Studying macroscopic mushroom diversity at Bandealit Resort, Meru Betiri National Park, Jember, East Java

Salma Fadilatul Lailiyah, Muhammad Zainul Arifin*, Fikri Sakti Firmansyah, Wahyudi Fauzi Tanjung, Pradhipta Oktavianto, Annas Abi Hamzah, and Elis Nina Herliyana

1 Silviculture Department, Faculty of Forestry, IPB University (Bogor Agricultural University), Bogor, Indonesia

*Corresponding e-mail: nifiraarifin98@gmail.com

Abstract. Mould is an important part of the eukaryotic organism in the forest ecosystem. The diversity of fungi in the Indonesian forest, especially in Bandealit Resorts is largely due to the conditions of vegetation and the supportive environment. The purpose of this study is to study the diversity of macroscopic mushroom in the Bandealit Resorts, Meru Betiri National Park, Jember Regency, East Java. Macroscopic mushroom diversity data is scooped up by cruising methods. The mould found is recorded as data based on mushroom morphology such as colors, substrates, covering forms, stalk forms, and has pores or lamella. In addition to environmental data of temperature, humidity, and headedness is also taken to determine biotic and environmental factors that foster the growth of mushroom. Mushroom documentation was then passed by way of comparison. Based on the identification, we found a fungus with two Phylum: Ascomycota and Basidiomycota, with as many as 33 species belong to 8 ordos. The Basidiomycota group is most commonly found and with the most dominated order of Polyporales. Most of the mushrooms are found in soot substrates.

1. Introduction

Forest are among ecosystem storing the wealth of biodiversity. Such biodiversity includes flora, fauna, and fungi. The presence of fungi within the forest ecosystem plays an important role in helping to reduce organic materials such as cellulose, hemicellulose, lignin, protein, and the starch compound with a rush aid. Mould describes organic material into a compound that is absorbed and used for growth and development so that the cycles of matter in nature can continue [1].

The role of mushrooms as a decomposer is very important because it can balance the diversity of species in the forest. Besides, macroscopic fungal groups significantly affect food webs in the forest, the survival or germination of tree saplings, tree growth, and overall forest health. So, the presence of macroscopic fungi is an important indicator of dynamic forest communities. Macroscopic fungi can grow in media containing high humus, such as humid soil, fallen trees that have rotted and leaf litter. However, it is not uncommon for macro fungus to grow in grasslands, in the soil, or in animal dung.

At present only 5 (five) per cent of the total fungi in the world are known, which is about 100,000 species (98,998 species to be exact). The biggest contributors were Ascomycota with 64,163 species and Basidiomycota with 31,515 species [2]. Besides, there are still many macroscopic fungal species whose benefits are not known to date, as a country that has extensive tropical rain forests with a high diversity of macroscopic mushroom species, in Indonesia's forests research on macroscopic mushroom
diversity has not been widely carried out. Until now, data and literature on the diversity of macroscopic fungi in Indonesia are still very limited. Mushrooms usually grow in shady environmental conditions and high levels of humidity, wind currents and lighting. Some other factors are the need for indirect sunlight, the condition of this fungus can grow quickly, the temperature and cool air circulation, and environmental conditions in the lowlands are very suitable for macroscopic fungal life [3].

The Meru Betiri National Park area is geographically located between 113 ° 37′23″ - 113 ° 58′11″ BT and 8 ° 20′31″ - 8 ° 35′09″ LS and its status are for the conservation of fauna species and flora, world heritage sites and biosphere reserves. Meru Betiri National Park has an abundant diversity of flora and fauna, one of which is from the type of fungus. The climate in the Meru Betiri National Park area is based on the Schmidt and Ferguson climate classifications, including climate types B to C with an average rainfall of 1300 mm - 4000 mm per year. Altitude from the coastline (0 m) to 1100 meters above sea level which is the highest peak of Mount Betiri [4]. Such environmental conditions can support the growth and development of fungi in Meru Betiri National Park. Therefore, it is necessary to examine the diversity of macroscopic fungi found in Meru Betiri National Park, especially in the Bandealit Resort. This research aims to examine the diversity of macroscopic fungi in the Bandealit Resort, Meru Betiri National Park, Jember, East Java.

2. Method

2.1. Time and Place
Observation activities carried out from June 7-11, 2018, which entered the dry season. Macroscopic mushroom diversity data collection was carried out in the lowland forest ecosystem with a height of 176 meters above sea level in the fourteen sample plot and 304 above sea level in the Pringtali sample plot included in the Bandealit Resort area, Meru Betiri National Park, Jember, East Java.

2.2. Materials
The tools and materials used in the study are stationery, HVS paper, tally sheets, stationery, coins, cameras, tweezers, thermo-higrometers, densiometers, tape, and mush-room identification books. Other paragraphs are indented (BodytextIndented style).

2.3. Procedure
Sampling was carried out by the roaming method [5], which was exploring all the plots that had been made, namely the Fourteen Plots and Pringtali Plots. In each plot, a measuring plot of 500 m x 500 m was made for the Fourteen plot and the Pringtali plot. Fungal observations include macroscopic fungal morphological characteristics, namely the size and shape of the fruit body, the color of the mushroom body, the shape of the hood edge, the width of the hood, the presence of pores or lamellae, the presence and location of the stalk, the length of the stalk, the length of the stalk, the color of the stalk, the presence of a ring.

Besides, environmental factors were measured including temperature, humidity, canopy density and soil pH in each plot. Measurement of temperature and humidity data used a thermohigrometer while the data density of the crown using a densiometer. Temperature and humidity measurements using a thermohigrometer are done by hanging the device in a branching plant. Then, wait for 1-3 minutes and record the results. Measurement of canopy density with a densiometer is done by taking 5 points on certain plots. Each of these points can be measured the density of the canopy by facing 4 different cardinal directions. Then, the data is written and processed the results of the header density.

The fungus found was then taken by a camera and given a coin comparison to find out its size and the morphological results were recorded into a tally sheet. Mushroom samples put in plastic. Identification of mushroom species refers to the book Illustrated Genera of Wood Decay Fungi by...
Charles L and Fergus, The Complete Encyclopedia of Mushrooms by Gerrit J Keizer, and Pocket Guide to Mushroom by Jean Marie Polese.

2.4. Data Processing
Data processing is done using the Ms. application. Excel. The data obtained is then processed to determine the number of types of mould found. Data is processed based on mushroom abundance, ecological function, and where mushrooms are found. Then presented in the form of graphs and tables. Data that has been processed illustrates the diversity of mushroom species found in lowland forest ecosystems observed in Meru Betiri National Park.

3. Result and discussion
Research related to macroscopic mushroom diversity carried out at the Bandealit Resort, Meru Betiri National Park which belongs to the lowland ecosystem. The location is at an altitude of 176 meters above sea level in the fourteen sample plot and 304 above sea level in the sample plot. Both sample plots have general conditions that tend to be the same because the location of the sample plot is at the same resort. Research conducted on the two sample plots produced a diversity of fungi that can be seen in Figure 1 below.

![Figure 1. Distribution of the number of fungi from the order found in the Bandealit Resort area](image)

Based on Graph 1, found 2 phylum, namely Ascomycota and Basidiomycota phylum. Both of these phyla are included in the Subkingdom Dikarya which represents the synmorph of diatrophic hyphae. This subkingdom has characteristics that can distinguish it from other subkingdoms, namely its single-celled fungus, hyphal-shaped, do not have a flagella locomotor, and generally are in the diatrophic phase [6, 7].

In Phylum Ascomycota, 3 orders were found, namely Xylariales consisting of 2 genera, Pezizales and Geoglossales consisting of 1 genus each. According to Herliyana [8], Phylum Ascomycota has the characteristics of sexual spores formed in the ascus, single cells, dimorphic mycelium, hyphae have septum, simple septal pores, cell walls generally consist of chitin, and can mate and reproduce asexually with individuals other. The Ascomycota phylum, which is a macroscopic fungus, is the Pezizomycotina subfile with the class Sordariomycetes.

Basidiomycota is a multicellular fungus and has insulated hyphae. Basidiomycota vegetative hyphae are present in its substrate, for example on bark, soil and leaf litter. Some generative hyphae
make up the fruiting body and some don't. The body of the fruit is called basidiocarp. Basidiomycota grows naturally, generally living as saprophytes on the remains of living things, such as leaf litter on the ground, rice straw, and dead tree trunks [9].

In the Basidiomycota Phylum, found 5 Order, namely Polyporales, Russulales, Hymenochaetales, Corticinales, and Trechisporales as well as 3 species that have not been identified which are thought to originate from the Phylum Basidiomycota. Based on Figure 1, the Polyporales Order has the most number of genera found, which is 10 genera. According to [10], the Order Polyporales is one of the orders originating from Basidiomycetes which has many species and is most found in wood substrates and can adapt to unfavorable environments.

The Polyporales Order is an order originating from the Agaricomycetes class which has the characteristics of a hymenomycetous or gasteroid fruit body, basidia consisting of 2 to 8 spores, and parentosomes perforat-imperforates. This class is equivalent to Homobasidiomycetes sensu plus Auriculales and Sebacinales. The Order of Polyporales is included in Agaricomycetes incertae sedis, which is a class of Agaricomycetes that is not placed in any subclass [7]. In addition to the order Polyporales, order Trechisporales, Hymenochaetales, Corticinales and Russulales are also included in Agaricomycetes incertae sedis.

Based on abundance and habitat (Substrate) of fungi in both plots examples, substrate and habitat are fungi that have a food source for fungi. Fungal substrate is usually found on weathered / dead stems, soil, litter, and plants that are still alive. The results of observations on the diversity of macroscopic fungi in the two sample plots can be seen in Figure 2 below.

![Figure 2. Abundance of fungi (order) of the two sample plots on various substrates](image)

Based on Figure 2, the abundance of fungi found was most found in the weathered stem substrate, which is 7 orders of fungi, while the living and litter tree substrate was only found 1 order each. Fungi found in weathered stem substrates, namely the order Polyporales, Russulales, Hymenochaetales, Xylariales, and Pezizales. Wood fungus will grow either on wood that has weathered, or wood that is experiencing weathering [10]. Fungi are organisms that do not have chlorophyll. In its growth, fungi need food substances from the weathering process of other organisms that have died. This is also consistent with the opinion of Munir [11] which states that macroscopic fungi are the main group of organisms that degrade lignocellulose. Macroscopic fungi can produce lignocellulosic degrading enzymes such as cellulase, ligninase, and hemicellulase.

The Order Corticinales found in the substrate of a living tree is the genus Upasia which is attacking branching plants. However, most of the genus Upasia is found in dead / weathered stems. This type of litter substrate is only found in the Trechisporales order with the genus Trechispora. For substrate soil, no species were found in the substrate. This is because the soil conditions are less suitable for fungal growth.
Each fungus has the characteristics of the place to grow respectively. There is a fungus that likes to live in the shade and in an open area and is quite light. In addition, there are fungi that prefer living tree substrates, dead wood, leaves, or soil. The difference in the substrate causes different characteristics of the growing fungus.

Discuss about diversity of fungi based on ecological function, based on the identification of fungi that have been carried out, the ecological functions of fungi obtained can be classified into saprophytic fungi, saprocytes / parasites, and parasites which can be seen in Figure 3 below.

![Figure 3. Number of fungi based on their ecological function](image)

Based on Figure 3, the number of mushroom species found mostly has ecological fungi as many as 26 species of mushrooms. Types of parasites / saprophytes found 6 types while parasites found only 1 type of fungus. The types of fungi that are included in the parasite / saprofit are *Phellinus noxius*, *Rigidoporus* sp., *Ganoderma* sp., *Daedalea* sp., and *Lenzites betulinus*. These types of fungi become parasites in plants that are still alive and will become saprophytes when the host in question is dead. The fungus is a type of fungus that can cause disease and cause death for the host.

The type of fungus found as a parasite is *Trichaptum* sp. This fungus was found in the field still alive at the host it was on. The parasitic fungus relies heavily on its entire life with the host it is traveling on so that it will die when the host it is unable to survive because its growth is disrupted by parasitic fungi. These parasitic fungi are pathogenic fungi that are harmful to plants.

Saprophyte fungi are very dominant in the plains forest ecosystem in the Bandealit Resort, Meru Betiri National Park. Saprofit fungus is a fungus that can grow on dead substrates so that this type of fungus is not detrimental to plants. The presence of saprophyte fungus which is very dominating shows that the fungus functions in the forest ecosystem as a decomposer. The fungus breaks down organic matter that is on the forest floor into nutrients that can be utilized by plants so that it can help fertilize plants that are in place.

Mushroom growth is strongly influenced by several factors, namely biotic factors and abiotic/environmental factors. Biotic factors that influence the growth of fungi are the presence of vegetation. The existence of vegetation causes canopy cover which can directly influence environmental factors such as temperature and humidity. Some environmental parameters that have been measured are presented in Table 1. Measurement of environmental data shown in Table 1 shows that the lowest to highest canopy density conditions are 66.49% to 93.30%. This shows that the location of the study conducted had a close canopy cover.
### Tabel 1. Environmental data at Bandealit Resort, Meru Betiri National Park

| Environmental Factors | Empat belasan Plots | Pringtali Plots |
|-----------------------|---------------------|----------------|
| Heading               | 78.13%              | 93.30%         |
| Temperature           | 27.09 °C            | 25.13 °C       |
| Humidity              | 74.63%              | 76.75%         |

The temperature at the study site was 25.12°C in the preterm sample plot and 27.09°C in the 14th sample plot. The temperature conditions are supportive for the growth of the fungus itself because based on the statements of Charlie et al. [12] states that the fungus generally grows optimally in a humid place in the temperature range of 200°C – 300°C. The type of fungus found at the Bandelit Resort is included in the mesophilic fungus because the fungus grows in the temperature range of 25°C - 37°C.

Temperature and humidity are closely related environmental factors. When the temperature is low, the humidity will get higher and vice versa. The humidity obtained by measurement was 74.62% for the 14th sample plot and 76.72% for the pre-sample plot. The condition of the growing place is suitable for the growth of fungi because it can grow in the air humidity range of 70% - 90%.

States that ecological light, temperature and water are important environmental factors [14]. Environmental factors determine the spread and growth of an organism and each species can only live in certain abiotic conditions that are within a certain tolerance range suitable for the organism [15]. At the time of the study, the climatic conditions at the Bandealit Resort were experiencing a dry season, which affected the type of fungus that was growing. Fungi found in these environmental conditions are dominated by hard fungus species and are on wood substrates and are mostly porous fungi.

Macroscopic fungi not only have benefits as decomposers and balancing ecosystems in the forest. However, there are other benefits that can be used for consumption needs, medicines, souvenirs or others. According to [8], macrophages can be grouped into 4 groups, namely edible mushrooms, mushrooms that can be used as medicines (medicinal mushrooms), poisonous mushrooms (poisonous mushrooms), and mixed or unknown fungi. Below are some of the types of mushrooms that are known to be used.

Of the 33 types of mushrooms that have been identified, there are types that can be used as ingredients for medicines, consumption, and souvenirs or others. The types of mushrooms that can be used as medicines are the fungus Ganoderma lucidum, Ganoderma applanatum, Pycnoporus sp., Trichaptum sp. Xylaria polymorpha, and Xylaria sp. According to [16], the species of fungus Pycnoporus sanguineus can be used as a wound medicine. The fungus Ganoderma applanatum and Ganoderma lucidum are mushrooms that have been used by Chinese people as traditional medicine to reduce inflammation and prevent cancer. Trichaptum sp. is a parasitic fungus that can be used as an antioxidant, antibacterial, and anticancer [17].

The local people of Central Kalimantan turned out to have used the type of mushroom Xylaria sp. as traditional medicines have declined. This fungus is believed by the people of Lamunti Village, Kapuas Regency as a medicine for treating breast cancer. Mushrooms Xylaria sp. known as mushroom karamu this is one alternative treatment. This has been proven by several informants who have recovered with this mushroom drug. This fungus contains higher lentinan which is 0.74 µg / mg than lentinan in shittake mushrooms (Lentinula edodes) 0.54 µg / mg and oyster mushroom 0.11 µg / mg. This lentinan compound is an anticancer compound contained in the mushroom fruit body [18].
| No | Species                        | Use                      |
|----|--------------------------------|--------------------------|
| 1. | *Anthracobia melaloma*         | Not yet known            |
| 2. | *Antrodiella semisupina*       | Not yet known            |
| 3. | *Daedalea quercina*            | Bioremediation           |
| 4. | *Daedaleopsis confragosa*      | Not yet known            |
| 5. | *Daedaleopsis sp.*             | Not yet known            |
| 6. | *Datronia molis*               | Not yet known            |
| 7. | *Ganoderma applanatum*         | Medicines                |
| 8. | *Ganoderma lucidum*            | Medicines                |
| 9. | *Hymenochaete sp.*             | Non edible               |
| 10.| *Hyphoxilon multiforme*        | Not yet known            |
| 11.| *Hyphoxilon rubiginosum*       | Not yet known            |
| 12.| *Lentinus sp.*                 | Edible                   |
| 13.| *Lenzites betulinus*           | Not yet known            |
| 14.| *Microglossum viridae*         | Not yet known            |
| 15.| *Microporus sp.*               | Not yet known            |
| 16.| *Microporus xanthopus*         | Souvenir                 |
| 17.| *Peniophora incarnata*         | Not yet known            |
| 18.| *Phellinus noxius*             | Non edible               |
| 19.| *Polyporals brunalis*          | Not yet known            |
| 20.| *Polyporus ciliatus*           | Not yet known            |
| 21.| *Polyporus sp.*                | Not yet known            |
| 22.| *Polyporus varius*             | Not yet known            |
| 23.| *Pychnoporus sp.*              | Drugs                    |
| 24.| *Rogersella sambuci*           | Not yet known            |
| 25.| *Stereum subtomentosum*        | Not yet known            |
| 26.| *Terana caerulea*              | Not yet known            |
| 27.| *Trametes sp.*                 | Drugs                    |
| 28.| *Treichispora farinacea*       | Not yet known            |
| 29.| *Trichaptum sp.*               | Drugs                    |
| 30.| *Upasia sp.*                   | Not yet known            |
| 31.| *Xylaria polimorpha*           | Medicines                |
| 32.| *Xylaria sp.*                  | Drugs                    |

Types of mushrooms that have attractive colours, hard and durable make *Microporus xanthopus* mushrooms can be used as souvenirs. *Daedalea quercina* is a fungus of the order Pezizales. This fungus is thought to be used for bioremediation because it can degrade toxic dyes and pigments [19].

The edible fungus found in this research is the type of *Lentinus* sp. This fungus is including the woody weathered fungus which is commonly found in weathered wood. *Lentinus* sp. can be consumed while still young because if it is old the texture will become clay [8]. In addition to edible mushrooms, there are non-edible species, namely *Hymenochaete* sp. and *Rigidoporus* sp. Besides the mushrooms that have been mentioned, there are still many types of mushrooms that are still unknown. That is because research on the benefits of mushrooms is still very little.
4. Conclusion

Based on the results of macroscopic fungal identification found 2 phylum, namely Ascomycota and Basidiomycota. There are 33 species from 8 orders (Polyporales, Xylariales, Pezizales, Geoglossales, Russulales, Corticiales, Hymenochaetales, and Trechisporales) and 3 species that have not been identified. Basidiomycota is the most common phylum, which is dominated by the order of 12 genus Polyporales. Most mold is found on weathered wood substrates.

References
[1] Hasanuddin 2014 Jurnal Biotik 2 (1):1-76
[2] Kirk P, Cannon P F, Winter D W, Stalpers J A 2008 Ainsworth and Bisby’s Dictionary of The Fungi. 10th edn (Wallingford: CAB International)
[3] Hidayati, Hidayat R M, Asmawati 2015 Jurnal Pemanfaatan Serat Tanda Kosong Kelapa Sawit 6 (2):73-78.
[4] Siswoyo 2002 Bandealit resort map. Meru Betiri National Park, East Java. [In Indonesian: Peta Resort Bandealit. Taman Nasional Meru Betiri. Balai Taman Nasional Meru Betiri, Jawa Timur] (Jakarta: Direktorat Jenderal Perlindungan Hutan dan Konservasi Alam. Departemen Kehutanan)
[5] Rugayah W, Pratiwi 2004 Guideline for collecting flora diversity data. [In Indonesian: Pedoman Pengumpulan Data Keanekaragam Flora] (Bogor: Pusat Penelitian Biologi LIPI)
[6] James T Y, Kauff F, Schoch C L 2006 Journal of Nature 443:818-822
[7] Hibbet D S, Binder M, Bischoff J F, Blackwell M, Cannon P F, Eriksson O E, Huhndorf S, James T, Kirk P M, Lucking R, Lumbsch H T, Lutzoni F et al. 2007 The British Mycological Society. Science Direct. Elsevier. Mycological Research 3: 509-547
[8] Herliyana E N 2014 Biodiversity and potensial fungi in Indonesia. [In Indonesian: Biodiversitas dan Potensi Cendawan di Indonesia] (Bogor: IPB Press)
[9] Santoso 2004 Biology and life skills. [In Indonesian: Biologi dan Kecakapan Hidup]. (Bandung: Ganeca Exact)
[10] Suhardiman 1995 Wood fungi. [In Indonesian: Jamur Kayu]. (Jakarta: Penebar Swadaya]
[11] Munir E 2006 Use of microbe in bioremediation: an alternative technology for environmental conservation. [In Indonesian: Pemanfaatan mikroba dalam bioremediasi: suatu teknologi alternatif untuk pelestarian lingkungan] (Medan: Universitas Sumatera Utara)
[12] Carlile, M J Watkinson S C 1994 The Fungi (London: Academic Press)
[13] Gandjar I, Sjamsuridzal W, dan Oetari A 2006 Basic and applied mikology. [In Indonesian: Mikologi Dasar dan Terapan] (Jakarta: ID): Yayasan Obor Indonesia
[14] Tampubolon J 2010 Macroscopic mushroom inventory in ecotourism area, Bukit LAwang, Langkat regency, North Sumatera. [In Indonesian: Inventarisasi jamur makroskopis di kawasan ekowisata Bukit Lawang Kabupaten Langkat Sumatera Utara [thesis]] (Medan: USU Repository)
[15] Suin N M 2002 Ecology methods [In Indonesian: Metoda Ekologi] (Padang: Universitas Andalas)
[16] Chang Y S, Lee S S 2004 Fungal Diversity 15: 15-22
[17] Rolando R, Hariono M 2017 Asian Journal of Cell Biology 12:1-19.
[18] Gunawan Y E, Sunariyanti S, Wulandari D F 2016 Phytochemical analysis of leech content in Karamu mushroom (Xylaria sp.) as anti-cancer to support fungal matter in Senior High School. [In Indonesian: Analisis fitokimia kandungan lenditil pada jamur karamu (Xylaria sp.) sebagai senyawa anti kanker untuk menunjang materi jamur di SMA] (Palangkaraya: Universitas Palangka Raya)
[19] Asgher M, Bhatti H N, Ashraf M, Legge R L 2008 Biodegradation 19 (6):771-783