Int.J.Curr.Microbiol.App.Sci (2019) *8*(4): 2775-2785

International Journal of Current Microbiology and Applied Sciences
***ISSN: 2319-7706* Volume 8 Number 04 (2019)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2019.804.323

Diversity Study of Wood Rotting Fungi from Two different Forests in Mizoram, India

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Keywords

Ascomycota, Basidiomycota, Mizoram, Wood rotting fungi

Article Info

Accepted:
20 March 2019
Available Online:
10 April 2019

A B S T R A C T

A three years (2015-2017) study was carried out to study the diversity of Wood Rotting Fungi from two different forest stands, Hmuifang forest and Tanhril forest of Mizoram, Northeast India. A total of 45 species were identified from both the study sites. It was observed that a total of 21 species were common to both the forests whereas 19 species were found only found in Hmuifang forest and 5 species only in Tanhril forest. Shannon-Wiener's diversity index of fungal species was found to be 3.31 in Hmuifang forest and 2.99 in Tanhril forest; Simpson shows 0.95 in Hmuifang and 0.90 Tanhril forest; Menhinick's index shows 1.91 for Hmuifang and 1.22 in Tanhril forest; Margelef's index shows 6.41 in Hmuifang and 3.98 in Tanhril forest; Pielou's eveness index shows 0.54 in Hmuifang and 0.51 in Tanhril forest. However, the species diversity of wood rotting fungi was higher in Hmuifang forest than compared to Tanhril forest which may be due to higher altitude, low temperature, high relative humidity, soil moisture content and experiences higher amount of rainfall annually which in turn have a great impact on the type of vegetation.

Introduction

Mizoram is one of the seven sister States in North East India. It lies in the extreme eastern corner of the country and shares its borders with Assam, Manipur and Tripura and has very long international borders with Myanmar and Bangladesh. The state has a geographical area of 21,087sq.km. and lies between 21˚56' and 24˚35' N Latitudes and 92˚16' and 93˚26' E Longitudes. The Tropic of Cancer passes through the State at 23˚30' N latitude. Wood-rotting fungi are one of the most important parts of forest ecosystem, and play an important role in degrading the wood in forest ecosystem. The major species of these fungi include the groups of Aphyllophorales (Basidiomycota), Discomycetes (Ascomycota) and some imperfect fungi. They have the ability to degrade cellulose, hemicelluloses and lignin of wood. Three type of wood decaying have been found, i.e., white rot, brown rot and soft rot. Many other organisms of forest ecosystem have symbiosis relationship with wood rotting fungi. Wood rotting fungi could offer the nutrition for

many insects and birds, and spores of many wood rotting species are spread by some insects. The rich diversity of wood rotting fungi is one of the important factors for the functioning of forest ecosystem.

Wood-rotting fungal communities are typically species-rich, and include multiple decomposer species in the same wood substrate. Throughout the decomposition of a fallen tree, fungal species interact with each other as community composition develops over time. The resident fungi must either defend an occupied domain or replace the mycelia of primary established species (Ottosson, 2013). As the main agents of wood decay, fungi can be considered as ecosystem engineers (Lonsdale *et al.,* 2008).

Only about 6.7% of 1.5 million species of fungi estimated in the world have been described and most of these are in temperate regions. The tropical region which is undoubtedly hosting the highest mycodiversity has been inadequately sampled and the mycoflora scarcely documented (Hawksworth, 2001). This makes the situation of macrofungi in the tropical forests unclear (Hawksworth, 2004). However new species are still being identified in the tropics (Douanla-Meli *et al.,* 2007).

(Zothanmawia *et al.,* 2016) identified 15 species of wood rotting fungi from Pachhunga University College Campus. (Zothanzama, 2011) identified a total of 53 species of wood rotting fungi from different forest stands in the districts of Aizawl, Mamit, Kolasib, Champhai and Saiha of Mizoram during the period of 2006-2010. (Bisht, 2011) in his book Wood Decaying Fungi of Mizoram also described 52 species collected from different parts of the state. (Zothanzama *et al.,* 2017) also identified a new species of wood rotting fungi from Mizoram *Ganoderma mizoramense*. The current study highlights the diversity framework of wood rotting fungi from a protected forest (Hmuifang) and a disturbed forest (Tanhril).

Materials and Methods

Study sites

Hmuifang

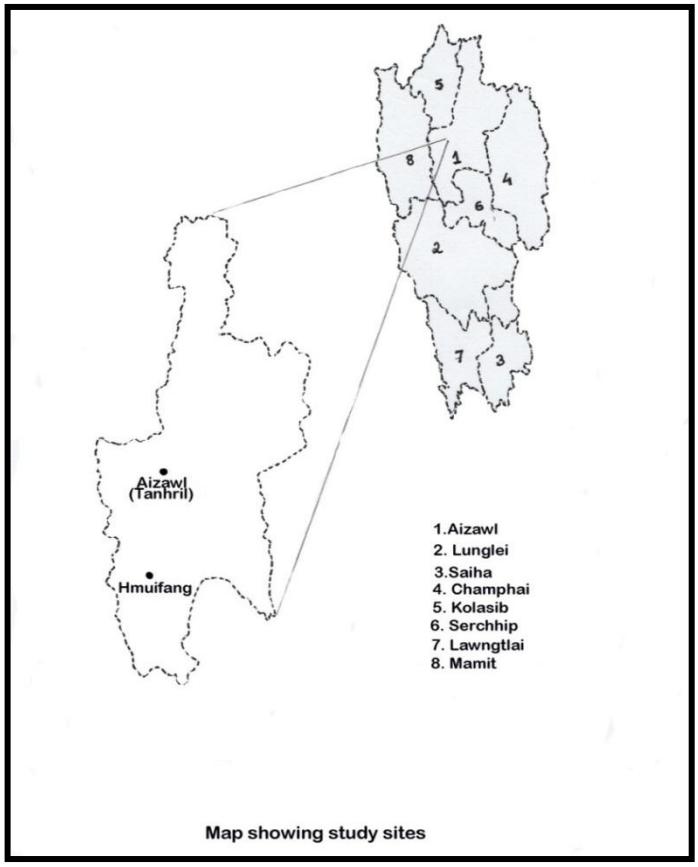
The study area is situated in the southern part of Aizawl. It is about 50 km away from the state capital Aizawl with an average elevation of 1619 amsl. The survey area lies between the coordinates 23°27′22′′ N - 23°27′31′′ N latitudes and 92°45′19′′ E - 92°45′24′′ E longitudes. The mountain area is still covered with virgin forests. The vegetations of the study area fall under Tropical semi-evergreen forests. The average annual rainfall is about 267.13 mm. The temperature ranges from 20°C - 29°C during summer and winter temperature ranges from 7°C - 21°C (Source: State Meteorological Centre, DST, Mizoram).

Tanhril forest

The sample collection was carried out at Tanhril Forest within Mizoram University Campus located on the south-western part of Aizawl city, the Capital of Mizoram which is 15 kms away from the capital and lies between 230.42’ to 230.46’ N latitude and 920.38’ to 920.42’E longitude and located at an altitude of 850 metres amsl with an average rainfall of 230 mm. (Source: State Meteorological Centre, DST, Mizoram).

Sampling, collection and preservation of specimens

The specimens were collected randomly since there are no standard methods for accurately estimating the macrofungal species richness of an area based on a sample of the macrofungi (Schmit *et al.,* 1999).



Map showing study sites

This is due to chances of occurrence of the fungal specimen. The number of individual specimen was recorded in both the sites. The collection periods are divided into two seasons (Rainy season from April to September and Dry season from October to March).

The samples were collected or isolated from its substrates or host (dried wood/branches) with the help of knife or other sharp materials and sometimes simply plucked with bare hand (in case of soft samples). Samples collected were kept in air-tight container or plastics bags which are labeled after collection. Photograph of each sample collected were taken in the field and in the laboratory (Prasher, 2015; Zothanzama, 2011).

The specimens are preserved by air drying, deep freezing and liquid preservation (Meenakshisundaram and Bharathiraja, 2013; Zothanzama and Lalrinawmi, 2015). Voucher numbers are given to the specimens and stored in the Department of Environmental Science, Mizoram University.

Identification of specimens

The collected specimens were identified according to standard macroscopic and microscopic characteristics through consultation with appropriate literature (Gilbertsonand Ryvarden, 1986; Núñez and Ryvarden, 2000; Roy and De, 1996; Lodge *et al.,* 2004). The morphology or the macro-characteristics *i.e.* the outward appearance (fruiting body) were studied carefully and compared or expressed through appropriate photographs and literatures from books and journals (Ian *et al.,* 2003; Jordan, 1993; Osemwegie and Okhuoya, 2009; Osemwegie *et al.,* 2010; Roda, 2010; Scott, 2006; Natarajan and Kolandavelu, 1998; Rattan,

1977). For microscopic study, thin sections of dried specimens are taken with the help of a sharp razor blade and were mounted in 3% KOH solution and stained in Lactophenol or 60% lactic acid + cotton blue. Spore print of the collected specimens was taken by cutting off the cap and placing it in a piece of white paper (Surcek, 1988).

Diversity indices

Using standard protocols, diversity indices such as Simpson and Shannon-Weiner diversity indices were used Simpson (1949), Shannon-Wiener (1949).

The Pielous measure of species evenness was estimated Pielou (1966). Species richness was measured using Menhincik's (1964) and Margalef's richness index (1958).

Results and Discussion

A total of 46 species were identified from both the study sites, 42 belonging to the phylum Basidiomycota and 4 belong to Ascomycota, 13 families and 26 genera. It was observed that a total of 21 species were common to both the forests whereas 19 species were found only found in Hmuifang forest and 6 species was present only in Tanhril forest (Table 1 and Fig. 2).

Polyporaceae is the dominant family (Fig. 1) and *Microporus xanthopus* represents the most abundant species in both the study sites with species number of 56 and 76 in Hmuifang and Tanhril forests respectively (Table 2).

Shannon-Wiener's diversity index of fungal species was found to be 3.31in Hmuifang forest and 2.99 in Tanhril forest; Simpson shows 0.95 in Hmuifang and 0.90 Tanhril forest; Menhinick's index shows 1.91 for Hmuifang and 1.22 in Tanhril forest; Margalef's index shows 6.41 in Hmuifang and 3.98 in Tanhril forest; Pielou's eveness index shows 0.54 in Hmuifang and 0.51 in Tanhril forest (Table 3) respectively. Most of the fleshy, jelly and gilled wood rotting fungi like *Coprinellus dessimentus, Fistulina hepatica, Lentinus edodes, Tremella fuciformis, T. mesenterica,* were recorded in the rainy seasons as this period is favourable for their production, since there is adequate amount moisture, favourable temperature, relative humidity. While the dry season collection was predominated by the polypores like *Daedaleopsis quercina, Microporus xanthopus, Trametes hirsutum, T. trogii, etc.*, which may be due to their tough and large sized fruiting bodies, and their unique adaptations of surviving for several periods.

Reportedly the diversity of tree species indices are such as tree density (Individual ha^{-1}) for Tanhril was 2079 and 1500 for Hmuifang forest; Shannon Weiner Diversity index for Tanhril was 4.32 and Hmuifang was 3.22; Simpson Index For Tanhril 0.98 and Hmuifang forest 0.94; Eveness index for Hmuifang 0.82 and not available for Tanhril forest; Margelef's index D_{mn} for Tanhril 14.28 and Hmuifang 8.21 (Table 4). The common tree species found in Hmuifang Reserved Forest are *Calophyllum polyanthum, Dipterocarpus retusus, Drypetes indica, Elaeocarpus rugosus, Helicia excels, Lithocarpus xylocarpus, Olea dioica, Machilus gamblei, Quercus floribunda, Symplocos racemosa, Styrax polysperma, Tarennoidea walichii, Wedlendia grandis* (Sharma *et al.*, 2017). And the common tree species of Tanhril Forest are *Alangium chinense Aporusa octandra, Castanopsis tribuloides, Dendrocalamus longispathus Schima walichii* and *Wendlandia grandi* (Lalchhuanawma, 2008).

It has been observed that the diversity of tree species have a great influence on the species

richness of wood rotting fungi in a forest community (Egbe *et al.,* 2013).

However, the species diversity of wood rotting fungi was higher in Hmuifang forest than compared to Tanhril forest which may be due to higher altitude, low temperature, high relative humidity, soil moisture content and experiences higher amount of rainfall annually which in turn have a great impact on the type of vegetation.

Also, Hmuifang forest is a community reserved forest and is free from anthropogenic activities, whereas Tanhril forest experiences various kind of anthropogenic disturbances from the ongoing development activities of Mizoram University Campus and collection of the dead wood and logs for fuel-wood by the nearby villagers. Thinning and clear cutting alter the fungal community and can reduce the production of sporocarps and ectomycorrhizae. Rydin *et al.,* (1997) found that habitat loss and some forest management practices in Europe have led to declines in the diversity of fungi and in the presence of rare fungal species. Berg *et al.,* (1994) reported that many fungal species in Swedish forests are threatened by the loss of old trees and declines in coarse woody debris.

Table.1 Species identified from both the sites

S.No	Species present only at Hmuifang forest	Species present only at Tanhril Forest	Species present in both the Sites
1	*Auricularia cornea*	*Amauroderma rude*	*Auricularia auricula-judae*
2	*Cymatodermata dendriticum*	*Amauroderma rugosum*	*Auricularia polytricha*
3	*Daedaleopsis quercina*	*Auricularia mesenterica*	*Coprinellus dessimentus*
4	*Ganoderma lingzhi*	*Ganoderma applanatum*	*Cyathus striatus*
5	*Laetiporus sulphureus*	*Ganoderma mizoramense*	*Daldinia concentrica*
6	*Lentinula edodes*	*Lenzites warneirii*	*Fistulina hepatica*
7	*Lentinus sajor caju*		*Hexagonia tenuis*
8	*Lenzites elegans*		*Lentinus badius*
9	*Micromphale foetidum*		*Marasmius sp.*
10	*Pleurotus ostreatus*		*Microporus affinis*
11	*Polyporus alveolaris*		*Microporus xanthopus*
12	*Polyporus arcularius*		*Mycena sp.*
13	*Polyporus badius*		*Schizophyllum commune*
14	*Polyporus dictyopus*		*Stereum hirsutum*
15	*Polyporus tenuiculus*		*Stereum rugosum*
16	*Pycnoporus sanguineus*		*Trametes hirsuta*
16	*Trametes modesta*		*Trametes trogii*
18	*Trichaptum biforme*		*Tremella fuciformis*
19	*Xylaria grammica*		*Tremella mesenterica*
20			*Xylaria hypoxylon*
21			*Xylaria longipes*

Table.2 Occurrence of species in both the sites and collecting season

Hmuifang Reserve Forest			**Tanhril forest**		
Species	**No. of Species**	**Season**	**Species**	**No. of Species**	**season**
Auricularia auricula-judae	12	Rainy	*Amauroderma rude*	8	Rainy and dry
Auricularia cornea	1	Rainy	*Amauroderma rugosum*	6	Rainy and dry
Auricularia polytricha	8	Rainy	*Auricularia auricularea*	26	Rainy
Coprinus dessimentus	25	Rainy	*Auricularia mesenterica*	5	Rainy
Cyathus striatus	3	Rainy	*Auricularia polytricha*	13	Rainy
Cymatodermata dendriticum	3	Rainy	*Coprinellus dessimentus*	38	Rainy
Daedaleopsis quercina	6	Rainy and dry	*Cyathus striatus*	9	Rainy
Daldinia concentrica	5	Rainy and dry	*Daldinia concentrica*	3	Rainy and dry
Fistulina hepatica	3	Rainy	*Fistulina hepatica*	2	Rainy
Ganoderma lingzhi	7	Rainy and dry	*Ganoderma applanatum*	1	Rainy and dry
Hexagonia tenuis	27	Rainy and dry	*Hexagonia tenuis*	19	Rainy and dry
Laetiporus sulphureus	1	Rainy	*Lentinus badius*	2	Rainy and dry
Lentinula edodes	1	Rainy	*Lenzites warneirii*	2	Rainy and dry
Lentinus badius	3	Rainy and dry	*Marasmius sp.*	15	Rainy
Lentinus sajor caju	3	*Rainy*	*Microporus affinis*	6	Rainy and dry
Lenzites elegans	17	Rainy and dry	*Microporus xanthopus*	76	Rainy and dry
Marasmius sp.	1	Rainy	*Mycena sp.*	5	Rainy
Micromphale foetidum	8	Rainy	*Schizophyllum commune*	34	Rainy and dry
Microporus affinis	12	Rainy and dry	*Stereum hirsutum*	12	Rainy and dry
Microporus xanthopus	56	Rainy and dry	*Stereum rugosum*	12	Rainy and dry
Mycena sp.	8	Rainy	*Trametes hirsuta*	23	Rainy and dry

Pleurotus ostreatus	1	Rainy	*Trametes trogii*	17	Rainy and dry
Polyporus alveolaris	16	Rainy	*Tremella fuciformis*	4	Rainy
Polyporus arcularis	5	Rainy	*Tremella mesentrica*	3	Rainy
Polyporus badius	12	Rainy	*Xylaria hypoxylon*	17	Rainy and dry
Polyporus dictyopus	15	Rainy	*Xylaria longipes*	14	Rainy and dry
Polyporus tenuiculus	8	Rainy			
Pycnoporus sanguineus	5	Rainy and dry			
Schizophyllum commune	25	Rainy and dry			
Stereum hirsutum	17	Rainy and dry			
Stereum rugosum	2	Rainy and dry			
Tramates modesta	12	Rainy and dry			
Trametes hirsuta	21	Rainy and dry			
Trametes trogii	6	Rainy and dry			
Tremella fuciformis	3	Rainy			
Tremelles mesentrica	6	Rainy			
Trichaptum biforme	18	Rainy and dry			
Xylaria gramica	24	Rainy and dry			
Xylaria hypoxylon	18	Rainy and dry			
Xylaria longipes	18	Rainy and dry			

Table.3 Species diversity indices of wood rotting fungi from both sites

Sites	**Shannon-Weiner**	**Simpson**	**Menhinick's**	**Margelef's**	**Pielou's eveness**
Hmuifang	3.31	0.95	1.91	6.41	0.54
Tanhril	2.99	0.90	1.22	3.98	0.51

Table.4 Tree species indices of Hmuifang forest (Sharma *et al.*, 2017) and Tanhril forest (Lalchhuanawma, 2008)

Paramerters	**Hmuifang**	**Tanhril**
Tree Density(Individual ha^{-1})	1500	2079
Shannon Weiner Diversity index	3.22	4.32
Simpson Index	0.94	0.98
Eveness index	0.82	--
Margelef's index D_{mn}	8.21	14.28

Fig.1 Representative families and number of species present from Hmuifang and Tanhril forest

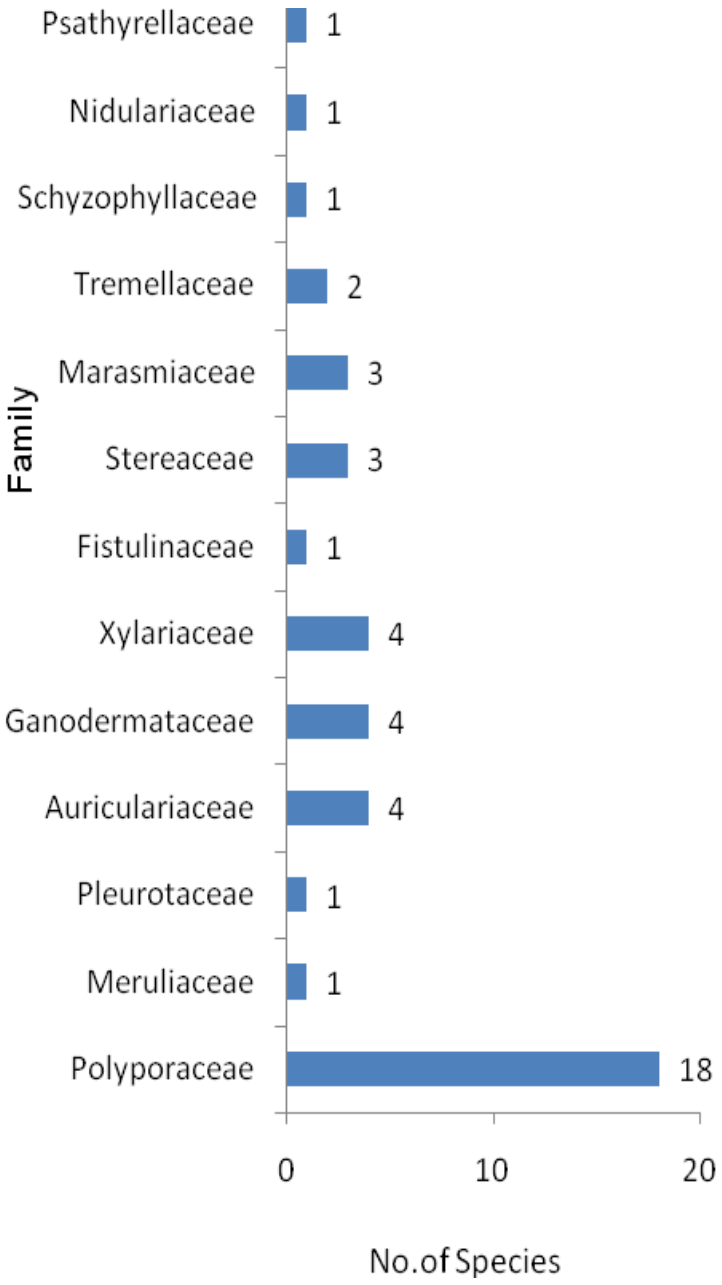


Fig.2 Some of the common fungal species

*1. Microporus xanthopus 2. M.affinis 3. Polyporus dictyopus 4. P. badius 5. P. tenuiculus 6. P. alveolaris 7. P. arcularis 8. Schizophyllum commune 9. Auricularia auriculara*e *10. A. polytricha 11. A. delicate 12. A. cornea. 13.Cymatodermata dentriticum 14. Lentinula edodes 15. Pleurotus ostreatus 16. Laetiporus sulphureus 17. Daldinia concentrica 18.L.badius 19. L. sajor-caju 20.Xylaria hypoxylon*

The importance of presence of old dying trees and fallen logs for presence of wood rotting fungi is recognized from studies where it was found that there is a correlation between the decay of the wood and the species of fungi recorded as sporocarps (Hoiland and Bendiksen, 1997; Lindblad, 1998; Renvall, 1994). The influence of removal of both the

live and dead substrata for the wood rotting fungal species may be the reason for the fewer number of species from Tanhril forest.

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How to cite this article:

Josiah M.C. Vabeikhokhei, Zohmangaiha, John Zothanzama and Lalrinawmi, H. 2019. Diversity Study of Wood Rotting Fungi from Two different Forests in Mizoram, India. *Int.J.Curr.Microbiol.App.Sci.* 8(04): 2775-2785. doi: https://doi.org/10.20546/ijcmas.2019.804.323