



Faculty of Resource Science and Technology

Diversity of Macrofungi in Gunung Gading National Park, Sarawak

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Bachelor of Science with Honours
Plant Resource Science and Management
2022

Diversity of Macrofungi in Gunung Gading National Park, Sarawak

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A final report submitted in partial fulfillment of the requirement for the degree of Bachelor of
Science with Honours
(Plant Resource Science and Management)

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Plant Resource Science and Management
Faculty of Resource Science and Technology
UNIVERSITI MALAYSIA SARAWAK
2022

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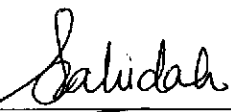
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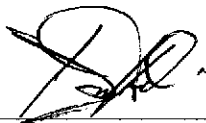
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ACKNOWLEDGEMENT

First and foremost, Alhamdulillah and most grateful to Allah S.W.T. for the strength and blessings throughout completing this final year project. I would like to express my deepest gratitude to my supervisor, Dr. Mohamad Hasnul bin Bolhassan for his expert guidance, suggestions, and support throughout the completion of this final year project.

I would like to thank Dr. Qammil Muzzammil Abdullah, coordinator of Plant Resource Science and Management programme, Faculty of Resource Science and Technology, Universiti Malaysia Sarawak, Gunung Gading National Park, and Sarawak Forestry Corporation.

My appreciation goes to Mr. Afifi, Mr. Azfar, and the laboratory assistants for their guidance and assistance. Extending my gratitude to my lab mates, Matelda and Dereenaldo, for lending me their helping hands. To my dearest friends, Aida, Aizuddin, Khairunnisha, Zulhakimi, Fadhlhin, Ilya, Nurfatin and Zulfurain, for their friendship, the great times, shared knowledge and supports.

Special thanks to my parents, Samsury Sahari and Salmah Mohamad Ali, my siblings, Siti Syahirah, Fatin Firzana, Faiz Syahmi and Faris Muzaffar, for their never-ending encouragement, supports and prayers.

Finally, to my batchmates, thank you for riding this wave together. This work was dedicated to all that I had mentioned above. Thank you.

Diversity of Macrofungi in Gunung Gading National Park, Sarawak

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ABSTRACT

Macrofungi are cosmopolitan, heterotrophic organisms with very specific nutritional and ecological needs. They are one of the world's most diverse organisms and play an important role in terrestrial ecosystems. This study investigated the diversity of macrofungi species in Gunung Gading National Park by observing the sporocarps in their natural habitat along the waterfall trail and identified based on macro morphological characteristics. A total of 14 species were identified, which belong to four different orders; Polyporales, Agaricales, Auriculariales, and Pezizales. The species found along the Waterfall Trail were *Trametes* sp., *Microporus* sp., *Polyporus grammacephalus*, *Ganoderma* sp., *Nigroporus* sp., *Clavaria* sp., *Marasmiellus* sp., *Cookeina speciosa*, *C. sulcipes*, *Auricularia polytricha*, and *A. delicata*. The list of macrofungi provides a better understanding of the diversity of macrofungi in Gunung Gading National Park. Further study is required to collect and identify more species of macrofungi in Gunung Gading National Park, as it is important to document the diversity of macrofungi in Sarawak.

Keywords: Macrofungi, diversity, macromorphology, Gunung Gading National Park

ABSTRAK

Makrokulat adalah organismakosmopolitan, heterotropik yang mempunyai keperluan nutrisi dan ekologi yang spesifik. Mereka merupakan salah satu kumpulan organisma yang paling pelbagai dan memainkan peranan penting dalam ekosistem daratan. Kajian ini telah membuat pemerhatian sporokarpa di habitat asal sepanjang laluan air terjun dan mengenalpasti sepsis makrokulat yang terdapat di Taman Negara Gunung Gading berdasarkan ciri-ciri makro morfologi. Sejumlah 14 spesis telah dikenalpasti dan tergolong dalam empat order; Polyporales, Agaricales, Auriculariales, dan Pezizales. Spesis makrokulat yang ditemui di sepanjang laluan air terjun adalah *Trametes* sp., *Microporus* sp., *Polyporus grammacephalus*, *Ganoderma* sp., *Nigroporus* sp., *Clavaria* sp., *Marasmiellus* sp., *Cookeina speciosa*, *C. sulcipes*, *Auricularia polytricha*, and *A. delicata*. Senarai makrokulat ini akan memberikan pemahaman yang lebih baik tentang kepelbagaian makrokulat di Taman Negara Gunung Gading. Kajian lanjut perlu dijalankan untuk mencari dan mengenalpasti lebih banyak sepsis makrokulat yang terdapat di Taman Negara Gunung Gading sebagai dokumentasi kepelbagaian makrokulat di Sarawak.

Kata kunci: Makrokulat, kepelbagaian, makro morfologi, Taman Negara Gunung Gading

Table of Contents

Declaration	i
Acknowledgement	iii
Abstract	iv
<i>Abstrak</i>	iv
Table of Content	v
List of Tables	vi
List of Figures	vii
List of Abbreviations	ix
CHAPTER 1: INTRODUCTION	1
CHAPTER 2: LITERATURE REVIEW	3
2.1 Macrofungi	3
2.2 Macrofungi Distribution and Diversity in Malaysia	3
2.3 Economic and Practical Importance of Macrofungi	4
CHAPTER 3: MATERIALS AND METHODS	6
3.1 Study Area	6
3.2 Observation of Macrofungi	6
3.3 Identification of Macrofungi	7
3.3.1 Macro morphology	7
CHAPTER 4: RESULTS AND DISCUSSION	8
CHAPTER 5: CONCLUSION	29
REFERENCES	30

LIST OF TABLES

Table		Page
Table 1	Macrofungi collected in Main Trail, Gunung Gading National Park	8

LIST OF FIGURES

Figure		Page
Figure 1	Trail map of Gunung Gading National Park	6
Figure 2	<i>Trametes</i> sp. Fruiting body a, b . Upper surface of basidiocarp c . Lower surface of basidiocarp.	9
Figure 3	<i>Trametes</i> sp. Fruiting body a . Side view of basidiocarp b . Lower surface of basidiocarp c . Upper surface of basidiocarp.	10
Figure 4	<i>Nigroporus</i> sp. Fruiting body a,b . Upper surface of basidiocarp c . Lower surface of basidiocarp.	11
Figure 5	<i>Clavaria</i> sp. Fruiting body	12
Figure 6	<i>Cookeina speciosa</i> fruiting body a . Side view of ascocarp b . Upper surface of ascocarp.	13
Figure 7	<i>Microporus</i> sp. Fruiting body a,c . Upper surface of basidiocarp b . Side view of basidiocarp d . Lower surface of basidiocarp.	14
Figure 8	<i>Cookeina speciosa</i> fruiting body a . Side view of ascocarp b . Upper surface of ascocarp.	15
Figure 9	<i>Nigroporus</i> sp. Fruiting body a,b . Upper surface of basidiocarp c . Lower surface of basidiocarp.	16
Figure 10	<i>Cookeina sulcipes</i> fruiting body a . Upper surface of ascocarp b . Side view of ascocarp.	17
Figure 11	<i>Microporus</i> sp. Fruiting body a,b . Upper surface of basidiocarp c . Lower surface of basidiocarp	18
Figure 12	<i>Cookeina speciosa</i> fruiting body a . Side view of ascocarp b . Upper surface of ascocarp c . Lower surface of ascocarp.	19

- Figure 13** *Polyporus grammacephalus* fruiting body **a.** Upper surface of 20
basidiocarp **b.** Lower surface of basidiocarp **c.** Side view of
basidiocarp.
- Figure 14** *Auricularia polytricha* fruiting body **a,b.** Upper surface of 21
basidiocarp **c.** Lower surface of basidiocarp.
- Figure 15** *Ganoderma* sp. Fruiting body **a.** Upper surface of basidiocarp **b.** 22
Lower surface of basidiocarp **c.** Side view of basidiocarp.
- Figure 16** *Auricularia delicata* fruiting body **a,b.** Upper surface of 23
basidiocarp **c.** Lower surface of basidiocarp.
- Figure 17** *Marasmiellus* sp. Fruiting body **a.** Upper surface of basidiocarp **b.** 24
Lower surface of basidiocarp **c.** Side view of basidiocarp.

LIST OF ABBREVIATIONS

Abbreviation

GGNP	Gunung Gading National Park
cm	centimeter
mm	millimeter

CHAPTER 1

INTRODUCTION

Macrofungi, commonly known as mushrooms, are one of the world's most diverse groups of organisms and play an important role in terrestrial ecosystems. Mushrooms are economically significant because they are used for food, medicine, biocontrol agents, and chemical producers of bioactive compounds used in pharmaceuticals and other industries. Macrofungi are classified ecologically into three groups: saprophytes, parasites, and symbiotic (mycorrhizal) species (Aqilah et al., 2019). Terrestrial macrofungi are saprobes or mycorrhizal symbionts, but some are pathogens of plants or fungi.

Several authors have defined macrofungi (mushrooms) or Macromycetes in different ways. The production of fruiting bodies visible to the naked eye is emphasised in all definitions. For instance, Prayudi et al. (2019) defined macrofungi as fungi that can be seen by naked eyes and have sporocarp. Macrofungi include well-known groups that have been described by popular terms such as 'gilled fungi', 'cup fungi', 'bracket fungi', 'puffballs', and 'truffles'. These terms refer to the wide range of morphological diversity found in macrofungi. Most macrofungi are classified under the phylum Basidiomycota and Ascomycota.

Gunung Gading National Park (GGNP), located in the district of Lundu, Sarawak, is home to the famous *Rafflesia tuan-mudae*. The main reason for the establishment of GGNP in 1983 was to conserve and preserve Sarawak indigenous flora and fauna *Rafflesia tuan-mudae* (Sarawak Forestry, 2021). Apart from the *Rafflesia* Conservation Program, GGNP is also a hotspot for research on biodiversity and ecotourism activities (Sarawak Forestry, 2021). GGNP consists of Mixed Dipterocarp Forest, Lower Montane Forest, shifting

agriculture, shrub, and secondary forest (Sarawak Forestry, 2021). These vegetations are suitable environments for macrofungi to grow.

Macrofungi were poorly understood and challenging to study due to their primarily hidden nature and frequently sporadic and short-lived sporocarps. Hence, they have been mainly neglected and overlooked in conservation actions. Hawksworth and Lücking (2017) estimated that the fungal population worldwide is 2.2 to 3.8 million, and only 120 000 accepted species. Only about 6.7 per cent of the world's estimated 1.5 million fungi species have been identified, with the majority of these occurring in temperate climates. The macrofungi are scarcely documented in the tropical region (Hawksworth, 2001). This makes the documentation of macrofungi in tropical forests unclear (Hawksworth, 2004).

Gunung Gading National Park has diverse flora and fauna. It is in a Mixed Dipterocarp Forest, which provides ideal climatic and environmental conditions for the establishment of many kinds of flora, particularly macrofungi. This study aimed to identify the macrofungi in Gunung Gading National Park based on morphological characteristics and document the macrofungal diversity in Gunung Gading National Park. This study will serve as baseline data for further studies of the same interest, especially in the fungal conservation of Gunung Gading National Park.

CHAPTER 2

LITERATURE REVIEW

2.1 Macrofungi

Macrofungi, or mushrooms, are distinct organisms belonging to the Fungi kingdom. Macrofungi are ecologically grouped as saprophytic, mycorrhizal, and parasitic (Aqilah et al., 2019). The saprophytes are fungi that grow on plant residues, and mycorrhiza is fungi that have a symbiotic relationship with the roots of higher plant species. The parasites fungi are those attached to host plants to get nutrients and cause harm to the hosts.

The most commonly known macrofungi are those having umbrella-like pileus (cap) and stipes (stem) such as *Lentinula edodes* and *Agaricus bisporus*, those with an annulus (ring) or/and a volva (cup) such as *Amanita muscaria* and *Volvariella volvacea* (Chang, 2008). Other forms of macrofungi that can be found resemble the corals, human's ear, round like golf balls, jelly-like globs, and many more (Chang, 2008).

2.2 Macrofungi Distribution and Diversity in Malaysia

In Malaysia, the study about the diversity of macrofungi mostly focused on Peninsular Malaysia. Mohamad Hasnul et al. (2012) documented the diversity and distribution of Polyporales in Peninsular Malaysia, which came from five families: Fomitopsidaceae, Ganodermataceae, Meruliaceae, Meripilaceae, and Polyporaceae. Several studies have documented the diversity of macrofungi in Sarawak (Yamashita et al., 2009; Nur Liyana, 2014; Nur Farhana, 2014; Mohamad Hasnul, 2019; Mohamad Fhaizal et al., 2020).

Yamashita et al. (2009) collected 101 species of Aphylophorales in Lambir Hills National Park, Miri, Sarawak, with *Amauroderma subrugosum*, *Ganoderma 3 ustral*, *Microporus xanthopus*, and *Microporus affinis* as the dominant species. Nur Liyana (2014)

and Nur Farhana (2014) listed 19 species of Polyporales from five families and 18 species of Polyporales from three families from Kubah National Park and Sama Jaya Nature Reserve, Kuching, Sarawak, respectively. Mohamad Hasnul (2019) identified macrofungi from eight families in Santubong National Park, Kuching, Sarawak, where Polyporaceae was the dominant family. Mohamad Fhaizal et al. (2020) only documented four species of macrofungi in Gunung Gading National Park, Lundu, Sarawak, from three genera, namely *Ganoderma*, *Cookeina*, and *Coprinellus*. Macrofungi in Sarawak are still scarcely documented. Therefore, documentation of macrofungi in Sarawak is very much needed.

2.3 Economic and Practical Importance of Macrofungi

One of the main importances of macrofungi is decomposers. Other than insects, dead plant materials are broken down by fungi. Many macrofungi grow on plant litters or dead animals, then decompose them and produce nutrient compounds that can be absorbed by other living organisms (Hazebroek & Abang Kashim, 2000). Fungi are responsible for the breakdown of lignin and cellulose, which are essential in the decomposition of organisms. Generally, there are three types of wood decaying fungi namely soft rot fungi, white rot fungi and brown rot fungi. These fungi will decompose the structure of cellulose, hemicellulose, and lignin in the cell wall of plants (Dai, 2012).

Nowadays, more people choose a vegan lifestyle and utilise mushrooms as their protein alternatives. Malaysian's National Agro-Food Policy (2011-2020) listed mushrooms as one of the high-value commodities in Malaysia. The mushroom industry is new and getting more attention from entrepreneurs (Mohd Zaffrie & Azahar, 2015). Malaysia has agro-climatic conditions that allow mushrooms to be cultivated all year round and have the potential to compete in the world market (Mohd Zaffrie & Azahar, 2015).

The demand for cultivated mushrooms is increasing regardless of raw mushrooms or the beneficial extracts from a mushroom. To expand the horizon of mushroom industry, the identification of wild mushrooms is needed and may lead to future discoveries of beneficial compounds extracted from wild mushrooms (Fung & Tan, 2021). There remains a need to identify and document more species of macrofungi in Malaysia.

Besides being utilised as food, macrofungi are also sought for their medicinal properties. Activity immunostimulating and anticancer features of polysaccharide-protein compounds found in fungi such as *Ganoderma lucidum*, *Lentinus edodes*, *Schizophyllum commune*, *Trametes versicolor*, and *Inonotus obliquus* are some of the most propitious (Hilszczańska, 2012).

CHAPTER 3

MATERIALS AND METHODS

3.1 Study Area

This study was carried out along the waterfall trail until Waterfall 1 (600 m from the park Headquarters) in Gunung Gading National Park (1.7333° N, 109.8333° E), Lundu, Sarawak.

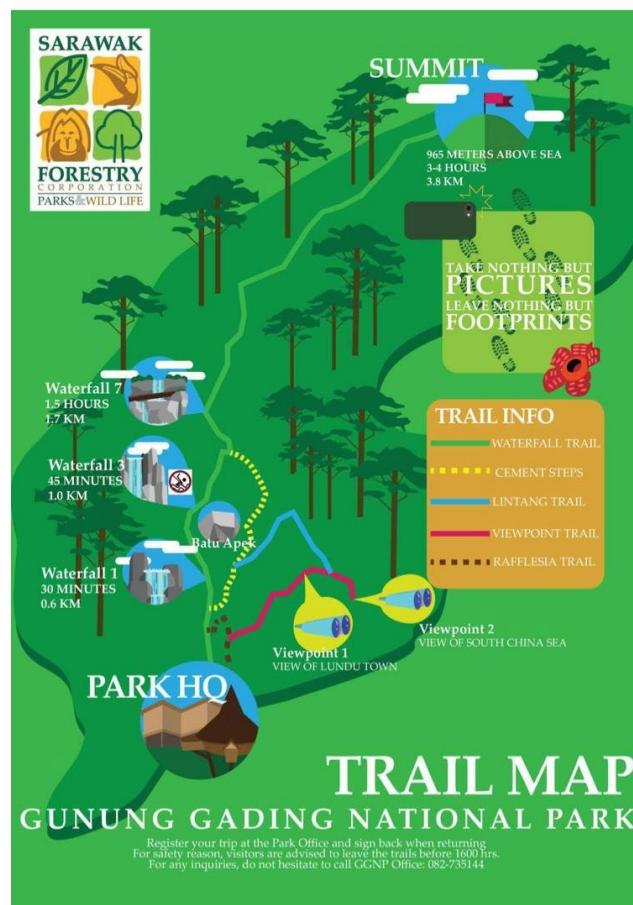


Figure 1. Trail map of Gunung Gading National Park (Sarawak Forestry, 2021)

3.2 Observation of Macrofungi

The sporocarp of macrofungi was observed along the waterfall trail. Multiple sporocarps of the same species growing on a single tree or log were considered as one sample and chosen haphazardly. The mushrooms were photographed in their natural habitat and

labelled. Then, each sample's photo was labelled with date, habitat, collector's name, and collection number, along with any details or remarks.

3.3 Identification of Macrofungi

The measurements of various parts of mushrooms, such as the pileus and stipe, were recorded, and morphological features were observed in the field. The substratum where the mushroom was growing, and colour change due to bruising or handling of specimens were also noted. The information of the various characters stated were used to identify each specimen by comparison with illustrations in colour field guides and the use of descriptions and keys in Núñez and Ryvar den (2000, 2001) and Hattori (2000, 2005). All data obtained during observation were tabulated for documentation.

3.3.1 Macro morphology

Macromorphological descriptions were done by following the methods by Lodge et al. (2004), whereby the samples were sorted according to their respective shape, size, odour, and colour of the sporocarp. After sorting the samples, descriptions and identification was made. Each of the characters was measured and the colour of the other related characteristics of the structures were observed and recorded. Many fleshy macrofungal species will lose their characteristics when dried. Therefore, thorough observation and documentation before drying was needed (Lodge et al., 2004).

CHAPTER 4

RESULTS AND DISCUSSION

A total of 16 samples were observed along Main Trail in Gunung Gading National Park belonging to 4 orders, seven families: Polyporaceae, Steccherinaceae, Ganodermataceae, Clavariaceae, Marasmiaceae, Sarcosyphaceae, and Auriculariaceae (Table 1). Seven samples were identified to the species level. Meanwhile, nine samples were identified to the genus level.

Table 1. Macrofungi collected in Main Trail, Gunung Gading National Park

Order	Family	Species	Utilisation
Polyporales	Polyporaceae	<i>Trametes</i> sp.	Edible*, Medicinal
		<i>Microporus</i> sp.	Edible*, Medicinal
		<i>Polyporus grammacephalus</i>	Edible
	Steccherinaceae	<i>Nigroporus</i> sp.	Edible*
	Ganodermataceae	<i>Ganoderma</i> sp.	Edible*, Medicinal
Agaricales	Clavariaceae	<i>Clavaria</i> sp.	Edible*
	Marasmiaceae	<i>Marasmiellus</i> sp.	Edible*
Pezizales	Sarcosyphaceae	<i>Cookeina speciosa</i>	Edible
		<i>Cookeina sulcipes</i>	Edible
Auriculariales	Auriculariaceae	<i>Auricularia polytricha</i>	Edible
		<i>Auricularia delicata</i>	Edible

*Some species of the mentioned genera were reported edible, however the edibility of those mentioned were unknown (Boa, 2004).

Description of macrofungi

The descriptions of samples collected along Main Trail are as follows:

Sample No : 01

Order : Polyporales

Family : Polyporaceae

Species : *Trametes* sp.

Fruiting body bracket, irregular margin, trooping, with size of 2.7 cm x 2.1 cm, up to 5 mm thick at the base in single fruiting body (Figure 2b). Pilei dimidiate, pileus upper surface velvety, zonate, darker brown at base to light cream towards margin, pore surface light brown with cream margin (Figure 2c.). Habitat found on dead log, growing gregariously (Figure 2a).



Figure 2: *Trametes* sp. fruiting body **a, b**. Upper surface of basidiocarp **c**. Lower surface of basidiocarp.

Sample No : 02

Order : Polyporales

Family : Polyporaceae

Species : *Trametes* sp.

Basidiocarp sessile, imbricate, several pilei conchate to flabelliform, pileal surface tomentose, with size 10 cm x 6.5 cm, up to 3 mm thick (Figure 3c), growing in groups (Figure 3a). Pileus colour alternating from light brown to brown, margin irregular; pore shape angular, three pores per mm (Figure 3b). Habitat found on a dead log.



Figure 3: *Trametes* sp. fruiting body **a.** Side view of basidiocarp **b.** Lower surface of basidiocarp **c.** Upper surface of basidiocarp.

Sample No : 03

Order : Polyporales

Family : Steccherinaceae

Species : *Nigroporus* sp.

Basidiocarp dimidiate, semicircular, up to 11 cm long, 7.5 cm wide, up to 5 mm thick (Figure 4b); pileus azonate with darker brown at base to lighter brown towards the margin, pores are small, barely seen with naked eyes, pore surface cream to brown (Figure 4c). Habitat on a dead log, growing gregariously (Figure 4a).

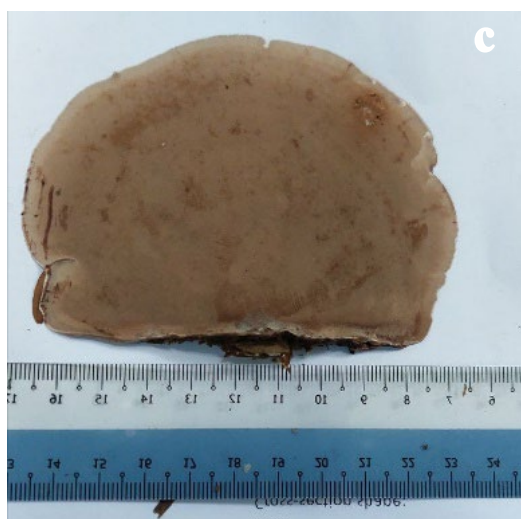


Figure 4: *Nigroporus* sp. fruiting body **a,b**. Upper surface of basidiocarp **c**. Lower surface of basidiocarp.

Sample No : 04
Order : Agaricales
Family : Clavariaceae
Species : *Clavaria* sp.

Fruiting bodies are slender cylindrical, and black with a glossy appearance (Figure 5).

Height up to 7 cm. Branching near the stipe. Stipe height 1 mm. Habitat on organic matter.



Figure 5: *Clavaria* sp. fruiting body

Sample No : 05

Order : Pezizales

Family : Sarcoscyphaceae

Species : *Cookeina speciosa* (Fr.) Dennis 1994

Apothecia light orange, with size of 15 mm x 10 mm, arising gregarious, centrally stipitate, funnel-shaped (Figure 6a). Receptacle concave, whitish. Stipe 2 cm long, paler than receptacle. Hairs are arranged around the margin in a single row (Figure 6b). Habitat on a dead twig.

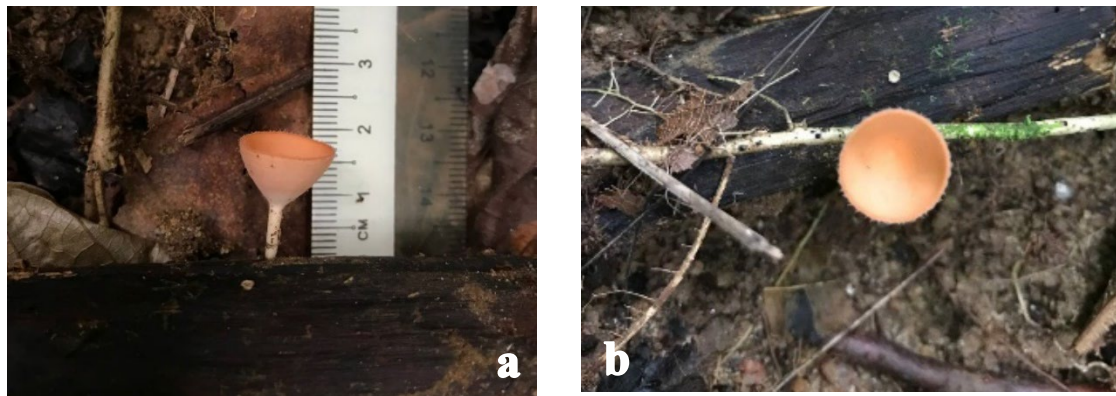


Figure 6: *Cookeina speciosa* fruiting body **a.** Side view of ascocarp **b.** Upper surface of ascocarp.