BIODIVERSITAS
Volume 20, Number 6, June 2019
Pages: 1699-1707

ISSN: 1412-033X
E-ISSN: 2085-4722
DOI: 10.13057/biodiv/d200628

Enumeration of *Hoya* species in Mindanao Island, Philippines: Conservation concerns

REN DIVIEN R. OBEÑA[1,♥], INOCENCIO E. BUOT, JR.[1,2,3]

[1]School of Environmental Science and Management, University of the Philippines Los Baños College, Batong Malake, Los Baños, Laguna 4031, Philippines. Tel.: +63-2-922 12 15, ♥email: rdobena@up.edu.ph.

[2]Faculty of Institute of Biological Sciences, College of Arts and Sciences, University of the Philippines Los Baños College, Batong Malake, Los Baños, Laguna 4031, Philippines

[3]Faculty of Management and Development Studies, University of the Philippines Open University, Los Baños, Laguna 4031, Philippines.

Manuscript received: 27 February 2019. Revision accepted: 25 May 2019.

Abstract. *Obeña RDR, Buot JrIE. 2019. Enumeration of* Hoya *species in Mindanao Island, Philippines: Conservation concerns. Biodiversitas 20: 1699-1707.* Unknown resources are difficult to utilize. Hence, an extensive study of literature was carried out to determine the *Hoya* species found in Mindanao, Philippines. The main purpose of the study was to know the *Hoya* resources in Mindanao, an area which is not exempted to extensive forest degradation. Many of these *Hoya* species are endemic and vulnerable to extinction. A total of 33 *Hoya* species which are epiphytes on trees had been recorded in Mindanao. Three species in the area were classified as endangered based on the Department of Environment and Natural Resources (DENR) list of threatened species (DAO 2007-01), while one species is classified as vulnerable based on DAO 2017-11. For the past years, forest cover in the Philippines has been continuously declining. This scenario can negatively affect the population of *Hoya* since the forest serves as a habitat for these species. Protection of the forest land in Mindanao can serve as a conservation strategy of the *Hoya* species.

Keywords: Conservation, enumeration, forest degradation, *Hoya*, Mindanao

INTRODUCTION

The Philippines is an archipelagic country located at the west of Pacific Ocean. It is geographically subdivided into three major islands, including (i) Luzon Island; (ii) Visayas Island; and, (iii) Mindanao Island (Rees 2016). This country is known for its rich biodiversity with high flora and fauna species endemism. A total of 7, 620 plant species are found in the Philippines, which 5, 832 are known to be native to this country. These endemic species are accounted for 1.9% of the floral species worldwide (Myers et al. 2002). Included in the plant groups that have high species endemism in the country is the genus of *Hoya* (Rodda et al. 2011).

Hoya species are angiosperm plants belonging to the family of Apocynaceae (Subfamily Aclepiadoideae) or the Dogbane family. This family is mostly characterized by having milky saps with leaves being positioned oppositely on each node (Kleijn & van Donkelaar 2001). *Hoya* species are commonly known as wax plants due to the waxy appearance of their leaves and flowers (Aurigue 2013). They are evergreen plants that have leaf shapes varying from orbicular to linear (Kleijn and van Donkelaar 2001), and flowers that have extra-axillary umbelliform inflorescence and star-shaped corona (Rodda and Nyhuus 2009). Commonly, *Hoya* species are cultivated and propagated as an ornamental plant due to their alluring and magnificent inflorescences, particularly in the countries of Europe, the United States and Australia (Wanntorp 2006).

The plant is geographically distributed to Indomalesian-Australian-Western Pacific Region (Rodda et al., 2011), with Philippines, Borneo and New Guinea as its center of diversity (Cabactulan et al. 2017). Among all of these countries, Philippines harbors the most diverse *Hoya* species. The genus of *Hoya* has the highest number of species in the family Apocynaceae with more than 500 species names recorded in IPNI (2012). According to Kloppenburg et al. (2012), there are more than 80 *Hoya* species found in the Philippines. On the other hand, Aurigue (2013) and Co's Digital Flora of the Philippines (Pelser 2018) have both reported higher estimated numbers of *Hoya* species found in the country with 109 *Hoya* species and 119 *Hoya* species, respectively. To date, there are four existing enumeration studies of hoyas found in the Philippines- Villanueva and Buot (2016; Mindoro), Santiago and Buot (2017; Palawan), Villanueva and Buot (2017; Quezon Province), and Vallena and Buot (2018; Bicol Peninsula). These studies are all focused in Luzon Island.

In the *Hoya* Handbook, Kloppenburg and Wayman (1992) listed 30 *Hoya* species where they provide short characteristics and cultivation of these species. These 30 species were found in the different regions of the world, and selected based on its accessibility, adaptability to the environment, and alluring appearance that are highly suitable for gardening. Among the listed species, four species were found in the areas of Mindoro Island, Palawan Island, Quezon Province and Bicol Peninsula. These species are *H. camphorifolia* Warb., *H. cumingiana* Decne., and *H. Meliflua* Merr. which are found in Mindoro, Quezon Province, and Bicol Peninsula, while *H. pubicalyx* Merr. is only found in Quezon Province. All of these

species, except *H. cumingiana* Decne., are endemic to the Philippines (Villanueva and Buot 2016; Santiago and Buot 2017; Villanueva and Buot 2017; Vallena and Buot 2018).

As a biodiversity hotspot country, the unique and rich diversity of these four areas are not exempted in facing multiple threats that lead to the degradation of its natural resources. The forest habitats of the sites are continuously subjected to land use conversion resulting in species habitat loss. The economic development and increase in number of migrants in these areas have led to the conversion of terrestrial forest into other land use such as agricultural land and settlement areas (Eder 1990; Gonzales et al. 2000; Shively and Martinez 2001; Mallari et al. 2011; Villanueva and Buot 2017; Vallena and Buot 2018). Since most *Hoya* species are epiphytes and usually found in the forest areas, these anthropogenic activities have placed endemic *Hoya* species in great jeopardize. Additionally, endemic species are known to be prone to extinction due to its limited growth range (Işik 2011). These circumstances could exacerbate the decline of the population of *Hoya* in the wild. It is also possible that the continuous occurrence of forest degradation may lead to the extinction of the endemic *Hoya* species found in these areas.

Attributed to the exceptionally rich biodiversity of the Philippines, the numbers of identified *Hoya* species in the country are expected to increase if there is continuous exploration of this genus (Aurigue 2013). The quantitative monitoring of biodiversity can provide fundamental understanding in detecting the changes in species population and habitat. This information can be useful in providing effective strategies for biodiversity conservation (Morrison et al. 2008). The research aims to provide enumeration of *Hoya* species found in the Mindanao, the second largest island in the Philippines archipelago. Three areas located in the site were identified as Centers of Plant Diversity in the Philippines, namely: the Mt. Kitanglad, Agusan Marsh and Mt. Apo. Despite the high diversity of flora in Mindanao, it still has limited representation in the general research of flora in the Philippines (Aribal and Buot 2009). New publication of *Hoya* species in the Philippines are largely gathered from the specimens collected in the islands of Luzon and Visayas compare to the research conducted in Mindanao (Cabactulan 2017).

MATERIALS AND METHODS

This study focused on Mindanao that is found in the southern part of the Philippines (Figure 1).

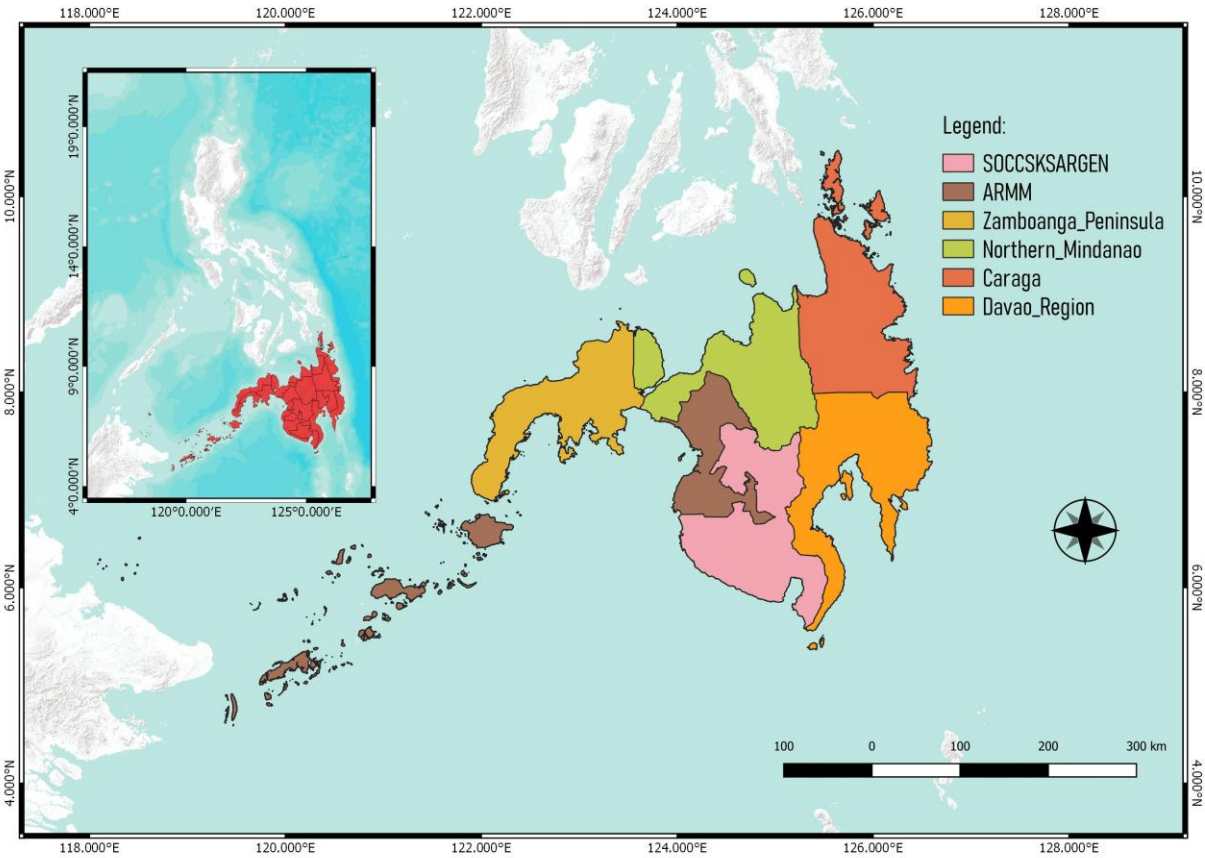

Figure 1. Map of Mindanao. Inset Map showing the location of Mindanao in the Philippines. Generated from QGIS (version 3.2.3) with ESRI satellite as base map

The site has a total land area of 102,043 sq km, occupying 34% of the country's total land area. It has six administrative regions, namely Zamboanga Peninsula, Northern Mindanao, Davao Region, SOCCSKSARGEN (that is composed of the provinces including South Cotabato, Sultan Kudarat and Sarangani, and General Santos City), Caraga and Autonumous Region in Muslim Mindanao (ARMM). The area is further divided into 26 provinces, 33 cities, and 423 municipalities (ADB 2010). Mindanao experiences three types of climate, this includes Type II, Type III and Type IV climate. Type II climate prevails in the eastern part of the island, which is characterized with maximum rain period in the months of December to February, and minimum rain period in the months of March to May with no dry season. Type III climate is described to have dry period for one to three months in the month of December to February and prevalent in the west part of the Mindanao. Most middle part of the island is experiencing form Type IV climate that has no dry season with more or less evenly distributed rainfall throughout the year (PAGASA, n.d.).

The methodology used in this study was adopted from the study of Villanueva and Buot (2016). This involves enlisting of identified *Hoya* species in Mindanao from secondary data. The secondary data used are collected from the botanical journals about *Hoya* (Merill 1923-1926; Foster 1991; Kloppenburg 2008; Kloppenburg 2012; Aurigue 2013), and recent publications of the said genus found in the Co's Digital Flora (Pelser 2011) and in the page of Robert Dale Kloppenburg (rdkloppenburg.wordpress.com). Each listed species were verified in The International Plant Name Index (IPNI), and their conservation status was determined using the Establishing the National List of Threatened Philippine Plants and Their Categories, and the List of Other Wildlife Species (DAO No. 2007-01) and the Updated National List of Threatened Philippine Plants and Their Categories (DAO No. 2017-11) as a references.

RESULTS AND DISCUSSION

Hoya species in Mindanao

Based on the literature that was reviewed, there are 33 *Hoya* species found in the Mindanao. Among the listed species, 21 *Hoya* species are endemic in the Philippines while 12 are indigenous (Table 1). The endemic *Hoya* species recorded in Mindanao includes *H. alwitriana* Kloppenb., Siar, Guevarra & Carandang, *H. amrita* Kloppenb. Siar & Ferreras, *H. angustisepala* Burton, *H. apoensis* Kloppenb. & Siar, *H. bilobata* Schltr., *H. cardiophylla* Merr., *H. ciliata* Elmer, *H. fischeriana* Warburg., *H. greenii* Kloppenb., *H. incrassata* Warb., *H. madulidii* Kloppenb., *H. mariae* (Schltr.) L. Wanntorp & Meve, *H. merrillii* Schltr., *H. migueldavidii* Cabactulan, Rodda & Pimentel, *H. odetteae* Kloppenb., *H. odorata* Schltr., *H. palawanica* Schltr., *H. pentaphlebia* Merr., *H. quinquenervia* Warb., *H. schallertiae* Burton, *H. surigaoensis* Kloppenb., Siar & Nyhuus, and *H. tsangii* Burton. On the other hand, indigenous *Hoya* species found in the Mindanao includes *H. angustifolia* Elmer, *H. carnosa* (L.) R. Br., *H. darwinii* Loher, *H. gracilis* Schltr. & Burton, *H. imbricata* Decne, *H. indaysarae* M.N. Medina, R.J.T. Villanueva, Kloppenb. & Cabras, *H. intermedia* Schltr. Ex Elmer, *H. meliflua* Merr., *H. mindorensis* Schltr., *H. multiflora* Blume, and *H. pseudomaxima* Koord. Some of these indigenous species, such as *H. angustifolia* Elmer are recorded in China, *H. mindorensis* Schltr. are found in Malaysia, while *H. multiflora* Blume is distributed to Myanmar, Sumatra, Peninsular Malaysia, Java and Borneo (Pelser et al. 2011). The characteristics of each *Hoya* found in Mindanao were described in the "A 2015 Philippine Key to *Hoya* Species" by Kloppneburg (2016). This reference can be accessed by anyone interested to use the key in the link http://dalekloppenburg.blogspot.com/2016/01/2015-philippine-key-to-hoya-species.html.

Almost 48% or equivalent to 16 *Hoya* species listed in this paper have no records in the previous studies of Checklist of *Hoya* species in the Philippines (Table 2). These are the species of *H. angustifolia* Elmer, *H. indaysarae* M.N. Medina, R.J.T. Villanueva, Kloppenb. & Cabras, *H. intermedia* Schltr. Ex Elmer, and *H. pseudomaxima* Koord. which are indigenous species, while the species of *H. angustisepala* Burton, *H. alwitriana* Kloppenb., Siar, Guevarra & Carandang, *H. amrita* Kloppenb., Siar, Ferreras, *H. apoensis* Kloppenb. Siar, *H. bilobata* Schltr., *H. cardiophylla* Merr., *H. ciliata* Elmer, *H. greenii* Kloppenb., *H. migueldavidii* Cabactulan, Rodda & Pimentel, *H. odetteae* Kloppenb., *H. pentaphlebia* Merr., *H. schallertiae* Burton were noted to be endemic species. The *H. bilobata* Schltr., *H. meliflua* Merr., and *H. pentaphlebia* Merr. were also included in the 30 *Hoya* species listed by Kloppenburg and Wayman (1992), which are famous to gardeners due to magnificent appearance, accessibility, and capability to easily adapt to the environment.

The number of the listed *Hoya* species in the Mindanao is lower compared to the number of *Hoya* in Quezon (Villanueva and Buot 2017). Quezon Province, found in the largest island (Luzon) in the Philippines and geographically located in the eastern part of the country has 39 *Hoya* species recorded. The province is part of Region IV-A or the CALABARZON Region that is composed of five provinces, namely: Cavite, Laguna, Batangas, Rizal, and Quezon. It is home to various faunal and floral endemic species, along with 37 *Hoya* species. The endemic *Hoya* species found in Quezon Province are *H. acanthominima* Kloppenb., G. Mend & Ferreras, *H. albida* Kloppenb., Cajano & Carandang, *H. bebsguevarrae* Kloppenb. & Carandang, *H. bifunda* Kloppenb., Siar, Cajano, G. Mend, Gueverra & Carandang, *H. bordenii* Schltr., *H. buotii* Kloppenb., *H. camphorifolia* Warb., *H. carandangiana* Kloppenb. & Siar, *H. concava* Kloppenburg., Siar, Guevarra, & Carandang, *H. cupula* Kloppenb. G. Mend, & Ferreras, *H. darwinii* Loher, *H. edwinofernandoi* Kloppenb. Cajano & Hadsall, *H. espaldoniana* Kloppenb., Siar & Cajano, *H. foxii* Kloppenb., *H. lazaroi* Kloppenb. & Siar, *H. leticiae* Kloppenb., Cajano & Hadsall, *H. litii* Kloppenb., Cajano & Hadsall, *H. madulidii* Kloppenb., *H. marananiae* Kloppenb.,

Siar, Cajano & Carandang, *H. martinii* Kloppenb. & G. Mend., *H. merrillii* Schltr., *H. moninae* Kloppenb. & Cajano, *H. nakarensis* Kloppenb., G. Mend. & Ferreras, *H. pimenteliana* Kloppenb., *H. platycaulis* Simonsson & Rodda, *H. polilloensis* Kloppenb., Guevarra, G. Mend. & Ferreras, *H. pubicalyx* Merr., *H. pubicenta* Kloppenb., G. Mend. & Ferreras, *H. pubicorolla* Kloppenb., G. Mend. & Ferreras, *H. ralphdavisiana* Kloppenb., G. Mend. & Ferreras, *H. salmonea* Kloppenb., Guevarra, G. Mend. & Ferreras, *H. soligamiana* Kloppenb., Siar, Cajano, *H. tangerina* Kloppenb., G. Mend. & Ferreras, *H. unruhiana* Kloppenb., Siar, G. Mend., Cajano & Carandang, *H. uplandgrantensis* Kloppenb., *H. williamoliveriana* Kloppenb., Cajano & Hadsall, and *H. williamsiana* Kloppenb., Siar, G. Mend., Cajano, Guevarra & Carandang.

The high number of listed *Hoya* species in Quezon Province is attributed to the thick forest in the area. The ENR Information and Statistics Report of the Region IV-A for 2017 listed 19 protected areas located in the region, whereas 13 of these are under the jurisdiction of Quezon Province. This includes one wilderness area, four protected landscape, and eight watershed forest reserved. Furthermore, some areas in Quezon Province is part of the Sierra Madre Mountain Range, a corridor covering an approximately 1,680,159 ha land area, and is known to be the largest mountain range in the Philippines. The Sierra Madre Mountain Range traverses the boundaries of nine provinces including Cagayan, Isabela, Nueva Vizcaya, Quirino, Nueva Ecija, Aurora, Bulacan, Rizal and Quezon Province (PAWB-DENR 1998; Antolin 2003). Based on the Biogeographic Zoning of the Philippines, a total of 492,800 ha land area of Sierra Madre Mountain Range was classified as High Biodiversity Quality. This category was described to have relatively rich and intact biodiversity. The 373,081 ha of this land area covers dipterocarp forest, and 108,599 ha of mossy forest (DENR & UNEP 1997). The Sierra Madre Mountain Range also holds 40% of the remaining primary forest in the country (Antolin 2003). Because of this thick and extensive forest cover, hoyas abound as well.

Table 1. List of *Hoya* species in Mindanao and their distribution status

Species	Distribution	References
Hoya alwitriana Kloppenburg, Siar, Guevarra & Carandang	Endemic	Asklepios 114: 16. 2012 [Sep 2012]
Hoya amrita Kloppenburg, Siar & Ferreras	Endemic	Asklepios 110: 27 (-29; figs.). 2011 [Mar 2011]
Hoya angustifolia Elmer	Indigenous	Leafl. Philipp. Bot. 10(131): 3572. 1938 [1 May 1938]
++*Hoya angustisepala* Burton Syn.: *Hoya mindanaensis* Elmer	Endemic	Hoyan 8(4.2): b (a-b; fig.). 1987 [1 Apr 1987]
Hoya apoensis Kloppenburg & Siar	Endemic	Asklepios 110: 25 (-27). 2011 [Mar 2011]
Hoya bilobata Schlechter	Endemic	Philipp. J. Sci. 1(Suppl. 4): 301. 1906
Hoya cardiophylla Merrill	Endemic	Philipp. J. Sci. 17: 310. 1921 [1920 publ. 1921]
Hoya carnosa (L.) R.Br.	Indigenous	On the Asclepiadeae 1810 = Memoirs of the Wernerian Natural History Society, Edinburgh 1 (1811) 16 (APNI)
Hoya ciliata Elmer	Endemic	Leafl. Philipp. Bot. x. 3577 (1938), anglice.
Hoya darwinii Loher	Indigenous	Gard. Chron. 1910, xlvii. 66.
Hoya fischeriana, Warburg	Endemic	in Perkins, Frag. Fl. Philipp. i. 129.
Hoya gracilis, Schltr. & Burton	Indigenous	Bot. Jahrb. Syst. 40(3, Beibl. 92): 14. 1908 [24 Jan 1908]
++*Hoya greenii* Kloppenburg	Endemic	Fraterna 1995(2): 12.
Hoya imbricata Decaisne	Indigenous	Prodr. [A. P. de Candolle] 8: 637. 1844 [mid Mar 1844] [Read the protologue in BHL].
Hoya incrassata Warbug Syn.: *Hoya orientalis* Li, *Hoya reticulata* Merrill	Endemic	in Perkins, Frag. Fl. Philipp. i. 130.
Hoya indaysarae M.N.Medina, R.J.T. Villanueva, Kloppenburg & Cabras	Indigenous	Hoya New 7(3): 2, figs. 1-10. 2018 [Jan 2018] (as "indaysarahae")
Hoya intermedia Schlechter Ex Elmer	Indigenous	Leafl. Philipp. Bot. x. 3574 (1938), in obs., nomen.
Hoya madulidii Kloppenburg	Endemic	Fraterna 1(3), Philipp. Hoya Sp. Suppl.: IV. 1990
Hoya mariae (Schlechter) L. Wanntorp & Meve	Endemic	Willdenowia 41(1): 98. 2011 [Jun 2011]
+*Hoya meliflua* Merrill Syn.: *Hoya davaoensis* Kloppenburg	Indigenous	Sp. Blancoanae 318 (1918).
Hoya merrillii Schlechter	Endemic	in Perkins, Frag. Fl. Philipp. i. 131.
Hoya migueldavidii Cabactulan, Rodda & Pimentel	Endemic	PhytoKeys 80: 107. 2017 [5 Jun 2017] [epublished]
Hoya mindorensis Schlechter	Indigenous	Philipp. J. Sci. 1(Suppl. 4): 303. 1906
Hoya multiflora Blume	Indigenous	Cat. Gew. Buitenzorg (Blume) 49. 1823; et Bijdr. Fl. Ned. Ind. 16: 1064 [Oct 1826-Nov 1827].
Hoya odetteae Kloppenburg	Endemic	Fraterna 11(2): 8. 1998
Hoya odorata Schlechter	Endemic	Philipp. J. Sci. 1(Suppl. 4): 303. 1906
Hoya palawanica Schlechter	Endemic	Fraterna 1(3), Philipp. Hoya Sp. Suppl.: V. 1990
Hoya pentaphlebia Merrill	Endemic	Philipp. J. Sci., C 13: 330. 1918
Hoya pseudomaxima Koorders	Indigenous	Philipp. J. Sci. 15: 265. 1919 [Read the protologue in BHL].
++ *Hoya quinquenervia*, Warbug	Endemic	in Perkins, Frag. Fl. Philipp. i. 132.
Hoya schallertiae Burton	Endemic	Hoyan 3(4): 96 (1982).
Hoya surigaoensis Kloppenburg, Siar & Nyhuus	Endemic	Asklepios 107: 23 (-26; figs.). 2010 [May 2010]
Hoya tsangii Burton	Endemic	Hoyan 9(4:2): i (1988).

Note: *Conservation status is based from DENR list of threatened species (Dao No. 2007-01, also found in Aurigue (2013), and DAO 2017-11). ++EN = Endangered, +VU = Vulnerable

Table 2. Geographic distribution of *Hoya* species in Mindanao shared by other regions

Species	Mindoro Island	Palawan Island	Quezon Province	Bicol Peninsula
Hoya alwitriana Kloppenburg, Siar, Guevarra & Carandang	-	-	-	-
Hoya amrita Kloppenburg, Siar & Ferreras	-	-	-	-
Hoya angustifolia Elmer	-	-	-	-
Hoya angustisepala Burton	-	-	-	-
Syn.: *Hoya mindanaensis* Elmer				
Hoya apoensis Kloppenburg & Siar	-	-	-	-
Hoya bilobata Schlechter	-	-	-	-
Hoya cardiophylla Merrill	-	-	-	-
Hoya carnosa (L.) R.Br.	-	-	-	+
Hoya ciliata Elmer	-	-	-	-
Hoya darwinii Loher	-	-	+	-
Hoya fischeriana, Warburg	-	-	-	-
Hoya gracilis, Schltr. & Burton	+	-	-	+
Hoya greenii Kloppenburg	-	-	-	-
Hoya imbricata Decaisne	-	+	-	+
Hoya incrassata Warbug	+	-	+	+
Syn.: *Hoya orientalis* Li, *Hoya reticulata* Merrill				
Hoya indaysarae M.N.Medina, R.J.T.Villanueva , Kloppenburg & Cabras	-	-	-	-
Hoya intermedia Schlechter Ex Elmer	-	-	-	-
Hoya madulidii Kloppenburg	+	-	-	-
Hoya mariae (Schlechter) L. Wanntorp & Meve	-	-	-	+
Hoya meliflua Merrill	+	+	+	-
Syn.: *Hoya davaoensis* Kloppenburg				
Hoya merrillii Schlechter	+	-	+	+
Hoya migueldavidii Cabactulan, Rodda & Pimentel	+	-	-	+
Hoya mindorensis Schlechter	-	-	-	-
Hoya multiflora Blume	+	+	-	+
Hoya odetteae Kloppenburg	-	-	-	-
Hoya odorata Schlechter	-	-	-	+
Hoya palawanica Schlechter	-	+	-	-
Hoya pentaphlebia Merrill	-	-	-	-
Hoya pseudomaxima Koorders	-	-	-	-
Hoya quinquenervia, Warbug	-	-	-	+
Hoya schallertiae Burton	-	-	-	-
Hoya surigaoensis Kloppenburg, Siar & Nyhuus	-	-	-	-
Hoya tsangii Burton	-	-	-	+

Note: "+": Present; "-": Absent

The number of hoyas in Mindanao though is higher compared with that of Bicol Peninsula (Table 3). Based on the study of Vallena and Buot (2018), there is lesser number of *Hoya* species recorded in Bicol Peninsula. It has a total 27 *Hoya* species with 19 endemic species. These include *H. bicolensis* Kloppenb., Siar & Cajano, *H. Blashernaezii* Kloppenb. subsp. *siariae* (Kloppenb.) Kloppenb., *H. blashernaezii* Kloppenb. subsp. *valmayoriana* Kloppenb., Guevarra & Carandang, *H. bordenii* Schltr., *H. bulusanensis* Elmer, *H. camphorifolia* Warb., *H. crassicaulis* Elmer ex Kloppenb., *H. davidcummingii* Kloppenb., *H. heuschkeliana* Kloppenb., *H. heuschkeliana* subsp. *cajanoae* Kloppenb, & Siar, *H. litii* Kloppenb., Siar & Cajano, *H. merrillii* Schltr., *H. mindorensis* Schltr., *H. obscura* Elmer ex C. M. Burton, *H. odorata* Schltr., *H. panchoi* Kloppenb., *H. pseudomaxima* Koord., *H. quinquenervia* Warb., and *H. tsangii* Burton ex Kloppenb. (Vallena & Buot 2018). Endemic species have limited growth range. The uncontrolled collection of native species, including the group of hoyas, may have lead to the gradual decline and extinction of this species if this practice is not regulated.

Mindanao also has higher number of hoyas compared with Palawan Island (Table 3). Palawan is home to endemic floral species with an estimated number of 3,000-3,500 species (Madulid 2002). Among these are the 11 native *Hoya* species, including *H. diversifolia* subsp. *elnidicus* Kloppenb., *H. golamcoana* Kloppenb., *H. juannguoana* Kloppenb., *H. mcgregorii* Schltr., *H. meliflua* Merr., *H. monetteae* Green, *H. palawanica* Kloppenb., *H. pulgarensis* Elmer, *H. taytayensis* Kloppenb. & Siar, *H. wibergiae* Kloppenb., and *H. Wibergiae* Kloppnenb. subsp. *alba* Kloppenb. (Santiago and Buot 2017). The unique possession of the Palawan Island should be preserved and sustainably utilized for posterity, owing to the significant position of this island in Malesian biogeography.

Again, Mindanao has higher number of hoyas compared with Mindoro (Table 3). Mindoro Island is the seventh largest island in the Philippines. It is known to have rich biodiversity that is accounted to the island's

diverse habitat. The forest types found in Mindoro Island varies along the elevation gradient (Gonzales et al. 2000). It caters a vast faunal and floral species, including the genus of *Hoya*. A total of 18 *Hoya* species, 14 are endemics, are recorded in the Island. These are the species of *H. alagensis* Kloppenb., *H. brittonii* Kloppenb., *H. camphorifolia* Warb., *H. cembra* Kloppenb., *H. espaldoniana* Kloppenb., *H. fischeriana* Warb., *H. galeraensis* Kloppenb., *H. halconensis* Kloppenb., *H. madulidii* Kloppenb. & Gilding, *H. mcgregorii* Schltr., *H. meliflua* Merr., *H. merrillii* Schltr., *H. mindorensis* Schltr., and *H. paziae* Kloppenb. The native species of hoyas in the area were threatened due to the forest degradation in the area. There are historical accounts that the land area of Mindoro Island was mostly covered by dense forest area in the past. However, only small portion of this forest remains today due to the continuous operation of various anthropogenic activities in the area (Villanueva and Buot 2015).

Comparing the number of recorded Hoya species between all sites, it is noted that Quezon Province has the highest number recorded. This province is geographically located in the eastern part of the Philippines. Most part of the Quezon Province experiences Climate Type II condition, described to have no dry season with maximum rain period in the months of December to February and minimum rain period from March to May. Though some areas of Mindanao also experience Climate Type II, the eastern part of the Quezon Province is included in parts of the country frequently visited by typhoons. In fact, at least 47 typhoons had passed in the political boundary of the Quezon Province from the period of 2000-2010. Mindanao on the other hand, had only at least 22 typhoons recorded in the same period (Padua 2019). Typhoons bring torrential rain that can be favorable for epiphytic species, such as hoyas, that requires high moisture for their growth and proliferation (Martinez & Buot 2017).

The area that has the highest number of *Hoya* species recorded among the six administrative regions in Mindanao is the Davao Region (13 species), followed by the Caraga Region (8 species). The Davao Region is composed of five provinces that include Compostella Valley, Davao del Norte, Davao del Sur, Davao Occidental and Davao Oriental (Rees 2016). Most of the *Hoya* species listed in this region are specifically found in Mt. Apo Natural Park, the highest mountain peak in the entire Philippines. This mountain traverses to the municipalities of the Davao Region and SOCCSKSARGEN (BMB 2015). In Caraga Region, the Dinagat Islands is the province that has highest number of hoyas recorded with 5 species. Coincidentally, Dinagat Island has also the same climatic type with Quezon province. Hence, this area is also a suitable habitat for epiphytic species. The Bukidnon, under the administrative region of Northern Mindanao, has the same number of *Hoya* species recorded with Dinagat Island. The boundary of Bukidnon encompasses the Mt. Kitanglad Natural Park, where most of hoyas in this province are usually found. The hoyas listed in this study were usually found in the areas of Mt. Kitanglad Range Natural Park and Mt. Apo Natural Park. These mountains are both declared as Protected Areas under the NIPAS Act of 1992 and identified as Centers of Plant Diversity in the country. The Mindanao has land area that is significantly larger compared to other sites. Nonetheless, the number of *Hoya* species recorded in the site have inconsiderable difference in terms of the number listed in other provinces (Table 2). There are other places in Mindanao that can be explored for botanical research purposes due to their highly diverse flora. These are the areas of Mt. Malindang Natural Park, the Mimbilisan Protected Landscape, and the Mt. Hamiguitan Range Wildlife Sanctuary, which are also declared as Protected Areas under the NIPAS Act of 1992. In addition to that, Mindanao has Agusan Marsh Wildlife Sanctuary which is also declared as a Protected Area, a Ramsar Site, and identified as one of the Center of Plant Diversity in the Philippines (BMB 2005; Aribal & Buot 2009; Primavera & Tumanda 2008). The results also show that there are less number of hoyas in the regions of SOCCSKSARGEN and ARMM. These regions are most affected by the rivalry between the Philippine Government and other Islamic Groups in Mindanao, which has been continuously occurring for the past 35 years (Tigno 2006). The peace and order condition in Mindanao have placed the security of the researchers at risk and limits them to conduct studies in the area. These findings emphasized that there is lesser number of botanical exploration in Mindanao compared to other sites, despite having a unique biological feature of the areas. There is a high possibility that a new species of *Hoya* may be discovered in Mindanao if there are continuous exploration in the area. An example of this is the discovery of *H. indaysarae* in Central Dinagat Island last January 2018 (Medina et al. 2018).

Conservation concerns

From year 1934- 2010, there around 23% or equivalent to 6.8 million hectares (ha) loss of Philippine forest's cover. This loss has been mainly attributed to anthropogenic activities including illegal logging, kaingin, and conversion of forest land for settlement areas and agricultural purposes (SEPO 2015). In Mindanao, conversion of forest land into oil palm and rubber plantations has been a threat for this natural habitat. The high demand for the oil palm and rubbers have caused an increase in production of these resources in the Philippines. During 1980's, harvested oil palm has covered 6,000 ha and it was increased into 22,000 ha in 2008. There was also an increase of rubber production in the Philippines from 54,000 ha in 1980 to 123,000 ha in 2008. These plantations are expected to expand in the forestlands of Palawan and Mindanao since the climatic condition and soil type of these areas have been discovered to be suitable for planting oil palm and rubber trees. In Mindanao alone, the production of rubber has increased by 25% from the period of 2005-2010 (Carandang et al. 2012). And with the loss of forest, dependent epiphytes like hoyas will be lost as well.

To protect the country's diverse biological resources and habitat, the Wildlife Resources Conservation and Protection Act or the Republic Act No. 9147 was enacted on July 30, 2001. This act has the following specific objectives of: (i) "to conserve and protect wildlife species

and their habitats to promote ecological balance and enhance biological diversity"; (ii) "to regulate the collection and trade of wildlife"; (iii) "to pursue, with due regard to the national interest, the Philippine commitment to international conventions, protection of wildlife and their habitats"; and (iv) "to initiate or support scientific studies on the conservation of biological diversity". Pursuant to the section 22 of this act, the National List of Threatened Philippine Plants and their categories, and the List of Other Wildlife Species or the Department of Environment and Natural Resources Administrative Order No. 2007-01 (DENR DAO 2007-01) was established last January 22, 2007. The DENR DAO 2007-10 was then updated on May 02, 2017 with DENR DAO No. 2017-11, also known as the Updated National List of Threatened Philippine Plants and Their Categories. These administrative orders were used to alert various sectors about the species under threats. Based on the DENR DAO No. 2007-01, three *Hoya* species found in the Mindanao were classified as endangered (EN), these include the endemic species of *H. angustisepala* Burton, *H. greenii* Kloppen., and *H. quinquenervia* Warb. Additionally, the indigenous species of *H. meliflua* Merr. was added as vulnerable (VU) species under DENR DAO 2017-11 (Figure 2). These *Hoya* species were described in the book of Aurigue (2013), entitled "A Collection of Philippine Hoyas and their Culture".

The degradation of forest can negatively affect the population and distribution of *Hoya* species since it serves as a habitat of this species (Santiago & Buot 2017; Villanueva & Buot 2017; Villanueva 2016). Majority of the *Hoya* species flourished 0-800 m. altitude, while some species are confined between 1200 and 2000 m. altitude (Kleijn and van Donkelaar 2001). This plant also thrives along rivers or exposed to other water resources such as seas where they usually growing in limestone cliffs (Aurigue 2013). The protection of forestlands and other habitats of hoyas are essential for the survival of these species. This natural characteristic of hoyas, where the plant mostly inhabits forest areas, made them vulnerable if trees in forest lands were removed. Hence, this study mainly suggested that in order to successfully conserve the hoyas in Mindanao, it is necessary to protect its forest area that is most essential for the survival and proliferation of this species in the site. It is also important that the regulations that protect *Hoya* species are strictly implemented. Effective management of hoyas involves protection of its habitat, and increasing communities awareness about the importance of the conservation of endemic species.

Table 3. *Hoya* sp. in other Provinces of the Philippines as compared with Mindanao

Study site	Ref.	Total no. of *Hoya* sp.	Total no. of endemic *Hoya* sp.	Total no. of indigenous *Hoya* sp.	Total no. of threatened *Hoya* sp.
Mindanao		33	21	12	3
Mindoro Island	Villanueva and Buot 2016)	18	14	4	3
Palawan Island	Santiago and Buot 2017)	17	11	6	2
Quezon Province	Villanueva and Buot 2017)	39	37	2	0
Bicol Peninsula	Vallena and Buot 2018)	27	19	8	4

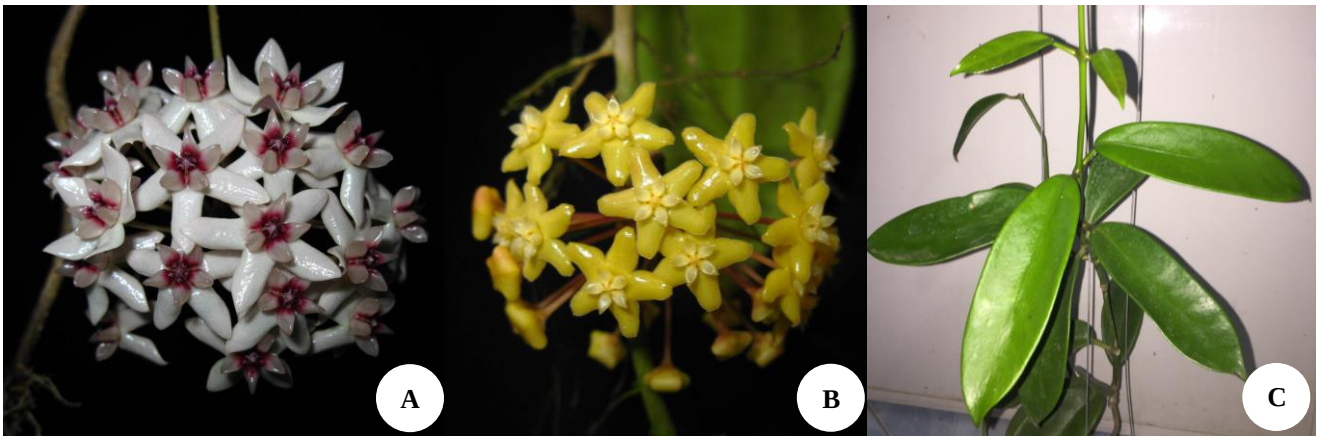

Figure 2. *Hoya* species in Mindanao Island. A. *H. greenii*; B. *H. quinquenervia*; C. *H. meliflua*. Photo credits: J.R. Sahagun and A.M. Baltazar available at http://www.phytoimages.siu.edu

In conclusion, this study showed that there are 33 *Hoya* species found in Mindanao, Philippines. Three of the listed species were classified as endangered based on DAO 2007-01 and one vulnerable species based on DAO 2017-11. There is little difference in terms of number of *Hoya* species found in the study site compared to existing studies of enumeration of *Hoya* species in the Philippines despite having larger land area than other provinces. This may imply that there is limited effort in terms of studies conducted in the Mindanao and continuous exploration may lead to discoveries of new *Hoya* species. The forest lands of Mindanao, like any other forest in the Philippines, has been constantly vulnerable to anthropogenic threats. Protection of forests is crucial for the survival of *Hoya* species.

ACKNOWLEDGEMENTS

The author would like to thank the Graduate Mentoring and Apprenticeship Program (GMAP) of the University of the Philippines, Los Baños, Laguna, and Sir Jorge Sahagun and Alcona Mae Baltazar for allowing the author to use the images of hoyas retrieved from http://www.phytoimages.siu.edu in this paper.

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