Philippine Journal of Science
146 (2): 159-165, June 2017
ISSN 0031 - 7683

Two New *Nepenthes* Species from the Unexplored Mountains of Central Mindanao, Philippines

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***Nepenthes* L. is the sole genus of the family Nepenthaceae. Having the highest rate of endemism of this family, the Philippines is considered a center of diversity of the genus *Nepenthes* along with Sumatra and Borneo. Recent explorations in Mindanao and Luzon raised the number of Philippine *Nepenthes* species to 50. This study reports the discovery of two new *Nepenthes* species, *N. malimumuensis* and *N. manobo* in the unexplored region of the Pantaron range of central Mindanao making the range a home to eight species. Habitat destruction has the biggest impact on the population of *Nepenthes* spp. in the Pantaron range. The Pantaron range is not a protected area therefore the diversity, distribution, conservation and habitat preservation of the new endemic *Nepenthes* species reported herein need to be monitored closely.**

Key words: Central Mindanao, *Nepenthes*, new species, Philippines

INTRODUCTION

Nepenthes species bear specialized leaves that can lure and catch arthropods, frogs, rodents and small birds, due to their highly specialized foliage, which takes the form of hollow, water-filled vessels, or pitchers (McPherson 2009; Cheek & Jebb 2013).

Nepenthes populations prefer nutrient deficient substrates allowing them to adapt alternative strategies such as carnivory, aquaplaning, myrmecotrophy, detrivory and mutualism with arthropods and mammals such as the mountain shrew rats and bats in obtaining nutrients (Moran et al. 2003; Greenwood et al. 2011; Grafe et al. 2011).

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Since the first encounter of *Nepenthes* in the mid-17th century, interest in the genus has profoundly altered knowledge on its taxonomy, diversity and distribution, particularly with respect to understanding the *Nepenthes* of Indochina and the Philippines (McPherson 2009; McPherson 2012).

In the Philippines, *Nepenthes* exhibits the highest rates of endemism of all species with many highland species occurring only on a single peak (McPherson 2012). Recent explorations in Mindanao and Luzon raised the number of Philippine *Nepenthes* species to 50 (Gronemeyer et al. 2014, 2016). Local and foreign botanists have extensively explored Mindanao's prominent mountains while the central cordillera composed of the Pantaron, Tangkulan and Tago ranges remain partly explored. In this area, only Mt. Kiamo in the Tago Range and a minor peak in the Pantaron

range in the area of Barangay St. Peter, Malaybalay City, Bukidnon was explored (Gronemeyer et al. 2014). The Pantaron and Tangkulan Ranges in Bukidnon remain unexplored due to political instability. The study's main proponent is an indigenous *Lumad* (special designation for the native population of Mindanao) in ancestry whose late father was a respected *dato* (chieftain) of the Talaandig tribe in Bukidnon. Because of this, the main proponent was granted special access to these unexplored mountain areas notwithstanding the political instability and tribal animosity.

Provided in the work herein are the description of two new species namely *N. malimumuensis* and *N. manobo* which were documented from the Mt. Malimumu of the Pantaron range based on botanical fieldwork.

MATERIALS AND METHODS

Botanical fieldwork was carried out in the Pantaron range on Dec 2013, Feb 2014 and Aug 2015 and at Mt. Tangkulan range on May 2014, Jul to Aug 2015 and Sep 2015. All the data and dimensions were either collected in the field from live plants or from the respective herbarium types cited in this work.

The Mt. Malimumu, Pantaron range in the area of Barangay Magkalungay, San Fernando Bukidnon and Mt. Pinamantawan and Mt. Bilbilisan in the Tangkulan range, Sto. Domingo, Lumintao, Quezon, Bukidnon was botanically explored after a Wildlife Gratuitous Permit (GP), no. R10 2015-19 was secured from the Department of Environment and Natural Resources (DENR), which was secured in accordance with RA 9147 of 2001 and its Implementing Rules and Regulations-Joint DENR-DA-PCSD Admin. Order No. 01, series of 2004 and in accordance with DAO No. 2004-55 in order to collect herbarium specimens for identification and taxonomic purpose. The consent of the barangay captains, indigenous people mandatory representatives (IPMRs) and tribal chieftains in the respective geopolitical territories were also secured prior to the conduct of the study.

Cropped plant material was placed between paper sheets *in situ* and processed subsequently using standard methods at the Biology Laboratory of Mountain View College, College Heights, Valencia City, Bukidnon.

Photographs and photomicrographs were made from suitable, representative plant specimens *in situ.*

RESULTS

Description of *Nepenthes malimumuensis*

Nepenthes malimumuensis Lagunday, Acma, Cabana, Sabas, V.B. Amoroso, *sp. nov.*

Type: Philippines, Mindanao, Pantaron range, Bukidnon, Municipality of San Fernando, Mt. Malimumu (1,016 masl), 09.02. 2014, N.E Lagunday, M. Acopio, H. C. Armecin, A. Calaguian and N.M. Sabas, holotype 00009841, Central Mindanao University Herbarium (CMUH), Musuan, Bukidnon, Philippines.

Diagnosis: *N. malimumuensis* differs from *N. sumagaya* Cheek in having upper pitcher wings that are reduced to ribs or not apparent (*N. sumagaya*: occasionally present in some pitchers visible close to the peristome); having four to five nerves on either side of the midrib (*N. sumagaya*: with 1-2 nerves); lid appendage is reduced to a keel (*N. sumagaya*: occasionally present).

Description: A terrestrial climbing vine. Stems up to 3 m long, glabrous, terete to triangular in transection, 1 to 1.5 cm in diameter; internodes are up to 5.8 cm in length.

Leaves have winged petioles that are up to 8 cm long and 3 cm wide. They are broadly spathulate to ovate, rounded leaf apex and attenuate base. They are up to 54.5 cm long and 11.2 cm wide and with four or occasionally five nerves running on either side of the midrib.

Lower pitchers are wholly cylindrical or slightly swollen in the bottom and slightly funnel-shaped towards the opening. They are up to 38 cm long and 11 cm wide in the upper half. Wings with sinuate margin run down in front of the trap up to 2/3 of the pitcher anterior and continue basally as a ridge, fringed with filaments up to 1.2 cm long. The pitcher opening is ovate acuminating towards the lid. The peristome has teeth-like projections that are short and triangular with proximally sunken nectar glands in the semilunar depressions between the ribs with canals emptying into the inner pitcher wall. They are slightly flattened, tapering posteriorly forming a distinct vertically oriented neck, 4.4 to 5.5 cm wide, up to 2 mm space between ribs. Lids are ovate, up to 12 cm long and 10 cm wide. The lid appendage is reduced to a keel. The lid nectar glands are round to ovate large and smaller glands evenly distributed. The lid spur is filiform, pubescent and occasionally branched, 1.7 to 2 cm long and up to 1 mm in diameter. Tendrils are non-coiling, up to 40 cm long and 5 mm in diameter.

The exterior of lower pitchers is olive drab green with blotches of garnet red or suffused with ruby red with a yellow green bottom depending on sunlight exposure. The interior of the pitcher is olive drab green with blotches of garnet red or entirely suffused with mahogany red.

Upper pitchers are funnel-shaped in the bottom third and tapers posteriorly towards the tendril becoming cylindrical above then slightly funnel-shaped towards the ovate opening, up to 37 cm long and 10.5 cm wide near the peristome; wings are reduced to ridges. The peristome morphology is consistent with the lower pitchers. The lid spur is filiform and unbranched, 1 to 2 cm long and up to 1 mm in diameter. The tendrils are coiling to non-coiling, up to 58 cm long and 5 mm in diameter. The nectar gland distribution, coloration and indumentum are consistent with the lower pitchers.

The male inflorescence observed in the type locality during the sampling was juvenile and was neither collected nor described in this paper.

The female inflorescence is a panicle composed of a 39 cm long scape up to 1 cm in diameter and an additional of up to 65 cm rachis. The partial peduncles are two-flowered and 12 mm long. The pedicels are up to 3.5 cm long and 1 mm in diameter bearing tetramerous narrow ovate petals that are up to 6 mm long and 2 mm wide with huge round to elongated nectar glands in the upper surface. The capsule bearing the seeds is 3 cm long and 5 mm wide. The seeds have filiform extensions and are up to 1.4 cm long and 1 mm wide.

The pitchers are composed of the digestive zone in the bottom and a waxy zone towards the opening.

The indumentum is a multicellular trichome with short pseudo-branches arising from the basal cell, glandular to non-glandular present in the tendril, pitcher exterior and inflorescence.

The plant habit of *Nepenthes malimumuensis* is illustrated in Figure 1. The morphology of the microstructures is shown in Figures 2 and 3.

The morphological features that separate *N. malimumuensis* from *N. sumagaya* are summarized in Table 1.

Comparison to other species

Differs from *N. truncata* Macfarl. in having a broadly spathulate to ovate lamina with rounded apex (*N. truncata*: rectangular to triangular lamina) and in having a flat lower pitcher peristome anterior (*N. truncata*: peristome anterior is elevated) and in having a lid appendage that is reduced to a keel (*N. truncata*: lid appendage is present).

Etymology: The specific epithet denotes that *N. malimumuensis* was discovered from Mt. Malimumu.

Description of *Nepenthes* manobo

Nepenthes manobo Lagunday, Acma, Cabana, Sabas, V.B. Amoroso, *sp. nov.*

Figure 1. Photographs of *N. malimumuensis*. (A) Plant habit, (B) young male inflorescence, (C) infructescence, (D) lower pitchers (E) upper pitchers. Photos by Adeline Calaguian (A,D), Harold C. Armecin (C,E), and N.E. Lagunday (B).

Type: Philippines, Mindanao, Pantaron range, Bukidnon, Municipality of San Fernando, Mt. Malimumu (1,016 m), 09. 02. 2014, *N.E. Lagunday, M. Acopio, N.M. Sabas,* holotype 00009842, Central Mindanao University Herbarium (CMUH), Musuan, Bukidnon, Philippines.

Diagnosis: Differs from *N. surigaoensis* Elmer in having sessile leaves clasping ½ of the stem diameter with three nerves on either side of the midrib (*N. surigaoensis*: Strongly decurrent with three to four nerves); lower pitcher bulbous to ovate bottom half, cylindrical towards the opening (*N. surigaoensis*: wholly cylindrical or ellipsoidal); upper pitchers with a distinct hip (*N. surigaoensis*: hip not apparent); lid shape orbicular to ovate (*N. surigaoensis*: ovate to elliptic); peristome inner margin with short teeth-like projections (*N. surigaoensis*: with long teeth-like projections).

Description: A terrestrial, climbing vine. Stems up to 5 m long, glabrous, terete to triangular in transection, up to 6 mm in diameter; internodes are up to 2.5 cm in length.

Leaves are sessile, broadly linear, acute leaf apex with 3 nerves on either side of the midrib. They are up to 21 cm long and 3.6 cm wide.

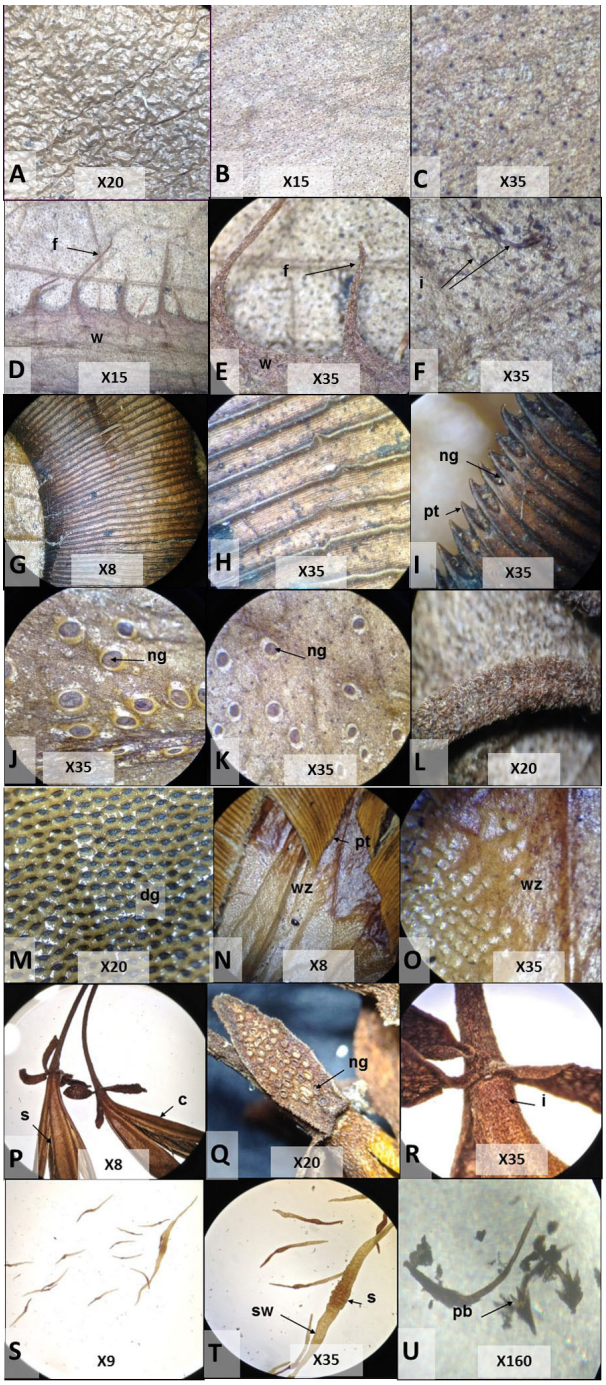

Figure 2. Photomicrographs of *Nepenthes malimumuensis*. (A) leaf adaxial, (B,C) leaf abaxial, (D,E) fringed wing (F) pitcher exterior covered with indumenta, (G,H) peristome, (I) peristome inner margin, (J,K) lid nectar glands, (L) pubescent lid spur; (M) digestive zone, (N,O) waxy zone, (P-R) female flower, (Q) tepal, (R) flower covered with indumenta, (S,T) seeds, (U) indumenta; f - filamentous fringe, i - indumentum, ng - nectar gland, pt - peristome teeth, w– wing, c - capsule, dg - digestive gland, i - indumenta, pb - pseudobranch, s - seed, sw - seed filiform wing, wz - waxy zone.

Figure 3. Photographs of *N. manobo*. (A) Plant habit with upper pitchers, (B) upper pitcher with two lids (anomalous growth), (C) rosette stem with lower pitchers, (D) plant habit with an upper pitcher and a male inflorescence. Photos by N.E Lagunday (A,C,D) and Harold C. Armecin (B).

Table 1. Major characteristics separating *N. malimumuensis* from *N. sumagaya*. Data of *N. sumagaya* were taken from Gronemeyer et al. (2014) and Cheek (2014).

	N. sumagaya	***N. malimumuensis***
Leaf shape	Broadly spathulate	Broadly spathulate to ovate
Leaf apex	Obtuse	Rounded
Longitudinal nerves	1 to 2	4 to 5
Upper pitcher wings	Occasionally present in some pitchers visible close to the peristome	Reduced to ribs or not apparent
Lid appendage	Occasionally present near the lid base	Reduced to a keel

Lower pitchers are up to 17 cm long, 3.5 to 6 cm wide in the lower half. The bottom half is bulbous or ovate forming a hip becoming cylindrical or slightly funnel-shaped towards the opening. Wings run down the entire front of the trap, fringed with filaments up to 4 mm long. The pitcher opening is oblique tapering posteriorly towards the lid. The peristome is ribbed, slightly flattened, tapering posteriorly forming a distinct vertically oriented neck, they are up to 1 cm wide and up to ca. 0.8 mm space between ribs. The peristome inner margin has teeth-like projections that are short and triangular with nectar glands that are proximally sunken in the semilunar depressions between the ribs with canals emptying into the inner pitcher walls.

The lid is ovate, with large and small round nectar glands evenly distributed in the lower lid surface.

The lid is up to 5.6 cm long and 4.8 cm wide with an appendage reduced to a keel. The lid spur is filiform tapering towards the apex and occasionally branched up to 1.2 cm long and up to 1 mm in diameter. The tendrils are non-coiling, up to 25 cm long and 4 mm in diameter.

The exterior of the pitcher is entirely light coral red or khaki yellow and may have peach puff four brown blotches; bottom is khaki yellow with goldenrod brown blotches, becoming chocolate brown with sangria and brick red blotches as it matures.

Upper pitcher bottom half is slightly inflated tapering towards the tendril becoming cylindrical in the middle forming a hip becoming slightly funnel-shaped towards the ovate opening, up to 19.1 cm long and 5 cm wide in the lower half. The wings are reduced to ridges. The pitcher opening is oblique tapering towards the lid forming a distinct vertically oriented neck. The peristome is ribbed, cylindrical in transection, up to 1 cm wide and up to ca. 0.8 mm space between the ribs. The lid is orbicular to ovate, 2.4 to 5.8 cm long and 2.7 to 5 cm wide; appendage is reduced to a keel. The lid spur is filiform and unbranched, 4 to 5 mm long and up to 1 mm in diameter. The tendrils are coiling to non-coiling, up to 31 cm long and 3 mm in diameter. The nectar gland distribution, coloration and indumentum are consistent with the lower pitchers.

Male inflorescence is a panicle composed of a 4.5 cm long and 5 mm wide scape and an additional 23.5 cm rachis. The partial peduncles are two-flowered up to 4 mm long. The pedicels bearing the florets are up to 1.6 cm long. The petal is tetramerous, ovate, with huge round to elongated nectar glands in the upper surface, up to 5 mm long, and up to 3 mm wide. The pollen is round and trilete. The female inflorescence has not been observed during sampling.

The indumentum is a multicellular trichome, glandular to non-glandular which is present in the flower and sparse in the tendril, pitcher exterior and in the scape.

Nepenthes manobo is illustrated in Figure 3 and 4.

The morphological features that separate *N. manobo* from *N. surigaoensis* are summarized in Table 2.

Etymology: The specific epithet was chosen to acknowledge the indigenous tribe of the manobo. *N. manobo* occurs in the ancestral territory of the manobo communities in the Pantaron range.

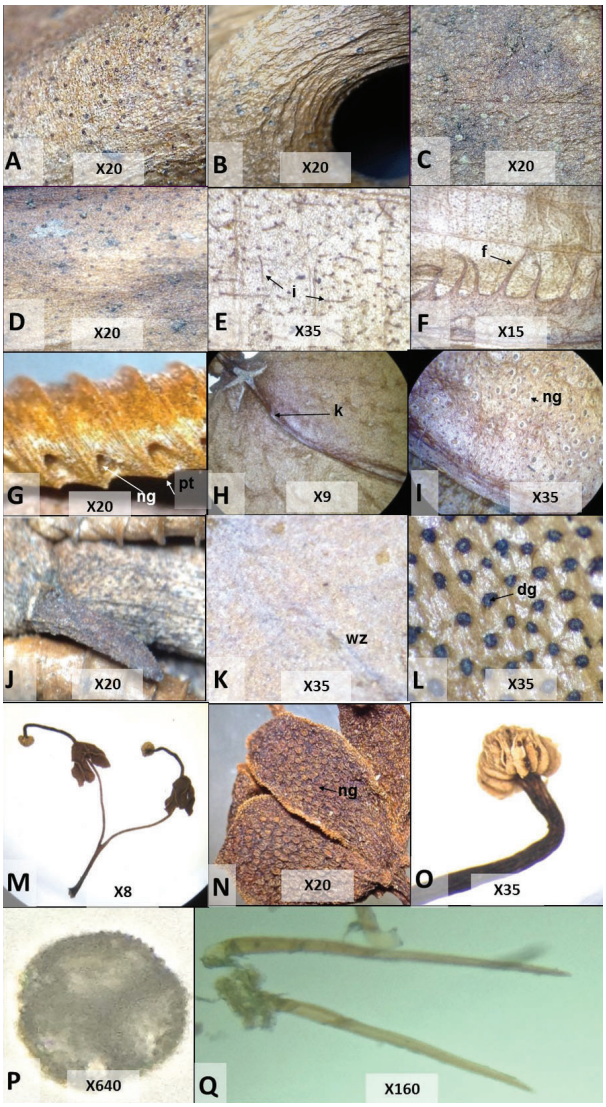

Figure 4. Photomicrographs of *Nepenthes manobo.* (A) stem, (B) tendril covered with sparse indumenta, (C) leaf adaxial, (D) leaf abaxial, (E) pitcher exterior covered with indumenta, (F) fringed wing, (G) peristome teeth, (H, I) lid nectar glands, (J) lid spur, (K) waxy zone, (L) digestive zone, (M-O) male flower, (N) tepal, (O) floret bearing the pollen, (P)trilete pollen, (Q) indumenta without pseudo-branches; f - filamentous fringe, i - indumenta, ng - nectar gland, dg - digestive gland, k - keel, pt - peristome teeth, wz - waxy zone.

Distribution and Ecology

N. malimumuensis and *N. manobo* were observed in a narrow altitude range at 1,000-1,020 masl along the ultramafic ridge trails of Mt. Malimumu, Pantaron range. The habitat type of these taxa is a mixed dipterocarp forest mostly covered with gravel and rocks; associated plants are sedges, with the very common sedge, *Themeda gigantica*; moss density is rare (20 %) with moderate leaf litter at the ground. *Nepenthes* is abundant (100 %); fallen logs are rare (20 %) while very common pteridophytes like *Pteridium aquilinum*, *Gleichenia hirta*, *Lycopodiella cernua*, *Dipteris conjugata*, *Dicranopteris linearis* can be

Table 2. Comparative major morphological characteristics separating *N. manobo* from *N. surigaoensis.*

	N. surigaoensis	***N. manobo***
longitudinal nerves	3 to 4	3
Petiole	Strongly decurrent	Sessile clasping ½ of the stem diameter
Lower pitcher	Wholly cylindrical or ellipsoidal	Bulbous to ovate bottom half, cylindrical towards the opening
Upper pitchers	Hip not apparent	Hip distinct
Lid shape	Ovate to elliptic	Orbicular to ovate
Peristome inner margin	Long teeth-like projections	Short teeth-like projections

found; common trees and shrubs are *Falcatifolium gruezoi Gymnostoma rumphianum*, *Melastoma malabathricum, Nauclea* sp., *Podocarpus* sp. and *Pandanus* sp. and *Wendlandia* sp. The site is only ca. 2 miles away from anthropogenic activities.

These species were only observed at ca. 2 miles northeast of Baranga*y* Magkalungay (N 07° 5.604' E 125° 24.391') ca. 3.5 km away from the civilized communities and nowhere else in the Pantaron and Tangkulan range or in Mindanao's prominent peaks (Gronemeyer et al. 2014, 2016).

There are about 10 individual plants recorded per species which were observed along the transect ridge trails connecting several local manobo tribe villages along the mountains of the Pantaron range.

N. malimumuensis and *N. manobo* were observed to be strictly terrestrial in their type habitat scrambling on neighboring plants. These species cohabit with *N. cornuta, N. surigaoensis, N. talaandig* and *N. truncata,* which are very abundant in the site.

N. sumagaya which was considered here a related species to *N. malimumuensis* is currently strictly known in Mt. Sumagaya, Northern Mindanao at elevations from 1600 masl to the summit at 2247 masl and was not observed in the area or elsewhere in central Mindanao (Gronemeyer et al. 2014, 2016). A distance of about 100 km separates the two species.

This finding adds to the previously known species, *N. pantaronensis*, *N. cornuta*, *N. talaandig*, *N. surigaoensis* and *N. truncata* in the Pantaron range (Gronemeyer et al. 2014) making it a home to seven Nepenthes species.

Conservation Notes

N. malimumuensis and *N. manobo* are classified here as Critically Endangered [CR B1ab (i)]; extent of occurrence estimated to be less than 10 km^2. Occurring at 1,000 to 1,020 masl in the Pantaron range and it may likely suffer habitat destruction by human development such as quarrying, illegal logging, agriculture and slash and burn farming. The species are known only from the type locality and probably are site endemics to Mt. Malimumu, Pantaron range, where it faces strong threat by deforestation (IUCN 2016).

DISCUSSION

Nepenthes malimumuensis morphologically falls under the *N. villosa* group and *N. manobo* under the *Nepenthes* sect. *Insignes*, which is most diverse in the Philippines (Cheek and Jebb 2013).

N. manobo was observed to exhibit anomalous growth on its upper pitcher lid development in having two lids as shown in Figure 3B.

This finding adds to the previously known species*, N. pantaronensis, N. cornuta, N. talaandig, N. surigaoensis* and *N. truncata* in the Pantaron range (Gronemeyer et al. 2014) making it a home to seven *Nepenthes* species.

N. malimumuensis and *N. manobo* are described in this work based on botanical field data.

ACKNOWLEDGMENTS

The authors are grateful to the research team members: Adeline Calaguian and Harold C. Armecin for the photo documentations, Gundi L. Badao, Samson M. Sabas, Stema Pinailid and Johnny I. Bangkiawan for the assistance in the collection of specimens; Maureen Acopio, Kyla Bocala, Ishter Uy and Saceo M. Sabas and Frisa Alburo Villaflor for the secretarial assistance. Special thanks to Dr. Alma Mohagan, Dr. Andrea G. Azuelo and Dr. Emmanuel P. Leaño for consultations and valuable inputs to the study.

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