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PROCEEDING

THE 2nd INTERNATIONAL SYMPOSIUM FOR SUSTAINABLE HUMANOSPHERE

" Balancing Efforts on Environment Usage in Economy and Ecology "

August 29, 2012
Auditorium LAPAN,
Bandung, INDONESIA

Organized by

Research and Development Unit for Biomaterials – LIPI

Research Institute for Sustainable Humanosphere – Kyoto University

Supported by

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PREFACE

The 2nd International Symposium for Sustainable Humanosphere 2012 attracted the interest of scientists from Indonesia and Japan. The symposium covered the disciplines of atmospheric science (equatorial atmosphere; space environment, radar observations; space weather), biosphere science (animal ecology; empowerment of local communities), geosphere science (land resource management option for global warming mitigations; water management system), marine science (development of marine ecosystem, fishery products processing), wood science and technology (wood cell wall formation; cellulose; wood biochemistry; wood deteriorating organisms; wood preservation; timber structure; wooden construction; wood-based material; carbonized wood based composites; wood adhesives; chemical, physical and mechanical properties of wood; biomass conversion; bio-composites; wood for energy; termites for new energy options), and forest science (biodiversity in tropical plantation forests; peat swamp forest ecosystem; forest biomass). The technical program consisted of 12 oral presentations under 4 sessions and 15 poster presentations.

This publication is a compilation of presented papers. Every effort has been carried out to retain the original meaning and views of authors during the editing processes. All claims on trade products and processes and views expressed do not necessarily imply endorsement by the editors.

We believe that this publication will be a useful source of information and achieved its primary objective of disseminating new experiences and information to researchers, academics, policy makers and students.

The organization of this international gathering and compilation of the proceedings could not have been achieved without the combined effort of all members of the organizing committee and the supports of Research Institute for Sustainable Humanosphere (RISH), Center for South East Asian Studies (CSEAS) Kyoto University, International Center for Interdisciplinary and Advanced Research (ICIAR)-LIPI, National Institute of Aeronautics and Space (LAPAN) and Sumitomo Chemichal. The editors hereby wish to acknowledge the contributions of all parties.

Editors

February 18, 2013

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SEEDLINGS PERFORMANCE OF INDIGINEOUS SPECIES WITH FERTILIZER ADDITION AND WEEDING IN EARLY STAGE REFORESTATION IN MT. PAPANDAYAN NATURE RESERVES, WEST JAVA

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Abstract

During the last decades, deforestation occured not only on global, but also on national scale (1,871 million ha/year). The exact solution for this problem is conservation-oriented reforestation; to restore the structure and composition of forests. The best reforestation method known so far was using germinated indigenous species with fertilizer addition combined with weed controlling as post-seeding treatment. This research aimed to verify the influence of fertilizer addition and weed removal towards the survivorship and growth rate of several indigenous species from Mount Papandayan Nature Reserves (MPNR). Seedlings from each indigenous species, i.e. *Acer laurinum, Distylium stellare, Schima walichii, Dacrycarpus imbricatus,* and *Syzygium glomeruliferum* were used in four kind of treatment (control, fertilizer addition treatment, weed removal treatment, combination of fertilizer addition and weed removal treatment). After eight months, result shows that fertilizer addition and weed removal treatment doesn't directly affect survivorship and growth rate. The highest survivorship rate showed by the fertilizer addition treatment (85 ± 0.06 %), and the lowest survivorship rate showed by the combination of fertilizer addition and weed removal treatment (58 ± 0.18 %). This result shows that weed gives positive effect for survivorship and growth of seedlings. This phenomenon called the nursing effect is a condition where weeds give coverage and formed micro-environmental condition that intensify the growth rate and survivorship of target plants. *Syzigium glomeruliferum* is the species with highest survivorship rate (80 ± 0.08%) and *A. laurinum* is the species with the highest Relative Growth Rate of Height (RGRH) (0.69 ± 0.03cm $cm^{-1}month^{-1}$) Relative Growth Rate of Diameter (RGRD) (0.18 ± 0.02mm mm^{-1} $month^{-1}$). *S. glomeruliferum* showed the best overall seedlings performance, therefore it is recommended as species for reforestation in MPNR. Statistic analysis using *one-way* ANOVA shows that inter-treatment survivorship value is significantly different (α = 0.05, sig = 0.016), the *post-hoc Turkey test* shows that inter-treatment survivorship value is different distinctly (coefficient = 0.27). The Relative Growth Rate (RGR) shows no inter-treatment significant difference (α = 0.05, sig = 0.052).

Keywords: nursing effect, Papandayan, Restoration, Reforestation, seedlings performance.

Introduction

Forests are important part on earth that has a central role as habitat, carbon sink, food and oxygen providers, and so on [1] [2]. Ironically, with this crucial role, decreasing of forests areas (deforestation) occured widespreadly. Rate of deforestation in Indonesia has reached 1.6-2.5 million hectare in 2000-2005. Moreover, forests area remained only 28% from 109 million hectare that was existed. This deforestation impact to habitat loss, decreasing of carbon sink and water retain capacity that implicate to key species extinction, global warming, and natural disaster [2][3]

Mount Papandayan Nature Reserves (MPNR) has deforestated by illegal land-conversion of natural forest to be agricultural area in 1990's. One of the solution for this problem is reforestation. Unfortunately, the most common action of reforestation that had been done was to make a production forest on the degraded land, instead of restoring its real structure as natural forest.

A research in grassland in South Kalimantan showed that reforestation using indigenous species have higher survivorship [5].

It also mentioned that the most affected factor of survivorship is the capability to compete with weeds [6]. Another study showed that survivorship of seedlings in land without weeds are higher than seedlings grow in grassland [7]. Higher nutrition in soil can also make higher survivorship [8]. Accordingly, reforestation with indigenous species with nutrition adding and weed removal can affect positively to plant's growth and survivorship. This research aimed to discover the effect of nutrition adding and weed removal to survivorship and growth of some selected indigenous species in MPNR.

Materials and Methods / Experimental

This research was performed in the 40 x 40 m plot in Dayeuh Luhur MPNR exactly at S 07° 17' 22.4", E 107° 46' 05.3" at altitude 1735 m (Figure 1). This area has relative humidity 71% and temperature 19.72°C. This study used five indigenous species: *Acer Laurinum, Distylium stellare, Schima wallichii, Dacrycarpus imbricatus,* and *Syzygium glomeruliferum*. Seedlings performance was measured in four different treatments (control, fertilizer addition treatment, weed removal treatment, combination of fertilizer addition and weed removal treatment). Each treatment used 20 individuals for each species. These twenty individuals were firstly-germinated seedlings at the same age (3 months) and have average height of approximately 17.6 cm. Planting distance for each individuals is 1 m. Methods for fertilizing and weeding refer to FORRU (2005) [3][4].

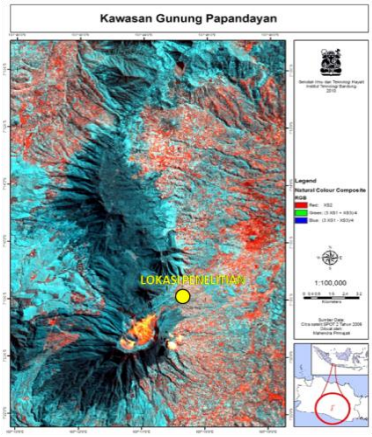

Figure 1. Research Location (Source : Citra Spot, 2008).

This study measured survivorship, height, health score, weeding score, and diameter of each individuals. Data was taken every two months from May to December 2011. Survivorship score was calculated with this formula.

$$SR = \frac{N_2}{N_1} \text{ x } 100\% \quad (1)$$

N_2 is amount of individuals survived till the last, and N_1 is amount of individuals planted from the beginning (20 individuals). Height data was used to calculate the Relative Growth Rate of Height (RGRH) and diamter data was used to calculate Relative Growth Rate of Diameter (RGRD). Relative Growth Rate of Diameter was calculated with formula:

$$RGR = \frac{\ln M_2 - \ln M_1}{T_2 - T_1} \quad (2)$$

M_1 dan M_2 respectively are height/diameter at the beginning and the end of observation. Value of RGRH and RGRD were calculated in average for a month. The statistical analysis used was *one-way* ANOVA with SPSS 17.0 software.

Results and Discussion

Survivorship

Result shows that fertilizer treatment has the highest survivorship compared to other treatments (85± 0.06%) (Table 1). Fertilizer and weed removal treatment has the lowest survivorship. *Syzigium glomeruliferum* is the species with the highest average survivorship in all treatments (80 ± 0.08%), while *A. laurinum* is the lowest (66,25 ± 0.16%).

Result of survivorship from all species (73.25 ± 0.13%) is higher than similar previous studies [10][11]. This higher survivorship is affected most significantly by the use of germinated seedlings. Survivorship of germinated seedlings is better than wildlings [10][12][13].

Comparing the weeding score data (Figure 3.1), fertilizer treatment has the highest average rate of weeds. Accordingly, the survivorship also shows the highest rate. In contrast, the weed removal treatment (III and IV) with zero weeding scores has the lowest survivorship.

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Tablel 1. Survivorship (%) all species from each treatment.

Species	Survivorship (%)				
	Treatment I (normal)	Treatment II (fertilizer)	Treatment III (weeding)	Treatment IV (combination)	**Average for each species**
Acer laurinum	80 ± 0.08	80 ± 0.04	70 ± 0.06	35 ± 0.19	**66.25 ± 0.16**
Distylium stellare	85 ± 0.04	85 ± 0.05	70 ± 0.12	55 ± 0.14	**73.75 ± 0.13**
Schima wallichii	75 ± 0.09	80 ± 0.03	75 ± 0.07	40 ± 0.17	**67.5 ± 0.13**
Dacrycarpus imbricatus	70 ± 0.09	95 ± 0.00	75 ± 0.06	75 ± 0.09	**78.75 ± 0.09**
Syzygium glomeruliferum	75 ± 0.05	85 ± 0.03	75 ± 0.10	85 ± 0.06	**80 ± 0.08**
Average for each treatment	**77 ± 0.08**	**85 ± 0.06**	**73 ± 0.09**	**58 ± 0.18**	**OVERALL 73.25 ± 0.13**

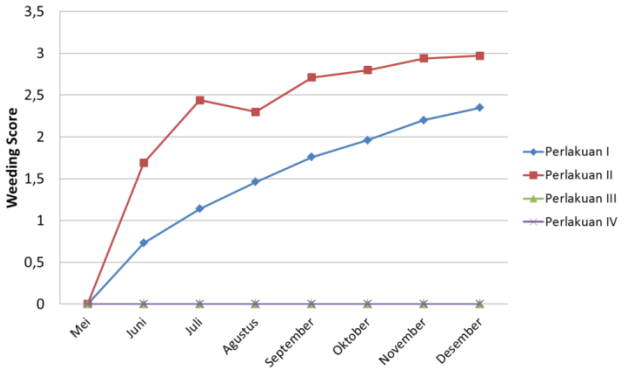

Figure 2. Graph comparing the average score weeding.

This results shows that the existence of weeds is actually giving positive effects to plant's survivorship. We can predict that weeds here act, not as a competitor, but is giving a better micro-environmental conditions for seedlings. This better micro-environmental condition can increase the survivorship of seedlings. In other study, this phenomenon was called Nursing Effect. Nursing effect is a shading mechanism of a nurse plant to other plant (target species) under coverage. These shades are making a microhabitat condition with light intensity, temperature, humidity and nutrients that helps the growth of seedlings [18]. Some studies show that nursing effect can really increase growth and survivorship of plants [17][18][21][20].

Nursing effect can also happen when abiotic factors are limiting the plant growth [17]. Ren *et al*. (2008) also mentioned that the positive effect of nursing effect is higher when the threatening abiotic factors is happening to the plant at the early stage of reforestation [18]. On the observation, primarily on August - September, the environmental condition was threatening; low rainfall to none in 28 days, high light intensity that's causing high mortality of plants caused by drought. The existence of shades was in role for protecting plants from the excessive exposal of sunlight. Sun light radiation can damage the center of photosystem reaction and produce oxidative damage [18]

Another reason for plant lower-survivorship from the weeding removal treatment was probably caused by the abundance of nutrients availability in soil, making competition become irrelevant. Competition usually happens because of limited resources available in soil contested by individuals, both inter-species and intra-species [19]. The abundance of nutrients is actually sufficient to eliminate competition and resource exploitation. These nutrients were retrieved from the fertilizer, given at the beginning of observation. Other than that, referring to previous land-use for agriculture, there might be fertilizer residues in soil [12].

The result of statistical analysis using *one-way* ANOVA shows a significant difference between survivorship rate from each different treatment ($\alpha = 0.05$, sig = 0.016, Ho rejected). The result of *post-hoc* test using *Turkey test* shows that the group of fertilizer addition treatment is significantly different with the

group of combination (fertilizer addition and weeding removal) with coefficient of 0.27.

Relative Growth Rate of Height (RGRH)

Taken from observation and data analysis, combination of fertilizer addition and weeding removal treatment shows the highest RGRH (0.66 ± 0.03 cm cm^{-1} month^{-1}) compared to other treatment (Table 3.2). *Acer laurinum* also shows the highest RGRH (0.69 ± 0.03 cm cm^{-} month^{-1}). For the group with the lowest RGRH is the control treatment group (0.40 ± 0.02 cm cm^{-1} month^{-1}) and the fertilizer addition treatment group (0.50 ± 0.02 cm cm^{-1} month^{-1}), and the species with the lowest RGRH is *S. walichii* (0.42 ± 0.02 cm cm^{-1} month^{-1}).

Taken from the results, the surviving species shows more efficient growth [16]. A study in Taiwan about *Cryptomeria japanica* shows that the surviving individuals are the species with a high value of RGR. In this research, *A. laurinum* shows a high RGR. This fact shows, that the surviving individuals shows a high relative growth rate. The fourth treatment (combination of fertilizer and weeding removal) has the highest RGR caused by low survivorship value, and the surviving individuals in this treatment shows a high RGR [16]. Fertilizer addition in the fourth treatment is also affecting the high value of RGR because the species with abundant resources also have a high RGR [16].

Relative Growth Rate of Diameter (RGRD)

Data of Relative Growth Rate of Diameter also shows variation in result (Table 3.3). Fertilizer addition treatment is increasing the survivorship and relative growth rate of diameter in tested seedlings. This treatment has the higher value compared to the control treatment. This data is different from weeding removal treatment and combination of fertilizer addition and weeding removal that is actually giving a negative effect compared to control treatment and also as a probable effect of nursing effect.

Table 2. Relative Growth Rate of Height (cm cm^{-} month^{-1}) of all species.

Species	**RGR (cm cm^{-1} month^{-1})**				
	Treatment I (normal)	Treatment II (fertilizer)	Treatment III (weeding)	Treatment IV (combination)	**Average for each species**
Acer laurinum	0.74 ± 0.02	0.55 ± 0.01	0.73 ± 0.04	0.73 ± 0.05	0.69 ± 0.03
Distylium stellare	0.46 ± 0.01	0.56 ± 0.01	0.64 ± 0.02	0.66 ± 0.03	0.58 ± 0.02
Schima wallichii	0.14 ± 0.03	0.54 ± 0.01	0.32 ± 0.02	0.76 ± 0.03	0.44 ± 0.04
Dacrycarpus imbricatus	0.43 ± 0.02	0.45 ± 0.02	0.39 ± 0.03	0.71 ± 0.02	0.50 ± 0.03
Syzygium glomeruliferum	0.23 ± 0.03	0.43 ± 0.03	0.59 ± 0.01	0.44 ± 0.01	0.42 ± 0.02
Average for all treatments	0.40 ± 0.02	0.50 ± 0.02	0.53 ± 0.03	0.66 ± 0.03	0.52 ± 0.03

Table 3. RGRD (mm mm^{-1} month^{-1}) of all species.

Species	**RGR Diameter (mm mm^{-1} month^{-1})**				
	Treatment I (normal)	Treatment II (fertilizer)	Treatment III (weeding)	Treatment IV (combination)	**Average for each species**
Acer laurinum	0.16 ± 0.12	0.16 ± 0.04	0.19 ± 0.03	0.20 ± 0.02	**0.18 ± 0.02**
Distylium stellare	0.10 ± 0.03	0.17 ± 0.05	0.12 ± 0.01	0.12 ± 0.03	**0.11 ± 0.03**
Schima wallichii	0.11 ± 0.07	0.13 ± 0.03	0.13 ± 0.03	0.07 ± 0.06	**0.13 ± 0.03**
Dacrycarpus imbricatus	0.15 ± 0.05	0.13 ± 0.00	0.14 ± 0.06	0.06 ± 0.01	**0.13 ± 0.01**
Syzygium glomeruliferum	0.15 ± 0.03	0.17 ± 0.03	0.13 ± 0.64	0.10 + 0.02	**0.15 ± 0.02**
Average for all treatments	**0.13 ± 0.04**	**0.15 ± 0.05**	**0.14 ± 0.00**	**0.09 ± 0.02**	**OVERALL 0.13 ± 0.02**

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The study done by Alvarez-Aquino et al.(2004) in Mexico is emphasizing the fact that the plantation done in forest (in shades) is significantly having a higher survivorship and RGR compared to the seedlings planted outside [9]. More specifically, Turner (2004) stated that water deficit and low-humidity can happen without shades, thus, causing death. RGR of seedlings is increasing with the existence of other plant's shade [5].

Health Score

Taken from the results (Table 3.4), the fertilizer addition treatment shows the highest health score compared to other treatment. The species with the highest health score is *S. glomeruliferum*.

This result shows that health score is correlated with survivorship. High health score on fertilizer treatment was caused by nursing effect. Thus, in conclusion, nursing effect is not only affecting survivorship and RGR, but also to health score. Health score is showing the growth quality of plants, with the visually given parameter such as leaf color, amount of leaf, leaf dryness, and survivorship. Nursing effect is giving a suitable microclimate condition for plants to grow faster and healthier [3].

Seedlings Performance in the Early Stage of Reforestation

Observation result shows a survivorship performance dynamic from each species per month (Figure 3). *D. Imbricatus* and *S. glomeruliferum* shows a high survivorship *Acer laurinum* and *S. walichii* shows a low survivorship, and *D. Stellare* shows moderate survivorship.

The first three months were the most critical phase for plant growth due to relatively high mortality on such phase according to the study results of Setiawan [12] that also shows a high mortality of plants in the first three months. *Syzigium glomeruliferum, D. imbricatus,* and *D. stellare* has a relatively high survivorship in dry season. Compared to the wet season (high rainfall, October-December), the mortality of all plants is realtively low, except for *D. Imbricatus* that shows high mortality rate [12].

Tabel 4. Health Score for each spesies in every treatment.

Species	Health Score				**Average for each species**
	Treatment I (normal)	Treatment II (fertilizer)	Treatment III (weeding)	Treatment IV (combination)	
Acer laurinum	2.79 ± 0.07	2.64 ± 0.08	2.64 ± 0.21	1.46 ± 0.75	**2.38 ± 0.35**
Distylium stellare	2.76 ± 0.15	2.74 ± 0.11	2.11 ± 0.39	2.59 ± 0.19	**2.55 ± 0.41**
Schima wallichii	2.49 ± 0.19	2.69 ± 0.18	2.45 ± 0.23	1.98 ± 0.54	**2.40 ± 0.28**
Dacrycarpus imbricatus	2.51 ± 0.20	2.88 ± 0.09	2.53 ± 0.35	2.59 ± 0.30	**2.63 ± 0.15**
Syzygium glomeruliferum	2.75 ± 0.10	2.91 ± 0.06	2.72 ± 0.21	2.79 ± 0.15	**2.79 ± 0.70**
Average for all treatments	**2.66 ± 0.19**	**2.77 ± 0.15**	**2.49 ± 0.35**	**2.28 ± 0.66**	**OVERALL 2.55 ± 0.43**

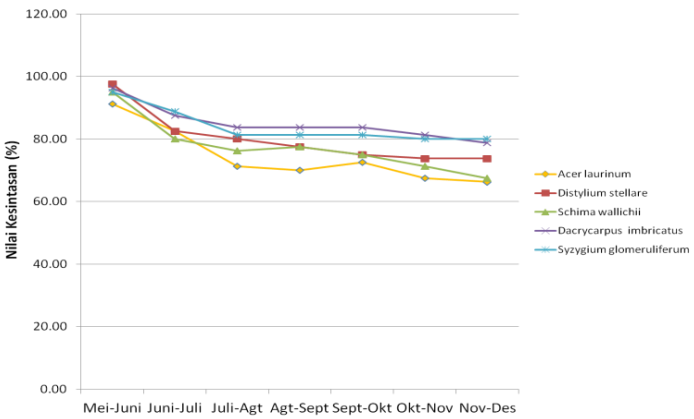

Figure 3. Survivorship of all species for eight months.

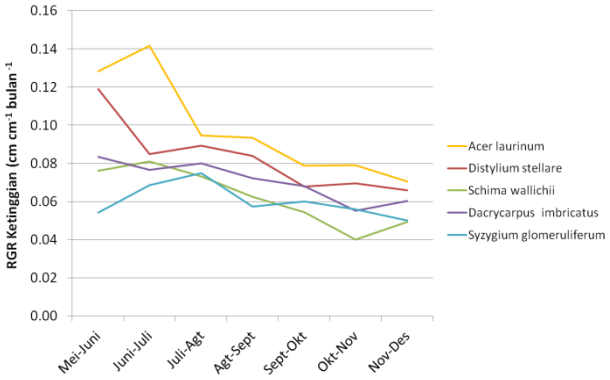

Figure 4. RGRH of all species for eight months.

Dystilium stellare has the second highest RGR. Compared to *S. glomeruliferum* and *D. imbricatus* that has a high survivorship, but low height RGR, and *D. stellare* shows both, high growth rate and high survivorship. Each species has each own character and different response to nutrient addition and weeding removal. These characteristics are worth noting before the starting reforestation.

Conclusion

In conclusion, The treatment of fertilizer addition shows the best results on survivorship values, relative growth rate of height and diameter, and health score. This is caused by nursing effect; shadings by fast-growing weeds and nurse plant as a result of abundant nutrient from fertilizer addition. *Syzygium glomeruliferum* and *Distylium stellare* shows a good performance in every treatments as a result of high survivorship and high growth rate on the early stage of reforestation. *Acer* laurinum is the species with the highest growth rate.

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References

[1] FAO (2007) : *State of the World Forests 2007,* United Nations Food and Agriculture Organisation, Rome.

[2] FORRU. (2005). *How To Plant a Forest: The Principles and Practice of Restoring Tropical Forests.* Chiang Mai: Biology Department Chiang Mai University.

[3] FORRU. (2008). *Research for restoring tropical forest ecosystems: a practical guide.* Chiang Mai: Chiang Mai University.

[4] Otsamo, A., Adjers, G., Hadi, T. S., Kuusipalo, J., & Vuokko, R. (1997). Evaluation of Reforestation Potential of 83 Tree Species Planted on Imperata cylindrica Dominated Grassland. *New Forests* , 127-143.

[5] Turner, I. (2004). *The Ecology of Trees in the Tropical Rain Forest.* Cambridge: Cambridge University Press.

[6] De Steven, D. (1994). Tropical tree seedling dynamics: recruitment patterns and their population consequences for three canopy species in Panama. *Journal of Tropical Ecology* , 10, 369–83

[7] Newton, A. C. (2007). *Forest Ecology and Conservation: Handbook of Techniques*. New York: Oxford University Press.

[8] Pareliussen, I., Olson, E.G.A., Armbruster, W.S. (2006) : Factors Limiting the Survival of Native Tree Seedlings Used in Conservation Efforts at The Edges of Forest Fragments in Upland Madagascar, Restoration Ecology, 14 (2), 196-203.

[9] Alvarez-Aquino, C., Williams-Linera, G., & Newton, A. C. (2004). Experimental Native Tree Seedling Establishment for the Restoration of a Mexican Cloud Forest.

 ISSN 2088-9127

Restoration Ecology Vol 12 No. 3 , 412-418.

[10] Adjers, G., Hadengganan, S., Kuusipalo, J., Otsamo, A., & Vesa, L. (1998). Production of Planting Stock from Wildlings of Four Shorea Species. *New Forests 16* , 185-197.

[11] Raman, T. R., Mudappa, D., & Kapoor, V. (2009). Restoring Rainforest Fragments: Survival of Mixed-Native Species Seedlings under Contrasting Site Conditions in the Western Ghats, India. *Restoration Ecology* , 137-141.

[12] Setiawan, N. N. (2011). Curahan Biji, Germinasi Biji, dan Kemampuan Bertahan Anakan Spesies Pohon Lokal pada Tahap Awal Reforestasi di Cagar Alam Gunung Papandayan, Jawa Barat. *Thesis S2 Biologi ITB*

[13] Nasution, R.E. (1999) : *Acer L*, 39-40, *dalam* : Sosef, M.S.M., Hong, L.T., Prawirohatmodjo, S., Eds., *Plant Resources of South-East Asia No. 5(3): Timber trees : Lesser-known timbers.* Backhuys Publishers. Leiden.

[14] Sulistyawati, E., Maryani, E., Sungkar, R., Ariwibowo, M., Rosleine, D., dan Gurnita (2005) : *Keanekaragaman Hayati Gunung Papandayan: Tumbuhan, Burung, dan Ancamannya*, Departemen Biologi ITB, 9-42

[15] Atmandhini, R. G. (2008). Penyebaran, Regenerasi, dan Karakteristik Habitat Jamuju (Dacrycarpus imbricatus Blume) di Taman Nasional Gede-Pangrango. Bogor: Skripsi Fakultas Kehutanan IPB.

[16] Guan, B. T., Lin, S.-T., Lin, Y.-H., & Wu, Y.-S. (2008). Growth Efficiency - Survivorship Relationship and Effects of Spacing on Relative Diameter Growth Rate of Japanese Cedars. *Forest Ecology and Management 255* , 1713-1723.

[17] Padilla, F. M., & Pugnaire, F. I. (2006). The Role of Nurse Plants in the Restoration of Degraded Environment. *Front Ecology Environment* , 196-202.

[18] Ren, H., Yang, L., & Liu, N. (2008). Nurse Plant Theory and Its Application in Ecological Restoration in Lower Subtropic of China. *Natural Science 18* , 137-142.

[19] Barbour, M. G., Burk, J., & Pitts, W. (1987). *Terrestrial Plant Ecology.* California: Benjamin Cummings.

[20] Jansen, A. M., Lof, M., & Witzell, J. (2012). Effects of Competition and Indirect Facilitation by Shrubs on Quercus robur Ssaplings. *Plant Ecology 213* , 535-543.

[21] Wagner, S., Fischer, H., & Huth, F. (2011). Canopy Effects on Vegetation Caused by Harvesting and Regeneration Treatments. *Europe Journal of Forest Restoration* 130 , 17-40

CULTURAL AND PRACTICAL USE OF FOREST PLANT RESOURCES IN DAYAK TUNJUNG COMMUNITY AT KELEKAT VILLAGE, EAST KALIMANTAN

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Abstract

The function of forest for the society is not only ecological, but also economic and cultural. Traditional knowledge is inherently linked to use and management of natural resources. This study aimed to investigate the traditional knowledge of use and the factual use of forest plant resources of Dayak Tunjung community in Kelekat Village, East Kalimantan. This ethnobotany study was conducted in February - April 2011, and Oktober 2011. To obtain information on the plant local names and the knowledge of people on plant use, 32 respondents were randomly selected for interview. To asses the actual uses of plants by the people, scan observation was conducted in 43 families. Sampled plants were brought for species identification in *Herbarium Bandungense*, ITB. This study found that 151 ethno-species were used by people in Kelekat Village; according to interviews, 18 ethno-species were used as medicine, 20 ethno-species were used as firewood, 54 ethno-species were used as building material, 42 ethno-species were used as tools material, 73 ethno-species were used as foods, and 31 ethno-species were used for others. According to scan observation data, we found that 6 ethno-species were used as medicine, 4 ethno-species were used as firewood, 15 were used as building materials, 15 were used as tools materials, 11 were used as foods, and 5 were used for others. This study suggests that Dayak Tunjung people have high number of forest plants in their traditional knowledge of use, however the number of forest plants species in factual use was lower than number of forest plant species in traditional knowledge.

Keyword: Ethno-botany, forest-plant, Dayak Tunjung

Introduction

Borneo (or Kalimantan) is one of the largest islands in Indonesia. It is known as one of the centers of plant diversity in the world, with estimated 10,000-12,000 species of flowering plants, with a huge number of endemic species. The cultural diversity of Borneo is as distinct and varied as the plant life which exists on the islands.

It is generally accepted that human has a close interaction with the environment around. Human ecology is one of disciplinary that discusses this interaction. Information in human ecologically scope is interpreted and translated into applied values and knowledge in either local or universal social system. Traditional knowledge is an accumulation of practical knowledge and believes which change adaptively through time [1]. Specific discipline in human ecology studying the interaction between human and plants are called ethno-botany.

The early people of Borneo were hunter-gatherers and later they have settled down as shifting cultivators. The indigenous population practising shifting cultivation in Borneo is usually referred collectively as "Dayak". However, hunting and gathering of forest produce continue to be an indispensable part of life for Dayak people, and through many generations they have accumulated extensive knowledge on the usage of plants. Harvest and gatherer plants forest product activity is important for indigenous people who live near and in the forest. These activities become the limited action which is contributed the biggest source revenue [2].

Shifting cultivation is still being practised by the Dayaks although only in limited extent. However, forest plant gathering activity by indigenous people tends to decrease rapidly.

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Among the reasons causing such trend are deforestation and limited access to forests by indigenous people. The decrease in the activity to collect forest products becomes a serious concern as it may lead to loss of traditional knowledge, especially on the local plant use. Therefore, it is important that the traditional knowledge of local plant use currently being practised is documented and this study is an effort in that direction. This study was conducted to investigate the traditional knowledge of use and the factual use of forest plant resources of Dayak Tunjung community in Kelekat Village, East Kalimantan.

Method

This study was conducted at Kelekat village in Kutai Kertanegara, East Kalimantan. Geographically, Kelekat village are situated at 00^0 12' 555' S and 116^0 18' 325' W. The ecosystem found in the study area are swamp forest, riparian forest, and rice field. Field works were conducted in early February 2011 until April 2011, and October 2011.

The people

Dayak Tunjung is one of tribal communities in Kalimantan that mostly lives in Kutai districts. Dayak Tunjung has relationship with Dayak Benuaq[3]. Both of Benuaq and Tunjung are part of Luangan Ethnic Group [4]. Because of the long term cultural acculturation, now Tunjung people in Kelekat have many believe systems. Most of Tunjung people are Christian and the rest are Muslims and Animism. Like others Dayaks, shifting cultivation, hunting, and gathering forest plants are still practised by Dayak Tunjung people. They still rely on these activities to meet the family daily needs. However, nowadays most of young Tunjung people work in industries near the village to fulfill their daily needs.

Free listing method

Free listing involves asking participants to spontaneously list the name of all the useful forest plants they knew and all the uses of each plant in their list[5]. The free listing method was used to reveal the knowledge of plant use representing cultural data. The number of respondents involved in freelisting were 32 randomly selected consisting of 13 men, and 19 women. We have asked several questions to the respondents, to get information about the plant use in their traditional knowledge. We categorized the use of plant into 6 groups : food, firewood, medicine, tools, construction, and others.

Scan observation method

Scan observation method was intended to reveal the actual use of plant representing the practical data. It was conducted by visiting the house of respondents and recording the plant-based materials currently being used in the visited household. As many as 43 households were selected randomly. We asked to them about plants species that they brought to their household[6]. We categorized the use of plants into 6 groups: food, firewood, medicine, tools, construction, and others.

Specimen Identification

The initial specimen identification was conducted in REAKON's library, using some literature as Dransfield[7], and Wee[8]. Then, the next identification continued in *Herbarium Bandungense* ITB, using some plant systematic literature as Munawaroh and Purwanto[9], Rao[10], Setyowati[11], Newman[12], van Balgooy[13] and identification website[14]. For the validity name we checked the plants name in the official site[15]. During the field work, not all plants that were mentioned by the respondents can be found while sampling. In such a case, we present the respondents with the picture of plants from an identification book to confirm and facilitate translation from local name to scientific name.

Result and Discussion

Dayak Tunjung Tradition

The forest for Dayak Tunjung people not only provide land for farming, but also supply them with various daily needs. They usually go to Gunung Anggi, or forest around Belayan river to search for firewood, foods, medicines, materials for construction and making tools. Dayak Tunjung still practice rituals inherited from their ancestors, for example marriage ceremony, ritual for opening forest for farming and ritual for expressing gratitude for good harvest.Another ritual still widely practised was traditional healing ceremony called *Belian.* The word *belian* is taken from the word *beli,* which means evil spirit. They believe that this ceremony can send away the evil from a sick person. They use some plants to fulfill the needs

of the ceremony, which are taken from forest or their own garden. Some plant species that are used for *belian* are ron jélo (*Musa acuminata* Colla.), kelapa (*Cocos nucifera* L.), teli'an (*Eusideroxylon zwageri* Teijsm. & Binn.), benda'a (*Arenga pinnata* (Wurmb) Merr.), sirih (*Piper betle* L.), tembakau (*Nicotiana tabacum* L.), and pulut (*Oriza sativa* L.).

In spite of that, there are still a lot of other Dayak Tunjung's heritage that still be practiced up to the present. Every their tradition from their ancestors, represent human interaction and relation with nature. In other words, they show us the tradition is not only to explore natural resources, but also as a lesson to live with nature mutually.

Cultural and Practical Analysis

Various uses of forest plants have been found from traditional knowledge, and factual use. Overall, 151 ethnospecies were listed by respondent in interview, and 36 ethnospecies were brought to household by scan observation respondent. In Figure 1, we show the comparison between ethnospecies that represent the traditional knowledge (free listing data), and factual use ethnospecies (scan observation data).

For all categories, the number of uses reported was higher than the number of uses observed. For example, informants cited 18 different ethno-species for medicine, but we only observed 6 ethno-species being used as medicine. Food is significantly different among other categories, which informants cited 73 different ethno-species are edible, but we only observed 11 ethno-species being home as food. It is likely because of observation period not coinciding within fruit season. Free listing method captured Tunjung's local knowledge of plant use. This local knowledge is collected inherently from long term knowledge by the time. Tunjung people know the uses of a plant species from their ancestor and parents, and it inherited through generations. They know the use of a plant although in present forest can not be found anymore. This explains why number of ethno-species that cited by informants during interview is more than number of ethno-species that observed.

Figure 2 shows ten highest cultural ethno-species. From 151 total cited ethno-species, we found 10 ethno-species that have high value in cultural analysis. There are kayu teli'an (*Eusideroxylon zwageri* Teijsm & Binn), belaa'ng (*Borassodendron borneense* J. Dransf.), merembu'ng (*Shorea bracteolate* Dyer.), ron biru (*Licuala grandis* H. Wendl.), lotong (*Durio oxleyanus* Griff.), kayu kapur (*Shorea* sp.), naka'a talun (*Artocarpus integer* (Thunb) Mer.), gaay sega (*Calamus caesius* Blume.), kayu kenikara (*Dillenia excelsa* (Jack) Gilg in Engl. & Pr.), and gaay kotok (*Daemonorops fissa* Blume.).

Teli'an wood (*Eusideroxylon zwageri*), merembu'ng (*Shorea* sp.) and keni kara (*Dillenia excelsa*) are common plants that are used as building construction and foundation. But people in Kelekat prefer Teli'an (*Eusideroxylon zwageri*) for construction because of the Kelekat village location is in riparian area, and usually flooded if the rain comes. Teli'an is chosen because of its hard and sturdy wood structure. The wood has low permeability and thick cell wall that makes it binds lots of water in hydroxyl cluster. Thus, in under water, Teli'an wood will be tighter than the normal one[16]. Belaa'ng (*Borassodendron borneense*), and ron biru (*Licuala grandis*) are two plants that frequently used to make *serawung,* one of Dayak's handycraft. Both species are dispersed in wide range of Borneo, especially east Kalimantan forest[17]. Lotong (*Durio oxleyanus*) and naka'a talun (*Artocarpus integer*) are used as food, while gaay sega (*Calamus ceasius*) and gaay kotok (*Daemonorops fissa*) are used as tools basic material.

Figure 3 shows proportion of plant forest used divided by 6 categories. The most uses plant forest as for food. The second is uses for building and tools.

Ethno-species cited for firewood is relatively low. This is because the plentitude of prime stock firewood species, leheban (*Vitex pinnata*), in the forest. Almost all of respondent cited this species for firewood that make this percentage of number species rated low. Unfortunately, uses for medicine are the lowest cite by informant. This is because of the plentiful number of chemically medicines that are sold at store around the village.

Figure 4 shows ten highest practical ethno-species. From 36 total observed ethnospecies, we found 10 ethno-species that have high value in practical analysis. There are gaay sega (*Calamus caesius* Blume.), gaay jahap (*Calamus trachycoleus* Becc.), preng bambu (*Dendrocalamus asper* (Schult.) Backer.), teli'an (*Eusideroxylon zwageri* Teijsm. & Binn.), ron biru (*Licuala grandis* H.Wendl.),

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rumbia (*Nypha* sp.), ron bengkuang (*Pandanus kaida* Kurz.), gaay kotok (*Daemonorops fissa* Blume.), merembu'ng (*Shorea bracteolate* Dyer.), and gaay jepung (*Daemonorops crinita* Blume).

In the other hand, free listing result shows that uses category in scan observation result mostly used as building and tools material. Both of uses category are durables, thus can be found during observation period in their house. The percentage of using forest plant as building material is 41.67%, while food is about 30.56%, medicine 16.67%, 13.89% for other uses, and 11.11% for firewood.

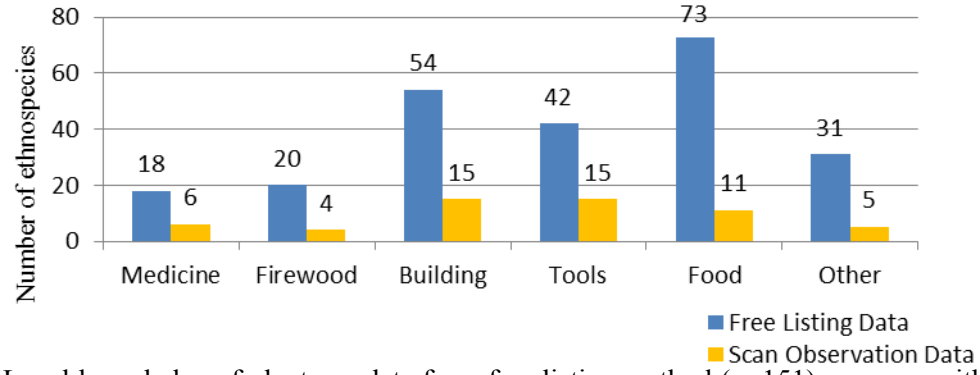

Figure 1. Local knowledge of plant use data from free listing method (n=151) compare with the plant factual use with scan observation method (n=36).

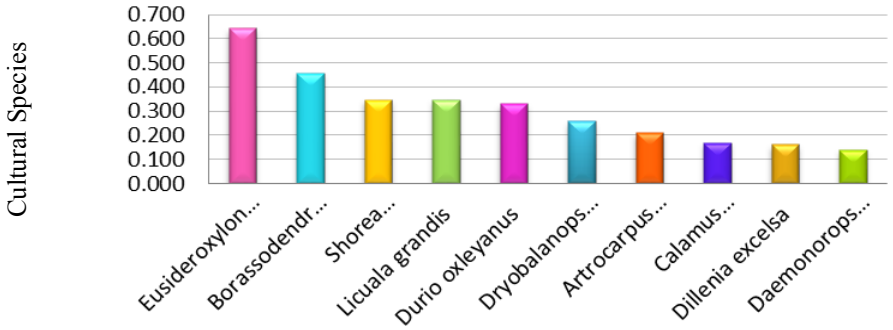

Figure 2. Ten highest cultural ethnospecies.

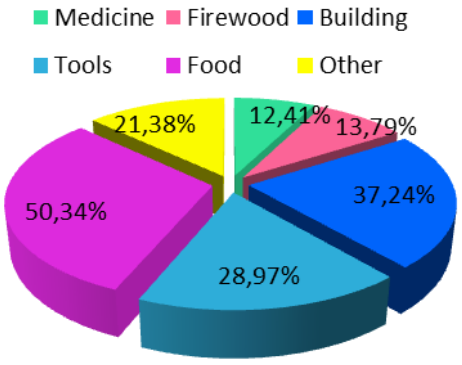

Figure 3. Ethno-species uses (in %) from total 151 cultural ethno-species cited by respondent.

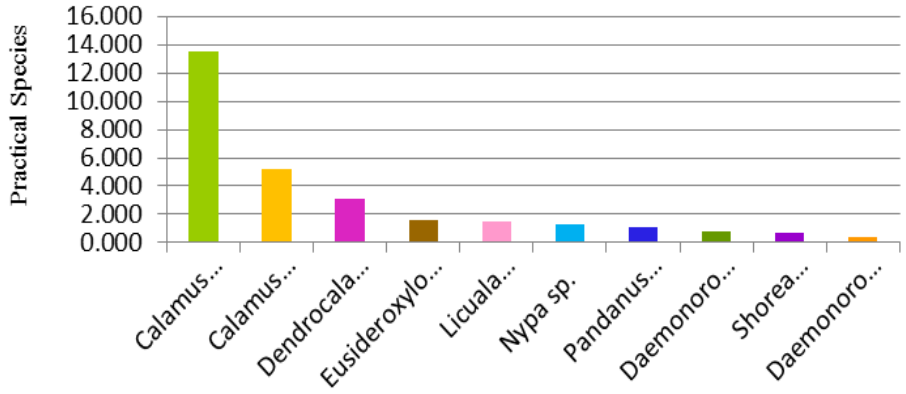

Figure 4. The ten highest practical ethno-species.

Conclusion

This study suggests that Dayak Tunjung people have high number of forest plants in their traditional knowledge of use, however the number of forest plants species in factual use was lower than number of forest plant species in traditional knowledge.

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References

[1] Stepp. J. R., Jones, E. C., Pavao-Zuckermann, M., Casagrande, D., Zarger, R. K., 2003, Remarkable Properties of Human Ecosystem, *Conservation Ecology*, Vol 7 (3): 11

[2] Arnold. J. E. M, 1994, *Nonfarm Employment in Small-scale Forest-based Enterprises: Policy and Enviromental Issues*, The Environmental and Natural Resources Policy and Training Project, Madison, Wiconsin.

[3] Gönner. C, 2001, *Natural Resources Maintenance in a Dayak Bnuaq's Village: A Dynamic and Prospects*, Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ), Eschborn, Germany.

[4] Weinstock. J. A, 1983, *Kaharingan and Luangan Dayaks: Religion and Identity in Central-East Borneo*, Doctoral Dissertation, Cornell University.

[5] Martin. J. G, 1995, *Ethnobotany: A People and Plants Conservation Manual*, Chapman and Hall, UK

[6] Reyes. G. V., Huanca. T., Vincent. V., Leonard. W., Wilkie. D, 2006, Cultural, Practical, and Economic Value of Wild Plants: A Quantitative Study in the Bolivian Amazon *Economic Botany*, Vol 60 (1): 62-74.

[7] Dransfield. S, 1992, *The Bamboos of Sabah*, Herbarium Forest Centre, Sabah, Malaysia.

[8] Wee. Y. C, 2005, *Ferns of the Tropics: Revised Edition*, Times Edition Marshall Cavendish, Singapore.

[9] Munawaroh. E., dan Purwanto. Y, 2008, *Studi Hasil Hutan Non Kayu di Kabupaten Malinau, Kalimantan Timur*, Pusat Konservasi Tumbuhan Kebun Raya Bogor, LIPI, Bogor.

[10] Rao. A. N., Rao. V. R., Williams. J. T., Dransfield. J., Dransfield. S., Widjaja, E., dan Renuka. C, 1998, *Priority Species of Bamboo and Rattan*, IPGRI and INBAR, Serdang, Malaysia.

[11] Setyowati. F. M, 2010, Etnofarmakologi dan Pemakaian Tanaman Obat Suku Dayak Tunjung di Kalimantan Timur, *Media Litbang Kesehatan*, Vol, 20 (3): 104-112.

[12] Newman. M. F., Burgess. P. F., dan Whitmore. T. C, 1999, *Pedoman Identifikasi Pohon-Pohon Dipterocarpaceae Pulau Kalimantan*, Prosea, Bogor.

[13] van Balgooy. M. M. J, 1997, *Malesian Seed Plants: Volume 1- Spot Character*, Rijksherbarium, Leiden, Netherland.

[14] Silk. F, 2009, www.asianplant.com. [Access on 12 October – 13 December 2011]

ISSN 2088-9127

[15] Plantlist, 2011, http://www.plantlist.org. [Access on12 Oktober 2011 – 21 Maret 2012]
[16] Basri. E., Rullianty. S., dan Saefudin, 2008, *Sifat dan Kualitas Pengeringan Lima Jenis Kayu dari Kebun Raya Bogor,* Lembaga Ilmu Pengetahuan Indonesia, Bogor.
[17] Toma. T., Oka. T., Marjenah., Tatawi. M., Mori. T, 2001, *Forest Rehabilitation Requires Fire Prevention and Community Involvement,* CIFOR, Bogor.