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CATATAN TENTANG *Amydrium zippelianum* (*ARACEAE*): JENIS MEMESONA DARI MALESIA TIMUR

NOTES ON Amydrium zippelianum (ARACEAE): A MESMERIZING SPECIES FROM EAST MALESIA

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Abstrak

Amydrium zippelianum (*Araceae*) dilaporkan dijumpai di Malesia mulai dari Sulawesi hingga Papua Nugini, namun kini sudah jarang dijumpai. Eksplorasi flora telah dilakukan untuk mengungkap keanekaragaman flora di Kabupaten Banggai Kepulauan, sebuah kepulauan kecil di Provinsi Sulawesi Tengah. Penelitian ini bertujuan untuk menemukan dan mengumpulkan spesimen *A. zippelianum*. Eksplorasi flora dilakukan menggunakan metode pengumpulan data taksonomi, bertempat di Pulau Peleng dan Bakalan, Kabupaten Banggai Kepulauan. Material tumbuhan dikoleksi untuk dijadikan spesimen herbarium dan disimpan di Herbarium Bogoriense (BO). Spesimen *A. zippelianum* yang disimpan di BO dan portal daring kemudian diamati. Sebagai tambahan, pengamatan spesimen herbarium juga dilakukan untuk memperkaya informasi tentang *A. zippelianum* di Malesia. Peta distribusi disediakan dan data dianalisis secara deskriptif. Terdapat satu spesimen fertil *A. zippelianum* yang dikoleksi di sekitar Hutan Kokolomboy, Kabupaten Banggai Kepulauan. Di Malesia, *A. zippelianum* dapat ditemukan di dataran rendah hingga dataran tinggi pada ketinggian mencapai 2.200 mdpl dan sebagian besar ditemukan pada area hutan. Distribusi jenis ini di alam meliputi Sulawesi, Maluku, Papua Nugini, dan Filipina. Tumbuhan ini telah diintroduksi ke Jawa (Kebun Raya Bogor), Bali (Kebun Raya "Eka Karya" Bali), dan Inggris (Royal Botanic Garden, Kew).

Kata kunci*: Amydrium zippelianum*; Banggai Kepulauan; Distribusi; Penemuan kembali

Abstract

Amydrium zippelianum (Araceae) was reportedly found in Malesia, from Sulawesi to Papua New Guinea, but it is rarely seen now. Flora exploration has been conducted to reveal flora diversity in Banggai Kepulauan Regency, a group of small islands in Central Sulawesi Province. This study was aimed to find and collect A. zippelianum specimen. Flora exploration was carried out by applying taxonomy data collecting method in Peleng and Bakalan islands, Banggai Kepulauan Regency. Plant materials were collected for herbarium specimens and deposited in Herbarium Bogoriense (BO). The specimens of A. zippelianum deposited in BO and online portal database were further examined. In addition, observations of herbarium specimens were also done to obtain more information about A. zippelianum in Malesia. A distribution map was provided and data were analyzed descriptively. One fertile specimen of A. zippelianum was successfully collected around Kokolomboy Forest, Banggai Kepulauan Regency. In Malesia, A. zippelianum can be found in lowlands to highlands at elevation up to 2,200 m asl and mostly in forest area. The distribution of this species in nature covers Sulawesi, Maluku, Papua New Guinea, and the Philippines. This plant was introduced to Java (Bogor Botanic Garden), Bali ("Eka Karya" Bali Botanic Garden), and United Kingdom (Royal Botanic Garden, Kew).

Keywords*: Amydrium zippelianum; Banggai Kepulauan; Distribution; Rediscovery*

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INTRODUCTION

Amydrium zippelianum (Schott) Nicolson belongs to aroids (*Araceae*) family and the first combination name was published by Nicolson (1968) based on former species: *Rhaphidophora zippeliana* Schott (*see* Miquel, 1863). The name *R. zippeliana* is dedicated to Alexander Zippelius (1797–1828), a horticulturist turned an assistant curator at the Buitenzorg Botanic Gardens (now Bogor Botanic Garden) since 1823 (Steenis-Kruseman, 1950). The various information about the history of taxonomic account of *A. zippelianum* can be seen in some publications, such as Miquel (1863), Nicolson (1968), Hay et al. (1995), Boyce (1998), Dzu and Boyce (1999), Kurniawan, Adjie, and Boyce (2011).

Amydrium zippelianum is easily recognized by the blade of leaves that is rather big, deeply laciniated, ovate-cordate in outline, up to 125x90 cm; spathe that is yellow and deciduous, fruit that turns red when mature (Nicolson, 1968). This species is possibly confused with a similar species: *Epipremnum pinnatum* (L.) Engl. The most easily observed distinguishing feature concerns the petiolar sheath, where *A. zippelianum* has sheath that reaches only to the top of the basal geniculum, while in *E. pinnatum*, the sheath is extending to half way along the apical geniculum (Boyce, 2004). The leaf pattern of *A. zippelianum* is very beautiful and potential to be ornamental plant (Yuzammi, 2018), indeed, their flower and fruit are also magnificent. *Amydrium zippelianum* is a huge climber aroid occurring in the east part of Malesia from Sulawesi, Maluku, and the Philippines to Papua New Guinea (Boyce, 1995). This species is also found in the small islands around mainland of Sulawesi, such as Talaud Islands (Dzu, 2003).

Amydrium zippelianum is commonly found and grows scattered in flat bank forest. It has an economical value as medicinal and ornamental plant. However, there is not enough information about its conservation status due to limited exploration data. Although it was reported as a common species, *A. zippelianum* was rarely found during the flora exploration (*Araceae* in particular). There is no record of this species in Talaud Islands exploration that was conducted by author (Ina Erlinawati) in May 2017 even though the species was already collected from the same place on 1 May 1926 [*H. J. Lam 2734* (BO)]. Additionally, in mainland of Sulawesi, Nugroho and Santika (2008) did not find *A. zippelianum* during their exploration in Silui Mountain and Uluisimbone Forest, Kolaka Regency, South East Sulawesi, whereas this species was formerly found around those areas [based on specimens of *H. Wiriadinata 13341* (L); *13343* (L)]. In the Mt. Watuwila complex, south-east of Sulawesi, Erlinawati (2010) reported the diversity of terrestrial Araceae only. Therefore, there is no sufficient record of climber aroids and it seems that *A. zippelianum* is rarely found now.

The total number of *A. zippelianum* specimens deposited in BO reaches 38 numbers, while 17 numbers were deposited in another herbarium. Most of the specimens were mainly collected from mainland of Sulawesi and there is no record from the surrounding small islands. Therefore, the exploration in the small island is necessarily done to obtain more information about this species. Banggai Kepulauan Regency is a group of small islands around mainland of Sulawesi that belongs to Central Sulawesi Province. It is an archipelago with 2,488.79 km^2 of a total land area and 6,671.32 km^2 of sea area (Badan Pusat Statistik Kabupaten Banggai Kepulauan, 2018). The islands are located in the south of the eastern peninsula of Sulawesi with an altitude of 0–1,000 m. The largest island is Peleng (it is pronounced as "*Peling*") (Badan Pengelolaan Lingkungan Hidup Kabupaten Banggai Kepulauan, 2009) covering area of 2,325 km^2 (Hasanah, 2017). Despite its status as developing region, the local people in this area have not yet optimized the forest resource due to limited information about its biodiversity. Hence, *A. zippelianum* is less recognized and not well utilized.

Flora and fauna exploration has been carried out by Rahmadi et al. (2014) in Banggai Kepulauan Regency. However, specimen of *Amydrium* species was not found during this exploration (Rahmadi et al., 2014) even though this area is its natural distribution. Recently, we re-conducted flora exploration in Banggai Kepulauan to reveal more species diversity of this location. This activity was aimed to find and collect *A. zippelianum*

specimen from Banggai Kepulauan Regency. The results of this study were presented in this paper. In addition, observations of herbarium specimens were also carried out and aimed to obtain more information regarding the existence of *A. zippelianum* species in Malesia.

MATERIALS AND METHODS

This study was conducted through flora exploration and herbarium specimen examination. Flora exploration was carried out by applying taxonomy data collecting method according to Rugayah, Retnowati, Windadri, and Hidayat (2004) from June to July 2019 in Peleng and Bakalan islands, Banggai Kepulauan Regency, Central Sulawesi Province (Figure 1). Sample of plant materials (leaves, flower, and fruit) were collected for herbarium specimens. Data of habitat, location, coordinates, and the altitude of the samples were also recorded. Photographs of fresh specimens were also taken. The herbarium specimens were sent to the Herbarium Bogoriense (BO) to be further processed (Djarwaningsih, Sunarti, & Kramadibrata, 2002) and deposited. The specimens were identified through literatures written by Boyce (1995), Dzu and Boyce (1999), Dzu (2003), Boyce and Wong (2015), and also by matching the specimens found with BO specimens and online specimen photographs.

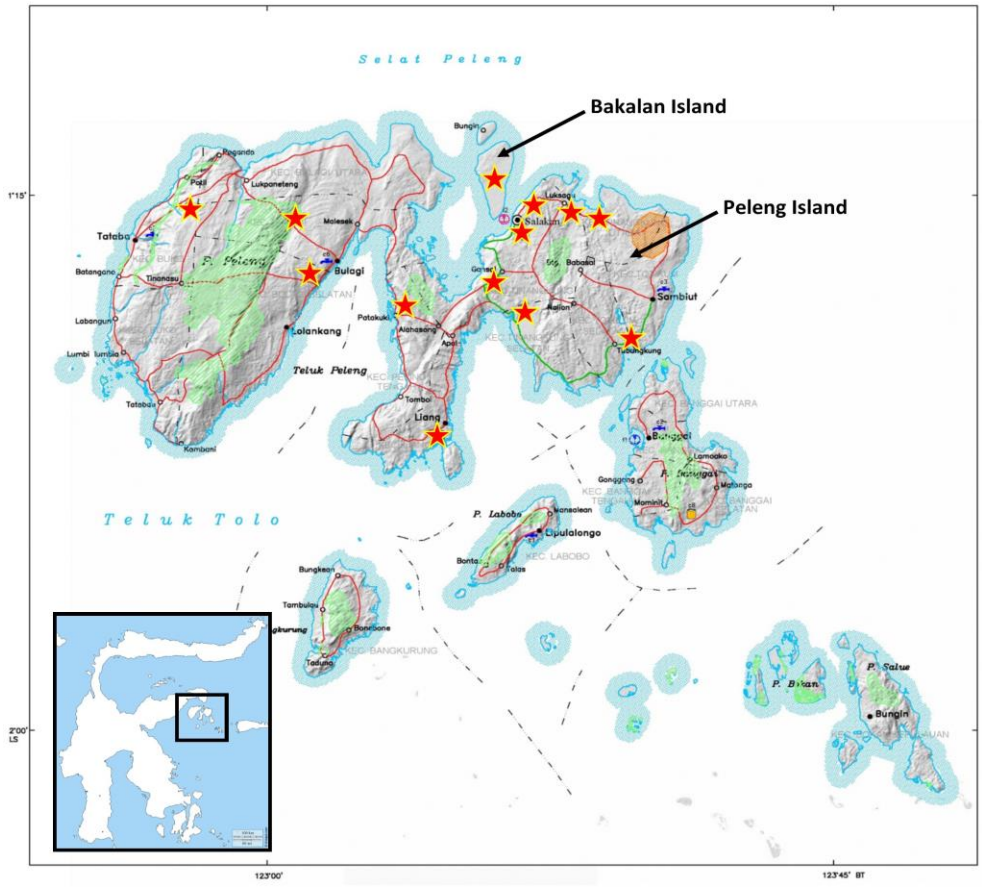

Figure 1. Location of flora exploration (orange star) in Banggai Kepulauan (modification from Kementerian Pekerjaan Umum, 2012)

The herbarium specimens of *A. zippelianum* deposited at BO and portal online databases were examined. A distribution map was made by using R software version 6.3.2. Coordinates were compiled from the data of BO specimens and other digital specimens that were available at portal online databases such as Jstor, GBIF, and POWO (*see* Jstor, 2020; Global Biodiversity Information Facility, 2020; Plant of the World Online, 2020). The areas without coordinates (just the name of the area) were fixed by using Google Maps. Eventually, data were analyzed descriptively.

RESULTS

Exploration conducted in all locations resulted in only one fertile specimen [*I. P. G. P. Damayanto & A. Haryadi 934* (BO)] of *A.*

zippelianum found from one individual mature plant in the shady and rather open areas around the forest of Kokolomboy, Banggai Kepulauan Regency at an altitude of 500 m. Specimen was added to the Araceae collection in the BO, especially as Sulawesi region collection. Eventually, this addition changed the total number of Malesia collection in BO to 39 numbers. Meanwhile, 103 sheets out of 56 collection numbers of *A. zippelianum* specimens have been observed (Table 1). This species can be found in lowlands to highlands at elevation of 3–2,200 m asl. Most of them (87.5%) were categorized as fertile collections (with flower or fruit) and widely found in forest areas. Specimen collections were mostly abundant in Sulawesi (34%), followed by Maluku (30%), Papua New Guinea (23%), Philippines (9%), and Java (4%). Specimens from Java are the cultivated species collected from Papua New Guinea. The oldest specimens were collected in 1906 and the newest was discovered in 2019. Most specimens were deposited in herbaria of BO and Naturalis Biodiversity Centre (L).

Table 1. The observation data of *Amydrium zippelianum* specimens deposited in BO and online portal database

Collector(s)	No. collection	Date of collection	Location	Altitude (m asl)	Habitat	F/S	Herbaria
I. P. G. P. Damayanto & A. Haryadi	934	5 Jul. 2019	C. Sulawesi, Peleng	500	Forest	Fertile	BO
J. T. Johansson, H. Nybom, S. Riebe	177	5 Mar. 1981	C. Sulawesi, Tongoa	650	Forest	Fertile	L
de Vogel & Vermeulen	6497	13 Mar. 1985	N. Sulawesi, Bolaang Mongondow	220	Forest	Fertile	BO, K
S. Bloembergen	4144	11 Jul. 1939	N. Sulawesi, Manado	1,000	Forest	Fertile	BO
H. J. Lam	3143	-	N. Sulawesi, Talaud	250	Forest	Fertile	BO
H. J. Lam	2734	1 May 1926	N. Sulawesi, Talaud	50	Forest	Fertile	BO
Julianto, A, Hidayat, Yessi S., U. Hapid	AJ026	14 Aug. 2009	S. E. Sulawesi, Kolaka	100	Village	Sterile	BO
H. Wiriadinata	13341	16 May 2008	S. E. Sulawesi, Kolaka	250–300	Forest	Fertile	L
H. Wiriadinata	13343	16 May 2008	S. E. Sulawesi, Kolaka	250–300	Forest	Fertile	L
S. Prawiroatmodjo & S. Soewoko	1714	13 Nov. 1978	S. E. Sulawesi, Makaleo	20–250	Forest	Fertile	L
H. A. B. Bunnemeijer	11976	9 Jun. 1921	S. Sulawesi, Bonthain (now Bantaeng)	2,200	Forest	Fertile	BO
H. A. B. Bunnemeijer	12031	10 Jun. 1921	S. Sulawesi, Bonthain (now Bantaeng)	2,060	-	Fertile	BO
H. A. B. Bunnemeijer	12376	20 Jun. 1921	S. Sulawesi, Bonthain (now Bantaeng)	1,860	-	Fertile	BO, L
H. A. B. Bunnemeijer	11599	18 May 1921	S. Sulawesi, Bonthain (now Bantaeng)	1,750	-	Fertile	BO

Collector(s)	No. collection	Date of collection	Location	Altitude (m asl)	Habitat	F/S	Herbaria
H. A. B. Bunnemeijer	11484	10 May 1921	S. Sulawesi, Lombasang	950	-	Fertile	BO
Teysmann	12850	Before 1907	S. Sulawesi, Makasar	-	-	Sterile	BO
Teysmann	12800	Before 1907	S. Sulawesi, Maros	-	-	Sterile	BO
G. Kjellberg	1987	28 Jul. 1931	S. Sulawesi, Palopo	-	-	Sterile	BO
E. Hennipman	5974	21 Jun. 1979	S. Sulawesi, Sorowako	150–350	Village	Fertile	L
A. Rant	871	17 Nov. 1931	Maluku, Ambon	-	-	Sterile	BO
Toseopens	189	11 Jun. 1921	Maluku, Buru	900	-	Fertile	BO
van Balgooy	5024	3 Dec. 1984	Maluku, Buru	800–850		Fertile	BO, L
Nooteboom	5377	5 Dec. 1984	Maluku, Buru	100–300	Valley	Fertile	L
P. J. Eyma	2352	1 Dec. 1937	Maluku, Seram	-	-	Fertile	BO
Kuswata & Soepadmo	143	10 Jun. 1959	Maluku, Seram	0–5		Fertile	BO
K. Ueda, M. Okamoto, U. V. Mahjar	2839	2 Jan. 1985	Maluku, Seram	810–900	-	Fertile	L
Idjan & Moehtar	269	19 Sep. 1957	N. Maluku, Halmahera	-	Forest	Fertile	BO
E. F. de Vogel	4512	9 Dec. 1974	N. Maluku, Halmahera	25	Forest	Fertile	BO, L
Beguin	1889	20 Nov. 1921	N. Maluku, Halmahera	20	-	Fertile	BO
Beguin	2121	13 Aug. 1922	N. Maluku, Halmahera	60	-	Fertile	BO
E. F. de Vogel	3284	6 Oct. 1974	N. Maluku, Halmahera	500	Forest	Fertile	L
E. F. de Vogel	3401	12 Oct. 1974	N. Maluku, Halmahera	950	Forest	Fertile	L
A. Kostermans	1238	27 May 1949	N. Maluku, Morotai	1,000	-	Fertile	BO
A. Kostermans	1651	30 May 1949	N. Maluku, Morotai	50	-	Fertile	BO
A. Kostermans	1190	30 May 1949	N. Maluku, Morotai	1,000	-	Sterile	BO
Beguin	1197	26 Nov. 1920	N. Maluku, Ternate	1,400	-	Fertile	BO
H. J. Lam	582	7 Jul. 1920	PNG	10	-	Fertile	BO
H. J. Lam	487	30 Jun. 1920	PNG	70	-	Fertile	BO
Aet (Exp. Lundquist)	361	26 Jun. 1941	PNG	4	-	Fertile	BO
C. Koster	BW13865	19 May 1962	PNG, Arfak Mt.	1,500	Forest	Fertile	BO, BISH
O. G. Gideon	57448	30 Aug. 1986	PNG, Bosavi	900	Forest	Fertile	L

Collector(s)	No. collection	Date of collection	Location	Altitude (m asl)	Habitat	F/S	Herbaria
A. Zippelius	s.n.	-	PNG, Irian Jaya	-	-	Fertile	L
S. H. Sohmer & P. Katik	75183	24 Apr. 1979	PNG, Madang	50–70	Forest	Fertile	L
W. N. Takeuchi	8704	26 Jan. 1993	PNG, Marobe	300–500	Forest	Fertile	F
D. R. Pleyte	1019	24 Sep. 1948	PNG, Misool	50	-	Fertile	BO
D. H. Nicolson	1476	22 Oct. 1961	PNG, Morobe	690	-	Fertile	BO
J. R. Croft & O. Gideon	71534	6 Nov. 1979	PNG, Nomad	250	Forest	Fertile	L
A. N. Vinas	59353	25 Apr. 1975	PNG, Telefomin	2,100	Forest	Fertile	L
D. H. Nicolson	1570	18 Nov. 1961	PNG, Fanindi	35	-	Steril	BO
G. Edano	75888	Oct. 1928	Philippines, Camarines Sur	-	Forest	Fertile	BO
A. D. E. Elmer	7295	Jan. 1906	Philippines, Leyte	-	-	Fertile	B, K
A. D. E. Elmer	14522	Oct. 1915	Philippines, Sorsogon	-	-	Fertile	BO, K
A. D. E. Elmer	15113	Nov. 1915	Philippines, Sorsogon	-	-	Fertile	A, BISH, GH, K, L, NY, U, UC
A. D. E. Elmer	16422	Jun. 1916	Philippine, Sorsogon	-	-	Fertile	BISH, K, NY
D. H. Nicolson	885	25 Feb. 1961	W. Java, Bogor Botanic Garden (collected from PNG)	260	Garden	Fertile	BO
A. H. G. Alston	12627	7 Dec. 1953	W. Java, Bogor Botanic Garden (collected from PNG)	260	Garden	Fertile	BO

Remarks: A= Herbarium of the Arnold Arboretum; B= Botanic Garden and Botanical Museum Berlin-Dahlem; BO= Herbarium Bogoriense; BISH= Herbarium Facificum Bishop Museum; F= The Field Museum; GH= The Gray Herbarium; K= Royal Botanic Gardens, Kew; L= Naturalis Biodiversity Centre; NY= New York Botanical Garden; U= Naturalis Biodiversity Centre; UC= University of California; PNG= Papua New Guinea; F/S= Fertile or Sterile

DISCUSSION

Taxonomy Information

***Amydrium zippelianum* (Schott) Nicolson**, Blumea 16(1): 126 (1968). Type: Papua New Guinea, Irian Jaya, *A. Zippelius s.n.* (L!). Figure 2.

Synonyms. *Amydrium magnificum* (Engl.) Nicolson, *Epipremnopsis magnifica* (Engl.) Alderw., *Epipremnopsis zippeliana* (Schott) Alderw., *Epipremnum asperatum* Engl., *Epipremnum elmerianum* Engl., *Epipremnum luzonense* K.Krause, *Epipremnum mampuanum* Alderw., *Epipremnum miniatum* Elmer ex Merr., *Epipremnum philippinense* Engl. & K.Krause, *Epipremnum sorsogonense* Elmer ex Merr., *Epipremnum zippelianum* (Schott) Engl., *Pothos miniata* Zipp. ex. Miq., *Rhaphidophora warburgii* Engl., *Rhaphidophora zippeliana* Schott.

Description. Low climber. Main stems prostrate or climbing, 2.5–3 cm thick, internodes 2–5 cm long, roots usually appear from stem nodes. Leaves blade 75–100x65–80 cm, ovate-cordate in outline, pinnatisect often

to the midrib, shiny green above and shiny pale green below. Sheath 7–8 cm long, not exceeding lower geniculum. Petioles 40–60 cm long, green, channelled apically. Peduncle 10–20 cm long, erect but sometimes spreading. Spathe broadly ovate, 9–10x8–10 cm long, reflexing at anthesis, turning green into yellow and finally deciduous. Spadix 5–6x3–4 cm, yellow when anthesis and turning orange-red when mature. Flowers arranged in a honeycomb pattern, bisexual; stamens 4. Infructescence cylindrical, 14–20x2–5 cm, yellow then turning orange-red when mature; seed 1.1x0.6x0.5 cm, brown to black, smooth, one seed per locule, locules two.

Conservation status. The information about the population of this species is not available. Conservation status of this species, therefore, is not evaluated. Based on some collector's notes, this species is relatively common in the forest of Papua New Guinea and Talaud Islands, Sulawesi. Moreover, according to Boyce (1995) this species is occasionally found in regrowth forest or as a weed in plantations. Unfortunately, author (Ina Erlinawati) did not find this species during aroid exploration in Talaud Islands in 2017.

Vernacular names. This species is known as *ganona* or *waliwaboya* (Milne Bay) (Dzu, 2003) or *kwap* (Hattam) or *panggal* (Manikiong) in Papua New Guinea. In Central Sulawesi, this species is known as *daun rusuk* (Gailea, Bratawinata, Pitopang, & Kusuma, 2016) or *ntaloni* (Besoa), whereas in Maluku, it is called *kopa* (Seram).

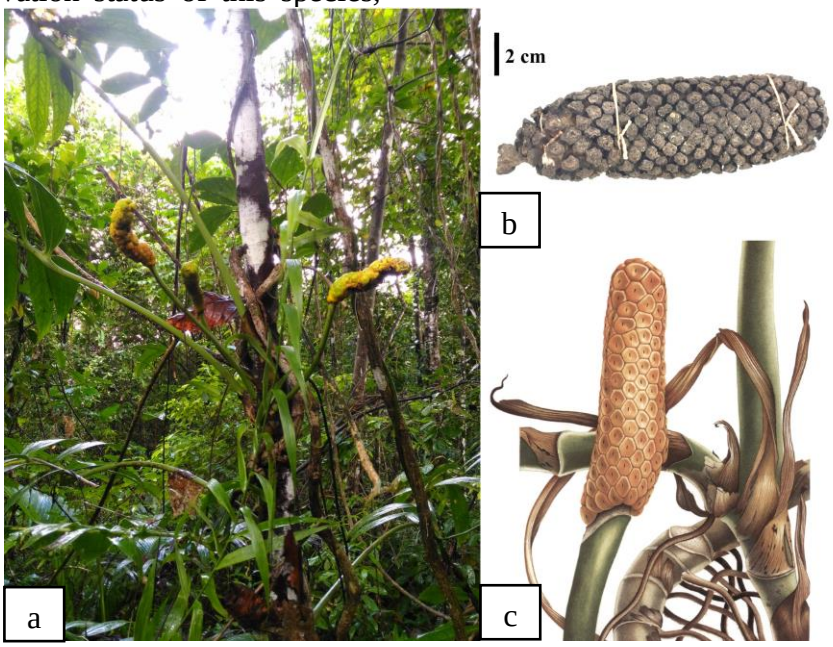

Figure 2. Habit (a), dry infructescence (b), line-drawing infructescence (c) of *Amydrium zippelianum* [Photos: Damayanto, pers. doc. from specimen *I. P. G. P. Damayanto & A. Haryadi 934* (BO) (a) and *Kuswata & Soepadmo 143* (BO) (b); modification from Boyce (1995) (c)]

Specimens examined. **Sulawesi**: C. Sulawesi, Banggai Kepulauan, Peleng Island, Buko District, Leme-leme Darat Village, Taman Kehati Forest near Kokolomboy Sub-Village, 1°16'56.3"S, 122°51'41.6"E, 500 m asl, 5 July 2019, *I. P. G. P. Damayanto & A. Haryadi 934* (BO); S. Sulawesi, Lombasang, 950 m asl, 10 May 1921, *H. A. B. Bunnemeijer 11484* (BO); S. Sulawesi, N. W. Zijde, Gg. Bonthain, 1750 m asl, 18 May 1921, *H. A. B. Bunnemeijer 11599* (BO); S. Sulawesi, Gg. Bonthain, 2200 m asl, 9 June 1921, *H. A. B. Bunnemeijer 11976* (BO); S. Sulawesi, Gg. Bonthain, 2060 m asl, 10 June 1921, *H. A. B. Bunnemeijer 12031* (BO); S. Sulawesi, Gg. Bonthain, 1860 m asl, 20 June 1921, *H. A. B. Bunnemeijer 12376* (BO); S. Sulawesi, Palopo, Boling, 28 July 1931, *G. Kjellberg 1987* (BO); S. Sulawesi, Maros, before 1907, *Teysmann 12800* (BO); S. Sulawesi, Makasar, before 1907, *Teysmann 12850* (BO); S. E. Sulawesi, N. Kolaka District, Rante Angin Subdristrict, Tinukari Village, 03°37'53.4"-03°35'51.9"N, 121°04'31.9"-121°14'12.4"E, 100 m asl, 14

August 2009, *A. Julianto, A, Hidayat, Yessi S., U. Hapid AJ026* (BO); N. Sulawesi, Bolaang Mongondow, Dumoga Bone National Park, Toraut Dam, 0°34'N, 123°54'E, 220 m asl, 13 March 1985, *de Vogel & Vermeulen 6497* (BO); S. E. Sulawesi, Kolaka, Mt. Watuwila, Upper Silui & Paraboa Village, 3°44'161"S, 121°35'482"E, 250–300 m asl, 16 May 2008, *H. Wiriadinata 13341* (L); S. E. Sulawesi, Kolaka, Mt. Watuwila, Upper Silui & Paraboa Village, 3°44'161"S, 121°35'482"E, 250–300 m asl, 16 May 2008, *H. Wiriadinata 13343* (L); N. Sulawesi, Manado, ten Oosten van het Lindoe-meer, van Kali Tokararoe tot het meer, W. Helling Goenoeng Ngilalaki, 1,000 m asl, 11 July 1939, *S. Bloembergen 4144* (BO); N. Sulawesi, Talaud, 250 m asl, *H. J. Lam 3143* (BO); N. Sulawesi, Talaud, Karakelong, S. W. Slope of G. Duata, 50 m asl, 1 May 1926, *H. J. Lam 2734* (BO); C. Sulawesi, the river S. of Tongoa, 1°10'S, 120°10'E, 650 m asl, 5 March 1981, *J. T. Johansson, H. Nybom, S. Riebe 177* (L); S. Sulawesi, Walanbalo Village, ca. 35 km from Soroako, direction Malili, 2°15'–3°S, 121°–21°45'E, 150–350 m asl, 21 June 1979, *E. Hennipman 5974* (L); S. E. Sulawesi, around Opa Swamp, Mt. Makaleo, 4°05'S, 122°E, 20–250 m asl, 13 November 1978, *S. Prawiroatmodjo & S. Soewoko 1714* (L).

Maluku: N. Maluku, Morotai, G. Pare-pare, 1,000 m asl, 27 May 1949, *A. Kostermans 1238* (BO); N. Maluku, Morotai, G. Pare-pare, 1,000 m asl, 30 May 1949, *A. Kostermans 1190* (BO); N. Maluku, Morotai, Kali Sengowo, 50 m asl, 30 May 1949, *A. Kostermans 1651* (BO); N. Maluku, Halmahera, Talaga Rano, 19 September 1957, *Idjan & Moehtar 269* (BO); N. Maluku, Halmahera, Akelamo Oba, 0°34'S, 127°36'E, 25 m asl, 9 December 1974, *E. F. de Vogel 4512* (BO); N. Maluku, Halmahera, Galela, 20 m asl, 20 November 1921, *Beguin 1889* (BO); N. Maluku, Halmahera, Soa Tabaroe, 60 m asl, 13 August 1922, *Beguin 2121* (BO); N. Maluku, Ternate, Foramadiahi, 1,400 m asl, 26 November 1920, *Beguin 1197* (BO); Maluku, Ambon, 17 November 1931, *A. Rant 871* (BO); Maluku, Boeroe (now Buru), Val. Besi, 900 m asl, 11 June 1921, *Toseopens 189* (BO); Maluku, N. W. Buru, c. 10 km S. of Bara, 800–850 m asl, 3 December 1984, *van Balgooy 5024* (BO); Maluku, Ceram (now Seram), Manusela Lama-Tanah, on the way to Hoale Pass., 1 December 1937, *P. J. Eyma 2352* (BO); Maluku, W. Ceram (now Seram), Kairatu, Gemba, 0–5 m asl, 10 June 1959, *Kuswata & Soepadmo 143* (BO); Maluku, Vicinity of Maraina (810 m), Manusela Valley, Seram Utara District, 3°10'S, 129°35'E, 810–900 m asl, 2 January 1985, *K. Ueda, M. Okamoto, U. V. Mahjar 2839* (L); Maluku, N. W. Buru, Wae Duna River, N. of Bara, 100–300 m asl, 5 December 1984, *Nooteboom 5377* (L); N. Maluku, Halmahera, Gg. Sahu, near Susupu, 1°11'N, 127°27'E, 500 m asl, 6 October 1974, *E. F. de Vogel 3284* (L); N. Maluku, Halmahera, Gg. Jailolo, 1°04'N, 127°27'E, 950 m asl, 12 October 1974, *E. F. de Vogel* 3401 (L).

Papua New Guinea: Irian Jaya, *A. Zippelius s.n.* (L); New Guinea, 10 m asl, 7 July 1920, *H. J. Lam 582* (BO); New Guinea, Pianissbivak, 70 m asl, 30 June 1920, *H. J. Lam 487* (BO); New Guinea, Arfak Mountains, Mt. Nerimbau, Near Minjambau, 1,500 m asl, 19 May 1962, *C. Koster BW13865* (BO, BISH); New Guinea, Morobe Distrcit, Wau, 690 m asl, 22 October 1961, *D. H. Nicolson 1476* (BO); West New Guinea, Fanindi, 1 km west of Manokwari, 35 m asl, 18 November 1961, *D. H. Nicolson 1570* (BO); New Guinea, Misool, Bij Waron, 50 m asl, 24 September 1948, *D. R. Pleyte 1019* (BO); New Guinea, Aria Bij Oeta, 4 m asl, 26 June 1941, *Aet (Exp. Lundquist) 361* (BO); New Guinea, Marobe Province, N. of the Busu River at Kumbok, 6°33'S, 146°59'E, 300–500 m asl, 26 January 1993, *W. N. Takeuchi 8704* (F); New Guinea, Medium north slopes of Mt. Bosavi, Tari Subprovince, 6°28'S, 142°50'E, 900 m asl, 30 August 1986, *O. G. Gideon 57448* (L); New Guinea, Gogol River Valley, Woodchip Project area, rt. bank of Ninam River. Subpr. Madang, Prov. Madang, 5°8'S, 145°31'E, 50–70 m asl, 24 April 1979, S. *H. Sohmer & P. Katik 75183* (L); New Guinea, Subprovince Nomad, Province Western, 6°17'S, 142°25'E, 250 m asl, 6 November 1979, *J. R. Croft & O. Gideon 71534* (L); New Guinea, Telefomin Subdistrict, West Sepik District. Top of ridge, 1.5 km north of Busilmin airstrip, 5°00'S, 141°05'E, 2,100 m asl, 25 April 1975, *A. N. Vinas 59353* (L).

Philippines: Irosin (Mt. Bulusan), Province of Sorsogon, Luzon Island, October 1915, *A. D. E. Elmer 14522* (BO, K); Irosin (Mt. Bulusan), Province of Sorsogon, Luzon Island, Nov. 1915, *A. D. E. Elmer 15113* (A, BISH, GH, K, L, NY, U, UC); Irosin (Mt. Bulusan), Province of Sorsogon, Luzon Island, Jun. 1916, *A. D. E. Elmer 16422* (BISH, K, NY); Leyte Island, Leyte Province, Palo, Jan. 1906, *A. D. E. Elmer 7295* (B, K); Luzon, Kamugong River, Camarines Sur, October 1928, *G. Edano 75888* (BO).

Java: W. Java, Bogor Botanic Garden, 25 February 1961, *D. H. Nicolson 885* (BO); W. Java, Bogor Botanic Garden, 7 December 1953, *A. H. G. Alston 12627* (BO).

Ecology and Distribution

Nicolson (1968), Boyce (1995), and Dzu (2003) mentioned that *A. zippelianum* can only be found at elevation up to 1,800 m asl. Moreover, the result of this study showed that this species could grow in lowlands to highlands at altitude of 0–2,200 m asl (Figure 3). The boxplot in Figure 3 shows the distribution of *A. zippelianum* in regard to the elevation where Malesia obtained maximum elevation. In this case, species occurrence in Malesia obtained lower median elevation compared to that in Maluku islands despite the similar range of elevation in area where the species was found. This result is possible since less exploration was conducted in Maluku Island, especially at a higher elevation. In addition, similar results of median elevation were shown in other locations, revealing this species is mainly found at lower elevation. This finding is in accordance with the other reports of *A. zippelianum* confirming the species is mostly found in primary forest, from lowland to lower mountain rainforest.

Plants have the adaptability to adjust to the expression of their morphological and physiological traits in response to environmental variations (Sultan, 1995; Robakowski, Montpied, & Dreyer, 2003; McIntyre, Lavorel, Landsberg, & Forbes, 2009). Altitude can significantly influence plant growth, structure, function, and metabolism (Berli, Alonso, Bressan-Smith, & Bottini, 2013; Dogra, Ahuja, & Sreenivasulu, 2013). At present, studies about the morphological changes as adaptation mechanism of *A. zippelianum* in relation to altitude variation is largely unknown and inadequate. However, some trees such as alpine plants show specific morphological, physiological, and biochemical responses as altitude increases followed by lower temperature, i.e. small leaf size and thickness increases (Richardson, Berlyn, & Gregoire, 2001; Guo, Li, & Zhang, 2016). Those morphological changes lead to highly efficient leaves with respect to photosynthesis (Korner & Diemer, 1987). The fact that cell size is not reduced at high altitudes indicating that mountain plants and their respective organs are small for producing fewer cells (Korner, Neumayer, Menendez-Riedl, & Smeets-Scheel, 1989).

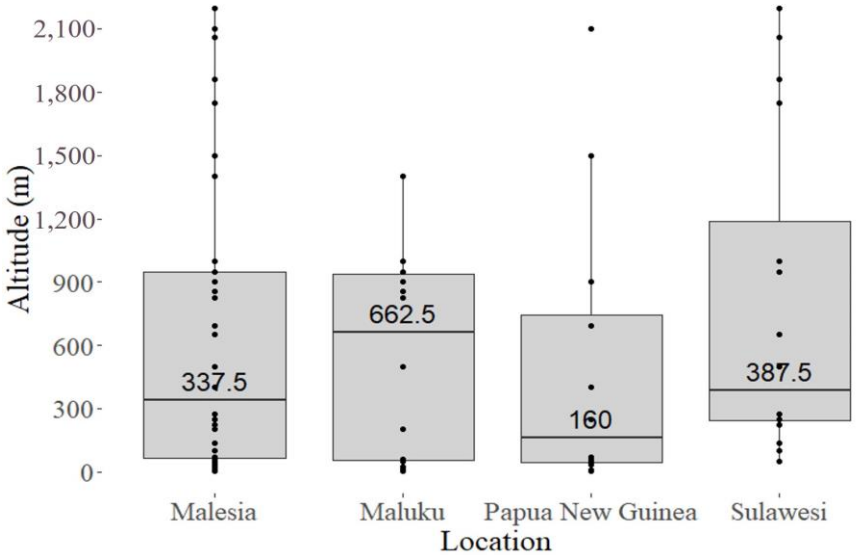

Figure 3. Trend of *Amydrium zippelianum* distribution in several areas in Malesia based by altitude

This species, furthermore, is occasionally found as weed in plantations (Boyce, 1995). Therefore, it can be found in a disturbed area or secondary forest as well. This plant is also found growing in moderate dense primary forest of 40 m high with less undergrowth, mixed forest on a steep limestone slope, limestone mix with gravel and stone, forest with sandy loam soil, forest with moderate moist alluvial flat and deep clay soil, primary forest of 10 m high with deep loose porous volcanic soil, riverbank, river valley with a steep slope, remnant forest in flood plain of the river, and along an access road. This species was also reportedly growing in undisturbed primary rainforest dominated by species of *Lithocarpus*, *Nothofagus*, and *Syzygium.* Meanwhile, Dzu (2003) reported the occurrence of *A. zippelianum* mainly in a primary rain forest, sometimes also in disturbed forest, in shady areas, climbs on trees and also rocks.

Distribution of *A. zippelianum* (Figure 4) covers area of mainland of Sulawesi (i.e. Central, North, South, and South East Sulawesi) and surrounding islands (Banggai Kepulauan and Talaud), Maluku Archipelago (Buru, Seram, Halmahera, Morotai, and Ternate), mainland of Papua New Guinea and its surrounding island (Misool), and the Philippines. The occurrence of this species in Banggai Kepulauan and several islands in Maluku, such as Buru, Morotai, Seram, and Ternate, and also island in Papua New Guinea, such as Misool are now officially a new distribution record for *A. zippelianum* in Malesia, where Nicolson (1968) and Boyce (1995) never mentioned about it before. Beside in Arfak Mountain, Irian Jaya, Bosavi, Madang, Marobe, Nomad, and Telefomin, *A. zippelianum* in Papua New Guinea was also reportedly found in Wara Ikil (Ikil River), near Madang (Takeuchi, 1999a) and Crater Mountain (Takeuchi, 1999b).

Amydrium zippelianum has also been reportedly introduced to West Java. This species has been cultivated in Bogor Botanic Garden where the original plant was collected from Papua New Guinea by Dr. van Leeuwen on 30 October 1926 with the collection number Y60 [based on collector's notes of specimens of *D. H. Nicolson 885* (BO) and *A. H. G. Alston 12627* (BO)]. A collection of *A. zippelianum* in Bogor Botanic Garden was reportedly having the ability to climb reaching up to 180 cm on *Canarium* plant. Based on a list of living plant collection in Bogor Botanic Garden, this species (reported as *A. magnificum* from Papua New Guinea) has been cultivated at block XII.B.VI.24 and Y55–55a, 60–60a (Danimihardja & Notodihardjo, 1978; 1985). Danimihardja and Notodihardjo (1978; 1985) also mentioned that another collection of *A. magnificum* from Sulawesi was also cultivated at block Y37–37a in Bogor Botanic Garden. In 2001, a collection of this species (reported as *A. magnificum*) at block Y60 might be dead because Astuti, Soewilo, Said, and Kosasih (2001) did not report it in a list of living plant collection in Bogor Botanic Garden. In 2010, only the collections at block XII.B.VI.24; Y55 were reported and there were two additional collections from Kalimantan and South East Sulawesi (reported as *A. zippelianum*) cultivated at block XII.B.V.116 and Z215, respectively (Sari, Ruspandi, & Ariati, 2010). Recently, plants of *A. zippelianum* were reportedly cultivated in block Y86, 95 (from South Kalimantan), Y118 (from Central Kalimantan), and Y55 (from Papua) (Ariati et al., 2019). A collection of *A. zippelianum* from Kalimantan requires re-identification since Kalimantan is not a distribution range of this species. On the other hands, "Eka Karya" Bali Botanic Garden was reported to have some living collections of *A. zippelianum* cultivated at block XIX.K.I.95–95a–95b (from South East Sulawesi), XIX.K.I.162–162a, N172 (from Papua), and XIX.K.I.167–167a–167b–167c–167d–167e (from Maluku) (Arinasa, Adjie, & Putri, 2017). Meanwhile, outside of the botanical garden, this species was reportedly not occurred naturally in Bali (*see* Kurniawan & Asih, 2012). In Cibodas Botanic Garden, this species was reportedly not occurred (*see* Widyatmoko, Suryana, Suhatman, & Rustandi, 2010).

Amydrium zippelianum was also reportedly introduced to Royal Botanic Garden, Kew, United Kingdom and Munich Botanic Garden, Germany (Boyce, 1995). This species reportedly thrived in both botanic gardens. However, based on personal communication in 2020, Prof. Dr. Susan S.

Renner, the Director of Munich Botanic Garden, mentioned that they do not have *A. zippelianum* in cultivation. Moreover, based on personal communication in 2020 with Roxana Glenn, a staff of the visitor information field of Royal Botanic Garden, Kew, there is one living collection of *A. zippelianum* in Princess of Wales Conservatory, a glassy house dedicated to carnivorous plant, succulent species, and some tropical plants. *Amydrium zippelianum* in those botanic gardens were reported flowering and fruiting regularly (Boyce, 1995). Based on data of herbarium specimens, *A. zippelianum* in nature can be found producing flowers and fruit throughout the year (Figure 5). Flowering and fruiting season of this plant in natural habitat most frequently occurs from May to June. It was observed that the end of the dry season in tropical area is the time when most plants produce fruit.

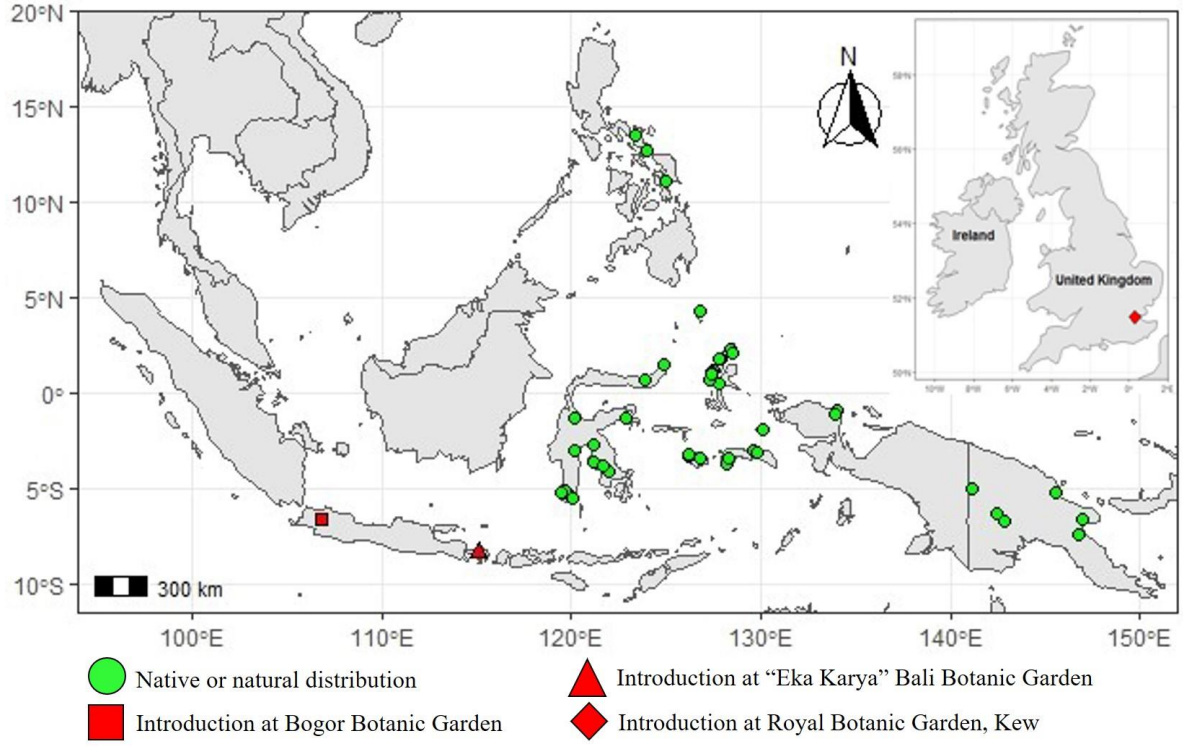

Figure 4. Distribution of *Amydrium zippelianum.* Remarks: Native species (Sulawesi, Maluku, Papua New Guinea, the Philippines), Introduced species (Java, Bali, Kew)

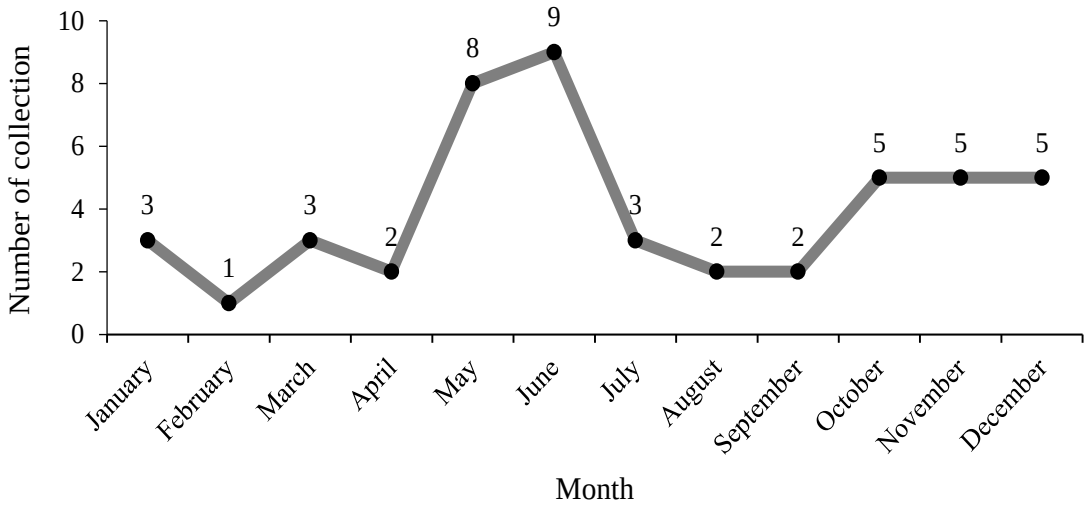

Figure 5. Flowering or fruiting period of *Amydrium zippelianum* based on herbarium specimen data

Uses and Cultivation

It was reported that the leaves of *A. zippelianum* are used to heal rib pain in Sulawesi (Gailea et al., 2016) besides treating coughs, cuts, and swellings in Papua New Guinea (Dzu, 2003). Furthermore, sap of *Araceae* is actually non-poisonous, but it can cause skin itching. Fortunately, washing the itchy skin under running water can reduce the side effect of itching. Since the phytochemistry information of this species is also unavailable, it is difficult to scientifically investigate the potential of *A. zippelianum* as medicine. However, this species is potentially used as an ornamental plant (Yuzammi, 2018), particularly by planting it in a pot for its beautiful leaf pattern. A plant confined to a pot with the moss-covered pole makes the plant significantly smaller, so its condition is ideal for house-plant (Boyce, 1995). Some online stores have sold *A. zippelianum* for IDR 235,000–352,000 per pot in domestic market (Bukalapak, 2020; Shopee, 2020; Tokopedia, 2020) or USD 45.00–59.99 per pot in global market (Nsetropicals, 2020; Patioplants, 2020; Steve, 2020). This item is currently out of stock, yet such guarantee is not available to ensure whether the plant sold is a correct species of *A. zippelianum*.

Propagation of *A. zippelianum* is possibly done by cutting the mature stem into pieces and each bearing a rooted portion to be potted individually (Boyce, 1995). It is a wise way to utilize this species as ornamental plants. Excessive exploration in nature will adversely affect the sustainability of this species. Although *A. zippelianum* has a fairly large area of distribution and locally common, however, it is mostly found in forest, thus the species may become listed as endangered because many forests are coming under a lot of pressure today (Dzu, 2003).

CONCLUSION

One fertile specimen of *A. zippelianum* was successfully collected around Kokolomboy Forest, Banggai Kepulauan Regency, Central Sulawesi Province. In Malesia, *A. zippelianum* can be found in lowlands to highlands at elevation up to 2,200 m asl and mostly in forest areas. The distribution of this species in nature covers the area of mainland of Sulawesi and its surrounding islands (Banggai Kepulauan and Talaud), Maluku Archipelago (Buru, Seram, Halmahera, Morotai, and Ternate), mainland of Papua New Guinea and its surrounding island (Misool), and the Philippines. This plant was reportedly introduced to Java (Bogor Botanic Garden), Bali ("Eka Karya" Bali Botanic Garden), and United Kingdom (Royal Botanic Garden, Kew). Flowering and fruiting season of this plant in natural habitat most frequently occurs from May to June.

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