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## Autecology of Begonia in Several Locations of Flores Island (Autekologi Begonia di Beberapa Lokasi di Pulau Flores)

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### ABSTRACT

Human activities in forest areas such as over-harvesting of *Begonia* species without being balanced with their cultivation activities can threaten the existence of *Begonia* in nature. Autecological studies of species in their natural habitat are the initial activities for the conservation of plant species. The purpose of this study was to study the distribution of *Begonia* on Flores and environmental/ microclimate characteristics in several locations on Flores Island. The 10x10 m plots were placed with purposive sampling with a minimum interval of 50 m. Multivariate analysis using Canonical Correspondence Analysis (CCA) was employed to determine the effect of microclimatic factors on the composition of vegetation. *Begonia kelimutuensis* is endemic in Kelimutu National Park, Flores lives at an altitude of 1,527 asl, at soil pH 5,8 and soil moisture of 75%, with a slope of 10° on the forest floor and light intensity 4,640 klux. In addition, five types of *Begonia* that we estimate have not been identified and two of them are identified as *Begonia sumbawaensis* Girm. and *Begonia brangbosangensis* Girm. *Begonia kelimutuensis* is distributed at a higher altitude than *Begonia brangbosangensis*. *B. sumbawaensis* is influenced by the slope factor while *B. longifolia* tends to be related to the air humidity factor. *B. kelimutuensis* is also often found living with *Macaranga* sp., and *Litsea* sp. *B. brangbosangensis*, also found near *Homalanthus* sp. and *Calliandra calothyrsus*.

### INTISARI

Aktivitas manusia di kawasan hutan seperti pemanenan berlebihan spesies *Begonia* tanpa diimbangi dengan kegiatan budidaya dapat mengancam keberadaan *Begonia* di alam. Studi autekologi spesies di habitat aslinya merupakan kegiatan awal untuk konservasi spesies tanaman. Tujuan penelitian ini adalah mempelajari distribusi *Begonia* di Flores dan karakteristik lingkungan/iklim mikro di beberapa lokasi di Pulau Flores. Plot 10x10 m ditempatkan dengan *purposive sampling* dengan interval minimum 50 m. Analisis multivariat (DCCA) untuk mengetahui pengaruh faktor mikroklimatik terhadap komposisi vegetasi. *Begonia kelimutuensis* endemik di Taman Nasional Kelimutu, Flores pada ketinggian 1.527 dpl, pada pH tanah 5,8 dan kelembaban tanah 75%, dengan tingkat keterengan 10° di lantai hutan dan intensitas cahaya 4.640 klux. Selain itu, ditemukan juga lima jenis *Begonia*

yang kami perkirakan belum teridentifikasi dan dua diantaranya teridentifikasi sebagai *Begonia sumbawaensis* Girm. dan *Begonia brangbosangensis* Girm. *Begonia kelimutuensis* terdistribusi pada ketinggian yang lebih tinggi dari *Begonia brangbosangensis*. *B. sumbawaensis* dipengaruhi oleh faktor kemiringan sedangkan *B. longifolia* cenderung terkait dengan faktor kelembaban udara. *B. kelimutuensis* juga sering ditemukan hidup bersama *Macaranga* sp., dan *Litsea* sp. *B. brangbosangensis*, juga ditemukan di dekat *Homalanthus* sp. dan *Calliandra calothyrsus*. Fenomena ini mungkin mengindikasikan adanya beberapa tingkat gangguan hutan.

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## Introduction

The name Flores comes from the Portuguese language "cabo de flores" which means "Cape of flowers". Flores is included in the cluster of the Lesser Sunda Islands with Bali and NTB, with an area of about 14,300 km<sup>2</sup>. Flores is one of the Island in the Eastern parts of Indonesia where *Begonia* studies are still scantily conducted. However, Flores currently holds one endemic *Begonia* species namely *Begonia kelimutuensis*. The genus *Begonia* was first introduced by Charles Plumier (1646-1704) in the 17th century, to commemorate and perpetuate the name Michael Begon (1638-1710), a French Governor in Santo Domingo (Pietsch 2019). *Begonia* is one of the six largest genera of flowering plants in the world. A total of ± 1,700 species of natural *Begonia* have been reported (Tebbitt 2005). The number and distribution of the *Begonia* clan turned out to be very broad, found in the tropics and subtropics in lowland forests and cold mountainous forests. Since the 17th century many types of *Begonia* have been found in many countries such as Mexico, Central America, South America, Asia and Africa. *Begonia*'s highest diversity is in Southeast Asia (Hughes 2008). In Indonesia, wild *Begonia* (*Begonia* which grow in the wild naturally) is estimated to be in the approximate amount of 213 species (Undaharta et al. 2012). *Begonia* distribution in Indonesia are in Kalimantan, Sulawesi, Sumatra, Java, Bali, East Nusa Tenggara, West Nusa Tenggara, Maluku and Papua (Hughes 2008).

Several *Begonia* species is now under threat. *Begonia* (Begoniaceae) is a ornamental because of the uniqueness of its leaves, both in shape, color and size. Human activities in forest areas such as excessive harvesting of *Begonia* species without being balanced with adequate cultivation activities can threaten the existence of *Begonia* in nature. Currently there are 64 species of *Begonia* are in the IUCN redlist category (IUCN 2018), ranging from least concerned, vulnerable, near-threatened, critically endangered, endangered even extinct (*Begonia eiromischa* Ridl./Woolly-stalked *Begonia*).

Understanding the characteristics of each individual plant species is very important to have knowledge related to the habitat of each species. The number of taxonomic studies has greatly increased in Indonesia but when the autecological data of each species of individual is questioned in particular the *Begonia* autecology, it is very limited in the available literature, especially for eastern islands of Indonesia such as Flores. However, several reports and studies has been conducted in other parts of Indonesia. (Efendi et al. 2017) study the wild *Begonia*'s preference habitat in the forest remnant of Cibodas Botanical Garden in West Java. Sutarno (2009) reviews autecology and utilization of *Begonia* in Manokwari Papua. Undaharta and Sutomo (2016) review autecology in three species of *Begonia* in part Mount Merapi area. Previously, Satyanti and Siregar (2012) conducts ecological studies *Begonia* in two locations

of forests, nature reserves and forests reforestation to describe the microclimate and habitat preference in several Begonia species in Bedugul Bali found that air humidity has important roles in Begonia. Flores Island is an important constituent of the Lesser Sunda Island. There is not much research regarding the ecology of Begonias in this Island although it has the endemic species (*Begonia kelimutuensis*). Hence, this research objectives is to study the distribution of Begonia in Flores and to understand their environmental/microclimate characteristics which influence their distribution and abundance.

### Method

This research was conducted in 16-29 April 2018. Due to time constraint, desktop pre-study was

conducted previously in order to make prediction of the suitable locations. Begonia is usually found in edge of forest, riverbanks or near waterfall from lowland to highland, but mostly at a median altitude to 1,500's m above sea level. A habitat suitability indeks was explored using the apps Biodiversity and Climate Change/BCCVL (BCCVL 2017). Based on this investigation several locations were visited on Flores Island, namely the Manggarai Barat, Tengah, Timur, Bajawa and Ende Regencies in the Komodo National Park, Borong KPH, Ngada KPH and Kelimutu National Park (Figure 1).

Plots of 10 x 10 m were placed by a purposive sampling with a minimum interval of 50 m in the habitat where Begonia is found. In total there were 10 plots of Begonia's habitat. Topographic and

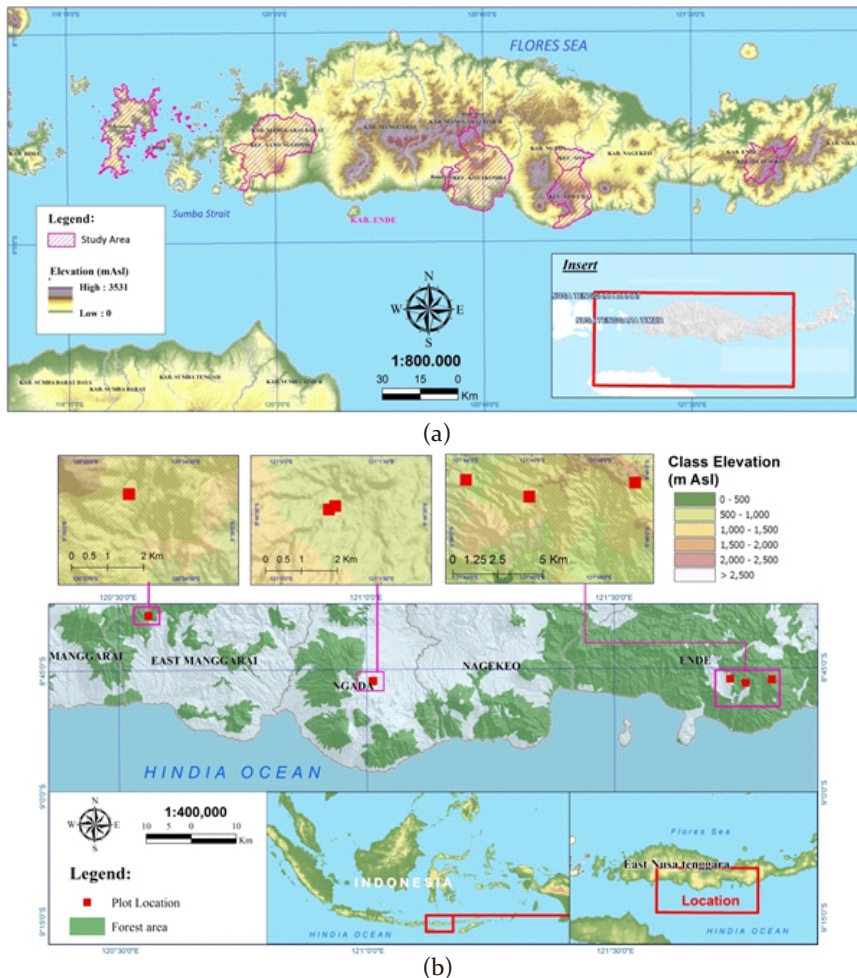


Figure 1. (a) Map of Flores Island and areas where the research was conducted (pink shade); (b) A more detailed map regarding elevation difference and plots lay out.

Gambar 1. (a) Peta Pulau Flores dan lokasi pelaksanaan penelitian (warna merah muda); (b) Detil peta mengenai perbedaan elevasi dan tata letak plot



microclimate data collection was then carried out. The location coordinate and elevation or altitude of the place is recorded from GPS (global positioning System), while the land slope is recorded by measuring the clinometer. The soil pH and soil moisture were measured with a soil tester instrument while the data on the intensity of the light intensity, temperature and humidity were carried out by a portable device to measure light intensity, humidity and air temperature named Lutron (Sutomo & Fardilla 2013).

We conducted canonical correspondence analysis (CCA) ordination to see the influence of microclimatic factors on vegetation composition and especially Begonia species. CCA was conducted using CANOCO program V.4.5 (Lepš and Šmilauer 2003).

### Result and Discussion

*Begonia kelimutuensis* was found at an altitude of 1,527 asl, in 5.8 soil Ph and 75% of soil humidity (Table 1). The soils in the sampling areas are all of young volcanic form so it has the acid of soil Ph. *Begonia kelimutuensis* was found not at a steep slope but rather flat terrain with slopiness level only 10° on the forest floor with light intensity of 4,640 klux. *Begonia kelimutuensis* (Figure 2) is an endemic species from Mt. Kelimutu in Ende District, Flores Island

Indonesia. In this study we also found five Begonia which we still can not identified. Begonia identification was done by direct consultation with Begonia experts from Bogor Botanical garden. Two Begonias we estimated to be identified as *Begonia sumbawaensis* Girm. and *Begonia brangbosangensis* Girm. (Table 1). Habitat notes and morphological features of the Begonias also appeared in table 1. Figure 3 give clear information regarding the distribution of the Begonias found in the field survey.



Figure 2. An endemic plant species from Kelimutu East Nusa Tenggara Indonesia: *Begonia kelimutuensis* (“Uta Onga”/local name) at Kelimutu National Park. Photo credit: Sutomo, 2018

Gambar 2. Jenis tanaman endemik dari Kelimutu Nusa Tenggara Timur Indonesia: *Begonia kelimutuensis* (“Uta Onga”/nama lokal) di Taman Nasional Kelimutu. Foto oleh: Sutomo, 2018



Figure 3. Map showing the distribution of the Begonia (Based on our field survey)  
 Gambar 3. Peta distribusi Begonia (Berdasarkan survey lapangan kami)

Based on consultation with Begonia expert from Bogor Botanical Garden, there are two unidentified Begonias that were predicted to be *Begonia sumbawaensis* and *Begonia brangbosangensis* (Hartutiningsih, 2018, pers.comm.). *Begonia sumbawaensis* is an endemic species belongs to West Sumbawa, Sumbawa Island West Nusa Tenggara Indonesia. According Girmansyah (2016) this species of Begonia is a terrestrial herb which lives on steep slopes of tropical forest at an altitude of up to 1,300 m asl. Furthermore, Girmansyah (2016) noted that *Begonia sumbawaensis* is a very attractive species with bright red petioles and leaf undersides, and with the inflorescence being longer than the petioles and bearing many flowers. As such the plant has potential for ornamental use. This species is found on steep

slopes and hence was very difficult to collect. This is in support to our findings of the habitat where we found the species. Based on our results, the species can also be found in Flores Island, in Faobasa Village, in Bajawa District and indeed it lives on a steep landscape near a waterfall of about 38° of slope level. *Begonia brangbosangensis* is also an endemic species in West Sumbawa, West Nusa Tenggara, Indonesia. *Begonia brangbosangensis* lives terrestrial on forest floor on wet and moist substrates especially it is usually found along stream margins and river banks at an altitude between 1,300–1,700 m altitude (Girmansyah 2016). Our expedition found this species in Rana Mese Lake Nature Reserve in Borong, Manggarai District, in Flores, East Nusa Tenggara. It supports Girmansyah findings of its habitat description.



**Figure 4.** (a). *Begonia* sp.(1); (b) *Begonia* sp. (2); (c) *Begonia* sp. (3) (Probably *Begonia sumbawaensis*); (d) *Begonia* sp. (4); (e) *Begonia* sp. (5); (f) *Begonia* sp. (6); and (g) *Begonia* sp. (7) (Probably *Begonia brangbosangensis*).  
**Gambar 4.** a). *Begonia* sp.(1); (b) *Begonia* sp. (2); (c) *Begonia* sp. (3) (Kemungkinan *Begonia sumbawaensis*); (d) *Begonia* sp. (4); (e) *Begonia* sp. (5); (f) *Begonia* sp. (6); and (g) *Begonia* sp. (7) (Kemungkinan *Begonia brangbosangensis*).

**Table 1.** Habitat and short morphological description of *Begonia* found at the study sites and are yet to be identified  
**Tabel 1.** Habitat dan deskripsi singkat morfologi *Begonia* yang ditemukan di kawasan penelitian dan yang belum diidentifikasi

No	Species	Location	Notes on morphological and habitat	Image code
1	<i>Begonia</i> sp. (1)	Saga Village, Detusoko, Ende, NTT	Terrestrial, leaves circular green. Rocky environment. Andesite rocks decay, elevation 788 mdpl, soil pH: 6.2, soil moisture 92%, dark brown ground color, clay texture on the sidelines of rock fracture, land slope 38°. Leaves can be eaten as vegetable.	Figure 4. (a)
2	<i>Begonia</i> sp. (2)	Saga Village, Detusoko, Ende, NTT	Terrestrial. Leaf circular. Colour under the leaves is red. Growing on the sidelines of a rock fracture or crevic, with a slope of 38°. The surroundings habitat are rocky, weathered andesite rock, elevation 788 mdpl, soil pH: 6.2, soil moisture 92%, dark brown ground color, clay texture.	Figure 4. (b)
3.	<i>Begonia</i> sp. (3) (Probably <i>Begonia sumbawaensis</i> )	Igo Waterfall, FaoBasa Village, Bajawa, District Ngada, NTT	Terrestrial on andesitic rocks, elevation of 782 meters above sea level, soil pH: 5.6, blackish brown color, loose soil texture, slope of 38°, Latitude: 8° 46' 22.750 "S, and longitude: 121° 0' 48,589 "E Light green leaves, petioles to young feathered shoots.	Figure 4. (c)
4.	<i>Begonia</i> sp. (4)	Rata Beke, Sokoria Village. Ndona Timur, Ende District, NTT	Young shoots are light green and the leaves are green, elongated serrated. Terrestrial grows around the water runoff area, elevation 1360 mdpl, soil pH: 6.2	Figure 4. (d)
5.	<i>Begonia</i> sp. (5)	TWA Ranamese Lake, GoloLoni Village, Borong, East Manggarai District NTT	Terrestrial, elevation of 1217 masl, soil pH: 6.5, soil moisture 90%, brown soil color, rocky soil texture, slope of land 33°, latitude: 8° 38' 26,696 "S, and longitude: 120° 33' 38,826" E "Large leaves with green leaves, leaves with fur,"	Figure 4. (e)
6.	<i>Begonia</i> sp. (6)	Igo Waterfall, FaoBasa Village, Bajawa, District Ngada, NTT	Terrestrial, elevation 778 masl, soil pH: 5.8, ground color blackish brown, loose soil texture, slope of 5°, Latitude: 8° 46' 25,950 "S, and longitude: 121° 0' 42,728" E. Light green leaves, short stalks	Figure 4. (f)
7.	<i>Begonia</i> sp. (7) (Probably <i>Begonia brangbosangensis</i> )	TWA Ranamese Lake, GoloLoni Village, Borong, East Manggarai District NTT	Terrestrial, elevation of 1217 meters above sea level, soil pH: 5.9, soil moisture 85%, brown soil color, rocky soil texture, slope of 33°, Latitude: 8° 38' 26,509 "S, and longitude: 120° 33' 39,236 "E	Figure 4. (g)



One form of early activity for plant species conservation is by conducting an autecological study of the species in its natural habitat. Autecology study takes the specificity of one species and studies its relation to the environment/microclimate in which it lives, both its abiotic and biotic factors (Sutomo & Fardilla 2013). Hence, ecological information, as well as microclimate conditions and habitat characteristics (pH, temperature, and light intensity) is very important to support *Begonia* conservation. For ex-situ conservation program, it is very useful data as it can be used for its acclimatization program before it can be used as propagation materials and finally planted in a botanic garden (Sutomo & Fardilla 2013).

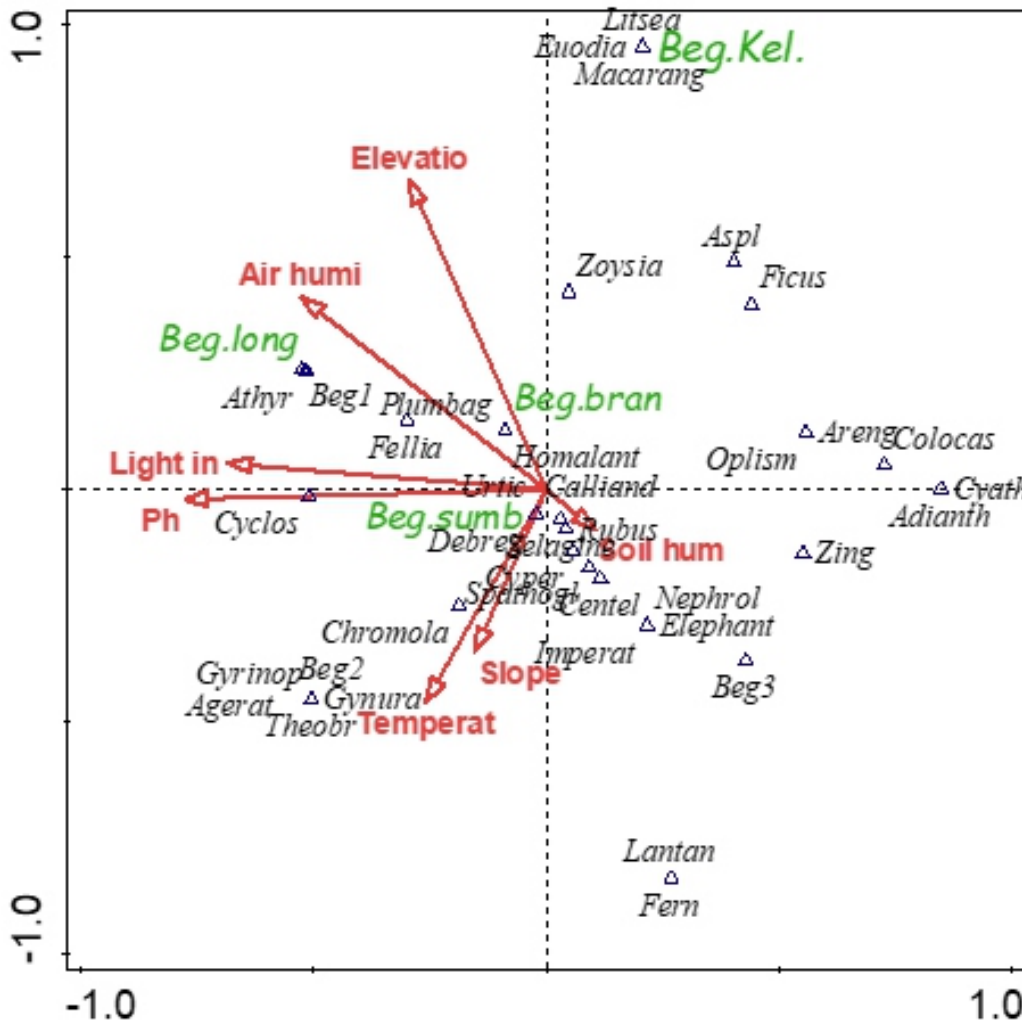
The analysis of CCA showed that the first axis is capable to explain 85% of the total variations whereas second axis explains 17.3% (Table 2). *Begonia kelimutuensis* and *Begonia brangbosangensis* are distributed mainly along the elevational gradient. *Begonia kelimutuensis* is distributed at higher altitude than *Begonia brangbosangensis*. From our analysis, *Begonia sambawaensis* appear to be influenced mainly by slope factor whereas *Begonia longifolia* tends to be related with air humidity factor (i.e. prefer more humid and moist locations). This description of *Begonia longifolia* habitat in our result matches with what Hughes & Girmansyah report (Hughes & Girmansyah 2011) which states that *B. Longifolia* commonly found in humid places. In terms of altitude factor, on Mt. Merapi in Central Java, (Undaharta & Sutomo 2016) found that the distribution of *Begonia*

*multangula* is located closer to the altitude axis and soil moisture compared to the pH axis of the environment. Their analysis also revealed that the altitude axis was more significant in the distribution of *Begonia* at the study site than the environmental axis of soil moisture. *Begonia kelimutuensis* is also found living together with several other species of plants such as pioneer tree species *Macaranga* sp., and also *Litsea* sp. on the altitude axis (Figure 5). *Begonia brangbosangensis*, was also found near a pioneer tree species *Homalanthus* sp. and fabaceae family member: *Calliandra calothyrsus*. This phenomenon might indicate the existence of some degree of forest disturbance which is shown by canopy openness in the field and the growing of pioneer tree species such as *Homalanthus* and *Macaranga*. The clearing of tree canopy create gap which would give way to pioneer (fast growing, sun loving or intolerant) tree species. As stated by Satyanti, (Satyanti & Siregar 2012) one of the main threat to species loss (including *Begonia*s) is perhaps conversion of forest and land use change. Gap creation in the forest due to forest clearance and climate change may alter and create uncertainty in the microclimate conditions and may modify groundcover plant germination and therefore change the composition of forest understorey which would impacted the *Begonia*s species as well (Babaasa et al. 2004; Brewer 2016). Gap creation increase temperature and decrease soil moisture, this will decrease the number of *Begonia*s as this species need high soil moisture and cool shade.

**Table 2.** Summary table statistic for the graph Figure 1. Method: DCCA with supplementary variables. Total variation was 4.99239, supplementary variables accounted for 76.1%

**Tabel 2.** Ringkasan tabel hasil statistik untuk grafik Gambar 1. Metode: DCCA dengan variabel tambahan. Variasi total adalah 4.99239, variabel tambahan sebesar 76.1%

Statistic	Axis 1	Axis 2
Eigenvalues	0.8580	0.7310
Pseudo-canonical correlation	0.9973	0.9902



**Figure 5.** Results from multivariate analysis showing distribution of Begonias (as well as other species) along environmental gradients. (Elevatio = elevation; Air humi = air humidity; Light in = light intensity; Soil hum = soil humidity; Temperat = air temperature).

**Gambar 5.** Hasil analisis multivariat yang menunjukkan distribusi Begonia (dan jenis lainnya) pada berbagai kondisi lingkungan (Elevatio = elevasi; Air humi = kelembaban udara; Light in = intensitas cahaya; Soil hum = kelembaban tanah; Temperat = suhu udara).

### Conclusion

Begonias in Flores are distributed on hill to mountain topography at 778 – 1,527 Asl. *Begonia kelimutuensis* distributes at a higher elevation than *Begonia brangbosangensis*. The distribution of *Begonia longifolia* is depend on air moisture (humidity). They also grow at sheltered areas. *Begonia kelimutuensis* is also found living together with *Macaranga* sp., and also *Litsea* sp. *Begonia brangbosangensis* is also found near *Homalanthus* sp. and *Calliandra callothyrus*.

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