

## The conservation of native, lowland Indonesian *Begonia* species (Begoniaceae) in Bogor Botanic Gardens

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**Abstract.** Siregar HM. 2017. *The conservation of native, lowland Indonesian Begonia species (Begoniaceae) in Bogor Botanic Gardens. Biodiversitas 18: 326-333.* Indonesia has a diversity of indigenous (i.e. wild type) *Begonia* species that have never been artificially hybridized. They are usually situated in tropical rain forests, from the lowlands to the uplands (2400 m asl.). There are many *Begonia* species that have not yet been collected and conserved ex-situ. Hence exploration and conservation of this diversity needs to be extensively pursued. The conservation of lowland adapted *Begonia* has been carried out for the last ten years in the Bogor Botanic Gardens. The research reported here developed an inventory of the *Begonia* collection held in the green house of the Bogor Botanic Gardens nursery. The method used was a study of the plant expedition database which contains collection lists, locality of their discovery and ecological data for the localities. Plant collection registration, acclimatization, propagation and collection care were documented. Bogor Botanic Gardens has conserved 124 collections of *Begonia*, made up of 93 indigenous species and 31 exotic species. The reported origins for the collection are as follows: Java (9 accessions), Sumatra (37 accessions), Kalimantan (5 accessions), Sulawesi (11 accessions), Maluku (15 accessions), Papua (4 accessions), Bali and West Nusa Tenggara (6 accessions) and East Nusa Tenggara (6 accessions). These wild *Begonia* have prospects for development as new ornamental plants and also as genetic material to research the creation of new *Begonia* varieties through artificial hybridization.

**Key words:** *Begonia*, Begoniaceae, Conservation, Bogor Botanic Gardens

### INTRODUCTION

Bogor Botanic Gardens has a long history as a facility for the ex-situ conservation of tropical plant life. It has a collection of plants organized according to taxonomic, bioregional and thematic principles, or a combination of these, for the purposes of conservation, research, education, tourism, and environmental services (Indonesian Presidential Regulation Number 93 of 2011 on the Botanic Gardens). Botanic gardens are institutions well-suited to the conservation of wild plant species and for developing their untapped potential to serve human needs.

Bogor Botanic Gardens as an institution for lowland plant conservation has conducted many exploration expeditions over the years to save threatened species and other plants that have known potential uses or are otherwise of interest. Currently, the gardens has a collection of 15,000 species of plants which are planted on an area of 87 hectares. The discovery of new species and varieties such as of orchids, begonias, and *Rafflesia* during botanic exploration is expected to stimulate research activities leading to opportunities for developing new useful plants including some with potential commercial value. This is one of the outputs expected from plant conservation institutions such as the Bogor Botanic Gardens (Siregar, 2013).

Besides orchids, Indonesia has many types of wild species from which can be developed new ornamental plants. This is part of the justification of research efforts

aimed at preserving the potential of Indonesian plant diversity. In the past, *Begonia* did not receive much attention from the floriculture industry. However, the Begoniaceae is a family of flowering plants with significant diversity within Indonesia and has become more popular in recent years because of its spectacular ornamental characteristics. Thus, there has been increasing interest in developing the potential of the genus for ornamental purposes. This has necessitated new initiatives in biodiversity exploration, sustainable collection activity and careful ex-situ cultivation, in order to conserve and develop species of *Begonia* with ornamental and other potential uses (Siregar, 2013).

Based on taxonomic records, there are currently 1825 species of *Begonia*, worldwide. These species are spread in the tropics and subtropics of Asia, America and Africa (Hughes et al. 2016; Kiew 2005). Indonesia is one of the centers of *Begonia* diversity in Southeast Asia. The number of species is now estimated to be more than 200, which are distributed from Sumatra to Papua, including in addition to the main islands numerous small islands. The island of Java has 15 species of indigenous *Begonia*, Sumatra 63 species, Kalimantan 8 species, Sulawesi 44, and Irian (New Guinea) 70 species (Ardi et al. 2014; Hughes et al. 2015a,b; Thomas et al. 2016). *Begonia* can be found in various types of habitat, ranging from karst hills and lowland tropical rain forests, up to mountain sites 2,400 m in asl..

Bogor Botanic Gardens has a strategic role in the conservation of Indonesian plant species, including

*Begonia* species. Ten year ago, there were only five collection items of *Begonia* species cultivated in the Bogor Botanic Gardens (Inggit et al. 2001; Sari et al. 2010). These were *B. isoptera* Dryand. ex Sm. (Java), *B. mexicana* G. Karst. ex Fotsch (Mexico), *B. popenoei* Standl. (Honduras), and *Begonia* sp. (Sumatra) planted in VAK XI and XIV (Sari et al. 2010). During the last ten years, with intensified exploration in the forest areas of Indonesia and through the program of development of ex-situ conservation in regional botanic gardens, the number of species in the *Begonia* collection has increased significantly.

A well-managed *Begonia* conservation efforts is very important for its survival, because habitat destruction is still going on, and the quality of *Begonia* habitat keep declining due to illegal logging and conversion of land to plantation. *B. eiromischa* Ridl. is an example of an extinct *Begonia* species as a result of habitat loss in Malaysia, while *B. socotrana* Hook. F. and *B. samhaensis* M. Hughes are examples of endangered species on Socotra Island, Yemen (Lucas and Synge 1978, Hughes and Miller 2002; Kiew 2005). *Begonia* is an important genus on which to concentrate conservation efforts, since it meets several ex-situ conservation criteria, such as its high level of local endemism, its unique characteristics, the feasibility of its reintroduction into natural habitat, and its economic value as an ornamental plant.

The research described in this paper, aimed to develop an accurate inventory of all *Begonia* species from past botanical exploration and to identify potential species to be domesticated and developed as new ornamental plants through artificial hybridization. The results are expected to be used as the initial step in determining more comprehensive conservation strategies for *Begonia* in the future.

## MATERIALS AND METHODS

The study was conducted in the Bogor Botanic Gardens greenhouse of the Center for Plant Conservation - Botanic Gardens, Indonesian Institute of Sciences (LIPI), Bogor, West Java, Indonesia. The method used was direct observation and inventorization of all native *Begonia* in the collection (Expedition reports, Hartutiningsih 2008, Ardi and Hughes 2010). The plants were acclimatized in the greenhouse nursery, planted in plastic pots of diameter 25 cm with a mixed medium of soil and compost ratio of 1: 1, and placed in a closed container for 90 days to form buds and to open gradually over 60 days, stimulating the plant to adapt to this new environment (Hartutiningsih 2008). All collections were observed morphologically and records were taken of such things as the shape of the whole plant stature, its stem color, its height, segment length, leaf shape, leaf size, leaf color, inflorescence details, male flowers, female flowers, etc. The taxonomic identification of the collection was done by referring to Kiew (2005) and Tebbitt (2005), as well as herbarium specimens at the Herbarium Bogoriense, Research Center for Biology, Indonesian Institute of Sciences (LIPI), Cibinong Science Center, West Java, Indonesia.

## RESULTS AND DISCUSSION

*Begonia* can be easily recognized by several specific character combinations: in general, they are perennial monoecious herbs with asymmetric leaves, are stipulate and have unisexual flowers, petal-like sepals (tepals), centripetal stamen development, cellular calcium oxalate crystals, and seeds with a seed lid and collar cell and very little endosperm (Tebbitt 2005). Most *Begonia* have asymmetrical leaves, which means that if the leaves are split into two, one side is larger than the other side. This trait is genetic so that just from looking at the shape of leaves, *Begonia* can easily be distinguished from other plant species (Kiew 2005).

Based on the results of research, observation and inventorization, 93 collection numbers are recognised for the *Begonia* collection in Bogor Botanic Gardens, of which 77 species are distinct species. Twenty-seven have recently been identified and published as new species, among which are *B. puspitae* Ardi, *B. simolapensis* Ardi and *B. olivacea* Ardi coming from Sumatra, *B. sendangensis* Ardi from Lombok, *B. siregarii* Ardi & Thomas from Sulawesi, *B. aketajawensis* Ardi & Thomas, *B. holosericeoides* Ardi & D.C. Thomas, *B. galeolepis* Ardi & D.C. Thomas of Maluku. The undescribed species will continue to be researched, in order to ensure the high scientific value of the collection. The results of the inventory of Indonesian lowland native *Begonia* species in the Bogor Botanic Gardens nursery are presented in the Table 1.

Based on the recorded places of origin, the *Begonia* collection comes from the following parts of Indonesia: Java Island (9 accessions), Sumatra (37 accessions), Kalimantan (5 accessions), Sulawesi (11 accessions), Maluku (15 accessions), Papua (4 accessions), Bali and Nusa Tenggara Barat (6 accessions) and Nusa Tenggara Timur (6 accessions). These numbers are still below expectation, when compared to the database for *Begonia* according to Hughes et al. (2015a) who have reported that Indonesia has more than 200 species in total. This total number is expected to be more than doubled in future because there are still many new species waiting to be described, based on observation of herbarium specimens in the Herbarium Bogoriense, in Edinburgh and in Kew, as well as in the online *Begonia* database.

Generally, *Begonia* species have limited distribution areas, i.e. high levels of endemism. For example, 83% of a total of 63 species found to date in Sumatra are endemic species, while 88% are endemic out of a total of 44 species in Sulawesi, and 62% of the total of 8 species currently known in Maluku (Hughes et al. 2015a,b; Undaharta and Ardi 2016). As for the collection conserved on Bogor Botanic Gardens, 98% of the total are endemic to Indonesia; some endemic on several islands, others on a single island, and yet others limited to a very specific area such as particular mountains or hills. Endemic species are generally prone to become rare or extinct, because they have a limited distribution and specific adaptations. One species that is known to have become extinct is *B. eiromischa*, which was formerly known from a single location in Penang, Malaysia. The extinction was caused by habitat loss caused by land conversion to agriculture (Kiew 2005).

**Table 1.** The collection of lowland native Indonesian *Begonia* in the Nursery of Bogor Botanic Gardens, Indonesia

Species	Collector number	Locality	Amount	Habitus
<i>Begonia augustae</i> Irmsch.	DW 1328	Waigeo, West Papua	6	CL
<i>Begonia aberans</i> Miq.	SUBOE 21	Sumatra	1	CL
<i>Begonia aketajawensis</i> Ardi & D.C. Thomas	YY 64	Halmahera, Maluku	3	TS
<i>Begonia atricha</i> Miq.	SUBOE 56	Sumatra	Seedling	CL
<i>Begonia bimaensis</i> Undaharta & Ardhaka	KRE	Bima, West Nusa Tenggara	4	T
<i>Begonia baliensis</i> Girm.	KRE	Bali	1	CL
<i>Begonia beludruvenea</i> M. Hughes	WA 09	West Sumatra	1	CL
<i>Begonia coriaceae</i> Hassk.	HT21	Karangasem, Bali	12	Rh
<i>Begonia dolichocarpa</i> Girm.	PWH 337	TNBT, Sumatra	3	CL
<i>Begonia droopiae</i> Ardi	WA 08	West Sumatra	2	Rh
<i>Begonia galeolepis</i> Ardi & D.C. Thomas	KRE	Seram, Maluku (Ceram, Moluccas)	10	TS
<i>Begonia galeolepis</i> Ardi & D.C. Thomas	KRE	Seram, Maluku	2	TS
<i>Begonia holosericeoides</i> Ardi & D.C. Thomas	YY 290	Halmahera, North Maluku	0	TS
<i>Begonia hooveriana</i> Wiriad.	KRME	Enrekang, South Sulawesi	10	CL
<i>Begonia hooveriana</i> Wiriad (green)	KRE	Makale, Sulawesi	2	CL
<i>Begonia heteroclinis</i> Miq.	Iz. s.n	Minahasa, North Sulawesi	4	TS
<i>Begonia holosericea</i> (Teijs. & Binn.) Teijs. & Binn.	Iz. s.n	Ternate, North Maluku	4	TS
<i>Begonia holosericeoides</i> Ardi & D.C. Thomas	YY 137	Halmahera, North Maluku	7	TS
<i>Begonia isoptera</i> Dryand. ex Sm.	KRB	Java	2	CL
<i>Begonia isoptera</i> Dryand. ex Sm.	Greg. H.	G. Payung, TNUK, West Java	2	CL
<i>Begonia isoptera</i> Dryand. ex Sm.	IP	TNUK, West Java	2	CL
<i>Begonia isoptera</i> Dryand. ex Sm.	WA 11	Bodogol, West Java	2	CL
<i>Begonia isoptera</i> Dryand. Ex Sm.	SUBOE 74	Tanggamus, Lampung, Sumatra	Seedling	CL
<i>Begonia isoptera</i> Dryand. ex Sm. ex Sm.	SUBOE 95	Lampung, Sumatra	5	CL
<i>Begonia isoptera</i> Dryand. ex Sm. ex Sm.	HR	Enggano, Bengkulu, Sumatra	5	CL
<i>Begonia isoptera</i> Dryand. ex Sm.	WA 01	Cibodas, West Java	1	CL
<i>Begonia karangputihensis</i> Girm.	CP 66	West Sumatra	1	Rh
<i>Begonia kemumuensis</i> M. Hughes	SUBOE 68	Sumatra	1	Rh
<i>Begonia kudoensis</i> Girm.	CP 66	West Sumatra	1	Rh
<i>Begonia lepida</i> Blume	WA 12	Bodogol, West Java	5	CL
<i>Begonia laruei</i> M. Hughes	WA 13	North Sumatra	2	CL
<i>Begonia longifolia</i> Blume	HH 116	North Sumatra	1	CL
<i>Begonia lugra</i> Ardhaka & Undaharta	KRE	Bali	2	Rh
<i>Begonia longifolia</i> Blume	WA	Curug Nangka, West Java	1	CL
<i>Begonia longifolia</i> Blume	HT 03	Cikaniki, West Java	1	CL
<i>Begonia mollis</i> A.DC	DN. S.n	Bengkulu, Sumatra	4	Rh
<i>Begonia manuselaensis</i> Ardhaka & Ardi	KRE	Seram, Maluku	4	TS
<i>Begonia natunaensis</i> C. W. Lin & C.-I Peng	HT 16	West Sumatra	3	Rh
<i>Begonia nephrophylla</i> Undaharta & Ardi ( <i>ined</i> )	KRE	Seram, Maluku	10	TS
<i>Begonia olivaceae</i> Ardi	WA 15	West Sumatra	12	Rh
<i>Begonia ozotothrix</i> D.C. Thomas	Sopian s.n	Enrekang, South Sulawesi	1	CL
<i>Begonia ozotothrix</i> D.C. Thomas	WA 04	South Sulawesi	1	CL
<i>Begonia oblongifolia</i> Stapfl.	MM.101	West Kalimantan	4	CL
<i>Begonia puspitae</i> Ardi	CP 134	West Sumatra	5	Rh
<i>Begonia puspitae</i> Ardi	DM 1742	West Sumatra	17	Rh
<i>Begonia pseudomuricata</i> Girm	Deden G.	Bali	3	Rh
<i>Begonia pasamanensis</i> M. Hughes	TT972	West Sumatra	5	Rh
<i>Begonia rubra</i> Blume	KRE	Seram, Maluku	4	Rh
<i>Begonia stenogyna</i> Sands	RL 256	West Kalimantan	3	CL
<i>Begonia sageaensis</i> Wiriad.	YY 202	Halmahera, Maluku	5	TS
<i>Begonia sublobata</i> Jack	CP 33	West Sumatra	6	Rh
<i>Begonia simolapensis</i> Ardi	WA 14	North Sumatra	6	Rh
<i>Begonia stictopoda</i> Miq.	WA 18	North Sumatra	2	Rh
<i>Begonia stictopoda</i> Miq.	WA 06	R. Panti, West Sumatra	2	Rh
<i>Begonia stictopoda</i> Miq.	SUBOE 22	Sumatra	Seedling	Rh
<i>Begonia stictopoda</i> Miq.	SUBOE 31	Sumatra	Seedling	Rh
<i>Begonia siccacaudata</i> J. Door.	MN 907	South Sulawesi	4	T
<i>Begonia scottii</i> Tebbitt	SUBOE 80	Lampung, Sumatra	1	Rh
<i>Begonia sabahaensis</i> Kiew & J.H. Tan	DO 1347	South Kalimantan	4	Rh
<i>Begonia sudjanae</i> Janson.	Sumbangan	Sumatra	10	Rh
<i>Begonia siregarii</i> Ardi & D.C. Thomas	RI 1367	South Sulawesi	1	CL
<i>Begonia sendangensis</i> Ardi	SH 1059	Lombok, West Nusa Tenggara	5	T
<i>Begonia trigintocolium</i> Girm.	PWH 341	TNBT, Sumatra	3	CL

<i>Begonia teysmaniana</i> (Miq.) Tebbitt.	KRC	Sumatra	2	Rh
<i>Begonia trichopoda</i> (Mig.) Mig	SUBOE 32	Sumatra	Seedling	Rh
<i>Begonia</i> sp.nov. " <i>fairchildii</i> "	YY 257	Halmahera, North Maluku	2	CL
<i>Begonia</i> sp.nov. " <i>viridifolia</i> "	YY 280	Halmahera, North Maluku	4	TS
<i>Begonia</i> sp.nov. " <i>spectabilis</i> "	YY 351	Halmahera, North Maluku	4	TS
<i>Begonia</i> sp. (Kelimutu)	HT 20	Kelimutu, East Nusa Tenggara	3	CL
<i>Begonia</i> sp.nov. " <i>moluccana</i> "	YY 123	Halmahera, North Maluku	3	CL
<i>Begonia</i> sp.nov. aff. <i>hooveriana</i>	WA 05	South Sulawesi	1	CL
<i>Begonia</i> sp. cf. <i>stictopoda</i>	WA 07	Agam, West Sumatra	5	Rh
<i>Begonia</i> sp. " <i>hybrid lepida isoptera</i> "	WA 10	Bodogol, West Java	12	CL
<i>Begonia</i> cf. <i>caespitosa</i>	KRC	Sumatra	2	Rh
<i>Begonia</i> sp. aff. <i>arfakensis</i>	KRE	Papua	2	CL
<i>Begonia</i> sp.nov. "MA 15"	KRE	Seram, Maluku	10	TS
<i>Begonia</i> aff. <i>stictopoda</i> Miq.	DN. S.n	Bengkulu, Sumatra	4	Rh
<i>Begonia</i> sp. nov.	Deden G.	Sumbawa, West Nusa Tenggara	9	T
<i>Begonia</i> sp (Randi)	Sumbangan	West Sumatra	2	CL
<i>Begonia</i> aff. <i>gemella</i>	Deden G.	Luwuk, South Sulawesi	3	TS
<i>Begonia</i> sp. (Mamuju)	Deden G.	Mamuju, West Sulawesi	2	CL
<i>Begonia</i> sp. (Enrekang)	KRME	Enrekang, South Sulawesi	6	CL
<i>Begonia</i> sp. (Lampung)	SY	TNBBS, Sumatra	1	CL
<i>Begonia</i> sp. aff. <i>naumoniensis</i>	AM 4	Sorong, West Papua	4	CL
<i>Begonia</i> sp. ( <i>inggitiae</i> )	IP	Central Kalimantan	2	TS
<i>Begonia</i> sp.	HR.818	P. Mursala, Sumatra	1	Rh
<i>Begonia</i> sp.	YY 391	Sumba, West Nusa Tenggara	3	Rh
<i>Begonia</i> sp.	YY 392	Sumba, West Nusa Tenggara	3	Rh
<i>Begonia</i> sp.	YY 429	Sumba, West Nusa Tenggara	3	Rh
<i>Begonia</i> sp.	PWH 351	TNBT, Sumatra	3	Rh
<i>Begonia</i> sp.	IY 044	Tambrau, West Papua	1	CL
<i>Begonia</i> sp.	HR.768	P. Mursala, Sumatra	8	Rh
<i>Begonia</i> sp.	YI 20002	East Kalimantan	2	CL

Notes: CL (cane like) erect stem *Begonia*, Rh (*rhizomatous*) stem rhizomatous, T (*tuberous*) bulbous, TS (*trailing scandent*) creeping stem. Source: Expedition reports (Ardi and Hughes 2010; Ardi 2014; Hughes 2009; Hartutiningsih 2008; Thomas 2012; Thomas et al. 2011; Wiriadinata 2012)

Based on the observation of stem morphology in the native *Begonia* collection at Bogor Botanic Gardens, the habit of *Begonia* species can be classified into four types; they are erect or cane-like *Begonia*, rhizomatous *Begonia*, tuberous *Begonia*, and creeping or trailing scandent *Begonia*.

There are 39 species of cane-like *Begonia*. The group is characterized by erect and upward growth of soft or woody stems that can grow up to two meters long (*B. aptera*, *B. isoptera*, *B. hooveriana*, *B. brevirmosa*). These groups are commonly found growing terrestrially on the shady forest or along rocky river banks. The adaptability of cane-like *Begonia* species is better than others, especially the erect woody stem habit of *B. hooveriana* which is collected from Tana Toraja, South Sulawesi, at 800 m asl. (Wiriadinata 2013). This species is very adaptable and easily propagated in the nursery environment of Bogor Botanic Gardens.

The second group is the rhizomatous *Begonia*. This group has a distinctive character, with stems that grow creeping over the surface of the substrate, and generally with very dense nodes. Apart from being able to grow terrestrially, this group can also grow on either horizontal or vertical limestone rocks. There are 35 species in this group that are successfully conserved in the Botanic Gardens, among which are *B. puspitae*, *B. sudjanae*, *B. coriaceae*, *B. stictopoda*, and *B. lugrae*.

The third group is that of bulbous *Begonia* (tuberous *Begonia*). The number in this group is very few, less than 7

species known in Indonesia; most of them are seasonal plants that are adapted specifically to dry areas such as karst. These species will usually start to go dormant at the end of the rainy season, but sometimes they are not completely dormant but grow much slower with smaller and fewer leaves. Examples of this type that have been collected include *B. tenuifolia*, *B. bimaensis* and *B. sendangensis*.

Scandent trailing *Begonia* species i.e. with creeping stems (TS = trailing scandent) are found in eastern Indonesia such as in Sulawesi, Maluku and Kalimantan. Currently, Bogor Botanic Gardens has managed to conserve 16 species, some of which are new species recently described such as *B. galeolepis*, *B. manuselaensis* and *B. nephrophylla*, while some others are still under observation.

### ***Begonia* potential**

Wild *Begonia* species generally have a simple leaf shape not especially attractive. However, there are some species of wild *Begonia* that can be enjoyed directly due to their interesting leaf shape or stature, which means that they potentially can be developed as ornamental plants. Beautiful wild *Begonia* species with unique characters such as *B. brevirmosa*, *B. droopiae*, *B. holocericeoides* and *B. puspitae* can be used as a genetic resource for developing new ornamental plant varieties through artificial hybridization.

*Begonia rex* cultorum is a good example of a popular exotic *Begonia*. This group has many variations of leaf shape and beautiful colouration, and species in this group are mostly grown as indoor plants. Another example of a popular exotic *Begonia* is *B. cucullata*, a species which is very famous for its flowering habit. This plant has been used widely as a bedding plant for garden landscaping, such as in the attractive, iconic, bird-shaped garden at Taman Bunga Nusantara which was created using 20,000 planted pots of *B. cucullata*.

Apart from uses as ornamental plants, some species of *Begonia* are also used as traditional medicinal plants; such as *B. glabra* used as an antiseptic to heal flesh wounds; *B. fimbriatipula* used as a fever and cough medicine and as a medication to ease menstrual pain. *B. grandis* is used in herbal medicines to clean wounds, reduce swelling and to treat a number of diseases. There are also species used as vegetables such as *B. lailana*, *B. baramensis*, *B. stenogyna*, *B. lazat* and *B. comestibilis* (Tebbit 2005; Thomas and Ardi 2011; Kiew et al. 2015). In Indonesia, *B. robusta* and *B. multangula* having a sour acidic taste are often used as substitutes for sour vegetables. Type *B. baliensis*, endemic to Bali, is also used as a salad vegetable and cough medicine (Hartutiningsih et al. 2013).

### Propagation

Generally, *Begonia* species can reproduce in two ways, generatively and vegetatively. In its natural habitat, *Begonia* usually reproduces generatively by seed, and sometimes also multiplies vegetatively by producing suckers or forming plantlets on the fallen leaves. In cultivation, *Begonia* is relatively easy propagated by stem or leaf cuttings, and also by seed. Sexual reproduction producing seed is usually employed for increasing genetic diversity or for developing new varieties by cross hybridization, whereas vegetative reproduction is used for propagating F1 hybrids or to get mature plants faster.

### Description of selected species

Below are selected species from the Bogor Botanic Gardens collections that have been recently published as new species (Figure 1).

*Begonia aketajawensis* Ardi & Thomas (Ardi et al. 2014)

**Description:** Perennial herbaceous plant, stem creeping and growing on the surface of the substrate, hairy on stem and petioles. Leaves alternate, lamina asymmetric, obovate to orbicular, 8.8-12 × 8.5-11 cm, green, variegated, margin fringed, base cordate, lobes sometimes overlapped, apex rounded. Male inflorescence arranged in panicles, with 2-4 flowers, white. The male flower has four tepals and female flowers 5-6 tepals.

**Notes:** This species has an interesting leaf shape which makes it suitable as an ornamental pot plant. The specific name of *aketajawensis* is taken from the type locality where this species was collected, Aketajawe-Lolobata National Park, in Halmahera.

**Habitat:** The species is found growing vertically on half-or fully-shaded limestone karst walls, 100 m asl.

**Distribution:** Endemic to Halmahera, in Aketajawe Lolobata National Park.

*Begonia droopiae* Ardi (Ardi and Hughes 2010)

**Description:** Perennial monoecious herb with rhizomatous stems. Leaves alternate. Lamina very asymmetric, ovate, 3.5-9.5 × 2-6.8 cm, adaxial glabrous, purplish-green to dark purple between the veins, bullate, veins green, abaxial surface pale green to dark purple between the veins, hairy on the veins, marine crenate, base cordate, lobes not overlapped, apex acuminate. Inflorescence axillary, bisexual. The male flowers have four tepals, white, hairy on its outer surface. Female flowers have tepals, white, fruit with three equal wings.

**Notes:** The small stature and beautiful leaf pattern makes this species suitable for use as a terrarium ornamental plant.

**Habitat:** This species grows vertically on shaded limestone walls or at the mouth of caves, 200 m asl.

**Distribution:** Endemic to West Sumatra, in the Batang Pangean limestone hill, Nagari Solok Ambah, Sawah Lunto.

*Begonia galeolepis* Ardi & D.C. Thomas (Ardi and Thomas 2015)

**Description:** Perennial monoecious herbs with creeping stems and semi erect, up to 40 cm long, all vegetative parts with sparse to moderately dense indumentum of multicellular, fleshy, appressed, red scales, except the upper surface of leaves. Stipules oval to triangular, edges slightly rolled up, persistent. Leaves alternate, lamina very asymmetrical, ovate to suborbicular, 16-23.8 × 12.5-17.2 cm, adaxially dark green or reddish, gloosy, abaxial paler, margin dentate, base coradate, lobes overlapped, apex acuminate male inflorescence is arranged in panicles, distale to female. Male flower with 4-11 cm long pedicels, tepals two, broadly ovate, white tinged pink. Female flowers with five tepals, obovate, pink.

**Notes:** The specific name “galeolepis” is derived from Greek Galeos (shark) and “Lepis” (scale), refers to the red fleshy flattened scale which resembles shark scales (placoid). This species has a unique leaf shape, making it suitable as an ornamental pot plant.

**Habitat:** The species grows on the vertical moist limestone rocks on riverbanks, shaded or half-shaded.

**Distribution:** Endemic Seram, Manusela National Park, Seram.

*Begonia holosericeoides* Ardi & D.C. Thomas (Ardi and Thomas 2015)

**Description:** Perennial monoecious herb with creeping stem and semi erect, hairy on the stem and petioles, thick and branched. Leaves alternate, lamina, asymmetric, ovate, 15-15.5 × 10.5-11 cm, adaxially reddish green to red, variegated with silver bands or spots between the veins sometimes fused forming a band along the margin, abaxial pale green, margin fimbriate, base cordate and lobes not or slightly overlapping, apex acuminate. Male inflorescence arranged in panicles. Male flowers with two tepals, ovate, white tinged pink of white, female flowers with 5 tepals.

*Notes:* This species looked similar to *B. holosericea* which is described in Ternate, but it can be easily distinguished by the absence of hairs on tepals and the ovaries. The beautiful colour pattern of the leaf shape make this species suitable for indoor ornamental pot plants.

*Habitat:* The species was found growing vertically on limestone walls, shaded or half-shaded, at 145 m asl.

*Distribution:* Endemic to Halmahera, in TN Aketajawe Lolobata.

*Begonia manuselaensis* Ardhaka & Ardi (Ardhaka et al. 2016)

*Description:* Perennial monoecious herbaceous, creeping stem, slender, sparsely with small flattened red scale on stem, petioles and leaves. Leaves alternate, lamina asymmetric, ovate to elliptic, 4.8-7 × 3-5 cm, green, margin serrate, base cordate and lobes often overlapping, apex acuminate. Male inflorescence arranged in panicles, with flowers 2-4 flowers, white. Male flowers with 2 tepals, broadly ovate to suborbicular and female flowers with 5-6 tepals.

*Notes:* The specific name *manuselaensis* is derived from the type locality, Manusela National Park, Seram, where the plant was first collected.

*Habitat:* The species is found growing on rocks in the karst in the tropical rain forest.

*Distribution:* Endemic Seram, Manusela National Park.

*Begonia olivaceae* Ardi (Hughes et al. 2015b)

*Description:* Perennial monoecious herbs, stems rhizomatous, with short nodes, stipules oblong-shaped, hairy, persistent. Petiole hairless. Leaves alternate, lamina asymmetric, suborbicular, adaxially dull green with purplish between the veins, glabrous, abaxially paler, margin crenate, base cordate and lobes not overlapping, apex rounded. Inflorescence axilar, bisexual. male flower with four tepals, ovate and elliptic, white, female flowers with three tepals, white, orbicular and elliptical. Fruit with three equal wings.

*Notes:* The specific name “olivacea” is derived from Latin and refers to the colour of the lamina. The small stature habit of *B. olivaceae* makes it suitable for terraria.

*Habitat:* The species grows on dusty limestone walls, half and fully shaded, 250 m asl.

*Distribution:* Endemic to Sumatra, Gunung Leuser National Park, Sumatra.

*Begonia puspitae* Ardi (Hughes et al., 2009)

*Description:* Perennial monoecious herbs, stem rhizomatous. Leaves alternate, Stipule densely covered with branched hairs, lamina asymmetric, broadly ovate, 8-22 × 5-13.5 cm, densely hairy, green, margin denticulate, base cordate and lobes often overlapping, apex acuminate. Inflorescence bisexual, axilar. Male flowers with two tepals white or white tinged with pink, female flowers with two tepals, white fruit of three equal wings.

*Notes:* *Begonia puspitae* is one of the highly adapted species in cultivation. The specific epithet is named after the collector, Dwi Murti Puspitaningtyas

*Habitat:* The species grows vertically on limestone crevices, shaded at 600-800 m asl.

*Distribution:* Endemic to West Sumatra, Gunung Silungkang, Batang Pangean Nature Reserve, Sawah Lunto, West Sumatra.

*Begonia sendangensis* Ardi (Ardi et al. 2013)

*Description:* Perennial and seasonal plant herbs, small. Stem tuberous. Leaves alternate, lamina asymmetric, ovate to broadly ovate 4-6.5 × 2.5-5 cm with serrated and hairy margin, base cordate and lobes sometimes overlapped, apex acuminate. Inflorescence axillary, bisexual, simple racemose. Male flowers with four tepals, pink, female flower with three tepals pink. Fruit with 3 equal wings.

*Notes:* *B. sendangensis* is one of the few tuberous species found in Indonesia. This species has a special adaptation to dry areas with a tuber. During the dry season the plant will be dormant but will resprout by the end of the dry season. The specific name is derived from the type locality, Sendang Gile Forest Reserve, where the species was first collected.

*Habitat:* The species grows on limestone rocks.

*Distribution:* Endemic to West Nusa Tenggara. This species is found in the nature reserve area of Forest Sendang Gile, North Lombok.

*Begonia simolapensis* Ardi (Hughes et al. 2015b)

*Description:* Perennial monoecious herbs, stem rhizomatous, slender, Very short internodes. Leaves alternate, stipules triangular, hairy, persistent. Petioles densely hairy. Lamina asymmetric, orbicular, 5-9.5 × 4-8 cm margin entire, base cordate and lobes slightly asymmetric, apex rounded, adaxially glabrous, glossy, green or reddish green. Inflorescence bisexual, axillary. Male flowers with four tepals, white tinged with pink. Female flowers with three tepals, white or tinged with pink. Fruit with three equal wings.

*Notes:* The name of the species epithet is derived from Simolap, the type locality where it was collected.

*Habitat:* It grows on dusty limestone walls, in half to full shade at 250 m asl.

*Distribution:* Endemic to Sumatra, Gunung Leuser National Park, Sumatra.

*Begonia siregarii* Ardi & D.C. Thomas (Ardi et al. 2014)

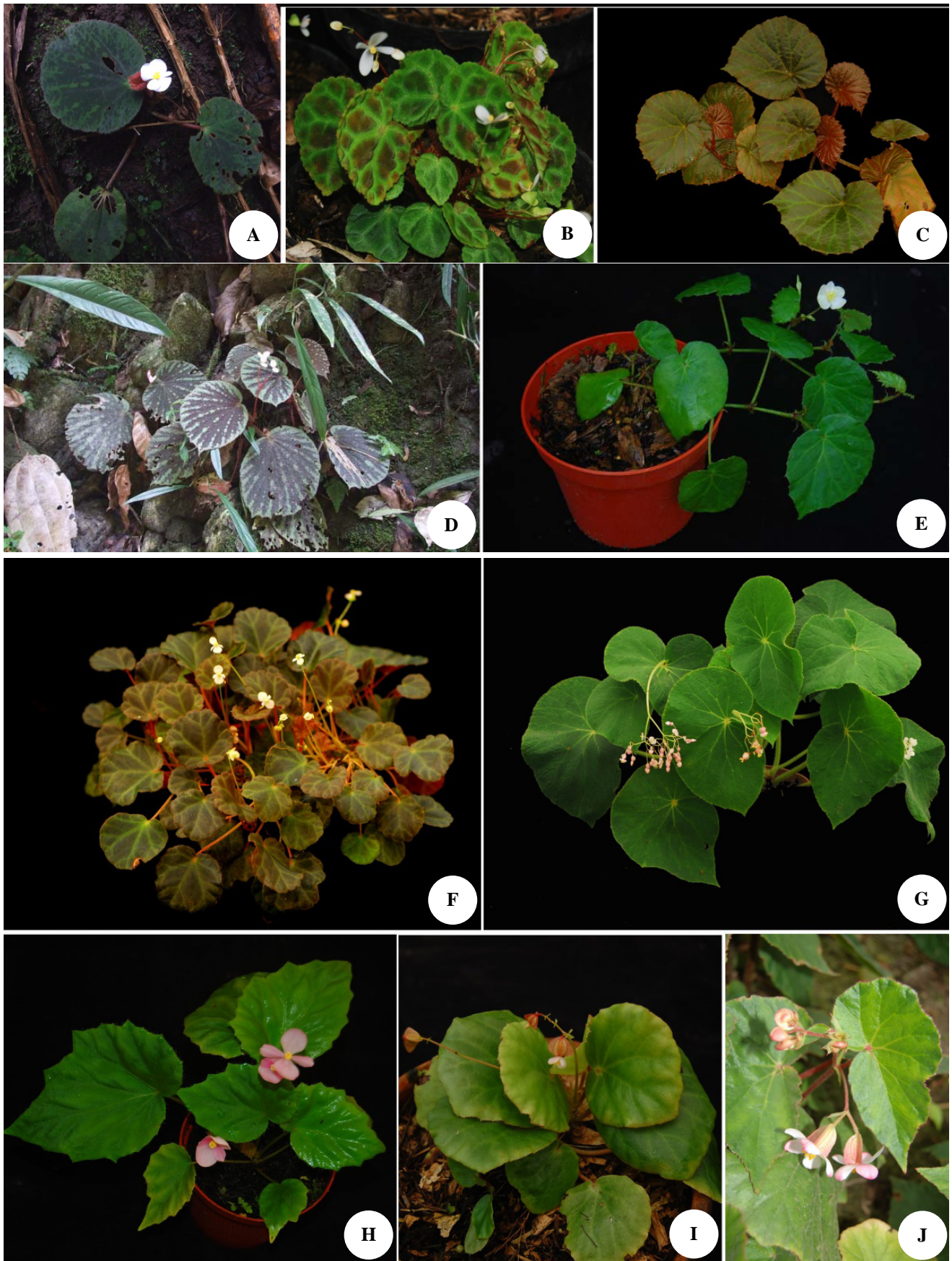
*Description:* Perennial monoecious herbs, stem erect up to 1 m tall, all the vegetative parts are covered with dense white hairs. Leaves alternate, stipule caducous. Lamina, asymmetric, ovate to elliptic, 7.5-23.5 × 4-14 cm, margin dentate to denticulate, base cordate with lobes slightly overlapping, apex acuminate. Male inflorescence cymose, female inflorescence peduncle up to 4 cm long. Male flowers with two tepals, female flowers with five tepals, white tinged with pink.

*Notes:* Although of modest stature, it has attractive flowers when flowering, compact and vibrant in appearance. The species epithet name “Siregarii” was given in honour of a former director of Bogor Botanic Gardens (2009-2013) who collected the species from Sulawesi

*Habitat:* The plant is found growing on karst hills in the area of traditional Toraja Tombs in Kate Kesu.

*Distribution:* Endemic to South Sulawesi, Tana Toraja.





**Figure 1.** Recently published new species from Bogor Botanic Garden's collection. A. *B. aketajawensis*; B. *B. droopiae*; C. *B. galeolepis*; D. *B. holosericeoides*; E. *B. manuselaensis*; F. *B. olivacea*; G. *B. puspitae*; H. *B. sendangensis*; I. *B. simolapensis*; J. *B. siregarii*. Photo by Ardi WH.

To summary, the conservation of *Begonia* meets several key for appropriate ex-situ conservation, such as a high level of local endemism, uniqueness, feasibility of reintroduction into their natural habitats, and high potential economic value as ornamental and medicine plants. The inventory of the *Begonia* collection assembled in the Bogor Botanic Gardens nursery during the past 10 years of exploratory expeditions records a total of 93 collection numbers consisting of 77 *Begonia* species. Twenty-seven of them are recently published new species. All of these species have prospects to be developed as ornamental plants or can be used as a genetic resource for developing new plant varieties through hybridization.

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