

The Euphorbiaceae (Spurge Family) in Bogor Botanic Gardens, Indonesia: Diversity, conservation and utilization

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Abstract. Munawaroh E, Yuzammi, Purwanto Y. 2020. *The Euphorbiaceae (Spurge Family) in Bogor Botanic Gardens, Indonesia: Diversity, conservation and utilization. Biodiversitas 21: 5021-5031.* Euphorbiaceae (Spurge family) is the fourth largest family worldwide, consists of 1,354 species and 91 genera. The family is also a part of the Bogor Botanic Gardens collections. The Gardens has evolved to fulfill its mission through five principal functions: conservation, research, education, tourism, and environmental services. The aims of this study are to reveal the diversity, conservation, and its potential in the Bogor Botanic Gardens. This research was based on direct observation of all members of Euphorbiaceae family in the Gardens, as well as Registration Unit and the Garden's catalog which were observed for more than 10 years. The Gardens collected 39 genera, 71 species, and 136 specimens where 91 specimens are trees, 38 specimens are shrubs, three specimens are climbers and four specimens are succulents. Most of the collections are native to Indonesia 75.91% (103 specimens) and only 33 specimens (24.09%) from overseas. Amongst native collections have dominated from Jawa 25.54% (34 specimens), Sumatra 24.08% (33 specimens). The others are from Sulawesi 9.48% (13 specimens), Kalimantan 7.29% (10 specimens), Maluku 6.56% (9 specimens), Papua 2.28% (three specimens), and Nusa Tenggara Timur 0.72% (one specimen). Many species of the family have potentially developed as traditional medicinal plants (11 species), ornamental plants (16 species), spices and vegetable (two species), timbers (14 species), rubber plants (one species), source of energy (two species) and toxic (six species). Several old collections have retained at the Gardens that aged over 75 years, such as *Mallotus philippensis* (Lam.) Mull. Arg. forma *mollis*, *Acalypha wilkesiana* Mull. Arg., *Acalypha hispida* Burm. var. *sanderi* (N.E.Br.) J. J. Sm., *Acalypha wilkesiana* Mull. Arg. forma *Montana*, *Sapium aucuparium* Jacq. and *Ricinodendron heudelotii* (Bail.) Heckel. A map of planting point of the Euphorbiaceae collections is provided.

Keywords: Bogor Botanic Gardens, conservation, diversity, Euphorbiaceae, potential

INTRODUCTION

Forests are important repositories of terrestrial biodiversity and play a key role in influencing socio-ecological and cultural attributes of human societies including livelihood activities of traditional societies living in these areas (Hermann 2006; Baboo et al. 2017; Karki et al. 2017). Biodiversity is essential for human survival and economic well being and for the ecosystem function and stability (Singh 2002). Globally, habitat destruction, over-exploitation, pollution, and species introduction are identified as major causes of biodiversity loss (UNEP 2001; Bargali et al. 2014, 2015; Mourya et al. 2019). The existence of a species in nature largely depends on its regeneration under varied environmental conditions like forest floor conditions; nutrient use efficiency of species and cycling as well as decomposition processes (Bargali 1994, 1995, 1996; Bargali et al. 1992, 1993; Bargali and Singh 1997). These pressures have put the species from their natural habitat to the ex-situ conserving conditions so that the species may be conserved for future generations.

Bogor Botanic Gardens is an ex-situ plant conservation area that has documented collections and its arranged based on classification, bioregion, thematic pattern, or a

combination of these patterns. It was founded on May 18, 1817 by G.G. Reinwardt, a botanist from Germany (Hendrian and Witono 2011). As an ex-situ conservation of plant species is an effort to preserve, research and use plants sustainably outside their natural habitat. In more specific the Gardens task and function are to carry out ex-situ plant conservation including to conduct research, to utilize and to develop potential of its collections in sustainable manner, and also to develop ecosystem services. One of the Gardens collections which have potential for further development is the Euphorbiaceae (spurge family).

The Euphorbiaceae is one of the largest and most diverse families of flowering plants, consists of ca. 340 genera and nearly 9000 species worldwide, commonly distributed in tropical regions in the world (Wurdack et al. 2004; Fayed et al. 2019). Most of the members are herbs but some, particularly in the tropics, are trees or shrubs or succulents or even cacti-like (Rahman and Akter 2013). From an ecological point of view, the existence of Euphorbiaceae is of utmost importance for ecosystem balancing. The members of this family are mostly tolerant of various environmental conditions, notably in open and dry areas (Polosakan and Alhamd 2012). Moreover, some

of the members can be used as traditional medicine, food, ornamental plant, poison, rubber, and material for construction (Djarwarningsih 2007). However, the potential of the Euphorbiaceae collection, particularly in the Gardens, for conservation and economic purposes has not yet been fully explored. Therefore, this study aimed to reveal the diversity of the Euphorbiaceae species at the Bogor Botanic Gardens, to conserve it and to list the species with particular potential such as for medicine, ornamental, food, rubber, toxic and material for construction.

MATERIALS AND METHODS

The materials used in this study are based on the cultivated plant at the Bogor Botanic Garden, Indonesian Institute of Sciences, Indonesia. The research was conducted from 2015-2018. The method used was direct observation of all the Euphorbiaceae collections, both are planted in the field and in the nursery. The observations encompassed planting and maintenance of the Euphorbiaceae collections in the Garden and how the

collections could grow well for ex-situ conservation purposes. Besides, the data were also obtained from various sources in order to support this study viz. Registration Unit of BBG (accession data, planting data, and death record data), the Garden's catalog, and literature. Ethnobotany study was obtained from direct observation during field works and from other sources.

RESULTS AND DISCUSSION

The diversity of Euphorbiaceae at the Bogor Botanic Gardens

Recent study on molecular phylogenetic have been segregated the Euphorbiaceae *sensu lato* (*s.l.*) into five families by many taxonomists, for instance, Webster (1994), Wurdack et al. (2004), Fayed et al. (2019), based on the most advance molecular taxonomy in conjunction with the morphology. These five families split off from Euphorbiaceae *s.l.* are Phyllanthaceae, Putranjivaceae, Pandanaceae, Picrodendraceae, and Euphorbiaceae *sensu stricto* (*s.s.*).

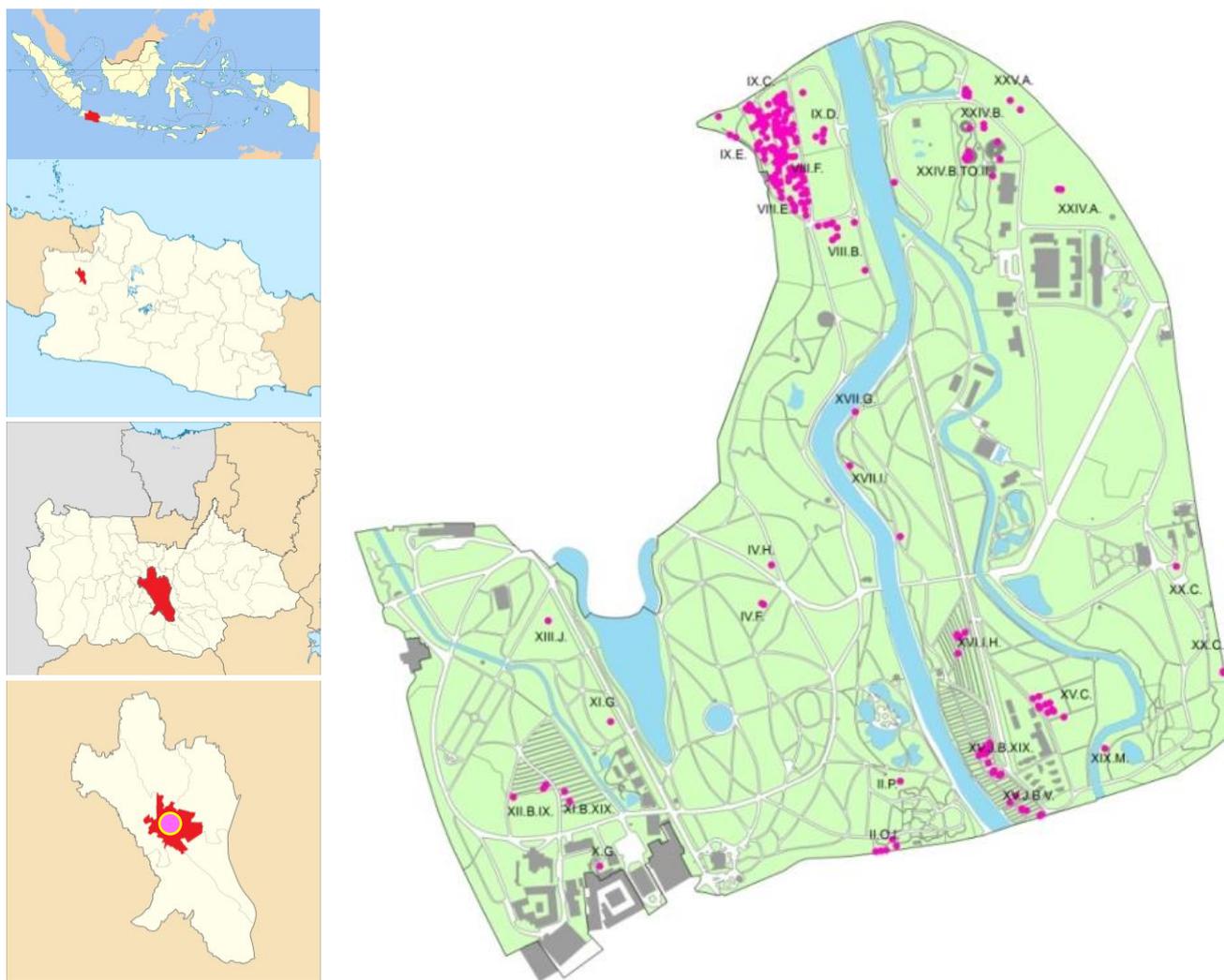


Figure 1. Euphorbiaceae collections planted at the Bogor Botanic Gardens of Bogor Tengah Sub-district, Bogor City, West Java, Indonesia (red-purple tiny dots)

Table 1. Euphorbiaceae collections at the Bogor Botanic Gardens, West Java, Indonesia

Genera	Species	Habitus	Origin	Planting year	No. of spec.	Bed numbers	
<i>Acalypha</i>	<i>hispida</i> Burm.F	S	India	1993	1	XVI.I.G.32	
	<i>hispida</i> Burm.F var. <i>sanderi</i> (N.E.Br.) J.J. Smith	S	India	1924	2	XVII.I.1.1a	
	<i>wilkesiana</i> Müll Arg.	S	W. Java	1924	1	XIX.I.D.16	
	<i>wilkesiana</i> Müll Arg.	S	Maluku	1924	2	XIV.G.11-11a	
	<i>wilkesiana</i> Müll Arg.	S	Australia	1924	1	XVII.G.5	
	<i>wilkesiana</i> Müll Arg. forma <i>illustris</i>	S	W. Java	1924	1	XXIV.A.XII.20	
	<i>wilkesiana</i> Müll Arg. forma <i>montana</i>	S	W. Java	1924	1	XXIVA.VI.15	
<i>Alchornea</i>	<i>rugosa</i> (Lour) Müll Arg.	S	W. Java	2013	1	VIII.F. 113	
					1	XI. B.XV.135	
<i>Aleurites</i>	<i>moluccanus</i> (L.) Willd.	T	NTT	1995	1	IX.A.92a	
<i>Balakata</i>	<i>baccata</i> (Roxb.) Esser	S	Sumatra:	2005	1	IX.E.91	
			Lampung				
<i>Blumeodendron</i>	<i>tokbrai</i> (Blume) Kurz	T	S. Kalimantan	1924	1	IX.C.144	
		T	Sumatra: Aceh	1924	1	IX.A.98	
<i>Botryophora</i>	<i>geniculata</i> (Miq.) Beumee ex Airy Shaw	T	Sumatra:Lampung	2005	1	IX.C.186	
<i>Cephalomappa</i>	<i>mallotcarpa</i> J.J. Smith	T	W. Java	2005	2	VIII.F.50-50a	
<i>Cleidion</i>	<i>spiciflorum</i> (Burm. f.) Merr.	T	W. Java	1997	2	IX.A.88-88a	
<i>Codianum</i>	<i>variegatum</i> Blume	S	W. Sumatra	2007	1	II.P.124	
		S	Sumatra	2007	1	XXIV.A.VII.26	
		S	S.E. Sulawesi	2012	1	XV.J.B.XXXIX.22	
<i>Croton</i>	<i>argyratus</i> Blume	T	Java: Banten	1965	1	XV.C.64a	
		T	S. Kalimantan	1995	2	IXC.154. XVI.IE.15	
		W.Cl.	Java	1965	2	XV.C. 17-17a	
		T	SE Asia	1995	1	XVII.D.36	
		S	Sumatra: Aceh	2003	1	IX.C.174	
<i>Elateriospermum</i>	<i>tapos</i> Blume	T	E.Kalimantan	2007	2	IX.C.194-195a	
<i>Endospermum</i>	<i>moluccanum</i> (Teijsm. & Binn) Becc.	T	Papua	2004	1	XXV.B.40	
<i>Euphorbia</i>	<i>lactea</i> Haw	Sc.	SE. India	1995	1	II.O.I.37	
	<i>neriifolia</i> L	Sc.	SE. India	2006	3	II.O.I.47-47a-47b	
	<i>pulcherrima</i> (Graham) Willd. ex Klotzsch	S	Mexico	1982	1	XXIV.A.II.5	
	<i>Tirucalli</i> L.	S	Africa	1971	1	II.O.I.1	
	<i>tithymaloides</i> (L.) Poit	S	W. Java	2002	1	XXIV.B.XVI.12	
	<i>Exoecaria</i>	<i>agallocha</i> L	S	S. Sumatra	2009	2	IX.D.310-310A
			S	Java	2007	1	XXIV.B.XVI.10
<i>Galeria</i>	<i>filiformis</i> (Blume) Pax	T	Sumatra:Lampung	2006	2	VIII.B.44-44a	
<i>Hancea</i>	<i>subpeltata</i> (Blume) M. Aparicio ex S.E.C.Sierra, Kulju & Welzen	S	W. Sumatra	2009	1	VIII.F.94	
<i>Hevea</i>	<i>brasiliensis</i> (Will. Ex A. Juss) Müll Arg.	T	Brazil	1996	1	IX.C.132	
			Sumatra: Jambi	1996	1	VIII.F.101	
		T	Guiana	2004	2	VIII.F.75-75A	
		T	Brazil	1980		IX.A.13	
		T	Brazil	1980	1	VIII.E.28	
<i>Homonoia</i>	<i>javense</i> (Blume) Müll Arg.	T	Java	1982	2	IX.A.26-26a	
		T	W. Java	1964	1	XVII.I.79	
<i>Hura</i>	<i>crepitans</i> L.	T	Mexico	1983	2	XXV.A.215-215b	
		T	Mexico	1983	2	XXV.A.215-215b	
<i>Jatropha</i>	<i>curcas</i> L.	S	W. Indies	1977	1	XXIV.B.XVI.11	
		S	Africa	1977	1	XXIV.B.XVII.4	
		S	W. Java	1996	1	XXIV.A.XII.13	
		S	C. America	1998	1	II.O.VII.42, 124	
		T	Brazil	2005	1	IX.C.172.187	
<i>Joannesia</i>	<i>princeps</i> Vell.	T	Brazil	2005	1	IX.C.172.187	
		T	W. Sumatra	2007	3	VIII.F.100.100a; 105A.309b	
<i>Macaranga</i>	<i>conifera</i> Müll Arg.	T	W. Sumatra	2007	3	VIII.F.100.100a; 105A.309b	
		T	S.E. Sulawesi	1995	1	IX.D.238	
		T	W. Kalimantan	1996	1	VIII.F.92	
		T	Sumatra: Riau	2009	1	IX.D.311a	
		T	Sumatra: Jambi	2002	2	IX.C. 166-166a	
		T	Sumatra: Jambi	1998	1	VIII.F.95	
<i>Mallotus</i>	<i>borneensis</i> J.J. Sm.	S	W. Kalimantan	2000	1	IX.C.163	

	<i>floribundus</i> (Blume) Müll Arg.	T	SE Sulawesi	2014	2	VIII.F.83
		T	SE. Sulawesi	2014	1	IX.C.158
		T	Bangka Island	1924	1	IX.C.102a
		S	N. Sulawesi	2014	1	IX.C.115
		T	W. Kalimantan	1995	1	IX.C.159
	<i>nudiflora</i> (L.) Kulju & Welzen	T	W. Sumatra	1924	2	X.E.40-40a
	<i>peltatus</i> (Geisel.) Müll Arg.	T	W. Java	1995	1	IX.C.151
		T	W. Sumatra	2002	1	VIII.E.44
	<i>philippensis</i> (Lam.) Mull. Arg.	T	Philippines	1981	1	IX.A.81a
	<i>philippensis</i> (Lam.) Müll Arg.forma	T	Philippines	1922	1	VIII.E.27
	<i>mollis</i>				1	IX.C.30a
	<i>rufidulus</i> (Miq.) Müll.Arg.	T	Sumatra: Bengkulu	1995	1	IX.C.153
	sp.	S	N. Sulawesi	2007	1	VIII.E.165
		S	W. Sumatra	2009	1	IX.C.207a
<i>Manihot</i>	<i>esculenta</i> Crantz	S	N. Maluku: Ternate	2008	2	XV.J.B.II.26-26A
		S	S. America	1997	1	XXIV.B.XVII.2
<i>Melanolepis</i>	<i>multiglandulosa</i> Reich.f.		N. Sulawesi	1998	2	X.A.96.X.A.92.93
<i>Neoscortechina</i>	<i>kingii</i> (Hook. f) Pax & Hoffm	T	W. Java	1080	2	IX.A.6-6a
<i>Omphalea</i>	<i>papuana</i> Gage	W.Cl.	Papua	1980	1	XVII.G.122
<i>Paracroton</i>	<i>pendula</i> (Hassk) Airy Shaw	T	W. Sumatra	2008	4	IX.A.104-104a.b.c
		T	N. Sulawesi	2002	2	IV.F.169-169a
<i>Pimelodendron</i>	<i>amboinicum</i> Hassk	T	Maluku: Ambon	1964	1	VIII.F.76a
		T	-	2003	2	IXC167a,XII.B.IX.3
		T	SE. Sulawesi	2012	1	XXIV.B.56
		T	SE. Sulawesi	2012	1	XV.J.B.XIX.21
	<i>macrocarpum</i> J.J. Smith	T	N. Sumatra	2009	1	IX.C.127
				2006	1	XXIV.B.53
	<i>zoanthogyne</i> J.J. Smith	T	Kalimantan	1981	1	XXIV.A.65
<i>Reutealis</i>	<i>trisperma</i> (Blanco) Airy Shaw	T	W. Java	1964	4	XXV.A.243a-d
<i>Ricinodendron</i>	<i>heudelotii</i> (Bail.) Heckel	T	Africa	1965	1	IX.A.86
		T	W. Java	1965	2	IX.C.201-201a
<i>Sapium</i>	<i>aucuparium</i> Jacq	T	W. Indies	1964	1	XX.C.71
<i>Shirakiopsis</i>	<i>Indica</i> (Willd) Esser	T	S. Sulawesi	1996	1	VIII.E.38
		T	W. Java	1993	2	XXIV.34-34a
<i>Spathiostemon</i>	<i>javensis</i> (Blume) Müll Arg.	T	Java	1982	2	IX.A.26-26a
<i>Strophoblancia</i>	<i>fimbricalyx</i> Boerl.	T	Maluku: Ambon	1996	2	VIII.F.43-43A
<i>Sumbaviopsis</i>	<i>albicans</i> (Blume) J.J.Sm.	T	Java	1988	2	VIII.F.81;IX.A.95
<i>Suregada</i>	<i>glomerulata</i> (Blume) Baill.	T	Java	1996	2	VIII.F.4, IX.C.124
		T	Sumatra: Bengkulu	1996	2	VII.E.41.,47
		T	W. Sumatra	1924	2	X.E.40-40a
<i>Trigonostemon</i>	<i>anomalus</i> Merr.	S	Papua	2009	1	XV.J.B.XX.7
		S	W. Java	1981	1	XII.B.VIII.57
	<i>longifolius</i> Baill	S	W. Sumatra	2002	2	XI.B.XVII.270-270a
	<i>serratus</i> Blume	T	Sumatra: Jambi	2003	1	XI.G.161
<i>Vernicia</i>	<i>montana</i> Lour.	T	W. Java	1989	1	XX.C.97-97a

Note: T: Tree, S: Shrub, W.Cl.: Wood Climber, Sc: Succulent. Sources: The Registration Unit database and the Gardens Catalogue (Sari et al. 2010)

In general, the Euphorbiaceae *s.l.* collections at the Bogor Botanic Gardens (BBG) have been cultivated since 1922. Most of the collections were collected throughout the Indonesian lowland forests, some of them were obtained from overseas via seed exchange among other botanic gardens in the world. The number of genera and species presented in Euphorbiaceae *s.l.* as cited in the Garden's Catalogue (Sari et al. 2010) were 54 genera, 136 species (eight are still spp.), and 235 specimens in total. Since the family has been split into five families thus an evaluation through the Gardens' collections resulted in 39 genera, 71 species, and 136 specimens (Table 1). Some of the

members have separated to be Phyllanthaceae family such as genera *Actephila*, *Antidesma*, *Aporosa*, *Baccaurea*, *Bischofia*, *Breynia*, *Bridelia*, *Cleistanthus*, *Galearia*, *Glochidion*, *Margaritaria*, *Phyllanthus*, and *Sauropus*. Moreover, the genus *Drypetes* segregated into Putranjivaceae family and *Galearia* into Pandanaceae family. As can be seen in Figure 1, the members of Euphorbiaceae (here used only Euphorbiaceae for the rest of this paper) have been cultivated at the Bogor Botanic Gardens in several bed numbers. However, it is suggested to do revision on the Garden's Catalogue as well as name tags on the Gardens collections.

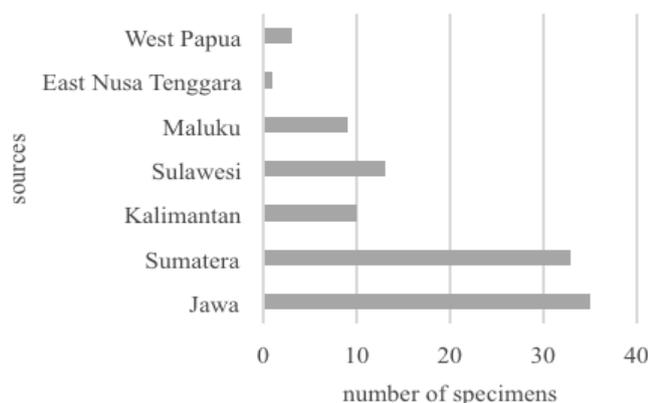


Figure 3. The number of Euphorbiaceae specimens has cultivated at the Bogor Botanic Gardens, West Java, Indonesia collected throughout Indonesian forests

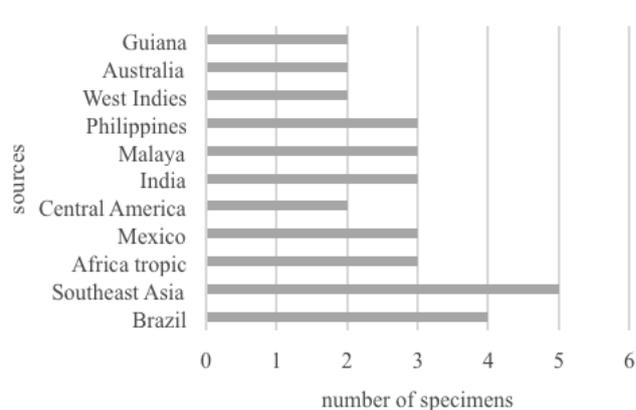


Figure 4. The number of Euphorbiaceae specimens has cultivated at the Bogor Botanic Gardens, West Java, Indonesia obtained from overseas

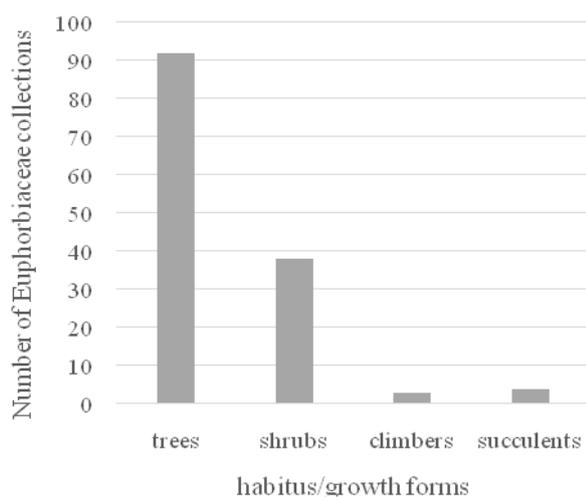


Figure 2. The Euphorbiaceae collections at the Bogor Botanic Gardens, West Java, Indonesia based on habitus

Habitus of the Euphorbiaceae family

The Euphorbiaceae family displays remarkable range of vegetative growth from woody plant to succulent. The growth forms represent at the BBG including tree, shrub, vines/climber, and succulent. In this case, the number of trees of Euphorbiaceae collections at the BBG is 92 specimens, of which 56 specimens have stem diameter over than 25 cm (from 20 genera and 24 species), such as *Aleurites moluccanus* (L.) Willd., *Blumeodendron tokbrai* (Blume) Kurz, *Cephalomapha malloticarpa* J.J. Smith, *Croton argyratus* Blume, *Endospermum moluccanum* (Teijsm. & Binn), *Hevea brasiliensis* (Will. Ex A. Juss) Müll Arg., *H. confuse* Hemsl., *Joanesia princeps* Vell., *Macaranga conifer* Müll Arg., *M. gigantea* Müll Arg., *M. triloba* Reinw. Ex Blume) Müll Arg., *Melanolepis*

multiglandulosa Reich.f., *Neoscortechina kingie* (Hook. f) Pax & Hoffm, *Pimelodendron amboinicum* Hassk, *Reutalis trisperma* (Blanco) Airy Shaw, *Rhichinodendron heudelotii* (Bail.) Heckel, *Sapium aucuparium* Jacq, *Shirakiopsis indica* (Willd) Esser, *Strophoblanchia fimbricalyx* Boerl., *Sumbaviopsis albicans* (Blume) J.J.Sm., *Suregada glomerulata* (Blume) Baill. and *Vernicia Montana* Lour. The rest of Euphorbiaceae collections growth forms at the Gardens are shrubs (38 specimens), climbers (3 specimens), and succulents (4 specimens) (Figure 2).

It should be noted that slightly over 60% of the tree's forms having stem diameter more than 25 cm which indicated the Gardens enable to maintain their collections in excellent condition. Thus, this indicates that ex-situ conservation of the Euphorbiaceae family at the BBG has been successful, in accordance with one of its functions.

Source locations of the collections

As mentioned above, the number of specimens of the Euphorbiaceae in the Gardens is 136 specimens of which 104 specimens mostly obtained from flora exploration throughout Indonesian forests. There are 35 specimens (25.54%) from Jawa, Sumatera is represented by 33 specimens (24.08%), Sulawesi is represented by 13 specimens (9.48%), Kalimantan is represented by 10 specimens (7.29%), Maluku is represented by nine specimens (6.56%), West Papua is represented by three specimens (2.18%) and East Nusa Tenggara is represented only one specimen (0.72%). Meanwhile, the Gardens also cultivated a number of specimens of the Euphorbiaceae from overseas, including Brazil (four specimens), Southeast Asia (five specimens), Africa tropic (three specimens), Mexico (three specimens), Central America (two specimens), India (three specimens), Malaya (three specimens), Philippines (three specimens), West Indies (two specimens), Australia (two specimens) and Guiana (two specimens) (Table 2, Figure 4).

Table 2. The number of the Euphorbiaceae family cultivated at the Bogor Botanic Gardens, West Java, Indonesia from overseas, together with the planting year

Origin	Species name	Planting year	Number of specimens
Australia	<i>Acalypha wilkesiana</i> Müll Arg.	1924	2
Brazil	<i>Hevea brasiliensis</i> (Will. Ex A. Juss) Müll Arg.	1996	1
	<i>Hevea pauciflora</i> (spruce ex Benth.) Müll Arg.	1980	1
	<i>Hevea spruceana</i> (Benth.) Müll Arg.	1980	1
	<i>Jatropha princeps</i> Vell.	2005	1
Central America	<i>Jatropha podagrica</i> Hook.f.	1998	2
	<i>Manihot esculenta</i> Crantz	1997	1
Guiana	<i>Hevea confusa</i> Hemsl	2004	2
India	<i>Acalypha hispida</i> Burm. F.	1993	1
	<i>Acalypha hispida</i> Burm. var. <i>sanderi</i> (N.E.Br.) J. J. Smith	1924	2
Malaya	<i>Acalypha wilkesiana</i> Mull. Arg. <i>forma montana</i>	1924	2
	<i>Codiaeum variegatum</i> Blume	1995	1
Mexico	<i>Euphorbia pulcherrima</i> (Grahamen) Wild ex Klotzsch	1982	1
	<i>Hura polyandra</i> Baill.	1983	2
Philippines	<i>Mallotus philippensis</i> (Lam.) Müll Arg.	1981	1
	<i>Mallotus philippensis</i> (Lam.) Müll Arg. <i>forma mollis</i>	1922	2
Southeast Asia	<i>Croton tiglium</i> L.	1995	1
	<i>Euphorbia lactea</i> Haw. <i>forma cristata</i>	1995	1
	<i>Euphorbia nerifolia</i> L.	2006	3
Tropic Africa	<i>Euphorbia tirucali</i> L.	1971	1
	<i>Jatropha gossypifolia</i> L.	1977	1
	<i>Ricinodendron heudelotii</i> (Bail.) Heckel	1965	1
West Indies	<i>Jatropha curcas</i> L.	1977	1
	<i>Sapium aucuparium</i> Jacq.	1964	1

Based on Registration Unit Data of BBG recorded that *Mallotus philippensis* (Lam.) Müll. Arg. *forma mollis* was introduced to the Gardens from the Philippines in 1922. In the following next two years (1924) three species were again introduced to the Gardens viz. *Acalypha wilkesiana* Müll. Arg. (Australia), *Acalypha hispida* Burm. var. *sanderi* (N.E.Br.) J. J. Sm (India) and *Acalypha wilkesiana* Müll. Arg. *forma montana* (Malaya). From 1964 to 1983, the director of the Gardens visited many botanic gardens in the world and brought several Euphorbiaceae collections such as, *Jatropha gossypifolia* L., *Euphorbia tirucali* L., and *Ricinodendron heudelotii* (Bail.) Heckel (Africa tropic), *Sapium aucuparium* Jacq. and *Jatropha curcas* L. (West Indies), *Hevea pauciflora* (spruce ex Benth.) Müll. Arg., *Hevea spruceana* (Benth.) Müll. Arg. (Brazil), *Euphorbia pulcherrima* (Grahamen) Wild ex Klotzsch and *Hura polyandra* Baill. (Mexico). From 1990 to 2006, nine species have been added to the Gardens' collections from overseas that were *Acalypha hispida* Burm.f. (India), *Codiaeum variegatum* Blume (Malaya), *Croton tiglium* L., *Euphorbia lactea* Haw. *forma cristata* and *Euphorbia nerifolia* L. (Southeast Asia), *Hevea brasiliensis* (Will. ex A. Juss) Müll. Arg. and *Jatropha princeps* Vell. (Brazil), *Jatropha podagrica* Hook.f. and *Manihot esculenta* Crantz. (Central America), *Hevea confusa* Hemsl. (Guiana) (Tabel 2). In addition, the Euphorbiaceae collections have increased from 1970 to 2005 through seed exchanged programs between BBG and other botanic gardens around the world. However, this program had been discontinued

since 2007 until now. Hence, additional collections usually donated from overseas.

The age of Euphorbiaceae collections at the BBG

Based on the age of Euphorbiaceae collections are divided into six groups (Figure 5), viz. the ages of 1-10 years (four genera, six species, seven specimens), the ages of 11-20 years (20 genera, 31 species, 55 specimens), the ages of 21-30 years (12 genera, 18 species, 27 specimens), the ages of 31-40 years (11 genera, 12 species, 21 specimens), the ages of 41-50 years (two genera, three species, three specimens) and the ages of over 50 years (eight genera, 13 species, 24 specimens). The age of 11-20 years is the greatest number of specimens among others, because flora explorations throughout Indonesian forests have been extensively carried out during those years. Moreover, the policy of the director of BBG strongly supported this activity, in accordance with other government institutions collaboration, such as forestry.

The Euphorbiaceae collections that have aged over 50 years old grew well in BBG until now, such as *Acalypha grandis* Benth., *A. hispida* Burm.f., *A. wilkesiana* Müll. Arg., *Alchornea rugosa* (Lour.) Müll.Arg., *Blumeodendron tokbrai* (Blume) Kurz, *Hura crepitans* L., *Mallotus floribundus* (Blume) Müll. Arg. *M. rufidulus* (Miq.) Müll.Arg., *M. philippensis* (Lam.) Müll. Arg. *forma mollis*, *Pimelodendron amboinicum* Hassk., *Ricinodendron heudelotii* (Bail.) Heckel. This because the collections have well maintained and supported with suitable environmental factors as well.

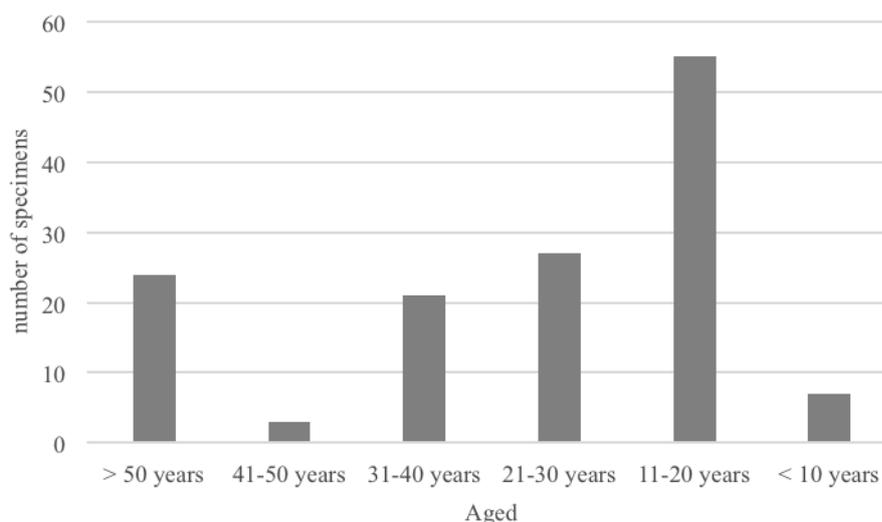


Figure 5. The age of Euphorbiaceae collections at the Bogor Botanic Gardens, West Java, Indonesia

Conservation status

Joannesia princeps Vell, *Pimelodendron amboinicum* Hassk, and *Cleidion spiciflorum* (Burm.f.) Merr. are considered as Vulnerable (VU) based on IUCN (2001). The other species, *Alchornea rugosa* (Lour) Müll.Arg, *Balakata baccata* (Roxb.) Esser, *Homonoia javensis* (Blume) Müll. Arg. and *Suregada glomerulata* (Blume) Baill., are recognized Least Concern (LC) and Not Evaluated (NE) for *Macaranga javanica* (Blume) Müll. Arg.

Uses and potential of Euphorbiaceae collections at BBG

Indonesian people have been used in various plant species for their daily life. Each of the communities has different knowledge to manage and to use of plant diversity which grew in their surrounding homes. These differences have been influenced by the level of cultures, the geographical and ecosystem conditions, the external communities' impact, and the effects of climate changed.

Many species in Euphorbiaceae family have been used by Indonesian people as ingredients of traditional medicines, as foodstuffs, as building materials, as energy source and firewoods, as ornamental plants and other necessities. Almost all parts of the plant have been used, for example, root, stem, bark, leaf, flower, fruit, and seed (Djarwarningsih 2007). Euphorbiaceae collections at the BBG which have potential economic as followed (Table 3): as traditional medicines (11 species), as ornamental plants (16 species), as ingredients and vegetables (two species), as natural dyes for woven cloth (three species), as building materials (14 species), as a source of energy (two species) and as toxics (six species).

Traditional medicines

There are 11 species (*Acalypha wilkesiana*, *Hevea brasiliensis*, *Jatropha curcas*, *J. gossypifolia*, *J. multifida*, *J. podagrica*, *Joannesia princeps*, *Macaranga gigantea*, *M. triloba*, *M. hypoleuca*, and *Ricinodendron heudelotii*) are found at the BBG that can be used as traditional medicines (Table 4). These are usually applied to cure several diseases such as eczema, stroke, rheumatism, wound, toothache, swelling, itching, indigestion, gout, acne, cough, and malaria. In addition, *J. gossypifolia* contains several chemical compounds such as, fat acid, glucose, alkaloid, amino acid, coumarin, steroid, flavonoid, lignan, protein, saponin, tannin, and terpenoid that can relieve the symptoms of eczema, itching, wound and diarrhea (Oduola et al. 2005; Ogundare 2007; Capobianco et al. 2009), while *J. multifida* is known to heal wounds, swelling, eczema, and indigestion (Anonymous 2020). Moreover, Tchoundjeu and Atangana (2006) mentioned that *R. heudelotii* can be used to heal cough, malaria, stomach-ache, and rheumatism.

It is noted that four species (*A. wilkesiana*, *H. brasiliensis*, *J. gossypifolia*, and *J. multifida*) would be the best remedy for eczema (Gotep et al. 2010). A mix of two kinds of species can be used to heal several diseases, for example: swelling (a mix of *J. multifida* and *M. gigantea*), rheumatic (a mix of *H. brasiliensis* and *R. heudelotii*), and digestive disorders (a mix of *J. multifida* and *R. heudelotii*). Peng et al. (2011) stated that leaf decoction of *H. brasiliensis* is used for stroke treatment, while acne can be treated by pounded a leaf of *M. triloba* then smeared it. Moreover, Batin and Carandang (2010) mentioned that the sap of *J. curcas* can be cure toothache by dripping it.

Table 3. The potential of species Euphorbiaceae cultivated at the Bogor Botanic Gardens, West Java, Indonesia for use as medicines, as ornamentals, as vegetables, as ingredients, as dyes, as constructions, as rubbers, as sources of energy, and as toxics

Genera	Species	Medicine	Ornamental	Vegetable	Ingredient	Dye	Building material	Rubber	Energy source	Toxic
<i>Acalypha</i>	<i>godseffiana</i> Masters		•							
	<i>grandis</i> Benth.		•							
	<i>hispida</i> Burm.f.		•							
	<i>hispida</i> Burm.f var. <i>sanderi</i> (N.E.Br.) J.J. Sm.		•							
	<i>wilkesiana</i> Müll Arg.		•							
<i>Aleurites</i>	<i>moluccanus</i> (L.) Willd				•	•	•			
<i>Blumeodendron</i>	<i>tokbrai</i> (Blume) Kurz									
<i>Codiaeum</i>	<i>variegatum</i> Blume		•							
<i>Endospermum</i>	<i>moluccanum</i> (Teijsm. & Binn) Becc.						•			
<i>Excoecaria</i>	<i>cochinchinensis</i> Lour		•							•
<i>Euphorbia</i>	<i>lactea</i> Haw		•							•
	<i>neriifolia</i> L.		•							•
	<i>pulcherrima</i> (Grahamen) Wild ex Klotzsch		•							•
	<i>tirucali</i> L.		•							•
	<i>racemosa</i> (Reinw. Ex. Bl) Müll Arg.		•							•
	<i>tithymaloides</i> (L.) Poit		•							•
<i>Hevea</i>	<i>brasiliensis</i> (Will. Ex A. Juss) Müll Arg.	•					•	•		
	<i>confusa</i> Hemsl.						•			
	<i>pauciflora</i> (spruce ex Benth.) Müll Arg.						•			
	<i>spruceana</i> (Benth.) Müll Arg.						•		•	
<i>Hura</i>	<i>crepitans</i> L.						•			
<i>Jatropha</i>	<i>curcas</i> L.					•				•
	<i>sapida</i> Bedd.	•	•							
	<i>multifida</i> L.	•	•							
	<i>podagrica</i> Hook.f.	•	•							
<i>Joannesia</i>	<i>princeps</i> Vell.	•					•			
<i>Macaranga</i>	<i>gigantea</i> Müll Arg.	•				•				
	<i>triloba</i> (Reinw. Ex Blume) Müll Arg.	•								
	<i>hypoleuca</i> Müll Arg.	•								
<i>Manihot</i>	<i>esculenta</i> Crantz			•					•	
<i>Melanolepis</i>	<i>multiglandulosa</i> Reich. f.						•			
<i>Pimelodendron</i>	<i>amboinicum</i> Hassk.						•			
	<i>macrocarpum</i> J.J. Smith						•			
<i>Reutealis</i>	<i>trisperma</i> (Blanco) Airy Shaw									
<i>Ricinodendron</i>	<i>heudelottii</i> (Bail.) Heckel	•								
<i>Shirakiopsis</i>	<i>indica</i> (Willd) Esser						•			
<i>Sumbaviopsis</i>	<i>albicans</i> (Blume) J.J. Smith						•			

Table 4. The usage of Euphorbiaceae family as traditional medicines

Species	Diseases	Material used	Usage
<i>Acalypha wilkesiana</i> Müll Arg.	Eczema	Leaf	Rubbed
<i>Hevea brasiliensis</i> (Will. ex A. Juss) Müll Arg.	Eczema, stroke, and rheumatic	Leaf	Rubbed or boil
<i>Jatropha curcas</i> L.	Wounds and toothache	Stem sap	Rubbed
		Leaf stalk sap	Dripped
		Sap	Rubbed
<i>Jatropha gossypifolia</i> L.	Wounds, eczema, hives, and diarrhea	Root	Boil
<i>Jatropha multifida</i> L.	Wound, swelling, eczema, and digestive disorders	Sap	Rubbed
		Root	Boil
<i>Jatropha podagrica</i> Hook. f.	Gout, fish poison	Sap	Rubbed and diluted
<i>Joannesia princeps</i> Vell.	Wound and hives	Stem bark	Mashed
		Oilseed	Rubbed
		Root bark	Pounded or rubbed
		Leaf	Mashed, rubbed
<i>Macaranga gigantea</i> Müll Arg.	Wound and swelling	Bark, root, young twig	Mashed, rubbed
<i>Macaranga triloba</i> (Reinw. ex Blume) Müll Arg.	Acne	Bark	Boil
<i>Macaranga hypoleuca</i> Müll Arg.	Fever		
<i>Ricinodendron heudelottii</i> (Baill.) Heckel.	Acne	Bark	Boil

Ornamental plant

It is recorded that 16 species of Euphorbiaceae collections at the BBG have potential as ornamental plants and also as hedges, namely *Acalypha godseffiana*, *A. grandis*, *A. hispida*, *A. hispida* var. *sanderi*, *A. wilkesiana*, *Codiaeum variegatum*, *Excoecaria cochinchinensis*, *Euphorbia lactea* forma *cristata*, *E. nerifolia*, *E. pulcherrima*, *Euphorbia tirucali*, *E. racemosa*, *E. tithymaloides*, *Jatropha multifida*, *J. podagrica* and *J. Sapida*. As already known that several *Acalypha* species have an economic value notably in Malesia. Both *A. hispida* and *A. wilkesiana* are widely cultivated as ornamental plants in South East Asia. Brown-leaved or variegated specimens of *A. wilkesiana* are popular and often grown as hedges, whereas *A. hispida* is preferred for its very red pistillate inflorescences (Sagun et al. 2010).

Ingredients and vegetables

Two species of the Euphorbiaceae family have been recognized as food ingredient and as vegetable, namely *Manihot esculenta* and *Aleurites moluccanus*, respectively (Adhil et al. 2019). *A. moluccanus* (candlenut) has long been used as a spice. However, this species seems less popular nowadays, even though some communities are still cultivated it in their gardens, yards, or in agroforestry areas, particularly in eastern parts of Indonesia: Maluku, Nusa Tenggara Timur, and Nusa Tenggara Barat, for instance. However, candlenut has been household income generated for these communities (Purwanto and Cosiaux 2016).

Natural dyes

At least three species which are cultivated at the BBG can be used as natural dyes, notably for woven cloth, namely *Aleurites moluccana*, *Macaranga gigantea*, and *Jatropha curcas*. Yellow color can be obtained from the pulp of flesh fruit of *A. moluccana*, whereas green color is obtained from the leaf of *M. gigantea* (Seran and Hana 2018). Meanwhile, a green color is gained from a leaf of *J. curcas* and black color is obtained from its seeds (Hariyanto 2017).

Building materials (timbers)

There are 14 species of the Euphorbiaceae collections at the BBG that can be used as timbers, namely *Aleurites moluccanus*, *Endospermum moluccanum*, *Hevea brasiliensis*, *H. confusa*, *H. pauciflora*, *H. spruceana*, *Hura crepitans*, *Joannesia princeps*, *Melanolepis multiglandulosa*, *Pimelodendron macrocarpum*, *Shirakiopsis indica*, and *Sumbaviopsis albicans*. The timbers are utilized, notably local communities, to build a hut or a shelter in their gardens. Mostly are used as poles, building frames, or boards. Even though it is lesser-known timbers; however, it could substitute the commercial timbers for building due to limited availability. *Aleurites moluccanus*, *Endospermum moluccanum*, *Hevea confusa*, *H. pauciflora*, *Pimelodendron amboinicum*, and *Sumbaviopsis albicans* are among timbers species in Euphorbiaceae family that are usually utilized for roof, roof-truss, post, and pillar (Martawijaya et al. 2005;

Soerianegara and Lemmens 1994; Lemmens et al. 1995; Sosef et al. 1998). On the other hand, *Hevea spruceana*, *Hura crepitans*, *Joannesia princeps*, *Melanolepis multiglandulosa*, *Pimelodendron macrocarpum*, and *Shirakiopsis indica* are used for boards (Sosef et al. 1998).

Poisonous plants

Six species of the Euphorbiaceae possess poisonous sap, such as *Excoecaria cochinchinensis*, its sap can kill fish in a short time (Dalimarta 2007), *Euphorbia lactea* has a perilous sap when gets into the eyes and the sap of *Euphorbia tirucalli* can be used as insecticide (Arneti and Putri 2016). Other species (*Euphorbia tithymaloides* and *Jatropha gossypifolia*) contain a fairly high toxin (Karyati and Adhi 2018). The other, *Jatropha curcas*, has been investigated primarily as a source of oil. The seed cake that remains after oil extraction is an excellent source of plant nutrients. However, the presence of high levels of toxic substances and anti-nutrients limits the further applications of *J. curcas* oil and meal. (Haas and Mittelbach 2000). *J. curcas* oil and its extract can exhibit insecticidal effects, pesticidal effects, and antimycobacterial activity and also offer the potential for snail-killing effects (Chumkaew et al. 2003; Makkar and Becker 2009; Diwani et al. 2009).

Collections value of the Euphorbiaceae at the BBG

Ecological value

Several genera in the Euphorbiaceae family have an important role in terms of land rehabilitation and reforestation of degraded areas, such as *Hevea*, *Hura*, and *Pimelodendron*. The species in these genera well adapted to surrounding areas therefore reforestation activities increased. In addition, the species also provided ecosystem services value (an ability to absorb carbon dioxide). Moreover, from an aesthetic value, the species showed great beauty as ornamental plants.

Economic value

Usage value of a plant species is divided into direct and indirect where both are crucial for community life, particularly in providing the daily needs (Purwanto et al. 2011). In Euphorbiaceae, several species can be used as a commercial commodity due to a high aesthetic value. Those are from genera *Acalypha*, *Codiaeum*, *Excoecaria* *Euphorbia*, *Jatropha* for instance, which have been wide traded (Chandra and Sitanggang 2007; Karyati & Adhi 2018).

The other species in Euphorbiaceae family is *Manihot esculenta* (cassava) that has been long time cultivated in Indonesia. It grows well from coastland up to mountain at an altitude of 1700 asl. This cassava can serve as a dessert or as main food during famine times. Besides, ethanol can be generated from its tuber and it becomes an industrial product (Prihandana et al. 2007). Another species is candlenut (*Aleurites moluccana*), which is native to Indonesia, notably in Maluku Islands and eastern part of Indonesian archipelago. It has been well-known since Dutch Era and became one of popular spices and medicine as well. It is easy to propagate by using polyculture in

agroforestry system or mixed cropping. Besides, it is an excellent species for reforestation and rehabilitation of degraded land purposed.

The usage of Euphorbiaceae plant species as traditional medicine has long been used by Indonesian communities, in particular, to deal with daily health problems. The communities usually grow various kinds of medicinal plants in their gardens. Consequently, supply of these raw materials is easily available and less health costs.

Development of Euphorbiaceae collections at the BBG

As an ex-situ conservation institution, BBG has to fulfill and maintain its collections properly. However, just maintaining the collections is not sufficient effort without exploring their potential values whether as ornamental plants or others. The genera *Acalypha*, *Jatropha*, *Aleurita*, *Hura*, *Macaranga*, and *Ricinodendron* for instance, are among potential genera as ornamental plants in Euphorbiaceae family. Species in those genera then selected for development and propagation purposes and would make a worthwhile contribution to the communities. Several Indonesian native species, *Aleurites moluccana* for example, have been widely developed as a spice. Others are also propagated for reforestation and rehabilitation in land degradation.

Conservation

Plant conservation activity takes priority over any other tasks of the BBG, furthermore, research, and domestication are followed. Cultivation, propagation, and maintenance of the collections is a form of conservation activities including the Euphorbiaceae collections at the BBG as well. To increase the collections, therefore, the exploration activities have to continuously carry out throughout Indonesian forests every year, which is recommended.

In conclusion, the Euphorbiaceae family has been segregated into five families viz. Phyllanthaceae, Putranjivaceae, Pandanaceae, Picrodendraceae, and Euphorbiaceae. Four of them are found at the BBG except for Picrodendraceae. Currently, the Euphorbiaceae collections at the BBG are classified into 39 genera and 136 specimens where 91 specimens are trees, 38 specimens are shrubs, three specimens are climbers and four specimens are succulents. *Mallotus philippensis* (Lam.) Mull. Arg. forma *mollis* was firstly introduced to BBG in 1922, originated from Philippines. Various species in Euphorbiaceae family can be utilized as traditional medicine (11 species), ornamental (16 species), spices and vegetables (two species), rubbers (one species), timbers (14 species), source of energy (two species), and toxics (six species). Euphorbiaceae collections have been successfully cultivated at the BBG. This proved that BBG has been carried out an ex-situ conservation very well.

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