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# Seed conservation of *Begonia* spp. from West Sumatra, Indonesia

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**Abstract.** *Begonia* collections in Indonesian Botanic Gardens are a source of germplasm for ornamental plants, foods, and future medicinal plants. Seed exploration activity was focused on the West Sumatra area to increase the representation of *Begonia* collections at the Indonesian Botanic Gardens's Seed Bank. It will accommodate collection numbers and genetic variation. The purpose of this study was to collect seeds and living collections of the Sumatran *Begonia* species, mainly from West Sumatra. Beside that, this study aimed to identify the storage characteristics of *Begonia* seeds in the Seed Bank. The research method was carried out exploratory and investigated in several districts of West Sumatra. From the explorations, we collected 27 species of *Begonias* from five districts, namely Solok, Sijunjung, Tanah Datar, Lima Puluh Kota, and West Pasaman. The most *Begonia* species were found in Solok Regency (25%). We found those *Begonias* in the vegetative and generative phases. About 76.67% of the plants found produce flowers. Some plants were producing fruit (60%). *Begonia* habitat is generally a humid area (karst cliffs, caves, streams, forest floors and wet rocks). Furthermore, the characteristics of 30 *Begonias*, types of seeds, and its storage, also associated plants around *Begonia* will be described in this paper.

## 1. Introduction

*Begonia* is one of the plant genera that have the potential to be developed and utilized. Aside from being an ornamental plant, *Begonia* can be used as a spice for cooking and vegetables [1], and also used as medicinal raw materials [2, 3, 4, 5]. *Begonia* research and ex-situ conservation efforts have been carried out intensively for the last ten years at the Cibodas Botanical Gardens (CBG). Currently, CBG has collected 25 species of *Begonias* from all over Indonesia [6]. *Begonia* is distributed across various regions of Indonesia, one of them on Sumatra Island.

West Sumatra is one of the centers of *Begonia* species diversity in Indonesia. During the last 10 years, 14 new species were reported from West Sumatra, namely *B. beludruvinea*, *B. fluvialis*, *B. halabanensis*, *B. harauensis*, *B. karangputihensis*, *B. korthalsiana*, *B. kudoensis*, *B. olivacea*, *B. raoensis* [7], *B. curvifolia*, *B. ocellata*, [8], *B. araneumoides*, *B. batuphila*, and *B. panjangfolia* [9]. Presently, there are 38 species of *Begonia*, or about 50% of the total number of *Begonias* in Sumatra [7, 9]. However, the discovery of new species of *Begonias* in West Sumatra is a big opportunity. Several areas have a chance to be explored. On the other hand, the level of species loss and endemism is high, so it becomes a threat to the extinction of Indonesian *Begonias*.



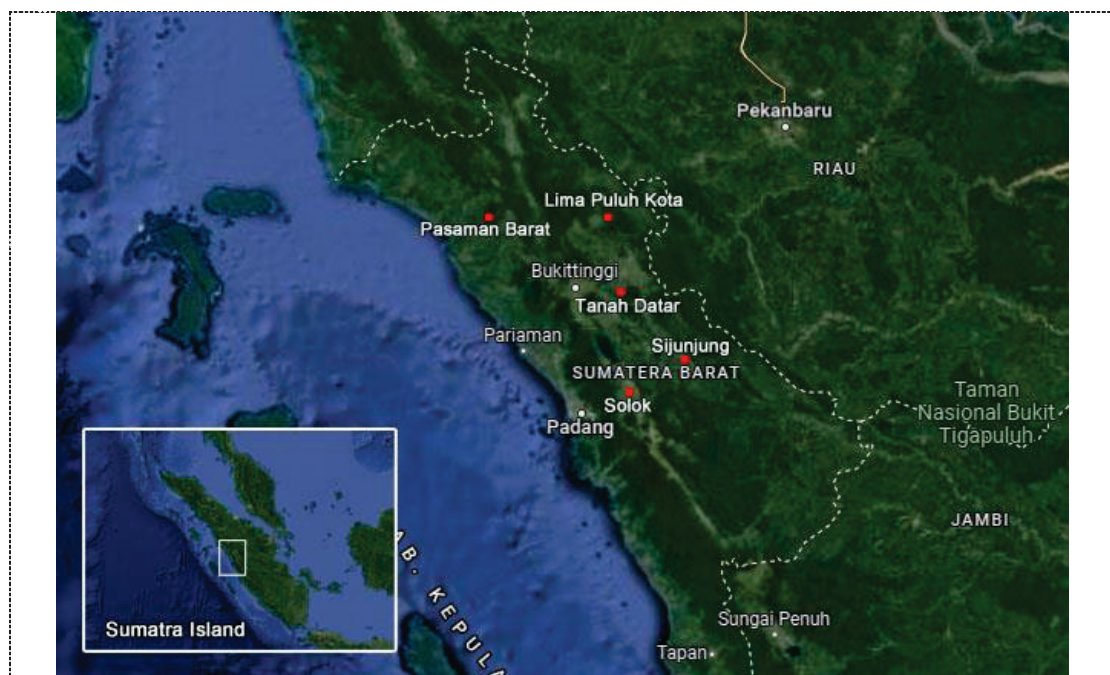
Several species of West Sumatran *Begonias* are classified as endangered, for example, *B. robii* [10]. Various strategies to save *Begonia* Indonesia need to be done. Apart from collecting live plants, seed collection is needed to increase the genetic diversity of *Begonias* kept in the Indonesian Botanical Gardens. This is supported by facilities at the seed bank in the Indonesian Botanical Gardens that have international standards.

*Begonia* seeds collection is more effective way to store more genetic material. However, the biological information of *Begonia* germination as basic information in *Begonia* seed conservation is still limited, so it needs to be studied further. The storage characteristics of the seeds are needed to determine the sensitivity of the seeds to drying. At the moment, six *Begonia* species are known to have orthodox types [11, 12]. However, these species do not yet accommodate Indonesian *Begonias*. In general, *Begonia* has a type of dry fruit, except for members of the *Begonia* sect. *Sphenanthera*, thus requiring different handling in harvesting [13]. This needs to be known to determine the steps in storing seeds in the seed bank, so that the seeds have high viability. Therefore, this study aimed to add the collection of *Begonia* seeds, especially from West Sumatra, and also to identify the storage characteristics of *Begonia* seeds in the Cibodas Botanical Garden Seed Bank.

## 2. Methods

### 2.1. Time and study site

Exploration and collection of *Begonia* seeds are carried out in nature reserves and protected forests in the West Sumatra region, covering Solok, Sijunjung, Tanah Datar, Lima Puluh Kota, and West Pasaman Regencies (Figure 1). *Begonia* exploration activities will be carried out on 18-31 August 2022.



**Figure 1.** Locations of *Begonia* seed exploration in West Sumatra (Source: Google Earth).

### 2.2. Pre-collection assessment of *Begonia* populations

Seed collection was carried out in five districts of West Sumatra. Site selection was based on the discovery of West Sumatra *Begonias*, referring to [7, 8, 9, 14]. Prior to collecting seeds, a pre-collection assessment was carried out using the standard procedure following the Kew Royal Botanical Gardens protocol. A cut test was held to assess the seed quality of *Begonia*. Ten to twenty

seeds were cut-test from random fruit in a population and/or individual, and make the record of the number of full, empty, infested, and immature seeds. The number of viable seed for the collection was estimated using the formula by Way and Gold [15], as follow:

*Estimated number of viable seeds for collection* = Maximum number of seed that can be collected x Percentage of full seeds

*Maximum number to seed that can be collected* = Available population × 20%

*Available population* = Total population × Percentage of full seeds.

*Total population* = Estimated number of plants at natural dispersal × Average number of fruits or dispersal units per individual plants × Average number of seeds per fruits or natural dispersal units

### 2.3. Seed collecting and processing in the field

Harvested seeds come from ripe fruit and are abundant in nature. *Begonia* fruit is divided into dry fruit and fleshy fruit, so the handling is also different. *Begonia* fruit is put in dry paper or an envelope, given an identity, and put in a plastic clip. The collection of seeds is accompanied by herbarium vouchers and live plants to assist in verifying the type of seeds collected.

Fruit or seeds collected from the field are cleaned of dirt. Furthermore, dry-type fruit or seeds can be immediately wrapped in aluminum foil and put in an envelope that has been given an identity. Fruit types that have been cleaned are dried and stored in the shade. The fruit is checked periodically to see the maturity level of the fruit and cleaned if it is moldy. Then, the fruit is wrapped in aluminum foil and put in an envelope that has been given an identity.

### 2.4. *Begonia* seeds storage

*Begonia* seeds are processed at the Cibodas Botanical Garden Seed Bank for long-term storage purposes (20 years). Seed processing is done by drying the seeds in a blue drum and/or a desiccator containing silica gel to reduce the water content in the seeds. The seeds were dried until the eRH level reached 15%. Storage of seeds is carried out in aluminum foil plastic and/or glass jars equipped with airtight rubber and then stored in the freezer at -20 °C. Seed viability testing was carried out before the seeds were stored in the freezer and six months after the seeds were stored. Furthermore, the seeds are tested for viability periodically every 5 years.

## 3. Results and Discussion

### 3.1. *Begonia* plant collection from West Java

A total of 27 species of *Begonia* were recorded from five districts in West Sumatra (Table 1). *Begonia harauensis*, *B. halabanensis*, *B. droopiae*, *B. batuphilla*, *B. robii*, and *B. kudoensis* are endemic species in each of West Sumatra. The most common types of *Begonias* were found in Solok District, namely eight species (Figure 2). The conditions of the plants found were in the vegetative and generative phases. About 76.67% (23 species) of plants were found to produce flowers. As many as 60% (18 species) of plants were producing fruit, both young and ripe fruit (Figure 3). *Begonia stictopoda* was found in several locations with both flowering and fruiting conditions. However, ripe seeds were only found on the Mount Talamau hiking trail, West Pasaman.

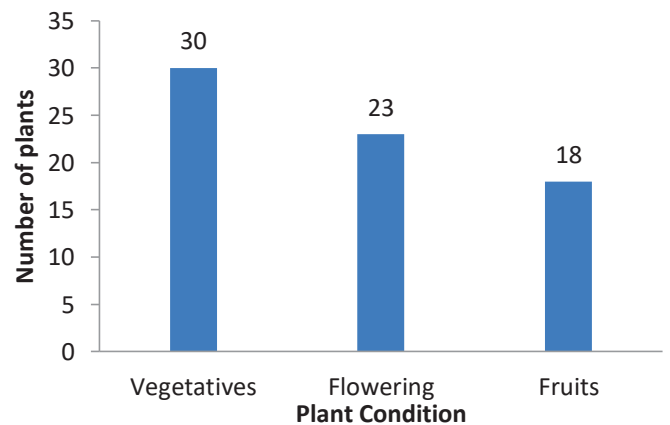
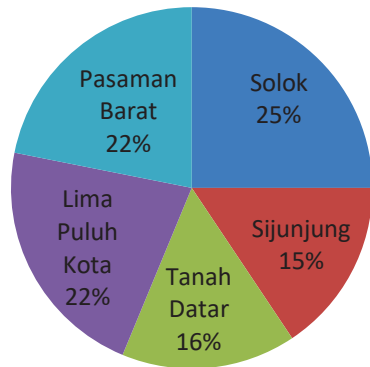
*Begonia* has two types of fruit, namely dry fruit (capsule type) and fleshy fruit (Table 1). Seeds on ripe dried fruit can be counted immediately, tested by cut-test and then stored in aluminum foil and envelopes for further viability testing in the seed bank, for example in *B. stictopoda*, *B. atricha*, *B. droopiae*, and *B. batuphila*. Meanwhile, fleshy fruit requires drying at room temperature until the fruit is perfectly ripe, for example in *B. longifolia* and *B. multangula*. Some species of *Begonias* collected from West Sumatra are shown in Figure 4.

**Table 1.** Plant species of Begonia collected from West Sumatra.

No.	Scientific names	Location	Fruit types	Plant Phase
1	<i>Begonia stictopoda</i> Miq. ex A.DC.	Solok	dry fruit	Vg, Fl.
2	<i>Begonia atricha</i> Miq. ex A.DC.	Solok	dry fruit	Vg; Fl; Fr.
3	<i>Begonia stictopoda</i> Miq. ex A.DC.	Solok	dry fruit	Vg; Fl; Fr.
4	<i>Begonia longifolia</i> Blume	Solok	fleshy-fruit	Vg; Fl.
5	<i>Begonia stictopoda</i> Miq. ex A.DC.	Solok	dry fruit	Vg.
6	<i>Begonia stictopoda</i> Miq. ex A.DC.	Solok	dry fruit	Vg.
7	<i>Begonia multangula</i> Blume	Solok	fleshy-fruit	Vg; Fl.
8	<i>Begonia droopiae</i> Ardi	Sijunjung	dry fruit	Vg; Fl; Fr.
9	<i>Begonia batuphila</i> Girm.	Sijunjung	dry fruit	Vg; Fl; Fr.
10	<i>Begonia droopiae</i> Ardi	Sijunjung	dry fruit	Vg; Fl; Fr.
11	<i>Begonia atricha</i> Miq. ex A.DC.	Sijunjung	dry fruit	Vg; Fl.
12	<i>Begonia batuphila</i> Girm.	Tanah Datar	dry fruit	Vg; Fl; Fr.
13	<i>Begonia</i> sp. cf <i>kudoensis</i> 1	Tanah Datar	dry fruit	Vg; Fl; Fr.
14	<i>Begonia</i> sp. cf <i>kudoensis</i> 2	Tanah Datar	dry fruit	Vg; Fl; Fr.
15	<i>Begonia kudoensis</i> Girm.	Tanah Datar	dry fruit	Vg; Fl; Fr.
16	<i>Begonia robii</i> Ardi & Girm.	Tanah Datar	dry fruit	Vg; Fl; Fr.
17	<i>Begonia halabanensis</i> M. Hughes	Tanah Datar	dry fruit	Vegetatif
18	<i>Begonia ocellata</i> Ardi	Lima Puluh Kota	dry fruit	Vg; Fl; Fr.
19	<i>Begonia lilliputana</i> Hughes	Lima Puluh Kota	dry fruit	Vg; Fl; Fr.
20	<i>Begonia stictopoda</i> Miq. ex A.DC.	Lima Puluh Kota	dry fruit	Vg; Fl
21	<i>Begonia goegoensis</i> N.E.Br.	Lima Puluh Kota	dry fruit	Vg; Fl; Fr.
22	<i>Begonia halabanensis</i> M. Hughes (II)	Lima Puluh Kota	dry fruit	Vg.
23	<i>Begonia araneumoides</i> Ardi & Girm.	Lima Puluh Kota	dry fruit	Vg; Fl; Fr.
24	<i>Begonia harauensis</i> Girm.	Lima Puluh Kota	dry fruit	Vg; Fl; Fr.
25	<i>Begonia stictopoda</i> Miq. ex A.DC.	Pasaman Barat	dry fruit	Vg; Fl; Fr.
26	<i>Begonia aberrans</i> Irmsch.	Pasaman Barat	dry fruit	Vg; Fl; Fr.
27	<i>Begonia</i> sp. sect. " <i>Petermannia</i> "	Pasaman Barat	dry fruit	Vg; Fl; Fr.
28	<i>Begonia gracilicyma</i> (Irmsch.) Hughes	Pasaman Barat	dry fruit	Vg
29	<i>Begonia teysmanniana</i> (Miq.) Miq. ex B.D.Jacks	Pasaman Barat	dry fruit	Vg; Fl.
30	<i>Begonia</i> sp. sect. " <i>Bracteibegonia</i> "	Pasaman Barat	dry fruit	Vg.

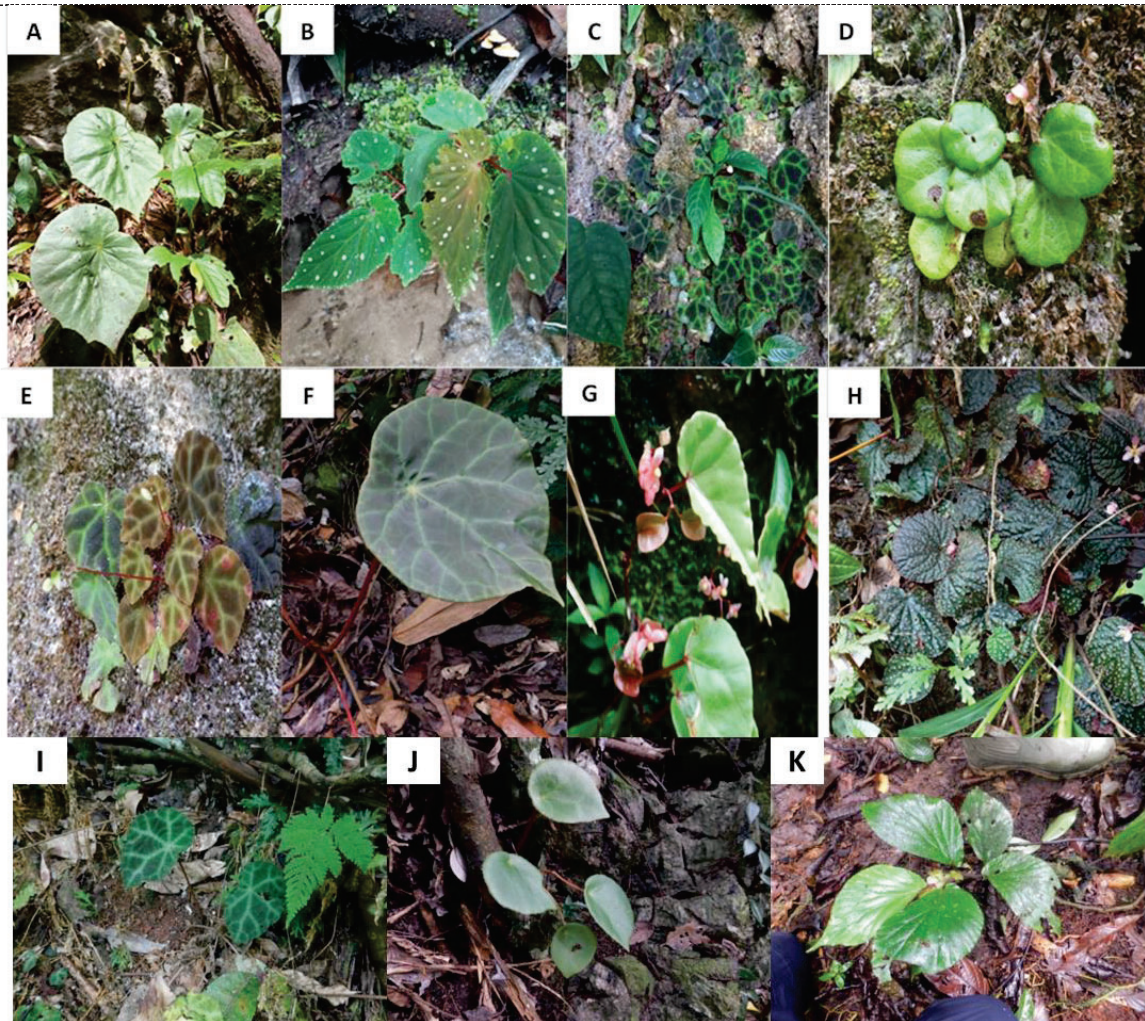
Notes: Vg: Vegetative phase, Fl.: flowering phase, and Fr: Fruiting phase





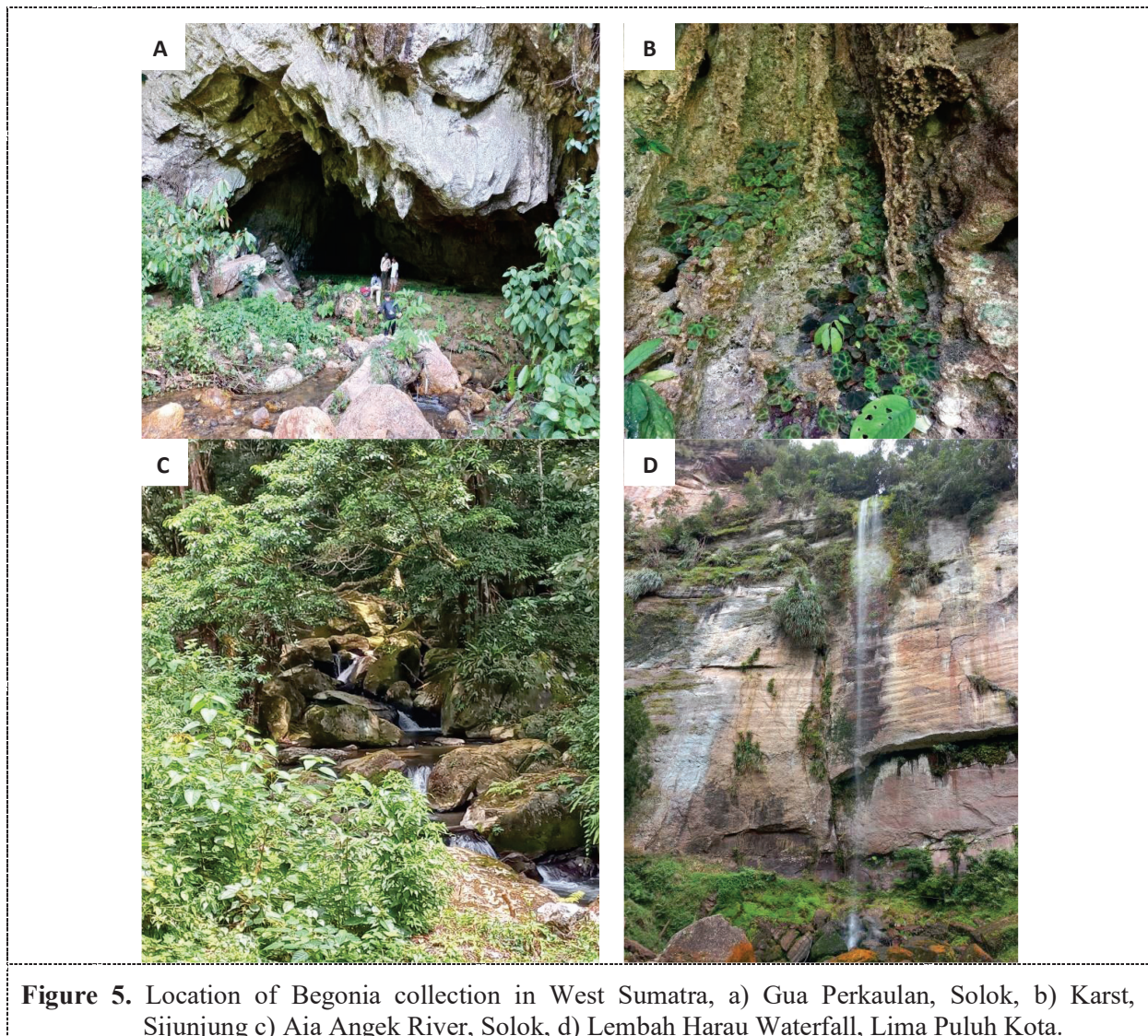
**Figure 2.** Percentage of *Begonia* species found in five districts of West Sumatra.

**Figure 3.** Condition of *Begonia* plants found in several locations of West Sumatra.



**Figure 4.** *Begonia* species found in several areas of West Sumatra. a). *B. stictopoda*, b). *B. atricha*, c). *B. droopiae*, d). *B. batuphila*, e). *B. robii*, f) *B. goegoensis*, g) *B. harauensis*, h). *B. ocellata*., i) *B. araneumoides*, j). *B. halabanensis*, k). *B. abberans*.





**Figure 5.** Location of *Begonia* collection in West Sumatra, a) Gua Perkaulan, Solok, b) Karst, Sijunjung c) Aia Angek River, Solok, d) Lembah Harau Waterfall, Lima Puluh Kota.

*Begonias* have habitats in moist and shade areas, not exposed to direct sunlight. Most of the *Begonias* that we collect are found on karst walls, cave mouths, and watersheds, such as rivers, waterfalls, and wet forest floors. The environmental parameters observed include light intensity, pH and RH of soils, pH and RH of air areas. Several locations of *Begonia* exploration can be seen in Figure 5.

### 3.2. The readiness of *Begonia* population for seed harvesting

Seed exploration activities are carried out by the free exploration method. When we find a plant species that has fruit, we first conduct a pre-collection assessment to determine whether the plant species is suitable for the standards for collection. This activity is carried out to maintain the availability of populations in nature. Collection activities include seeds, live plants (seedlings), and some parts of plants for the herbarium.

Plant identification, population assessment, also population preparedness for seed collection, physical quality of seeds, and seed availability were all included in the seed pre-collection evaluation. The ideal amount of healthy seeds to collect would be 5,000–10,000 without taking more than 20% of the available seeds during natural dispersal [15]. It can include seeds for a variety of purposes such as maintaining a base collection (long-term storage in the event that the wild population is in danger of going extinct), establishing a successful germination protocol and viability monitoring, monitoring

viability over the collection's anticipated 200-year lifespan, duplicating the collection at another bank for safety, distributing the seeds to users, and future propagation, restoration, and reintroduction projects [16].

In this study, the population area ranged from 1000 to 10,000 m<sup>2</sup>. *B. kudoensis* and *B. harauensis* were present only in a small area with a limited number of plants (Table 2). After scanning the research area and calculating the population, an estimate was generated. To ensure a representative population, the quantity of gathered seeds was sampled at random and uniformly throughout the population [15]. The physical quality of seeds were shown by a cut-test of ten seeds randomly from the examined samples and then the result was referred to as the most frequently occurring state, i.e. full seeds, infested seeds, empty seeds, and immature seeds. Generally, a full seed was firmed and white inside, not shriveled or overly dry. Empty seeds contained little or no seed tissue inside and may even have evidence of insect damage or an aborted seed. In *Begonia*, the empty seed is shown with an irregular shape and no endosperm. From the assessment, there are 11 species that more than 70% of full seeds and possible to collect. Meanwhile, there are six *Begonias* that not possible to collect. The estimated number of viable seeds to collect is not sufficient to collect (<5,000). They were *B. kudoensis*, *B. robii*, *B. goegoensis*, *B. harauensis*, *B. stictopoda*, and *B. abberans* (Table 2).

**Table 2.** The assessing results for the readiness of *Begonia* population for seed harvesting.

No.	Scientific Names	Population area (m <sup>2</sup> )	Number of plants	Full seeds (%)	Seeds per fruit	Fruits per plant	Estimated number of viable seeds to collect	Collection possible*
1	<i>Begonia atricha</i>	10000	120	80	1008	3	46449	Yes
2	<i>Begonia</i> sp.	5000	440	80	945	2	106445	Yes
3	<i>Begonia droopiae</i>	5000	2500	80	414	4	529920	Yes
4	<i>Begonia batuphila</i>	5000	2750	90	246	2	219186	Yes
5	<i>Begonia droopiae</i>	2000	450	80	200	2	23040	Yes
6	<i>Begonia batuphila</i>	2000	1980	90	203	2	130228	Yes
7	<i>Begonia</i> sp. Ngarau Pangian (I)	1000	2600	90	420	4	707616	Yes
8	<i>Begonia</i> sp. Ngarau Pangian (II)	1000	380	80	263	3	38377	Yes
9	<i>Begonia kudoensis</i>	1500	6	60	375	2	324	No
10	<i>Begonia robii</i>	5000	435	70	46	1	1961	No
11	<i>Begonia ocellata</i>	5000	720	60	194	1	10057	Yes
12	<i>Begonia lilliputana</i>	2500	890	70	313	1	27300	Yes
13	<i>Begonia goegoensis</i>	1000	160	70	82	1	1286	No
14	<i>Begonia araneumoides</i>	1500	460	70	85	3	11495	Yes
15	<i>Begonia harauensis</i>	1000	5	70	695	4	1362	No
16	<i>Begonia stictopoda</i>	10000	350	80	93	1	4166	No
17	<i>Begonia aberrans</i>	5000	55	80	94	1	662	No
18	<i>Begonia</i> sp. "PETERMANIA "	5000	385	80	250	4	49280	Yes

Apart from *Begonias*, we also collect seeds from other species, such as *Ficus asperiuscula*, *Mycetia cf oblongifolia*, *Impatiens* sp., *Liebigia* sp., and others. There are several species that are flowering or fruiting. However, not all plant species can be collected for seed banks. This is related to several considerations, including the availability of seeds that do not sufficiently the minimum numbers, the fruit is not yet ripe or only a few are ripe, the ripe fruit has fallen from the tree, the type of fruit is recalcitrant, so it cannot be stored for a long time, for example, *Pinanga coronata*. From exploration,



we also found plant that were potentially invasive, such as *Clidemia hirta*, so we did not collect their seeds.

### 3.3. *Begonia* conservation and its threatened

The existence of plants in their natural habitat is highly dependent on their biotic and abiotic factors. The abiotic factors that influence are the environmental conditions where they live, both the landscape, light intensity, temperature, and humidity, as well as soil pH and RH. Meanwhile, humans as biotic factors also play an important role in the sustainability of plants. Human activities, such as logging and burning of forests, conversion of land functions as settlements and plantations, and mining seriously threaten the existence of native plants, in this case, *Begonia* in particular. This must receive special attention, so the native Indonesian and West Sumatran endemic *Begonia* species can be maintained and not extinct from nature. Therefore, the efforts to conserve seeds and living plants are carried out by the Botanical Gardens in order to ensure the ex-situ plant preservation. In addition, conventional plant propagation and tissue culture are also expected to be able to increase the quantity and quality of *Begonias* which have various potentials for human life in the present and the future.

## 4. Conclusions

Twenty-seven species of *Begonias* have been collected from five districts of West Sumatra (Solok, Sijunjung, Tanah Datar, Lima Pulu Kota, and West Pasaman). *Begonia* species were mostly found in Solok Regency (25%). We found those *Begonias* in the vegetative and generative phases. *Begonia* seeds were collected from ripe and sufficient fruit based on the pre-assessment collection. Furthermore, the *Begonia* seeds are stored in the Cibodas Botanical Garden's Seed Bank.

## Acknowledgments

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