



Wood-rotting fungi in two forest stands of Kohima, north-east India: a preliminary report

Chuzho K¹, Dkhar MS¹ and Lyngdoh A^{2*}

¹Microbial Ecology Laboratory, Department of Botany, North Eastern Hill University, Shillong- 793022, Meghalaya, India.

²Department of Botany, Shillong College, Boyce Road, Laitumkrah – 793003, Shillong, Meghalaya.
email: aromalyngdoh@gmail.com.

Chuzho K, Dkhar M. S, Lyngdoh A. 2017 – Wood-rotting fungi in two forest stands of Kohima, north-east India: a preliminary report. Current Research in Environmental & Applied Mycology 7(1), 1–7, Doi 10.5943/cream/7/1/1

Abstract

Wood-rotting fungi were collected from two forest stands - a disturbed (Lower Kitsubozou) and an undisturbed forest stand (Mount Puliebadze) of Kohima, Nagaland in India. A survey and collection of wood-rotting fungi were done during the months of October and November, 2013 (Autumn); January and February, 2014 (Winter); March and April, 2014 (Spring). A total of 32 species belonging to 18 families were identified based on the macro and micro morphology of the fruiting bodies. Three species belong to phylum Ascomycota and 29 species belong to phylum Basidiomycota. More wood-rotting fungi were collected from the undisturbed forest stand, Puliebadze than from the disturbed forest stand, Lower Kitsubozou. Of the total species of wood-rotting fungi collected, 68.96% species occurred on logs, 17.24% on tree stumps, 15.51% on twigs and 12.06% on living trees. More wood-rotting fungi were collected in Autumn season. *Ganoderma applanatum*, *Microporus affinis* and *Trametes versicolor* were collected in all three seasons.

Key words – Nagaland – occurrence – Polyporaceae – seasons – substrata.

Introduction

Fungi have fascinated humans since ancient times. A good number of these fungi produce large and conspicuous fruit-bodies and are called as macrofungi. Studies based on fruiting bodies have been widely used as the first indicators of polypore diversity in the forest. They account for the majority of the fruit bodies found on the woody debris (de Vries 1990). Determining the magnitude and patterns of fungal species diversity has been an ongoing challenge for mycologists (Hawksworth 1991, 2001, 2004, Hawksworth & Mueller 2005, Hawksworth & Rossman 1997, Hyde 2001). It was estimated 1.5 million species of fungi on the globe and one third of which exists in India (Hawksworth 2004) and of this, only 50% are characterized (Manoharachary et al. 2005). The importance of fungal biodiversity in the forest ecosystem is well documented (Lodge 1996, Molina et al. 2001).

With new reports and findings, efforts are also made for the conservation of wood-rotting - fungi. Many polypores are listed in red data books (Arnolds 1989, Benkert et al. 1996, Bendiksen et al. 1997, Larsson 1997). Studies on wood-rotting fungi of India, particularly in the northeast region

are scanty (Lyngdoh & Dkhar 2014) however, with its rich forest cover, huge biodiversity and new findings, this area is now of great interest for the study of wood-rotting fungi.

Nagaland is a small state in North East India, blessed with a vast range of forest vegetation types and has an elevation ranging from a few hundreds to over three thousand meters above sea level. Kohima, the capital of the state, has some of the highest mountain peaks in Nagaland, like Mount Japfu (2nd highest) and Mount Puliebadze (6th highest), with an elevation of 3,014 msl and 2,318 msl respectively. However, there has been no report of wood-rotting fungi so far. The current work presents the first study of wood-rotting fungi from the state of Nagaland.

Materials & Methods

Study site

Kohima district, the land of Angami Naga tribe is located towards the South West of Nagaland. It is situated at a mean elevation of 1,468 msl, with geographical coordinates at 25°11' and 25°58' North Latitude and 93°20' and 45°55' East latitude. It receives an average rainfall of 250 cm with a mean summer and winter temperature of 25°C and 4°C respectively, and harbours a huge biodiversity of flora and fauna, including macrofungi.

The study sites selected were Mount Puliebadze (protected area and wildlife sanctuary), located within greater Kohima, at an altitude of 2,318 msl and Lower Kitsubozou (disturbed forest stand), located at the vicinity of Kohima town at an altitude of 1,468 msl.

Survey and collection of wood-rotting fungi

Collection of the fungal fruiting bodies was done from the two forest stands of Kohima during the months of October and November, 2013 (Autumn); January and February, 2014 (Winter); March and April, 2014 (Spring). All the sporocarps and clusters of sporocarps of the same species of the wood rotting fungi on a log or a tree were counted as one occurrence, independent of the number of sporocarps.

The frequency percentages of occurrence of each fungal species in the three seasons were calculated using the formula as:

$$\text{Frequency \% of occurrence} = \frac{\text{Number of seasons in which species is present}}{\text{Total number of seasons studied}} \times 100$$

Identification of wood-rotting fungi and host trees

Detailed observation and necessary measurements of the fruit bodies were made both in the field and laboratory. For observing the microscopic details, the specimens were soaked with 5% KOH. The sectioning were done using razor blade and cotton blue or Melzer's reagent were used for staining. Identification was done according to standard macroscopic and microscopic characteristics through consultations with appropriate literatures (Overholts 1953, Ryvar den & Johansen 1980, Gilbertson & Ryvar den 1986). Host trees were identified in the field or laboratory with the help of experts and herbarium curators.

Results

A total 32 species were identified, belonging to 18 families (Table 1). Three species belonged to phylum Ascomycota and 29 species belonged to phylum Basidiomycota (Fig. 1). More wood-rotting fungi (i.e., 77.58%) were collected from the undisturbed forest stand, Puliebadze (Fig. 2). Only 25.86% of wood-rotting fungi were collected from disturbed forest stand, Lower Kitsubozou. It was also observed that, with the increase in altitude, there is a decrease in the diversity of wood-rotting fungi.

Among the different substrata, wood logs harboured more wood-rotting fungi (68.96%) while living trees harboured the least with only 12.06% (Fig. 3).

Ganoderma applanatum, *Microporus affinis* and *Trametes versicolor* were collected in all three seasons (100 % frequency occurrence). Maximum number of species was collected in Autumn season and least in Spring season (Fig. 4).

A higher number of white rot macrofungi were found (75 %) as compared to brown rots (25 %). The highest number of wood rotting fungi was recorded from the family Polyporaceae (Table 1). Of the total identified species, 62.5 % (20 species) were confirmed to be saprotrophs while few were parasitic or pathogenic.



Fig. 1 – Some common wood-rotting fungi. a, *Auricularia auricula*; b, *Daldinia concentrica*; c, *Ganoderma applanatum*; d, *Hexagonia tenuis*; e, *Microporus xanthopus*; f, *Schizophyllum commune*; g, *Steccherinum ochraceum*; h, *Trametes hirsutum*; i, *T. versicolor*

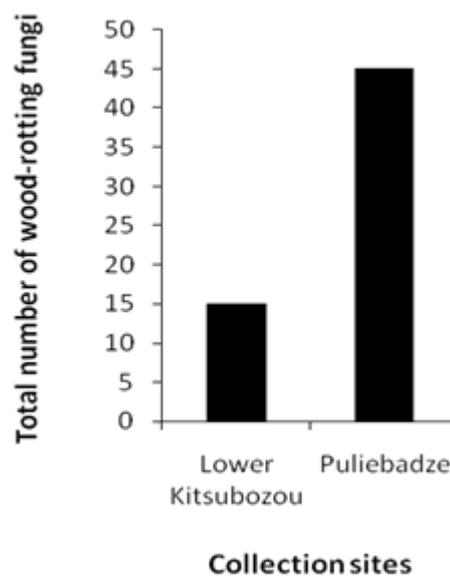


Fig. 2 – Total number of wood-rotting fungi in the two forest stands

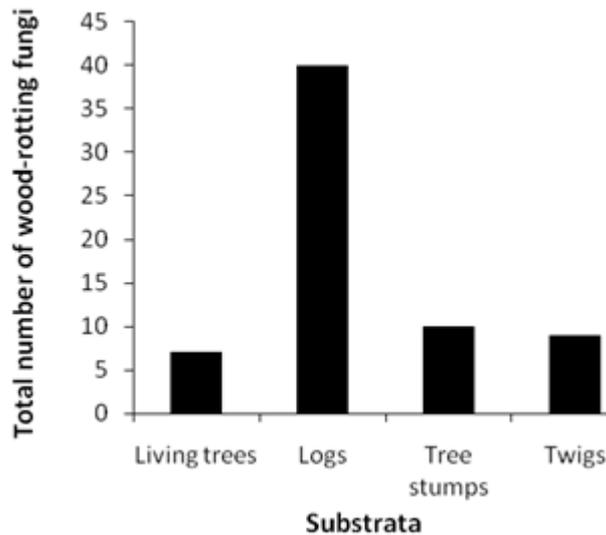


Fig. 3 – Total number of wood-rotting fungi on different substrata

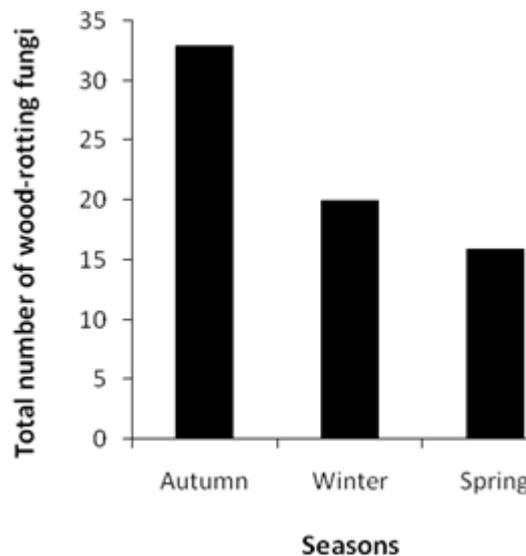


Fig. 4 – Total number of wood-rotting fungi collected in different seasons

Discussion

The undisturbed forest stand of Puliebadze, being a reserve forest with no human activity allowed has rich natural vegetation and harboured more wood-rotting fungi (i.e., 77.58%). This shows that a diverse and healthy plant community supports diverse species of fungi. Hawksworth (1991) gave a similar assumption that the number of wood inhabiting fungi is expected to increase with increase in number of tree species. Only 25.86% of wood-rotting fungi were collected from disturbed forest stand, Lower Kitsubozou. The main factor responsible for the lower wood-rotting fungal diversity in the disturbed forest stand of Lower Kitsubozou is anthropogenic activities. The fallen dead wood were removed swiftly, leading to less abundance and availability of substrata, deforestation is high, the understory vegetation is reduced to a large extent and agricultural practices were also carried out.

Altitude has an influence on the diversity of wood-rotting fungi. It was observed that, with the increase in altitude, there is a decrease in the diversity of wood-rotting fungi, the uppermost region of Mount Puliebadze being only covered by trees of *Rhododendron arboreum*. This result is also supported with the report published from Central Europe (Pouska et al. 2010), suggesting that elevation gradient and structural characteristics causes changes in species composition of wood decay fungi and that the elevation in turn had a negative influence on the occurrence of fungi.

Table 1 List of wood-rotting fungi collected from the two forest stands of Kohima

ASCOMYCETES	
Xylariaceae	<i>Daldinia concentrica</i> (Bolton) Ces. & De Not., <i>Ustilinea deusta</i> (Fries) Petrak, <i>Xylaria longipes</i> Nitschke
BASIDIOMYCETES	
Amaurodermaceae	<i>Amauroderma rugosum</i> (Bl. & Nees ex Fr.) Torrend
Agaricaceae	<i>Pleurotus ostreatus</i> Fr.
Auriculariaceae	<i>Auricularia auricula</i> (Hooker) Underwood
Crepidotaceae	<i>Crepidotus</i> sp.
Dacrymycetaceae	<i>Dacrymyces palmatus</i>
Fomitopsidaceae	<i>Daedalea quercina</i> Fr., <i>Fomes fomentarius</i> (L. : Fr.) Kickx, <i>Fomitopsis carneus</i> (Blume & Nees) Imaz., <i>F. feei</i> (Fr.)Kreisel
Ganodermataceae	<i>Ganoderma applanatum</i> (Pers.) Pat.
Hapalopilaceae	<i>Bjerkandera adusta</i> (Wild.: Fr.) Karst
Hymenochaetaceae	<i>Hymenochaete tabacina</i> (Sowerby) Leveilli, <i>H. cyclomellata</i> Fr. <i>Phellinus pini</i> (Fr.) A. Ames, <i>P. wahlberghii</i> (Fr.) D. A. Reid
BASIDIOMYCETES	
Meripilaceae	<i>Rigidoporus ulmarius</i> (Fr.)Imazeki
Meruliaceae	<i>Flavodon flavus</i> (Kl.) Ryv.
Phanerochaetaceae	<i>Irpex</i> sp.
Polyporaceae	<i>Hexagonia tenius</i> (Hook.) Fr., <i>Microporus affinis</i> (Fr.: Blume &Nees) Kunt., <i>M. xanthopus</i> (Fr.) Kuntze, <i>Trametes hirsutum</i> (Wulf. Fr.) Pil., <i>T. lactinea</i> (Berk.) Pat., <i>T. versicolor</i> (L. Fr.) Pilat, <i>Trichaptum biforme</i> (Fr. in Kl.) Ryvardeen
Schizophyllaceae	<i>Schizophyllum commune</i> Fr.
Steccherinaceae	<i>Steccherinum ochraceum</i> (Pers. ex J.F. Gmel.) Gray
Stereaceae	<i>Xylobolus subpileatus</i> (Berk. & M. A. Curtis) Boidin
Strophariaceae	<i>Pholiota aurivella</i> (Bertsch) P. Kumm

Among the different substrata, wood logs harboured more wood-rotting fungi (68.96%) while living trees harboured the least. A study conducted in Sweden revealed that wood decay fungi depends on specific substrata such as old trees and logs (Berg et al. 1994). This may be a result of different species adaptation to the defence mechanism present in the living trees and not in logs and twigs, as well as the difference in the microclimate within the substrata (Boddy 2001). A number of studies have also demonstrated that different types of substrata such as living trees, fallen logs and stumps support different species of fungi (Jonsell & Weslien 2003, Lindhe et al. 2004). The abundance and availability of substrata is an important factor in fungal diversity in forest ecosystem (Norden & Paltto 2001, Penttila et al. 2006, Kuffer et al. 2008, Abrego & Salcedo 2012).

Ganoderma applanatum, *Microporus affinis* and *Trametes versicolor* were collected in all three seasons (100 % frequency occurrence). Maximum number of species was collected in Autumn season and least in Spring season. This is because the fungal fruiting bodies which emerged during summer, just after the rains, persisted till autumn. Macrofungi are highly affected by weather conditions (Gulden 1992, Ohenoja 1993, Carrier 2003). It was also observed that there was a great variety and number of fungi during dry season which is similar to the results of Rayner & Todd (1979).

A higher number of white rot macrofungi were found (75 %) as compared to brown rots (25 %). Similar results were obtained from North America, where only 7% produced brown rot (Kirk 1984). Studies conducted in temperate Himalayas and in East Khasi hills, Meghalaya also showed that only 13% and 10.4% of wood-rotting fungi caused brown rot (Sharma 2006, Lyngdoh & Dkhar 2014).

The highest number of wood rotting fungi was recorded from the family Polyporaceae. Studies conducted in tropical Northern Brazilian Atlantic forest (Gilbertoni & Calvacanti 2004) and in East Khasi hills, Meghalaya (Lyngdoh & Dkhar 2014) also showed parallel results.

Of the total identified species, 62.5 % (20 species) were confirmed to be saprotrophs while few were parasitic or pathogenic. The findings by Roberts and Ryvarde that most poroid wood-rotting fungi are saprotrophs (Roberts & Ryvarde 2006) conforms to the results of this study in which 62.50% (21 species) were confirmed to be saprotrophs while only few were parasitic or pathogenic.

The current study on wood-rotting fungi in Nagaland is only preliminary. Many years of intensive surveys are required to describe the macrofungal communities of a particular area adequately (Tofts & Orton 1998). Besides, many species of wood-rotting fungi are transient, and their production of fruiting bodies depends on the availability of substrata together with the requisite environmental conditions. Thus, a consistently long-term study must be done to precisely enumerate and study the diversity of wood-rotting fungi.

Acknowledgements

The authors thank the Head, Department of Botany, North Eastern Hill University, Shillong for all the necessary laboratory facilities, Dr. N.S.K. Harsh (Scientist – G) and Mr. M. Kumar (research scholar) Forest Research Institute, Dehradun, India, for identification of the fungi.

References

- Abrego N, Salcedo I. 2012 – Variety of woody debris as a factor influencing wood-inhabiting fungal richness and assemblages: Is it a question of quantity or quality? *Forest Ecology and Management* 291, 377–385.
- Arnolds E. 1989 – A preliminary red data list of macro fungi in the Netherlands. *Persoonia* 14, 77–125.
- Bendiksen E, Hoiland K, Brandrud TE, Jordal JB. 1997 – Truete og sarbare sopparter i Norge; en kommentert rodliste – Red list of threatened fungi in Norway. *Fungiflora*, Norway.
- Benkert D, Dorfelt H, Hardetke HJ, Hirsch G et al. 1996 – Rote Liste der Grosspilze Deutschlands. In: Bundesamt für Naturschutz (ed), *Rote Listegefährdeter Pflanzen Deutschlands*, Bundesamt für Naturschutz, Germany, pp 377–426.
- Berg A, Ehnström B, Gustafsson L, Hallingbäck T et al. 1994 – Threatened plant, animal and fungus species in Swedish forests: distribution and habitat associations. *Conservation Biology* 8, 718–731.
- Boddy L. 2001 – Fungal community ecology and wood decomposition processes in angiosperms: from standing tree to complete decay of coarse woody debris. *Ecological Bulletin* 49, 43–56.
- Carrier P. 2003 – Effects of water addition on biotic and abiotic components of a dry boreal forest in the Yukon. Ph. D. Thesis.
- de Vries BWL. 1990 – On the quantitative analysis of wood-decomposing macrofungi in forests. *Wageningen Agricultural University Papers* 90, 93–101.
- Gilbertoni TB, Calvacanti MA. 2004 – Poroid fungi (Basidiomycota) of the Atlantic rain forest in Northern Brazil. *Synopsis Fungorum* 18, 33–46.
- Gilbertson RL, Ryvarde L. 1986 – North American Polypores. *Fungiflora*, Oslo.
- Gulden G. 1992 – Macromycetes and air pollution. *Mycocoenological studies in three Oligotrophic spruce forest in Europe*. *Bibliotheca Mycologia*. Berlin, Cramer, pp 144.
- Hawksworth DL. 1991 – The fungal dimension of biodiversity: magnitude, significance and Conservation. *Mycological Research* 95, 641–654.
- Hawksworth DL. 2001 – The magnitude of fungal diversity: the 1.5 million species estimate revisited. *Mycological Research* 105, 1422–1432.
- Hawksworth DL. 2004 – Fungal diversity and its amplifications for genetic resource collections. *Studies in Mycology* 50, 19.

- Hawksworth DL, Mueller GM. 2005 – Fungal communities. In: Dighton J, White J and Oudemans P (eds) Their diversity and distribution. The fungal community: Its organisation and role in the ecosystem, 3rd edn. CRC Taylor and Francis, New York, pp 27–37.
- Hawksworth DL, Rossman AY. 1997 – Where are all the undescribed fungi? *Phytopathology* 87, 888–891.
- Hyde KD. 2001 – Where are the missing fungi? Does Hongkong have any answers? *Mycological Research* 105, 1514–1518.
- Jonsell M, Weslien J. 2003 – Felled or standing retained wood - it makes a difference for saproxylic beetles. *Forest Ecology and Management* 175, 425–435.
- Kirk TK. 1984 – Degradation of lignin. In: Gibson DT (ed) *Microbial Degradation of Organic Compounds* pp 399–437.
- Kuffer N, Gillet F, Senn-Irlet B, Aragno M, Job D. 2008 – Ecological determinants of fungal diversity on dead wood in European forests. *Fungal Diversity* 30, 83–95.
- Larsson KH. 1997 – Rödlistadesvampari Sverige Artfakta. Art Databanken, Sweden.
- Lindhe A, Åsenblad N, Toresson HG. 2004 – Cut logs and high stumps of spruce, birch, aspen and oak-nine years of saproxylic fungi succession. *Biological Conservation* 119, 443–454.
- Lodge DJ. 1996 – Microorganisms. In *The Food Web of a Tropical Forest*, Regan DP, Waide RB (eds) Chicago, University of Chicago Press, pp 53–108.
- Lyngdoh A, Dkhar MS. 2014 – Wood-rotting fungi in East Khasi Hills of Meghalaya, Northeast India, with special reference to *Heterobasidion perplexa* (a rare species – new to India). *Current Research in Environmental & Applied Mycology* 4, 117–124.
- Manoharachary C, Sridhar K, Singh R, Suryanarayanan TS et al. 2005 – Fungal Biodiversity: Distribution, Conservation and Prospecting of Fungi from India. *Current Science* 89 (1), 58–71.
- Molina R, Pilz D, Smith J, Dunham S et al. 2001 – Conservation and management of forest fungi in the Pacific Northwestern United States: an integrated ecosystem approach. In *Fungal Conservation, Issues and Solutions*, Moore D, Nauta MN, Evans SE, Rotheroe M, (eds) Cambridge, Cambridge University Press, U.K., pp 19–63.
- Norden B, Paltto H. 2001 – Wood-decay fungi in hazel woods: species richness correlated to stand age and dead wood features. *Biological Conservation* 101, 1–8.
- Ohenoja E. 1993 – Effect of weather conditions on the larger fungi at different forest sites in northern Finland in 1976–1988. Ph.D. Thesis.
- Overholts LO. 1953 – The Polyporaceae of the United States, Alaska and Canada. University of Michigan Press, Ann. Arbor, Michigan, pp 466.
- Penttilä R, Lindgren M, Miettinen O, Rita H, Hanski I. 2006 – Consequences of forest fragmentation for polyporous fungi at two spatial scales. *Oikos*. 114, 225–240.
- Pouska V, Svoboda M, Lepsova A. 2010 – The diversity of wood-decaying fungi in relation to changing site condition in an old growth mountain spruce forest, Central Europe. *European Journal of Forest Research* 129, 219–231.
- Rayner ADM, Todd NK. 1979 – Population and community structure and dynamics of fungi in decaying wood. *Advances in Botanical Research* 7, 333–420.
- Roberts P, Ryvarden L. 2006 – Poroid fungi from Korup National Park, Cameroon. *Kew Bulletin* 61, 55–78.
- Ryvarden L, Johansen I. 1980 – A Preliminary Polypore Flora of East Africa. *Fungiflora*, Oslo.
- Sharma JR. 2006 – Wood rotting fungi of Temperate Himalaya. In: Mukerji KG and Manoharachary C (eds), *Current concepts in Botany*, IK International Publishing House Pvt. Ltd., New Delhi, pp 101–120.
- Tofts RJ, Orton PD. 1998 – The species accumulation curve Agarics and Boleti from a Caledonian Pinewood. *Mycologist* 12, 98–102.