Dynamics of vegetation structure and composition within early regeneration forest in the Danau Bangko Protected Area, Jambi, Indonesia

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ABSTRACT

An analysis of the growth dynamics of a 1-ha (100 m x 100 m) permanent plot was carried out in the Danau Bangko Protected Area (DBPA) in March 2020. DBPA is part of the industrial plantation forest concession of PT Rimba Hutani Mas (PT RHM) in Jambi Province. The study aims to determine the dynamics of vegetation structure and composition between 2018 and 2020 in early regeneration forest. All trees tagged in 2018 were remeasured in 2020. Trees that had not been tagged previously but were ≥10 cm in diameter at breast height (DBH) were identified as a new recruit and tagged with a new number. Observations and data analysis were carried out on three stages of growth phases, namely in the tree phase (≥ 10 cm DBH), sapling phase (<10 cm DBH), and seedling phase (height <1.5 m). The results showed that the number of species, genera, and families within the tree and sapling phases were high, but were low in the seedling phase. The dominant species in the tree phase in 2018, *Alseodaphne bancana*, had been replaced by *Archidendron bubalinum* in 2020, whereas the dominant species in the sapling phase (*Rothmania* sp.) and seedling phase (*Aporusa microsphaera*) remained the same from 2018 to 2020 . Mortality rates in all growth phases (tree, sapling and seedling) together is 4.67%. Recruitment into the tree phase from 2018 to 2020 was 2.67%, consisting of eight species, eight genera, and seven families. Within one hectare permanent plot, all members of each tree species were distributed randomly. The vertical structure of the forest area is dominated by stratum C (4-20 m height). The results of hypothesis testing for each phase (tree, sapling, seedling) were different, however overall the results showed that the plot structure and composition had changed.

ABSTRAK

Studi dinamika hutan dilakukan di Kawasan Lindung Danau Bangko (KLDB) pada Maret 2020 dengan menggunakan pendekatan plot permanen seluas satu hektar (100 m x 100 m). KLDB merupakan bagian dari konsesi hutan tanaman industri PT Rimba Hutani Mas (PT RHM) di Provinsi Jambi. Penelitian ini bertujuan untuk mengetahui dinamika struktur dan komposisi vegetasi antara pengukuran tahun 2018 dan 2020, khususnya pada areal dengan tutupan Belukar Tua (BT). Diameter semua pohon yang telah diberi tanda nomor pada tahun 2018 diukur kembali. Pohon yang belum diberi tanda sebelumnya tetapi diameternya ≥10 cm setinggi dada (DBH) ditetapkan sebagai rekrutmen baru dan diberi tanda dengan nomor baru. Pengamatan dan analisis data dilakukan terhadap tiga tahap tahap pertumbuhan, yaitu tingkat pohon (≥10 cm DBH), tingkat pancang (<10 cm DBH), dan tingkat semai (tinggi <1,5 m). Hasil penelitian menunjukkan bahwa jumlah spesies, jumlah marga, dan jumlah famili pada tingkat pohon dan pancang tinggi, sedangkan pada tingkat semai rendah. Jenis dominan pada tingkat pohon pada tahun 2018 adalah *Alseodaphne bancana* telah digantikan oleh *Archidendron bubalinum* pada tahun 2020, sedangkan pada tingkat pancang (*Rothmania* sp) dan tingkat semai (*Aporusa microsphaera*) merupakan jenis yang dominan baik pada tahun 2018 maupun pada tahun 2020. Angka kematian pada semua tahapan pertumbuhan bervariasi dengan rata-rata 4,67%. Rekrutmen di tingkat pohon 2,67% yang terdiri dari 8 spesies, 8 marga, dan 7 famili. Secara keseluruhan, semua spesies tersebar secara acak. Tinggi tajuk pohon didominasi oleh stratum C (tinggi 4 m - 20 m). Hasil pengujian hipotesis pada setiap tingkatan (pohon, pancang, semai) berbeda, namun hasil penggabungan semua data menunjukkan bahwa telah terjadi dinamika.

Keywords: *Forest dynamics, early regeneration forest, structure and composition, Danau Bangko, Batanghari, Jambi, Indonesia*

INTRODUCTION

Forests consist of biotic (like trees, animals, plants, and other living things) and abiotic (such as soil, water, air, and landforms) components. All of these components together make up a forest ecosystem.

Management designed to produce rational and optimal use of forest resources is based on long-term sustainability, not oriented towards or influenced by current short-term use. Sustainable forest management depends on a variety of data and information on the condition of the vegetation, including data on the dynamics of the stands from each

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period. Absolute data and information must be available as the basis for determining long-term management policy strategies, so as to maximize the benefits obtained based on the principle of sustainability.

Continuous deforestation has wide-ranging impacts, especially by reducing biodiversity, thereby weakening or removing links in the food chain in forest areas, and ultimately weakening the entire forest ecosystem. In 2004, when the company granted a permit to manage a production forest for industrial plantation forest, some blocks of remaining natural forest were set aside as protected areas within the industrial plantation forest (HTI) of PT. Rimba Hutani Mas (PT. RHM), Batanghari District, Jambi Province, which is one of them called as DBPA that aiming to preserve the complete range of forest habitats within the locality.

Based on the report of Samsoedin et al. (2018), the DBPA is divided into three land cover types, namely Early Regeneration Forest or Young Regeneration forest (YRF), Scrub (S), and Open Land (OL), as are used in the classification of the High Carbon Stock (HCS) area (Adriani et al., 2017).

The DBPA is a relatively intact forest area located within the plantation forest concession of PT. RHM, the latter dominated by eucalyptus (*Eucalyptus pellita*) and acacia (*Acacia mangium*). In addition to protecting an intact forest are, the DBPA provides and enhances a range of ecosystem services affecting the surrounding areas, particularly as a source of germplasm for several climax forest tree species that are still found in the DBPA (Samsoedin et al., 2018).

Monitoring forest areas continuously (*time series*) is a tool that can answer many hypotheses when studying forest growth dynamics. The permanent plot in the DBPA, which was established in 2018, is a natural laboratory for studying the dynamics of vegetation (succession), including stem diameter growth rates, mortality, natality, population growth, dominance, and recruitment. (Kusumo et al., 2016).

Vegetation studies using permanent plots in forest areas are still relatively rare, so relevant information is still limited, and little is known about the DBPA itself (Samsoedin, 2009). The challenge for this research was that there was no existing comprehensive information on the dynamics of the specific forest locality. The objective of the study was therefore to understand the dynamics of the vegetation structure and composition in the DBPA that occurred in the short term, over the two years following the setting up of the permanent plot.

METHODS

A one hectare of permanent plot (100 m x 100 m) was set up in 2018 in DBPA when the first set of data collected. Remeasurement of similar parameters carried out in March 2020, in the same permanent plot. The DBPA lies inside the industrial plantation forest concession of PT Rimba Hutani Mas (PT. RHM), which has set aside DBPA as the required protected area. Administratively, it is located in Lubuk Ruso Village, Subdistrict Pemayungan, Batanghari District, Jambi Province (Figure 1).

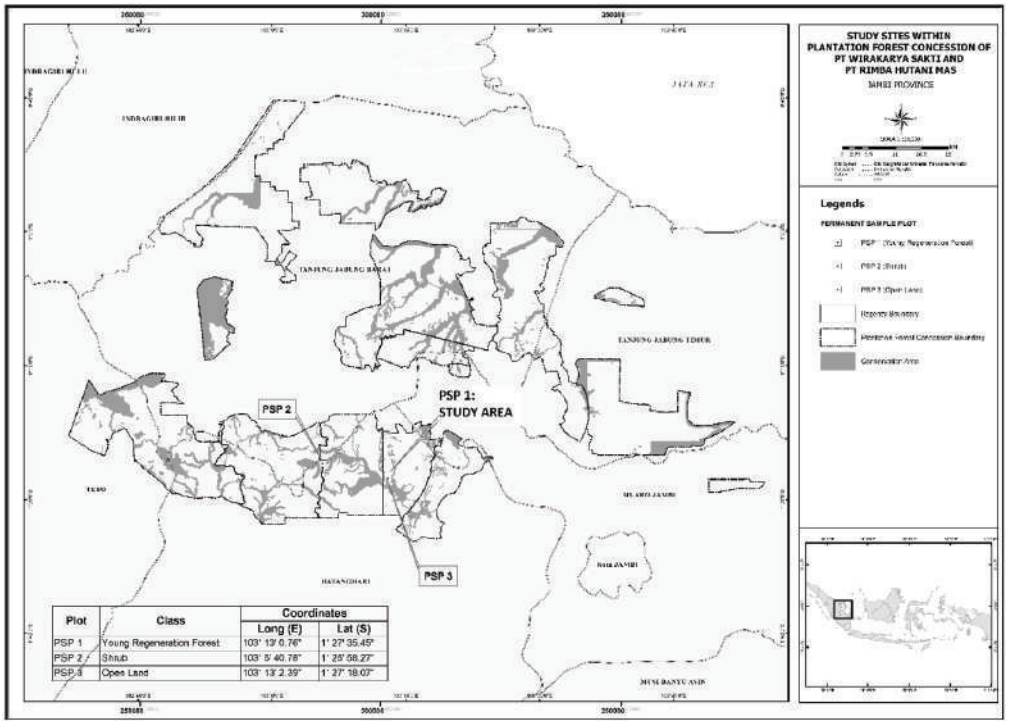

Figure 1. Location of the study area in the DBPA within PT. RHM concession, Jambi.

Three phases of research activities were undertaken. Pre-field studies included preparation of tools and materials. The field research included re-measuring all trees that were tagged in 2018 as well as identifying newly recruited trees, and preparing herbarium samples. Post-field studies included data input and analysis, drying of herbarium samples, and taxonomic identification of the samples which carried out at the Botany Laboratory, Herbarium Bogoriense, Indonesian Institute of Sciences (LIPI), Cibinong, Bogor.

General conditions of the study site

The permanent plot is located within a lowland wet tropical forest area of the DBPA. It is geographically located at 1°27'33.5" South and 103°13'00.2" East with an elevation of ±40 m above sea level (asl). Topographically, the area is a mix of flat and hilly areas with slopes ranging from 8% to15%. Soil types include alluvial associations consisting of acid tuff, sandstone, and sand deposits. There is a thick layer of red to yellow solum, with low nutrient content, which is easily eroded (Samsoedin et al., 2018). The microclimate within study area is considered to be type "A" based on Schmidt and Ferguson's climate classification (Schmidt & Ferguson, 1951). Rainfall total was 958.7–1,613.5 mm over 57-73 days, the wet season being from February to June. Above ground biomass content varied between 167.6 tonnes/ha and 307.6 tonnes/ha (Samsoedin et al., 2018). Average air temperature was 28.78 °C (27.2-30.4 °C), soil temperature 28.50 °C (27-30.2 °C), humidity level 82.40% (66% - 89%), soil moisture 83.64% (69% - 90%), and average soil pH 5.35 (4 - 6).

Data analysis

All field data collected in 2020 from the permanent plot were processed and analysed following Mueller-Dombois & Ellenberg (1974) as well as Soerianegara & Indrawan (2014), using Excel software.

RESULTS

The analysis used data collected from the permanent plot collected in 2018 when the plot was first established and data from 2020. The data were categorized according to three growth phases, namely the tree, sapling and seedling phases, and in 2020 comprised a total of 101 species, 77 genera, and 38 families. The families represented by five or more species were Euphorbiaceae (11 species), Rubiaceae (eight species), Lauraceae (six species), Annonaceae (six species), Dipterocarpaceae (five species), and Myristicaceae (five species) (Heriyanto et al., 2020; Kartawinata et al., 2004; Samsoedin et al., 2018; Wardani & Heriyanto, 2015).

Composition and structure in the tree phase (≥10 cm DBH)

This phase contained 83 species, 65 genera and 35 families, at a density of 485 trees/ha. The change in numbers from 2018 to 2020 was not statistically significant. The diversity index (H'), number of species, number of genera, number of family, and basal area all increased from 2018 to 2020, but tree density decreased (Table 1). Thirteen tree species had been recruited (2.67%) in the permanent plot between 2018 and 2020 (Table 2). These comprised eight species, eight genera, and seven families.

Sixteen trees died between 2018 and 2020 (mortality rate 2.88%), consisting of 14 species, 13 genera, and 12 families (Table 3). Seven dominant species had an Important Value Index (IVI) >10% (Table 4). The most dominant species is *Archidendron bubalinum* (IVI= 24.92%), with *Alseodaphne bancana* (INP = 19.52%) as a subdominant. The distribution pattern of all species is random. The value of hypothesis test result is -1.28 which means that there has been dynamic within two years period (between the period of 2018 and 2020). The result of the analyses with Graphic of Trend (GT) also shows that there has been significantly dynamics, and it is predicted that there will continue to be development or dynamics.

Table 1. Characteristics of the tree phase in the 1-ha permanent plot.

Parameter	2018 *	2020
Species diversity index (H')	3.64	3.80
Richness index (C)	0.05	0.05
Similarity index (E)	0.05	0.32
Mortality (%)	0	2.88
Number of species	75	83
Number of genera	64	65
Number of families	34	35
Density (trees/ha?)	486	485
Basal area Units?	19.74	20.09
Frequency/distribution (Number of individual trees?)	344	335

Note: *Samsoedin et al. (2018)

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Table 2. Species recruitment in the tree phase in 1-ha permanent plot.

No.	Species	DBH (cm)	Height (m)	Tagging No.	Subplot location
1	*Ixora javanica**	10.83	9.4	487	A
2	*Endiandra rubescens**	10.83	9.3	488	A
3	*Sandoricum koetjape*	11.94	12.6	489	C
4	*Neouvaria acuminatissima**	10.51	12.2	490	G
5	*Aglaia* sp.*	10.51	14.4	491	L
6	*Dyera costulata*	16.82	10.5	492	T
7	*Knema* sp.*	11.46	15.3	493	R
8	*Alseodaphne bancana*	10.51	7.8	494	R
9	*Diospyros frutescens**	10.73	16.4	495	P
10	*Baccaurea* sp.*	10.83	11.2	496	O
11	*Canarium* sp.	10.38	15.4	497	Y
12	*Antidesma cuspidatum**	10.70	13.7	498	Y
13	*Dacryodes rostrate*	11.11	16.3	499	V

Note: *New record in the plot

Table 3. Individual trees in 1-ha permanent plot found dead in 2020.

No.	Species	DBH (cm)	Height (m)	Tagging No.
1	*Agelaea trinervis*	17.70	1.,8	248
2	*Alseodphane bancana*	24.00	18.3	353
3	*Alseodphane bancana*	11.20	89	209
4	*Antidesma tomentosa*	11.10	13.0	115
5	*Archidendron bubalinum*	13.50	9.2	352
6	*Archidendron bubalinum*	13.50	22.4	60
7	*Baccaurea motleyana*	12.00	8.8	157
8	*Gaertnera* sp.	19.00	17.1	350
9	*Kokoona reflexa*	25.00	20.9	198
10	*Monocarpia* sp.	21.90	21.1	411
11	*Palaquium ridleyi*	41.60	21.3	370
12	*Rothmania* sp.	20.00	13.2	147
13	*Sandoricum koetjape*	30.00	19.9	246
14	*Santiria laevigata*	10.00	8.2	227
15	*Shorea acuminate*	17.00	18.1	412
16	*Syzygium* sp.	17.30	16.8	300

Table 4. Species in tree phase with Important Value Index (IVI)= >10% in 1-ha permanent plot (DR= Relative Dominance; KR= Relative Density; FR= Relative Frequency).

Species	DR (%)	KR (%)	FR (%)	IVI (%)
Archidendron bubalinum	7.23	11.42	6.27	24.92
Alseodphane bancana	7.83	6.61	5.07	19.52
Agelaea trinervis	6.94	7.21	4.18	18.33
Ochanostachys amentacea	6.66	5.81	4.18	16.65
Strombosia ceylanica	7.27	2.81	2.39	12.47
Monocarpia sp.	5.50	3.21	2.69	11.39
Sandoricum koetjape	4.95	2.81	2.99	10.74

Growth in the sapling phase (<10 cm DBH)

The sapling level in 2020 consisted of 47 species, 43 genera, and 27 families with a sapling density of 218 trees/ 625 m^2 (or 3,488 trees/ha). The results from 2018 and 2020 do not vary significantly. The 2020 *Shannon Wiener* (H') Index, density and basal area were higher than in 2018, but other parameters remain the same (Table 5).

Table 5. Characteristics of the sapling phase at the 1-ha permanent plot.

Parameter	2018*	2020
Species diversity index (H')	3.40	3.42
Richness index €	0.35	0.35
Similarity index €	0.88	0.88
Mortality (%)	0	3.54
Number of species	47	47
Number of genera	43	43
Number of family	27	27
Density	226 (3,616/ha)	218 (3,488/ha)
Basal area	0.18 (2.88 m^2/ha)	0.21 (3.36 m^2/ha)

The mortality rate of saplings over the two years was 3.54% (eight saplings) (Table 6). There are ten dominant species in 2020 with IVI > 10% (Table 7), the most dominant being *Rothmania* sp. (IVI= 23.17%), followed by *Aporusa microsphaera* (IVI= 19.68%). The most dominant species at sapling phase in 2018 was also *Rothmania* sp. (IVI= 28.45%), , (with an increased IVI The dominance and IVI of other species had shifted from 2018 to 2020, with some species' IVI increasing to >10 in 2020, e.g., *Gonocaryum littorale* (IVI= 12.94%) and *Ixora siamensis* (IVI= 10,67%).

The distribution pattern of species within this phase is also random. The hypothesis test results is -1.03 indicating significant change in the plot structure within this phase. The analyses of GT shows that there is a change but that is not as significant as in the tree phase (R^2= 0.81).

Table 6. Individual saplings in 1-ha permanent plot found dead in 2020

Species	DBH (cm)	Height (m)
Alseodphane bancana	6.0	11.4
Archidendron bubalinum	3.0	4.8
Diospyros bantamensis	1.0	3.1
Diospyros bantamensis	1.0	2.6
Paraserianthes falcataria	7.5	6.8
Pimelodendron griffithiianum	7.6	5.2
Prunus arborea	2.5	5.8
Syzygium clavimyrtus	0.5	2.1

Table 7. Species in the sapling phase with Important Value Index (IVI)= >10% in 1-ha permanent plot (DR= Relative Dominance; KR= Relative Density; FR= Relative Frequency).

Species	KR (%)	FR (%)	DR (%)	IVI (%)
Rothmania sp.	7.60	8.26	7.32	23.17
Aporusa micosphaera	7.77	6.42	5.49	19.68
Archidendron bubalinum	7.82	5.50	4.88	18.20
Monocarpia sp.	5.47	5.96	5.49	16.92
Hydnocarpus woodii	4.58	5.96	5.49	16.03
Dacryodes rostrata	4.92	5.50	5.49	15.91
Sterculia oblongata	4.10	6.42	4.88	15.40
Ochanostachys amentacea	4.28	5.96	4.88	15.12
Gonocaryum litorale	3.01	5.05	4.88	12.94
Ixora simalurensis	3.34	3.67	3.66	10.67

Growth in the seedling phase (height <1.5 m)

Within the seedling phase, most of the parameters (diversity, richness and similarity indexes, and number of species and family) decreased from 2018 to 2020. In 2020, there were 28 species, 27 genera, and 21 families (Table 8). The mortality rate was 8.44%, with the loss of 12 trees and saplings species. There are six dominant species (five families) within the sapling phase with an IVI= >10% (Table 9).

Aporosa micosphaera (IVI= 30.32%) was the most dominant species in 2018 and in 2020, although there was a change in the IVI values for other species, including *Monocarpia* sp. which was replaced in 2020 by *Archidendron bubalinum*.

Table 8. Characteristics of the seedling phase at 1-ha permanent plot.

Parameter	2018*	2020
Species diversity index (H')	2.78	2.70
Richness index (C)	0.54	0.42
Similarity index (E)	0.82	0.81
Mortality (%)	0	8.44
Number of species	30	28
Number of genera	29	27
Number of family	22	21
Density	154 (15,400/ha)	142 (14,200/ha)

Note: *Samsoedin et al. (2018)

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There was no additional species recruitment into the seedling phase by 2020, but two species decreased, namely *Gluta velutina* and *Hydnocarpus woodii*. Thirteen seedlings (from seven species and five families) died (mortality rate 8.44%) (Table 10). The species distribution pattern at this phase was again random, and the hypothesis test shows that low levels of dynamics.

Species	KR (%)	FR (%)	IVI (%)
Aporusa micosphaera	16.90	13.41	30.32
Archidendron bubalinum	14.08	976	23.84
Monocarpia sp.	14.08	8.54	22.62
Rothmania sp.	13.38	6.10	19.48
Strombosia ceylanica	4.93	8.54	13.47
Ixora simalurensis	4.93	6.10	11.03

Table 10. Species in seedling phase in 1-ha permanent plot found dead in 2020

No.	Species	Family	N
1	*Rothmania sp.*	Rubiaceae	4
2	*Ixora simalurensis*	Rubiaceae	2
3	*Ixora* sp.	Rubiaceae	1
4	*Strombosia ceylanica*	Olacaceae	1
5	*Gluta velutina*	Guttiferae	1
6	*Hydnocarpus woodii*	Flacourtiaceae	1
7	*Monocarpia sp.*	Annonaceae	3
Total			**13**

Forest regeneration

Regeneration in the tree phase is relatively good (Figure 2). The area is dominated by trees with a DBH of 10-19.9 cm (299 trees / 61.65%). Trees with a DBH of >50 cm are least frequent (6 trees / 1.24%). The sapling phase is dominated by those with a DBH of 1-2.9 cm (116 trees / 53.21%), and the least common are those with a DBH of 6 - 9.9 cm (24 trees / 11.01%). The 2020 survey showed that 15 species (11 families) have been recruited across all growth phases (tree, sapling, seedling) since 2018 (Table 11).

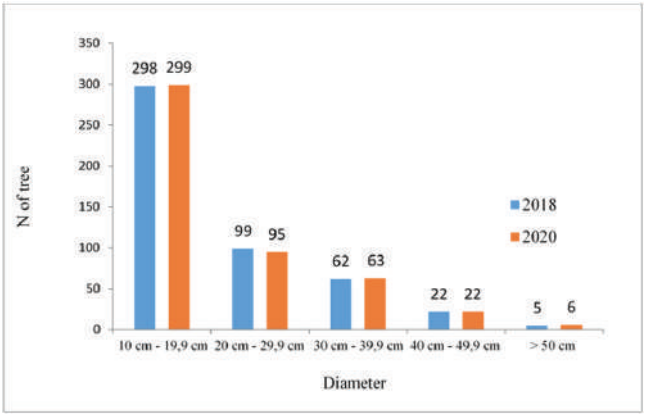

Figure 2. Distribution of all tree diameter classes (>10cm DBH) within a 1-ha permanent plot in 2018-2020.

In the tree and sapling phases, six species showed a DBH increase >0.1 cm, the highest growth occurring in *Archidendron bubalinum* (average 1.04 cm) and the lowest in *Strombosia ceylanica* (average = 0.23 cm). The average growth of all other species is <0.1 cm (Table 12).

Table 11. Species occurring in all growth phases in 1-ha permanent plot.

Species	IVI (%)		
	Tree	Sapling	Seedling
Agelaea trinervis	18.33(3)*	2.43	1.92
Alseodphane bancana	19.52(2)*	9.74	1.92
Aporusa micosphaera	0.56	19.68(2)*	30.32(1)*
Aporusa sphaeridophora	0.61	5.93	3.85
Archidendron bubalinum	24.92(1)*	18.20(3)*	23.84(2)*
Baccaurea motleyana	4.14	5.98	9.62
Dacryodes rostrata	4.76	15.91(6)*	1.92
Diospyros bantamensis	4.49	5.04	4.55
Gompia serrata	1.16	1,22	7.69
Ixora simalurensis	3.22	10.67(10)*	11.03(6)*
Litsea tomentosa	4.98	1.14	1.92
Monocarpia sp.	11.80(6)*	16.92(4)*	22.62(3)*
Ochanostachys amentacea	19.86	15.12(8)*	6.48
Rothmania sp.	9.34	23.17(1)*	19.48(4)*
Xanthophyllum excelsum	2.24	5.93	1.92

Note: *IVI= >10%

Table 12. Species with highest increase in DBH during the period 2018-2020 in 1-ha permanent plot.

Species	Family	Mean DBH growth (cm)
Archidendron bubalinum	Leguminosae	1.04
Bouea oppositifolia	Anacardiaceae	0.49
Koompassia malaccensis	Caesalpinaceae	0.72
Nephelium mutabile	Sapindaceae	0.13
Sandoricum koetjape	Meliaceae	0.17
Strombosia ceylanica	Olacaceae	0.23

Forest stratification

Tree stand structures in various diameter classes are horizontally spread across subplots A-Y within the 1 haa permanent plot (Figure 3). The tallest tree is 32 m in height and the smallest is 7 m, with an average of 15.17 m. The tallest in the sapling phase is 11.4 m and the smallest 1.2 m, with an average of 3.77 m. Overall, canopy cover averages 40%, or classified as medium category according to Indriyanto (2008).

The tree canopy within study area is divided into three strata. Trees in stratum C (4-20 m height) are most dominant, followed by those in stratum B (20-30 m height), and stratum A with trees>30 m. The highest percentage of species at stratum C (which greater than 5%) are *Alseodphane bancana* (75 trees / 18.75%), *Ochanostachys amentacea* (32 trees / 8.00%), and *Agelaea trinervis* (25 trees / 6.25%). While the family in stratum C which greater than 10% are Leguminosae (47 trees / 11.75%). The highest percentage of species at stratum

B (which greater than 5%) are including *Diospyros bantamensis* (7 trees / 8.33%), *Bouea oppositifolia* (6 trees / 7.14%), *Dehaasia* sp. (6 trees / 7.14%), *Barringtonia racemosa* (5 trees / 5.95%), and *Baccaurea motleyana* (5 trees / 5.95%). Stratum A only contains one species (0.21%), namely *Horsfieldia glabra*.

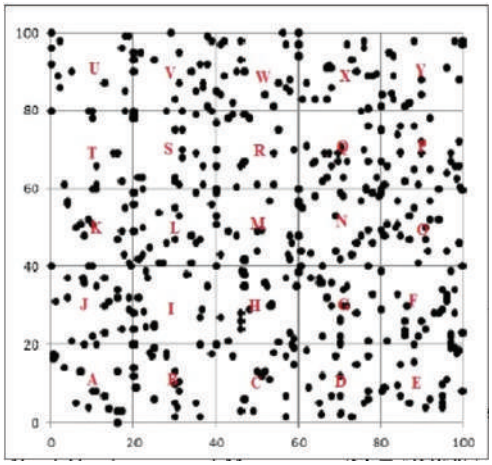

Figure 3. Distribution of trees (≥10 cm DBH) in subplots within the permanent plot in 2020.

Similarity index

The Similarity index (SI) is used to determine the similarity of a species which has IVI= >10% within 25 subplots. The results of the analyses showed that most of species are different, and only three species have a SI index >50%. The highest correlation occurs between Alseodaphne bancana and Mococaria sp. (SI = 52.25%) with Ochanostachys amentacea (SI = 50.03%). The correlation among other species is <50%, some even tends to uncorrelated such as Strombosia ceylanica (SI = 31.44%). The occurrence of different correlation between these species means that the symbiosis between species is considered as low mutualism (Figure 4). There are eight subplots that have SI > 50% while another 17 subplots have SI < 50%, this means that each subplot has a relatively different condition.

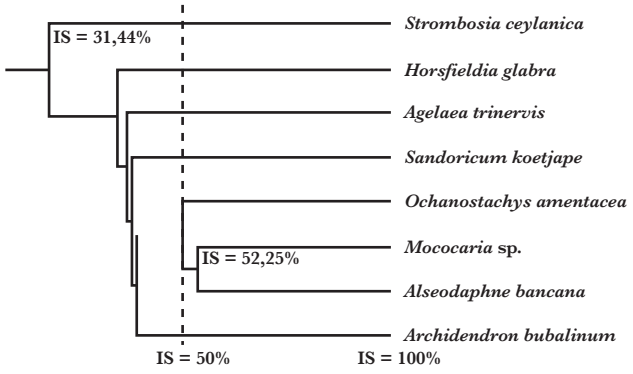

Figure 4. Percentage of tree species correlation IVI=> 10% within one hectare permanent plot.

DISCUSSION

Indonesia's forests are among the most diverse and the most threatened in the world, especially lowland rainforest (occurring below 500 metres asl). The country's largest remaining tract of lowland rainforest is located on Sumatra, and this includedthe forest area within DBPA (Suwardi et al., 2013 in Sadili et al., 2019).

Permanent plots can contribute significantly to our understanding of the dynamics of lowland rainforest and its resilience in the face of different disturbances, but few such plots exist in Indonesia. The 1-ha plot examined here was only set up two years ago and the various analyses presented here indicate change but nothing statistically significant(Table 1, 5, 8). According to Kuswandi (2017), a 1-ha permanent plot that is observed periodically for more than fiveyears is sufficiently representative of the area to illustrate the dynamics of growth. The permanent plot within DBPA is therefore still included in the category of YRF, with DBH measurements being predominantly relatively small (Figure 2).

Altitude affects the diversity of natural forest in one hectare of lowland forest there are usually more than 150 tree species (Whitmore, 1994). Mansur et al. (2010) found 123 and 126 tree species/ha in two plots in a lowland area of Harapan Rainforest, Jambi, Central Sumatra. . The tree species diversity in DBPA is lower than in Harapan. This is because the vegetation conditions in the two forest areas are different, where the vegetation conditions in Harapan Rainforest is better, while in DBPA used to be heavily logged before 2004. Tree species richness in DBPA is also lower than the eastern core zone of Bukit Duabelas National Park, Jambi, which is consisting of 113 species and 38 families (Rahmah et al., 2016). Moreover, the tree species diversity in both areas is lower than in the lowland rainforest of Sekundur, Gunung Leuser National Park in Northern Sumatra, which has 133 species (39 families) (Priatna et al., 2006). The tree species richness and tree density in DBPA is also lower than in a permanent plot located ini Bodogol, Gunung Gede Pangrango National Park, West Java, which has 119 species (44 families) (Sadili, 2014; 2018).

The mean mortality rate of species measured in DBPA over the two years was 4.67% (trees, saplings, seedlings). This mortality rate indicates that the successional process is still a long way from reaching a climax forest, because the natural climax tropical forests usually have a mortality rate of 1%-2%/year. In addition, the DBPA permanent plot is characterized by many species of shrubs and pioneer trees (fast growing species), but already some slow-growing families are also present, such as Lauraceae, Annonaceae, Dipterocarpaceae, Myristicaceae, Fagaceae, and Burseraceae.

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Euphorbiaceae (11 species) and Rubiaceae (eight species) are two of the largest families in Malaysiana flora, but they usually occupy the lower or middle forest strata. Euphorbiaceae's success in dominating many forest types is evidence that this family is highly adaptableto environmental conditions and opportunistic (Proctor at al, 1983; Priatna et al., 2006; Sadili, 2014).

Occurrence of gaps in the forest canopy can stimulate dormant seeds of pioneer tree species are growing up, and provide opportunities for of several species of shrubs to develop, so that plant species show a mixture of pioneer trees and shrub species. Based on visual observation, several small gaps also formed both in and around the permanent plot due to naturally broken tree branches. Indriyanto (2008) classify forest canopy covers into three different phases namely high (> 70%), moderate (40 -70%), and low (<40%).

The similarity index (SI) determines the level of similarity or degree of grouping among several objects under the study using several variables (positive or negative collaboration). In this study we employed SI to measuring whether the composition of the plant community in each sub-plot is similar. According to Kramer & Kozlowski (1979) in Pamoengkas & Prayogi (2011), growth is the end result of the interaction of various physiological processes that are influenced by environmental conditions. The picture of the species correlation of IVI >10% is mostly low (SI= <50%), which means that there is no high mutualism symbiosis. Then the results of the analysis for 25 different subplots (SI= <50%), shows that the research area within permanent plot is representative (heterogeneous subplots).

The distribution of all tree diameter classes (≥10cm DBH) within a 1-ha permanent plot in 2018-2020 can be seen in (Figure 2). This shows common condition of a natural tropical forests including in permanent plot, and is called the "inverted J" type. This pattern is a characteristic of dynamic natural forests (Proctor et al., 1983; Samsoedin & Heriyanto, 2010).

Knowing the species distribution pattern is very important for basic forest management. Many factors influence these distribution patterns, particularly climatic conditions and nutrient availability (Sofiah et al., 2013). According to Wahyuni et al. (2017), random distribution patterns of plant species occur when the dispersal of their seeds is mostly by wind or animals, and when the species displays significant environmentally tolerance. This study shows that the overall distribution pattern of the tree species is random, which is indicating that they are mainly plant species that dispersed by wind or animals.

High IVI values such as *Archidendron bubalinum* (tree), *Rotmania* sp. (sapling), and *Aporusa microsphaera* (seedling) are species that have a big opportunity of maintaining their growth and sustainability because the dominant species is the species that can utilize the environment where they grow in more efficiently than other species in the same area. The results of this study indicate that those three species, *Archidendron bubalinum*, *Rotmania* sp., and *Aporusa microsphaera*, are the most dominant species in each growth phases (tree, sapling and seedling) in the plant communities within the DBPA forest.

The Dipterocarpaceae are one of the main constituent families of Indonesia's lowland forests, particularly in Sumatra (Purwaningsih, 2004) and five Dipterocarp species were recorded in the permanent plot area, namely *Shorea acuminata*, *S. hemsleyana*, *S. leprosula*, *Dipterocarpus hasseltii*, and *Vatica rassak*. Not all species were recorded in all growthphases. *Shorea leprosula* was only found in the seedling phase, while *Shorea acuminata* occurred in both seedling and sapling phases. Other species are only recorded in the tree phase, so at this point, *Shorea acuminata* is the most dominat of the Dipterocarp species.

The emergent layer was categorized as very poor because only one single species and single tree was recorded in that emergent layer (>30 meters height). Natural, undisturbed forests of Sumatra and Kalimantan are usually dominated by members of Dipterocarpaceae, Burseraceae, and Leguminosae in the emergent layer. Again, this is an indication the permanent plot has had previously been disturbed and heavily logged, because based on its history, prior to 2004 this DBPA area was a logging concession area which was accompanied by illegal logging activities.

CONCLUSION

1. In a 1-ha permanent plot in Central Sumatra, we found a total of 101 species, 77 genera, and 38 families occurring in the tree, sapling, and seedling phases. All species are randomly dispersed.
2. *Archidendron bubalinum*, *Rothmania* sp., and *Aporusa microsphaera* are the most dominant species in the growth phases of tree, sapling and seedling, respectively.
3. Regeneration as manifested in the tree and sapling phases is quite good, but not in the seedling phase. Basal area, or stand density of trees and saplings, had increased over the two years by 3.64%.
4. Eight species, eight genera, and seven families had been recruited into the permanent plot from 2018 to 2020.
5. Mortality rates in all growth phases (tree, sapling and seedling) is 4.67% across 2018-2020, or 2.34% / year.
6. Tree densities are 485/ha in the tree phase, 3,488/ha in the sapling phase, and 14,200/ha in the seedling phase.

7. Overall, the analyses indicatethat permanent plot has experience some growth dynamics in tree and sapling phases but not in the seedling phase.

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