A Correlation among the Microclimate Forest to the Diversity of Orchids at Climax of the Lowland Dipterocarp Forest in Malinau Regency

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Short running title: forest microclimate and orchid ephipyte

ABSTRACT

The purpose of this study was to determine the relationship between microclimate and diversity of orchids in the climax. The presence of orchids data collection carried by census on every tree that is overgrown, while the research plots using single plot to the extent of 6 plots, each of the sized of 100 x100 m of lowland dipterocarp forest in Malinau Regency. Overall the number of orchids were found in 6 hectares of climax forest could be 3324 clumps or 554 clumps/hectares from 43 species especially of the genus *Bulbophyllum* (7 genus or 35%). The analysis uses a multiple linear regression, while to find out the correlation between X (climate parameters) and Y (number of orchid) variables using Pearson's correlation method. Correlation between the elements of micro-climate with a number of orchids in climax shows a positif and strong correlation between the presence of orchids with average daily humidity (0.99) and the intensity of radiation at each vertical tree stratum (0.95), instead the relationship with temperature showed negative and a weak correlation (-0.51).

Keywords: orchid, microclimate, climax, diversity, correlation, dipterocarp forest

INTRODUCTION

Forests and climate are two components that are highly related and influence each other, because there will be no growth and development of forest formations without the existence of climate behavior. Changes in one of these components are directly or indirectly affect the other components. A change of formation and existence of forest stands

will affect the climate component and vice versa. Climatic conditions is very important element for the regeneration and the formation of the forest, the forest canopy conditions will affect the fluctuation of climatic elements in the forest and outside the forest environment. Vegetation that grows in the forests, especially tropical forests produce micro-climate in the 3-dimensional and highly complex, in this case the "umbrella" canopy formed naturally produce micro-climatic conditions that differ significantly from the microclimate outside the forest area. Forest canopies are very important biologically, particularly as centers of diversity and acting as the main interface between the atmosphere and the forest, playing a vital role in many ecological processes.

Organisms and processes of tree canopy communities contribute to the maintenance of the diversity, resiliency, and functioning of forest ecosystems. The forest canopy is defined as "the combination of all foliage, twigs, fne branchs, epiphytes as well as the interstices in a forest". The forest canopy is considered a structurally complex as well as ecologically critical sub-system of forests. Forest canopy that forms naturally produce different micro-climatic conditions with outside forests. Micro-climatic conditions most of the rain forest canopy varies greatly from peak to get to the forest floor. Every life form of forest ecosystem components including orchid ephypites have different capabilities in terms of satisfying their needs for environmental conditions including light, humidity, temperature and other climatic elements (Mingxu et al. 2015, Mucunguzi 2007)

Epiphyte is one of a group of plants of the constituent community of forest that his presence barely gets attention. The existence of epiphyte on tree parts largely determined by the type and size of trees as well as micro-climatic conditions in the interior of the forest stands. Elements of climate conditions are essential for the existence and plant regeneration of epiphyte. The amount of a type of epiphyte will increase in accordance with the changing conditions of the interior microclimate of forest stands are toward more profitable, especially an increase in the level of air humidity, relatively low temperature conditions and a reduced

intensity shines on the interior of the forest (Mingxu et al. 2015). With regard to the condition of the forest ecosystem of micro-climate forests especially humidity, temperature and sunlight so it can be used to find the relationship between the micro-climatic conditons in the forest with the epiphyte diversity in habitat. (Ingram & Nadkarni 1993, Nadkarni and Parker 1994, Barker & Sutton 1997, Stork et al. 2007)

MATERIALS AND METHODS

Observations were made on the permanent sample plots (PSP) consists of 6 plots of forest climax, each plot a sample size of 10,000 m^2. Each PSP is separated by woods within a radius of 50 m from the buffer zone. Trees of *Dipterocarpaceae* dominate the entire plot of the research, as well as dominate the forest canopy, *Dipterocarpus* (27% of the tree density and 40% basal area) especially Meranti *(Shorea sp),* Keruing *(Dipterocarpus sp),* Merawan *(Hopea sp), Agathis borneensis* and *Kompassia excelsa.* Another species that has a high density and basal area is *Shorea.* Observations were made on the species of orchids on every tree plastered/overgrown orchid (census method) and climatic parameters, especially temperature, lighting and humidity. Orchids that growing most found at the tree canopy, the branch-free trunk and the base of the tree. The orchids sampled (herbarium) were identified based on the Herbarium Bogoriensis collections

RESULTS

This research was conducted in lowland dipterokarpaceae forest in Seturan village, sub district of Long Loreh, Malinau District. The geographical position of research locations are $2^0$45'12 "-$3^0$21'03" N and $116^0$34'2,79 "E. Areas of research is at an altitude of 100~300 m above sea level, the hilly topography with slopes varying between 10~70%. Overall the number of trees

found as a host tree as many as 610 trees (17.9% of 3400 trees have diameter > 20 cm) or average 50.8 tree ha^{-1}. The host consists of 158 types of 101 genera that belong to 43 tribes. The host tree of the Dipterocarpaceae tribe is found with the most individual number of 227 individuals or 37.2% of the entire host tree. Among the Dipterocarpaceae are clan Shorea (16 types or 9.9%), Vatica Marga (5 types or 3.1%), the Anisoptera clan and the Parashorean clan (1 type or 0.2%).

Diversity of orchids

Overall the number of orchid in the forest climax on a 6 hectare plot studies found 3324 cluster or 554 cluster.ha^{-1}, this included 43 species from 20 genera. The observation shows that most of epiphytic orchids that live in the canopy grow into colonies and associated with *Licopodium* sp and *Selliguea* sp. Fern genera found was in the form of stacks shaped substrates (moss), in Table 1 we can see the type of orchid that is often found in the climax. Orchids in singly-clumps or in the form of colonies generally found to grow and thrive in the canopy (97.6%), especially on large branches. Only 3 species of orchids or (2.4%) were found alive in branch-free trunk, and found no orchid that lives at the base of the tree trunk. This situation suggests that different types of orchids tolerant of sunlight, the humidity is not too high, this condition is ideally located on the canopy (Wolf 1994, Kromer et al. 2007, Hardwick et al. 2015).

Microclimate and the Presence of Orchids

Rainforests occur in the Malinau basins of East Kalimantan isthmus, rainfall exceeds 2500~3000 mm a year and is distributed over the year, usually with one or more relatively "dry" seasons. This variation in temperature between winter and summer is less than that between night and day. Therefore, seasonal periodicities in activities of plants are largely related to variation in rainfall. The profusion of epiphytes (orchids, ferns and bromeliads) perhaps reaches its culmination in the tropical rainforests. In the rain forest, the intensity of light reaching the

forest floor is much lower than in the canopy. The maximum air temperature and the average was also lower in the forest floor with air humidity (RH) is always higher than above the forest canopy (Table 2).

According to Zotz (2007) and Krömer et al. (2007) the light intensity are different in every strata canopy in a forest very influential on dominance and species diversity. Microclimate is a major determinant of the local distribution of vascular epiphytes as can be deduced from the vertical stratification of species documented in a large number of studies. While vertical gradients of microclimatic variables and epiphyte species distribution are relatively easy to document. The results of the analysis of the degree of correlation between the elements of microclimate and epiphytes in the number of types of climax forest (Table 3). The presence of orchids is strongly correlated with moisture conditions and the intensity of light in the forest environment at every strata tree vertical. In contrast, relationship between the number of epiphytic and daily average temperature showed weak correlations (-51.1%).

DISCUSSION

This indicates that different types of orchids tolerant of sunlight, and hight humidity, this condition is generally characterize canopy tropical rainforest (Wolf 1994). Epiphytes exist in many types of ecosystem; however, they are a classic feature of tropical rainforest systems. Of the 25,000 known orchid species, more than 70% are thought to live as epiphytes in tree canopies (Gravendeel et al. 2004). Epiphytes contribute to the complexity, structure and function of the canopy, and are an important component in terms of both biomass and species diversity.

Orchids are found mostly in the form of colonies on the former branch or limb fractures deep enough or large branches sidelines and filled with garbage or organic materials. The orchids are predominantly found alive in the trunk with a large diameter and can't be found alive in other parts of the tree, because it is not like a shadow in all parts of his life. Epiphytic

Orchids love shade in all parts of their lives and also in parts of trees that have relatively stable humidity so that many are found in the tree's canopy. Although often found piled up on one side of the stem opposite the sun direction. Because epiphytic orchids, like most epiphytic plant species, don't like being exposed to direct sunlight (Wolf, 1994 in Sujalu, et al 2015).

Where a stick in cracks or crevices narrow canopy system is much longer and stretched over parts of the body, whereas if you live in crevices or holes big enough and the error branch (full garbage) then the root is almost invisible. It shows orchid tolerant of direct sunlight, but not resistant to drought. Orchids epiphytic plants attached to their hosts high in the canopy have an advantage over herbs restricted to the ground where there is less light and herbivores may be more active. Orchid epiphytes can have a significant effect on the microenvironment of their host, and of ecosystems where they are abundant, as they hold water in the canopy and decrease water input to the soil. Plans create a significantly cooler and moister environment in the host plant canopy, potentially greatly reducing water loss by the host through transpiration.

The spread of orchids epiphyte closely related to the tolerance of sunlight, so most epiphytes found living inside the canopy and some live in the trunk and none were found living at the base of the stem. Understanding when and how these orchids diversified is vital to understanding the history of epiphytic biomes. We investigated whether orchids managed to radiate so explosively owing to their predominantly epiphytic habit and/or their specialized pollinator systems by testing these hypotheses from a statistical and phylogenetic standpoint. No evidence was found for a positive association between pollinator specialization and orchid species richness (Graveendel et al, 2004).

The existence of orchids can be used as an indicator that shows the area is very humid environmental conditions and often foggy (Flores-Palacios and García-Franco 2006). The combination of environmental factors such as radiation, water vapor , and air temperature, may be most suitable for the establishment and growth of the orchids, as well as for other epiphytic species compared to the upper and lower stratum of the host trees (Benzing,

1990, Cervantes et al., 2005). There appears to be a link between the occurrence of certain genera or species with the height of the branch. The balance between light requirement and excessive water loss are probably the main reasons for vertical variation such as this (Mucunguzi 2007).

This condition is consistent with the results mentioned by Partomihardjo (1991) on a 6 hectare research plot at Forest Research Samboja-Kutai Kartanegara regency show that Orchidaceae is the type that is easy to find, rich in species, spread, and the most abundant. A similar correlations similar delivered by Adhikari et al. (2017) orchid species richness and abundance increased with increasing southern aspect whereas it decreased with increasing canopy cover, and fern species richness increased with host bark roughness. Orchid abundance was positively correlated with increasing bark pH, stem size, tree age and tree height and negatively correlated with increasing steepness of the area. The pattern of spread of orchids vertically more based on life forms, the presence and distribution of orchids are generally abundant in the canopy, especially those that grow in branching relatively flat at various heights canopy. There are also a number of epiphytic types that can be found in every part of the tree. Spreading orchid closely related with differences in tolerance to sunlight has limited the spread of vertical epiphytes on trees. So there is a group of epiphytic capable of receiving direct sunlight, for example *Bulbophyllum* sp, *Dendrobium* sp, and *Eria* spp. Conversely, there is also a group of orchids that are tolerant to direct sunlight and grows on the trunk or epiphytes that need shade, for example, *Lycopodium* sp. and *Selliguea* sp and *Pyrrosia vittaria*, some are tolerant to the conditions and other factors i.e. forest interior humidity. This is consistent with the statement Renske (1997) that the difference in the diversity of epiphytes in a variety of forest types associated with forest humidity specifications and host factors, especially those related to tree architecture.

The species composition and community structure of orchid is strongly influenced by fluctuations in environmental factors including density/density of trees, the branching structure

178 and diameter, and the quality of the porophytes bark (host tree for epiphytes). Event of logging
179 may affect the presence of epiphytic through changes and shrinkage canopy closure, which will
180 produce sudden changes in the condition of elements of microclimate interior forest and lasts
181 for a long time, especially the penetration of sunlight, temperature and humidity, which would
182 potentially affect the abundance and distribution types (Sutton et al. 1983, Wolf 1994, Hazell
183 1998). According to Kromer et al. (2007) the different intensity of light in every strata in the
184 forest canopy is very influential on the dominance and species diversity.
185 The vertical structure of forest stands will result in variations in the form of a tree
186 structure that includes a canopy tree height, branching pattern, the abundance of different kinds
187 of vegetation alive. Other aspects of branch and tree size may have further implications on
188 orchid diversity. Microclimate is a major determinant of the local distribution of vascular
189 epiphytes as can be deduced from the vertical stratification of species documented in a large
190 number of studies Host identity is another potential determinant, which has been invoked
191 and/or investigated in >200 studies (Krömer *et al.* 2007). Branch diameter correlates with bark
192 roughness and thick branches tend to have a dense covering of mosses and vascular plants, both
193 ideal substrates for epiphyte growth. Branch size is also an aspect worth considering as large
194 branches provide good platforms for debris accumulation, supplying humus for epiphytes to
195 colony. Structure of the tree crown, bark characteristics, foliage density, tree health and
196 dispersal limitations of seeds are all factors that may contribute to orchids epiphyte abundance
197 and diversity (Parker 1995, Sillett 1999). Because the vertical structure of trees identical to the
198 presence of vegetation types that live in trees and vegetation orchid survival. This is what can
199 differentiate depiction where the vertical structure of forest stands in general with a vertical
200 structure in the tree. Moreover, generally vertical structural diversity of forest stands indicates
201 the existence of a similarity with biological diversity contained in it, because it has a
202 micro-climatic conditions and suitable microhabitats more different types of biota, as well as
203 providing life-supporting factors are more diverse (Malcolm 1995). The diversity of orchid

epiphytes is influenced by host characteristics as well as host types. The most important pre-requisite for a high epiphyte biodiversity is the presence of old respectively tall trees, independent of the recent protection status Adhikari et al (2017).

Composition and vertical distribution of vegetation orchid is primarily determined by the variability of temperature, humidity and lighting as well as the characteristics of the microhabitat under the canopy is determined by the moisture while under canopy and lighting. There are three mechanistycs reasons to expert strong relation-ship between vegetation structure and microclimate. First, plant canopies absorb, scatter and reflect incoming sun light, thus reducing the amount of energy that penetrates through to the soil and below-canopy air. Second, plant canopies absorb momentum from the air and thus wind speed decreases with depth within the canopy. Finally, the amount of water vapour that air can hold strongly dependent upon the air temperature (Malcolm 1995, Benzing 1981, Freiberg 1996, Krömer et al. 2007).

Ecological competition is great in "jungle" growth. The competitive interaction involves common space, nutrients, light, moisture, and other types of mutual interactions. Light- and air-loving orchids would have been pushed out of existence if they had not "moved" up and away from the stifling mass of undergrowth. Parameters of vertically micro-climatic conditions in the trees and forest stands showed that the majority of micro-climatic conditions are very different types of rainforest and varied vertically from the top of the canopy to the forest floor, and horizontally from one location to another location within the forest canopy umbrella. And also differ between the various sizes of the hiatus, and between secondary forests and climax (Dodson, 2003).

As a consequence of the intensity of sunlight available in every strata of the canopy in different forest stands, then this condition will greatly affect the size of the dominance of species, vegetation diversity, differentiation grade canopy, the ratio of the crown of life and the crown of overall dimensions canopy (Migenis and Ackerman. 1993 in Sujalu et al 2015,

Kromer et al. 2007). The species composition and community structure of orchid is strongly influenced by environmental factors including fluctuations in the density of trees, branches and stem diameter, and the quality of the host tree bark. According to Gandawidjaja (1997) that a particular difference in environmental conditions or epiphytic tolerance to the environment either at the altitude of the location attached to the host tree or the difference from tree to tree varies considerably that nothing is significant the association between types of epiphytes and trees.

Associated with the two environmental factors are the most important component because it affects the stability of the interior environment of the forest, especially the components which maintain a steady level of wet bark and this means that the rate of penetration of sunlight are permanent, so the percentage of sunlight blocked by every strata of the forest canopy is also relatively do not change (Wolf 1994, Hazell et al. 1998, Kromer and Gradstein 2003). High species richness of primary forests was presumed due to the closed canopy, resulting in permanently high atmospheric humidity in these forests. Similarity in species composition of secondary and primary forests increases with forest age, but after 40 years of succession one third (46 species) of primary forest species had not re-established in the secondary forest. Community composition in primary and secondary forests differed markedly and indicates that a long time is needed for the re-establishment of microhabitats and reinvasion of species and communities adapted to differentiated niches (Holz, and Gradstein. 2005).

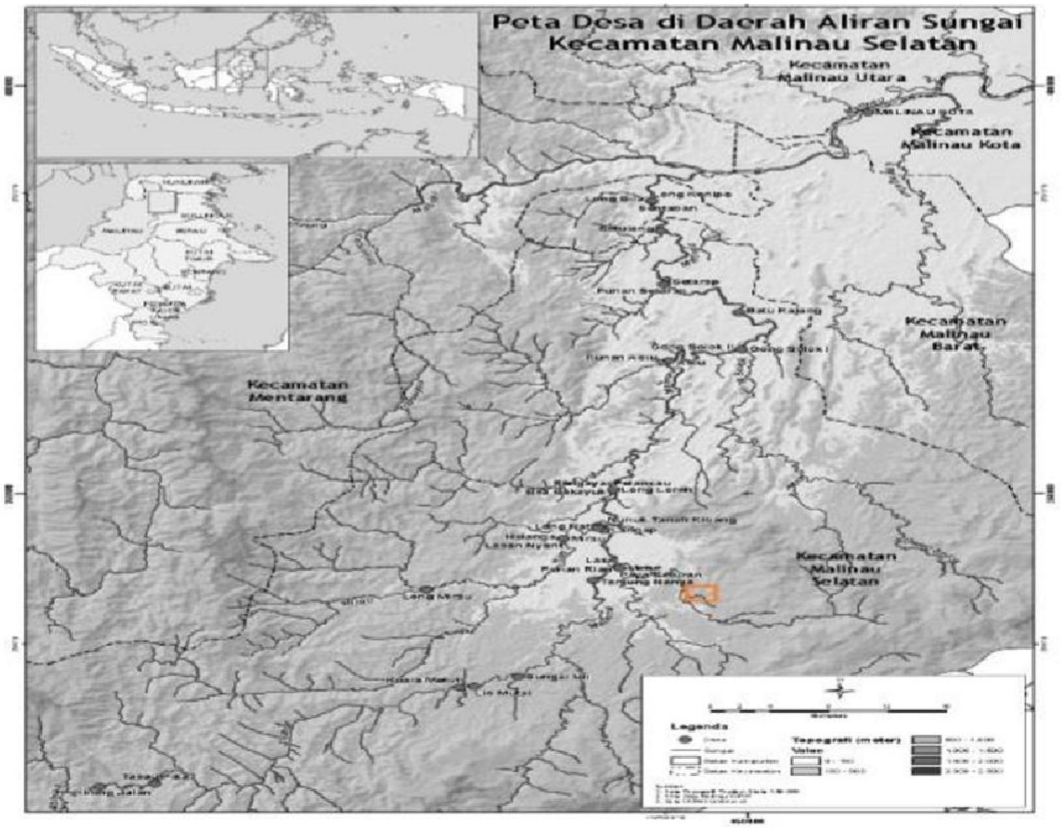
Thus, though orchids (and all epiphytes in general) are a very characteristic element in the structure of the rainforest, their role in its economy is small. Their chief interest lies in the clearness with which their distribution is correlated with the ecological factors of microclimate, humidity, temperature, illumination, etc., and in their extraordinary structural specializations, which more perhaps than those of any other group of plants, truly deserve to be called adaptations. If stratification at different levels in a rain forest is controlled by light, air

movement, water supply and microclimatic factors, then epiphytic succession should be evident and orchids may well be termed the climax of the epiphytic layer.

CONCLUSIONS

Of research and literature that has been done it can be concluded that conditions microclimate elements in the climax forest interior, especially the penetration of sunlight, temperature and humidity influence orchid existence through changes in canopy closure and depreciation. *Bulbophyllum beccariu* Rchb.f. genus *Bulbophyllum* is the most common species. The vertical distribution of epiphytes within a tree is determined by several microenvironment gradients, with light intensity, wind speed, and air temperature increasing and air humidity decreasing from the ground level to the canopy.

Reference



267 Figure 1. Location research

268 Table 1. Orchids often found in In Climax

Species	Genera	Sum Of Clumps	
		Canopy	Bark
Bulbophyllum binnendijkii J.J.S.	*Bulbophyllum*	197	-
Bulbophyllum beccariu Rchb.f.	*Bulbophyllum*	165	102
Bulbophyllum gracillum Rolfe.	*Bulbophyllum*	143	46
Bulbophyllum lepidum (Bl.) J.J.S.	*Bulbophyllum*	132	-
Bromheadia finlaysiniana (Lindl.) Miq.	*Bromheadia*	117	-
Bulbophyllum vaginatum (Lindl.) Rchb.	*Bulbophyllum*	114	32
Cimbidium finlaysonium Lindl.	*Cymbidium*	110	-
Acriopsis javanica Reinw.	*Acriopsis*	108	102
Sarcanthus subulatus Rchb.f.	*Sarcanthus*	107	14
Bulbophyllum macranthum Lindl.	*Bulbophyllum*	98	23
Bulbophyllum purpurescens Ted. & B.	*Bulbophyllum*	89	17

269

270 Table 2. Microclimate condition at the climax

Climate parameters	Canopy	Bark	Steam Bolt
Temperature (^{0}C)	24~28	26~29	23~30
RH (%)	83~91	84~90	85~99
Radiation (μmol cm^{-2})	60~109	62~91	23~31

271

272 Table 3. Correlation Between Microclimate with Orchids in Climax

Parameter	Temperature	Humidity	Radiation	∑ Species
Temperature	*1.000*	*-0.528*	*0.961*	*- 0.511*

Humidity	*1.000*	*-0.744*	*0.999*
Radiation		*1.000*	*0.995*
∑ Species			*1.000*

273

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