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Article

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Effects of environmental factors and host characteristics on diversity and distribution of wood-rotting fungi of Mount Puliebadze, Nagaland

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Abstract

The study on the effects of environmental factors and host characteristics on diversity and distribution of wood-rotting fungi Mount Puliebadze, Nagaland was carried out for a period of two successive years (January 2015 to December 2016). A total of 46 wood-rotting fungi belonging to 16 families were identified. The occurrence of wood-rotting fungi demonstrated a decreasing trend with increase in elevations and correlation between the two variables showed a strong negative correlation with Pearson's correlation coefficient (r) value of -0.993. The zone with lowest elevation (zone 1) comprised maximum number of species (25 species) whereas the zone with highest elevation (zone 4) comprised minimum number of species (05 species). Highest species similarity percentage (25.9%) was observed between zone 2 and 3. One way ANOVA showed significant variations between the occurrence of wood-rotting fungi with different seasons, light intensity, type of substrata and decay stage of wood. Shannon's diversity index (H') of zone 1 was highest (H'= 3.073) and that of zone 4 was lowest (H' = 1.242).

Key words – Correlation – ecology – elevation – Non-matric Multidimensional Scaling

Introduction

Wood-rotting fungi comprised a diverse group of macrofungi and are widely distributed under the divisions Basidiomycota, Ascomycota and a few from Myxomycota. They decompose complex organic polymers such as lignin, cellulose and hemicellulose of plant cell wall and are responsible for the release of nutrients and carbon from fallen woody debris (Berg & Laskowski 2005, Senkowsky 2006). Diversity of wood-rotting fungi at a given forest stand depends on various environmental factors such as altitudinal and seasonal variation, the type of forest vegetation and different host characteristics such as type of host tree species, type of substrata and decay stages of wood (Hattori 2005, Robledo & Renison 2010, Pouska et al. 2011).

Northeast India comprises of eight culturally diverse states and a major part of Northeast India, is under the Indo-Burma Biodiversity Hotspot region of the world (Moghe 2011). Nagaland is one of the mountainous states of Northeast where majority of the forest still remain unexplored. Mount Puliebadze is a part of Japfu Range which includes Mount Japfu, the 2nd highest mountain peak in Nagaland and is located in Kohima district (Sustainable Development Forum, Nagaland

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2013). Studies on wood-rotting fungi of Nagaland have been performed for the past five years (Chuzho et al. 2017, Chuzho & Dkhar 2017). The present study was carried out to understand effects of environmental factors and host characteristics on diversity and distribution of wood-rotting fungi of Mount Puliebadze, Nagaland along an elevation gradient.

Materials & Methods

Survey and collection of wood-rotting fungi was performed from January 2015 to December 2016 on seasonal basis (spring: April to May, summer: July to September, autumn: October to November and winter: December to February). The forest stand was divided into four zone viz. zone 1 (1640-1800msl), zone 2 (1810-2000msl), zone 3 (2010-2200msl) and zone 4 (2210-2318msl). Line transect method was used for sampling fruiting bodies (Mueller et al. 2004).

Identification was carried out according to standard macroscopic and microscopic characters through standard monographs (Bakshi 1966, Ryvarden & Johansen 1980, Nunez & Ryvarden 2000, 2001) and also form Databases – Fungi from India (2012-'16). The current scientific names and taxonomic status of all the species were confirmed from Mycobank (www.mycobank.org). Method by Pouska et al. (2011) was followed for differentiating the various stages of wood decay. Five stages of wood decay were recognized: decay stage I (newly fallen woods; knife penetrates only a few millimeters into the wood), decay stage II (knife penetrates 1-2cm into the wood), decay stage III (knife penetrates 3-5cm into the wood), decay stage IV (knife penetrates 6-10cm into the wood) and decay stage V (wood very old, easily disintegrates when lifting). The occurrence of wood-rotting fungi on different types of substrata (logs, twigs, stump), surface of substrata (bark, sapwood) and type of host trees (hardwood, softwood and bamboo culms) were recorded at the time of sampling.

One way ANOVA was done to see if there is significant variation between the occurrence of wood-rotting fungi with different seasons, light intensity, type of substrata and decay stage of wood. Similarity in species compositions between the four different zones was determined using Jaccard Similarity index (J). Non-matric multidimensional scaling (nMDS) ordination was used to plot the similarities in species composition in different zones and seasons. Species diversity was calculated using Shannon's diversity index (H'). All the statistical analyses were performed using SPSS 16 software.

Results

A total of 46 wood-rotting fungi belonging to 16 families were identified. Maximum number of species belonged to Polyporaceae (14 species). Wood-rotting fungi belonging to Hymenochaetaceae and Polyporaceae were found in all the 4 zones. The zone with lowest elevation (zone 1) comprised 25 species (54%) whereas the zone with highest elevation (zone 4) comprised only 5 species (10.8%). The occurrence of wood-rotting fungi showed an increasing trend with increase in elevations and correlation between the two variables showed a strong negative correlation with Pearson's correlation coefficient (r) value of -0.993. This implied that diversity of wood-rotting fungi was higher in lower altitudes as compared to higher altitudes. Highest species similarity percentage (25.9%) was observed between zone 2 and 3, which was confirmed by nMDS ordination plot.

Diversity and distribution of wood-rotting fungi varied with different seasons, light exposure, type and surface of substrata and decay stages of wood effect. Highest number of wood-rotting fungi was recorded during summer season. There was similarity in species composition in different seasons and nMDS ordination plot confirmed this finding. Maximum similarity in species composition was observed between summer and autumn seasons. The occurrence of wood-rotting fungi along the four zones and nMDS ordination plots are presented in Fig. 1. Majority of wood-rotting fungi was found on the substrata which were exposed to sunlight. Logs, barks and decay stage III seemed to be the suitable habitat for the formations of sporocarps of majority of the species (Table 1). Maximum number of species was found growing on hardwood debris and no species was found growing on softwood debris.

One way ANOVA showed that there is a significant variation for the analyses of occurrence of wood-rotting fungi with different seasons, light intensity, type of substrata and decay stages of wood. Shannon's diversity index (H') of zone 1 was highest (H' = 3.073) and that of zone 4 was lowest (H' = 1.242).

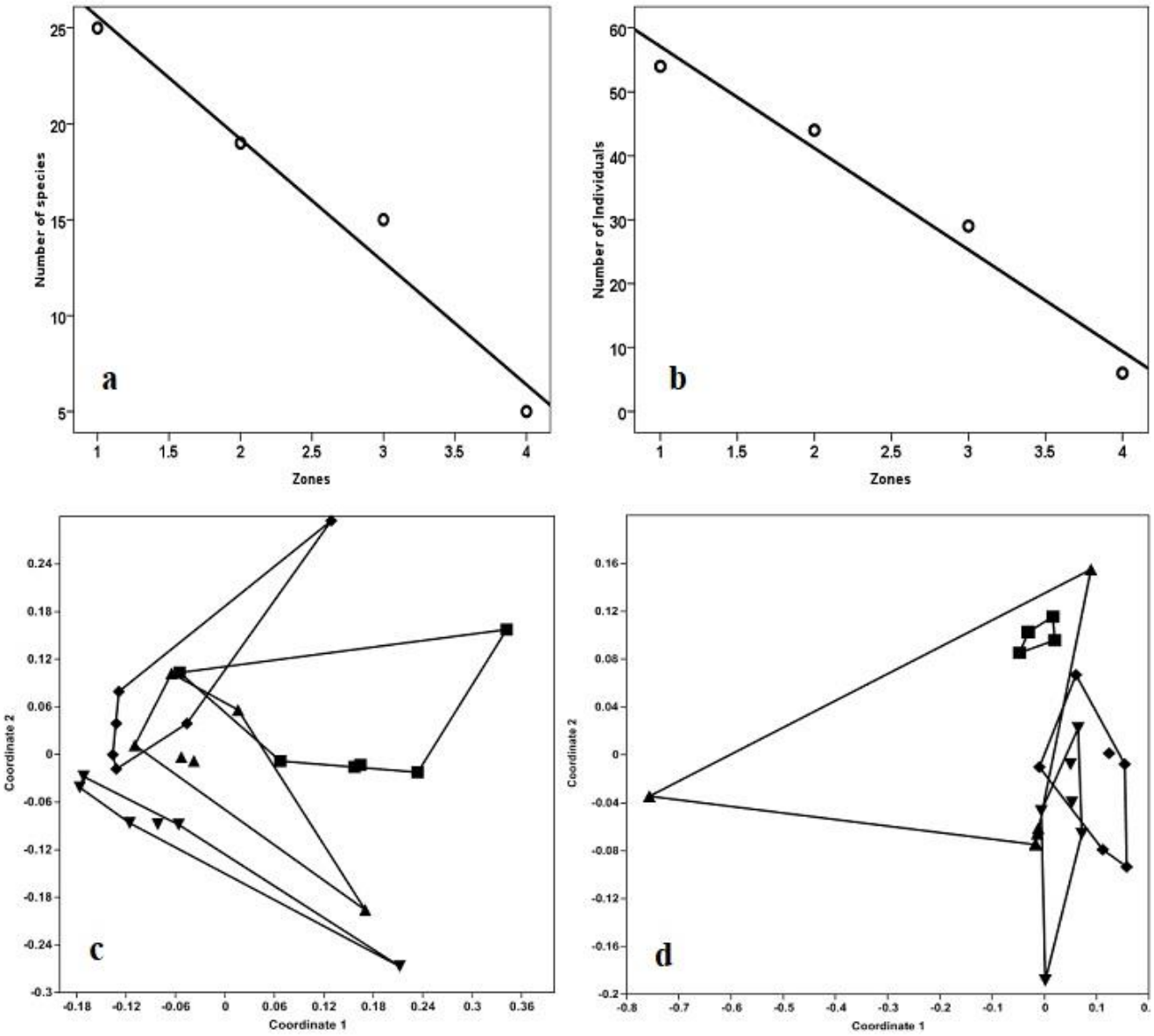

Fig. 1 – a Total number of species at different zones. b total number of individuals at different zones. c nMDS ordination diagram of species composition in different zones (zone 1 – filled inverted triangle; zone 2 – filled diamond; zone 3 – filled triangle, and zone 4 – filled square) with zone 2 and zone 3 showing maximum similarity. d nMDS ordination diagram of different seasons (spring – filled triangle; summer – filled inverted triangle; autumn – filled diamond and winter – filled square) with summer and winter seasons showing maximum similarity.

Discussion

Highest number of the wood-rotting fungi is classified under Polyporaceae. The dominance of this family was also reported by Sailo (2010), Lyngdoh & Dkhar (2014a, b), Lyngdoh 2014 from north-east India. The occurrence of wood-rotting fungi showed an increasing trend with increase in elevations and correlation between the two variables showed a strong negative correlation This demonstrated that diversity of wood-rotting fungi was higher in lower altitudes as compared to higher altitudes. Similar findings were also reported by Kuffer & Senn-Irlet (2005), Yamashita et

al. (2014) where the number of species recorded in lower elevations was greater than those recorded from higher elevations. However, a study by Robledo & Renison (2010) in Argentina showed a contrary result where altitude was positively related to species richness.

Diversity and distribution of wood-rotting fungi varied with different seasons, light exposure, type and surface of substrata and decay stages of wood effect. The effects of various environmental factors on the diversity and distribution of wood-rotting fungi was reported by several authors (Kodsueb et al. 2008, Gilbertoni et al. 2007, Kenney et al. 2006, Boddy & Heilmann-Clausen 2008, Bassler et al. 2010). Growth of wood-rotting fungi is positively imparted by rainfall and thus more fungi were reported to be present during wet season (Zhou & Hyde 2002). The preference of wood-rotting fungi to certain decay stages of wood particularly to wood at decay stage III was observed during our study. According to Pouska et al. 2011, majority of the species favored intermediate stage of decaying wood (stage III) which supports our results. Maximum number of species was found growing on hardwood debris. This is because the forest stand is dominated by hardwoods such as *Alnus nepalensis*, *Castanopsis indica*, *Prunus* species *Rhododendron arboreum* and *Quercus* species. The only softwood tree recorded from the study area was *Cryptomeria japonica* and furthermore, diversity and distribution of wood-rotting fungi depends on the type of vegetation (Hattori 2005).

Studies on wood-rotting fungi of Nagaland have been done only for the past five years (Chuzho et al. 2017, Chuzho & Dkhar 2017). Hence, a detailed study is recommended for a complete documentation of wood-rotting fungi in forests of Nagaland.

Table 1 List of species with their code, zones of occurrence, types of substrata, surface of substrata, decay stages of wood and light exposure.

Sl. no.	Species	Zone	Type of substrata	Surface of substrata	Decay stage	Light expo-sure
1	*Agaricus squarrosus*	1	Li	Sp	I	Ex
2	*Antrodiella zonata*	1	St	Br	II	Ex
3	*Auricularia auricula-judae*	1	Lo	Sp	III	Ex, Sh
4	*A. polytricha*	1, 3	Lo, Tw	Sp	II, III	Ex
5	*Bjerkandera adusta*	1	Lo	Br	II	Ex
6	*Coprinellus micaceus*	1, 2	Lo	Br	III	Ex
7	*Coriolopsis gallica*	1	Lo	Sp	II	Ex
8	*C. telfarii*	1	Lo	Sp	III	Ex
9	*Cyathus striatus*	1	Tw	Sp	III	Ex
10	*Dacrymyces plamatus*	4	Lo	Br	II	Ex
11	*Daldinia concentrica*	1, 2, 3	Lo	Br	III	Ex, Sh
12	*Deflexula subsimplex*	2	Lo	Br	III	Ex
13	*Ganoderma applanatum*	3	Li, Lo	Br	I, II	Ex
14	*Hexagonia tenuis*	1	Tw	Br	II	Ex
15	*Hymenochaete cyclomellata*	2	Lo	Br	III	Ex
16	*H. tabacina*	1, 2	St, Tw	Br	II	Ex
17	*Hypoxylon fuscum*	3	Tw	Sp	III	Ex
18	*Irpex lacteus*	1	Tw	Br	III	Ex
19	*Jackrogersella cohaerens*	3	Tw	Br	II, III	Ex
20	*Jackrogersella* sp. 1	2	Tw	Br	II	Sh
21	*Kretzschmaria deusta*	2	Lo	Br	IV	Ex
22	*Lentinus fasciatus*	2	St	Sp	III	Ex
23	*Lopharia cinerascens*	1	Tw	Br, Sp	III	Ex, Sh
24	*Microporus affinis*	4	Lo, Tw	Sp	III	Ex
25	*M. vernicipes*	2, 3	Tw	Br	III	Ex

Table 1 Continued.

Sl. no.	Species	Zone	Type of substrata	Surface of substrata	Decay stage	Light expo-sure
26	*M. xanthopus*	1, 3	Lo, Tw	Sp	II, III	Ex
27	*Phellinus gilvus*	2	Lo	Sp	III	Ex
28	*P. wahlberghii*	2, 3, 4	Lo	Br	I, IV	Ex
29	*Pleurotus ostreatus*	1	Lo	Sp	III	Ex
30	*Porodisculus pendulus*	3	Tw	Br	III	Ex
31	*Pycnoporus sanguineus*	1	Lo	Br	III	Ex
32	*Schizophyllum commune*	1	Tw, Cu	Sp	III	Ex
33	*Stemonitis splendens*	1	Lo	Sp	IV	Sh
34	*Stereum hirsutum*	2, 3	Lo	Br	II, III	Ex
35	*S. ostrea*	1, 2, 3	Lo	Br	III	Ex
36	*Trametes hirsuta*	1	Lo, Cu	Br	II	Ex
37	*T. lactinea*	1, 2	Li, St	Br	II	Ex
38	*T. pubescens*	4	Lo	Sp	IV	Ex
39	*T. versicolor*	1, 2	Lo, St, Tw	Br, Sp	II, III	Ex
40	*Trichaptum byssogenum*	3, 4	Lo, Tw	Br, Sp	II, III	Ex, Sh
41	*Xylaria apiculata*	2, 3	Tw	Sp	III, IV	Ex, Sh
42	*X. hypoxylon*	2	Lo	Br	IV	Ex
43	*X. longipes*	1	Lo	Sp	IV	Ex
44	*X. polymorpha*	1, 2, 3	Lo, St	Br, Sp	III, IV	Ex, Sh
45	*Xylobolus frustulatus*	2	Lo, Tw	Sp	IV, V	Ex
46	*X. subpileatus*	3	Li	Sp	I	Ex

*1: Zone 1; 2: Zone 2; 3: Zone 3; 4: Zone 4; Li: Living trees, Lo: Logs; St: Stumps; Tw: Twigs; Cu: Bamboo culms; Br: Bark; Sp: Sapwood; I: Decay stage I; II: Decay stage II; III: Decay stage III; IV: Decay stage IV; V: Decay stage V; Ex: Exposed to sunlight; Sh: Under shaded condition.

Conclusion

This study gives gave an insight into the altitudinal distribution, seasonal variations and substrate preferences of wood-rotting fungi. It can be concluded that species diversity of wood-rotting fungi decreased with increase in elevation. Logs, twigs and wood decay stage III combined with adequate macro-environmental factors provide essential habitat for the formation and growth of the wood-rotting fungi. More intensive study on wood-rotting fungi of Nagaland will further unveil many interesting and unexplored wood-rotting fungi of the region.

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