

***Sciaphila ledermannii* (Triuridaceae), a Biogeographically Significant Holosaprophyte Newly Reported from Príncipe in the Gulf of Guinea**

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The holosaprophyte *Sciaphila ledermannii* (Triuridaceae) is newly reported from the oceanic island Príncipe off the western coast of tropical Africa. This is the first report of Triuridaceae among the islands in the Gulf of Guinea. *Sciaphila ledermannii* is the first holosaprophyte known from the Republic of São Tomé and Príncipe and the second known among the islands in the Gulf of Guinea. Its presence on Príncipe provides additional evidence for islands in the Gulf of Guinea likely forming part of an African pre-Pleistocene refugium.

At least 36 species of holosaprophytes, in four unrelated families, have been reported from continental Africa (Cheek and Williams 1999; Cheek 2003a, 2003b). Triuridaceae are an entirely holosaprophytic family, represented in Africa by six species in four genera. One of them, *Sciaphila ledermannii* Engl., is herewith newly reported from the oceanic island of Príncipe in the Gulf of Guinea. This represents the first report of a holosaprophyte in the nation of São Tomé and Príncipe and the first report of any Triuridaceae among the islands in the Gulf of Guinea.

The four major islands in the Gulf of Guinea (Annobón, Bioko, Príncipe, and São Tomé) are all volcanic in origin and lie along the Cameroon line, a linear zone of weakness in the Earth's crust along which Mt. Cameroon and the Cameroon Highlands also occur on the African continent. The islands vary in age, size, distance from the continent, elevation, past connections to the mainland (i.e., continental vs. oceanic islands), and species compositions (Daniel and Figueiredo 2009). Of the three major oceanic islands in the Gulf of Guinea, Príncipe is the oldest (ca. 31 mybp) and closest to continental Africa (210 km). It is 128 sq. km in size and attains an elevation of 948 m.

Holosaprophytes are technically achlorophyllous mycotrophs (or mycoheterotrophs) because they are dependent on symbiotic fungi to provide metabolites from dead/decaying matter. Cheek and Williams (1999) showed that in Africa a disproportionate number of holosaprophytic species occur in the Gulf of Guinea region. For example, 16 species have been recorded from Cameroon (with 12 occurring on Mt. Cameroon) and 11 are known from Nigeria. The only holosaprophyte previously known from the islands in the Gulf of Guinea is the widespread (three continents and numerous islands) terrestrial orchid, *Epipogium roseum* (D. Don) Lindl., on Annobón (Exell 1973; Cheek and Williams 1999). Cheek and Ndam (1996) and Cheek and Williams (1999) proposed that a regional concentration of saprophytes is likely indicative of a refugial area, and that such concentrations are present in forests of the Gulf of Guinea region (at least on mainland Africa). Indeed, the younger (ca. 13 mybp) oceanic island São Tomé has been postulated to have been an important climatic refuge for *Begonia* since the Miocene (Plana et al. 2004). It remains unknown whether recently discovered occurrences of *Sciaphila ledermannii* on Príncipe represent remnants of a formerly wider distribution of the species or the result of one or more relatively recent dispersal

events. In either case, the species had to disperse from or to Príncipe. Because Triuridaceae lack obvious mechanisms for either wind or animal dispersal of their seeds (Cheek and Williams 1999), rafting would appear to be a likely method of dispersal from the African continent to the oceanic islands in the Gulf of Guinea. The orientation of major rivers, oceanic currents, and island locations make rafting from either Nigeria/Cameroon or Angola/Congo/Gabon possible. Such a scenario has been proposed for both plants (e.g., *Elytraria*; Wenk and Daniel 2009) and animals (amphibians; Measey et al. 2007).

Cheek and Williams (1999) noted that most species of African holosaprophytes: 1) consist of rare perennial herbs, 2) have restricted distributions, 3) are confined to lowland and montane evergreen forests, and 4) often occur in shaded leaf litter along streams where the annual rainfall is in excess of 2000 mm. Two populations of *Sciaphila ledermannii* were encountered in 2010 along two separate river-systems on Príncipe. A population along the Rio Papagaio consisted of fewer than 20 individuals within 1 m², and a population along the Ribeira São Tomé consisted of about 50 individuals within 40 m². Although *S. ledermannii* may be locally abundant on Príncipe, its previously known distribution was limited to Cameroon and Nigeria; basis for inclusion of the species from Gabon by Symoens (1984) remains unknown. Both populations on Príncipe occur in moist leaf litter along streams in the shade of the surrounding moist evergreen forest at elevations of 10 and 150 m. Because this is the first report of Triuridaceae from both the nation of São Tomé and Príncipe and from any island in the Gulf of Guinea, a brief taxonomic overview of the family and *Sciaphila* on Príncipe is presented below.

Triuridaceae Gardner, Proc. Linn. Soc. London 1: 177. 1843

TYPE. *Triuris* Miers

Achlorophyllous mycotrophs (holosaprophytes), mostly perennial herbs. Stems erect from subterranean rhizomes, white, yellow, red, or purplish. Leaves scale-like, alternate. Inflorescence a terminal bracteate raceme. Flowers unisexual or bisexual, mostly actinomorphic, pedicellate. Perianth of 3–6 (–10) valvate tepals in single whorl. Bisexual flowers with 2–6 free stamens and numerous free carpels. Staminate flowers with 2–6 (–8) stamens, anthers 2–4-locular, pollen mostly inaperturate, exine reduced to gemmae. Carpellate flowers with 10 to many free carpels, each containing 1 (–2) basal, anatropous (or hemi-anatropous to campylotropous) ovule(s). Fruit an achene or follicle. Seed with copious endosperm.

A monocot family of 11 genera with 50 or more species occurring in tropical (and subtropical) regions worldwide. Although sometimes treated as related to the alismatid families (e.g., Cronquist 1981), recent molecular and morphological analyses show a closer affinity to an expanded Pandanales (Rudall and Bateman 2006). The anomalous flowers (or floral units) of Triuridaceae have been hypothesized to be either highly reduced inflorescences (pseudanthia) or highly modified flowers (see Rudall and Bateman 2006).

***Sciaphila* Blume, Bijdr. 10: 514. 1825**

TYPE. *Sciaphila tenella* Blume

Plants monoecious or andromonoecious. Tepals (4–) 6 (–10), basally connate, internally papillate, apically sometimes bearded. Flowers unisexual or bisexual. Staminate flowers usually concentrated toward distal portion of raceme, stamens 2–6, epitepalous, filaments absent or less than 1 mm long, anthers (3–) 4-locular. Carpellate or bisexual flowers usually concentrated in proximal portion of raceme, carpels 10–80, style lateral. Fruit a follicle.

A genus in the tribe Sciaphileae Miers with 30–35 species occurring in tropical and subtropi-

cal regions worldwide, but with a center of species richness in the Indo-Malesian region of south-eastern Asia. A single species in São Tomé and Príncipe, where it is known only from Príncipe.

Sciaphila ledermannii Engl., Bot. Jahrb. 43:304, t. 1 (A-K, M-R). 1909. **TYPE:** CAMEROON. “Nkolebunde, an feuchten Stellen des Waldes mit wenig grossen Bäumen und viel Unterholz, ganz vereinzelt,” Oct 1908, C. Ledermann 745 (holotype: B). (Fig. 1)

Andromonecious perennial herbs to 2.5 dm tall; stems glabrous, usually simple, sometimes 1–2 branched, or less often with stems numerous and clustered (some with more than 2 branches) from a short subterranean rhizome or caudex, subterranean stems whitish, aerial stems bright red. Sterile scale-leaves 4–9, triangular-clasping, 2–5 mm long, 1.2–2 mm wide, glabrous, those above ground bright red. Inflorescence a terminal raceme, 3.5–13 cm long; rachis glabrous, bright red. Flower bearing scale-leaves (= bracts) triangular to lanceolate to ovate to elliptic to oblong, 1.3–3 mm long, 0.5–1 mm wide, glabrous. Pedicels ascending proximally and curved-reflexed distally,

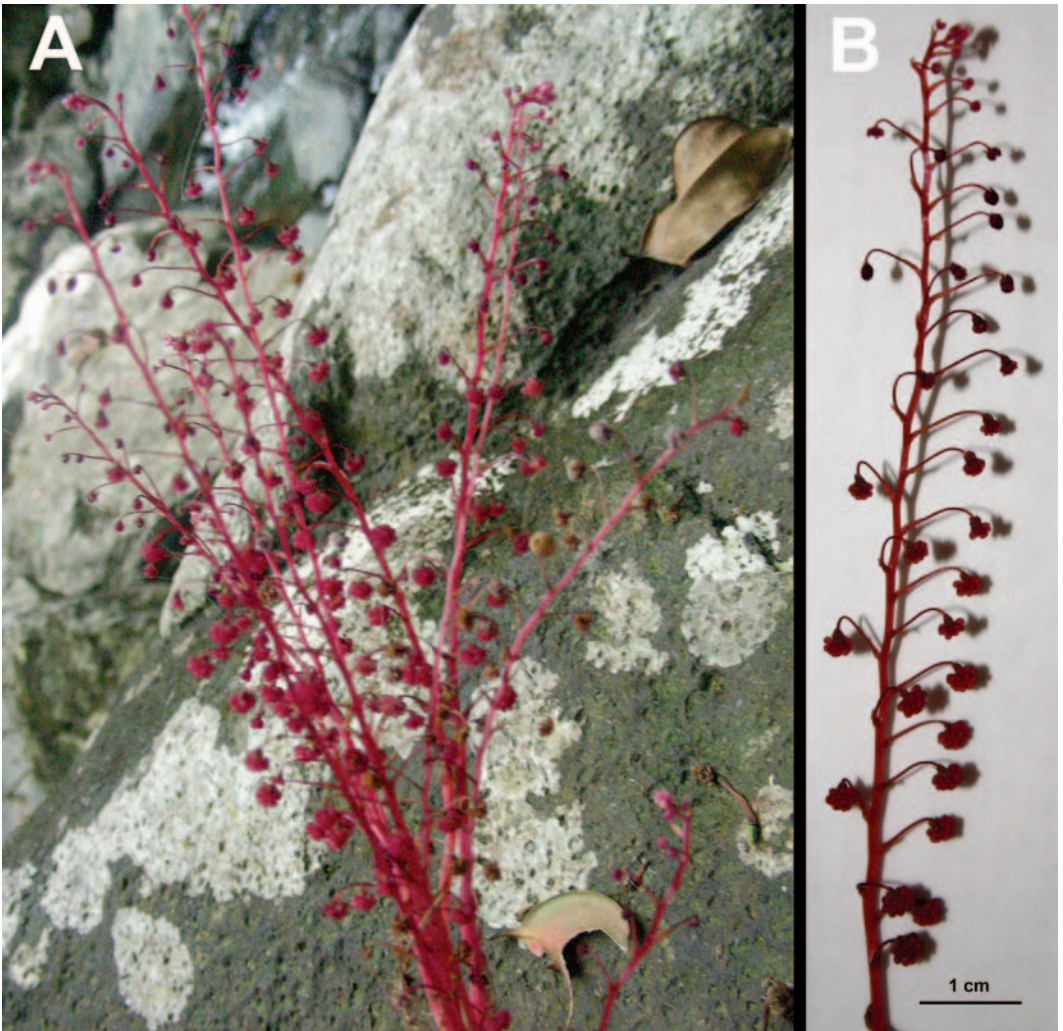


FIGURE 1. *Sciaphila ledermannii* (Daniel et al. 11,699) from Príncipe. A. Several individuals. B. Single plant.

(1–) 2–8.5 (–10) mm long, glabrous, bright red. Flowers 9–40 per raceme, mostly pendant, perianth reflexed during anthesis, 6-lobed, 0.9–1.4 mm long, lobes triangular to ovate, 0.6–1.2 mm long, 0.4–0.6 mm wide at base, apices pubescent with translucent and multi-celled trichomes to 0.7 mm long, trichomes deciduous and often not evident on older flowers. Staminate and bisexual flowers with 3 anthers, anthers 2-theous, thecae \pm explanate, broadly elliptic, 0.2 mm long. Bisexual (and carpellate?) flowers with 10–20 red carpels. Follicles ellipsoid to obovoid, 0.8–1.3 mm long, papillate. Seeds (Fig. 2A–C) broadly ellipsoid with \pm tapered base (thus appearing \pm oblacrymiform), 0.7–1 mm long, 0.4–0.7 mm wide, surface with 8 prominent longitudinal ribs and numerous less prominent transverse ridges.

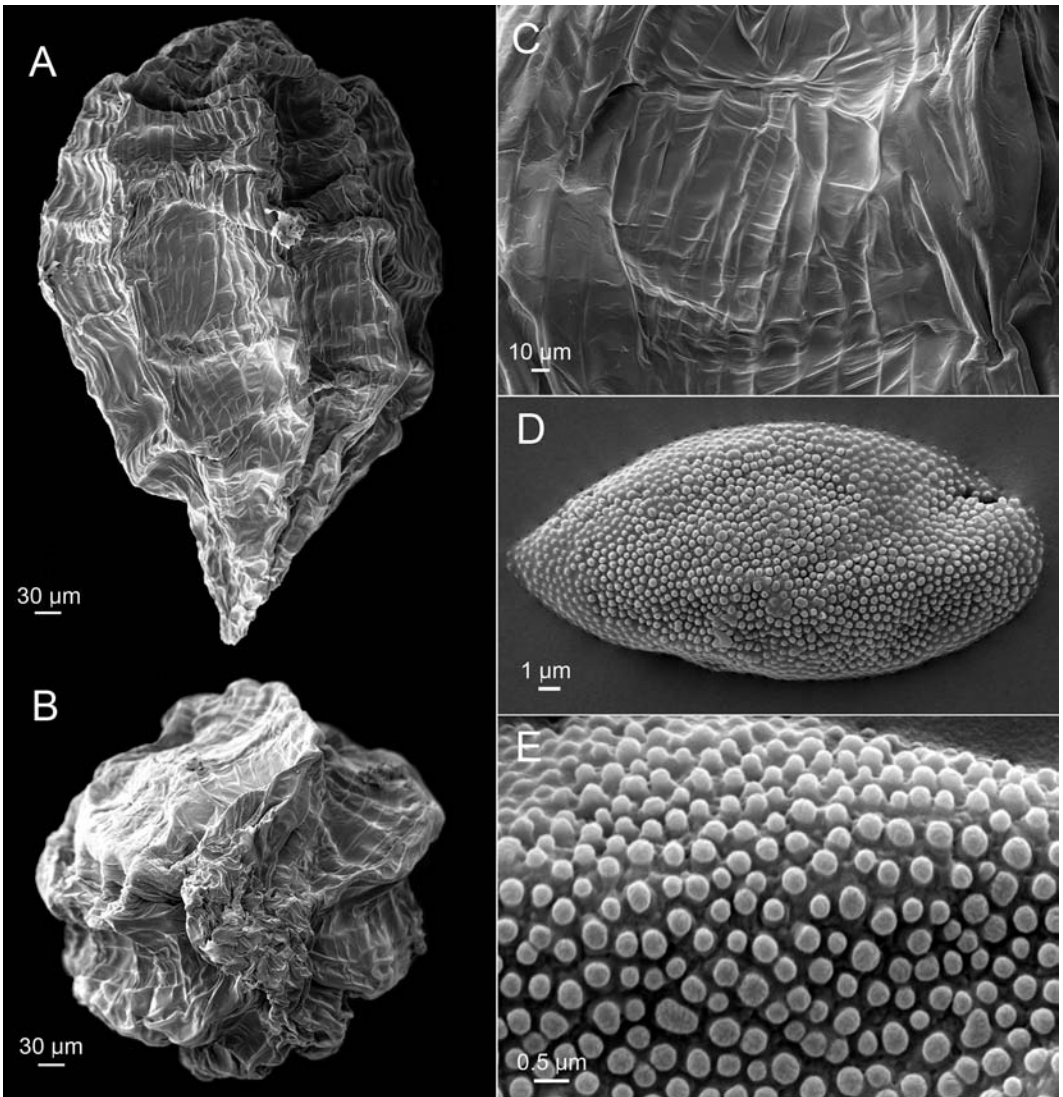


FIGURE 2. Scanning electron microscope images of seeds (Daniel *et al.* 11,699) and pollen (Daniel *et al.* 11,716) of *Sciaphila ledermannii* from Principe. A. Seed, lateral view. B. Seed, polar view. C. Seed surface. D. Pollen grain. E. Pollen surface with gemmate exine.

ILLUSTRATIONS.—Engler (1909: 305, fig. 1, A–K, M–R); Hepper (1968: 14, fig. 320); Symoens (1984:71, pl. 16).

PHENOLOGY.—Flowering: March; fruiting: March.

DISTRIBUTION AND HABITATS.—Known from Cameroon, Nigeria, and the Republic of São Tomé and Príncipe in the Gulf of Guinea region of western Africa; on Príncipe, plants occur in shade of undisturbed forests along streams at elevations from 10 to 150 m.

SPECIMENS EXAMINED.—**SÃO TOMÉ AND PRÍNCIPE:** Príncipe: along Rio Papagaio ca. 2 km S of Bela Vista (SW of Santo Antonio), from hydroelectric dam site (01°36'15.6"N, 007°24'24.6"E) to ca. 0.5 km upstream (01°36'09.3"N, 007°24'22.1"E), 130–180 m, *T. Daniel et al. 11,699* (CAS, STPH); vicinity of mouth of Ribeira São Tomé and ca. 300 m upstream at southwestern end of island, between 01°33'36.5"N, 007°21'05.8"E and 01°33'42.8"N, 007°21'22"E, 0–50 m, *T. Daniel et al. 11,716* (CAS, STPH).

For plants from Príncipe, most of the flowers in an inflorescence are apparently bisexual, and these sometimes occur to the apex of the raceme. More typically, the terminal few flowers are staminate (i.e., lack carpels). Anthers or their remnants are present on many proximal flowers that bear fruits. It is unclear whether all of the proximal flowers have (or had) anthers or whether some are truly carpellate. Symoens (1984) likewise described plants from Cameroon as having inflorescences with the proximal flowers carpellate or bisexual and the distal flowers staminate, or sometimes with all the flowers bisexual.

Pollen of *Sciaphila ledermannii* (Daniel et al. 11,716, Fig. 2D, E) is generally collapsed and irregular in shape when observed with SEM. Like most other Triuridaceae, its pollen is inaperturate and covered with gemmae (Furness et al. 2002). Gemmae of *S. ledermannii* are relatively smooth, lacking the small protuberances observed in other taxa by Furness et al. (2002).

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