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Original Article

Trees structure and composition on logged over forest at Kopiyo Meratus, Hulu Sungai Tengah District, South Kalimantan

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Abstract

Natural forest area in Kalimantan has changed drastically. The aim of this study was to reveal the diversity of tree in Kopiyo Forest of Meratus after termination of Forest Concession was over. Study was carried out at two different observation sites with square method (slope and drier especially). The obtained data was varied, which diversity in the sapling group in two site was 32 species, 28 genera, 25 families, and density of 285 individuals/ha, with basal area ± 9.50 m^2/ha. Whereas, diversity in the tree group in two site was 34 species, 28 genera, 23 families, and density of 485 individual/ha, basal area ± 32.85 m^2/ha. *Gordonia cf. borneensis* was the most dominant species of sapling group in site I and II, and *Macaranga hypoglauca* was the most dominant species of the tree group in site I and II. Euphorbiaceae, Dipterocarpaceae, Sapindaceae, Myrtaceae, and Rubiaceae were mostly found in observation sites. *Shorea parvifolia, S. pinanga,* and *S. Smithiana* were species with endanger status.

Key words: trees, structure, Kopiyo, Meratus, South Kalimantan.

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INTRODUCTION

Kalimantan has been known as one area with large tropical forest which always green throughout the year (evergreen forest). Beside of that, Kalimantan shows high biodiversity index. Previous studies were done in order to reveal the plant diversity in Kalimantan (Krisnawati *et al.*, 2012). Natural conditions in Kalimantan, such as altitude, topography, geology, soil type, climate, and temperature that provide optimum condition to be inhabited by various organism. Most of forest area in Kalimantan are good condition, while the risk of change is high because of human activities.

The decrease rate of forest coverage in Kalimantan has reached ± 2.000 ha for each day (Mac Kinnon, 1994). It can be predicted if it keep decreasing without any prevention efforts, the primary area of natural forest in Kalimantan will be extincted rapidly. Political development based on Indonesia Constitution No. 22 1999 on regional autonomy has urged environtmental changes because of forest utilization in order to increase the regional revenues. There are a lot of natural forest that have changed because of utilization for human needs. The local government has applied the regulation in forest utilization as one of sustainable regional development programs to minimize the negative effects from bad forest management such as erosion, drought, and flood. In addition, the other consequences from forest utilization are loss of biodiversity, habitat of endanger species, and risk for human.

This research aim was to investigate recent condition of species richness and plant stands in Meratus mountain focused on Kopiyo Forest after Forest Concession was over, which studies that are conducted in this area are rare. The obtained data from this research is expected can provide important information about flora composition and forest structure as one of efforts for forest conservation and better sustainable forest management.

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METHODS

Meratus mountain area belongs lowland forest and sub-mountaine forest (500 m to 1900 m above sea level), extended from southeast to north. This area included in East Kalimantan Province. It is geographically located in 115°38’00" - 115°52’00" east longitude and 2°28’00" - 20°54’00" south latitude. This mountain area has an important hydrological function for Batangalai, Barabai, and Amandit rivers that flow into Barito river, South Kalimantan. Decree of the Minister of Forestry No. 2.828/KPTS-II/2002 stated that Meratus mountain is protected forest area. Biodiversity of this area was high which dominated by some species such as Meranti putih (*Shorea resinosa*), Meranti merah (*Shorea* spp.), Damar (*Agathis borneensis*), Kanari (*Canarium* sp.), Nyatoh (*Palaquium* sp.), Medang (*Litsea* spp.), Durian (*Durio* spp.), Kempas (*Koompassia malaccensis*), and Belatung (*Quercus* spp.) (Anonym, 2001).

Location of this study was administered as region of Hinas Kiri Village region, Batang Alai Timur Sub-district, Hulu Sungai Tengah District, South Kalimantan Province (Figure 1A). Forest in this location was classified as disturbed primary forest with type B climate which has been explored with forest concession by PT Daya Sakti. Type B climate region described as region which has rainfall distribution for throughout the year with high humidity (Schmidt and Ferguson, 1951). Rainfall in this area is about 1.355 mm/year for 167 days. Monthly rainfall was about 112.92 mm. The highest rainfall is on April and the lowest is on August (Anonym, 2001).

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Observation was done by plotting with 20 m x 50 m square plot in two different locations. The first location was in the left side of Kopiyo river and the second location was on the right side. Each of location was located ± 500 m from riverside with the same altitude ± 800 m asl. Each square plot was divided into 10 subplots for group of trees and sapling (Figure 1B). Stem diameter with ± 1.3 m of height of each individu on square plot was measured. Plant was classified as tree when it had stem diameter > 10 cm and it was classified as sapling when it had stem diameter < 10 cm. Then, all tree diameters were measured to estimat total height and of branch height.

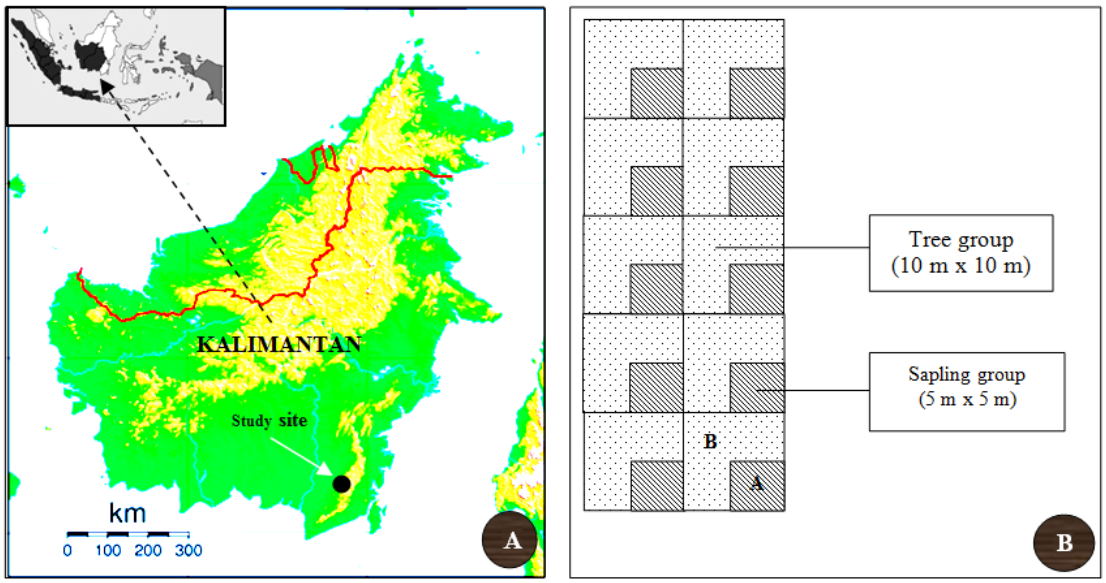

Figure 1. Observation area (A) and research plot

Plants were firstly identified in study location, after that some parts of plant were taken for identification. Field observation was done on common plants that could be identified directly. Samples that were taken then compared with the collection of Herbarium Bogoriense, Cibinong–Bogor. Species identification was based on the latest publication on Flora Malesiana (Steenis, 1950), Plant list (Anonym, 2015), and Tree Flora of Kalimanatan Check List (Whitmore *et al.*, 1989).

Data were analyzed to estimate the dominance, density, frequency. The importance value index (IVI) of density was obtained from the calculation of relative frequency, relative dominance, and relative density. The importance value index then divided by three for summed dominance of ratio (SDR=simple importance value for 100%).

Estimated density values were then used for correlation analysis of species and location (Similarity index). Other analysis was mischung coefficient complexity index (Q) and species diversity index (H').

The Shannon-Wiener diversity index:

$$H' = - \sum (ni/N) \log (ni/N)$$

H'= Shannon-Wiener diversity index
ni = individual number of species 1
N = individual total of species.

According to Barbour *at al.* (1987) diversity index is classified into 4 categories:

- Very high (H' ≥ 4)
- High (H'= 3 – 4)
- Intermediate (H'=2–3)
- Low (H'=1–2)
- Very Low (H' ≤ 1)

Mischung coefficient index (Q) determined from individual number divided by species number. The higher Q value, the poorer species richness on the location of study.

RESULTS

Sapling Group Diversity

Density average of vegetation stand on sapling group in Kopiyo-Meratus forest from two locations was 28.5 individuals/1.000 m^2 (±285 individual/ha) with basal area average was ±0.95 m/1.000 m^2 (±9.50 m^2/ha) (Standard Deviation/St.Dev.=0.06). The average of complexity index was ±1.75 with St.Dev.=0.35. Shannon-Wiener index average was ±2.50 with St.Dev.=0.01 (Table 1). Identification results were consisted of 32 species, 28 genera, and 25 families. *Gordonia* sp. dominated both locations of study, with important value index ±44.18 % (SDR=14.73%) for the first location and ±73.26% (SDR=24.42 %) for the second location.

Both of first location I and location II were dominated by families from primary and secondary forest vegetations such as Anacadiaceae, Moraceae, Sapotaceae, Theaceae, and Euphorbiaceae with two species for each family. Topography variation of each location affects on species density. Location II was higher than location I.

Tree Group Diversity

Tree group diversity of two study locations was consisted of 34 species, 28 genera, and 23 families (Table 3). Shannon-Wiener species diversity index average of tree group was ±2.69 with St.Dev.=0.19. The average of species density was 48.5 individual/1.000 m^2 (±485 individual/ha) with St.Dev.=4.95. The average of basal

area was ±3.28 m/1000 m^2 (32.85 m^2/ha) and complexity index was ±0.07 with St.Dev.= 0.07. *Macaranga hypoglauca* was the species that dominated the study locations with important value ±56.10% with SDR=18.70% for the first location and ±62.34% with SDR=20.78% for the second location (Table 4).

Species and family density for tree group were similar almost with sapling group, but the number of each familys was different, such as Euphorbiaceae (6 species), Diperocarpaceae (3 species), Sapindaceae (3 species), Myrtaceae and Rubiaceae were 2 species found.

Stratification and Correlation

Individual distribution according to total height stand of branch for both of sapling and tree groups were equal (Figure 2). Emergent distribution was found more in location I, while in locataion II there was one individu stand with low branch height (Figure 2). It is noticeable that plants in location II are higher with denser population.

Species correlation which obtained was varied. Most of species were ±50 % correlated to each other (Figure 3A). The most correlated species were *Vitex pestita*, *Saurauia nudiflora*, and *Aporosa prutescens*. Their correlation with the other species was very low (± 2 %). *Ediandra rubescens* and *Chisocheton divergent* were closely correlated to *Cratoxylon coochinensis* (± 86 %). While *Dillenia* was ± 99 % correlated to *Alangium ridley* and ± 42 % correlated to the other species (Figure 3). The higher similarity index value shows the higher correlation of compared species. The correlation of location I and location II was low, it was ± 22 % (Figure 4). And distribution of diameter classification formed imperfect "L" curve (Figure 5).

Table 1. Identified sapling group in Kopiyo-Meratus Forest.

Location	Quantity			Observation Area (m)		Index	
	Individuals (1.000 m^2)	Individuals (ha)	Species (1.000 m^2)	1.000 m^2	Ha	Complexity (Q)	Diversity (H')
I	21	210	14	0.05	5.0	1.50	2.49
II	36	360	18	0.14	14.0	2.00	2.51
Total	**57**	**570**	**32**	**0.19**	**1.9**	**3.5**	**5.0**
Mean	**28.5**	**285**	**16**	**0.95**	**9.5**	**1.75**	**2.5**

Table 2. Species enlisted of sapling group, IVI/SDR (importance value index/summed dominance of ratio) in Kopiyo-Meratus Forest.

No	Species	IVI (%) Location		SDR (%) Location	
		I	II	I	II
1	*Alangium ridleyi* King		10.15		3.38
2	*Aporosa frutescens* Blume	9.98		3.33	
3	*Camnosperma auriculatum* (Blume) Hook.f.		11.46		3.82
4	*Haemocharis* sp.		8.32		2.77
5	*Chisocheton patens* Blume	16.01		5.34	
6	*Cratoxylumn cochinchinense* (Lour.) Blume		9.86		3.29
7	*Dacryodes rubiginosa* (A.W.Benn.) H.J.Lam	35.96		11.99	
8	*Dillenia excelsa* (Jack) Martelli ex Gilg.	22.00		7.33	
9	*Diospyros* sp.		23.27		7.76
10	*Elaeocarpus glaber* Blume		6.48		2.16
11	*Endiandra rubescens* (Blume) Miq.	14.82		4.94	
12	*Ficus* sp.	23.81		7.94	
13	*Ficus fistulosa* Reinw. ex Blume		18.94		6.31
14	*Gordonia* cf. *borneensis* H. King (*)	44.18	73.26	14.73	24.42
15	*Harpullia arborea* (Blanco) Radlk.	12.82		4.27	
16	*Lasianthus* sp.		9.86		3.29
17	*Macaranga tanarius* (L.) Mull. Arg.		11.46		3.82
18	*Mangifera longipetiolata* King	12.01	8.11	4.00	2.70
19	*Palaquium obtusifolium* Burck		7.91		2.64
20	*Palaquium walsurifolium* Pierre ex Dubard	9.93		3.31	
21	*Parkia timoriana* (DC.) Merr.	18.75		6.25	
22	*Pernandra azurea* (DC.) Burkill		7.37		2.46
23	*Prunus arborea* (Blume) Kalkman		35.34		11.78
24	*Saurauia nudiflora* DC.	10.38		3.46	
25	*Shorea pinanga* Scheff.	42.00		14.00	
26	*Stemonurus secundiflorus* Blume		29.04		9.68
27	*Sterculia rubiginosa* Zoll. Ex Miq.	27.08		9.03	
28	*Syzygium subglobosum* Merr. & L.M.Perry		13.05		4.35
29	*Vitex vestita* Wall. Ex Schuer		9.86		3.29
30	Unidentified sp. 4		6.49		2.16

(*) The highest main species

Table 3. Identified tree group in Kopiyo-Meratus Forest.

Location	Quantity			Observation Area (m)		Index	
	Individuals (1.000 m^2)	Individuals (ha)	Species (1.000 m^2)	Individuals (1.000 m^2)	Individuals (ha)	Species (1.000 m^2)	Individu (1.000 m^2)
I	45	450	23	3.42	34.2	0.08	2.82
II	52	520	17	3.5	31.5	0.06	2.55
Total	**97**	**970**	**40**	**6.57**	**65.7**	**0.14**	**5.37**
Mean	**48,5**	**485**	**20**	**3.28**	**32.85**	**0.07**	**2.69**

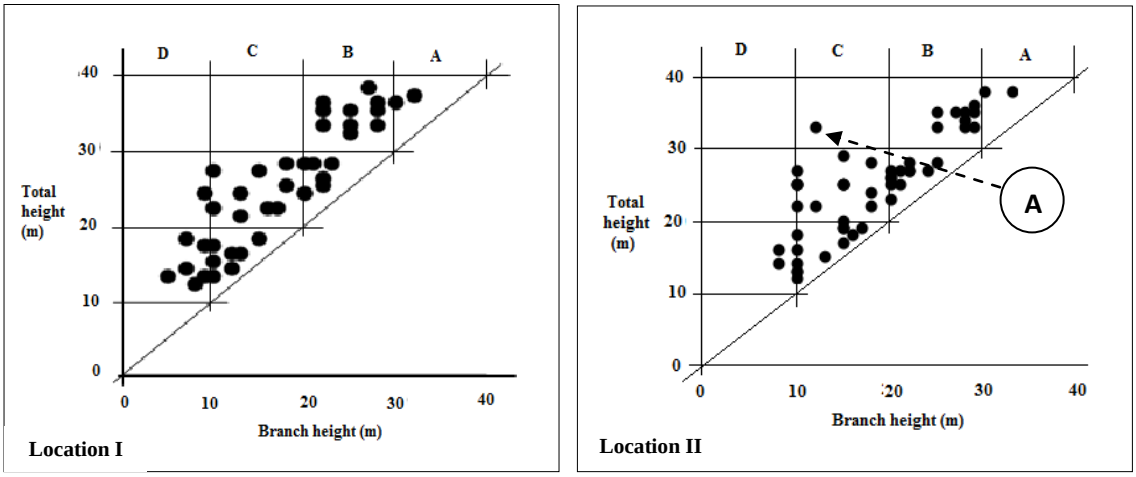

Figure 2. Individual distribution according to comparison of total height with branch height in Kopiyo-Meratus Forest.

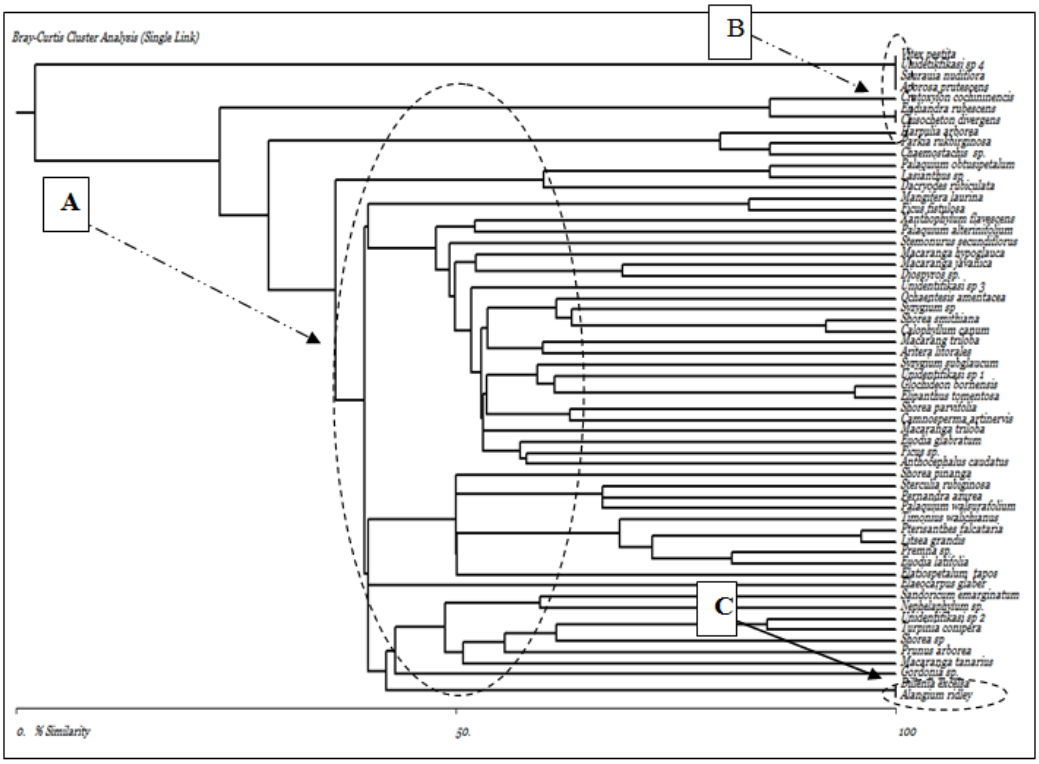

Figure 3. Species correlation (%) in Kopiyo–Meratus Forest.

DISCUSSION

Plant species diversity in Kalimantan covers more than 150 species, while in Kopiyo-Meratus forest was found 58 species (± 39 %). This condition was lower than condition of study by Aqla (2004) in Loksado conservation forest, Hulu Sungai Selatan that found more than 100 species. Kopiyo-Meratus and Loksado forests were relatively identical because they were located on the same area of Meratus Mountains. While, statistical analysis showed that the correlation between location I and location II was low (± 22 %). This condition was caused by different micro environments in both locations that will provide different optimum condition for specific vegetation and their sturture also distribution.

Family that mostly found are Euphorbiaceae (6 species), followed by Dipterocarpaceae (3 species), Sapindaceae (3 species), Myrtaceae (2 species), and Rubiaceae (2 species). Secondary plant such as Euphorbiaceae and Rubiceae have small diameter that make them suitable to take place under the forest canopy (under storey). These two families were found dominated and distributed equally in all square plots of observation locations. Genus *Macaranga* is one of Euphorbiace family that dominated Kopiyo-Meratus forest. Some studies reported that *Macaranga* has been known can be found abundantly in the forest logging location or other disturbed locations in the natural forest (Priatna *et al.* 2006).

Forest exploitation in some locations have threatened plants preservation. There were 148 species of *Shorea* genus (Dipterocarpaceae) that have been listed by IUCN (2000) as critically endangered species. Species from Dipteroceae that found in the observed locations were *Shorea parvifolia*, *S. pinanga*, and *S. smithiana*.

These species have been traded then fell that cause their low density. They were found with small diameter (<50 cm). *Shorea parvifolia* has wide distribution included Semenanjung Malaysia, Sumatra, and Kalimantan. While, *S. pinanga* and *S. smithiana* have limited distribution that endemic to Kalimantan. Considering of these two endemic species existence, there must be any efforts in order to conservation.

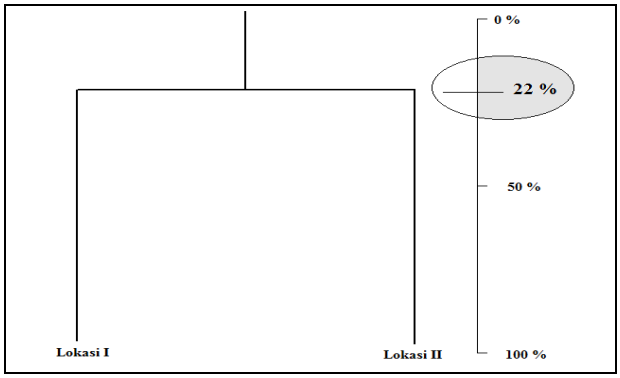

Figure 4. Location correlation (%) in Kopiyo–Meratus Forest

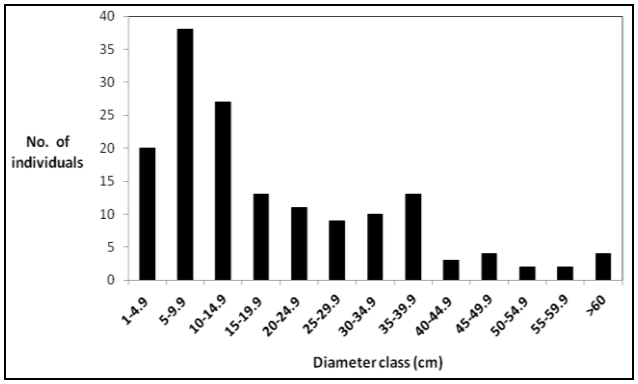

Figure 5. Diameter class distribution in two observation areas.

Table 4. Species enlisted of tree group, IVI/SDR (importance value index/summed dominance of ratio) in Kopiyo-Meratus Forest.

No.	Species	IVI (%)		SDR (%)	
		Location		Location	
		I	II	I	II
1	*Alangium javanicum* (Blume) Wangerin	5.28		1.76	
2	*Anthocephalus cadamba* ((roxb.) Miq.		31.11		10.37
3	*Arytera litoralis* Blume	16.66		5.55	
4	*Calophyllum canum* Hook.f. ex T. Anderson	6.53		2.18	
5	*Camnosperma auriculatum* (Blume) Hook.f.		26.20		8.73
6	*Diospyros* sp		21.88		7.29
7	*Elatiospermum tapos* Blume	32.75		10.92	
8	*Ellipanthus tomentosus* Kurz	7.64		2.55	
9	*Euodia glaberrima* Merr.	13.05	9.23	4.35	3.08
10	*Euodia latifolia* DC.	5.93		1.98	
11	*Ficus* sp.	6.33	16.21	2.11	5.40
12	*Glochidion borneense* (Mull. Arg.) Boerl.	7.14		2.38	
13	*Litsea grandis* (Nees) Hook.f.	5.05		1.68	
14	*Macaranga hypoleuca* (Rchb.f. & Zoll.) Mull. Arg. (*)	56.10	62.34	18.70	20.78
15	*Macaranga javanica* (Blume) Mull. Arg.	11.53		3.84	
16	*Macaranga tanarius* (L.) Mull. Arg.		4.81		1.60
17	*Macaranga triloba* (Thunb.) Mull. Arg.		33.57		11.12
18	*Nephelaphyllum* sp.	7.14		2.38	
19	*Ochanostchys amentacea* Mast.	22.52		7.51	
20	*Palaquium angustifolium* Merr.	7.54		2.51	
21	*Premna* sp		7.27		2.42
22	*Pterisanthes parvifolia* Merr.	5.11		1.70	
23	*Sandoricum emarginatum* Hiern.	10.57		3.52	
24	*Shorea pinanga* Scheff.	10.59		3.53	
25	*Shorea parvifolia* Merr.	30.75	9.51	10.25	3.17
26	*Shorea smithiana* Symington	6.03		2.01	
27	*Syzygium* sp.		13.89		4.63
28	*Syzygium subglobosum* Mer. & L.M. Perry		17.75		5.92
29	*Timonius wallichianus* (Korth) Valeton	15.85		5.28	
30	*Turpinia corymbosa* G.Don	4.96		1.65	
31	Unidentified (sp. 1)		10.69		3.56
32	Unidentified (sp. 2)		5.00		1.67
33	Unidentified (sp. 3)		4.95		1.65
34	*Xanthophylum flavescens* Roxb.	4.99	25.57	1.66	8.52

*The highest main species

Natural forest composed by biotic and abiotic components which interact each other. This interaction provides variation of dynamic vegetation composition, such as in Kopiyo-Meratus forest. One of important factor that can be used as an indicator of forest structure in this study was diameter class which formed "L" curve show, and it caused by the first diameter group was lower than the other groups (Figure 5). This condition was interpreted forest balance condition (Meyer, 1952; Samsoedin and Heriyanto, 2010). The comparison of IVI and SDR shown that each species had different value. The most dominant species in location I and location II were *Gordonia* sp. (sapling group) and *Macaranga hypoglauca* (tree group). Therefore, these two species were more tolerant than the other species but they did not dominate absolutely with SDR<75%.

Each living thing competes to get minerals, light, water, and space in their habitat. Competition begins from soil particle interspace and on canopy surface layer also. This competition formed pattern and structure of plant under the forest canopy (Soeseno & Edris 1977). Canopy layers of Kopiyo-Meratus forest was relatively in good

condition which similar to the other natural primary forests (Figure 2). The A layer commonly consisted of emergtent trees, B layer consisted of trees, C layer consisted of both of sapling and tree, and D layer consisted of sapling. Location I and location II had similar condition, although some individual plants were separated from the community. This canopy was suitable to be chategorized as natural primary foresr because it consisted of complete layers (A, B, C, and D).

For further, biodiversity is a character of community which correlated to individu density (Q). Higher Q value represents low diversity in the observation area and general condition in Kopiyo-Meratus forest. Table 1 and Table 3 presented the actual value of high species density in observation area with Q value ± 2.13. It was correlated to a report that described tropical forest in Malesiana area such as Semenanjung Malaysia, Kalimantan, Sumatra, and Java have Q value 2-3 and rarely have Q value 4 or 5 (Whitmore & Wong, 1958).

Mildly disturbed forest such as forest with low canopy, generally has high diveristy and high species density. Low canopy will allow dormant seeds to germinate and grow to be seedling, then grow into belta, and become tree. This condition is a regeneration process (Yamamoto, 2000). While of composistion disturbed forest generally consisted of secondary forest species and primary forest species. Sapling group plant will grow and replace the dead higher plant that commonly occur in primary forest. These sapling group plants are from Dipterocarpaceae, Lauraceae, Meliaceae, Sapotaceae, and several other families that commonly found in Kalimantan forest or other Indonesian natural forest area. Based on recent condition of Kopiyo-Meratus forest, we can conclude that Kopiyo-Meratus condition has been disturbed few years ago under forest concession. Kopiyo-Meratus forest condition has been recovered, eventhough some extreme areas were dominated by shrubs (Whitmore, 1989).

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