The Thailand Natural History Museum Journal 12(1): 9-18, June 2018
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Original article

Altitudinal Distribution of Some *Hoya* species in the Philippines

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ABSTRACT: Altitudinal gradient is among the ecological factors which limits the distribution of a particular species of plants. It is a subject to many ecological studies around the world. This study sought to know the effect of altitude to the distribution of *Hoya* species in the Philippines. Using the existing literature of *Hoya*, known records of the altitude were documented. Results have shown that most of the *Hoya* species (33) were found at the lower elevation ranges 0–700 m a.s.l. Further, some *Hoya* species occupied wide ranges of elevation. Among these, *Hoya cumingiana* Decne. occupied the widest range of altitude (0–2000 m a.s.l.). The study determined that *Hoya* species could thrive wide elevation ranges with lower altitude as more suitable altitude condition.

KEY WORDS: adaptation, elevation, mass elevation effect, temperature

INTRODUCTION

One of the interesting topics in ecological research is to determine the pattern of vegetation distribution along an altitudinal gradient. Plethora of researches (i.e. Ohsawa, 1984; Ohsawa *et al.*, 1985; Ohsawa, 1993; Frahm and Gradstein, 1991; Buot and Okitsu, 1998) have shown that the distribution of plant species changes with elevations as affected by change in abiotic factors such as temperature, moisture, and air pressure. Different group of plants can be found at different altitudinal zones such were lowland, lower montane, upper montane, among others. The range of elevations within each altitudinal zone varies with the size and height of the mountain. Lower mountains have different range of elevation for lowland when compared to taller mountains. This is similar with lower montane and upper montane. However, all expected zones are present. This is known as 'massenerhebung' in German, meaning "mountain mass elevation effect (Grubb, 1971). Therefore, zonation pattern can tell initially the type of weather and climate a place has. As such, presence of a particular plant species could indicate environmental conditions of a place. Generally, plants thrive in an environment where their needs and requirements are met and in an environment that they can tolerate.

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Hence, distribution of a specific species of plants across altitudinal gradient would tell the ability of that species to adapt to different environmental conditions. One of the interesting plants species that we are curious of its adaptability is *Hoya*. This plant species is known for its aesthetic and potential value for medicine. There were plenty of studies about *Hoya* species in the country such as Kloppenburg *et al.*, (2012); Jumawan and Buot, (2016); Santiago and Buot (2017); Torrefiel and Buot, (2017); Villanueva and Buot, (2017); Martinez and Buot (2017) among others. None of these studied the distribution of *Hoya* species along an altitudinal gradient. Most of these studies are either taxonomic or checklist. This study therefore sought to determine the adaptability of *Hoya* species in the Philippines along an altitudinal gradient.

MATERIALS AND METHODS

Area of study

The Philippines (Fig. 1) is a country in Southeast Asia (12.8797°N, 121.7740°E) known for its rich biodiversity. Archipelagic in nature, the country is composed of 7,641 islands (NAMRIA, 2017). Located near the equator, Philippines is a tropical country with wet and dry seasons. Unique geological and meteorological conditions favor diverse ecosystem with rich biodiversity in the country.

Data Mining

Different *Hoya* references, monographs and journal articles were reviewed and conferred resulting to the list of the altitudinal distribution of known *Hoya* species in the Philippines (Table 1). The following were the references used: A Collection of Philippine *Hoyas* and their culture (Aurigue, 2013); New Species of *Hoya* R. Br. (Apocynaceae) from the Philippines (Kloppenburg *et al.*, 2012); Checklist of *Hoya* Species on Palawan Island, Philippines (Santiago and Buot, 2017); An enumeration of Hoyas in Quezon Province, Luzon Island, Philippines (Villanueva and Buot, 2017); and *Hoya* New Volumes 1 to 7 (Kloppenburg R. D., 2013-2017). Each name was verified in the International Plant Names Index (IPNI). Records on the elevation of each *Hoya* species were noted. This study include *Hoya* species in the Philippines with known elevation data in various published literature.

RESULTS AND DISCUSSION

From the 169 *Hoya* species and subspecies found in the Philippines, only 51 had their elevations reported. Out of the 51 with known elevations, only 45 had numerical elevations recorded while the remaining six were described as low and medium altitude without specifying the ranges of this altitude. From the listed 45 species, there were 33, 8, and 9 species of *Hoya* found at elevation ranges of 0–700 m a.s.l., > 700 –1000 m a.s.l., and above 1,000 m a.s.l. respectively (Table 1). The lowest elevation range (0–700 m a.s.l.) had the most number of *Hoya* species. One of the possible explanations for this was most of the biodiversity studies conducted were at lower elevations. Another is that there is not much of higher mountain elevations in the Philippines except in the islands of Luzon and Mindanao i.e. Mt. Apo (2,954 m); Mt. Pulag (2,934 m); Mt. Halcon (2,582 m) (Belonias and Aguilar, 2004). However, it is also possible that most *Hoya* species were epiphytic which prefer humid or damp environment for water and nutrient resource. Therefore Hoya species would likely occur in low altitudinal forested areas. At lower altitude, optimum environmental conditions such as sufficient sunlight, rainwater, and average wind characterized the formation of tropical forests in the Philippines.

Similarly, altitudinal zonation of pteridophytes



Figure 1. Map of the Philippines. This map was generated using QGIS. Base map was downloaded from google maps.

had higher frequency of epiphytes in a less disturbed zones in lowland to secondary mountain elevations ranging 900–1200 meters above sea level (Banaticla and Buot, 2005). However, because of the mountain mass elevation effect (Massenerhebung effect), elevation range for lowland area differs from larger massifs (Buot and Okitsu, 1998; Belonias and Aguilar, 2004; Sopsop and Buot, 2013). Hence lowland forests in shorter mountains could range from 200–400 m a.s.l. (all depending on the size of the mountains). Further, pteridophyte distribution is dependent to some extent in the floristic structure of woody vegetation.

This is also possible for the epiphytic *Hoya* species as this group of plants require trees with sufficient canopy cover, wide crown and multiple branches suitable for growth of *Hoya* species.

Results also revealed that there were 8 species that occupy several elevation ranges (Table 1). These were *Hoya litii* Kloppenb., Siar & Cajano, *Hoya camphorifolia* Warb., *Hoya martinii* Kloppenb. & Mendoza, *Hoya meliflua* (Blanco) Merr. ssp. *escobinae* Kloppenburg, Conda, Buot & Pitargue, *Hoya cumingiana* Decne., and *Hoya leytensis* Elmer ex C. M. Burton, *Hoya josetteae* Milton, Norman, Medina & Kloppenburg, and *Hoya benguetensis* Schltr. Among these, *Hoya cumingiana* Decne. occupied the most frequency in species with several elevations gradient ranging from of 0–2000 m a.s.l. This implied that the species was adaptive to wide range of elevation.

CONCLUSION AND RECOMMENDATION

Based on the analyzed data, *Hoya* species were more adaptable in the environmental conditions at the lower elevations (0–700 m a.s.l.). This could be good for the horticulturists and hobbyists who were interested in propagating *Hoya*. There will be no need to install an expensive controlled environmental conditions at lower elevations. This might also imply that *Hoya* species diversity could be adversely affected by the anthropogenic activities at lower elevations. Therefore, this study would like to recommend for the conservation of the remaining lowland forest which as preferred habitat for *Hoya* species. Furthermore, it is also recommended to document altitudinal preferences of other *Hoya* species.

ACKNOWLEDGMENTS

The authors are thankful to Robert Dale Kloppenburg for the wisdom and encouragement, to the DOST-ASTHRDP, and to the University of the Philippines Los Baños (UPLB) Graduate Mentoring and Apprenticeship Program (GMAP) allowing the senior author to pursue this work at the Plant Systematics Laboratory (Plant Biodiversity Laboratory), Institute of Biological Sciences, College of Arts and Sciences, University of the Philippines Los Baños.

REFERENCES

Banaticla, M. and I.J. Buot. 2005. Altitudinal zonation of pteridophytes on Mt. Banahaw de Lucban, Luzon Island, Philippines. *Plant Ecology* 180: 135-151.

Belonias, B. and N. Aguilar. 2004. Altitudinal zonation of dicots on Mt. Pangasugan, Leyte, Philippines. *Journal of Environ-Science and Management* 7(2): 47-66.

Buot, I.J., and S.Okitsu. 1998. Vertical distribution and structure of the tree vegetation in the montane forest of Mt. Pulog, Cordillera Mountain range, the highest mountain in Luzon Is. Philippines. *Vegetation Science* 15: 19-32.

Frahm, J.P. and S.R. Gradstein. 1991. An

altitudinal zonation of troppical rain forests using bryophytes. *Journal of Biogeoggraphy* 18: 669-678.

Grubb, P.J. 1971. Interpretation of the 'Massenerhebung' Effect on Tropical Mountains. *Nature* pp. 229: 44-45.

Jumawan, J.H. and I.J. Buot. 2016. Numerical taxonomic analysis in leaf architectural analysis of some *Hoya* R. Br. (Apocynaceae) from the Philippines. *Bangladesh Journal of Plant Taxonomy*, 199 - 207.

Kloppenburg, R.D. 2013. *Hoya New Vol. 1 Issue 1*. Fresno, CA: http://dalekloppenburg.blogspot.com/2017/02/new-hoya-publications-full-list.html.

Kloppenburg, R.D. 2013. *Hoya New Vol. 1 Issue 2*. Fresno, CA: http://dalekloppenburg.blogspot.com/2017/02/new-hoya-publications-full-list.html.

Kloppenburg, R.D. 2013. *Hoya New Vol. 1 Issue 3*. Fresno, CA: http://dalekloppenburg.blogspot.com/2017/02/new-hoya-publications-full-list.html.

Kloppenburg, R.D. 2013. *Hoya New Vol. 1 Issue 4*. Fresno, CA: http://dalekloppenburg.blogspot.com/2017/02/new-hoya-publications-full-list.html.

Kloppenburg, R.D. 2013. *Hoya New Vol. 2 Issue 1*. Fresno, CA: http://dalekloppenburg.blogspot.com/2017/02/new-hoya-publications-full-list.html.

Kloppenburg, R.D. 2013. *Hoya New Vol. 2 Issue 2*. Fresno, CA: http://dalekloppenburg.blogspot.com/2017/02/new-hoya-publications-full-list.html.

Kloppenburg, R.D. 2013. *Hoya New Vol. 2 Issue 3*. Fresno, CA: http://dalekloppenburg.blogspot.com/2017/02/new-hoya-publications-full-list.html.

Kloppenburg, R.D. 2013. *Hoya New Vol. 2 Issue 4*. Fresno, CA: http://dalekloppenburg.blogspot.com/2017/02/new-hoya-publications-full-list.html.

Kloppenburg, R.D. 2013. *Hoya New Vol. 3 Issue 1*. Fresno, CA: http://dalekloppenburg.blogspot.com/2017/02/new-hoya-publications-full-list.html.

Kloppenburg, R.D. 2013. *Hoya New Vol. 3 Issue 2*. Fresno, CA: http://dalekloppenburg.blogspot.com/2017/02/new-hoya-publications-full-list.html.

Kloppenburg, R.D. 2013. *Hoya New Vol. 3 Issue 3*. Fresno, CA: http://dalekloppenburg.blogspot.com/2017/02/new-hoya-publications-full-list.html.

Kloppenburg, R.D. 2013. *Hoya New Vol. 4 Issue 1*. Fresno, CA: http://dalekloppenburg.blogspot.com/2017/02/new-hoya-publications-full-list.html.

Kloppenburg, R.D. 2013. *Hoya New Vol. 4 Issue 2*. Fresno, CA: http://dalekloppenburg.blogspot.com/2017/02/new-hoya-publications-full-list.html.

Kloppenburg, R.D. 2013. *Hoya New Vol. 4 Issue 3*. Fresno, CA: http://dalekloppenburg.blogspot.com/2017/02/new-hoya-publications-full-list.html.

Kloppenburg, R.D. 2013. *Hoya New Vol. 4 Issue 4*. Fresno, CA: http://dalekloppenburg.blogspot.com/2017/02/new-hoya-publications-full-list.html.

Kloppenburg, R.D. 2013. *Hoya New Vol. 5 Issue 2*. Fresno, CA: http://dalekloppenburg.blogspot.com/2017/02/new-hoya-publications-full-list.html.

Kloppenburg, R.D. 2013. *Hoya New Vol. 5 Issue 3*. Fresno, CA: http://dalekloppenburg.blogspot.com/2017/02/new-hoya-publications-full-list.html.

Kloppenburg, R.D. 2013. *Hoya New Vol. 5 Issue 4*. Fresno, CA: http://dalekloppenburg.blogspot.com/2017/02/new-hoya-publications-full-list.html.

Kloppenburg, R.D. 2013. *Hoya New Vol. 6 Issue 1*. Fresno, CA: http://dalekloppenburg.blogspot.com/2017/02/new-hoya-publications-full-list.html.

Kloppenburg, R.D. 2013. *Hoya New Vol. 6 Issue 2*. Fresno, CA: http://dalekloppenburg.blogspot.com/2017/02/new-hoya-*mental Science and Management* 7(2): 47-66.

Kloppenburg, R.D. 2013. *Hoya New Vol. 6 Issue 3*. Fresno, CA: http://dalekloppenburg.blogspot.com/2017/02/new-hoya-publications-full-list.html.

Kloppenburg, R.D. 2013. *Hoya New Vol. 6 Issue 4*. Fresno, CA: http://dalekloppenburg.blogspot.com/2017/02/new-hoya-publications-full-list.html.

Kloppenburg, R.D. 2013. *Hoya New Vol. 7 Issue 1*. Fresno, CA: http://dalekloppenburg.blogspot.com/2017/02/new-hoya-publications-full-list.html.

Kloppenburg, R.D. 2013. *Hoya New Vol. 7 Issue 2*. Fresno, CA: http://dalekloppenburg.blogspot.com/2017/02/new-hoya-publications-full-list.html.

Kloppenburg, R.D., J. Conda and I.J. Buot. 2016. *Hoya meliflua* subspecies escobinae (Apocynaceae): A new subspecies of *Hoya melifua* from Quezon Protected Landscape, Quezon Province, Philippines. *Hoya New* : 9-16.

Kloppenburg, R.D., M. L. Guevarra, J. M. Carandang and F. S. Maranan. 2012. New Species of *Hoya* R. Br. (Apocynaceae) from the Philippines. *Journal of Nature Studies* 11 (1&2): 34-48.

Martinez, M.R. and I.J. Buot. 2017. Distribution of Hoya species across climate types. *The Thailand Natural History Museum Journal* 11(2): 77-89.

NAMRIA. 2017. *News and Events*. Downloaded from National Mapping and Resource Information Authority: http:// www. namria.gov.ph/list. php?id=1032&alias= administrator-tiangco-welcomes-2017& Archive=1.

Ohsawa, M. 1984. Differentiation of vegetation zones and species strategies in the subalpine region of Mt. Fuji. *Vegetation*: 15-52.

Ohsawa, M. 1993. Latitudinal pattern of mountain vegetation zonation in southern and eastern asia. *Journal of Vegetation Science* 4: 13-18.

Ohsawa, M., P. H. Nainggolan, N. Tanaka and C. Anwar. 1985. Altitudinal zonation of forest vegetation on Mt. Kerinci, Sumatra: with comparisons to zonation in the temperate regions of east Asia. *Journal of tropical ecology* 1: 193-216.

Salvaña, F.R. and I.J. Buot. 2014. Leaf architectural study of *Hoya coriaceae, Hoya halconensis*, and *Hoya buotii. International Research Journal of BIological Sciences*: 37-44.

Santiago, J.O. and I.J. Buot. 2017. Checklist of Hoya species on Palawan Island, Philippines. *Journal of Nature Studies*: 34-44.

Sopsop, L.B. and I.J. Buot. 2013. The forest types in Aborlan Guba System, Palawan Island, Philippines. *IAMURE Multidisciplinary Research*: 88-104.

Torrefiel, J. and I.J. Buot. 2017. *Hoya carandangiana, Hoya bicolensis, Hoya camphorifolia* (Apocynaceae) species delineation: Insights from leaf architecture. *The Thailand Natural History Museum Journa*l 11(1): 35-44.

Villanueva, E.L. and I. J. Buot. 2017. An enumeration of *Hoyas* in Quezon Province, Luzon Island, Philippines. *The Thailand Natural History Museum Journal* 11(1): 23-33.

Received: 5 March 2018
Accepted: 28 May 2018

Table 1 Altitude distribution of some *Hoya* species in the Philippines.

	Hoya species	Location	Elevation (masl)
sea level - 700masl			
1.	*Hoya benitotanii* Kloppenb.	Badian, Cebu	15
2.	*Hoya edwinofernandoi* Kloppenb., Cajano & Hadsall	Nakar, Quezon	20
3.	*Hoya soligamiana* Kloppenb., Siar & Cajano	Atimonan, Quezon	20
4.	*Hoya williamoliveriana* Kloppenb., Cajano & Hadsall	Burdeos, Polillo Island, Quezon	20
5.	*Hoya marananiae* Kloppenb., Siar, Cajano & Carandang	Burdeos, Polillo, Quezon Province	22
6.	*Hoya heuschkeliana* Kloppenb.	Lake Bulusan, Sorsogon	50
7.	*Hoya crassicaulis* Elmer ex Kloppenb.	Bulusan, Sorsogon	76
8.	*Hoya foxii* Kloppenburg	Dibutunan, Baler, Aurora; Polillo Island, Quezon	100
9.	*Hoya baguioensis* Kloppenburg	Baguio Village, Quirino	150
10.	*Hoya capotoanensis* Kloppenburg	Mt. Capotoan, Samar	180
11.	*Hoya anncajanoae* Kloppenb. & Siar	Siniloan, Laguna	300
12.	*Hoya cembra* Kloppenb.	Alag River, Mindoro	300
13.	*Hoya ilagiorum* Kloppenb., Siar & Cajano	Nagcarlan, Laguna; Gen. Nakar, Quezon; Infanta, Quezon; Polilio Island	300
14.	*Hoya leticiae* Kloppenb., Cajano, & Hadsall	Gen. Nakar, Quezon	300
15.	*Hoya lucardenasiana* Kloppenb., Siar & Cajano	Siniloan, Laguna (UPLB Landgrant)	300
16.	*Hoya capotoanensis* Kloppenb. subsp. quezonensis Kloppenb. & Mendoza	Mt. Tingkoyan, Quezon	350
17.	*Hoya cumingiana* Decne. subsp. catanauanensis Kloppenb. & Mendoza	Catanauan, Quezon Province	350
18.	*Hoya lambioae* Kloppenburg, Guevarra, Cajano, & Carandang	Mudspring, Mt. Makiling, Laguna	350
19.	*Hoya loheri* Kloppenb. ssp., tanawanensis Kloppenb., & Mendoza	Mt. Tanawan, Quezon Province	350
20.	*Hoya salmonea* Kloppenb., Guevarra, G. Mend. & Ferreras	Gen. Nakar, Quezon	400

Table 1 (Continued).

	Hoya species	Location	Elevation (masl)
21.	*Hoya santafeensis* Kloppenb. & G. Mend.	Sta. Fe, Nueva Vizcaya	400
22.	*Hoya mindorensis* Schltr. subsp. lagyoensis Kloppenb. & Mendoza	Mt. Lagyo, Quezon Province	450
23.	*Hoya lagunaensis* Kloppenb.	Siniloan, Laguna (UPLB Landgrant, Quezon)	500
24.	*Hoya ormocensis* Kloppenb.	Antilao River, Ormoc, Leyte	500
25.	*Hoya ralphdavisiana* Kloppenburg, Mendoza, & Ferreras	Mt. Tagumpay, Quezon	500
26.	*Hoya larrycahilogii* Medina & Kloppenburg	Tampakan, South Cotabato	529
27.	*Hoya wibergiae* Kloppenb. ssp. alba Kloppenb.	Victoria Mt. Range, Palawan	600
28.	*Hoya litii Kloppenb.*, Siar & Cajano	Burdeos, Polillo, Quezon Province; Legazpi, Albay	10 and 60
29.	*Hoya camphorifolia* Warb.	Sampaloc, Quezon; Benguet; Mindoro; Sorsogon; Mindanao	305 - 1200
30.	*Hoya martinii* Kloppenb. & Mendoza	Real, Quezon	400-600
31.	*Hoya meliflua* (Blanco) Merr. ssp. escobinae Kloppenburg, Conda, Buot & Pitargue	Quezon Protected Landscape, Quezon Province	80 - 150
32.	*Hoya cumingiana* Decne.	Mindoro; Benguet; Bontoc; Bataan, Camarines; Albay; Rizal; Ticao, Palawan	sea-level - 2000
33.	*Hoya leytensis* Elmer ex C. M. Burton	Palo, Leyte	near sea levels
>700masl - 1000masl			
1.	*Hoya pseudoleytensis* Kloppenb., Mendoza & Carandang	Baler, Aurora	800
2.	*Hoya halconensis* Kloppenb.	Mt. Halcon, Mindoro Island	900
3.	*Hoya paziae* Kloppenb.	Mt. Halcon, Mindoro Island; Quezon; Luzon; Antique	900

Table 1 (Continued).

	Hoya species	Location	Elevation (masl)
4.	*Hoya odorata* Schltr. ssp. taytayensis Kloppenb.	Lake Balinsasayao, Tanjay, Negros Oriental	976
5.	*Hoya migueldavidii* Cabactual, Rodda & Pimentel	Mt. Kitanglad, Bukidnon	1000
6.	*Hoya josetteae* Milton Norman Medina & Kloppenburg	Marilog District, Davao City	1000 - 1500
7.	*Hoya camphorifolia* Warb.	Sampaloc, Quezon; Benguet; Mindoro; Sorsogon; Mindanao	305 - 1200
8.	*Hoya cumingiana* Decne.	Mindoro; Benguet; Bontoc; Bataan, Camarines; Albay; Rizal; Ticao; Palawan	sea-level - 2000
above 1,000masl			
1.	*Hoya carmelae* Kloppenb., Siar & Ferreras	Mt. Pinalinaw, Maconacon, Isabela	1,110
2.	*Hoya greenii* Kloppenb.	Mt. Apo Davao del Sur	1,200
3.	*Hoya corazoniae* Kloppenb., Siar & Ferreras	Mt. Bololomot, Kiblawan, Davao del Sur	1,201
4.	*Hoya odorata* Schltr.	Mariveles, Bataan; Batanes Island; Polillio Island; Batangas; Mt. Gintaban Negros Oriental; Mt. Makiling, Laguna; Mt. Panigtingan, Rizal; Montalban, Rizal; Irosin, Sorsogon; Mt. Talinas, Negros Oriental/ Lake Danao, Balinsasayao, Taytay, Negros Oriental; Mt. Kanlaon, Negros	1,300

Table 1 (Continued).

	Hoya species	Location	Elevation (masl)
		Occidental; Panay Island; Camiguin Island; Misamis Oriental	
5.	*Hoya sulitii* Kloppenb.	Mt. Kitanglad, Bukidnon	1800
6.	*Hoya josetteae* Milton Norman Medina & Kloppenburg	Marilog District, Davao City	1000 - 1500
7.	*Hoya camphorifolia* Warb.	Sampaloc, Quezon; Benguet; Mindoro; Sorsogon; Mindanao	305 - 1200
8.	*Hoya cumingiana* Decne.	Mindoro; Benguet; Bontoc; Bataan, Camarines; Albay; Rizal; Ticao, Palawan	sea-level - 2000
9.	*Hoya benguetensis* Schltr.	Baguio City (1,200 - 1,800)	1,200-1,800