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Research Article

Macroscopic Fungi in Grassland and Rubber Plantation Habitat Types in Special Purpose Forest Areas of Universitas Lambung Mangkurat, Indonesia

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Abstract

In addition to secondary natural forests, other habitat types that also exist in the Special Purpose Forest Area of Universitas Lambung Mangkurat (KHDTK ULM) are grasslands and rubber plantations. While previous studies have documented macroscopic fungal species in secondary natural forests, there has been no documentation on fungi in the last two habitat types. This study aimed to analyze macroscopic fungal species present in these two habitat types and the substrates they inhabit. Fungal species and their substrates were recorded on a 250 m x 8 m track between May and September 2024. Each track was placed at three locations representing grasslands and three locations representing rubber plantations. In total, ten fungal species were found in grasslands and 7 species in rubber plantations. The similarity index of the fungal communities in the two habitats was categorized as very low (23.53%). Additionally, more fungal species were found on substrates such as dead trunks (rotten wood) compared to those found in the soil.

Keywords: fungi, grasslands, rubber plantations, species richness, substrate.

1. Introduction

The Special Purpose Forest Area (Kawasan Hutan Dengan Tujuan Khusus) of Universitas Lambung Mangkurat, hereinafter referred to as KHDTK ULM is a forest area whose management was handed over to Universitas Lambung Mangkurat by the Ministry of Environment and Forestry (now called the Ministry of Forestry). The 1,617-hectare area located in Karang Intan District, Banjar Regency, South Kalimantan is managed for education and training purposes. Its determination is based on the Decree of the Minister of Forestry and Environment No. 900/Menlhk/Setjen/PLA.0/2016 dated December 6, 2016.

Various activities have been carried out in the area. The Faculty of Forestry ULM carries out fieldwork practices (Praktek Kerja lapang) for its students every year. Numerous research are carried out by both educators and ULM students. The results are published, not only to demonstate ULM's responsibility as the manager of KHDTK ULM, but also to contribute to scientific discussion, enriching insight and facilitating the discovery of new things in science. The publications cover a range of topics, including biodiversity (Purbaya et al., 2020; Saputra et al., 2021, Susilawati et al., 2023; Syaifuddin et al., 2023), ecology (Alfiannoor et al., 2023; Nurhidayati et al., 2021), medicinal plants (Nugroho et al., 2022, 2023), physical, mechanical, and chemical properties of wood

(Fadhil et al., 2020; Pujowati et al., 2022), and phytochemistry (Muhammad et al., 2021; Wibisono et al., 2020).

Recent research results, macroscopic fungi are interesting topic to further study. Macroscopic fungi have visible fruiting bodies (Christita et al., 2017) which generally consist of parts such as blades, caps, stalks, rings, and volva, although some species do not have rings (Fauzan et al., 2023). Fungi, also known as mushrooms, can be observed with the naked eye, without using a microscope (Christita et al., 2017; Fauzan et al. 2023). They play an ecological role, including as organisms involved in the decaying of wood and organic matter (Fukasawa & Matsukura, 2021), nutrient cycles (Salillih, 2023). Economically, they serve important functions, such as a source of food (Pouris et al., 2024) and medicine (Hobbs, 2023; Valverde et al., 2015).

Nearly 36 species of macroscopic fungi have been identified in the KHDTK ULM arboretum, although some of the species' names have not been confirmed (Ayunisa et al., 2020). This number is estimated to be smaller than the number of fungi that can actually be found in the area. KHDTK ULM is not only an arboretum which according to its forest type is classified as a secondary forest. Within this education and training forest area, there are two other types of forests, namely grasslands and rubber plantations.

The purpose of this study was to analyze the presence of macroscopic fungal species in various habitats, specifically in grasslands and rubber gardens. Each species found was documented through photographs. These photographs are not only for identification and publication, but also prepared for field guide materials that will be compiled later.

2. Material and Method

Research location

This study using the exploration method, was conducted in two types of habitats in KHDTK ULM: grasslands and rubber plantations. Each type of habitat is represented by three locations (Table 1 and Figure 1). These locations were determined randomly based on their accessibility by 4-wheeled vehicles and the visibility of the plants directly in the field.

Table 1. Coordinates of research locations and habitat types

Habitat Types	Location 1	Location 2	Location 3
Rubber plantations	S 3^0 30' 49", E 114^0 56' 14"	S 3^0 30' 52.62", E 114^0 55' 54.82"	S 3^0 32' 9.74", E 114^0 56' 28.33"
Grasslands	S 3^0 30' 23.82", E 114^0 57' 16.53"	S 30 30' 54.25", E 1140 56' 48.64"	S 3^0 32' 37.40", E 114^0 54' 57.79"

A grassland is an area dominated by wild grass known as ilalang (*Imperata cylindrica*). This area initially was a forest that was then cut down illegally and abandoned or burned, due to deliberate burning or natural causes. At certain times this area is replanted through reforestation program or critical land rehabilitation, although the outcomes of the program not as expected. Some plants fail to thrive, while others manage to survive even though they only lived a little or up to the level of saplings. In addition to areas formerly

covered by forests, grasslands can also be formed from a thin layer of topsoil that covers or is underneath rocks.

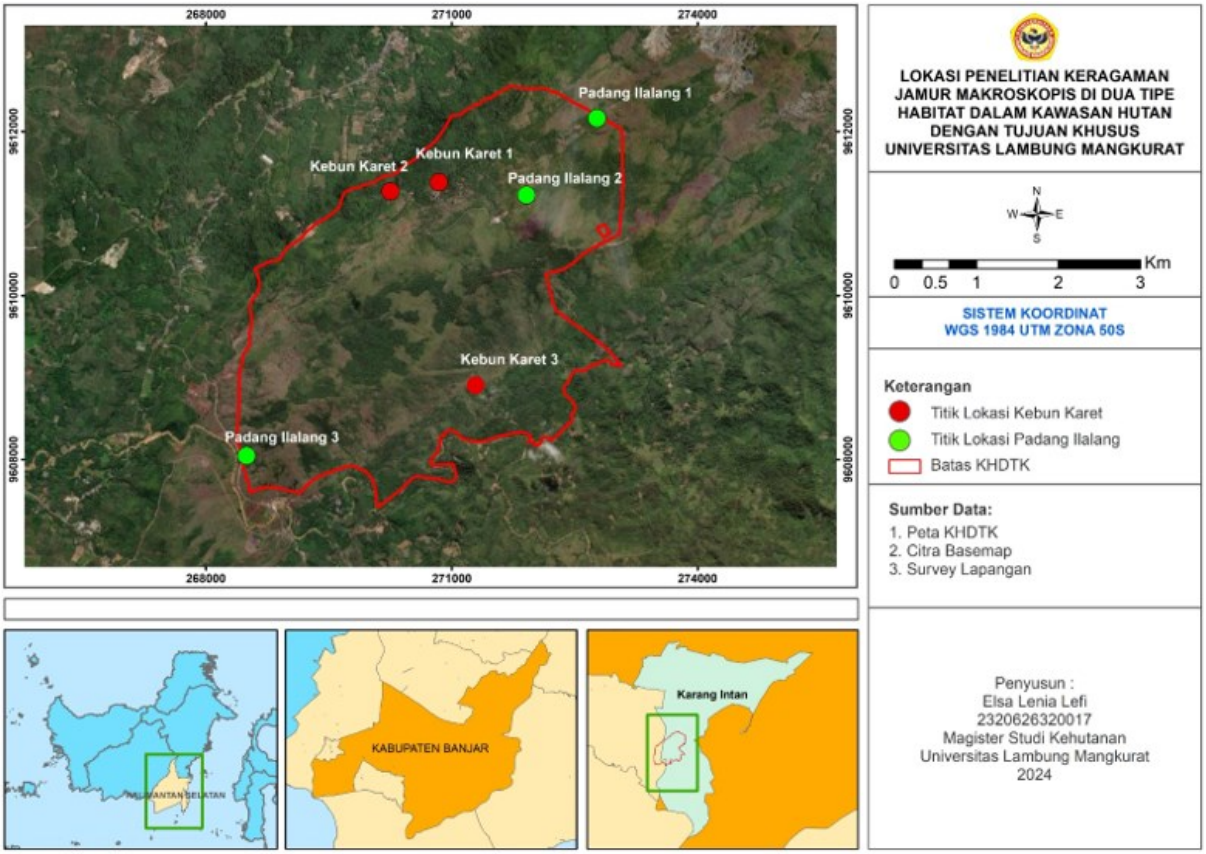


Figure 1. Map of research locations (grasslands and rubber plantations)

Rubber plantations are areas dominated by cultivation of rubber trees (*Hevea brasiliensis*). This area is managed by people who live in nearby villages close to the forest. Their daily activities includes tapping rubber sap, mixing sap, and clearing land from undergrowth or other plants that could hinder sap production.

Data collection and analysis

At each location, an observation path measuring 250 m x 8 m was placed. Macroscopic fungi observed on the path were recorded, their dimensions were measuredand documented through photographs taken from May to September 2024. Photos were taken from various angles, including above, below, and to the side of the object. Fungi were identified by comparing documented photos with those from published articles, such as from Christita et al. (2017), Putra (2021), Putra et al. (2018, 2022), Putri et al. (2024), and Wibowo et al. (2021).

Other objects that are recorded are the substrates where the mushrooms grow. These substrates are categorized into dead trunks, dead branches, or rotten wood (DT), both fallen and still standing; leaf litter (LL), twig litter (TL), and soil (S).

The data were then analyzed in greater detail. Species diversity is identified with species richness (S), which refers to the number of species found or present based on their substrate or present based on their habitat type. The similarity index (Sorensen) is calculated based on Formula 1. The substrate utilization ratio is calculated based on Formula 2.

Species diversity = species richness = **S**

Sorensen similarity index $\mathbf{IS} = \frac{\mathbf{2\,C}}{\mathbf{A + B + 2\,C}}$ ..... Formula 1

Substrate utilization ratio $\mathbf{SUR} = \frac{\mathbf{FPS}}{\mathbf{FAS}}$ ..... Formula 2

In this case:

1) IS = Sorensen similarity index; A = number of fungal species found only in habitat type A; B = number of fungal species found only in habitat type B; C = number of fungal species found in both habitat types; in this case A and also B.
2) SUR = substrate utilization ratio; FPS = number of fungal species living on a particular substrate; FAS = number of fungal species on all substrates.

3. Results and Discussion

3.1. Results

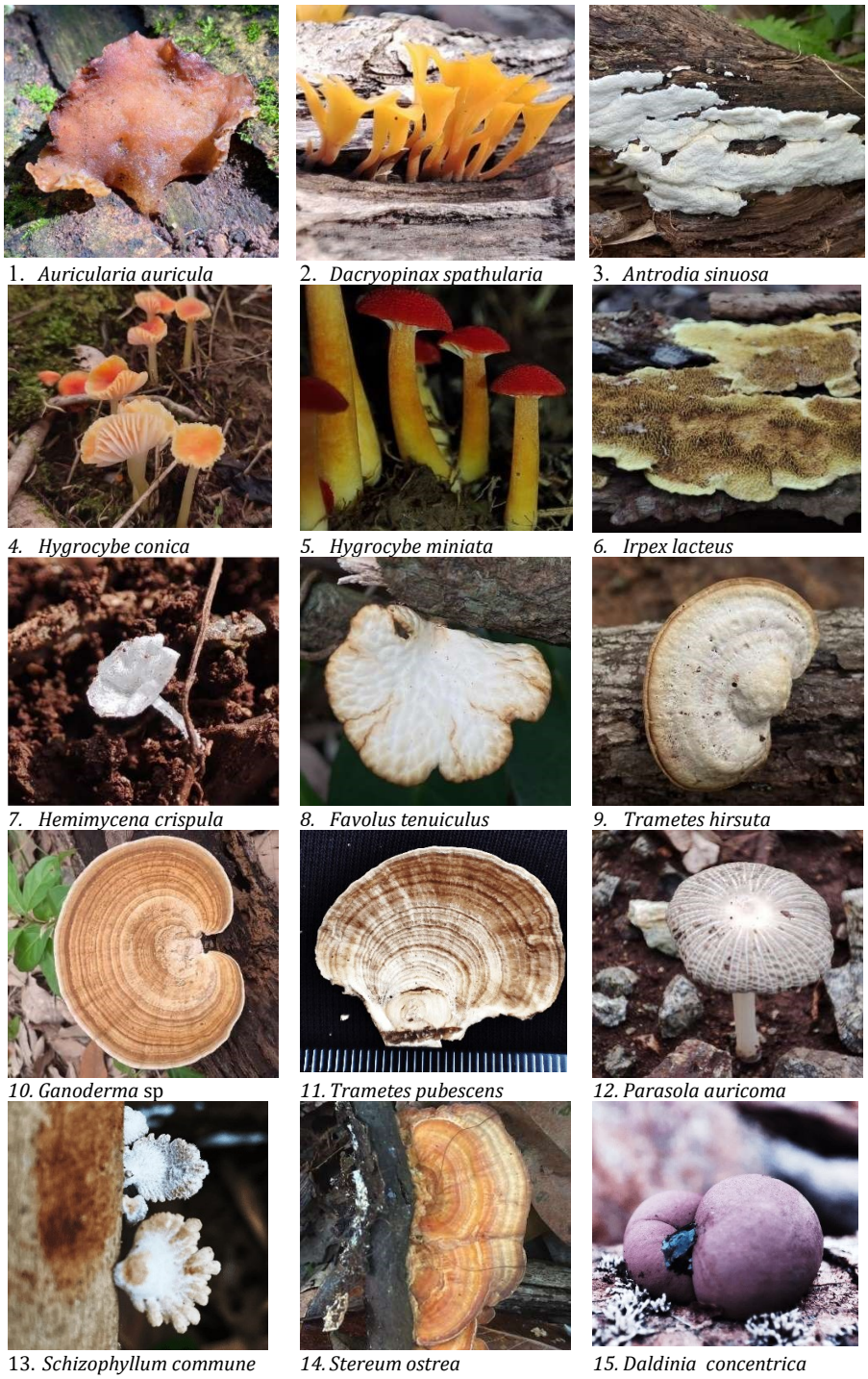
A total of fifteen species (11 families, 2 divisions) of macroscopic fungi were found in the grasslands and rubber gardens (Table 2, Figure 2).

Table 2. Macroscopic fungal species and their substrates in KHDTK ULM

No.	Divisions, families, and species of macroscopic fungi	Vernacular name	Substrate in the grassland		Substrate in rubber plantation	
			DT	S	DT	S
I.	**Basidiomycota**					
	A. Auriculariaceae					
	1. *Auricularia auricula*	Jamur kuping	P	-	-	-
	B. Dacrymycetaceae					
	2. *Dacryopinax spathularia*	Jamur *jelly*	P	-	-	-
	C. Fomitopsidaceae					
	3. *Antrodia sinuosa*	-	-	-	P	-
	D. Hygrophoraceae					
	4. *Hygrocybe conica*	Kulat tiung	-	-	-	P
	5. *Hygrocybe miniata*	Kulat jala	-	-	-	P
	E. Meruliaceae					
	6. *Irpex lacteus*	Jamur-pelapuk putih	P	-	-	-
	F. Mycenaceae					
	7. *Hemimycena crispula*	-	-	P	-	-
	G. Polyporaceae					
	8. *Favolus tenuiculus*	Jamur mekar	P	-	-	-
	9. *Ganoderma* sp.	-	-	-	P	-
	10. *Trametes hirsuta*	Kulat tadung	P	-	-	-
	11. *Trametes pubescens*	Kulat gadong	P	-	P	-
	H. Psathyrellaceae					
	12. *Parasola auricoma*	-	-	P	-	-
	I. Schizophyllaceae					
	13. *Schizophyllum commune*	Kulat taun, jamur gerigit	P	-	P	-

J. Stereaceae					
14. *Stereum ostrea*		-	-	P	-
II. Ascomycota					
K. Xylariaceae					
15. *Daldinia concentrica*	Kulat kancing	P	-	-	-
Richness of fungal species according to their substrate		**8**	**2**	**5**	**2**
Richness of fungal species according to their habitat type		**10**		**7**	

Note: P = present; DT = dead trunks, dead branches, or rotten wood; S = soil



1. *Auricularia auricula* 2. *Dacryopinax spathularia* 3. *Antrodia sinuosa*
4. *Hygrocybe conica* 5. *Hygrocybe miniata* 6. *Irpex lacteus*
7. *Hemimycena crispula* 8. *Favolus tenuiculus* 9. *Trametes hirsuta*
10. *Ganoderma* sp 11. *Trametes pubescens* 12. *Parasola auricoma*
13. *Schizophyllum commune* 14. *Stereum ostrea* 15. *Daldinia concentrica*

Figure 2. Macroscopic fungi species in KHDTK ULM

Fungi were observed in two different types of habitats. The number of species found in the grassland was greater than that in the rubber plantation. Based on the presence of fungi in the two types of habitats, the fungal community similarity index in this study was categorized as very low (23.53%). Only two fungal species were found in both habitat types but on the same substrate. They are *Trametes pubescens* dan *Schizophyllum commune.* In terms of substrate, more fungal species were found in the dead stems than in the soil, in both the grassland habitat and the rubber plantation (Figure 3). Additionally, no fungi were found that utilized leaf litter and twig litter as substrates.

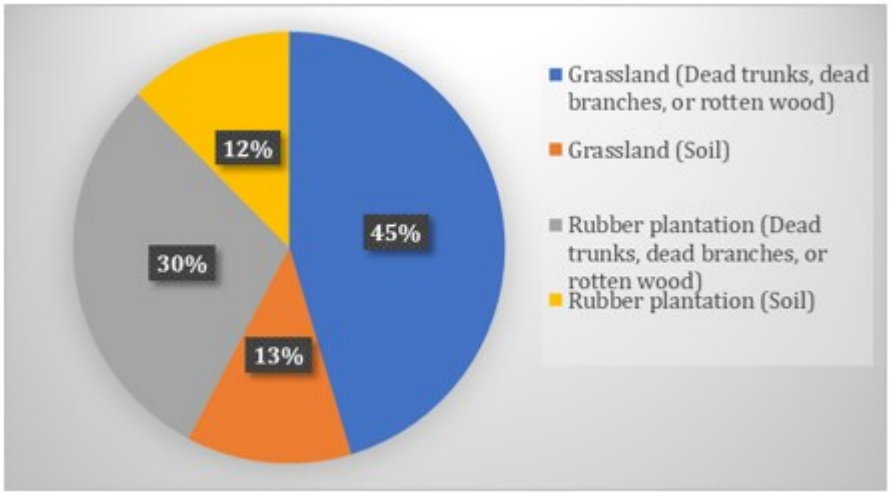


Figure 3. Ratio of fungi utilizing substrate

3.2. Discussion

Macroscopic fungal species

Researchers only observed the existence of species of fungi in grassland and rubber plantation ecosystems, which accounts for the variance in numbers. This number is lower than the number reported by Ayunisa et al. (2020) in secondary forests within the KHDTK ULM, which found 36 species (17 families). While the identification of several fungal species found by Ayunisa et al. (2020) remains unclear, the presence of 15 fungal species in the grasslands and rubber gardens not only contribute to the total number of species, but also show the richness of fungal species in the KHDTK ULM.

Fungi diversity is low in grassland habitats when there are not numerous trees or shrubs. Though the temperature and humidity in grasslands are typically higher, the fungal diversity in these ecosystems is relatively low due to the limited forms of organic materials (such as fallen leaves or plant waste) that are available to fungus. The absence of natural vegetation structure, intense crop management, and pesticide use frequently ends in a decrease of fungi diversity in rubber plantation locations.

Naturally, there are additionally specific times during the year when mushrooms will grow. This happens as consequence of their dependence on specific humidity and temperatures. The humidity in the closed secondary forest area will be higher than that of

the grassland. The forest floor receives very little sunlight because of the shade provided by the many, dense trees. The roots and canopy of plants hold on water when it rains. The vapor of water will be absorbed during this process, leading to lower temperatures, lower humidity, and cooler environments. High intensity light is not needed for mushrooms to survive and grow. Primordia initiation in mushrooms is dependent on light, and it additionally influences the growth of stalks, caps, spores, and hymenium development. Each area has a variable light intensity, which may be caused by uneven canopy cover.

For the record, the following research findings outlines the number of fungal species found in KHDTK and research forests managed by other universities. In KHDTK Tanjungpura University, 17 out of the 24 macroscopic fungal species were found in open-crown peat swamps and 13 species were found in closed-crown peat swamps (Utama et al., 2019). Putra et al. (2019) reported 11 species (7 families) of fungi found in the IPB University Campus Forest. In a subsequent study, Putra et al. (2020) reported 18 species comprising 13 families of fungi.

Several species of mushrooms found in KHDTK ULM are considered beneficial for human health and well-being. *A. auricula* (ear mushroom) contains antioxidant and antibacterial substances (Elfirta & Saskiawan, 2020; Sukmawati et al., 2019). It has medicinal substances that slow down aging, control the digestive system, overcome cardiovascular disorders (Yu et al., 2023), and serve as food ingredients (Arko et al., 2017). *H. conica* (tiung mushroom) is a source of natural antioxidants (Chong et al., 2014; Chun et al., 2021) and can be used as functional food (Chong et al., 2014). *Ganoderma* spp. is widely recognized as a medicinal mushroom (Jong & Birmingham, 1992). *S. commune* has antioxidant and antitumor properties and can also be used as a food ingredient (Arko et al., 2017). Despite these benefits, these mushrooms have not been widely utilized by either ULM or the local community. Usually, community knowledge about edible mushrooms is conveyed orally or by word of mouth (Dewi et al., 2022), a common communication method in traditional communities.

Similarity index and substrate

Environmental factors have a significant impact on an organism's spread and growth (mycelium and mushroom fruit bodies); each species must survive in abiotic environments that are within its tolerance limits (Roosheroe, 2006; Tapwal et al., 2013). The abiotic variables environment (temperature, pH, and humidity) has a significant impact on fungal growth. Different substrates will usually cause different types of mushrooms to grow, as will differences in environmental conditions, such as air humidity, soil humidity, temperature, soil acidity (pH), light intensity. Fungi that grow on dead or living tree trunk substrates, particularly from the Basidiomycota Division, are the primary decomposers of lignin and lignocellulose in wood or roots (Tampubolon, 2012). Mushrooms become parasites, mutualistic symbionts, and decomposers in order to receive nutrition (Wati et al., 2019).

The higher presence of fungal species in dead trunks compared to soil is believed to be due to the several factors. Trunks or branches (also known as wood) are natural materials primarily composed of cellulose, hemicellulose, and lignin along with extractive substances (Augustina et al., 2021; Shobib et al., 2023). In dead wood, these components provide a rich source of nutrients that are abundant and suitable for fungal growth. Nutrients are part of the trunk that is basically organic material, they remain intact even when the trunk is exposed to heavy water or flooding.

The opposite happens in soil substrates. Nutrients resulting from wood decay or the breakdown of organic matter do not remain in the soil for long. Nutrients are not part of the soil and are not bound to it, making them susceptible to loss. Nutrients are easily washed away by infiltrating water, which flows through the pores of the soil to deeper layer. Nutrients are also easily lost by floods. Flooding is a process when water flows rapidly from a certain area to a further area where the ground surface is lower. In such soil substrate, there may be a complete absence of nutrients and fungi.

Conclusion

Out of 15 macroscopic fungal species, 10 species (*Auricularia auricula*, *Dacryopinax spathularia*, *Irpex lacteus*, *Hemimycena crispula*, *Favolus tenuiculus, Trametes hirsuta, Trametes pubescens, Parasola auricoma, Schizophyllum commune, Daldinia concentrica*) were found in the grassland and 7 species (*Antrodia sinuosa*, *Hygrocybe conica*, *Hygrocybe miniata*, *Ganoderma* sp., *Trametes pubescens*, *Schizophyllum commune*, *Stereum ostrea*) in the rubber plantation. Most of the fungi utilized dead stems as their substrate rather than the soil. The similarity index of the fungal communities in both habitat types was classified as very low.

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