THE DIVERSITY AND RICHNESS OF TREE SPECIES OF TAMBANG SAWAH FOREST, KERINCI-SEBLAT NATIONAL PARK, SUMATRA INDONESIA

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ABSTRACT

The conservation of tropical ecosystem is increasingly relevant as the recent global warming and climate change generate serious impacts on human life. Tropical forest becomes an important ecosystem to fight global warming due to its capability to sequester atmospheric carbon and to mitigate climate change. It is very unfortunate that such a vital ecosystem has been severely subjected to conversion to both plantations and illegal loggings. The tropical ecosystem has long been recognized to have high species diversity, but very few individual trees per species. The latter is almost ignored, even though can certainly bring serious difficulties on tree conservation. The objectives of the research were to know the tree community structure of Tambang Sawah Forest, Kerinci-Seblat National Park, and to determine the rareness of tree species. A plot of 1 ha was established at Tambang Sawah, Kerinci-Seblat National Park, Lebong Regency. All trees with BDH of > 5 cm were collected their herbarium specimens, and identified. The results showed that Tambang Sawah forest consists of 42 families, 94 genera, and 185 tree species/ha. It has 19.51% (8 families), and 26.82% (10 families) respectively categorized as very rare and rare. The pattern also occurs at genus level, where both categories contribute to 81.91% (78 genera) of the total genera. In species level, both are respectively 90 and 28 species, and altogether contribute to 63.78% of the total species. These values appeared higher than that of the other forests in Bengkulu. Across taxon level, very rare and rare categories appeared to be an ecological attribute in Sumatran forests. This implies that the loss of single tree can cause the loss of entire family. The conservation works even turn into more difficult, because tropical trees are commonly diocious, even bisexual trees, they tend to be self-incompatible, and out-crossed, and required at least 200 mature trees to ensure sexual regeneration and to avoid species extinction.

Key words: *biodiverity, dioecious, forest structure, Importance Value Index, taxon, very rare and rare species*

INTRODUCTION

In the recent global warming and climate change era, the presence of the tropical forest becomes a vital ecosystem because of its significant capability to sequester atmospheric carbon and to mitigate the impacts of climate change. This most diverse forest is known to contain various future genetic sources for foods, fiber, pharmaceutical substances, and biomass. Unfortunately, the forest has been heavily subjected to conversion into plantations, coal mining, and illegal loggings. Such condition could jeopardizes environmental quality as well as people's welfare.

The tropical forest has long been recognized to have high species diversity with few individuals per species (Whitmore, 1983), and appears to be a very complicated ecosystem where the high diversity is a result of the long interactions of its biology, environments, and time (Leigh *et al*., 2008). However, not many people are aware of that the high species diversity can bring serious consequences on the future tree species regeneration, because each species has few indivual trees, and every tree is not often mature, and does not always produce flowers. Even if they are flowering, they are not always phenologically shynchronized, a requirement to polination (Gunter, *et al*., 2008). It is worsened by the fact that tropical trees are commonly diocious (Ng, 1983), and even bisexual trees, they tend to be self-incompatible, and outcrossed (Bawa, *et al*.,1985). These certainly bring difficulties for trees to ensure their future generations. The objectives of the research were to know the tree community structure of Tambang Sawah Forest, Kerinci-Seblat National Park, and to determine rareness of tree species.

MATERIALS AND METHODS

Tambang Sawah site is located within Kerinci-Seblat National Park, and briefly selectively logged in early 80's. The site is located close to the border Kerinci-Seblat National Park and a private land planted by mixed coffee crops and durian trees. The site had an altitude of 540 m, and is considered as lower montane forest formation. The site was considered as moist climate, where its average of the annual rainfall in the past five years was 3436.2 mm. A hundred plots of 10×10 m^2 were established

at the site. All trees with diameter at breast height (DBH) > 5 cm were recorded their coordinates, tagged, measured their diameters, and collected their herbarium vouchers. Species identification was carried out in The Herbaria of Bengkulu University (HUB), National University of Malaysia (UKMB), and Forest Research Institute of Malaysia (KEP). Species nomenclature followed IPNI, Turner (1995), Ng (1978), and Whitmore (1973). Species was grouped into very rare and rare categories. Very rare and rare were defined as a taxon that has only a single tree, and 2–5 trees in its lower taxon level, respectively. All data were used to calculate Importance Value Index (IVI) (Ludwig and Reynolds 1988).

RESULTS AND DISCUSSIONS

The research site consisted of 42 families, 94 genera, and 185 species within 1 ha, and was considered as lower montane rain forest. The tree species richness appears higher that that of Northern Siberut forest. Hadi *et al*. (2009) found that within 16 ha forest plot in the Northern Siberut island, they only found 35 families, 70 genera, and 139 species. Tambang Sawah forest formation is characterized by the presence of *Shorea platyclados* and the pecies of Theaceae. These species are usually found in montane forest formation (Laumonier, 1992; Whitmore, 1983). Species of Theaceae found in the site include *Adinandra lamponga*, *Eurya acuminata, Pyrenaria kunstleri*, *Ternstroemea lamponga,* and *Ternstroemia evenia* Furthermore, other families commonly found in the mid and high elevations such as Lauraceae, Myrtaceae, and Symplocaceae (Laumonier, 1992) also occured in Tambang Sawah. Other species characterizing high elevation area such as *Chisocheton tomentosus*, *Dysoxylum densiflorum* (Meliaceae), *Drypetes crassipes* (Euphorbiaceae), *Dracontomelon dao* (Anacardiaceae), and *Turpinia sphaerocarpa* (Staphyleacaeae) (Laumonier, 1992) were also found in this site. Tambang Sawah forest was also rich in species of Myrtaceae with various IVI values such as *Syzigium patchycepala, S. arcuatinervis, S. filiforme, S. garcinifolium, S. kunstleri, S. lanceolarium, S. oblatum, S. lineatum,* and *S. variolosum.*

Fourty-two families were found in Tambang Sawah plot, in which Euphorbiaceae was a dominant family with the highest overall IVI (55.26%). The dominancy of Euphorbiaceae indicated two speculations. Firstly, the numerous presence of species of Euphorbiaceae appears to be a unique ecological characteristic of Sumatran forest as it is also found elsewhere in the region (Hadi *et al*., 2009; Kohyama *et al*., 1989). Secondly, It shows that parts of the forest plots are subjected to disturbances, because the species of Euphorbiaceae are know to thrive on open habitats (Whitmore, 1983). The next highest IVI families were Meliaceae (33%), Sapotaceae (21.01%), Moraceae (19.93%), Lauraceae (14.18%), Urticaceae (12.82%), Violaceae (12.11%), Rubiaceae (11.74%), Sapindaceae (10.66%), and Theaceae (10.22%). However, these high IVI families were not major taxa composing the forest structure. In fact, families with IVI less than 10% became main taxa in the forest. These families with IVI less than 10% contribute to 75% of the total families. Eight very rare families consisted of Bombacaceae, Cornaceae, Leguminosae, Proteaceae, Dilleniaceae, Rhizophoraceae, Guttiferae, and Styracaceae were found at the site. This category showed that each family has only a single genus, species, and tree.

Tambang Sawah plot also consists of 94 genera, and is the richest in genera compared to the lowland rain forests of Taba Penanjung and Talang Tais (Susatya, 2007). Euphorbiaceae has 15 genera (15.98%), 35 species (19.02%), and 115 individuals (19.9%). Most of members of Euphorbiaceae are known to have pioneer characters, which thrive in disturbed and open habitat (Steenis, 1950; Whitmore, 1983). Tambang Sawah forest is arranged by both rare and very rare genera. Of 94 genera, rare category consists of 53 genera, and contributes to 56.38%. Meanwhile, very rare comprises to 25 genera or 25.53% of the total genera (Table 1). Futhermore genera with pioneer characters appear to be more dominant in this forest. They include *Rinorea, Mallotus, Villebrunea, Ficus, Macaranga*, and *Croton* (Ng, 1983), and seem to have no constrain to regenerate.

Of the 185 identified species, very rare and rare species respectively consists of 56% (90 species) and 16% of the

Table 1. The percentage of the rareness across taxa at Tambang Sawah Lower Montane Forest

Category	Family	%	Category	Genus	%
very rare	8	19.05	very rare	25	56.38
Rare	6	14.28	Rare	53	25.53
famili >10 trees	12	28.57	genus with > 10 trees	14	14.89
famili <10 trees	30	71.43	genus with <10 trees	84	85.11
Total	42			94	

total species (28 species). Similar to the family and genus levels, the forest structure is dominated by species with low IVI (<10%). This implies that the rare and very rare also become major species composing the forest. Only *Rinorea anguifera* and *Villebrunea rubescens* that have IVI more 10%, and become the most common species (Table 2). Even these most common species, they are not widely distributed, and only respectively found in 21 and 19 plots of the 100 plots. The other common species include *Macaranga triloba* (frequency of 0.15), *Croton laevifolius* (0.13), *Vitex gamosepala* (0.12), *Aglaia eximia* (0.09), *Microcos laurifolia* (0.09), *Pometia pinnata* (0.09), *Cleistanthus sumatranus* (0.08), and *Neolamarckia cadamba* (0.08). These pioneer species indicate either that the part of the forest stand are disturbed habitats, because all these species generally thrive at forest edges (Whitmore, 1983) or that the pioneers gradually take over the forest community. The dominance of the pioneer species could be speculated that more available ecological space to the pioneers due to disappearing very rare and rare climax trees.

Table 2. The ten highest IVI species at Tambang Sawah Forest

No	Species	Family	IVI (%)
1	*Rinorea anguifera*	Violaceae	12.09
2	*Villebrunea rubescens*	Urticaeae	11.59
3	*Palaquium hexandrum*	Sapotaceae	8.51
4	*Palaquium gutta*	Sapotaceae	8.42
5	*Aglia affinis*	Meliaceae	8.37
6	*Macaranga triloba*	Euphorbiaceae	7.69
7	*Microcos laurifolia*	Tiliaceae	6.66
8	*Castanopsis javanica*	Fagaceae	6.50
9	*Cleistanthus sumatranus*	Euphorbiaceae	6.25
10	*Croton laevifolius*	Euphorbiaceae	6.23
	Total		82.33

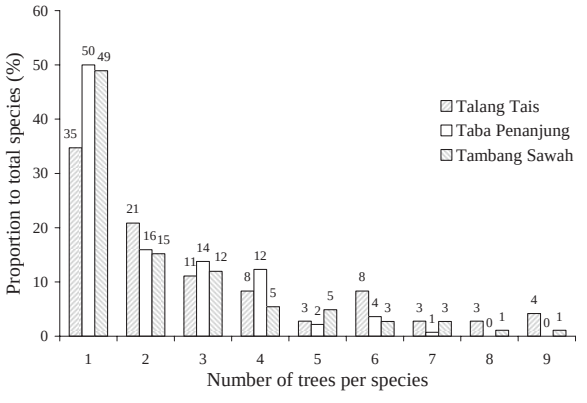

Figure 1. Species rareness according to the number of individual trees per species at three different forest formations; Talang Tais, Taba Penanjung lowland rain forests, and Tambang Sawah Lower Montane Forest

The number of very rare and rare categories of the research site is higher than that of Northern Bengkulu lowland rain forests (Azwar, 1998; Haryono, 1998), Rindu Hati Protection Forest (Kurniati, 1999), and Tes Montane Forest of Kerinci-Seblat National Park (Erianty, 1998). The dominance of these two categories is also found at Talang Tais, Taba Penanjung lowland rain forests (Figure 1), Peninsular Malaysia forests (Hikmat, 2005), and Northern Siberut forest (Hadi *et al*., 2009). Therefore, it can be infered that the dominance of the two categories appear to be an ecological attribute for South East Asia rain forests. Adekunle (2006) further finds that 84% rare species of Nigeria forests are threatened to extinction. Furthermore, the dominance of the two categories becomes one of the factors that causes the forests becoming much more vulnerable to local extinction. Due to very rare and rare categories, the loss of a single tree means the local loss of entire family, genus as well as species.

The fact that Tambang Sawah Forest is composed by either very rare and rare species or species with very low density is worsened by their sexual regenerations. The sexual regeneration not only depends on the sexual reproductive system, but also requires the synchonization of flowering, and presence polinators, as well as seed dispersal agents (Whitmore, 1983). Leigh *et al*. (2008) prove that the absence of mamals as dispersal agents signifantly contributes to the decline of tree diversity. Ashton (1969), Ng (1983) and Bawa *et al*. (1985) futher revealed that the most of tropical trees shows dioucious flowers, and tend to perform outcrossing. Ng (1983) further showed Ebenaceae, Myricaceae, Daphniphyllaceae, Burseraceae (*Canarium*), Euphorbiaceae (*Agostistachys, Alchornea, Antidesma, Aporusa, Baccaurea, Bluemeodendron, Chaetocarpus, Cheilosa, Claoxylon, Cleidion, Drypetes, Endospermum, Exoecaria, Homonoia, Hymenocardia, Macaranga*), Flacourtiaceae (*Hydnocarpus, Ryparosa, Scaphocalyx*), Guttiferae (*Garcinia*), Meliaceae (*Aglaia*), Moraceae (*Ficus*), Proteaceae (*Heliciopsis*), Sapindaceae (*Xerospermum*), and Ulmaceae (*Gironniera* have dioecism syndrome. Dioecism is known to reduce reproduction success more than 50% at *Myristica fragran.* (Purseglove, 1968), *Endospermum malaccensis* (Yap and Razali 1980), and *Xerospermum intermedium* (Yap, 1982). In terms of flowering phenology, the flowering trees do not necessarily ensure the future tree generations, because they sometimes show low interspecific synchronizations (Gunter *et al*., 2008). Engel and Martinez (2005) further showed that it is very few tree species performing both continuous flowering and fruiting. Probably because of these all considerations,

Ashton (1976) recomends that it is required 200 mature trees to ensure sexual regeneration in tropical rain forests, otherwise species will face species extinction.

CONCLUSIONS

Tambang Sawah forest of TNKS appears to be very high species tree diversity, which consists of 42 families, 94 genera, and 185 tree species/ha. The forest structure is dominated by very rare and rare categories at genus and species levels. Of 78 genera, 81.91% are categorized very rare and rare genera, while of 185 species, 63.78% are grouped into very rare and rare categories. This indicates that the loss of a single tree due to various causes can triger the loss of a species, genus, and even a family. Despite of its high tree species diversity, this forest structure and the reproductive biology of the forest trees intrinsically cause ecological contrains for the forest to regenerate. It has been recognized that tropical trees are commonly diocious, which require the flowering synchronizations among separate female and male trees. Furthermore, even bisexual trees, they tend to be self-incompatible, and out-crossed. Therefore, the loss of a tree also can cause the sexual reproductive processes disturbed. This causes the conservation works on the tropical forests are increasingly more difficult.

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