

POPULATION OF POTENTIAL RATTAN IN BUKIT TIBAN PROTECTION FOREST, BATAM, INDONESIA (Populasi Rotan Potensial di Hutan Lindung Bukit Tiban, Batam, Indonesia)

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ABSTRACT

Rattan is one of the promising non-timber forest products which grow widely in Indonesia. The occurrence of rattan species, especially the commercial species, is threatened due to illegal over-exploitation. The study has been done in the Bukit Tiban Protection Forest (BTPF) to investigate the occurrence of rattan species and observe the characteristic of morphology properties and their utilization. In this study, a descriptive exploration method was applied and we performed an interview with local people in the field regarding the utilization. Morphological characteristics observed including habitus, leaves (such as color, leaflets, leaf arrangement, knee, ocrea, and climbing organ/cirrus/flagellum), and fruit. The identification key, illustrations, as well as the diagnostic character of each species were presented. Ten species of rattans were found in the BTPF, namely *Calamus* sp.1 (*Daemonorops verticillaris* (Griff.) Martius), *Calamus* sp.2 (*Calamus rugosus* Beccari), rotan sabut (*Daemonorops sabut* Beccari), rotan buah kecil (*Daemonorops didymophylla* Beccari), *Plectocomia* sp. (*Plectocomia elongata* Martius ex Blume), rotan bukit (*Daemonorops sepal* Beccari), rotan dahan (*Korthalsia rostrata* Blume), *Calamus* sp.5 (*Calamus spectatissimus* Furtado), *Calamus* sp. (*Daemonorops longipes* (Griff.) Martius), and *Calamus* sp.6 (*Calamus tanakadatei* Furtado). Those ten species of rattan are potentially used for handicrafts, basketry, and ropes. Only five of ten species of rattan have been used commercially.

ABSTRAK

Rotan merupakan salah satu komoditas hasil hutan bukan kayu yang menjanjikan dan tumbuh tersebar luas di Indonesia. Keberadaan rotan, khususnya rotan komersial, terancam oleh eksploitasi yang berlebihan secara ilegal. Kami melakukan penelitian di Hutan Lindung Bukit Tiban (HLBT) untuk menginvestigasi keberadaan spesies rotan di lokasi ini dan mengobservasi karakteristik morfologis serta pemanfaatan dari spesies rotan dari Batam. Dalam penelitian ini, kami menggunakan metode deskriptif eksploratif. Kami juga melakukan wawancara terhadap masyarakat lokal yang membantu selama di lapangan. Karakteristik morfologi yang kami teliti antara lain habitus, daun (warna daun, pucuk daun, susunan daun, lutut, ocrea, dan organ pemanjat/sirus/flagela), dan buah. Kunci identifikasi, ilustrasi bersama dengan karakteristik penciri dari tiap spesies ditampilkan dalam tulisan ini. Sepuluh spesies rotan telah berhasil ditemukan di HLBT yaitu *Calamus* sp.1 (*Daemonorops verticillaris* (Griff.) Martius), *Calamus* sp.2 (*Calamus rugosus* Beccari), rotan sabut (*Daemonorops sabut* Beccari), rotan buah kecil (*Daemonorops didymophylla* Beccari), *Plectocomia* sp. (*Plectocomia elongata* Martius ex Blume), rotan bukit (*Daemonorops sepal* Beccari), rotan dahan (*Korthalsia rostrata* Blume), *Calamus* sp.5 (*Calamus spectatissimus* Furtado), *Calamus* sp. (*Daemonorops longipes* (Griff.) Martius), dan *Calamus* sp.6 (*Calamus tanakadatei* Furtado). Kesepuluh spesies rotan tersebut potensial untuk dimanfaatkan sebagai kerajinan tangan, anyaman, maupun tali-talian. Hanya lima spesies yang berpotensi untuk digunakan sebagai pengganti rotan komersial yang saat ini umum dimanfaatkan.



I. INTRODUCTION

Batam is commonly known as the center of industry, trade, and tourism in Indonesia. It is located between the Straits of Malacca and Singapore. The increasing of social and economic activities followed by the higher requirement of land, lead to the massive forest conversion in this area (Setiyohadi, 2016). Forests in Batam, including its protection forests, are considerable potential. One of Batam protection forests is Bukit Tiban Protection Forest (BTPF) in Sekupang, where forest fire and land conversion are continuing in this area (Rezkiari, 2014; Hazliansyah, 2014). Those activities become serious threats related to forest existence and forest role in ecological aspects (Rifardi, 2008).

The establishment of BTPF is according to a ministerial decree no. 428/Kpts-II/1994 of Minister of Forestry. BTPF has a total area of 1,770 hectares belongs to Batuaji Sub-district and Sekupang Sub-district, with a good vegetation condition (Yuliastrin, 2014). One of the characteristics of vegetation in this area is its rattan species diversity. However, there is still no research on rattan species in the Batam forest. On the other hand, the information regarding the rattan species diversity in Indonesia is highly required. Hence, it is important to explore more about the diversity of rattan species in the BTPF and identify the characteristic of rattan species in this area.

Rattan is a multipurpose species and belongs to the Arecaceae family. Rattan grows leaning, or climbing on trees. Rattan has a unique characteristic, exotic form, well-known and commonly used by the Indonesian people for chair and binding materials (Kusnaedi & Pramudita, 2013). Rattan has many utilities such as the source of food, drinks, basic ingredients for drugs and cosmetics, handicraft, building materials, and furniture in which could support the rattan industry (Ariana *et al.*, 2011; Kalima & Susilo, 2015). Rattan identification is one of the important processes before the use of its. In general, rattan species are accurately identified based on taxonomic characteristics such as habitus, leaves, climbing organs, inflorescences, and flower types (Krisdianto *et al.*, 2018).

The population of rattan species in BTPF is important to be identified considering the high role of rattan in terms of economic, ecological, and ethnobotany aspects while its habitat continues to experience disturbance. This study is expected to support the rattan identification related to the rattan utilization or cultivation on Batam Island and increase the knowledge on the morphology characteristic of rattan species.

II. MATERIALS AND METHODS

A. Study Site

This study was conducted in the BTPF, Tiban Lama Village, Sekupang Sub-district, Batam (Figure 1). Geographically, the study site is located in 1°05'47.4"-1°09'65.0" N and 103°59'23.9"-103°98'99" E. Rattan species identification was carried out in the Botany and Forest Ecology Herbarium, Forest Research and Development Center, Bogor.

B. Species

Rattan, as our object of study, is rattan species in the BTPF. Rattan in this study is referred to as a thorny liana plant climbs using flagella or sirus, scaly fruit, slippery trunk, and belongs to the family Arecaceae (Calamoideae) (Kalima & Rustiami, 2018).

C. Sampling design and measurement

Field exploration and herbarium study were done in this research. The method used for field exploration was a descriptive exploration method. In the field, we collected the data to obtain a general overview of the rattan germplasm. In the herbarium laboratory, we compared our specimen with the herbarium collections (Kalima, 2014). The observation of the rattan population was based on the occurrence of rattan in the field. We established three square plots of 20 m x 20 m, equal to 0.12 ha in total. The three plots established were also considering the feasibility of plots establishment since many disturbances found in this area, such as illegal plantations, illegal logging, and illegal settlement. The sampling plots were established only in Sekupang Sub-district due to the vegetation condition in this area, which more vegetated than the Batuaji Sub-district, which was more dominated by open areas with no rattan occurrence. We calculated the

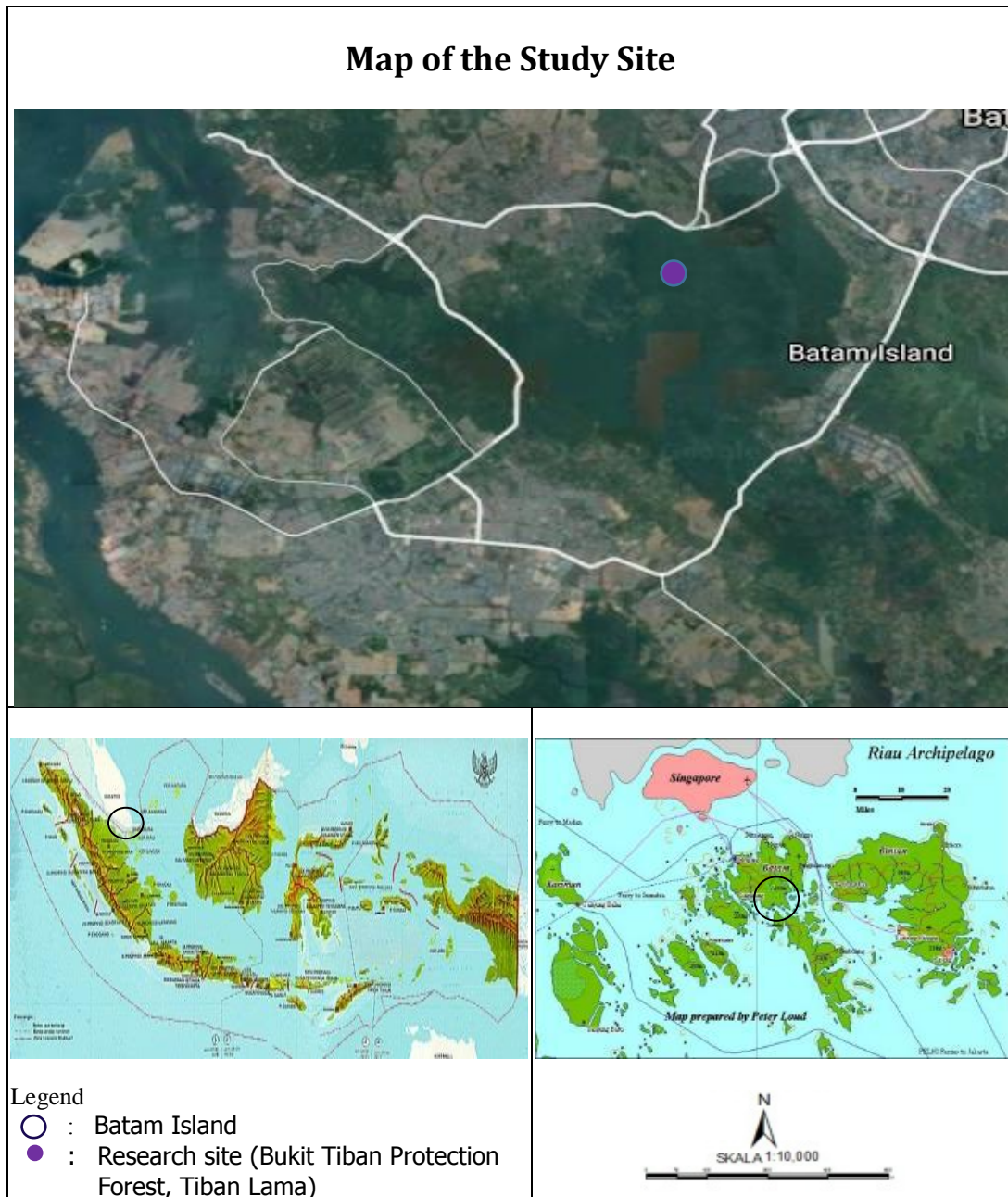


Figure 1. Map of research location at BTPF, Sekupang Sub-district, Batam

Gambar 1. Peta lokasi penelitian di Hutan Lindung Bukit Tiban, Kecamatan Sekupang, Batam.

population of rattan as the density or number of individuals per hectare. In each plot, we observed the number of individuals for each rattan species. An individual rattan is a rattan with a length of stem >50 cm. The length of the stem starts from the stem base to the tip of the shoots.

1. Fieldwork

We used exploratory method for the data collections by exploring the field study

through the following steps:

- a. We prepared the route for exploring and collecting all the data needed in the BTPF. The research parameters are the morphological characters observed, including habitus, leaves (such as color, leaflets, leaf arrangement, knee, ocrea, and climbing organ), and fruit (Kalima & Rustiami, 2018).
- b. We collected the botanical data by observing the habitus morphological

characteristics of rattan species based on the local information about the existence of rattan species in this area. All data obtained were recorded in tally sheets such as date and place of collection, name of the collector, genus, local name, and distinctive note regarding its color.

- c. The rattan herbarium was collected, and because of their frequently bulky nature and unfamiliar morphology, rattans need special attention to be adequately collected. The collection method followed Kalima (2014).
- d. We collected mature rattan stems in which ready to be harvested. If the rattan species could be determined in the field, the scientific name is directly decided.
- e. We documented the collection process of rattan.

We also collected the information related to the use of rattan species in this area, the preference of rattan species to be used, and the possible threats to the forest area through the interview (Roy *et al.*, 2017) with the local people. The respondents were chosen purposively to the local people who have information regarding the rattan species and rattan use.

2. Laboratory activities

We performed the herbarium specimen drying process followed Kalima (2014) as the first step to identify the accuracy of the scientific name of the unidentified rattan herbarium specimens that have been collected. We used a comparative method through the morphological aspect comparison between unidentified herbarium specimens from the field and herbarium specimens that have been identified and collected in the Herbarium Laboratory of Botany and Forest Ecology, Forest Research and Development Center, Bogor to determine the scientific name. The identification of rattan species also referred to Kalima & Rustiami (2018); Dransfield *et al.* (2008), as well as several rattan studies in Indonesia such as the study from Kalima (2008), Kalima & Jasni (2015), and Witono *et al.* (2013).

D. Data Analysis

We compared the herbarium specimen from the field with the identified herbarium

specimens in the Herbarium Botany and Forest Ecology. The identification key was made to find the species based on their morphological characteristics. The results of the rattan species identification are shown as the description of each species contained its photos and its habitat description

The total area of the research plot was 0.12 ha, in which the accumulation of three plots of 20 m x 20 m. We converted the number of individuals or density per ha (Table 2).

$$ND = \frac{\text{Number of individuals of species}}{\text{Sample of area per ha}} \quad (1)$$

Remarks: ND= Density per ha

The data collected from the interview were analyzed descriptively. The information describes the general information about how the people near the forest use the rattan species, what kind of species they tend to be used, and the information about the possible threat to the rattan population and forest area.

III. RESULT AND DISCUSSION

A. The population of Rattan Species

Based on the field exploration at Tiban Lama Village area, BTPF, Sekupang Sub-district, Batam, ten rattan species have been identified, which consisted of four genera i.e. *Calamus*, *Daemonorops*, *Korthalsia*, and *Plectocomia*. The botanical explanation of the genera was presented in Table 1.

The morphological differences of ten rattan species were found in the study site, in which four species had solitary growth character, while six other species were clumped (Table 1). Eight rattan species were found in the forest area where the local people usually use it as the rattan collection area. However, the local people did not utilize all of the potential rattan species. They tend to use only the rattan species, which they believed (generally) have a good quality without considering the other potential rattan species. The potential rattan species which has good quality or similar class quality could potentially substitute the utilization of the good quality of rattan or commercial rattan species which they usually used. It becomes our challenge to change the

Table 1. List of rattan species at Tiban Lama Village area, BTPF in Sekupang Sub-district Batam.
Tabel 1. Daftar spesies rotan di desa Bukit Tiban Lama, Hutan Lindung Bukit Tiban, Kecamatan Sekupang, Batam.

No	Vernacular name (<i>Nama lokal</i>)	Genera (<i>Genus</i>)	Species (<i>Spesies</i>)	Grow/Climbing tool (<i>Tipe pertumbuhan/alat pemanjat</i>)
1	<i>Calamus</i> sp.2	<i>Calamus</i>	<i>C. rugosus</i> Beccari	Solitary, flagellum
2	<i>Calamus</i> sp.5	<i>Calamus</i>	<i>C. spectatissimus</i> Furtado	Clustering, flagellum
3	<i>Calamus</i> sp.6	<i>Calamus</i>	<i>C. tanakadatei</i> Furtado	Solitary, flagellum
4	Rotan buah kecil	<i>Daemonorops</i>	<i>D. didymophylla</i> Beccari	Clustering, cirrus
5	Rotan sabut	<i>Daemonorops</i>	<i>D. sabut</i> Beccari	Clustering, cirrus
6	<i>Calamus</i> sp.	<i>Daemonorops</i>	<i>D. longipes</i> (Griff.) Martius	Clustering, cirrus
7	Rotan bukit	<i>Daemonorops</i>	<i>D. sepal</i> Beccari	Clustering, cirrus
8	<i>Calamus</i> sp.1	<i>Daemonorops</i>	<i>D. verticillaris</i> (Griff.) Martius	Solitary, cirrus
9	Rotan dahan	<i>Korthalsia</i>	<i>K. rostrata</i> Blume	Clustering, cirrus
10	<i>Plectocomia</i> sp.	<i>Plectocomia</i>	<i>P. elongate</i> Martius ex Blume	Solitary, cirrus

way of rattan industrial work, including local people's perception of the good quality of rattan species. Local people need to pay more attention to the quality which the rattan industry required. Hence, when some potential rattans fulfill the rattan industry requirement, the local people will have more options to substitute the current commercial rattan with those potential rattans. If a particular species such as *Calamus manan*, *Calamus trachycoleus*, *Calamus zollingeri* as a commercial rattan are continuing exploited, their existence will be extinct in the near future.

The structure of the rattan species can generally be distinguished from the midrib of leaves, flowers, and fruit (Kalima & Rustiami, 2018). The number of species found on this location was higher compared to the exploration result from Bukit Lubuk Pekak Forest, Merangin, Jambi, where the rattan species were found less than ten species (Kalima *et al.*, 2019). It showed that BTPF has more potencies of rattan to substitute the use of current commercial rattan. The effort to keep the diversity of rattan species in this location must be increased considering the potential use of those species in the future. The effort to avoid overexploitation should be made as rattan has various kinds of utilization.

Today, based on the result of this study, there are two main purposes of natural forest resource utilization i.e. productive and consumptive (used for their own) purposes. Rattan harvesting has become the main activity of indigenous people who live around the forest. Rattan cultivation has a long

history with people near the forest. Moreover, rattan could provide additional income for local people to improve their socio-economic welfare (Arifin & Mitlöhner, 2003). They tend to sell the natural products of rattans to Sumatera, Java, Kalimantan, and Singapore. However, not all potential rattan species are utilized. Rattan is not only ecologically but also economically important. The increasing of a human population and their needs requires our attention, in this case, regarding the conservation strategy of rattan species.

B. Rattan Species Identification

A key identification of the rattan genera and species on the study sites is presented below to facilitate the identification of several rattan species on the island of Batam.

Identification key of four genera of rattan in Batam

- 1a. Leaflets entire2
 - b. Leaflets praemorse *Korthalsia*
- 2a. Leaf sheaths bearing a flagellum *Calamus*
 - b. Leaf sheaths without a flagellum 3
- 3a. Leaf sheath spines small, very numerous arranged in long horizontal combs *Plectocomia*
 - b. Leaf sheath usually heavily armed with spines, the spines frequently highly organized *Daemonorops*

Identification key of five species

Daemonorops

- 1a. Leaflets regularly arranged. Black horse-hair-like spines on collar interspersed with large flat straw-colored or black spines..... *D. verticillaris*

- b. Leaflets irregularly arranged or grouped. Horse-hair-like spines may be of different lengths but not interspersed with flat spines 2
- 2a. Leaflets irregularly arranged 3
 - b. Leaflets regularly arranged 4
- 3a. Leaflets rather broad and short, neatly arranged in divergent pairs; fruit covered in dragon's blood, leaf sheaths dark green armed with scattered somewhat reflexed *D. didymophylla*
 - b. Leaflets in groups of 2 and more; fruit without dragon's blood, leaves, sheaths dark green armed with large brown spines in partial horls *D. longipes*
- 4a. Leaflets very variable in arrangement to 20 on each side, rarely subregular, usually grouped into 3's-6's, the longest usually the most basal to 40 cm long by 2,5 cm wide *D. sabut*
 - b. Leaflets close, regular rather narrow, 80 on each side of the rachis the longest to 35 cm long by 1,5 cm wide *D. sepal*

Identification key of three species

Calamus

- 1a. Leaflets generally broad and somewhat plicate, rather rarely narrow, 11-18 on each side the longest up to 30 cm long by 4 cm wide, stem solitary or rarely clustered *C. tanakadatei*
 - b. Leaflets very fine and numerous, 40 on each side rachis, the longest and grows no so 2
- 2a. Stem clustered, the size of leaflets to 35 cm long by 1,5 cm wide, unarmed above, but densely armed with short bristles beneath *C. spectatissimus*
 - b. Stem solitary, the size of leaflets to 25 cm long by 1,2 cm wide, armed with black bristles on three veins above, unarmed beneath, minutely denticulate along margin *C. rugosus*

We have successfully identified ten rattan species from the BTPF. The description of each species is presented below.

1. *Korthalsia rostrata* Blume

- Synonym** : *Korthalsia scaphigera* Martius; *Calamosagus scaphiger* (Martius) Griff.; *Korthalsia lobbiana* H.Wendl; *Korthalsia machadonis* Ridl.; *Ceratolobus rostratus* (Blume) Beccari
- Local name** : rotan dahan
- Description** : Clustering high-climbing rattan branching in the canopy up to 20 m or more. Stem with sheaths 8-15 mm, without sheaths 6-9 mm in diameter; internodes up to 10 cm. Sheaths dull green with scattered short 2 mm black-tipped spines. Knee absent. Ocrea rarely exceeding 3 x 2 cm, inflated, armed with very short scattered spines 3 mm; ant abundant. Leaf up to 55 cm, petiole up to 15 cm and cirrus up to 60 cm. Leaflets broad rhomboid, up to 20 cm long by 10 cm wide, petiole leaflets up to 3 mm or almost sessile, upper leaflet surface dark green, whitish indumentose beneath; leaflets about 3-7 on each side rachis. Flowers and fruit are unknown.
- Habitat** : It is found in lowland and hill forest, Dipterocarp forest, and kerangas forest.



Figure 2. *Korthalsia rostrata* Blume: sheaths & ocrea (a), leaf (b), stem (c) (Pic. Kalima, 2014).

Gambar 2. *Korthalsia rostrata* Blume: pelepah & okrea (a), daun (b), batang (c) (Foto Kalima, 2014).

2. *Calamus tanakadatei* Furtado

- Synonym** : -
- Local name** : *Calamus* sp.6
- Description** : Solitary or clustering rattan with stems up to 20 m tall. Stem without sheaths up to one cm in diameter, with sheaths up to 1.75 cm, with internodes up to 20 cm long. All parts are drying shiny dirty green to blackish. Dark green sheaths armed with horizontal rough ridges and rarely with scattered dark green spines up to 5 mm long and abundant buff-colored indumentum between the spines. The knee is conspicuous. Ocrea sometimes well-developed up to one cm high. Flagellum up to 1.5 m. Leaf ecirrate up to 80 cm long, with no petiole or petiole up to 15 cm long; leaflets generally broad and somewhat plicate, rather rarely narrow, 11-18 on each side and the longest one up to 30 cm long by 4 cm wide, \pm unarmed except for sparse bristles near the tip.
- Habitat** : It is found both on hillslopes and in valley bottoms.
- Note** : This species is similar to *C. holttumii* which, however, *C. holttumii* has more linear-lanceolate, acuminate leaflets that are placed generally at a narrow distance on the leaves than that *C. tanakadatei*.

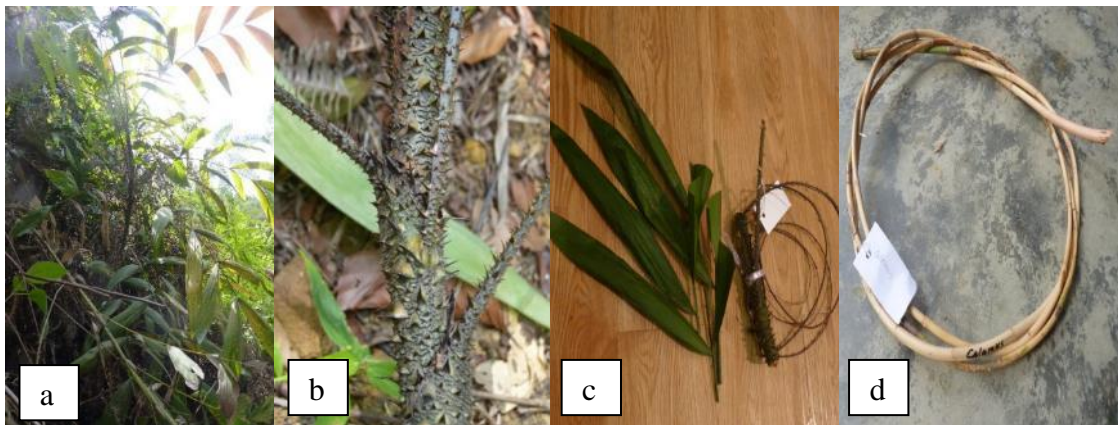


Figure 3. *Calamus tanakadatei* Furtado: habitus (a), leaf sheath (b), herbarium sample (c), stem (d) (Pic. Kalima, 2014).

Gambar 3. *Calamus tanakadatei* Furtado: habitus (a), pelepah daun (b), sampel herbarium (c), batang (d) (Foto Kalima, 2014).

3. *Calamus spectatissimus* Furtado

- Synonym** : -
- Local name** : *Calamus* sp. 5
- Description** : Clustering high climbing sized rattan with stems up to 25 m tall. Stems size with sheaths up to 19 mm, without sheaths up to 13 mm in diameter, and internodes up to 35 cm long. Sheath dull green in color, rather densely armed with dull green swollen spines of variable length with the longest one up to 1.5 cm long, horizontal, or slightly reflexed. Ocrea is obscure. The knee is well developed. Flagellum up to 1.5 m. Leaf up to 1.3 m long, including petiole up to 29 cm long. Leaflets about 40 on each side of the rachis, close and regular, the longest one up to 35 cm long by 1.5 cm wide, unarmed above, but densely armed with short bristles beneath. Flowers and fruit are unknown.
- Habitat** : It has been found on the lower slopes in the lowland Dipterocarp forest.



Figure 4. *Calamus spectatissimus* Furtado: habitus (a), herbarium sample (b), stem (c) (Pic. Kalima, 2014).

Gambar 4. *Calamus spectatissimus* Furtado: habitus (a), sampel herbarium (b), batang (c) (Foto Kalima, 2014)

4. *Calamus rugosus* Beccari

- Synonym** : -
Local name : *Calamus* sp.2
Description : Solitary slender rattan climbing up to 10 m. Stem size with sheaths up to 13 mm, without sheaths up to 0,6 mm in diameter, internodes up to 8 cm long. Leaf sheaths color is bright green, closely and sparsely armed with short triangular reflexed convex spines, dull reddish-brown with paler bases and dense annular ridges minutly rough on their crests. The knee is conspicuous. Flagellum up to 1.5 m long. Leaf ecirrate up to 90 cm long including petiole up to 20 cm long; petiole tinged red in fresh state, very sparsely armed. Leaflets up to 40 on each side, very fine, regular, the longest in the mid-section decreasing gradually to the leaf tip; largest leaflets up to 27 cm long by 12 cm wide, armed with black bristles on three veins above, unarmed beneath, minutly denticulate along margins. Flowers and fruit are unknown.
Habitat : It grows in lowland and hills Dipterocarp forest.

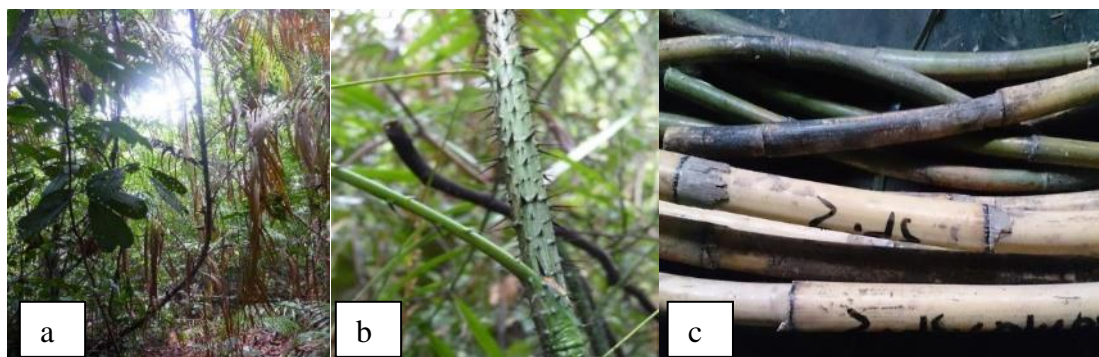


Figure 5. *Calamus rugosus* Beccari: habitus (a), leaf sheath (b), stem (c) (Pic. Kalima, 2014).

Gambar 5. *Calamus rugosus* Beccari: habitus (a), pelepah daun (b), batang (c) (Foto Kalima, 2014).

5. *Plectocomia elongata* Martius

- Synonym** : *Calamus maximus* Reinw. ex Schult.f.; *Plectocomia crinita* Gentilex Chitt.; *Plectocomia elongata* var. *bangkana* Beccari; *Plectocomia elongata* var. *elongate* Martius; *Plectocomia griffithii* Beccari; *Plectocomia hystrix* Linden; *Plectocomia sumatrana* Miquel; *Plectocomia sumatrana* Miquel; *Rotang maximus* Baill
- Local name** : *Plectocomia* sp.
- Description** : Solitary rattan climbing up to 40-50 m. Stem size with sheaths up to 25-100 mm, without sheaths up to 6-9 cm at near base, at upper parts 10 cm in diameter, internodes up to 30-40 cm. Sheaths dull green color armed with horizontal or oblique combs of golden-brown spines up to 4 cm and abundance white indumentum. Knee and ocrea are absent. Leaf up to 3,5 m, petiole up to 30 cm, and cirrus up to 3 m. Leaflets are lanceolate, bluish-green on the upper surface, whitish indumentose beneath; leaflets up to 56 on each side, arranged irregularly in 2's - 7's and fanned within the groups. Flowers and fruit are unknown.
- Habitat** : It is found in secondary forests up to an altitude of 1,200 m above sea level.

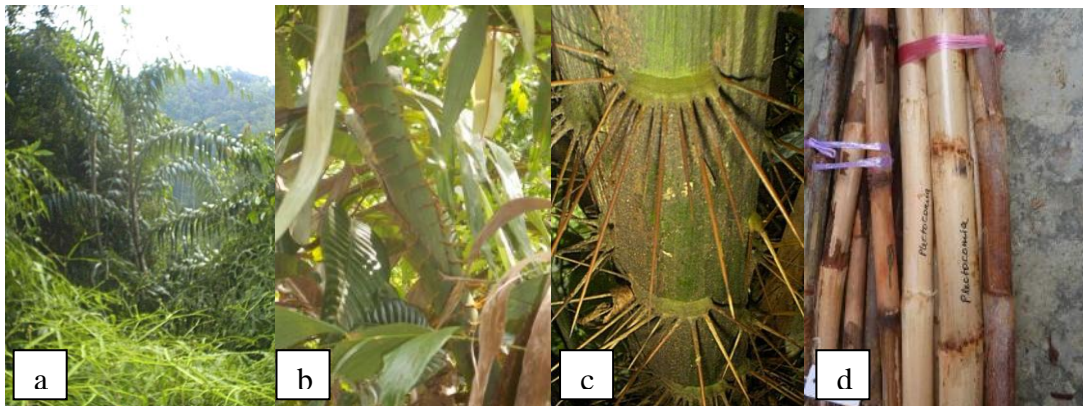


Figure 6. *Plectocomia elongata* Martius: habitus (a), leaf sheath (b), thorn arrangement (c), stem (d) (Pic. Kalima, 2014).

Gambar 6. *Plectocomia elongata* Martius: *habitus* (a), *pelepah daun* (b), *susunan duri* (c), *batang* (d) (Foto Kalima, 2014).

6. *Daemonorops verticillaris* (Griff.) Martius

- Synonym** : *Calamus verticillaris* Griff., *Daemonorops setigera* Ridl., *D. stipitata* Furtado, *Palmijuncus verticillaris* (Griff.) Kuntze.
- Local name** : *Calamus* sp.1
- Description** : Solitary rattans with stems rarely exceeding 15 m in length. Stems size with sheaths up to 3 cm or more in diameter, without sheaths up to 2 cm in diameter. Internodes rather short, less than 12 cm long in general. Sheaths bright green in color, densely armed with interlocking pairs of collars and single collars of short black horse-hair like spines, usually less than 2 cm long intermingled with large laminar yellowish-green to blackish spines up to 6 cm long; interlocking collars forming galleries inhabited by ants. Knee present but mostly obscured by spines. Leaf size up to 3 m long with petiole up to 40 cm and cirrus up to 1 m. Petiole armed with large reflexed spines in whorls and minute bristles in small groups. It has regular leaflets, 45 to 60 on each side of the

rachis, the longest leaflets up to 40 cm long by 2.3 cm wide, sparsely bristly on mid-vein, and some lateral veins below. Inflorescences male and female superficially similar but the male is more highly branched. Fruit rounded sessile or shortly stalked, rape fruit up to 15 mm in diameter very shortly beaked, covered in 145 vertical rows of pale straw to red-brown scales, with dull brown marginal lines. Seed rounded.

Habitat : It is found both on hillslopes and in valley bottoms.



Figure 7. *Daemonorops verticillaris* (Griff.) Martius: leaf sheath (a & b), herbarium sample (c), stem (d) (Pic. Kalima, 2014).

Gambar 7. *Daemonorops verticillaris* (Griff.) Martius: pelepah daun (a & b), sampel herbarium (c), batang (d) (Foto Kalima 2014).

7. *Daemonorops didymophylla* Beccari

Synonym : *Calamus didymophyllus* (Beccari) Ridl.,
Daemonorops mattanensis Beccari, *Daemonorops motleyi* Beccari

Local name : rotan buah kecil, rotan duduk

Description : Clustering by short suckers rattan rarely exceeding 15 m. Stem size with sheaths up to 30 mm, without sheaths up to 8-12 mm in diameter, internodes to 15 cm long. Sheaths are dark green armed with scattered somewhat reflexed, variable grey-black triangular spines with yellow bases 4-26 mm. The knee is conspicuous. Leaf size up to 2.2 m, often much less. Petiole up to 40 cm long, rounded in cross-section, armed with on the dark green upper sides. Cirrus size up to 1.1 m. Leaflets up to 15 on each side rachis, grouped in alternate or sub-opposite pairs, leaflets rather broad, up to 35 cm long by 3.4 cm wide, shortly bristly along margins. Inflorescence up to 25 cm. Ripe fruit ovoid, rather large up to 2.5 cm long by 2 cm wide, the widest part is near the base, covered by 12-15 vertical rows of brownish rather swollen scales, densely covered by red dragon's blood.

Habitat : It grows in the lowland Dipterocarp forest and hillslopes area.



Figure 8. *Daemonorops didymophylla* Beccari: habitus & fruits (a), sheath & flowers (b), fruits (c), stem (d) (Pic. Kalima, 2014).

Gambar 8. *Daemonorops didymophylla* Beccari: habitus & buah (a), pelepah & bunga (b), buah (c), batang (d) (Foto Kalima, 2014).

8. *Daemonorops longipes* (Griff.) Martius

- Synonym** : *Calamus longipes* Griff., *Calamus ramosissimus* Griff., *Calamus strictus* (Blume) Miquel., *Daemonorops calothyrsa* Furtado, *Daemonorops longipedunculata* Furtado, *Daemonorops ramosissima* (Griff.) Martius, *Daemonorops sabensis* Beccari ex Gibbs, *Daemonorops stricta* Blume, *Daemonorops virescens* Beccari, *Palmijuncus ramosissimus* (Griff.) Kuntze, *Rotang longipes* (Griff.) Baill.
- Local name** : *Calamus* sp.
- Description** : Clustering rattan with short to long, robust stem, rarely high climbing. Stem size with sheaths up to 50 mm, without sheaths up to 30 mm in diameter, internodes up to 5 cm. Sheaths' color bright green armed with large brownish-black laminar reflexed spines arranged in horizontal to slightly oblique groups, the largest one up to 4 cm long by 4 mm wide, much smaller spines in between and dense caducous brown indumentum. The knee is absent. Ocrea up to 6 mm wide densely covered in minutely black spines. The leaf is ecirrate, up to 4.5 m long, with petiole up to 50 cm and cirrus up to 1.3 cm. Leaflets up to

50 on each side rachis, rather distant, arranged regularly below and slightly irregularly above, the longest one is up to 50 cm long by 3 cm wide. Flowers and fruit are unknown.

Habitat : It has been found on the lower slopes in the lowland Dipterocarp forest.



Figure 9. *Daemonorops longipes* (Griff.) Martius: habitus (a), leaf sheath (b), thorn arrangement (c) (Pic. Kalima, 2014).

Gambar 9. *Daemonorops longipes* (Griff.) Martius: habitus (a), pelepah daun (b), susunan duri (c) (Foto Kalima, 2014).

9. *Daemonorops sabut* Beccari

Synonym : *Daemonorops annulata* Beccari, *Daemonorops pseudomirabilis* Beccari, *Daemonorops turbinata* Beccari

Local name : rotan sabut

Description : Clustering rattan, climbing up to 15 m or more. Stem size with sheaths up to 30 mm, without sheaths 8-12 mm in diameter, internode 15 cm. Sheaths' color bright green densely armed with collars tipped with black and brown horse-like spines 1-6 cm long, blackish-brown indumentum between the collars, at least some of the collar interlocking to produce ant-galleries. Knee conspicuous, usually less heavily armed than the rest of the sheaths. Leaf size up to 2.2 m including petiole up to 40 cm and cirrus up to 1.1 m; petiole with scattered reflexed spines up to 5 mm long and small groups of black spicules on collar near the base. Leaflets number up to 15 on each side of the rachis, very irregularly clustered, rather narrow about 35 cm long by 3.4 cm wide, sparsely spiny along the margin. Flowers and fruit are unknown.

Habitat : It has been found on hillslopes and in valley bottoms starts from above 500 m altitude.



Figure 10. *Daemonorops sabut* Beccari: habitus (a), leaf sheath (b) (Pic. Kalima, 2014).
Gambar 10. *Daemonorops sabut* Beccari: habitus (a), pelepah daun (b) (Foto Kalima, 2014).

10. *Daemonorops sepal* Beccari

Synonym	:	<i>Daemonorops scortechinii</i> Beccari, <i>Daemonorops nurii</i> Furtado, <i>Daemonorops kiahii</i> Furtado, <i>Daemonorops imbellis</i> Beccari, <i>Daemonorops aciculata</i> Ridl.
Local name	:	rotan bukit
Description	:	Clustering rattan, climbing up to 10 m. Stem size with sheaths 20 mm in diameter, without sheaths 35 mm in diameter; internode 20 cm. Stem's color is cream. Sheaths' color is dull green, densely brown spine, and arranged in a group. The knee is present. Leaf size up to 2.5 m long, including petiole up to 30 cm with spines along its side. Leaflets is linear, green in color, the number up to 80 on each side of the rachis, rachis' color is green, arranged in near irregularly pinnate, hairy below the surface, 35 cm long by 2.5 cm wide. The inflorescence size is 30 x 10 cm with black spiny fruit. Round fruit around 3 cm in diameter, covered by 15-18 light green to brown vertical shell. The seed is 2.5 cm in diameter.
Habitat	:	It grows near the river and in a valley.



Figure 11. *Daemonorops sepal* Beccari: habitus (a), herbarium sample (b), stem (c) (Pic. Kalima, 2014).
Gambar 11. *Daemonorops sepal* Beccari: habitus (a), sampel herbarium (b), batang (c) (Foto Kalima, 2014).

Genus *Daemonorops* dominated rattan species in this study site. Most of the rattan species that have been found could substitute the commercial rattan. It could be a good opportunity to prevent over-exploitation of the current commercial rattan. The effort to cultivate rattan species in the private garden could be an option to keep the stable supply to the rattan industry where we could also develop the other potential rattan species to be cultivated.

C. The density of Rattan Species

The population density of rattan species in three research plots was shown in Table 2. From the three research plots, ten species of rattan were found in a different density. However, *C. rugosus* was not found in plot 2, *C. tanakadetei* was not found in plot 1 dan 2, and *D. verticillaris* was not found in plot 3.

In Table 2, we could see the population density of rattan from three site plots, in which we found 73 individuals or 608 individuals/ha. *D. didymophylla* (117 individuals/ha), *D. sabut* (108 individuals/ha), and *D. sepal* (83 individuals/ha) showed the highest density among the ten other rattan species. Bukit Tiban, Sekupang is the only protected forest in Batam Island (Yuliastrin, 2014), and this result was high enough for rattan population in a protected area compared to the other observations from Andayani *et al.* (2018) that only found seven rattan species in Mandanau Island, Belitung. Another result from Kalima *et al.* (2019) found nine species of rattan in Bukit Lubuk Pekak

forest, Merangin, Jambi. The high density of rattan species in Bukit Tiban, Sekupang need to be monitored since the disturbances or the threats to this forest were also high, such as forest fire in a dry season and illegal land conversion. People near the forest have a high dependency on the BTPF. Hence, we found many anthropogenic disturbances in this area. If we compared the vegetation condition in Batu Ampar I and II, Bukit Tiban, and Batuaji, Batam Island, the massive disturbances to the vegetation triggered by land conversion have caused the high erosion in this area (Yuliastrin, 2014).

The high density of a rattan species indicates the high potency of rattan species especially rattan species in this area. On the other hand, the growth potency will also increase linearly with the high density of a species. Based on the Minister of Forestry Decree No P.19/Menhut-II/2009, rattan is one of the non-timber forest products with high economic value. Due to its potential value, it is important to optimize the management, use, and harvesting of this species. Hence, all stakeholders, such as the government, local government, business entity, and community, should coordinate and built good coordination regarding this species use and harvesting management.

The management of the protected forest, including the management of the BTPF, is based on the ministerial decree no P. 6/Menhut-II/2010 about the norm, standard, procedures, and criteria of forest management of Protection Forest

Table 2. The density of rattan species in BTPF, Sekupang

Tabel 2. Kerapatan rotan di BTPF, Sekupang

No	Local name	Species	P1	P2	P3	ND	ND/ha
1	Calamus sp.2	<i>C.rugosus</i> Beccari	(1)	-	(1)	(2)	(17)
2	Calamus sp.5	<i>C.spectatissimus</i> Furtado	1 (3)	1 (3)	1 (2)	(8)	(67)
3	Calamus sp.6	<i>C.tanakadetei</i> Furtado	-	-	(1)	(1)	(8)
4	Rotan buah kecil	<i>D.didymophylla</i> Beccari	2 (6)	1 (3)	1 (5)	(14)	(117)
5	Rotan sabut	<i>D.sabut</i> Beccari	1 (4)	2 (6)	1 (3)	(13)	(108)
6	Calamus sp.	<i>D.longipes</i> (Griff.) Martius	1 (2)	1 (4)	1 (3)	(9)	(75)
7	Rotan bukit	<i>D.sepal</i> Beccari	1 (2)	1 (3)	3 (5)	(10)	(83)
8	Calamus sp.1	<i>D.verticillaris</i> (Griff.) Martius	(2)	(1)	-	(3)	(25)
9	Rotan dahan	<i>K.rostrata</i> Blume	2 (5)	1 (2)	1 (2)	(9)	(75)
10	Plectocomia sp.	<i>P.elongata</i> Mart. ex Blume	(2)	(1)	(1)	(4)	(33)
Total						(73)	(608)

Remarks: The number in the brackets show the number of stems; the number without brackets show the number of clumps.

Keterangan: Angka di dalam tanda kurung menunjukkan jumlah batang; angka di luar tanda kurung menunjukkan jumlah rumpun.

Management Unit (KPHL) and Production Forest Management Unit (KPHP). The management of the BTPF should pay more attention to the community near the forest. People near the BTPF have been utilized the rattan species for basketry, rope, food, ornamental plant, and medicine. Almost all rattan species in the BTPF were ecologically and economically important to substitute the commercial rattan species except *Plectocomia elongata* (Pari *et al.*, 2018). The stem of *Korthalsia rostrata* is resistance to the powder beetles, but the stem is branched (Jasni *et al.*, 2012). From the field observation, the potency of rattan species in BTPF is very prospective as we found these species grow naturally throughout the forest.

Furthermore, *D. didymophylla* is one of the rattan species which producing resin called jernang or dragon blood. Jernang is a product derived from rattan fruit, which is used for coloring materials in batik and porcelain industry and used as a mixture of cure (Matangaran & Puspitasari, 2012). Jernang is very promising for increasing the income of people near the forest. The socialization to the community near the forest regarding the prospect of rattan and its derived and its utilization will help increase the people's interest in the non-timber forest product and also their income (Suharti, 2015). Hence, it is important to get the government's support through a policy about the sustainability of rattan's management and conservation.

D. Implication for Conservation

This study shows the diversity of rattan species and its population in BTPF of Batam. This location was chosen as this location is the protection forest left in Batam Island. Based on this study, the potential rattan species that were found need to be managed and conserved to support the protected area's management. From the result, five out of 10 species, *Daemonorops longipes*, *Daemonorops didymophylla*, *Daemonorops verticillaris*, *Calamus rugosus*, *Calamus spectatissimus* are on the first-quality regarding durability and potentially to substitute the Manau rattan. It is important to start the conservation action of this species since they have good quality, and the exploitation is possible to occur. Based on the information from the people

near the area and the direct field observation, the massive land conversion will happen in the near future.

Due to some problems above, the need to conserve the diversity of rattan species is urgently needed. On the other and, with all the potency of rattan, it also needs to be further developed. One possible action of rattan management and development is through the ex-situ conservation in the nursery (Rachmat *et al.*, 2020) before we planted it in the field. The characteristic of rattan in the nursery also becomes an interesting topic to be observed and will produce a good recommendation for the planting program in the field. Considering all the importance of the diversity of rattan species, we need to focus on the three aspects of its conservation effort i.e. 1) increasing the protection effort for BTPF, 2) decreasing the pressure of local people to the forest area, the agroforestry initiation using rattan as the commodity in the community area will be a promising choice, 3) expanding an ex-situ conservation of rattan species, germplasm or nursery in the community forest area could be chosen.

IV. CONCLUSION

This research is a preliminary study of the diversity of rattan species in the BTPF. Ten potential rattan species are found and five species of them have a good quality, therefore, they can be used as a substitute for commercial rattan. Rattan from the BTPF is potential to be developed to support the rattan industry as the substitution for the current rattan commercial. Most of the species found at study sites are used locally (*Korthalsia rostrata* and *Plectocomia elongata*) or sell outside the island. This study suggests future research regarding the cultivation or silviculture system of rattan species inside and outside forest areas, possibly through the agroforestry system in the community areas. This system is expected to increase the income of people near the forest and also the conservation effort.

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AUTHOR CONTRIBUTION

RAF and TK: both are main contributors, developed the study plan, conducted the field exploration, and collected the data, analyzed and interpreted the data, wrote and edited the manuscript.

CONFLICT OF INTEREST

Both authors have neither financial nor personal relationships which might influence them in writing this manuscript.

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