = 0.5 mm.

ments with a swollen apex bearing long hairs in both staminate and carpellate flowers, three stamens and 2-lobed anthers. So far, the above combination of morphological characters is known only in *Sciaphila brevistyla* described from West Kalimantan, Borneo (Tsukaya & Okada 2013). However, *S. lambirensis* is clearly distinguishable from *S. brevistyla* by the second arrangement of the flowers (vs. spirally arranged), pedicels 7–9 mm long, 0.1 mm in diam. (vs 2 mm long, 0.2 mm in diam.), angle between the pedicel and rachis axis 70–100° and pedicel slightly recurved apically (vs. angle 90–155° and pedicel nodding proximally or distally).

During morphological comparisons of *S. lambirensis* with closely related species, I also noticed that a plant of *Sciaphila* recently recorded as “*S. thaidanica*” by Tsukaya & Okada (2013) from Borneo may differ from *S. thaidanica* K. Larsen originally described from Thailand (Larsen 1961) because *S. thaidanica sensu* Tsukaya & Okada (2013) differs morphologically somewhat from *S. thaidanica* from Thailand such as the arrangement of the flowers (spirally-arranged vs. secund). Further studies are needed to elucidate the taxonomic identity of *S. thaidanica sensu* Tsukaya & Okada (2013).

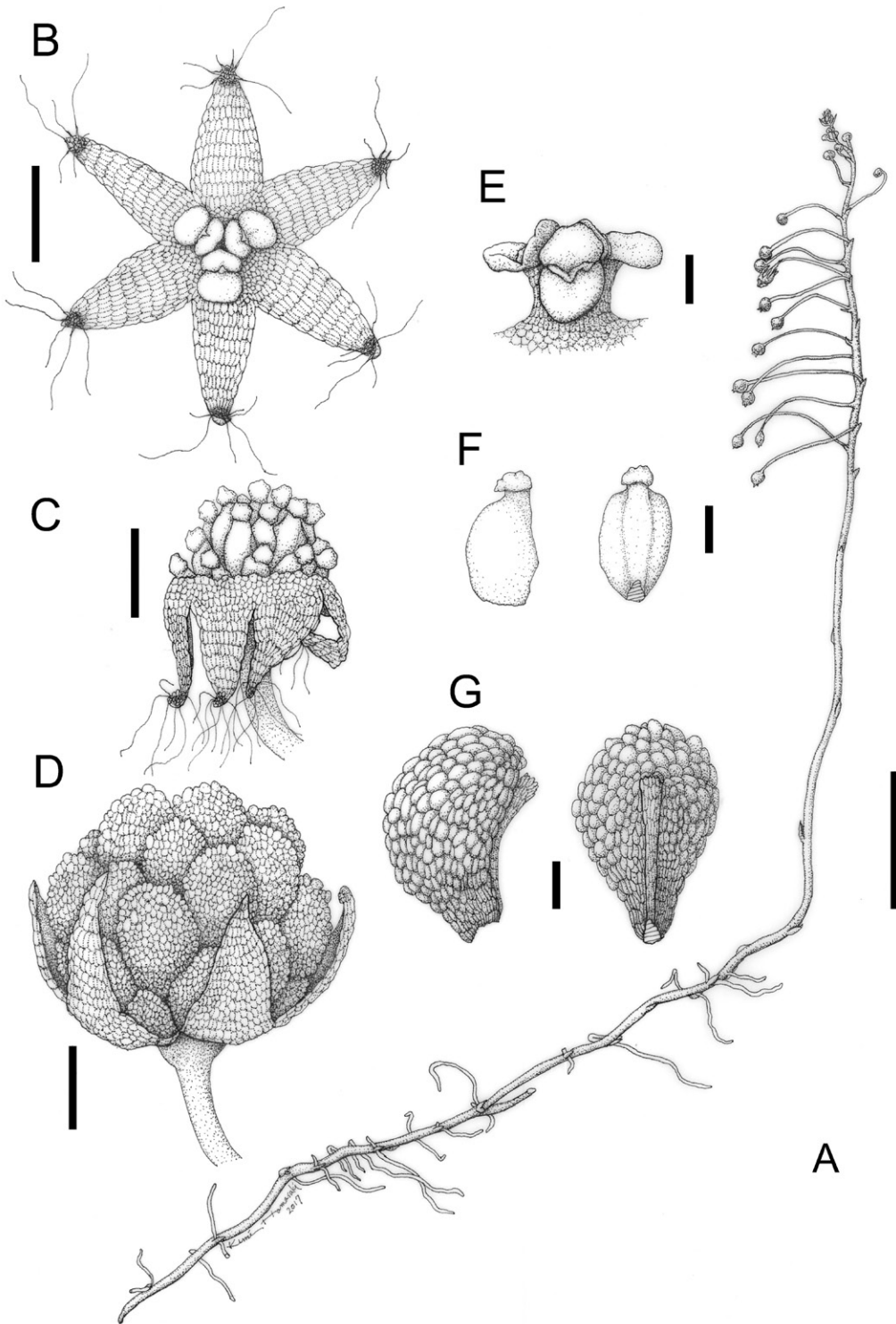


FIG. 2. *Sciaphila lambirensis* (from the holotype). A. Flowering plant. B. Flattened staminate flower. C. Carpellate flower. D. Carpellate flower at fruiting stage with persistent perianth segments. E. Anthers with floral disc. F. Immature carpel with stigma. G. Immature fruits. Scale bars A = 1 cm. B–D = 0.3 mm. E–G = 0.1 mm. Drawn by Kumi Hamasaki.

Key to the Species of *Sciaphila* in Borneo.

1a. Plants with bisexual and unisexual flowers	2
1b. Plants with unisexual flowers only	4
2a. Perianth segments 4 (or 5)	<i>S. betung-kerihunensis</i> Tsukaya & H. Okada
2b. Perianth segments 6	3
3a. Staminate and bisexual flowers with 3 stamens	<i>S. maculata</i> Miers.
3b. Staminate flowers with 6 stamens; bisexual flowers with 3–6, but generally 6 stamens	<i>S. tenella</i> Blume
4a. Perianth segments equal	5
4b. Perianth segments unequal (3 larger alternating with 3 smaller)	9
5a. Flowers secund	6
5b. Flowers spirally arranged	7
6a. Staminate flowers 1.3–1.4 mm in diam. when flattened; apex of perianth segments bearded ...	<i>S. lambirensis</i> Suetsugu, sp. nov.
6b. Staminate flowers 7–8 mm in diam. when flattened; apex of perianth segments glabrous ...	<i>S. secundiflora</i> Thwaites ex Benth.
7a. Flowers white; staminate flowers 7–8 mm in diam	<i>S. alba</i> Tsukaya & Suetsugu
7b. Flowers purple; staminate flowers less than 5 mm in diam	8
8a. Staminate flowers ca. 1.2 mm in diam. when flattened; apex of perianth segments bearded ..	<i>S. brevistyla</i> Tsukaya & H. Okada
8b. Staminate flowers 3–4(–5) mm in diam.; apex of perianth segments glabrous
.....	<i>S. thaidanica</i> K. Larsen <i>sensu</i> Tsukaya & Okada (2013)
9a. Stamens 6	<i>S. densiflora</i> Schltr.
9b. Stamens 3	10
10a. Anthers 3-lobed	<i>S. micranthera</i> Giesen
10b. Anthers 2-lobed	11
11a. Apex of perianth segments acute; three longer perianth segments of carpellate flowers 1–1.2 mm long alternating with shorter ones 0.4–0.6 mm long	<i>S. winkleri</i> Schltr.
11b. Apex of perianth segments obtuse; three longer perianth segments of carpellate flowers 1.4 mm long alternating with shorter ones 1.1 mm long	<i>S. inouei</i> Tsukaya & Suetsugu

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