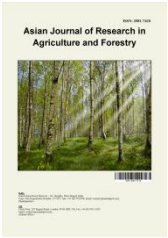

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Diversity of Seedlings in the Kerangas Forest Kersik Luway Nature Reserve

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The Extreme Kerangas Forest is an edapic type of kerangas forest dominated by a much higher quartz sand content than the soil. However, the vegetation in this area is still abundant and the species have their own criteria that are very distinctive and different from other forest types. This paper describes in detail the investigation of seedling variety in the extreme Kerangas Forest of the Kersik Luway Nature Reserve. The research focuses on sapling vegetation in a 1-hectare area of this unique forest type, which is distinguished by high quartz sand content in the soil. The study methodologies are thoroughly described, including the application of the sensus method. The investigation found 38,225 unique saplings representing 16 species from 13 different groups. The most common species were Tristania obovata, Ilex hypoglauca Laec, Podocarpus neriifolius D.Don, Ficus sp. and Calophyllum glaucum. These species thrive in the Kerangas forest's nutrient-poor, acidic soils. According to the report, conservation efforts should prioritize the preservation of these unique ecosystems as well as the rehabilitation of barren areas containing rare species. The severe Kerangas forest in the Nature Reserve is home to a broad assortment of species that have evolved to thrive in harsh environments.

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Keywords: Seedling; kerangas forest; vegetation; diversity.

1. INTRODUCTION

Kerangas forests are a type of aseasonal lowland tropical rain forest that develop in dryland sites with predominantly podzolized, highly acidic, sandy soils. Kerangas forests in East Kalimantan are known as "*Kerangas*" forests, originating from an Dayak Iban language that refers to infertile soils in which rice cannot grow. Kerangas is a distinct, fragile type of tropical rainforest commonly found in Borneo, it has podzol soil with a pH of 3-4 and low nutritional content [1]. Kerangas forest is a unique forest ecosystem. The trees in this forest grow in an extreme environment of nutrient-poor, acidic soil, the forest floor consists of podsol soil and quartz sand soil, characterized by poor nutrients and low pH so that the trees cannot grow big and tall [2].

Kerangas forests are distinctive in their forest structure, physiognomic features, and tree characteristics as compared with the lowland mixed dipterocarp rain forests that are more dominant throughout Borneo [3]. Kerangas trees are typically shorter and unbuttressed and have stilt roots. The plants exhibit sclerophylly with leaves that are usually small and thick and with a low nitrogen content [4] Kerangas trees are often densely packed, giving the appearance of a pole forest. Various Kerangas formations have been recorded in Borneo, including dry land. Kerangas formations such as coastal and inland Kerangas forests and open "Padang" forests, as well as wetter Kerangas formations, known soils derive from siliceous parent material andthus are typically low in bases and nutrients [5].

The formation of Kerangas forests begins with the growth of various vegetation that is able to survive in nutrient-poor layers which over time results in piles of peat litter in the area. Extreme kerangas forest is an edapic type of kerangas forest dominated by quartz sand content that is much higher than the soil, sometimes reaching 100%, especially on the soil surface [3,5].

Kerangas forests have been previously studied in terms of either their ecology and plant community compositions, soil, environmental characteristics, and ecophysiology or variations in tree leaf form and function. Composition of kerangas forest species is generally less complex than in other lowland tropical forests. Kerangas forests are characterised by a special vegetation composition, with trees appearing short and spindly in contrast to lowland mixed forests in general [5].

The kerangas forest structure is often characterised by open scrub with scattered trees and only two canopy stratums that are often uniform in appearance. Nevertheless, the vegetation in this area still grows abundantly and the species have their own criteria that are very distinctive and different from other forest types. Because of this speciality, the Kerangas Forest in Kersik Luway –West Kutai Regency, the province of east Kalimantan was designated as a Nature Reserve Forest [6].

The Kerangas forest area has an important role for local life, especially in protecting ecological functions and biodiversity. Vegetation composition and structure is one of the parameters that must be considered in forest conservation activities. One of the conservation efforts is through the analysis of tree vegetation in the forest ecosystem [7].

Padang Luway Nature Reserve with an area of 4,785.23 ha is one of the Nature Reserves that currently does not know the exact pattern or form of distribution of several types of orchids found in the area after the fire in 2014. Based on the above problems, research to determine the distribution of orchids in Padang Luway Nature Reserve is important and relevant to do [5,6].

2. KERANGAS FOREST IN KERSIK LUWAY NATURE RESERVE

The most famous area of extreme kerangas forest can be found in the Kersik Luway Nature Reserve. This area is located in West Kutai Regency, about 17 km from the sub-district capital of Melak or about 400 km from the provincial capital of East Kalimantan in Samarinda. According to the forestry administration, this area is included in the RPH Damai, BKPH Damai, CDK Mahakam Ulu and the Regional Forestry Service of West Kutai Regency [8].

2.1 Research Methods

The objects in this study were all types of standing vegetation found in the observation plots from the seedling level. The seedling level, which is plants starting to germinate until the

saplings are less than 1.5 metres high. Data collection was carried out by census on 2500 research plots which in total covered an area of 1 Hectare with each plot measuring 2 x 2 m for the seedling level [9].

Vegetation analysis is a way to study the species composition and structure of vegetation in an ecosystem. Quantitative vegetation analysis can be viewed from several parameters as basic data such as density and relative density, frequency and relative frequency of dominance and relative dominance and INP.

3. RESULTS AND DISCUSSION

3.1 Location

The kerangas forest area in Kersik Luway village was designated as a conservation area with the name Kersik Luway Nature Reserve Area, covering an area of 5,000 ha based on the Decree of the Governor of East Kalimantan Number 85/TAHUN-Kehut/1967 dated 15 June 1967 and confirmed by the Minister of Agriculture with Decree of the Minister of Agriculture Number 792/Kpts/Um/10/1982 dated 29 October 1982 [6].

This conservation area is located at an altitude of 200 - 1000 m above sea level and covers the areas of Kersik Serai, Kersik Lepok, Kersik Meraduk, Kersik Kerbangan and Kersik Luway itself. Geographically located at 0017' - 0022' South latitude and 115040' - 115047' East, with climatic conditions in type A of the Schmidt and Fergusson classification. The extreme kerangas forest in this area is dominated by low-trunked trees of the species *Syzigium sp, Tristaniopsis sp, Vitex pubescens, Melastoma malabathricum* and others, while in the burnt shrub area many plants of pioneer species are found including *Anthocephallus sp, Octomeles sumatrana*, and others.

3.2 Discussion

Fields in former Kerangas forest areas are left abandoned, invaded by bushes and dominated by various types of ferns. The results of research on sapling vegetation or better known as the sapling stage of extreme kerangas forest in 2500 research plots in Kersik Luway Nature Reserve contained 38 225 individuals consisting of 16 species from 13 tribes, with 4 of them being vegetation classified as shrubs, namely *Hoya sp, Humata vestita, Rodomytus tamentosa Hask and Nephenthes*. As for the 10 species that were the most common vegetation saplings (Table 1), 5 of them dominated, namely *Tristania obovata* species found 198 individuals, *Ilex hypoglauca* Laec species found 188 individuals, *Podocarpus neriifolius* D.Don species found 177 individuals, *Ficus* sp. found 167 individuals, and *Calophyllum glaucum* species found 162 individuals. The vegetation types that were found in the highest number of individuals also showed that they were most often found in all research plots. As for the 10 types of sapling vegetation most often found in (Table 1), 5 of them are most easily found in almost every part of the extreme kerangas forest, namely *Tristania obovata, Ilex hypoglauca* Laec, *Podocarpus neriifolius* D.Don, *Ficus* sp, and *Calophyllum glaucum*.

Mueller-Dombois [9] also argue that the high frequency of presence of a species gives an idea that the presence of the species is more stable or has the opportunity to be able to maintain the growth and sustainability of the species. Conversely, if the species found in natural forests are evenly distributed or scattered in the area, where the more evenly distributed the number of individuals of each species found in an area, the more evenly distributed and abundant the species will be. Species diversity has a strong relationship with species richness which is also influenced by the distribution/evenness of a species. The more species found and with a high level of evenness in an area can indicate that the area has high species diversity as well.

After measuring the average height of the saplings, it was found that it showed the same trend as the observation of the number of individuals and the number of times a species could be found. Of the 10 species of seedling vegetation with the tallest trees (Table 1), 5 species had the largest average height, namely *Vancinium bancamum* Miq with an average height of 98.88 cm, *Eugenia palembanica* Merr with an average height of 86.74 cm, *Calophyllum glaucum* with an average height of 76.36 cm, *Tristania obovata* with an average height of 70.71 cm, and *Podocarpus neriifolius* with an average height of 66.94 cm.

Under such low nutrient conditions, some plants can grow there with morphological performance, some of which have stems skinny-dwarf, small-thick leaves, wide-rather hairy, thick-somewhat watery and others. This is a form of adaptation of each plant to the conditions its environment [6,7].

Table 1. Recapitulation of the number of individuals (N), frequency (F) and average height (H) of the top 10 species of seedling in the kerangas forest area of Kersik Luway Nature Reserve

No	Seedling Spesies	N (individual)	F (Frequency)	H (cm)
1.	*Tristania obovata*	198	85	70.71
2.	*Ilex hypoglauca* Laec.	188	71	65.99
3.	*Podocarpus neriifolius* D.Don	177	70	66.94
4.	*Ficus* sp	167	67	63.17
5.	*Calophyllum glaucum*	162	71	76.36
6.	*Vancinium bancanum* Miq	144	62	98.99
7.	*Ardisia* sp	99	59	59.39
8.	*Vitex pubescens*	87	58	56.56
9.	*Eugenia spicata* Lam	71	55	55.62
10.	*Eugenia palembanica* Merr.	62	59	86.74

The type of *Tristania obovata* with the highest number of individuals shows that this type of vegetation is better able to adapt to the conditions of the kersik soil which is composed of podzolic soil and silica sand which is very poor in nutrients, high rainfall and very low nutrient availability. At a depth of one metre below the soil surface of the Kerangas forest you will find a layer of white podsol that acts as a water catchment. The groundwater is black and nutrient-poor. In these low nutrient conditions, some plants can grow there with diverse morphological performance, some have thin-dwarf stems, small-thick leaves, wide-rather hairy, thick-rather juicy and others [9].

Based on the research results presented in Table 1, these vegetation saplings turned out to be after the calculation of the Scientific Domination Ratio also showed the highest number, although the order of the highest and the lowest was not identical with the highest number of individuals. And also the most resistant to damage to ecological conditions due to forest fires, because based on the results of research by [10] the type of *Tristania obovata* also shows a high level of dominance. And this species can also It was found in almost every subplot of the study, which means it showed the best distribution compared to the sapling vegetation of other species [2,11] .

This is because these plants have the ability to survive and tolerate soil conditions that are very low in nutrients. The vegetation in the kerangas forest has very little diversity. This is because not all plant species can survive on soil that can be said to be quite heavy. This is also one of the characteristics of the kerangas forest ecosystem, where vegetation can survive in nutrient-deficient conditions. Such vegatation over time and accompanied by changes in environmental conditions and also its habitat has shown a high level of stability [9,12].

These observations show that the species found in the extreme kerangas area are able to survive and continue to grow and reproduce well, even though the area has experienced forest fires. At the same time, they were also able to maintain their presence against high levels of competition, especially as a result of pioneer plants and alang-alang grass (*Imperata cylindrica*) [13]. Based on these diameter classes, the density of individuals decreases from small-diameter trees to large diameter trees, like an inverted J curve [3,9,14].

This is due to the seedling level, plants that require shade so that the species found below are resistant species underneath is a species that is resistant to competition with other species in nutrients and sunlight. Differences in the level of species stability are caused by certain species that only occupy a location or do not spread in an area and the existence of species that dominate over other species in one area compared to other species in one level of growth [1,6].

This confirms that the of the kerangas forest consists of a mixture of all diameter classes with dominated by trees that are not diameter trees, thus ensuring continuity of the stand in the future future. The distribution of forest stands by tree diameters like an inverted J curve is referred to as abalanced forest. Efforts to preserve the remaining Kerangasland forests can be made into conservation areas. Meanwhile, unproductive Kerangas forests will immediately be rehabilitated with endemic tree species. Kerangas forests in plantation areas need to be made into protected areas to maintain their biodiversity [2,14].

4. CONCLUSIONS

In the extreme kerangas forest area of Kersik Luway Nature Reserve covering an area of 1

hectare, 38,225 individual saplings can be found consisting of 16 species from 13 tribes.

Tristania obovata sapling vegetation is vegetation that has the ability to grow and develop in extreme kerangas areas, especially in the extreme kerangas forest of Kersik Luway Nature Reserve.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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