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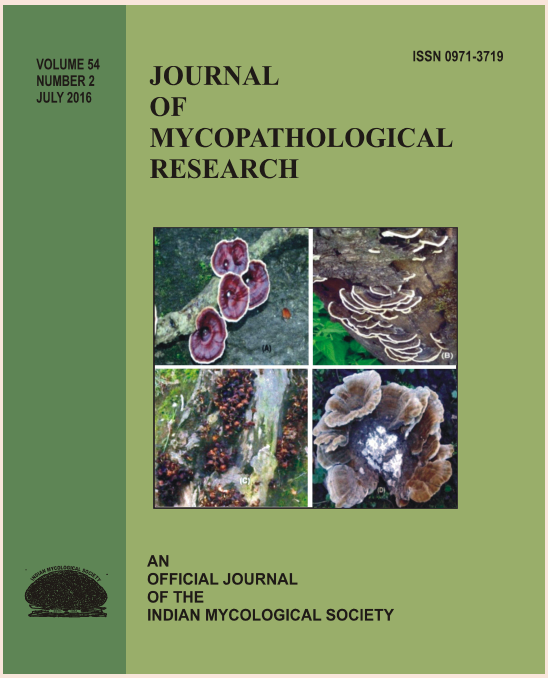

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A preliminary survey report on diversity of wood decaying fungi from East Sikkim

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The study on macrofungi especially mushroom forming wood decaying fungi (WDF) is least explored in the state of Sikkim. The temperate and subtropical forest type of study area supports rich diversity of macrofungi. Wood decaying fungi an important biodiversity component are essential for the functioning of forest ecosystem; it plays a decisive role in nutrient recycling and soil formation. It is also significant for its food value, production of pharmacological important bioactive substances and enzyme at industrial scale. At the same time it causes huge losses by destroying wood in forest and urban area as pathogen or as saprobes. Proper understanding is needed while dealing with this group of fungi from ecological and conservation point of view. Hence preliminary survey report on diversity of wood decaying fungi from East Sikkim is presented in this paper. An attempt has been made to give morphological, microscopical and ecological description of 18 species of wood decaying fungi. Isolation, characterization and molecular identification will be initiated in future study.

Key words: Ascomycetes, Basidiomycetes, forest ecosystem, phytopathogen, wood decaying fungi, Sikkim

INTRODUCTION

Wood decaying fungi (WDF) an important biodiversity component have the potential of impacting forest ecosystem, without them dead trees and shrubs would cover the soil and decompose very slowly. In the state of Sikkim, forests are one of the rich natural resource, with tree cover of approximately 47.69 percent of total geographical area of the state. Sub- tropical and temperate forest ecosystem type of study area are abode for wood inhabiting fungi and they are the primary biotic decomposer of wood. As a result, wood-decaying fungi play an important role in nutrient cycling and soil formation. Wood decaying fungi responsible for this decay and cycling are almost exclusively a narrow range of fungi like Basidiomycetes and a few Ascomycetes and a good number of these fungi produce large and conspicuous fruiting bodies or sporocarps/ascocarps. They comprise 10% of total fungal diversity, of which 16 - 41% have been described to date (Mueller *et al,* 2007). Some of them are important pathogens of tree, but most are saprotrophs thus plays major roles in nutrient cycling. WDF decompose wood by the means of several types of rot, rots caused by fungi are sorted to three main types; white, brown and soft rot. White rot fungi decompose all major constituents of wood, i.e. hemicelluloses, cellulose and lignin, whereas brown rot fungi de-

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compose hemicelluloses and cellulose and modify or cleave lignin but do not metabolise it, Yelle *et al,* (2011). Soft rot fungi (mainly ascomycetes) decompose lignin to a lesser extent than white rot fungi.

With the advancement in biotechnological field, these fungi have received special attention of researcher over past decades due to their potential applications in pollutant purification, bioremediation and antibiotic production (Maygaonkar *et al,* 2012). Some of the species are edible, thus good source of nutritious food (Heleno *et al,* 2010). Lignocellulose is a heteropolymer consisting mainly of three components, cellulose, hemicellulose and lignin. There is significant interest in the enzymes responsible for lignocelluloses degradation in terms of understanding their ecological role, also in the biotechnology potential of enzymes involved in this process. Various plant pathogens also produce extracellular laccases that enable the fungus to overcome the immune response of the host. The laccase also facilitates the detoxification of the plant tissue via the oxidation of antifungal phenols or 14 deactivation of phytoalexins.

Wood-inhabiting fungi itself is an important component of the biodiversity of a forest ecosystem; some wood-decaying fungi are threatened due to habitat loss and their sensitivity to the fragmentation of old-growth forests (Penttilä *et al*, 2006). Many polypores are listed in red data books. Therefore important target for conservation point of view and through investigation and understanding of this fungal group will contribute to the knowledge of the local biota and will greatly strengthen initiatives to protect and to sustainably use our natural resources and perhaps also in control measures for timber decay and forest pathogen. Thus, keeping the aforementioned facts in view the preliminary survey was carried out to study the diversity of wood decaying fungi in East Sikkim in the initial phase.

MATERIALS AND METHODS

Study area

Sikkim an Indian state situated in the Eastern Himalayan range at 27^0 00' 46" - 28^0 07' 48" N latitude and 88^0 00' 58" to 89^0 55'20' E longitudes rich in biodiversity and has been identified as one of the hotspot of biodiversity in the Eastern Himalaya. East Sikkim is one of the four districts of the Sikkim; good in forest cover with old growth trees, receives highest rainfall in the state due to close proximity to Bay of Bengal. Temperate and subtropical forests type of study area is rich in dead trees; hence provide good environment or habitats for wood decaying fungi. An attempt has been made to provide here, the first checklist for wood-decaying of the region as there is no consolidated account available in literature form this area.

Collection and identification of the wood decaying fungi

The fruit bodies of the wood-decaying fungi were photographed in their natural habitats at regular interval 2013 to 2015. All important morphological characters such as shape, size, texture, colour, colour change on ageing, odour, including substrata were also noted (living trees, logs, tree stumps and twigs). The fruit bodies were then brought to the laboratory where close-up images were taken and detailed observations made following the mthods and field key provided by Atri *et al,* (2005). Some of the specimens were preserved by air drying or liquid preservation and stored in the Laboratory, Department of Botany, Sikkim Government College, Tadong. The collected specimens were identified on the basis of critical observation both macroscopic and microscopic, and identified with the consultation of relevant literature and keys Kanad, 2009; Ostry *et al,* 2010.

RESULTS AND DISCUSSION

Diversity of wood decaying fungi

Basidiomycetes and Ascomycetes are the two major phylum of fungi mainly found to be associated with the wood decay in the study area. Around 30 species of wood inhabiting fungi were spotted mostly from phylum basidiomycetes and few ascomycetes belonging to the different families. Some of the species found in the district includes, *Armillaria, Lentinus, Pleurotus, Bulgaria, Trichoma, Daldinia, Hypholoma, Fomes, Lenzitus, Lactiporus, Porodaedalea, Pycnoporus, Lycoperdon, Daedalea, Polyporus, Pseudohydnum, Auricularia, Bjerkandera, Cerrena, Coprinus, Dacryopinax, Microporous, Ganoderma, Mycena, Scutellinia, Oxyporus, Schizophyllum, Xylaria, Termates, Tremella.*Maximum number of fungal species spotted belonged to the family Polyporaceae.

Fig. 1 : (A) *Microporous xanthopus* (Fr.) Kuntze. (B) *Trametes versicolor* (L.) Lloyed, (C) *Armillaria mellea* (Vahl) P.Kumm .,(D) *Cerrena unicolor*(Bull.) Murrill., (E) *Tremella fuciformis* Berk., (F) *Pycnoporus cinnabarinus* (Jacq.)P. Karst, (G) *Fomes sp.*, (H) *Trametes gibbosa* (Pers) Fr., (I) *Auricularia auricular-judae* (Bull.)Quel., (J) *Irpex lacteus(*Fr.)Fr., (K) *Coprinus disseminates*(Pers.) Gray, (L) *Xylaria polymorpha* (Pers.) Grev., (M) *Annulohypoxylon thouarsianum* (Lév.) Y.-M. Ju, J.D. Rogers & H.-M. Hsieh (N) *Polyporus tenuiculus* (P.Beauv.) Fr., (O) *Dacryopinax spathularia* (Schwein) G.W.Martin, (P) *Polyporus arcularius*(Batsch) Fr., (Q) *Schizophyllum commune Fr.*, (R) *Daldinia concentrica* (Bolton) Ces & De Not.

Table 1 : Description of fruitbody of macrofungi (WDF)

Botanical name/family	Common name	Description of Fruiting body	Substrate/ Host	Season	Spore dimention	Decay type	Potential uses
Auricularia auricular-judae (Bull.)Quel. /Auriculariaceae	Jew's Ear	Fruitbody 2 -7 cm in diameter, ear -shaped;upper surface smooth, ,light brown,lower surface wrinkled with folds and ridges.	Dead wood	June-oct	16-18x6-8 µm, cylindrical smooth, white.	Saprobic/parasite (Brown rot)	Edible/ medicine
Armillaria mellea (Vahl) P.Kumm. /Physalacriaceae	Honey fungus	Cap 2 -6cm diameter, convex with an umbo, honey brown to reddish brown, centre with dark brown scales. Gills decurrent, cream coloured.stem 8 -14x1-2cm.,cylindrical, fibrous,reddish brown,collar ring.	Base of dead tree trunk.	June – sept	8-9x5-6 µm, ellipsoid, smooth.	Saprobic/ Parasitic/ (white rot, root rot)	Edible
Annulohypoxylon thouarsianum (Lév.) Y. -M. Ju, J.D. Rogers & H.-M. Hsieh. /Xylariaceae	Cramp ball	Fruit body annual, sessile, 1 -3 cm broad, up to 2.0 cm in height, compressed-globose to hemispheric, occasionally lobed; surface dark -brown to black, densely pimpled with perithecia, the tips encircled by a flat, sometimes sunken disc; context fibrous-woody.	Bark of hardwoods, Dead branch	June-oct	Spores 15.0 -21.0 x 4.5-6.0 µm, smooth, inequilateral, narrowly elliptical to slightly fusoid.	Parasitic/saprobic	--
Cerrena unicolor (Bull.) Murrill. /Polyporaceae	Mossy maze poypore	Fan-shaped cap 3 -10 cm across; upper surface velvety to hairy, whitish to brownish usually with concentric zones of texture. Pores whitish when young, becoming grey; pores maze -like, becoming tooth-like with age; tubes to 4 mm deep.	Stumps,logs,branch	Year-round	Spores 5-7 x 2.5 -4 µ; smooth; long -elliptical; inamyloid; white	Saprobic/ white rot	Enzyme /industrial application
Coprinus disseminates (Pers.) Gray /Psathyrellaceae	Fairie's bonnets	Cap 0.5 -1cm diameter, bell shaped to conical,striate,white turning brownish to grayish.gills adnate,white when young,black at maturity. Stem 1 -3x0.1-0.2cm., hollow, white, ring absent.	Grow in troops around rotting /decaying log/stumps	April-nov	7.5-10x4-5 µm,ellipsoid,smooth,black.	Saprobic	--
Dacryopinax spathularia (Schwein) G.W.Martin /Dacrymycetaceae	Sweet osmanthus ear/ Fan-shaped jelly fungus	Fruiting body upto 1 – 1.5 cm high,cylindrical, club-shaped to funnel shaped,jelly like,upper part divided into irregular flattened valves, orange-yellow. Stem la teral 0.3-0.5x0.1-0.15cm	Decorticated dead wood	June-oct	7.8-9.8x3-4 µm, ellipsoid,smooth,septate,hyaline,white.	Saprobic	Edible
Daldinia concentrica(Bolton) Ces.De Not. /Xylariaceae	Coal fungus, cramp ball.	Ball shaped fruiting body, 1 -7x 1 -4cm. hemispherical, hard, white when young, grayish-brown to blackish. black powdery	clustered on dead and decaying wood	Year-round	Spores ellipsoidal to fusiform, 12 -17 x 6-9µm. black	Saprobic/ white rot	--

		spores over the surface, inner structure show concentric zones. Stem absent.					
Fomes fomentarius(L.) J.J.Kickx. Polyporaceae	Tinder fungus	Bracket 10 -20cm across,hoof shaped,mix of white, grey and brown with distinct zones, tough and woody.pores up to 4permm,grey ish brown.	Tree trunk	Perennial	Spores 15 -18x5-7 μm, cylindrical, smooth,yellowish white.	White heart rot	--
Microporous xanthopus (Fr.) Kuntze. /Polyporaceae	Yellow foot micropor us	Friutbody 4-5 cm high,3-6 cm broad,funnel -shaped. Concentrically zonate with different colouration,upper surface brown,red brown, lustrous. Stem central 1 -2x0.4-0.6 μm.,cylindrical,brownish, with distinct disc -shaped foot. Pores white to dirty white, 5 -7 per mm.	Dead branches and twig of trees	Aug-Dec	Cylindrical to ellipsoid, smooth,5 -6x2.5 μm	saprobic	Enzyme /industrial applicatio n
Polyporus arcularious (Batsch) Fr. /Polyporaceae	Spring polypore	Cap, 1 -4cm,convex to flat orshallowly depressed;dry,taugh, with central stem,2 -4cm long,2-4mm wide,brown. fringed,finely hairy margin, brown, pale tan. Pores running down the stem,brownish, 0.5-1 per mm.,hexagonal, ,radially arranged.	Decaying wood	April-june	5-8.5x1.5-2.5 μ, cylindrical, smooth, white.	White rot	Enzyme/industrial applicatio n
Polyporus tenuiculus (P.Beauv.) Fr. /Polyporaceae	unknown	Fruit body stipited with poroid himenium. Fan -shaped, spoon shaped or semicircular. Soft when young becomes tough at maturity. Cap 2-7 cm across, 3mm thick. White to creamy in color, smooth surface.woody smell. Stem short and strout. Pore 1-3 per mm.	Dead tree stump	June-oct.	9-12x2-3.5 μm, cylindrical with ends, smooth and hyaline.	White rot	Edible
Pycnoporus cinnabarinus (Jacq.) P. Karst. /Polyporaceae	Cinnabar bracket	Bracket 2 -8cm, 0.5 -1.5 cm thick, semicircular, plate like thin margin, sometime overlapping, smooth to warty, tough, orange to orange red. Pores upto 3 per mm. Orange red.	Dead wood of castanopsis.	Year round	6-7x2.4-3 μm, cylindrical, smooth white.	Saprobic/ White rot	Enzyme/industrial applicatio n
Irpex lacteus (Fr.)Fr. /Steccherinaceae	Milk white toothed polypore	1-3cm across,fused to form spreading patch of whitish to creamish pore surface (resupinate),dry. Pores 2 per mm in young,become tooth like in mature.	Dead branches of trees or on logs.	Year round	Spore 5 -7x2-3μ, smooth,elliptical to subcylindric, white.	Saprobic/ White rot	Bioremediation.
Schizophyllum commune Fr. /Schizophyllaceae	Split- gill fungus	Gray and hairy, 1 to 3cm across and 0.3 to 1cm thick. Lobed margin, fan shaped. Whitish to brown grey, radiating from the attachment point. The 'gills' are split	Bamboo/ wood log	Year round	Cylindrical to ellipsoidal; smooth, 3-5 x 1.5-2.5μm. Light brown to white.	Saprobic/parasitic/White rot	Food/medicine

		lengthways and they curl back to protect the fertile surfaces (hymenium) Stem is very short					
Trametes gibbosa (Pers.) Fr. /Polyporaceae	Lumpy bracket	5-15cm across.1 -5cm thick,semicircular, white,corky.pores 1 -2 per mm,elongated grey white.	Dead tree stump	Year round	4-5x2-2.5 μm, subcylindrical white.	Saprobic	medicine
Tremella fuciformis Berk. /Tremellaceae	Snow fungus/jelly fungus	Friutbody getatinous but firm, translucent white,smooth surface. 7.5cm across, 4cm high,branching fronds,	Recently fallan branch,twig and dead stump.	June-sept	Ellipsoid, smooth,white, 5 - 8x4x6 μm.white	Saprobic	Medicine and cosmetic
Termetes versicolor(L.) Lloyed. /Polyporaceae	Turkey tail	Fruit body 2 -7cm wide,bracket shaped, leathery, forming overlapping tires, with concentric zones of black,brown,grey,green, cream. White to cream margin;surface velvety, smooth with age.pores 3-5 permm, white to cream or pale grey.	Dead and decaying stumps /logs	Year round	4-7x1.5-2.3 μm, ellipsoid,smooth,white.	White rot	Medicine /enzyme of industrial impor
Xylaria polymorpha (Pers.)Grev. /Xylariaceae	Dead man's fingers	Fruit body 1 -4x0.5-1cm., irregularly club -shaped, tough, grayish brown, black on maturity. Flesh tough,fibrous,white.	Dead and decaying stump/wood.	Year round	22-28x7.3 μm,fusiform,smooth, black.	Saprobic/soft rot	Medicine /enzyme

Occurrence of wood decaying fungi

The wood decaying fungi were found to occur on a variety of substrata ranging from living trees to dead fallen twigs, tree stumps and wood logs of different sizes. Maximum number of wood-rotting fungi occurred on logs, tree stumps and twigs had lesser number of wood-rotting fungi while living trees had the least. Living trees one can hardly expect the fruiting body, because wood rotting fungi seldom fruit on the surface until their host trees die and general trend is most of the tree are infected by the hyphae of the fungus.

Morphological and microscopical description

As the result of present survey, only 18 wood decaying fungi have been described and presented here, belongs to 10 families, 18 genera, 15 species (Figure 1). The taxa were listed along with relevant information and individually described in Table 1. The present work reveals few uncommon and common wood decaying mushrooms found in region of survey. The results of this preliminary study of wood decay fungi will provide more databases for the researchers. The references of previous work that fungal species have ability to degrade wood, have important role in forest conservation, in terms of wood and litter decomposition therefore have great contribution to the ecological recycling, bioremediation, pulp and paper industry etc. Besides they have tremendous medicinal and food value, thus it become necessary to explore, conserve and document this natural wealth for more new findings and applications in future.

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