

## Botanical observations from a threatened riverine lowland forest in Aborlan, Palawan, Philippines

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### ABSTRACT

This research provided a general overview of the vegetation structure of the Talakaigan watershed, Aborlan, Palawan, Philippines, with highlights on some ecological aspects of selected flora and intent of providing urgently needed data supporting existing conservation efforts in the area. Observations were carried during regular trekking activities in the watershed and surrounding areas from 2009 to 2016. Photographs were taken to facilitate species identification. Several noteworthy observations are presented, including a new locality for *Begonia palawanensis*, a short description of several new species of *Begonia* and notes on a large population of the Critically Endangered *Orania paraganensis*, including details on the early life history of these palm. A large number of anthropogenic disturbances were observed in the area, including well-intended forestation and development efforts by the local and provincial government. Since the watershed does not hold any formal protective status, these disturbances pose a serious threat to the future existence of this unique watershed and some of the endemic species it contains. Our findings support the call to declare the entire watershed as an official protected area.

**Keywords:** floral inventory, lowland rainforest, conservation, Southeast Asia, *Begonia*, *Orania*.

### INTRODUCTION

Palawan is a large island province in the southwest of the Philippines, northeast of Borneo. Because of the island's low population density and the fact that its forests contain relatively few valuable hardwood species, it has been spared from massive deforestation that has plagued the rest of the Philippines (Vitug 1993). Subsequently, the 450 km long island still has a forest cover of approximately 50% (PCSDDS 2015). In Southeast Asia forests have been decimated and continue to disappear at a rapid and unprecedented pace (Hughes 2018). The high forest cover in Palawan is thus exceptional, but unconfirmed reports suggest that the island is quickly being deforested and heading down the same road.

Previous local bureaucratic barriers made biological research difficult to conduct in the province and as a result, Palawan's biodiversity and the status of its forests are still poorly mapped and understood. However, renewed interest in research and conservation from both the local and provincial government has recently resulted in a number of new research initiatives to map the island's biodiversity. A collaborative framework of local stakeholders have engaged in a research and conservation initiative that focuses on the Cleopatra's Needle Mountain Range in northern Palawan (van Beijnen and Hoevenaars 2015; Vermeer et al. 2016). This initiative opened the gateway for researchers to record and publish several new island records including a very large freshwater fish (van Beijnen and Jose 2016), rediscovered two lost amphibian species (Jose and van Beijnen 2017), and described a number of ants and damselflies that are new to science (General and Buenavente 2015; Villanueva et al. 2018). Moreover, recent botanical expeditions in central and northern Palawan, resulted in the description of several new *Begonia* species for the island (Hughes et al. 2010, 2011, 2018).

Other parts of Palawan, especially south of the island's capital city of Puerto Princesa, have been much less explored for biological research. Updated records on the distribution, natural history and behavior of species from these areas, particularly locally endemic ones, will be of great use to both conservationists and policy makers. Especially given the paucity of information on species in this region, baseline data is lacking and essential for further studies and conservation, thereby empowering conservation efforts.

One of the least explored areas in Palawan is the municipality of Aborlan, located 69 km south of the island's capital city. This municipality covers 807.33 km<sup>2</sup> and contains one small town, with most of the surrounding countryside being covered by primary forest and secondary vegetation (PCSDS 2015). This forest is part of the Victoria-Anipahan Mountain Range that stretches from the municipality of Narra in the south up to Puerto Princesa. In Aborlan, three rivers spring from this mountain range, of which the Talakaigan River and its accompanying watershed contain some of the least disturbed lowland riverine forest remaining on the island. The forested area in this municipality is entirely listed as a Key Biodiversity Area in the Philippines (Ambal et al. 2012) and it is part of the ancestral lands of the Tagbanua tribe, who still depend on these forests for a large portion of their livelihood (Sopsop and Buot Jr. 2011). However, these forests, including the Talakaigan River watershed, largely remain unprotected and are in peril due to the influx of outsiders that bring in unsustainable harvest practices of a variety of forest products (Sopsop and Buot Jr. 2011; Bernardo 2016), and the provincial government push for so-called economic development, including a proposed hydropower (Tabuada 2015).

This research provided a general overview of the vegetation structure of the Talakaigan watershed and to highlight some ecological aspects of selected flora with the intent of providing urgently needed scientific data to support existing conservation efforts in the area.

## METHODS

As part of their weekly exercise routine, two biologists that are based in Palawan made bimonthly treks through the Talakaigan watershed and surrounding areas (Figures 1 and 2) between 2009 and 2016. The watershed was crossed mostly at random, following the river upstream and several of its side creeks uphill. All interesting encounters with different plant species were photographed using a Canon 6D Camera with high-resolution capabilities and GPS coordinates were recorded automatically. All photographs were taken by the first author. Species identifications were verified through consultation with taxonomic experts for each species group. The Co's Digital Flora of the Philippines online platform was extensively used for this purpose. Ecological observations, including records on vegetation structure, were noted down after each trip and stored for future reference. Based on the observations of selected threatened and undescribed species, a family by family, genus by genus approach were carried out to describe the sub-canopy and understory of the study site and highlight the importance of protecting its biodiversity. This sometimes required the team, during for example the germination of palm seeds, to make follow up visits to specific areas in the watershed within a short timeframe.

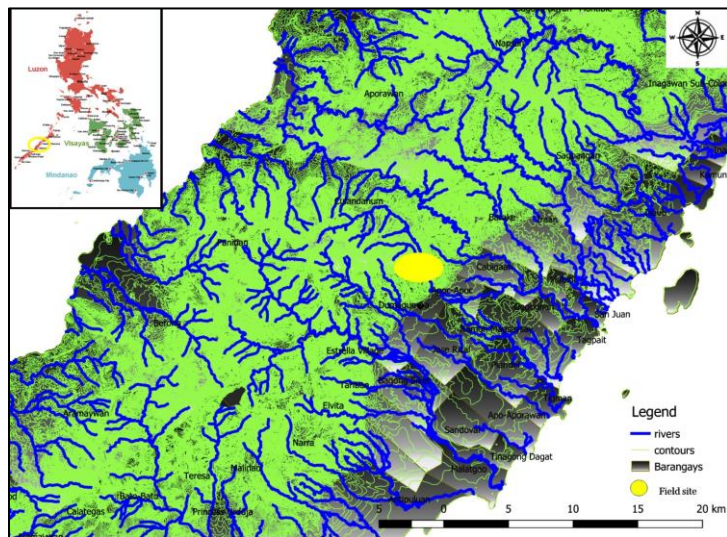


Figure 1. Map of the Philippines (inset), Aborlan and the location of the Talakaigan watershed (yellow circle).



Figure 2. The upper reaches of Talakaigan River characterized by rocky substrate, and shallow clear waters with lush vegetation along the banks.

As this research had been based on opportunistic non-professional observations only, no specimens were hurt, mishandled, or collected for the production of this research and besides photographs with GPS coordinates, no actual measurements were taken.

## RESULTS

The vegetation structure of the Talakaigan watershed was a characteristic for riverine lowland forest in central and southern Palawan (Figure 3); with the canopy along the river dominated by massive *Koompassia excelsia* (Becc.), *Dipterocarpus*, and *Ficus* species. Some large *Agathis philippinensis* (Warb.) are still present in the canopy layer, especially on hill tops. The under canopy was characterized by a high density of *Orania paraguanaensis* (Becc.) and *Barringtonia acutangula* (L.), as well as some *Artocarpus* species. The understory was dominated by *Myrmeconuclea strigosa* (Korth.) at the riverbank, mixture of *Etlingera* spp., *Pinanga* spp., *Caryota* spp., *Alocasia* spp., *Areca* spp., *Begonia* spp., and a variety of other species.



Figure 3. Views of the steep riverbank (a) with assorted palm trees (b) that characterize a large portion of the watershed of the Talakaigan River.

***Areaceae: Orania paraganensis***

A notably large population of *O. paraganensis* (Becc.), consisting of at least several hundred individuals, was encountered at the watershed. This species seems to prefer the riverbank as they mainly occurred in close vicinity of the river, where they grow predominantly on very sandy loam or sand, sometimes mixed with limestone. Palm trees were observed flowering in June and July, during the peak of the rainy season, with fruits maturing around November (Figure 4). Trees carry several inflorescences, totaling most likely over 100 fruits. The seeds were perfectly round, very hard, and approximately 5 cm in diameter (Figure 4c). When seeds mature, they fall off and, in most cases, they ended up in the river because of the steeply inclining riverbank. This method is presumably their main mode of dispersal, and this would explain why the presence of these palm trees is concentrated around a small number of larger rivers, underlining the importance of protecting upstream populations.

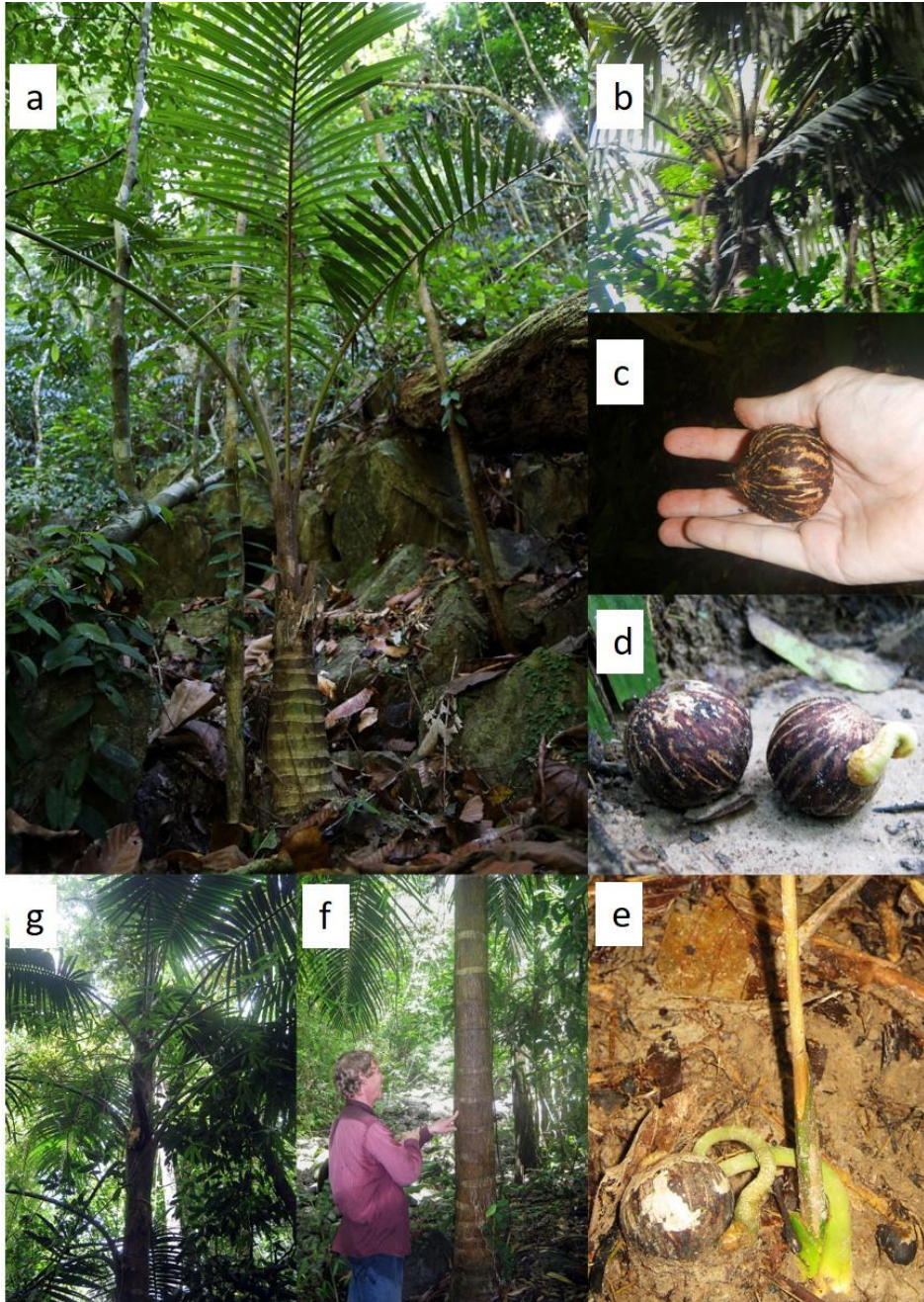


Figure 4. Different developmental stages of *Orania paraguaneensis*: Sub-adult tree (a), fruiting tree (b), freshly fallen seed (c), germinating seeds (d), germinated and settled seedling (e), close-up of the trunk of a mature tree (f) and close-up of the canopy of a mature tree (g).

**Begoniaceae: *Begonia palawanensis*, *Begonia mindorensis* and several new *Begonia* species**

On 20 March 2015, about 5-km hike upstream along the watershed a very small number of plants were found. Three non-flowering individuals of *Begonia palawanensis* were observed. Plants measured about 10 to 15 cm tall and this small size in combination with the absence of flowers likely indicates that the plants were still immature. All observed plants were growing in loamy clay, mixed with loose limestone. The plants were overhanging a steep bank of a side-creek of the Talakaigan River (Figure 5), approximately 2 m from the creek bed and roughly 150 m above sea level.



Figure 5. Immature *Begonia palawanensis* growing in-situ along a small creek in Aborlan, Palawan. This is the first published in-situ photograph of the species.

Additionally, further upstream, one epiphytic individual that somewhat seems to resemble *B. mindorensis* has been observed (Figure 6). The plant is characterized by having long petioles (about 10-20 cm), surrounded with reddish brown hairs. Leaves are medium-size, ovate-lanceolate shape. We found the plant inhabiting a tree trunk shared with dense fern-moss species. However, *B. mindorensis* is said to be restricted in the forest floor. Apparently, our observation of the species could be the first record of its epiphytic habit.



Figure 6. An undescribed epiphytic *Begonia* found in the area.

Besides *B. mindorensis* (Merr.), three other *Begonia* phenotypes had been observed in this particular watershed and surrounding areas. The leaves of this deciduous *Begonia* measure only 1-2 cm in diameter (Figure 7). During the dry season leaves were absent and plants survived in tuberous form.



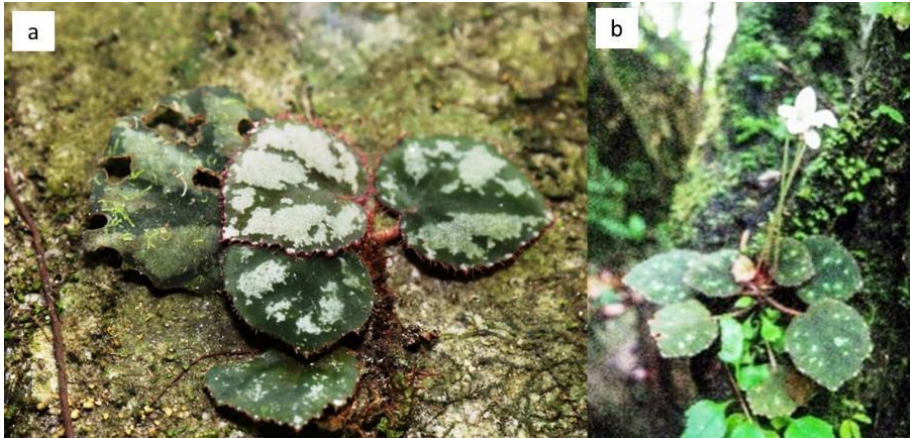


Figure 7. An undescribed miniature deciduous *Begonia* found in the area (a), and a different flowering individual from the same area (b).

### **Zingiberaceae: *Wurfbainia palawanensis***

Another noteworthy finding was the endemic *Wurfbainia palawanensis* (previously *Amomum palawanense*, Elmer) on 13 July 2015. Several hundred individuals were found growing in a relatively open secondary forest area on sandy clay. Some of these plants were flowering (Figure 8). This rare, large-size ginger plants bear flowers sprouting from its rhizomes. Our record is the first photograph and known in-situ season of its inflorescence.



Figure 8. Inflorescence of *Wurfbainia palawanensis*.

**Araceae tribe Potheae: *Pothos insignis***

Several fruiting individuals of the liana *Pothos insignis* (Becc.) were recorded on 12 November 2013. These fruiting individuals (Figure 9) were part of a large group of plants that were found growing in the trunk of a large unidentified tree just along the river. This climbing aroid was commonly growing and climbing on large trees along the forest of the Talakaigan watershed.



Figure 9. Fruits (a) and habit (b) of *Pothos insignis*.

**Araceae: *Homalomena palawanensis***

On 12 November 2013, *Homalomena palawanensis* (Merr.) was also recorded in the watershed (Figure 10). A small group of these semiaquatic clump-forming perennials was found growing along the side of the river where the water reached a depth of 15–20 cm. Aborlan, and most likely this particular watershed, is the type locality of this species.

**Miscellaneous recordings**

Other plants that have been recorded in the watershed by this study and that have been identified by consulted experts include *Pothos dolichophyllus* (Merr.), *Globba aurea* (Elm.), *Geocharis fusiformis* (Ridl.), *Citrus macroptera* (Mon.), *Boesenbergia* spp., *Amischotolype marginata* (Hassk.), *Leea* spp., *Psychotria* spp., *Alocasia culionensis* (Engl.), *Pinanga curranii* (Becc.), *Caryota* spp., *Hoya* spp., and *Piper* spp.



Figure 10. Semi-aquatic *Homalomena palawanensis* growing in shallow water along the river.

## DISCUSSION

*Orania paraguayensis* is endemic to Sabah and Palawan (Keim and Dransfield 2012). It is classified as Critically Endangered by DENR Administrative Order 2017-11 but has not been yet assessed for IUCN (2018). Mature individuals can reach an average height of 9 to 12 m, with literature references of up to 18 m and a trunk diameter of 20–30 cm (Keim and Dransfield 2012). Almost all populations of *O. paraguayensis* in Palawan are located on the east coast of the island, where higher rainfall occurs, with the species dominating only a few kilometers from the seashore, where seeds can be carried inland during high tide and strong winds. However, a small number of individuals are found pretty far from the riverbanks and it could be that the wild boar, large flying foxes, rodents (squirrels) and birds (hornbills), of which Palawan harbors several species, disperse some of the seeds as well. Dispersal by flying foxes has been recorded for *Orania sylvicola*, a species that occurs throughout most of Southeast Asia and which has a very similar seed size (Zona 2006). Seeds were observed to germinate rapidly after landing on the forest floor, often within 1 or 2 weeks. The seeds germinate remotely and the first structure to emerge from the seed is the cotyledonary petiole (Meerow and Broschat 2017). The petiole will securely anchor the seed at a depth of 20–30 cm after which it swells and develops the first root, and eventually a single shoot. From this shoot, the first leaf will emerge and

seedlings add 2 or 3 more leaves in the two following months, before the start of the dry season in January. It should be noted that the species has been officially recorded for Palawan and the province of Sabah in Malaysia. However, the presence of this species in Malaysia is based on a single observation from 1961 (Keim and Dransfield 2012), with no other records known. As such, it is safe to assume that the center of distribution for this species is located in Palawan.

Since the original discovery of the species in 1910, there have been only three recorded observations of *B. palawanensis* in Palawan; first in 1991 in Brooke's Point (Hughes et al. 2010), approximately 100 km southeast from the original type locality. Additionally in 2011 and 2014 two other observations have been made in the vicinity of the Salakot waterfalls in Puerto Princesa (Hughes et al. 2018). Besides *B. mindorensis* (Merr.) which is restricted to the forest floor, three other *Begonia* phenotypes have been observed in this particular watershed and surrounding areas. This includes a still to be described minute deciduous *Begonia* (Hughes pers. comm.) that limits its occurrence to some rocky outcrops along the river. A colleague, Esquerion Prieto found a very similar *Begonia* (Figure 11) in the Inagawan watershed, just 20 km north of the Talakaigan watershed. Actual specimens and further research are needed to determine if this *Begonia* is just an anomaly or if it represents a new species. More research is needed to determine if they belong to the same species or if they show enough variation to be classified as different species.



Figure 11. An undescribed *Begonia* from Inagawan watershed (a), and a different flowering individual from the same area (b).

*Wurfbainia palawanensis* is somewhat uncommon Zingiberaceae, and has only been recorded a few times (Nickrent et al. 2018), not because of its rarity but more likely because it rarely flowers and is consequently often overlooked in botanical surveys.

*Pothos insignis* is an uncommon aroid known only from Borneo and Palawan (Boyce and Hay 2001) and this is the first publication of in-situ photographs and inflorescence season of the species (Boyce pers. comm.). A literature review confirmed only one observation of the species since its original description: an observation that was made by Leonard Co in the same area in 2011 (Nickrent et al. 2018).

The above observations considerably increase our insights in the general vegetative structure of the watershed and the ecology and distribution of several endemic and threatened species. To further update the botanical record for this watershed, Leonard Co identified a number of other species and genera in the watershed in 2011 that have not been published, and which were not observed by this team. These species include: *Aerva lanata* (Schult.), *Pomatocalpa bicolor* (J.J.Sm.), *Ptyssiglottis* spp., *Arenga brevipes* (Becc.), *Habenaria muricata* (Barb. Rodr.), *Rinorea* spp., *Jatropha gossypifolia* (L.), *Mycetia javanica* (Hook.), *Trigonostemon villosus* (Hook.) and *Selaginella* spp. Photographs of these species are available from Nickrent et al. (2018). Altogether, these recorded observations demonstrate that the study area has interesting diversity, and includes a number of noteworthy species of conservation importance. More studies are needed to compare the results of this study with other sites to demonstrate how remarkable the diversity and conditions of this primary forest are, but based on their years of experience the authors believe this particular watershed clearly stands out.

Besides the noted species records and vegetation analysis, the team observed a number of anthropogenic disturbances in the watershed and surrounding areas and over the years, the severity of these disturbances has increased. Most notably these include the well-intended forestation and development efforts (Figures 12 and 13) by the local and provincial government, land grabbing and consequent clearings for land speculation and illegal quarrying activities, again highlighting the urgency for further study and formal protection of the area. The clearing of primary vegetation to make place for non-native trees with a higher economical value, like mahogany and rubber, is a common development approach used by government agencies across Palawan (CALG 2015), even in protected areas like national parks. Although this “greening” policy stems from poorly guided but well-intended efforts to sustain and improve the livelihoods of local residents, the impact of this practice on the native biodiversity can be substantial. Most endemic species, like the discussed *O. paraguensis* and *Begonia* spp., have very specific habitat preference and small tolerance range in terms of temperature, humidity, and light influx (Işik 2011). When clearing the understory, the

increased influx of light, increases the temperature while decreasing the humidity, and endemic species with their narrow niche are the first to disappear (Işık 2011). With the extremely limited distribution range of many *Begonias* in Palawan, this practice clearly has the potential to push these species into extinction.



Figure 12. Well-intended clearing of the understory inside the Talakaigan watershed to make place for non-native trees.

More importantly, the Talakaigan watershed and surrounding forests are also vital to the survival of indigenous people, like the Tagbanua tribe that are mainly dependent on the forests for their livelihood (Sopsop and Buot Jr. 2011). These indigenous people primarily use native plant species to sustain their diet and livelihood and the practice of slowly replacing the original forest composition with non-native species will certainly affect their livelihood negatively. As such, it is highly recommended to the relevant government agencies to reevaluate this counterproductive “greening” and “livelihood” policy and modify it.

The livelihoods of indigenous people are more likely positively impacted by officially protecting these last remaining lowland forest habitats and by limiting the influx of informal settlers and other outsiders that often employ less sustainable methods of extracting forest resources. Additionally, when planting seedlings of tree species, it is highly recommended to solely use

native species that have germinated from seeds that have been sourced in the same area. Species like *Almaciga* (*A. philippinensis*), assorted dipterocarps and *Ficus* spp. are recommended as they play an important role in the livelihood of indigenous people while also performing a key function in these threatened forest ecosystems.



Figure 13. A public irrigation project in vicinity of the Aborlan River watershed.

Our observations also give us the opportunity to make some recommendations on the existing or proposed conservation status of the discussed species. *Orania paraguayensis* seems to be much more common than previously reported, which can probably be attributed to the limited amount of fieldwork in Palawan by previous authors. Over the years, the team has recorded the species in many coastal riverine areas along the east coast of the island. At least three of these rivers are located in the newly established protected area of the Cleopatra's Needle Critical Habitat (Dasgupta 2017) in central Palawan. However, the distribution of the species remains limited to riverbanks of larger rivers in lowland areas on the east coast of the island, and this specific habitat type is increasingly under pressure by anthropogenic land conversions. Considering that the species occurs in an area over 5,000 km<sup>2</sup>, but of less than 20,000 km<sup>2</sup>, and that the adult population most likely holds over 2,500 individuals, based on IUCN criteria it is recommended to update the status of this species to Vulnerable.

*Begonia palawanensis* has no longer been observed at its type locality in Napsan, Puerto Princesa, and the continued occurrence of the population from which the specimen that was collected in 1991 originated in Brooke's Point, could not be verified despite visiting the area. This makes the watershed of the Aborlan River and the forest around the Salakot waterfalls

in western Puerto Princesa the only two verified locations where the species currently occurs. The lack of any formal protective status of both of these sites, together with the large number of disturbances in the watershed, endanger the future existence of this species. Additionally, the area surrounding the Salakot waterfalls seems to have been opened up for development by the local government and the recent influx of numerous settlers have resulted in massive deforestation. With this extremely limited distribution range, the small number of mature plants that have been observed and the large number of threats to the species, the authors believe it is warranted to classify *B. palawanensis* as Endangered, supporting the earlier proposal by Hughes et al. (2010).

Despite the numerous treks made by the team around the entire municipality, the miniature deciduous *Begonia* and the epiphytic *Begonia* have both been recorded from a single location only. While the larger *Begonia* with an acuminate apex has been observed in two small localities, all localities spanning less than 1 km<sup>2</sup> per site, and with only a handful of individual plants observed. Considering this very limited distribution and adding the clearing of the understory in the watershed, there is an urgent need of taxonomic and ecological studies for the species. Results from these studies would be the basis of recommendations for IUCN status. With our current knowledge of these species, we argue recommending a data deficient status for each species based on IUCN criteria. *Wurfbainia palawanensis* is currently listed as Vulnerable and despite the fact that the species is uncommon throughout its range, it has a wide distribution and few threats, thus its conservation status is likely warranted. Lastly, the single observation of *P. insignis* and *H. palawanensis* confirmed that both species are still present in the study site.

The lowland forest of Aborlan still holds several endemic and threatened species and, as recorded by other studies, these forests continue to play a vital role in the survival of the island's indigenous people (Sopsop and Buot Jr. 2011). With the many threats present, immediate action to protect these forests is paramount or they, and the local indigenous people who depend on them for their survival, will be lost forever. There seems to be hope as the local government of Aborlan is planning to prioritize conservation and tourism in their future development plan (WWF 2016). Furthermore, with considerable support of the local government, a local conservation NGO is in the process of developing a plan to protect 164,789 hectares of old growth forest in the area (Magdayao 2018). With forests throughout Southeast Asia disappearing at an alarming rate (Hughes 2018), support and funding for these type of conservation projects and for more comprehensive, targeted surveys to fully document community composition and prevalence of rare and threatened species should be prioritized, as to hopefully safeguard Palawan's amazing forests for future generations.



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