Laporan Eksekutif

POPULASI GENETIK DAN EKOFISIOLOGI JENIS-JENIS MERANTI YANG TERANCAM PUNAH

Oleh:

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I. PERMASALAHAN DAN TUJUAN PENELITIAN

Pengetahuan tentang pentingya informasi genetik dalam rangka konservasi genetik tanaman hutan masih belum banyak dipertimbangan untuk kebijakan pengambilan keputusan jenis-jenis yang terancam punah. Secara umum tujuan dari penelitian ini adalah untuk mengkaji resiko potensial dari kepunahan beberapa jenis-jenis meranti yang mulai sulit ditemukan di lapangan serta menyusun pedoman teknis konservasi bagi jenis tersebut yang berbasis informasi genetik. Adapun tujuan khususnya adalah: i). Menduga parameter populasi genetik dari jenis-jenis meranti baik yang masih mudah dijumpai (*common species*, c.s.) ataupun yang terancam punah (*endangered species*, e.s), ii). Mengkaji kondisi biofisik habitat dari jenis tersebut serta mengetahui potensi permudaan dan pertumbuhannya di lapangan, iii). Membandingkan kecepatan fotosintesis dari jenis-jenis c.s dan e.s, iv). Mengetahui potensi perbanyakan jenis-jenis e.s. secara vegetatif dan generatif, dan v). Menduga tingkat penyerbukan silang (*outcrossing rate*) dan tingkat silang dalam (*inbreeding coefficient*) serta mengaitkannya dengan viabilitas pertumbuhan di lapangan.

II. INOVASI IPTEKS

Hasil dari penelitian ini dapat memberikan kontribusi terhadap pembaharuan dan pengembangan IPTEKs. Hasil penelitian dapat digunakan sebagai dasar pengambilan strategi konservasi jenis meranti yang terancam punah serta teknik perbanyakannya baik secara generative maupun vegetative. Selain itu hasil penelitian ini juga dapat dijadikan dasar panduan dalam rangka upaya penyelamatan jenis-jenis lain yang terancam punah, khususnya pohon hutan.

III. KONTRIBUSI TERHADAP PEMBANGUNAN

Indonesia mengalami kehilangan keanekaragaman jenis-jenis tumbuhan yang cukup cepat bahkan sebelum kita mengenal jenis-jenis tersebut. Konservasi yang dilakukan masih bersifat *ad hoc* yang belum mempertimbangkan informasi genetik. Untuk itu hasil penelitian ini memiliki urgensi untuk kebijakan pengambilan keputusan jenis-jenis yang terancam punah. Konservasi sumber daya genetik bertujuan untuk mencegah kepunahan suatu jenis dengan menyimpan *gene pool* tanaman yang bersangkutan. Untuk menyusun strategi konservasi sumber daya genetik diperlukan informasi tentang sejarah kehidupan (evolusi) tanaman dan pengetahuan tentang genetik populasi yang mengukur tingkat variabilitas genetik dalam jenis dan populasi. Oleh karena itu perlu diketahui variabilitas gen kloroplas, mitokondria dan nuklear. Analisis polimorfisme genom yang diturunkan secara uniparental mungkin sangat berguna untuk mengumpulkan informasi tentang sejarah evolusi jenis dan populasi.

Potensi hasil dari penelitian yang didapat hingga akhir penelitian adalah didapatkannya informasi mengenai populasi genetik dan ekofisiologi pohon-pohon meranti sebagai dasar pertimbangan untuk kebijakan pengambilan keputusan jenis-jenis meranti yang terancam punah. Selain itu hasil dari penelitian ini adalah adanya *joint* publikasi ilmiah, pembuatan buku panduan (*Guidelines*) untuk penyelamatan jenis-jenis terancam punah, khususnya pohon hutan.

III. MANFAAT BAGI INSTITUSI

Dalam pelaksanaan penelitian ini, selain melibatkan unit-unit yang ada di Departemen Silvikultur, khususnya Lab. Analisis genetika, Bagian Silvikultur, juga melibatkan unit-unit lain di perguruan tinggi di IPB. Unit yang terlibat didalam pelaksanaan penelitian ini adalah Lab. Ekologi Hutan, Bagian Perlindungan hutan, dan Lab. Tanah.

Selain adanya *joint* publikasi ilmiah, pembuatan buku panduan (*Guidelines*) untuk penyelamatan jenis-jenis terancam punah, khususnya pohon hutan, salah satu manfaat yang dapat diambil dari penelitian ini adalah terjalinnya kerjasama internasional (penelitian dan pendidikan) dengan Universitas Kyushu, Jepang.

IV. PUBLIKASI ILMIAH

Study on Rarity status and Habitat of *Shorea laevis* Ridl. and *Shorea leprosula* Miq. in Sungai Teweh – Sungai Lahai compound, Muara Teweh, Central Kalimantan, Indonesia

By

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ABSTRACT

Study on rarity status and habitat of *Shorea laevis Ridl* and *S. leprosula Miq* was conducted in three types of ecosystem (virgin forest, secondary forest and fragmented forest) in forest complex (forest compound) of Sungai Teweh-Sungai lahai, Muara Teweh, Central Kalimantan, Indonesia. The objective of this study was to learn the rarity status of the two species based on IUCN criteria, their habitat characteristics, and their association with other species, as one of the basis for determining their conservation strategy. This research used technique of vegetation analysis and tree diversity analysis. Study results showed that both *S. laevis* and *S. Leprosula* were included within category of Low Risk in the three types of ecosystem in the forest compound being studied. Habitat characteristics which determined the absence of *S. Laevis* in the virgin forest habitat was the soil permeability which was too low, whereas other soil chemical and physical properties in the three types of ecosystems were relatively similar. Presence of *S. Laevis* were positively associated with species of *Shorea uliginosa*, *Dialium platysepalum*, *Dipterocarpus ibmalatus*, *Palaquium rostatum* , *Vatica rasak*, *Adinandra sp* and *Memecyclon steenis*. On the other hand, for *S. leprosula*, other species which followed its presence (positively correlated), were *Shorea kunstleri* , *Castanopsis sp, Shorea sp, Quercus bennettii, Castanopsis argentea* , and *Dipterocarpus hasseltii*

Key words: Threathened Species, *S. laevis. S. leprosula*, habitat characteristic, species diversity, conservation strategy

INTRODUCTION

Indonesia is rich of tropical forest resources, which is mainly dominated by family members of Dipterocarpaceae. The number of species from Dipterocarpaceae family in Indonesia is 62% (238 species) of the whole numbers found in Malay area (386 species) (Purwaningsih, 2004). Distribution of Dipterocarpaceae is mainly in Sumatera and Kalimantan islands, and the more towards eastern area the less diversity is found (Ashton, 1982).

Dipterocarpaceae forest has high ecological, economy dan social functions, however, continuing forest exploitation, forest conversion to other land-use, forest fire and illegal logging drastically decreased the area of Dipterocarpaceae forest and its population. Decreased population and forest fragmentation could lead to extinction of the species, because those two factors have important genetic consequnence for the species survival in the area. One consequence is the occurence of inbreeding, which would increase homozigosity and mortality of the species due to lethal dan semi-lethal alleles. This phenomena, which is known as inbreeding depression has been well documented on both flora and fauna. Other consequence is decreased genetic diversity due to loss of unique allele in a short period, and may lead to total loss of allelic diversity caused by genetic drift in the long term. The whole consequences will influence population fitness and increase the risk of extinction.

International Union for Conservation of Nature and Natural Resources (IUCN) data (2009) showed that many flora were already on the brink of extinction as stated in the red list summary report. Some species in Indonesia listed are *S. laevis* Ridl dan S. *leprosula*, which have been categorized by IUCN as rare Dipterocarpaceae species with low risk and endangered. Heriyanto dan Soebiandono (2003) results from Sungai Lengkawi-Sungai Jengonoi forest compound, in Sintang, West Kalimantan , underlined the rarity status of *S. laevis* Ridl.

In order to preserve the above mentioned species a conservation strategy incorporating some genetic and biology consideration needs to be developed. For those purposes a comprehensive research on some Dipterocarp, as keystone species of the wet tropical forest is necessary to study the relationship between the genetic factor and the extinction process, and then formulate a conservation program, which includes a regeneration program.

The objective of this study is to find out the rarity status of *S. laevis dan S. leprosula* as reported by IUCN (2009) and their habitat characteristics, as basic consideration for their conservation strategy formulation.

METHODOLOGY

Research was done in PT. Austral Bina concession area, which is located in Sungai Teweh – Sungai Lahai and Sungai Montalat- Sungai Sempirang forest compound, about 100 km from Muara Teweh. Geographically the forest compound is in between $0^{o}30'$ - $1^{o}68'$ South Latitude, and $114^{o}45'$ - $115^{o}45'$ East Latitude. The whole concession area of PT. Austral Bina is 294.600 Ha. Based on its forest status, PT. Austral Bina consists of three forest classes, i.e. production forest of 117.375 ha (%) and limited production forest of 59.835 ha and conversion forest of 117.390 ha. The surveyed area includes production, limited production forests as well as conversion forest.

The forest compound is located at 150-550 m above sea level. The topography varies from plain land to hill, with slope ranges of 5-45%.

Vegetation Analysis

Data collection was done in three different ecosystem types, i.e. (1) virgin forest (KPPN) (2) secondary and (3) fragmented forests. Survey method used combination of transect line and plot establishment (Kusmana, 1997). Several plots, i.e. size 20 m x 20 m for observation at tree level, size 10 m x 10 m for pole level, size 5 m x 5 m for sapling, and size 2 m x 2 m for seedling, were established along the transect. Each transect line has 20 m width and 500 m length, sometimes modified according to field condition **(Figure 1)**.

Density shows the number of individuals per Ha, while frequency indicates the regularity occurrence of the species in a stand area, meanwhile dominance refers to space occupation of the species in a certain area. Important value index (IVI) is a value computed from adding the relative density (RD), relative frequency (RF), dan relative dominance (RD). Important value index in a forest very rich of species diversity could be as high as 300%, and vice versa. Important value index is computed with the following formula (Soerianegara and Indrawan, 1985):

Collection of soil samples

Collection of soil samples was conducted according to the method of Leenher and de Boodt (1959) as explained in Guidelines of Physical Soil Analysis (Lembaga Penelitan Tanah, 1969). Collection of soil samples was conducted in each strip of vegetation transect with distance of 100 m between collection points. In each collection point, there were collection of undisturbed soil samples and composite soil samples at depth of 0-30 cm, and the soil samples were put in plastic bags. Undisturbed soil samples were taken by using soil sample rings. Soil samples were afterwards carried to soil laboratory for complete analysis of physical and chemical properties.

Data Analysis

Data will be analyzed to find out the dominant species. Dominant species has highest important value index in a certain vegetation type (Samingan 1979) and the following formula is used for calculating dominant species (Soerianegara dan Indrawan 1982):

$$\text{Relative Density (\%)} = \frac{\text{Density of one species}}{\text{Density of all species}} \times 100\%$$

$$\text{Relative Frequency (\%)} = \frac{\text{Frequency of one species}}{\text{Frequency of all species}} \times 100\%$$

$$\text{Relative Dominance (\%)} = \frac{\text{Dominance of one species}}{\text{Dominance of all species}} \times 100\%$$

In order to find out specific ecological distance among different ecosystem types, data will be analyzed using a sofware Tree Diversity Analysis (Kindt and Coe, 2005). Soil samples were analyzed in Soil Laboratory of Bogor Agricultural University.

RESULTS AND DISCUSSION

Rarity (scarcity) of *S. laevis* and *S. leprosula* species

International Union for Conservation of Nature and Natural Resources (IUCN), categorizes rare plant species into various categories, such as the following: vulnerable, endangered, critically endangered and low risk. Results of vegetation analysis in the study location showed that *S. leprosula* were still sufficient and were distributed in the three study plots, whereas *S. laevis* were found only in two study plots, namely Secondary Forest (SF) and Fragmented Forest (FrF). According to IUCN criteria, rarity (scarcity) of a species could be categorized into Critically Endangered (CR), Endangered (EN), Vulnerable (Vu) and Low Risk (LR)/ not threatened (Heriyanto and Subiandono 2003). The characteristic for CR was that if the trees surveyed in the natural habitat, there was at least one individual adult trees in area as large as 20 ha. The characteristic for EN was that if in the surveyed area in the natural habitat, there was at least one individual of adult tree in area size of 200 ha. The characteristic for Vu was that if plants in the natural habitat were not categorized as critical and in the surveyed area there were at least one individual tree in area of 200 ha. Category of LR was adopted if the situation did not belong to any of the rarity category as mentioned before. On the basis of such criteria, by considering the density values of the two species, which for *S. leprosula* reached 5.51, 10.82 and 17.56 trees per ha, and *S. laevis* which showed value of 0.33 and 4.87 trees per ha (Table 1), it can be suggested that the species *S. leprosula* was not included in the criteria of CR, EN, or Vu. In other words, the species could be categorized as not threatened (LR). The interesting phenomenon here was that in plot of KPPN (virgin forest), the species of *S. laevis* was not found, so the consequence was that the species was categorized in the criteria of CR, although the species occured in the two other plots. Therefore, particularly for *S. laevis*, in the plot of SF and FrF, the species was categorized as LR.

Analysis results of regeneration development showed that species *S. leprosula* was found in the tree study plots in the form of seedlings and up to pole stage. Even for pole stage, in the plot of SF, the species was categorized as dominant species (31.50%). On the other hand, the for species of *S. laevis* the presence of its regeneration in plot of SF and FrF were not categorized as dominant (Table 2). In general, the presence of the two species did not play significant role, either in the ecosystem of KPPN (virgin forest), SF or FrF, except for pole stage of *S. leprosula* species in Fr plot. This phenomenon was in conformity with the opinion of Sutisna (1981) which suggested that a plant species could play some role in an ecosystem if the IVI values for seedling and sapling stage of vegetation reached 10% and that for pole, reached 15%.

Growth site characteristics of *S. laevis* and *S. leprosula*

Presence of a plant species in an ecosystem was determined by various factors, both genetically and envrionmentally (Kozlowsky dan Pallardy, 1997). Environmental factors which influence very much the plant growth and distribution, are edaphic and climatic factor. Results of analysis of soil chemical properties which comprises pH, N Total, C Organic and Total Base Cation in the three types of ecosystem (Figure 1) showed no significant differences among the ecosystems. Considering that the content of N-tot and C-org in all plots were within low category, then the change in N-tot and C-org, as parameters which were sensitive toward disturbance, had not occured significantly as shown by comparison between secondary forest (SF) and fragmented forest (FrF) and primary forest. The same phenomenon was also found in other parameters. Phosphorus constituted the main nutrients needed by plants, beside the nitrogen. In acid soil with low pH, element P was less available due to fixation by some forms of Al and Fe in the soil. In the study area, P content in all soils were categorized as low , in top soil and in subsoil, which ranged between 2.33-4.90 ppm. Analysis results showed that content of Ca cation in all plots were categoirzed as low. On the contrary, the content of Mg was categorized as moderate, as well as the content of K. The study area was characterized by low Cation Exchange Capasity (CEC) which ranged between 8.48-10.5147 me/100g of soil. On the other hand, in terms of percentage of amount of cations Ca, Mg, K and Na which occupied the collloidal surface (adsorption surface), the study plot showed the level of moderate to high, on the average.

The above data showed that soil properties in the study plot was relatively homogeneous. Therefore, if this phenomenon was related with the absence of *S. laevis* in the primary forest, it could be suggested that the soil chemical properties did not determine the absence of this species.

Water and oxygen could become the limiting factor for plant growth and distribution (Ertherington, 1976). Each plant species has different respond toward the availability of water and oxygen. Availbility of water and oxygen in the soil are related with soil porosity and soil permeability. Analysis results of several soil physical properties in study location (Figure 3) showed that density and porosity in the three types of ecosystem did not show significant differences. However, permeability in primary forest plot were categorized as low, if compared with permeability in secondary forest and in fragmented forest.

Soil with low permeablity retards water infiltration to the soil. The consequence was that if raifall is high, there would be waterlogging and soil oxygen will be reduced due to occupation of soil pores by water. Climate condition in the study location was categorized as climatic type A, based on Schmidt and Ferguson classification, with average rainfall of 2.195 mm/year, without any presence of dry month, and average number or raindays of 17 days (Stasiun Bandar Beringin, Muara Teweh, 1992-2002*)*. For tree species which are sensitive toward waterlogging, these species would not grow in soil with low permeability. From the study of natural distribution of *S. laevis* and *S. leprosula*, it was known that *S. laevis* grows well in hill slopes. Whereas *S. leprosula* grows well in hill valley (Ashton, 1982, Departemen Kehutanan, 2002). This phenomena showed that *S. laevis* requires soil condition with considerably good permeability, so that this species occupies hill slopes. Results of this study showed that in primary forest plots, *S. Laevis* were not found, and this was in conformity with the low permeability of the soil in the plot (Figure 3).

Analysis of Species Diversity

Species presence in a habitat is often affected by presence of other species in that habitat. Variable used in the analysis for this phenomenon was tree density per ha. Figure 5 showed that each type of ecosytem or study plot had different characteristic, or in other words, the ecological distance between study plots were far from each other. Several species had large variability or had varying density values in each study plot, such as species *S. laevis*, *Dipterocarpus sp*, *Shorea sp*, *Dipterocarpus ibmalatus*, *Palaquium rostatum*, and *Quercus bennettii* (data were not shown). Presence of *S. Laevis* in the plot of secondary forest (EKO2) was followed by the appearance of such species as *Shorea uliginosa*, *Dialium platysepalum*, *Dipterocarpus ibmalatus*, *Palaquium rostatum* , *Vatica rasak*, *Adinandra sp* and *Memecyclon steenis*. On the other hadn, for *S. leprosula*, other species which followed its presence (positively correlated) were *Shorea kunstleri* , *Castanopsis sp, Shorea sp, Quercus bennettii*, *Castanopsis argentea* , and *Dipterocarpus hasseltii*

Figure 6 showed that for seedling stage, each study plot had differing characteristics. Species of *S. laevis* possessed the highest abundance in study plot of secondary forest (EKO2). This species had positive correlation with species of *Dysoxylum sp* and *Sindora beccariana.* Presence of *S. leprosula* had some relation with the appearance of species *Memecyclon steenis*, jamihing, raja mandak, *Alseodaphna sp* and *Polythia glauca*.

Species which have been included in red list of IUCN should be conserved by combining the ecological, physiological, and genetic properties with conservation action, while the species were still in the category of low risk.

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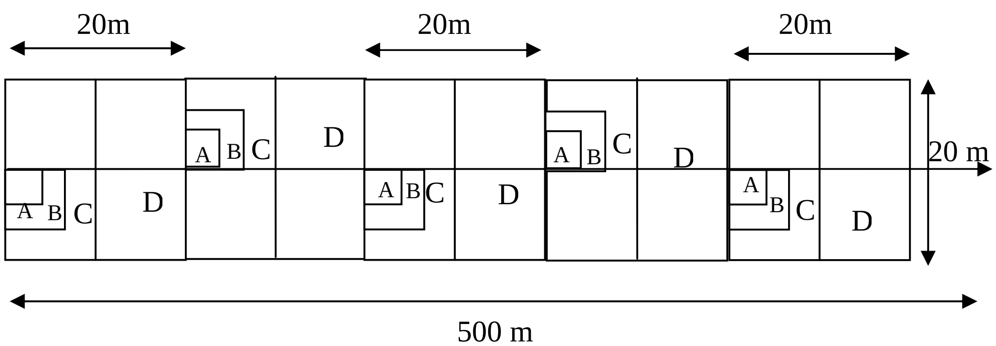


Note:

A	=	Observation plot for seedling (2 m x 2 m)
B	=	Observation plot for sapling (5 m x 5 m)
C	=	Observation plot for pole (10 m x 10 m)
D	=	Observation plot for tree (20 m x transect length)

Figure 1. Lay out of transect line in the survey of vegetation analysis (Kusmana, 1997)

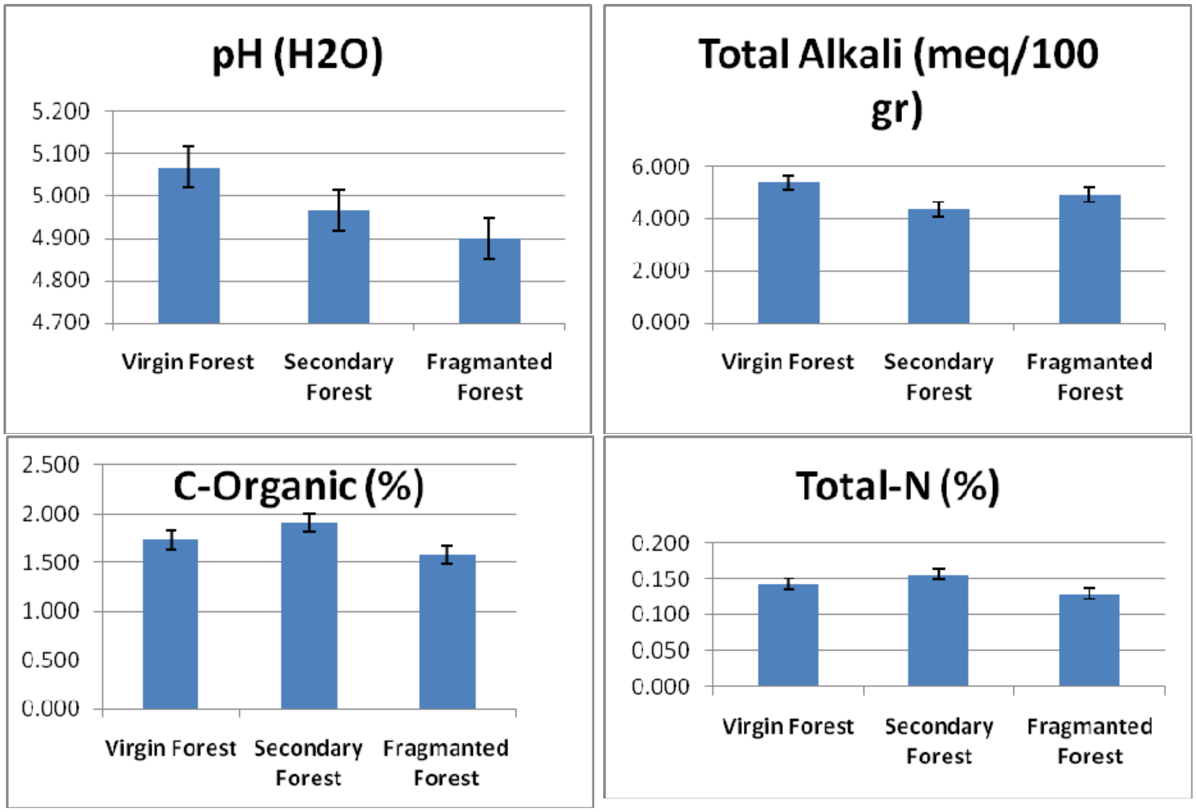


Figure 2. Several soil chemical properties in the study location

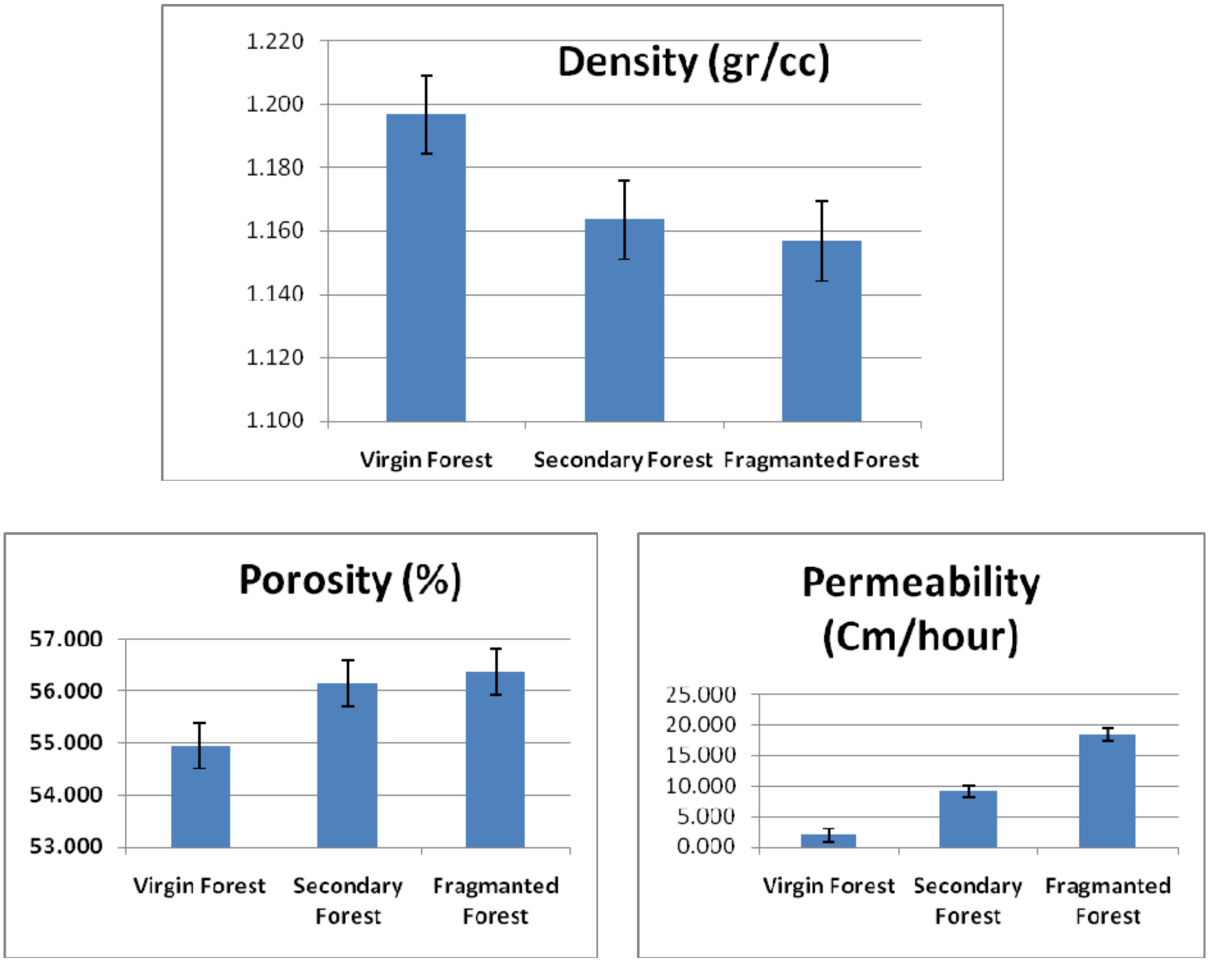
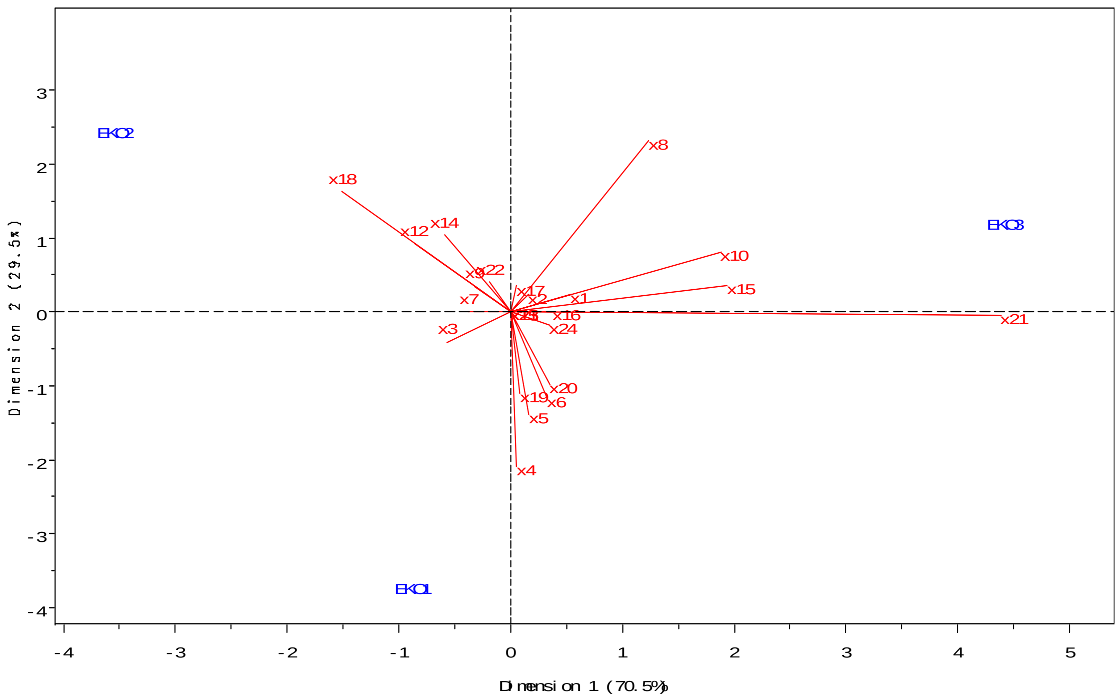


Figure 3. Several soil physical properties in the study location



Figrure 4. Analysis of Species Diversity of Tree Stage in Study Location.

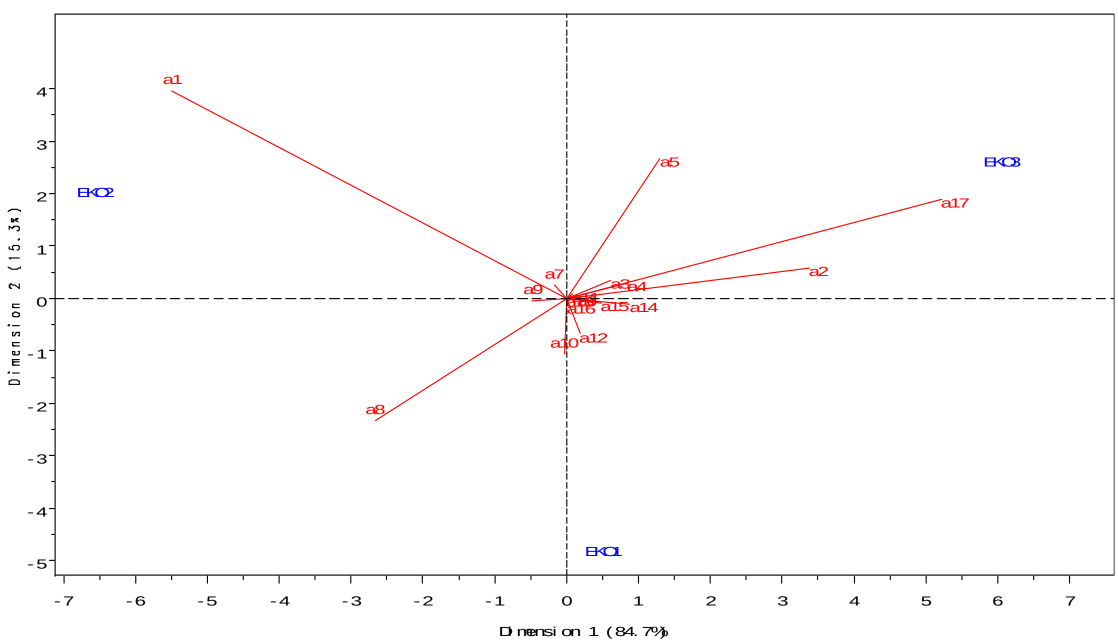


Figure 5. Analysis of Species Diversity of Seedling Stage in Study Location

Table 1. Important Value Index of rare plant species of tree stage in study plots

No.	Plot	Species name	K = Density	KR = Relative Density	F = Frequency	FR = Relative Frequency	D = Density	DR = Relative Density	IVI
1.	KPPN	Rare species							
		S. leprosula	10.82	6.26	0.64	5.16	1.64	7.41	18.84
		S. laevis	-	-	-	-	-	-	-
2.	HS	Jenis species							
		S. leprosula	5.51	4.72	0.37	3.86	1.19	8.25	16.83
		S. laevis	4.87	4.16	0.29	3.08	0.31	2.34	9.60
3.	HFr	Rare species							
		S. leprosula	17.56	12.59	0.80	6.75	1.84	12.27	31.61
		S. laevis	0.33	0.24	0.04	0.33	0.05	0.33	0.91

Table 2. Important Value Index of regeneration of rare plant species in the study plots

Plot	Species name	IVI (%)		
		Seedling	Sapling	Pole
KPPN	Rare species			
	S. leprosula	4.85	1.44	7.69
	S. laevis	-	-	-
SF	Rare species			
	S. leprosula	4.34	5.64	3.10
	S. laevis	1.45	-	3.89
FrF	Rare species			
	S. leprosula	8.34	2.26	31.50
	S. laevis	1.11	1.13	3.68