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RESEARCH ARTICLE

Exploitation and Diversity of Edible Macrofungi Resources in Mount Harriet National Park, Andaman and Nicobar Islands

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ABSTRACT

Mushrooms have an essential part in ecological dynamics as well as human health. The present investigation on the assessment of macrofungal diversity was carried out in one of the reserve National Park of Andaman and Nicobar Islands, Mount Harriet National Park. The ecological characterization of mushroom taxa surveyed and revealed 17 families. At least 22 species belong to the genera *Polyporus, Trametes, Ganoderma, Clitocybe, Daedaleopsis, Steccherinum, Auricularia, Coltricia, Panus, Calvatia, Xeromphalina, Cookenia, Geastrum, Amanita, Calocera, Ischnoderma, Neonectaria, Stereum, Agaricus* and *Schizophyllum.* Out of these, 08 species were reported to be edible, while the rest were inedible. Furthermore, this study is one of the first to examine macrofungal diversity in Mount Harriet National Park in the Andaman and Nicobar Islands. It aids in a better understanding of the mushroom types found in this biologically diverse National Park.

Keywords: Andaman and Nicobar Islands; Macrofungi Diversity; Mount Harriet National Park; Mushroom Ecosystem; National Park; Wild Edible Mushrooms

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INTRODUCTION

The Andaman and Nicobar Islands are one of India's eight Union territories, with 572 islands (38 of which are inhabited) and an area of 8,249 km^2 located at the confluence of the Bay of Bengal and the Andaman Sea. The biomass of the islands is divided into two groups: the Andaman Islands and the Nicobar Islands. The islands, known as the Princess of the Bengal Sea, contain tropical rainforests and twelve types of atypical forests with diverse flora and fauna, including endemic species. The forest covers roughly 94 percent of the entire land area.

Mount Harriet National Park, located between the latitudes 11º42'59" N and 92º44'02" E, is the third highest peak in the Andaman and Nicobar archipelago, after Saddle Peak (North Andaman) and Mount Thullier (Great Nicobar). It covers 4.56 km^2 and is located between the latitudes 11o42'59" N and 92o44'02" E. The overall elevation is 459 metres above sea level, and the area is classified as IUCN category II protected. Due to its proximity to the equator, the park experiences marine climatic conditions (Negi, 2002) as well as hot and humid weather. The typical temperature ranges from 22 to 33 degrees Celsius, with little or higher rainfall throughout the year.

The high altitude (459 m) and suitable environment, which resembles the copious development of macrofungi, contribute to a high degree of variety in this protected region. As a result, mushroom diversity must be carefully exploited, as there are still numerous unidentifiable species to be discovered, and valuable species should not be driven to extinction indefinitely. So far, about 1,105 to 1,208 mushroom species belonging to 128-130 genera have been identified, with 300-315 edible species belonging to 75-80 genera (Thiribhuvanamala et al., 2011). In recent years, India's mushroom output has increased by about 0.13 million tonnes per year, with the mushroom business growing at an annual rate of 4.3 percent (Sharma et al., 2018)

In the culinary and pharmaceutical sectors, mushrooms have a wide range of commercial applications. They are a significant resource so they are utilised as food, medicine, biocontrol agents, and a source of bioactive compounds including antioxidants, immunomodulatory, anti-allergic, anti-cancer, nephroprotective, anti-microbial, anti-diabetic, and hypocholesterolemic substances (Patel & Goyal, 2012). One of the most difficult areas of research for many researchers is the utilisation of bio-molecules from mushrooms for pest and disease management (Onduso et al., 2018). Being cosmopolitan, this sporadic fruiting body of Macrofungi possesses therapeutic, gastronomic, and even toxic properties. Despite the lack of relevant studies on mushroom exploitation in Mount Harriet National Park, this area remains unexplored and underappreciated. Furthermore, the commencement of this research might inspire mushroom producers to cultivate edible species and support an introductory innovation in mushroom exploitation in this National Park.

This research aims to increase our comprehension of Mt Harriet National Park's mushroom flora, offer minuscule data on wild edible mushrooms, and protect their richness in the future for prospective use of these mushroom species. Furthermore, this study offers one of the first investigations on macrofungal diversity in the Mount Harriet National Park, Andaman and Nicobar Islands.

MATERIALS AND METHODS

The study and collection were conducted within Mount Harriet National Park, with the following locations considering convenient accessibility area: From the entrance gate to the park's central, Kalapathar (2.5 km from the park's centre) and alongside the parking area, in September to November 2018, owing an ideal climatic condition for mushroom samplings,

The Queensland Herbarium handbook was used to guide the mushroom collecting and storage procedures (Prance and Fechner, 2017) The following tools and supplies were necessary for the collection. Uprooting the samples from the wooden substratum was done with a sharp pocket knife, while ground-dwelling mushrooms were done with a tiny trowel. A small brush was used for dusting off the alien spores and dirt that had settled on the surface. Throughout the survey, a face mask and latex hand glove were required to wear for safety precautionary measures. An image was taken before collection to minimize misunderstanding and a data sheet was utilised to record the visible character with a tag name.

To keep contamination to a minimum, the storing was done meticulously. Excess dirt on the stipe of the brittle, stiff, and crisp mushroom was removed with

a tiny brush after the samples were dried in the sunlight by hanging them on the clothesline in a zip lock cover. The samples were also marked with their respective tag names and kept in a ziplock container with some silica gel to remove ambient moisture.

The morphological characters were noted down to identify the collected mushrooms, and the following key parameters were used for identification: size; colour; pileus: shape, apex, surface, margin; lamella: attachment, arrangement; stipe: attachment, shape, surface, attached to the substratum; annulus and substrate (Chandulal et al., 2013)

RESULT AND DISCUSSION

The current investigation is the first to identify the preliminary species in the Mount Harriet National Park of the Andaman and Nicobar Islands. According to the findings, there are 22 mushroom species, divided into 21 genera and 17 families. Table 1 summarises the findings of these indicated samplings. As a result, two *Xylaria* species and one of each genus *Polyporus, Trametes, Ganoderma, Clitocybe, Daedaleopsis, Steccherinum, Auricularia, Coltricia, Panus, Calvatia, Xeromphalina, Cookenia, Geastrum, Amanita, Calocera, Ischnoderma, Neonectaria, Stereum, Macrolepiotia* and *Schizophyllum.* were discovered (Figure. 1). The forest Macrofungi ecosystem is primarily found in rotting wood (Table 1). Furthermore, the study looks into the edibility of wild mushrooms in this area. Only eight of the 22 mushroom species discovered are edible, while the remaining 14 are reported to be inedible. Table 2 illustrates the morphological findings of 22 species from 17 Ascomycota and Basidiomycota groups.

Table 1. Showing data of collected mushroom samplings

Sl. No.	Identified Species	Family	Habitat	Edible
1	*Polyporus resinosus* Schrad. Ex F.	Polyporaceae	Wooden log	Yes
2	*Trametes versicolor* L.	Polyporaceae	Decaying wood	No
3	*Ganoderma applanatum* (Pers.) Pat.	Ganodermataceae.	Decaying wood	Yes
4	*Clitocybe adirondackensis* (Pk.) Sacc	Tricholomataceae.	Decaying wood	Yes
5	*Daedaleopsis confragosa* (Bolton) J. Schrot.	Polyporaceae	Decaying wood	No
6	Steccherinum sps	Steccherinaceae	Decaying wood	No
7	*Xylaria polymorpha* (Pers.) Grev.	Xylariaceae	Decaying branch	No
8	*Auricularia auricula-judae* (Bull.) J. Schrot.	Auriculariaceae	Decaying wood	Yes
9	*Coltricia cinnamomea* (Jacq.) Murrill.	Hymenochaetaceae.	Decaying wood	No
10	*Panus rudis* Fr.	Polyporaceae	Decaying wood	No
11	*Calvatia craniiformis* (Schwein.) Fr. Ex De Toni.	Agaricaceae	Decaying wood	Yes
12	*Xeromphalina campanella* (Batsch) Kuhner & Maire	Marasmiaceae	Decaying wood	No
13	*Cookenia tricholoma* (Mount.) Kuntze	Sarcoscyphaceae	Twig and rotten tree	No
14	*Geastrum triplex* Jungh	Geastraceae	Decaying wood	Yes
15	*Amanita vaginata* (Bull.) Lam..	Amanitaceae	Soil	Yes
16	*Xylaria hypoxylon* (L.) Grev.	Xylariaceae	Decaying hardwood	No
17	*Calocera viscosa* (Pers.) Fr.	Dacrymycetaceae	Decaying wood	No
18	*Ischnoderma resinosum* (Schrad.) P.Karst	Fomitopsidaceae	Decaying wood	No
19	*Neonectria coccinea* (Pers.) Fr.	Nectriaceae	Decaying wood	No
20	*Stereum ostrea* (blume & t. nees ex fr.).	Stereaceae	Decaying wood	No
21	*Macrolepiotia procera* (Scop.) Singer	Agaricaceae	Soil	Yes

22	*Schizophyllum commune* Fr. ex Fr.	Schizophullaceae	Decaying wood	No

Figure. 1. (a). *Polyporus resinosus* Schrad. Ex F.; (b). *Trametes versicolor* L.; (c). *Ganoderma applanatum* (Pers.) Pat.; (d). *Clitocybe adirondackensis* (Pk.) Sacc; (e). *Daedaleopsis confragosa* (Bolton) J. Schrot.; (f). *Steccherinum* sps; (g). *Xylaria polymorpha* (Pers.) Grev.; (h). *Auricularia auricula-judae* (Bull.) J. Schrot.; (i). *Coltricia cinnamomea* (Jacq.) Murrill.; (j). *Panus rudis* Fr.; (k). *Calvatia craniiformis* (Schwein.) Fr. Ex De Toni.; (l). *Xeromphalina campanella* (Batsch) Kuhner & Maire.; (m). *Cookenia tricholoma* (Mount.) Kuntze.; (n). *Geastrum triplex* Jungh.; (o). *Amanita vaginata* (Bull.) Lam.; (p). *Xylaria hypoxylon* (L.) Grev.; (q). *Calocera viscosa* (Pers.)

Fr.; (r). *Ischnoderma resinosum* (Schrad.) P.Karst.; (s). *Neonectria coccinea* (Pers.) Fr.; (t). *Stereum ostrea* (blume & t. nees ex fr.).; (u). *Macrolepiotia procera* (Scop.) Singer.; (v). *Schizophyllum commune* Fr. ex Fr.

Table 2. Showing the morphological data of the collected Macrofungi

Family	Scientific Name	Characters				
		Colour	Pileus	Texture	Spore Bearing Surface	Annulus
Agaricaceae	*Calvatia craniiformis* (Schwein.) Fr. Ex De Toni.	Whitish Tan	Skull shaped; crumpled base attached to a cord-like rhizomorph.	Smooth but peridium develops wrinkles and folds and becomes areolate	Glebal hymenium	Absent
	Macrolepiotia procera (Scop.) Singer	Chocolate brown	umbonate, later become flat.	Large, soft membrane.	Gills on hymenium	Present
Amanitaceae	*Amanita vaginata* (Bull.) Lam..	Orange brown	Applanate in shape with umbonate apex.	Gills are free	Gills on hymenium	Absent
Auriculariaceae	*Auricularia auricula-judae* (Bull.) J. Schrot.	Brownish red	Ear like cup shaped, normally attached to the substratum with a short stalk.	Tough, gelatinous, elastic Cup shaped texture.	-	Absent
Dacrymycetaceae	*Calocera viscosa* (Pers.) Fr.	Bright yellow	Jelly fungus with gelatinous structure and slimy to touch	Smooth.	Irregular attachment of hymenium.	Absent
Fomitopsidaceae	*Ischnoderma resinosum* (Schrad.) P.Karst	Pale brownish white	Irregular bracket-shaped, spongy but tough and leathery.	Fairly smooth, dry, and tough	Pores on the hymenium.	Absent
Ganodermataceae	*Ganoderma applanatum* (Pers.) Pat.	Brown	Fan shaped to bean shaped, Leathery Surface.	Hard as leather, woody-textured and institiously attached to the substratum.	Pores on the hymenium.	Absent
Geastraceae	*Geastrum triplex* Jungh	Light brown	Spherical resembling puff balls, Exoperidium splits around the spore sac which appears to rest in a collar.	-	Glebal hymenium	Absent

Hymenochaetaceae.	*Coltricia cinnamomea* (Jacq.) Murrill	Cinnamon brown	Vase like dry silky-shiny shaped with concentric bands of colour.	Tough, velvety and dry.	Pores on hymenium	Absent.
Marasmiaceae	*Xeromphalina campanella* (Batsch) Kuhner & Maire	Brownish yellow	Small umbrella shaped and thin brown stipe with yellow hairs at the base.	Smooth	Gills on hymenium	Absent
Nectriaceae	*Neonectria coccinea* (Pers.) Fr.	Red with orange tint	Cylindrical and slightly tapering towards the tip with flasked shaped structure.	Thin walled, smooth without gelatinous sheath	Perithecia	Absent
Polyporaceae	*Daedaleopsis confragosa* (Bolton) J. Schrot.	Brown to creamy yellow under cap	Concentric zones, lines with fan-shaped, Umbilicate apex.	Brittle, tough, leathery and woody.	Pores on hymenium	Absent
	Panus rudis fr.	Brownish red	Vase-like with central stipe.	Surface with a rather coarse, velvet-like, hairy coating	Gills on the hymenium.	Absent
	Polyporus resinosus Schrad. Ex F.	Dark brown to blackish brown	Sessile, bracket-like and nearly glabrous surface with thick margins.	Hard, leathery and woody.	Pores on the hymenium	Absent
	Trametes versicolor L.	White with blackish brown at edge	Infundibuliform shape.	Brittle, tough, leathery and woody.	Pores on hymenium	Absent
Sarcoscyphaceae	*Cookenia tricholoma* (Mount.) Kuntze	Bright orange	Infundibuliform (funnel shaped)	Pubescent	Apothecia	Absent
Schizophullaceae	*Schizophyllum commune* Fr. ex Fr.	Greyish white in colour.	Undulating waves of tightly packed corals like. Longitudinally divided gills produce basidiospores.	Spongy body texture	Gills on hymenium.	Absent
Steccherinaceae	Steccherinum sps	Yellowish white.	Horizontal, overlapping sessile pilei united at the base and form a massive cluster	Whitish becomes yellowish white with finely hairy.	Hynoid on the hymenium	Absent

Stereaceae	*Stereum ostrea* (blume & t. nees ex fr.).	Reddish brown.	Offset pileus on lateral stipe.Concentric circles of colours often reddish to dark brown.	Hard and shell-like fruiting bodies	Pores on hymenium	Absent
Tricholomataceae.	*Clitocybe adirondackensis* (Pk.) Sacc	Dull Creamy white.	Infundibiliform, slippery to smooth when moist, rubbery-pliant consistency.	Thin, decurrent lamellae.	Gills on hymenium.	Absent
Xylariaceae	*Xylaria hypoxylon* (L.) Grev.	Black with whitened tips.	Cylindrical and erect ascocarps with typically sparsely branched, covered completely by conidia which shows the white to greyish powdery deposits	Ascocarp	Conidia and Perithecia	Absent
	Xylaria polymorpha (Pers.) Grev.	Blackish brown but white on the inside, with black dots.	Elongated upright, strap like stromata, club shaped much like fingers.	Ascocarps. often produce asexual spores, conidia – grown on its surface	Sac like structure, the ascus.	Absent

A noteworthy discovery in Bangladesh's restricted forest areas found 14 genera and 24 species, most similar to the current study (Rumainul et al., 2015), in Bangladesh's Southern region (Rashid et al., 2016)and in the United States' Standing Rock Indian Reservation (Onduso et al., 2018). As a result, the findings of the current study are supported by the findings of other researchers from around the world.

Ganoderma applanatum was the most exquisitely found species throughout the survey in most of the decaying trees in and around Mount Harriet National Park. The same species was also found in Pathorghata and Dumki (subdistricts of Borguna and Patuakhali districts) in Bangladesh's southern region (Rumainul et al., 2015), in India (Dwivedi et al., 2012), and in China (Wang et al., 2012). As a result, the abundance of this species confirmed that it is the most common and diversified mushroom globally. Furthermore, it is inedible but possess medicinal properties (Usui et al., 2014), including antibacterial (Osińska-Jaroszuk et al., 2014; Smânia-Jr et al., 1999), anti-tumor (Chairul et al., 1991; Usui et al., 1981, 1983) and anti-fibrotic properties (Luo et al., 2015).

Trametes versicolor, on the other hand, was found in lower numbers than *G. applanatum* but covered a larger area. In Karnataka, the same species was studied and discovered therapeutic properties (Pushpa & Purushothama, 2012). *T. Versicolor* was also reported in Chung cheong Province of Korea (Jo et al., 2013) as well as in Lagos State of Nigeria (Bankole & Adekunle, 2012).

Stereum ostrea have been reported to have antibacterial actions against *Bacillus subtilis, Klebsiella pneumonia, Micrococcus species, Pseudomonas aeruginosa,* and *Staphylococcus aureus* (Praveen et al., 2012). *Calvatia craniiformis*, an edible species, has been used in Chinese and Japanese traditional and folk medicine as a hemostatic agent (Takaishi et al., 1997). The species *Daedaleopsis confragosa* was discovered in the protected park, and there are six species of this genus globally (Kirk et al., 2008). Furthermore, the same species was also reported in Central Luzon of the Philippines (Leon et al., 2013) and first reported in Europe (Bolton, 1788). *Auricularia auricula* has been shown to have hypoglycemic, anticoagulant, and cholesterol-lowering effects (Francia et al., 1999; Yaun et al.,

1998). Although some mushrooms, such as *Panus rudis, Xeromphalina campanella, Geastrum triplex, Calocera viscosa*, and *Ischnoderma resinosum*, are non-toxic, their texture, odour, and taste make them unpalatable.

The soil-dwelling macrofungi *Amanita vaginata* and *Macrolepiota procera,* among other species, were found throughout the survey. *A. vaginata* has also been found in California (Desjardin et al., 2014; Thiers *et al*. 1982), North America (Jenkins, 1986), Switzerland (Breitenbach & Kränzlin, 1984) and also reported in Bangladesh (Rumainul et al., 2015). Finally, the morbific mushroom species reported in this study, *Neonectria coccinea* and *Schizophyllum commune* cause beech bark disease and human disease, respectively (Chowdhary et al., 2014; J et al., 1999)

CONCLUSION

Many researches have shown a keen interest in mapping Macrofungi flora in various places throughout the world. This study aimed to collect data on Macrofungi diversity, which is understudied in comparison to flowering plants. However, unlike plants, macrofungi identification is notoriously difficult since it relies on collecting fruiting bodies in a moist environment. As a result, the current research establishes a baseline and basic understanding of macrofungal diversity in Mount Harriet National Park. I am convinced that extending the sampling period and expanding the study region will uncover even more of this immense mushroom treasure. The outcome of this study highlights the diversity and exploitation of mushrooms in the study area. As a result, it will open up new avenues for macrofungal research and encourage mushroom cultivators to cultivate edible species.

DISCLOSURE STATEMENT

Authors declare no conflict of interest.

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