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Batam Botanic Garden, Indonesia: Recommendation for Its Living Collections from Riau Archipelago Exploration

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Abstract

Batam Botanic Garden is a relatively new botanic garden in Indonesia that is assisted by and under collaboration with Bogor Botanic Garden. Recently, a team of Bogor Botanic Garden and Research Center for Biology–LIPI conducted flora exploration in Riau Archipelago, particularly on Karimun Island, Sugi Island and the surrounding areas. The aim of this exploration is to inventory the flora diversity in Riau Archipelago and to enrich living collection of the Batam Botanic Garden. Based on the data gathered from this inventory, we recommend 20 selected plant species with significant conservation value to be targeted for and included in the living collections of Batam Botanic Garden. Five of them (*Aquilaria malaccensis*, *Ceriops decandra*, *Hopea ferruginea*, *Pterocarpus indicus* and *Vatica hullettii*) need more attention to be conserved due to their IUCN red list status.

Keywords: Batam Botanic Garden, flora recommendation, living collection, Riau Archipelago

1. Introduction

Indonesia is very rich in the diversity of flora species. There are 1,500 species of alga, 80,000 species of fungi, 595 species of mosses, 2,197 species of ferns, and 30,000 to 40,000 species of Angiosperm reported in Indonesia [1]. However, the rate of biodiversity loss is getting higher due to primary forest cover loss. Indonesia has lost about 17% of its forests between 1985 and 1997 [2]. In 2000 to 2012 alone, Indonesia has lost its forest cover over 6.02 m ha and increased on average by 47,600 ha per year [3]. In the 2009 to 2013 period, deforestation in Indonesia has reached about 4.50 million ha and the rate of natural forests loss was about 1.13 million ha per years [4]. Therefore, Indonesia should pay very serious attention to the *ex situ* and *in situ* conservation of its biological diversity. Bogor Botanic Garden is one of the *ex situ* conservation institutions in Indonesia, which is only able to accommodate around 8.5–11% of Indonesian plant diversity [5]. Therefore, the establishment of botanic gardens in every province in Indonesia and the development of their capabilities to function as *ex situ* conservation institutions is urgent and of great importance [6].

The establishment of new botanic garden in Indonesia was initiated by Megawati Soekarnoputri [6], who stated explicitly and emphasized the importance of botanic garden development in every province in Indonesia [7]. This was then followed up by the Minister of Research and Technology, who suggested that all governors in Indonesia must set a plan to develop botanic garden(s) in their provinces, coordinated and

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supervised by LIPI (Indonesian Institute of Sciences), c.q. Bogor Botanic Garden [8].

In 2008, the Local Authorities of Batam City - Riau Archipelago Province, in collaboration with Bogor Botanic Garden, initiated a new botanic garden, namely Batam Botanic Garden, which is located in Sambau Administrative Village, Nongsa, Batam City, Riau Archipelago Province (1°10'45.1"N 104°05'21.0"E) (see Fig. 3 description a). Based on the master plan (Fig. 1), it has an area of approximately 86 ha [6], [9], [10]. This botanic garden was designed to represent the eco-region of Riau Archipelago rainforest. The collections are focused on small islands flora [6], coastal flora, colorful thematic garden, and palm thematic garden [11]. The infrastructure development began in 2014 [12] and there are not so many plants collected in the garden landscape that time (Fig. 2). In December 2017, this botanic garden officially opened [6]. However, for some reasons, it was postponed until March 2018 [13], [14]. Since 2013, several flora explorations in Riau Archipelago have been carried out by the staff of Bogor and Batam Botanic Garden to increase the plant collections.



Figure 1. Master plan of Batam Botanic Garden (Source: [11])



Figure 2. Landscape of Batam Botanic Garden from the air (Source: [11])

Recently, Bogor Botanic Garden and Research Center for Biology–LIPI have been conducted a flora exploration in Riau Archipelago. The exploration is focused on the Karimun Island, Sugi Island, and the surrounding areas. These areas were chosen because they were suspected of having high diversity of the flora. Secondly, because only few floristic data available of these areas due to under-collection of herbarium specimens of Herbarium Bogoriense (BO). So, there are two purposes of this exploration, (a) to inventory the flora diversity in Riau Archipelago and (b) to enrich living collection of the Batam Botanic Garden. Based on this inventory data, we made a recommendation of selected species that is expected to be a reference for the staff of Batam Botanic Garden in setting the priority for their living collections.

2. Methods

The research was conducted using exploration method [15]. Exploration conducted for 21 days in April–May 2017, at Karimun Island ($1^{\circ}05'40.8''\text{N}$, $103^{\circ}20'88.4''\text{E}$) and its surrounding areas such as the Islands of Karimun Anak ($1^{\circ}08'42.8''\text{N}$, $103^{\circ}23'28.4''\text{E}$), Kera ($1^{\circ}08'63.6''\text{N}$, $103^{\circ}17'75.8''\text{E}$), Asam ($1^{\circ}07'32.2''\text{N}$, $103^{\circ}18'11.5''\text{E}$), Telunjuk ($1^{\circ}07'449''\text{N}$, $103^{\circ}19'899''\text{E}$), Baran ($1^{\circ}06'56.7''\text{N}$, $103^{\circ}19'29.9''\text{E}$) (all of them are administratively located in Karimun District, Karimun Regency, Riau Archipelago Province); and also Sugi Island ($0^{\circ}48'24.6''\text{N}$, $103^{\circ}46'52.3''\text{E}$) and its surrounding areas such as the Islands of Sugi Bawah ($0^{\circ}47'63.2''\text{N}$, $103^{\circ}42'39.4''\text{E}$), Durian ($0^{\circ}43'30.6''\text{N}$, $103^{\circ}41'56.5''\text{E}$), Durian Kecil ($0^{\circ}43'48.7''\text{N}$, $103^{\circ}40'98.3''\text{E}$) and Subi Laut ($0^{\circ}48'07.4''\text{N}$, $103^{\circ}43'26.3''\text{E}$) (all of them are administratively located in Moro District, Karimun Regency, Riau Archipelago Province) (Fig. 3 description b to l). Some of these islands are named incorrectly on the Google Map.

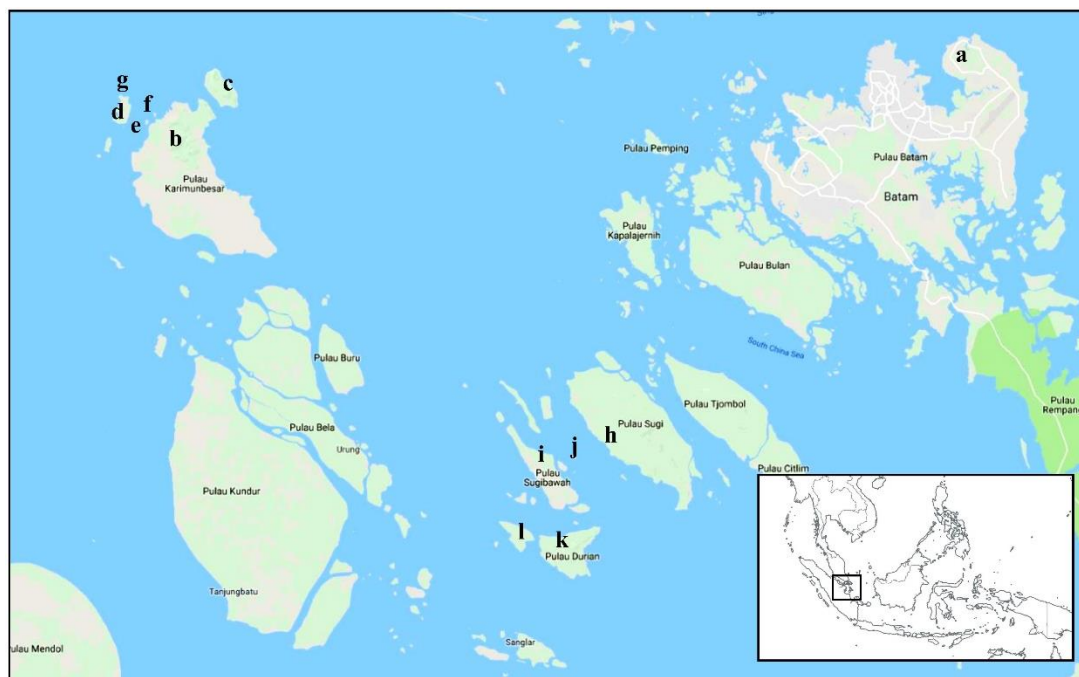


Figure 3. Location of Batam Botanic Garden in northeast of Batam Island (a) and flora exploration in the Islands of Karimun (b), Karimun Anak (c), Asam (d), Baran (e), Telunjuk (f), Kera (g), Sugi (h), Sugi Bawah (i), Subi Laut (j), Durian (k) and Durian Kecil (l) (Source: modification from [16])

The fertile plant specimens (with flowers, fruits or spores) were collected for herbarium. For bamboos, the sterile specimens were also collected because they are very rarely found with flowers and/or fruits [39]. Other supporting data were recorded as well. The specimens were sent to the Herbarium Bogoriense (BO) for further processing (see [17], [18]), including identification using BO specimens and related literatures as references. Based on this data, we made a list of selected species that are interesting and have high conservation value to be targeted as living collections of Batam Botanic Garden. The consideration is based on their IUCN (International Union for Conservation of Nature) red list status (see iucnredlist.org), their status according to CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) Appendix (see [26] or checklist.cites.org), their suitability for garden themes, their status as native flora of Riau Archipelago, and also their uniqueness.

3. Result and Discussion

There are more than 1,000 number collections of herbarium specimens were collected from Karimun Island, Sugi Island and the surrounding areas. At least 350 species were recorded. Furthermore, we found several species with an alarming IUCN status and included in the appendix of CITES. So, they need more attention for their conservation. Moreover, we also found several species that are suitable for garden themes. Therefore, we recommend these species to be listed as priority for and included in the living plant collections of Batam Botanic Garden (Table 1).

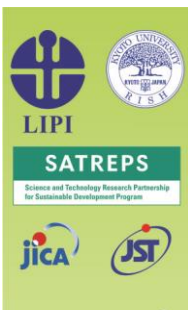
Table 1. List of selected plant species from Riau Archipelago exploration

No	Family/Species	Distribution in Riau Arch.	Habit	IUCN	CITES
Asclepiadaceae					
1	<i>Dischidia major</i> (Vahl) Merr.	Kera Island & Telunjuk Island	Climber	NE	-
Dipterocarpaceae					
2	<i>Hopea ferruginea</i> Parijs	Karimun Anak Island	Tree	CR	-
3	<i>Vatica hullettii</i> (Ridl.) P.S.Ashton	Mt. Jantan & Ds. Pongkar, Karimun Island	Tree	CR	-
Leguminosae					
4	<i>Pterocarpus indicus</i> Willd.	Mt. Jantan, Karimun Island	Tree	VU	-
5	<i>Dalbergia pinnata</i> (Lour.) Prain	Mt. Jantan, Karimun Island	Shrub or Tree	NE	II
Nepenthaceae					
6	<i>Nepenthes ampullaria</i> Jack.	Ds. Pongkar Waterfall & Mt. Jantan, Karimun Island	Herb	LC	II
7	<i>Nepenthes gracilis</i> Korth.	Ds. Pongkar Waterfall, Mt. Jantan & Mt. Betina, Karimun Island; Karimun Anak Island	Herb	LC	II
8	<i>Nepenthes rafflesiana</i> Jack	Mt. Jantan & Ds. Pongkar Waterfall, Karimun Island	Herb	LC	II

No	Family/Species	Distribution in Riau Arch.	Habit	IUCN	CITES
Orchidaceae					
9	<i>Acriopsis liliifolia</i> (J.Koenig) Seidenf.	Mt. Jantan, Karimun Island & Telunjuk Island	Epiphyte	NE	II
10	<i>Bromheadia finlaysoniana</i> (Lindl.) Miq.	Ketam Beach, Plambung & Mt. Betina, Karimun Island; Sugi Bawah Island	Terrestria l orchid	LC	II
11	<i>Dendrobium acutilingue</i> Schuit. & Peter B.Adams	Kera Island	Epiphyte	NE	II
12	<i>Dendrobium aloifolium</i> (Blume) Rchb.f.	Mt. Betina, Karimun Island	Epiphyte	LC	II
13	<i>Dendrobium crumenatum</i> Sw.	Asam Island	Epiphyte	NE	II
14	<i>Callostylis pulchella</i> (Lindl.) S.C.Chen & Z.H.Tsi	Karimun Anak Island	Epiphyte	NE	II
Poaceae					
15	<i>Dinochloa malayana</i> S.Dransf.	Karimun Anak Island & Batam Island	Climber	NE	-
Podocarpaceae					
16	<i>Podocarpus neriifolius</i> D.Don	Asam Island; Mt. Jantan, Karimun Island	Tree	LC	-
Rhizophoraceae					
17	<i>Ceriops decandra</i> (Griff.) W.Theob.	Durian Kecil Island	Tree	NT	-
Simaroubaceae					
18	<i>Eurycoma longifolia</i> Jack	Kera Island & Subi Laut Island	Shrub	NE	-
Thymelaeaceae					
19	<i>Aquilaria malaccensis</i> Lam.	Durian Island	Tree	VU	II
Vitaceae					
20	<i>Cayratia geniculata</i> (Blume) Gagnep.	Karimun Anak Island	Climber	NE	-

As shown in Table 1, there are 20 selected plant species belong to 10 families. Most of them are from the Orchidaceae (six species), followed by Nepenthaceae (three species). Those species vary in habit, from climbers, herbs, epiphytes, shrubs, to trees. The variety of plant habit becomes an added value to the Batam Botanic Garden living collections. Most of those species were found in the small islands, mostly near the waterfall and in the mountainous areas.

So far there is no living collection of plant species of Batam Botanic Garden that is included in IUCN red list status (see [9]), whereas one of the roles of the botanic garden is the *ex situ* conservation, especially for those that categorized as threatened. We recorded five species which are included in IUCN red list. Two species with VU status (*Aquilaria malaccensis* [19] and *Pterocarpus indicus* [20]), two with CR status (*Hopea ferruginea* [21] and *Vatica hullettii* [22]), and one with NT status (*Ceriops decandra* [23]). The living collections of these five species should be targeted and included in the living collection of Batam Botanic Garden because of its IUCN red list status.



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Previously, *V. hullettii* was reported only found in south part of Malaya Peninsula [24], [25], particularly on the hill areas [25]. So, it is not a big surprise if *V. hullettii* can also be found in Mt. Jantan at Karimun Island. The living collection of *V. hullettii* and also *A. malaccensis* were already collected. Unfortunately, the other three cannot be collected for garden living collections due to no seedling available. *C. decandra* is commonly found in mangrove vegetation, and is suitable for mangrove area in Batam Botanic Garden. The most unfortunate thing is that the natural habitat of *C. decandra* in Durian Kecil Island will soon be destroyed for dock construction. Herbarium specimens of *C. decandra* were only collected from Durian Kecil Island during this exploration, even though the author (KR) mentioned that this species also found in Karimun Island (but no specimen collected).

In addition to its IUCN red list status, *A. malaccensis* was also included in Appendix II of the CITES [26]. Therefore, this species is very important to be conserved. There are 11 other species which are included in Appendix II of the CITES namely *Dalbergia pinnata*, *Nepenthes ampullaria*, *N. gracilis*, *N. rafflesiana*, *Acriopsis liliifolia*, *Bromheadia finlaysoniana*, *Dendrobium acutilingue*, *D. aloifolium*, *D. crumenatum* and *Callostylis pulchella* (see [26]). *Dalbergia pinnata* is found in Java [27], [28], Sumatra, Borneo and Sulawesi [29]. Recently, this species also was found in Karimun Island and its living plant was collected for Batam Botanic Garden.

Species that are included in Appendix II of the CITES need great attention for their conservation due to their utilization as trade object, especially orchid and *Nepenthes*. On the other hand, the display of living collections of orchid and *Nepenthes* are interesting objects for garden visitors due to their unique morphology and the beauty of their flowers or pitcher cup. In Bogor Botanic Garden orchid collection is one of the most favorites for the visitors [30]. *Nepenthes* is reported abundant in Batam Island [31] and alleged as native to the island, so it is very suitable to be the icon of Batam Botanic Garden. *Nepenthes* and orchid on the pot or tissue culture can also be used as official souvenir of Batam Botanic Garden.

Podocarpus nerifolius is the only collection of Gymnosperm that was found in Karimun Island and Asam Island. This species represents the Gymnosperm in the living collection of Batam Botanic Garden. Another species, *Eurycoma longifolia*, is a shrub up to 2 m high with small red flowers. In Indonesia, *E. longifolia* is known as pasak bumi, which is used as herbal to increase male vitality. The root of *E. longifolia* is traded by local people in Karimun Island, but surprisingly not so many people have seen the living plant of the species. Therefore, the display of the living collection in the Batam Botanic, accompanied with sufficient information about the importance of this species, would be very interesting.

Dinochloa malayana is a climber bamboo species with purple young shoot as its distinct character. This species is very interesting to be included as living collection of Batam Botanic Garden due to their uncommon habit, compared to other erect bamboo species. This is previously only known from Peninsular Malaysia and Southern Thailand [32], [33], [34], [35], [36], [37]. But recently, it is also found in Karimung Anak Island and Batam Island [see 38].

Dischidia major found on uninhabited islands of Kera and Telunjuk Island. While *Cayratia geniculata* was only collected from Karimun Anak Island. *D. major* is beautiful climber plant with green and yellowish leaves, whereas *C. geniculata* has interesting fruit with striking pink colour. These appearances make the two species very potential to be used as ornamental plants. See Fig. 4.



Figure 4. Several selected plant species from exploration in Riau Archipelago. Clockwise from the left: *Dinochloa malayana*, *Ceriops decandra*, *Nepenthes gracilis*, *Eurycoma longifolia*, *Cayratia geniculata* (Photos: I Putu Gede P. Damayanto & Kusuma Rahmawati)

4. Conclusion

There are 20 plant species collected from Riau Archipelago exploration that have significant conservation value as the living collections of Batam Botanic Garden. Five of them (*Aquilaria malaccensis*, *Ceriops decandra*, *Hopea ferruginea*, *Pterocarpus indicus* and *Vatica hullettii*) need more attention to be conserved due to their IUCN red list status.

5. Acknowledgements

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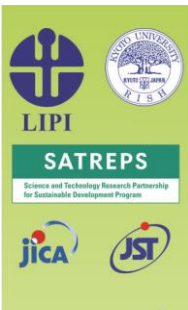
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