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## **Taxonomy and Conservation of the Genus *Noronhia* Thouars (Oleaceae) in Mauritius**

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# Taxonomy and conservation of the genus *Noronhia* Thouars (Oleaceae) in Mauritius

Cynthia Hong-Wa, Martin W. Callmander & Cláudia Baider

## Abstract

HONG-WA, C., M. W. CALLMANDER & C. BAIDER (2014). Taxonomy and conservation of the genus *Noronhia* Thouars (Oleaceae) in Mauritius. *Candollea* 69: 157-163. In English, English abstract.

The genus *Noronhia* Thouars (Oleaceae), formerly known only from Madagascar and the Comoros, also occurs in Continental Africa and the Mascarene Islands. We present a taxonomic and conservation overview of the genus in Mauritius. Two new combinations are proposed for the Mauritian endemic species previously recognized in *Chionanthus* L. and described in *Olea* L.: *Noronhia macrophylla* (Baker) Hong-Wa & Callm. & *Noronhia obovata* (Baker) Hong-Wa & Callm. while the third species occurring on the island, a Mascarene endemic, already has a valid name in *Noronhia*: *Noronhia broomeana* Oliv. Applying the IUCN Red List Categories and Criteria, the three species occurring on Mauritius are considered as threatened with extinction. Discussion on the conservation status of each species is provided.

## Key-words

OLEACEAE – *Chionanthus* – *Noronhia* – Mauritius – Taxonomy – Conservation – IUCN Red List

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## Introduction

*Noronhia* Thouars (Oleaceae) included as its first member a taxon initially described as *Olea emarginata* Lam. (= *Noronhia emarginata* (Lam.) Thouars). *Noronhia* is nonetheless very distinct from *Olea* BAKER (1877: 219) by the presence of a corona, a structure found between the corolla tube and the stamens that typically characterizes the genus, although it is replaced by the thickening of the base of the corolla when absent in some species. *Noronhia* has also a woody petiole, an axillary inflorescence and usually a thick and short stamen. By contrast, *Olea* lacks a corona and a woody petiole, and generally has a terminal inflorescence and a slender and longer stamen. Furthermore, recent studies have shown that the two genera present some anatomical differences, especially in the diversity of their crystals and more importantly in their fiber content, which is very much higher in *Noronhia* (LERSTEN & HORNER, 2009).

*Noronhia* was originally known to occur only in Madagascar and the Comoro Islands. The type species, *N. emarginata*, commonly known as the “Malagasy Olive tree” or “Takamaka of Madagascar”, is widely cultivated in various tropical botanical gardens (MADAGASCAR CATALOGUE, 2014) and has also become naturalized in several regions (e.g. Florida, French Polynesia, Réunion and Seychelles) and is even invasive in Hawaii (PIER, 2011). A recent molecular phylogenetic study (HONG-WA & BESNARD, 2013) showed that all species previously recognized as *Chionanthus* L. and *Linociera* Schreb. in Africa and the Western Indian Ocean Islands are embedded in *Noronhia*, which led to a broadening of the circumscription of the latter to maintain its monophyly, also resulted in the expansion of its geographic distribution. Madagascar and the Comoros remain the center of diversity of this genus, with 90 species occurring there (HONG-WA, in prep.) whereas nine species were recognized in Continental Africa and three others in the Mascarenes. Consequently, the necessary nomenclatural changes were made by HONG-WA & BESNARD (2013).

While attempting to propose the new combinations for the taxa present on Mauritius, HONG-WA & BESNARD (2013) failed to do so validly for two of the names. They based their combinations in *Noronhia* on the *nomina nova* published by SCOTT (1979) in *Chionanthus* Gaertn. for species originally published in *Olea*: respectively *O. macrophylla* Baker and *O. obovata* Baker, although their epithets are still available in *Noronhia*. In this article, we propose to correct these nomenclatural errors validating: *N. macrophylla* (Baker) Hong-Wa & Callm. and *N. obovata* (Baker) Hong-Wa & Callm. We also provide notes on the taxonomy of the three native species of *Noronhia* occurring on Mauritius, two of which are endemic. A fourth species (*N. emarginata*), the “Takamaka of Madagascar”, is also cultivated on Mauritius as well as on Réunion, and is naturalized in the coastal regions.

In addition, we discuss the conservation status of the three native species of *Noronhia* on Mauritius. The island lost most of its native vegetation cover in a period of 150 years mainly starting in the early 18<sup>th</sup> Century, primarily for the cultivation of sugar cane (VAUGHAN & WIEHE, 1937). Habitat fragmentation and the presence of invasive alien plants and animals are today the main drives of native species decline on Mauritius (PAGE & D’ARGENT, 1997; SAFFORD, 1997; BAIDER & al., 2010; FLORENS & al., 2012), as it is the case for most tropical oceanic islands (CAUJAPÉ-CASTELLS & al., 2010). It is estimated that less than 5% of native habitat remains on Mauritius, of which less than 2% is considered to have over 50% native canopy cover (PAGE & D’ARGENT, 1997). All remnants of native vegetation on Mauritius are invaded by alien species (VAUGHAN & WIEHE, 1937; PAGE & D’ARGENT, 1997; FLORENS & al., 2012), and invasion is an ongoing process leading to continuous habitat degradation (BAIDER & FLORENS, 2006; FLORENS, 2008). For example, the invasion process alone has led to a reduction to up to half of the trees with diameter of breast height over 10 cm in the last 70 years in sites with the best preserved and protected native forests (BAIDER & FLORENS, 2011; FLORENS, 2008; LORENCE & SUSSMAN, 1986). In some of these sites, invasion of non-native species has caused local extinction of understory shrubs that were once common (BAIDER & FLORENS, 2011).

The ecological processes leading to habitat degradation and rarefaction of native species populations are various. For example, mortality of native plant species is higher in invaded areas compared to sites where alien plants have been removed; also recruitment is lower in these invaded remnants (BAIDER & FLORENS, 2006, 2011; FLORENS, 2008). Competition with invasive alien plants reduces the production of flowers of native species in both the canopy and understory, and consequently trees and shrubs produce smaller quantities of fruits and seeds compared to individuals located in areas where aliens were removed (BAIDER & FLORENS, 2006; MONTY & al., 2013). Apart from reduced flowering, pollination is today reduced in invaded native vegetation due to a lower number of pollinator species and of individuals in those species that remain (FLORENS & al., 2010; KAISER & al., 2008; KAISER-BUNBURY & al., 2009). Effective dispersal of native species on Mauritius, especially of species with large diaspores such as *Noronhia*, has most probably been disrupted as several dispersers are now extinct (CHEKE & HUME, 2008). Some of these negative effects caused by alien species have been reversed in sites where alien plants have been removed (known in Mauritius as Conservation Management Areas), but these today cover less than 200 ha in total. Taking these various threats into consideration, we present the results of a risk of extinction assessment of each species of *Noronhia* native to Mauritius using the IUCN Red List Categories and Criteria.

### The genus *Noronhia* in Mauritius

For an identification key to the species, see SCOTT & GREEN (1981: 10).

*Noronhia* Thouars, Gen. Nov. Madag.: 8. 1806.

**Typus:** *Noronhia emarginata* (Lam.) Thouars (= *Olea emarginata* Lam.)

*Noronhia broomeana* Oliv. in Hooker's Icon. Pl.: tab. 1365. 1881.

= *Linociera broomeana* (Oliv.) Knobl. in Notizl. Bot. Gart. Berlin 11: 1028. 1934.

= *Chionanthus broomeana* (Oliv.) A. J. Scott in Kew Bull. 33: 570. 1979.

**Typus: MAURITIUS:** The forests in the vicinity of Grand Bassin, 690 m, 16.III.1881, *Horne s.n.* (holo-: K [K000233209]!; iso-: K [K000233208]!).

= *Linociera verrucosa* Soler. in Bot. Centralbl. 45: 399. 1891. = *Mayepea verrucosa* (Soler.) Knobl. in Engler & Prantl, Nat. Pflanzenfam. IV(2): 10. 1892. **Typus: MAURITIUS:** s.loc., s.d., *Sieber [Fl. Mauritius II] 125* (holo-: M [M0174392] image seen; iso-: E [E00193166] image seen; G [G00008578]!, K [K000233210]!, MO-2235287!).

**Observations.** – *Noronhia broomeana* includes two varieties, both of which occur on Réunion Island: *N. broomeana* var. *cordemoyana* (Knobl.) Hong-Wa & Besnard and *N. broomeana* var. *cyanocarpa* (Cordem.) Hong-Wa & Besnard. The taxon occurring on Mauritius, the typical variety, *N. broomeana* var. *broomeana*, differs from these two by its much denser indumentum and its wider and larger leaves (SCOTT & GREEN, 1981) (Fig. 1A).

**Conservation status.** – *Noronhia broomeana* var. *broomeana* is the most commonly occurring member of the genus on Mauritius. The largest population occurs on Deux Mamelles Mountain (estimated to comprise 40–60 reproductive trees), with scattered individuals found at various wet locations at higher elevations (500–600 m). Deforestation and exploitation (trees provided good construction wood; *Bouton* in MAU [MAU 0014578]), were the main historical threats responsible for the decline of this taxon. Nowadays these factors are negligible (FLORENS, 2013), although a site where *N. broomeana* var. *broomeana* is known to have occurred was cleared after 1940 (e.g. Bassin Anglais). There is only one known plant occurring at a lower elevation site (ca. 200 m, Rivulet Beau Bois), suggesting that this taxon was probably more widespread in the past. The “Extent of Occurrence” (EOO), calculated on the basis of the historically known populations, is 256 km<sup>2</sup> and the “Area of Occupancy” (AOO) is 32 km<sup>2</sup> (calculation following GEOCat version β, see BACHAM & al., 2011) (Fig. 2A). However, at least one site (Bassin Anglais) is now destroyed, reducing the AOO by 13%

(28 km<sup>2</sup>), although the EOO has not decreased. There has been a reduction in the number of known locations, and therefore, of mature individuals. The total number of reproductive trees of *N. broomeana* var. *broomeana* is unknown but it is likely to be less than 150. All known reproductive trees are located on invaded forest sites, which are thus undergoing continuous habitat degradation. Apart from the reduced reproductive fitness, as explained above, the majority of fruits are depredated by alien rats, which is also the case for the other species of *Noronhia* on Mauritius (CB, pers. obs.). Species regeneration is consequently very low, with only a few seedlings recorded in the site where the majority of reproductive trees occur (PAGE & D'ARGENT, 1997). *Noronhia broomeana* var. *broomeana* should therefore be considered in Mauritius as “Endangered” [EN B1ab(ii,iii,iv,v); C2a(i,ii); D] according to the IUCN Red List Categories and Criteria (IUCN, 2012). In Réunion, two varieties of *N. broomeana* present on the island were assessed together and have been classified as “Vulnerable” [VU C2a(i)] (IUCN-FRANCE & al., 2010).

**Specimens examined.** – MAURITIUS. **Dist. Pamplemousses:** Deux Mamelles, 16.I.2003, *Pynee, d'Argent & Chitbauhaal s.n.* (MAU [MAU 0014598]); *ibid. loc.*, 20.V.2004, *Pynee, Wiehe & Sevathian s.n.* (MAU [MAU 0014599]). **Dist. Plaines Wilhems:** Bassin Anglais, s.d., *Vaughan V/583A* (MAU [MAU 0014588]); Garden in Curepipe, 30.V.1975, *Coode [leg. Gerval] 4712* (MAU [MAU 0014596]); Mare Longue, 11.V.1946, *Vaughan 3130* (MAU [MAU 0014590]); Rivulet Bérichon, Henrietta, 24.V.1974, *Owadally s.n.* (MAU [MAU 0014594]). **Dist. Savanne:** Bassin Blanc, 550 m, 25.V.1976, *Richardson, Guého & Lecordier 4165*, (K, MAU [MAU 0014597]); Plaine Champagne, 18.I.1995, *d'Argent & V. Florens s.n.* (MAU [MAU 0014734]); Rivulet Bois Beau, near Rivière des Anguilles, 25.V.1964, *Duljeet s.n.* (MAU [MAU 0014592]); *ibid. loc.*, 193 m, 20°27'57"S 57°33'25"E, 17.V.2010, *V. Florens & Baider CB 2367* (MAU [MAU 0015022], MAU 0015023, MAU 0015024, MAU 0015025, MAU 0015026]). **Sine loc.:** s.d., *Bouton s.n.* (MAU [MAU 0014578]); s.d., *Bijoux s.n.* (MAU [MAU 0014579], MAU 0014580, MAU 0014581, MAU 0014582, MAU 0014583, MAU 0014584); s.d., *Vaughan 583* (MAU [MAU 0014587]); s.d., *s. coll.* (MAU [MAU 0014585], MAU 0014586]).

### *Noronhia macrophylla* (Baker) Hong-Wa & Callm., **comb. nova.**

= *Olea macrophylla* Baker, Fl. Mauritius: 219. 1877.

= *Linociera macrophylla* (Baker) H. Perrier in Humbert, Fl. Madagascar Comores 166: 9. 1952 [non G. Don, Gen. Hist. 4: 53. 1837].

= *Chionanthus boutonii* A. J. Scott in Kew Bull. 33: 570. 1979 [non *C. macrophyllus* (Wall. & G. Don) Blume, Mus. Bot. 1: 317. 1851].

= *Noronhia boutonii* (A. J. Scott) Hong-Wa & Besnard in Mol. Phylogenet. Evol. 67: 375. 2013 [nom. illeg.].

**Typus: MAURITIUS:** s.loc., 1859, *Bouton s.n.* (holo-: K [K000233207]!).





**Fig. 1.** – Living plants of *Noronhia* Thouars on Mauritius. **A.** *Noronhia broomeana* Oliv. var. *broomeana*; **B-C.** Close-up of *Noronhia macrophylla* (Baker) Hong-Wa & Callm.; **D.** *Noronhia obovata* (Baker) Hong-Wa & Callm.

[**A:** V. Florens & Baider CB 2367; **B-C:** Baider s.n., pers. obs.; **D:** Baider & V. Florens CB 2461] [Photos: **A, D:** V. Florens; **B:** C. Baider]

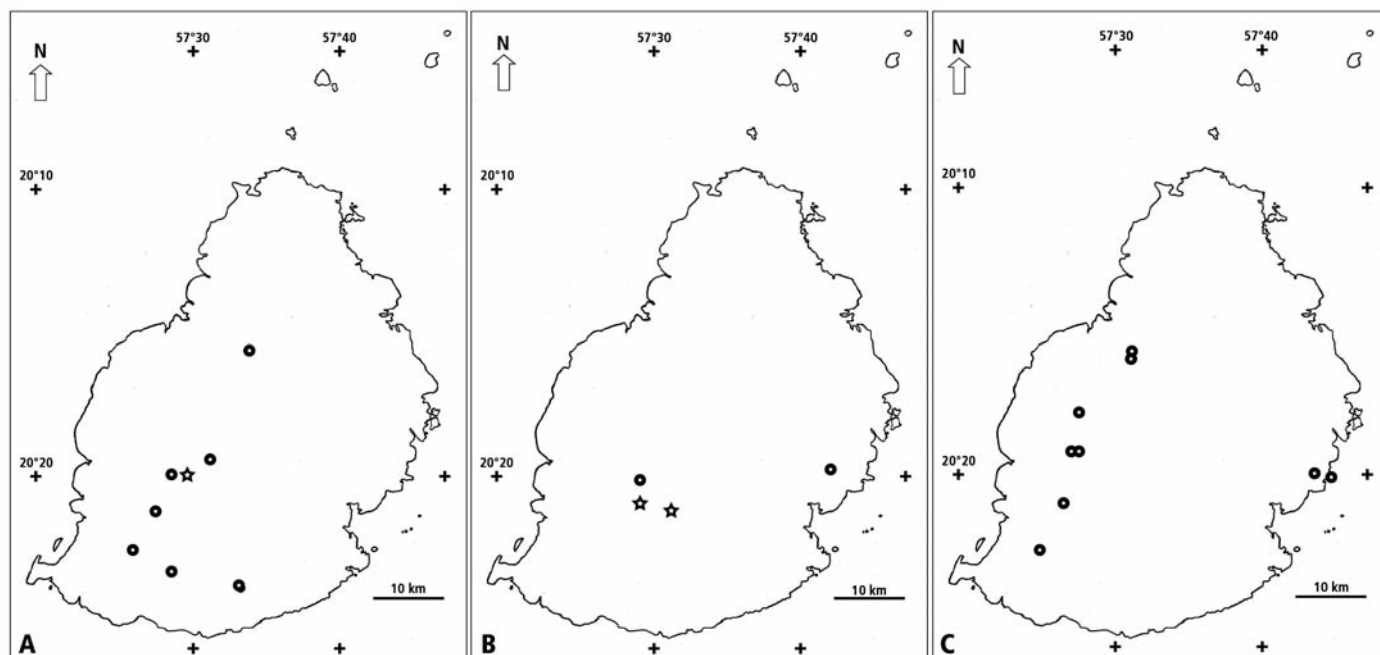


Fig. 2. – Distribution maps of *Noronhia broomeana* Oliv. var. *broomeana* (A), *Noronhia macrophylla* (Baker) Hong-Wa & Callm. (B), and *Noronhia obovata* (Baker) Hong-Wa & Callm. (C): Current localities (circles), historical localities (stars).

**Observations.** – *Noronhia macrophylla* is a rare treelet, known until recently only from the region of Mare aux Vacoas and Perrier. It can be distinguished from the other members of the genus in Mauritius by its white bark with striking black markings, its widely obovate to almost circular leaves (but more elliptic in the population at Mt. Camizard) (Fig. 1B, 1C), and its small white odoriferous flowers (SCOTT & GREEN, 1981).

**Conservation status.** – The area of Mare aux Vacoas had a “good population” of *Noronhia macrophylla* (G. D’ARGENT, pers. comm.), implying that it comprises numerous individuals, although no quantitative estimate has been made. The site was deforested in the early 1970s and almost no native vegetation remains today, except around a few small streams. Perrier, the smallest Nature Reserve of Mauritius (1.44 ha), is surrounded by eucalyptus plantations, and it has been actively managed (weeded and fenced against large hoofed mammals) since early 1960s. Due to the reserve’s small size, easy access and numerous botanical inventories, it is very unlikely that other individuals will be found at this locality. A population decline of 50% occurred at Perrier during the last 30 years, from two individuals (VAUGHAN, 1980) to just a single tree that is about 3.5 m tall and has 4 main stems of 2.8 to 3.3 cm diameter. This tree seems healthy, although it grows on the edge of a small stream that crosses the Nature Reserve, and is

thus threatened by the normal process of fluvial erosion. Material from this population has been propagated by the Mauritius Forestry Services and is also under cultivation at the Royal Botanic Gardens, Kew. Recently, a previously unknown population of *N. macrophylla* was located near Mt. Camizard, where an estimated 80 individuals, including seedlings, occur within a patch of forest that has been weeded and restored by a private company (BCM Mauritius) (Fig. 2B), which is trying to augment the population on the site, although no ripe fruits have been observed (C. GRIFFITHS, pers. comm.). The historical EOO (40 km<sup>2</sup>) and AOO (16 km<sup>2</sup>) are small (calculation following GEOCat version  $\beta$ , see BACHAM & al., 2011). The AOO has been reduced by 50% since 1970s, and today is around 8 km<sup>2</sup> (reduction in EOO cannot be calculated since there are only two points). In contrast to the other members of *Noronhia* on Mauritius, all known plants of *N. macrophylla* occur within sites where alien plants have been removed. Nonetheless, *N. macrophylla* should be considered as “Critically Endangered” [CR A1c; B2ab(ii,iii,iv); C2a(ii); D] according to the IUCN Red List Categories and Criteria (IUCN, 2012) due to its restricted range, loss of known localities, documented population decline (mainly by deforestation that has now ceased), and small number of reproductive individuals mostly found at a single site (< 50 plants; > 99% of all reproductive plants).



*Specimens examined.* – MAURITIUS. **Dist. Plaines Wilhems:** Mare aux Vacoas, 550 m, 11.XII.1933, *Vaughan 842* (P [P05090507, P0509 0508]); *ibid. loc.*, VIII.1937, *Vaughan s.n.* (MAU [MAU 0014564]); Perrier, 533 m, 17.II.1939, *Vaughan V/3176* (MAU [MAU 0014564]); *ibid. loc.*, 4.I.1948, *Vaughan V/3176A* (MAU [MAU 0014568]); *ibid. loc.*, 12.I.1963, *Vaughan s.n.* (MAU [MAU 0014569]); **Dist. Grand Port:** Vallée de l'Est, 23.II.2011, *Sevathian s.n.* (MAU [MAU 0004 821]); Mt. Camizard (aka Vallée de l'Est), 340 m, 20°19'53''S 57°43'31''E, 21.VI.2014, *V. Florens s.n.* (MAU [MAU 0015248]).

*Noronhia obovata* (Baker) Hong-Wa & Callm., **comb. nova.**

- ≡ *Olea obovata* Baker, Fl. Mauritius: 219. 1877.
- ≡ *Chionanthus ayresii* A. J. Scott in Kew Bull. 33: 570. 1979 [non *C. obovatus* Raf., New Fl. 3: 87. 1838].
- ≡ *Noronhia ayresii* (A. J. Scott) Hong-Wa & Besnard in Mol. Phylogenet. Evol. 67: 375. 2013 [nom. illeg.].

**Typus:** MAURITIUS: s.loc., 27.II.1864, *Ayres s.n.* (holo-: K [K000233211]!; iso-: GH [GH00075134] image seen).

*Observations.* – *Noronhia obovata* is a small treelet (2-2.5 m) (Fig. 1D), exceptionally a medium-sized tree, that can be distinguished by its grayish bark and its very short inflorescences (3-8 mm) and fruits (10-18 mm) (SCOTT & GREEN, 1981). It is found in drier areas than the two other native species of *Noronhia*, at sites from 200 to 700 m elevation. In addition to facing the same threats as those described above for *N. broomeana* var. *broomeana*, some of the remnant areas of forest where *N. obovata* occurs are leased for ranching of alien deer in which the understory is regularly cut, browsed and heavily trampled.

*Conservation status.* – Despite having a somewhat larger EOO (491 km<sup>2</sup>) than *Noronhia broomeana* var. *broomeana*, the AOO of *N. obovata* is similar (28 km<sup>2</sup>; calculation following GEOCat version β, see BACHAM & al., 2011). *Noronhia obovata* may no longer occur at some historically known localities such as Chamarel Hill, and only one of those where it is currently known to occur (Brise Fer) has actively weeded vegetation. As a consequence, this species is undergoing continuous habitat degradation, although some individuals occur within a protected area (Corps de Garde Nature Reserve). The largest population is located on Le Pouce, where most of the plants occur outside of the Nature Reserve in the surrounding State Lands, in areas classified as a Mountain Reserve (Fig. 2C). The other 7 or 8 known localities have few reproductive individuals, hence the total number of reproductive individuals of *N. obovata* is estimated to be less than 100 plants. This species should therefore be considered as “Endangered” [EN B1ab(ii,iii,iv); C1+2a(i)] according to the IUCN Red List Criteria (IUCN, 2012).

*Specimens examined.* – MAURITIUS. **Dist. Black River:** Chamarel Hill, 19.VI.1939, *Vaughan s.n.* (MAU [MAU 0014549]); Brise Fer, IV.2004, *Sevathian s.n.* (MAU [MAU 0014562]); Cabinet, 7.III.1958, *Vaughan s.n.* (MAU [MAU 0014550]); Mt. Corps de Garde, 29.III.2001, *V. Florens & Sevathian s.n.* (MAU [MAU 0014558]); Magenta, 26.VIII.1984, *Wellings s.n.* (MAU [MAU 0014557]); Trois Mamelles, 119 m, 20°18'58''S 57°26'49''E, 31.III.2011, *Pynee, Byng & d'Argent s.n.* (MAU [MAU 0002716]); *Sine loc.*, s.d., *Bijoux s.n.* (MAU [MAU 0014548]). **Dist. Grand Port:** Mt. Bambou, IX.2003, *Sevathian s.n.* (MAU [MAU 0014561]); Mt. Brisé, 200 m, 20°20'46''S 57°45'10''E, 30.III.2007, *Pynee & Chitbauhaal s.n.* (MAU [MAU 0014563]). **Dist. Port Louis:** Le Pouce, 1.VI.1969, *Guého s.n.* (MAU [MAU 0014552]); *ibid. loc.*, 21.V.1971, *Guého s.n.* (MAU [MAU 0014555]); *ibid. loc.*, 654 m, 20°12'01''S 57°31'33''E, 28.VIII.2008, *Pynee, Sevathian, Seepaul & Nabee s.n.* (MAU [MAU 0014600]); *ibid. loc.*, 613 m, 20°12'58''S 57°31'49''E, 29.VII.2011, *Baider & V. Florens CB 2461* (MAU [MAU 0015021]).

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