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A Correlation between the Microclimate Forest to the Diversity of Orchids at Climate of the Lowland Dipterocarp Forest in Malinau Regency

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Abstract. This research evaluated forest microclimate effects on biodiversity, explore relationships among canopy properties, and disentangle their relationship on orchid ephypite diversity in the climax. The presence of orchids data collection carried by census on every tree that is over grown, 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 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 used a multiple linear regression, while Pearson's correlation method.was used to find out the correlation between X (climate parameters) and Y (number of orchid) variables. 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).

1. Introduction

The dynamic behaviour of forest trees and stands isbeing changed constantly by interactions between cover, biotic and abiotic conditions, and especially climatic and microclimatic conditions. In forestry, the concept of interaction between forest stand and climate is definedby changes in the nature, structure, composition and ecophysiologicalbehaviour of cover and the different ofthe stand components. Microclimatic conditions created by the physical characteristics of the cover influence each other, because there will be no growth and development of forest formations without the existence of climate behavior.

The presence of vegetation cover in general and forest cover in particular modifies the climatic parameters and creates a microclimate whose characteristics depend on the general climate itself and the physical characteristics defining the nature and structure of the cover. A change of formation and existence of forest stands will affect the climate component and vice versa. In fact, cover, i.e. the trees and vegetation in which it consists, adapts to these new microclimatic conditions by modifing its specific architectural and functional components. Thus, it is really an interactive and even a retroactive system: any change in one of the components results in an adjustment of the others.

Climatic conditions is critical 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. All variables defining climate are greatly modified by forest cover which creates a microclimate and highly complex, 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. The changes in the environment have huge effects especially on plants growth and its distribution. Interaction between plants and the environment will influence plants physiological functions thus affecting some ecological processes [1].

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.

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. Epiphytes play a significant function in influencing their nearby area microclimate particularly the canopy area. 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 [2]. 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 [3-6].

Orchid ephypites have different capabilities in terms of satisfying their needs for environmental conditions including light, humidity, temperature and other climatic elements. They are also an important component of any forest ecosystem with a highly intricate mutual relationship with other biota. Their presence along with other epiphytes is an indication of a healthy ecosystem [2], [7].

2. 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 *(Shoreasp),* Keruing *(Dipterocarpussp),* Merawan *(Hopeasp), Agathisborneensis* and *Kompassia excelsa*. Observations were made on the species of orchids on every tree plastered/overgrown orchid (census method) and climatic parameters, especially temperature, lighting and humidity.

A simple linear regression (multiple linear regression) used to make predictions about relationship between the explanatory (independent) variables (X, climatic parameters) and response (dependent) variable (Y, some of orchids). The coefficient of determination (R^2-squared) used Pearson's Correlation method to measure how much of the variation can be explained by the variation in the independent variables. 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.

3. Results and Discussion

This research was conducted in lowland dipterokarpaceae forest in Paya Seturan, sub district of Long Loreh, Malinau District. The geographical position of research locations are 2045'12 "- 3021'03" N and 116034'2,79 "E.All research plots are located in the low lands of Paya Seturan-Seturanvillage (100-300 m above sea level), is a lowland primary forest area with wavy topography with slopes 10~70%. Overall the number of trees found as a host tree as many as 696 trees (17.9% of 3400 trees have diameter > 20 cm) or average 50.8 tree ha-1. The host consists of 179 species of 85 genus that belong to 39 families. The ephipyte host trees of the Dipterocarpaceae is found with the most individual number of 294 individuals or 42.2% of the entire host tree. Among the Dipterocarpaceae are *Shorea* sp (18 species or 9.9%), *Dipterocarpus* sp and *Vatica* sp (5 species or 4.7%).While many other families are found as host tree ie Myrtaceae, Myristicaceae, Euphorbiceae and Fagaceae.

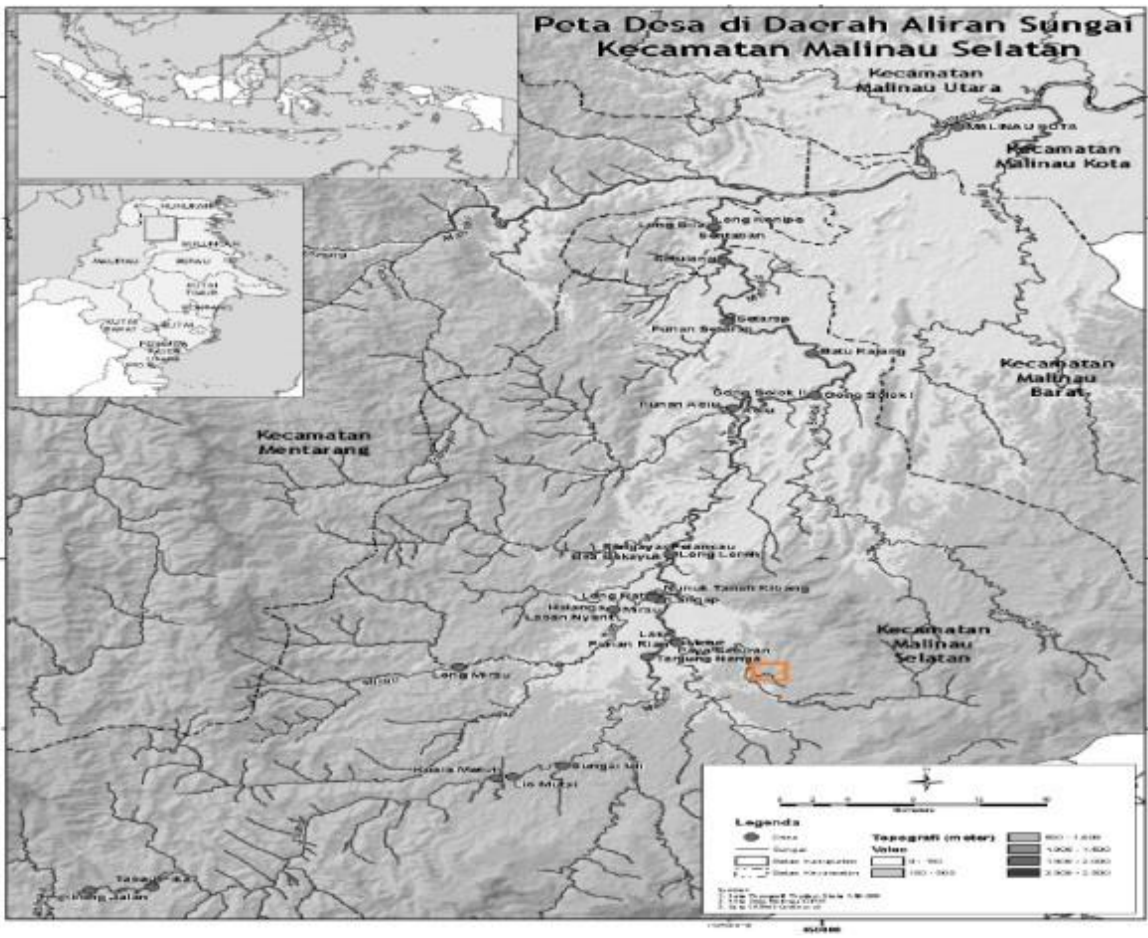

Fig. 1. Location of research

3.1. Diversity of orchids

Overall the number of orchid in the forest climax on a 6 hectare plot studies found 3324 cluster or 554 clumps.ha^{-1}, this included 43 species from 20 genera. The observation shows that most of epiphytic orchids that live in the canopy grow into coloniesand associated with *Licopodium*sp and *Selliguea* sp. The species (*Licopodium*sp and *Selliguea* sp) is fern genus found was in the form of stacks shaped substrates (moss).

Approximately 380 accepted species_of mosses, commonly known as "peat moss". Accumulations of Sphagnum can store water, since both living and dead plants can hold large quantities of water inside their cells; plants may hold 16 to 26 times as much water as their dry weight, depending on the species. Hence, as sphagnum moss grows, it can slowly spread into drier conditions, forming larger mires, both raised bogs and blanket bogs. The empty cells help retain water in drier conditions. The air filled porosity of moss range from 15-26% under general conditions, is great for epiphytic because its allows air to circulate around the roots.Moss hold enough moisture, can hold up to 20 times its weight in water, so moisture is retained for subsequent up take by the plant. Sphagnum can influence the composition of such habitats, with some describing Sphagnum as 'habitat manipulators [8].

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 [9-11].

Table 1. Orchids often found in Climax

Species	Genera	Sum of Clumps	
		Canopy	Bark
Bulbo phylum 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	-
Bromheadiafinlay siniana (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
*Bulbophyllumpur purescens*Ted. & B.	*Bulbophyllum*	89	17

3.2. 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. Forests are well-known for their moderating effect on below-canopy local climate, generally allowing lower maximum temperature and wind speed as well as higher minimum temperature and humidity.The air humidity (RH) is constantly higher than above the forest canopy (Table 2).

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

Although tropical rainforests receive 12 hours of sunlight daily, the canopy trees can block out over 95% of the sunlight, less than 2% of that sunlight ever reaches the ground, is significantly lower than in the canopy. The upper canopy of a forest consists of a markedly different ecosystem than what existsbelow. In general, the upper canopy isbrighter, hotter, drier and windier than the below-canopy measurements. Specific patterns within forests vary depending upon factors such as species composition, topography and climatic regime. The upper canopy receives direct solar radiation, which is filtered through leaves, branches, and epiphytes to reach the lower canopy. Depending upon the height ofthe canopy and the degree of layering within, the diffusion of light will vary at the forest floor [12].

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 [13, 14]. 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 environmentat every strata tree vertical. In contrast, relationship between the number of epiphytic and daily average temperature showed weak correlations (-0.51). The sensitivity of epiphytes to microclimates supports the idea that not only are epiphytes having an effect on their own habitat, but that abiotic conditions must be present to facilate epiphyte establishment before epiphytes can begin to feed back into the ecosystem.

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
Light Intensity			1.000	0.995
∑ Species				1.000

Epiphytic orchids are not positioned randomly on all parts of the host. The occurrence of orchids at each zone depends on itsrequirements for light and nutrients. Naturally, most orchids tend to grow at the particular part of the host treethat optimizes their resource acquisition. This condition indicates that different types of orchids tolerant of sunlight, and hight humidity, generally characterize canopy tropical rainforest [9]. 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 [15]. 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 [8].

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 [15].

The existence of orchids can be used as an indicator that shows the area is very humid environmental conditions and often foggy [16]. 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 [17]. 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 [7].

This condition is consistent with the results mentioned by Ref. [18] 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 Ref. [19] 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., *Selliguea*sp and *Pyrrosiavittaria*, some are tolerant to the conditions and other factors i.e. forest interior humidity. This is consistent with the statement of Ref. [20] 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.

Epiphytes are influenced by abiotic and biotic variables, but little is known about the relative importance of direct and indirect effects on epiphyte distribution. The direct and indirect effects of abiotic factors (climatic and edaphic) and tree community characteristics on orchid epiphytes species diversity were examined. Fluctuations in environmental factors including density/density of trees, the branching structure and diameter, and the quality of the porophytesbark (host tree for epiphytes). Logging can affect within-forest microclimate through effects on forest structure, changes and shrinkage canopy closure, which will produce sudden changes in the condition of elements of microclimate interior forest and lasts for a long time, especially the penetration of sunlight, temperature and humidity, which would potentially affect the abundance and distribution types" [21,22]. According to Ref. [10] the different intensity of light in every strata in the forest canopy is very influential on the dominance and species diversity. Overall, climate (relative humidity) and tree community characteristics (tree size represented by basal area) had the strongest direct effects on epiphyte diversity.

The vertical structure of forest stands will result in variations in the form of a tree structure that includes a canopy tree height, branching pattern, the abundance of different kinds of vegetation alive.Other aspects of branch and tree size may have further implications on orchid 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 Host identity is another potential determinant, which has been invoked and/or investigated in >200 studies [14]. Branch diameter correlates with bark roughness and thick branches tend to have a dense covering of mosses and vascular plants, both ideal substrates for epiphyte growth. Branch size is also an aspect worth considering as large branches provide good platforms for debris accumulation, supplying humus for epiphytes to colony. Structure of the tree crown, bark characteristics, foliage density, tree health and dispersal limitations of seeds are all factors that may contribute to orchids epiphyte abundance and diversity [23, 24]. Because the vertical structure of trees identical to the presence of vegetation types that live in trees and vegetation orchid survival. This is what can differentiate depiction where the vertical structure of forest stands in general with a vertical structure in the tree. Moreover, generally vertical structural diversity of forest stands indicates the existence of a similarity with biological diversity contained in it, because it has a micro-climatic conditions and suitable microhabitats more different types of biota, as well as providing life-supporting factors are more diverse [25]. 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 [19].

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 relationship 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 [25], [17], and [14].

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 at a local scale, forest trees and stands have a marked influence on climate; thus it is possible to define microclimates.These effects depend on local climatic characteristics and stand type. All climatic parameters should be considered, but particular attention should be paid to temperature, light and water. This also differ between secondary forests and climax [27].

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 [28]. [10]. The orchid epiphytic preference for certain regions of phorophyte is related to factors such as the search for moisture, light and substrate conditions.Showed a possible preference of these species for the forest understory, where climatic conditions are stable and the humidity is higher when compared to the canopy at the upper ranges of height. According to Ref. [29 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 environmental factors including fluctuations in the density of trees, branches and stem diameter, and the quality of the host tree bark. Among different-aged forests, forest structure and ageinfluenced epiphyte species composition as density and species richness increased withforest age, and many epiphyte species were confined to microhabitats unique to old-growth forests. 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 [9]. 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 forestsincreases 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 [30].

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. The sensitivity of epiphytes to microclimates supports the idea that not only are epiphyteshaving an effect on their own habitat, but that abiotic conditions must be present to facilateepiphyte establishment before epiphytes can begin to feed back into the ecosystem. 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. Epiphytes access the canopy by having their populations expand upward and outward (on branches) as the tree grows. Once a suitable habitat is found, then the feedback into the microclimate begins and species interactions diversify the population.

4. Conclusion

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* Rchbf. genus *Bulbophyllum* is the most common species. The vertical distribution of epiphytes within a tree is determined by several microenvironment gradients, with light intensity, air temperature increasing and air humidity decreasing from the ground level to the canopy.

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