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Investigations on Diversity of Wood Inhabiting Fungi in Sarkaghat Region of District Mandi, Himachal Pradesh, North-Western Himalaya

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ABSTRACT: Wood inhabiting fungi are obligate-parasites of living or dead woody substrates and produce macroscopic fruiting bodies for reproduction. These fungi produce a variety of hydrolytic/lingocellulolytic enzymes and obtain nutrition for their growth via hydrolysis of wood components (cellulose and lignin). The dead wood inhabiting fungi that decompose wood are called wood rot fungi. Owing to the ecological and economic importance and in contrast to the insufficient data available on the geographical distribution, floristic and diversity of wood rot fungi in Sarkaghat region of District Mandi of Himachal Pradesh, the floristic investigations were initiated to describe and preserve the wood inhabiting fungi of this region. During the present investigation, eleven species of wood rot fungi *viz. Auricularia auricula-judae* (L.:Fr.) Schroet., *Fomitopsis dochmia* (Berk & Broome) Ryv., *Ganoderma lucidum* (Leyss.-Curt.:Fr.) Karst., *Hexagonia sulcata* Berk., *Phellinus fastulosus* (Lev.) Ryv., *Polyporus grammocephalus* Berk., *P. hirsutus* Wulf. ex Fr., *Schizophyllum commune* Fr.:Fr., *Trametes gibbosa* (Pers.:Fr.) Fr., *T. versicolor* (L.:Fr.) Pilat and *Xylobolus frustulatus* (Pers.) Boidin, belonging to nine genera *viz. Auricularia* Bull., *Fomitopsis* Karst., *Ganoderma* Karst., *Phellinus* Quél., *Hexagonia* Fr., *Polyporus* (Pers.) Gray, *Trametes* Fr., *Schizophyllum* Fr. and *Xylobolus* Karst. of seven families *viz.* Auriculariaceae, Fomitopsidaceae, Ganodermataceae, Hymenochaetaceae, Polyporaceae, Schizophyllaceae and Stereaceae of basidiomycota have been recorded for the first time from Sarkaghat Region of District Mandi, Himachal Pradesh (North-Western Himalaya). Of these seven species *viz. A. auricula-judae* (L.:Fr.) Schroet., *F. dochmia* (Berk & Broome) Ryv., *P. fastulosus* (Lev.) Ryv., *H. sulcata* Berk., *P. grammocephalus* Berk., *P. hirsutus* Wulf. ex Fr. and *X. frustulatus* (Pers.) Boidin and three genera *viz. Auricularia* Bull., *Polyporus* (Pers.) Gray and *Xylobolus* Karst. are new records of wood inhabiting fungi from district Mandi of Himachal Pradesh.

Keywords: Wood rot; Diversity; Sarkaghat; Mandi; North-Western Himalaya.

INTRODUCTION: Wood inhabiting fungi are obligate-parasites of living or dead woody substrates and produce macroscopic fruiting bodies for reproduction. These fungi produce a variety of hydrolytic/lingocellulolytic enzymes and obtain nutrition for their growth via hydrolysis of wood components (cellulose and lignin). The dead wood inhabiting fungi that decompose wood are called wood rot fungi. The enzymatic systems of wood rot fungi are capable of oxidizing C-C components of wood polymers. Basically, there are two categories of wood rot fungi- the white-rot and brown-rot fungi. White-rot fungi decay the lignin molecules, whereas the brown-rot fungi decompose celluloses and hemicelluloses. Wood-inhabiting fungi mainly belong to Ascomycota, however, taxa of Basidiomycota especially belonging to the order Polyporales of class Agaricomycetes are the efficient decomposers of wood. Wood inhabiting fungi are characterized by having a wonderful parallel morphological adaptation for sporulation over various wood substrates.[1] Review of literature reveals that, whereas 41 species of polyporoid fungi have been reported randomly from some parts of Mandi district of Himachal Pradesh (Table 4), however Sarkghat tehsil of Mandi district (H.P.) still remains unexplored.[2-41] Owing to the ecological and economic importance and in contrast to the insufficient data available on the geographical distribution, floristic and diversity of wood rot fungi in Sarkaghat region of district Mandi of Himachal Pradesh, the floristic investigations were initiated to describe and preserve the wood rot fungi of this region.

MATERIAL AND METHODS:

Study Area: Sarkaghat Tehsil, Mandi District (H.P.): Sarkaghat is one of the seventeen tehsils of

Mandi District of Himachal Pradesh. It is located situated at $76^0$44′10″E longitude and $31^0$41′55″N latitude and is located in the Shivalik hills of North Western Himalaya. The average elevation of Sarkaghat is and the temperature varies between 10^0C to 45^0C with June as the hottest and January as the coldest months. The hilly slopes are mostly covered with *Pinus roxburghii* (Chir pine) forest.

Experimental: The specimens were collected from eight localities *viz.* Bakarta, Barchwar, Tataher, Rakhoh, Mohin, Fatehpur and Paunta of Sarkaghat Tehsil, District Mandi, Himachal Pradesh during January-April, 2017. The field data such as texture, size, colour and macroscopic features have been recorded in the field data book during the excursions.[36] A hand lens (20 X), knife, and a saw were the tools used while collecting the specimens. The collected specimens were placed in paper packets of suitable size and a paper slip containing the field data such as collection number, details of collection site, host/substrate and date of collection was placed in each paper packet. The fragile specimens were placed in card boxes of suitable size. The fresh specimens were observed for morphological investigations and sun dried at the camping site. The specimens were then brought to the Botany Laboratory at Department of Bio-Sciences, Career Point University, Hamirpur for further taxonomic studies and preservation. The following mountants/stains were used for the taxonomic investigations pertaining to different groups of macrofungi during the present study:

1. **Amann's Lactophenol:** It was used for mounting of microscopic structures and composed of 20g Phenol, 20ml Lactic acid, 40ml Glycerol and 20ml distilled water.
2. **Glycerine:** It was used for mounting of microscopic structures and composed of 2ml Glycerine in distilled water to make 100ml.
3. **Potassium hydroxide:** It was used for microchemical tests and softening of the study materials and composed of 5g KOH in distilled water to make 100ml.
4. **Melzer's Iodine:** It was used to test amyloidity of the sporulating structures and composed of 22g Chloral hydrate , 5g Iodine, 0.5g Potassium iodide and 20ml distilled water.
5. **Distilled water:** It was used for observing the natural colour of the microcopic structures.
6. **Erythrosine B in ammonia:** It was used for observing septation in spores & mycelium and composed of 1g Erythrosine B, 10ml Ammonia and 90ml distilled water.
7. **Phloxine:** It was used to stain and observe septaion in spores & mycelium and composed of 1g Phloxine and distilled water to make 100ml.
8. **Cotton blue:** It was used to stain the cytoplasm of the fungal cells & also to observe cyanophilly of the microscopic structures and composed of 0.01g Cotton blue in 100ml Lactic acid.
9. **Lugol's iodine:** It was used to check amyloidity and composed of 5g Iodine, 10g Potassium Iodide and 100ml distilled water.
10. **Congo red:** It was used to stain ascus wall, paraphyses, ascospores & excipular tissues and composed of 2% Congo red or 1% Congo red in 50% ammonia.
11. **Potassium hydroxide-phloxine-glycerine:** It was used to stains the cytoplasm bright pink & for clarity of the septa and walls. The thin sections were placed in 2% KOH on the slide, to which a drop of 1% aqueous phloxine was added after 10-15 minutes the sections were transferred to a drop of 50% glycerine (slightly acidified) and then the cover slip was placed on it.
12. **Sulfobenzaldehyde:** It was used to stain gloeocystidia and composed of 1.5ml distilled water, Sulphuric acid 5.0ml and 4.5ml benzaldehyde.

The specimens were identified by consulting latest literature and comparing with authenticated specimens. Naphthalene balls were placed in each herbarium packet containing specimen to avoid insects attack and all the specimens were deposited in Herbarium of Department of Bio-Sciences, Career Point University, Hamirpur. Following data have been presented in the text for each taxa:

- Taxonomic keys to Families
- General description of family
- Taxonomic keys to Genera
- General description of Genus
- Taxonomic keys to the species
- Description of species along with authority, citation and remarks.
- Herbarium no. with locality, host substrate and date of collection from the study area.
- Photographic image.

RESULTS AND DISCUSSION: A total of eleven species of wood inhabiting fungi (Table 1) were recorded during present investigations. All these species

have been reported for the first time from Sarkaghat Tehsil of district Mandi (H.P.).

The detailed descriptions of eleven species of the wood inhabiting fungi (Table 1) recorded from the study area are:

Key to the Families of Basidiomycota

1 Basidioma gelatinous, basidium transversely septate ….....…**Auriculariaceae** Fr.
1' Basidoma non gelatinous…….....2
2 Basidiospores ornamented, ganodermatoid..... ….....**Ganodermataceae** (Donk) Donk
2' Basidiospores not ganodermatoid….....……..3
3 Basidioma with crustaceous upper surface .....……...**Fomitopsidaceae** Jülich
3' Basidioma lacking crustaceous upper surface…….…….4
4 Hyphal system typically monomitic…… .....**Schizophyllaceae** Qúel.
4' Hyphal system mono- or di- or trimitic……..5
5 Hyphae unclamped…….....……..…… ……..…..**Hymenochaetaceae** Imazeki & Toki
5' Hyphae clamped……..……..……6
6 Basidiospores cylindrical……...……...…... ……**Polyporaceae** Fr. Ex Corda
6' Basidiospores suballantoid or ellipsoid-globose……**Stereaceae** Pilat

Table 1: Wood Inhabiting Fungi of Sarkaghat Tehsil, District Mandi (H.P.).

Family	Genus	Species
Auriculariaceae Fr.	*Auricularia* Bull.	*A. auricula-judae* (L.:Fr.) Schroet.
Fomitopsidaceae Jülich	*Fomitopsis* Karst.	*F. dochmia* (Berk & Broome) Ryv.
Ganodermataceae (Donk) Donk	*Ganoderma* Karst.	*G. lucidum* (Leyss.-Curt.:Fr.) Karst.
Hymenochaetaceae Imazeki & Toki	*Phellinus* Quél.	*P. fastulosus* (Lev.) Ryv.
Polyporaceae Fr. Ex Corda	*Hexagonia* Fr.	*H. sulcata* Berk.
	Polyporus (Pers.) Gray	*P. grammocephalus* Berk.
		P. hirsutus Wulf. ex Fr.
	Trametes Fr.	*T. gibbosa* (Pers.:Fr.) Fr.
		T. versicolor (L.:Fr.) Pilat
Schizophyllaceae Qúel.	*Schizophyllum* Fr.	*S. commune* Fr.:Fr.
Stereaceae Pilat	*Xylobolus* Karst.	*X. frustulatus* (Pers.) Boidin

Family – **Auriculariaceae** Fr.
Epicr. Syst. Mycol. (Uppsala): 530, 1838

Basidioma annual, lignicolous, gelatinous; basidium cylindrical, transversely septate; basidiospores cylindrical, ballistosporic.

Remarks: A single genus of this family (*Auricularia* Bull.) have been reported for the first time from district Mandi (H.P.) and the study area.

Auricularia Bull.
Gen. Pl.: 4, 1789

Basidioma annual, lignicolous, subcoriaceous or gelatinous when moist, broadly attached; hymenium reticulately costate or plicate, collapsing when dry; basidia cylindrical, transversely tri- quadric- or quinque-septate, each cell producing a single sterigma from its apex; basidiospores oblong, curved, producing on germination a branched promycelium bearing several strongly curved sporidiola.

Remarks: A single species (*A. auricula-judae* (L.:Fr.) Schroet.) of this genus is being reported for the first time from the study area and district Mandi (H.P.).

Auricularia auricula-judae (L.:Fr.) Schroet.
Fl. Schles. **3**: 386, 1889
(PLATE I, Fig. A)

Basidioma annual, lignicolous, ear shaped, 2-4 cm across, light brown, gelatinous, soft when moist, becoming black & hard after drying; margin acute, incurved in dried specimens; hyphal system dimitic; generative hyphae hyaline, branched, septate, 1.6-2.4 µm in diam.; skeletal hyphae thick walled, aseptate, unbranched, 4.8-6.4 µm in diam.; basidia clavate, 3-septate, brown, 15-24 X 2-4 µm; basidiospores hyaline, smooth, ellipsoid, 10.0-13.4 X 6.8-7.2 µm.

Remarks: The species is being reported for the first time from the study area and district Mandi (H.P.). It is widely cultivated in china and around the world for its special nutrition and medicinal value in curing of diabetes and heart attacks.[42-43]

Collection examined:- CPUH 101, on the bark of *Syzygium cumini*, Place: Bakarta, Date: 19-February-2017; CPUH 102, on bark of *Mangifera indica*, Place: Mohin, Date: 21-February-2017.

Family – **Fomitopsidaceae** Jülich
Biblthca. Mycol. **85**: 367, 1982

Basidioma perennial, lignicolous, sessile or effused reflexed, hard; pileus sessile, convex; upper surface crustose; margin obtuse; context pinkish; tubes stratified; hyphal system monomitic or trimitic; generative hyphae hyaline, thin walled, septate, clamped; skeletal hyphae subhyaline to yellowish, thick walled, aseptate, mostly unbranched; binding hyphae subhyaline, thick walled, much branched; basidiospores hyaline, thin walled, smooth, non amyloid, broadly ellipsoid to ellipsoid, cylindric.

Remarks: One genus (*Fomitopsis* Karst.) of this family is being reported for the first time from the study area.

Fomitopsis Karst.
Meddn Soc. Fauna Flora Fenn. **6**: 9, 1881

Basidioma perennial, lignicolous, sessile or effused reflexed, hard; pileus sessile, convex or ungulate; upper surface covered with a crust; margin obtuse; context pinkish; tubes stratified; hyphal system trimitic; generative hyphae hyaline, thin walled, septate, clamped; skeletal hyphae subhyaline to yellowish, thick walled, aseptate, mostly unbranched; binding hyphae subhyaline, thick walled, branched; basidiospores hyaline, thin walled, smooth, non amyloid, broadly ellipsoid to ellipsoid.

Remarks: Whereas this genus was earlier recorded from other parts of district Mandi (H.P.), however it is being reported for the first time from the study area and a single species (*Fomitopsis dochmia* (Berk & Broome) Ryv.) of this genera is being reported for the first time from the study area and district Mandi (H.P.).

Fomitopsis dochmia (Berk & Broome) Ryv.
Norw. J. Bot. **19**: 231, 1972
(PLATE I, Fig. B)

Basidioma perennial, lignicolous, solitary, sessile, attached by a broad base, conchate to applanate, occasionally imbricate, hard, 16-20 X 8-10 X 0.5-2 cm; upper surface greyish black, glabrous, subzonate to zonate, radiately wrinkled, slightly cracking; margin pale yellow, slightly velvety when growing; context pale pink, fibrous, glossy, 0.5-1 cm thick; hymenial surface pink to cream, smooth, occasionally pustular; pores round, 6-8 per mm, pore wall thick, entire; pore tubes pink to cream, concolourous with hymenium, erect, distinctly stratified; context between well defined two layers, upto 3 mm long in each layer; hyphal system dimitic; generative hyphae hyaline, thin walled, branched, with simple septa or clamp connections, 1.2–3.0 µm in diam.; skeletal hyphae light pale to yellow, thick walled, unbranched, 2.0-6.0 µm in diam.; basidiospores 8-10 X 4-6 µm.

Remarks: The species is is being reported for the first time from the study area and district Mandi (H.P.).

Collection examined- CPUH 103, on the bark of *Pyrus pashia*, Place: Barchwar, Date: 09- February-2011; CPUH 104, on the of bark *Pyrus pashia*, Place: Rakhoh, Date: 09-February-2017; CPUH 105, on the bark of *Mangifera indica*, Place: Paunta, Date: 18-February-2017.

Family – **Ganodermataceae** (Donk) Donk
Bull. Bot. Gdns Buitenz., Ser. 3, **17**: 474, 1948

Basidioma annual to perennial, lignicolous, sessile to stipitate, coriaceous with waxy crust; pileus circular, semiorbicular, dimidiate, reniform to flabelliform, concave, umbilicate to infundibuliform; upper surface yellow, brown to black, dull or shiny, finely tomentose to glabrous, azonate to concentrically zonate, often sulcate, with or without a crust or cuticle; stipe when present central or lateral, round to flattened, dull to shiny and usually with a crust; pore surface initially white when young, finally brown with age; pores small to medium sized, regular, usually round; tubes stratified; context light brown to wood coloured duplex or with several zones or bands; hyphal system di to trimitic; generative hyphae hyaline to yellow, thin to thick walled, branched, septate, clamps present; skeletal hyphae of two types: i) unbranched, thick walled, mostly coloured ii) arboriform skeletal hyphae with a long unbranched lower segment and a branched upper part, thick walled to almost solid; binding hyphae strongly branched, tortuous, aseptate; cystidia absent; cystidioles may be present; basidia thin walled, hyaline, clavate, 4-sterigmate; basidiospores brown, globose to ellipsoid with double walls; endosporium brown, ornamented, reticulate or verruculose; exosporium hyaline and transluscent; lignicolous, causing decay of timber.

Remarks: One genus (*Ganoderma* Karst.) of this family is being reported for the first time from the study area.

Ganoderma Karst.
Revue Mycol., Toulouse **3(9)**: 17, 1881

Basidioma annual or perennial, lignicolous, pileate, centrally or laterally stipitate or sessile, dimidiate to flabelliform, hard, woody and heavy or corky and light; upper surface covered with a coloured, glossy distinct cortex, brown to deep purplish, occasionally varnished, smooth; pore surface entire, ochraceous to brown; pores small to medium, round or slightly angular; tubes often stratified; stipe when present, glossy with distinct cortex, yellowish, reddish to deep

puplish in colour; context white to brown, corky fibrous to hard and woody non xanthochroic; hyphal system trimitic; generative hyphae hyaline, thin walled, septate, with clamps; skeletal hyphae pale brown to brown, thick walled, aseptate, long; binding hyphae pale brown to brown, thick walled, much branched; cystidia and setae absent; basidia clavate, hyaline, 4-sterigmate; basidiospores truncate, large, distinctly double walled; exosporium hyaline, thin and smooth; endosporium brown, thick, ornamented, echinulate.

Remarks: Whereas this genus was earlier recorded from other parts of district Mandi (H.P.), however it is being reported for the first time from the study area and a species (*Ganoderma lucidum* (Leyss.-Curt.:Fr.) Karst.) of this genus is being reported for the first time from the study area.

Ganoderma lucidum (Leyss.-Curt.:Fr.) Karst.
Rev. Mycol. **3(9)**: 17, 1881
(PLATE I, Fig. C)

Basidioma perennial, lignicolous, stipitate, woody, 10-12 X 10-12 X 3-4 cm; stalk lateral, with laccate crust, 5-22 cm long; pileus surface shiny with laccate crust, reddish-brown, smooth; hymenial surface cream coloured; context 2-9 mm thick; pores 4-6 per mm, brown, 90-245 µm in diam.; pore tubes 6-7 µm long; hyphal system trimitic; generative hyphae thin walled, hyaline, clamped, branched, cyanophilous, 3.0-2.0 µm in diam.; skeletal hyphae light brown, thick walled, lumen narrow, sparsely branched, 1.6-4.8 µm in diam.; binding hyphae pale-brown, thick walled, much branched, 3.2-4.8 µm in diam; basidia hyaline, clavate, 4-sterigmate, 10.5-17 X 5.0-7 µm; basidiospores ganodermatoid, brown, ornamented, ovoid-ellipsoid, truncate, 7-9 X 4-6 µm.

Remarks: Whereas this species was earlier recorded from other parts of district Mandi (H.P.), however, it is being reported for the first time from the study area. It is commonly grown in China, Japan, and USA because of being a useful source of feed supplements and medicine to suppress the growth rate of tumour in cancer patients.[44]

Collection examined – CPUH 106, on bark of *Syzygium cumini*, Place: Bakarta, Date: 17-February-2017.

Family- **Hymenochaetaceae** Imazeki & Toki
Bull. Govt. Forest Exp. Stn. Meguro. **67**: 24, 1954

Basidioma annual to perennial, lignicolous, resupinate, effused reflexed, pileate, sessile to stipitate, fibrillose, soft, coriaceous, hard; pileus brown; upper surface tomentose to glabrous, azonate to zonate, smooth or sulcate, with or without a distinct crust; pore surface smooth, poroid or lamellate; pores round or angular; context brown, strongly xanthochroic; hyphal system mono or dimitic; generative hyphae hyaline to yellow, thin to thick walled, branched, septate, unclamped; skeletal hyphae yellow to brown to deep rusty brown, thick walled to solid; cystidia absent; setae present or absent; basidia thin walled, hyaline, clavate, 4-sterigmate; basidiospores hyaline to brown, thin to thick walled, globose to ellipsoid, non amyloid.

Remarks: One genus (*Phellinus* Quél) of this family is being reported for the first time from the study area.

Phellinus Quél.
Enchir. Fung.: 172, 1886

Basidioma annual to perennial, lignicolous, solitary to imbricate, resupinate to effused reflexed or sessile, attached by broad lateral base; pileus effused reflexed or conchate, ungulate or applanate; upper surface tomentose to hirsute, or glabrous, with or without crust; pore surface yellowish brown to brown, dark brown, even to uneven, dull or somewhat shining; pores rounded to angular, large or small; tubes generally stratified, strata distinct or indistinct; context brown, homogeneous, xanthochroic; hyphal system dimitic; generative hyphae hyaline to pale brown, thin walled, septate, clamps absent; skeletal hyphae coloured, brown, thick walled, aseptate to septate, appearing pseudoseptate; setae present or absent, subulate or ventricose, thick walled, brown to dark brown, apices straight; basidia hyaline, clavate, 2-4 sterigmate; basidiospores hyaline or brown, smooth, mostly thin walled, variously coloured.

Remarks: Whereas this genus was earlier recorded from other parts of district Mandi (H.P.), however it is being reported for the first time from the study area and a single species (*Phellinus fastulosus* (Lev.) Ryv.) of this genera is being reported for the first time from the study area and district Mandi (H.P.).

Phellinus fastulosus (Lev.) Ryv.
Norw. J. Bot. **19(3&4)**: 234, 1972
(PLATE I, Fig. D)

Basidioma perennial, lignicolous, sessile, solitary or imbricate, rigid, applanate, somewhat convex, 3.0-9.0 X 2.0-11.0 X 1.0-4.0 cm; pileus surface yellowish brown to dark brown, compactly tomentose, concentrically sulcate, velvety, rimose; margin acute to blunt, rigid, entire, concolourous with pileus surface; hymenial surface yellowish brown to brown, even; pores rounded to angular, 6-8 per mm; pore tubes finely velutinate, stratified, brown; context yellowish brown, azonate, homogenous, xanthochronic, 1-2 mm thick, separated by a thin black line from tomentose

on upper surface; hyphal system dimitic; generative hyphae thin walled, hyaline, septate, clamped, branched, 1.8-2.5 µm in diam.; skeletal hyphae yellowish brown, thick walled, rarely branched, aseptate or pseudoseptate, acyanophilous, 2.0-6.4 µm in diam.; setae absent; basidia hyaline, clavate, 4-sterigmate, 8.6-12.7 X 5.5-11.2 µm; basidiospores brown to dark brown, ovoid to subglobose, smooth, thin walled, non-amyloid, 4-6 X 3.5-5 µm.

Remarks: The species is being reported for the first time from the study area and district Mandi (H.P.).

Collection examined – CPUH 107, on bark of *Pyrus pashia*, Place: Mohin, Date: 19-February-2017.

Family – **Polyporaceae** Fr. ex Corda
Icon. Fung. **3**: 49, 1839

Basidioma annual to perennial, terrestrial or lignocolous, variable in shape, stipitate, pileate, effused reflexed to resupinate, white, cream, ochraceous, brown, orange, red, pink, violet, grey to black, consistency soft, fleshy, succulent, coriaceous to hard; pore surface poroid, lamellate, daedaloid, labyrinthine to hydnoid; tubes in one layer or stratified; cortex homogeneous to duplex, non-xanthochroic; hyphal system mono-di or trimitic; generative hyphae thin to thick walled, simple septate or with clamps, hyaline or coloured; skeletal hyphae thick walled to almost solid, aseptate, unbranched or rarely branched, hyaline to coloured; binding hyphae hyaline to coloured, branched, aseptate, thick walled, smooth to verrucose, variably shaped, mostly non amyloid, rarely amyloid or dextrinoid; setae absent; basidiospores cylindrical.

Remarks: Three genera (*Trametes* Fr., *Polyporus* (Pers.) Gray, *Hexagonia* Fr.) of this family are being reported for the first time from the study area.

Key to the genera of Polyporaceae

1 Hyphal system dimitic……..……..…2
1' Hyphal system trimitic……..…..… ***Trametes*** Fr.
2 Pores rounded - angular .. ***Polyporus*** (Pers.) Gray
2' Pores hexagonal……..…***Hexagonia*** Fr.

Hexagonia Fr.
Fl. Scand.: 339, 1835

Basidiocarp annual, lignicolous, sessile, dimidiate to applanate, imbricate; upper surface brown to blackish, yellowish brown near the margin, crusty, concentrically sulcate; context brown, hard and brittle; hymenial surface yellowish brown to dark brown; pores hexagonal to occasionally irregular; hyphal system dimitic; basidia clavate; basidiospores elongated, thin walled.

Remarks: Whereas this genus is already reported from other parts of district Mandi, however, it is being reported for the first time from the study area. A single species of this genus (*Hexagonia sulcata* Berk.) is being reported for the first time from the study area and district Mandi (H.P.).

Hexagonia sulcata Berk.
London J. Bot. **6**: 510, 1847
(PLATE I, Fig. E)

Basidioma annual, lignicolous, sessile, dimidiate to applanate, imbricate, coriaceous when fresh, hard and brittle on drying, 5.5-24 X 2.5-12 X 1-3 cm; upper surface brown to blackish, yellowish brown near the margin, crusty, concentrically sulcate; context brown, hard and brittle, 0.2-0.5 cm thick; hymenial surface yellowish brown to dark brown, pores hexagonal to occasionally irregular, less than one per mm; margin thick, entire; hyphal system dimitic; generative hyphae hyaline, thin-walled, branched, septate, 2-3.5 µm in diam., skeletal hyphae hyaline, thick walled, unbranched, 3-6 µm in diam.; basidia clavate, 4 sterigmate, 8-14 X 4-7 µm; basidiospores elongated, thin walled, 4-5.5 X 1.5-2 µm.

Remarks: The species is being reported for the first time from the study area and district Mandi (H.P.).

Collection examined- CPUH 108, on the bark of *Pyrus pashia*, Place: Rakhoh, Date: 18-02-2017.

Polyporus (Pers.) Gray
Nat. Arr. Brit. Pl. **1**: 645, 1821

Basidioma annual, lignicolous, soft coriaceous, stipitate, consisting of pileus based on single stipe or many pilei on many times branched stipe; pileus circular, dimidiate, flabelliform or infundibuliform; upper surface white, ochraceous, brown, greyish brown, reddish brown, smooth to scaly at first, minutely tomentose to smooth at maturity; stipe central, eccentric or lateral, simple or branched, short or long, light brown to black, tomentose to glabrous, smooth to longitudinally wrinkled; pore surface white to cream; pores small to large, entire, round to angular; tubes in one later; context white to cream, coriaceous, homogeneous, non xanthochroic; hyphal system dimitic; generative hyphae hyaline, thin walled, branched, septate, clamps present or absent; binding hyphae thick walled, aseptate, branched, mostly dichotomously branched, segments ending with thin whip like tips; cystidia and setae absent; basidia hyaline and clavate; basidiospores hyaline, thin walled, smooth, cylindric, cylindric ellipsoid to ellipsoid, non amyloid.

Remarks: This genus and its two species (*P. grammocephalus* Berk., *P. hirsutus* Wulf. ex Fr.) are being reported for the first time from the study area and district Mandi (H.P.).

Key to the species of *Polyporus* (Pers.) Gray

1 Basidioma stipitate, stipe central……..……. ……..……***P. grammocephalus*** Berk.

1' Basidioma sessile, effused-reflexed……..….. ……..……***P. hirsutus*** Wulf. ex Fr.

Polyporus grammocephalus Berk.
J. Bot. **1**: 1184, 1842
(PLATE I, Fig. F)

Basidioma annual, lignicolous, stipitate or nearly sessile, solitary or imbricate, soft and fleshy, drying rigid, flabelliform, obovate or reniform, 5-15 X 2-7 X 0.2-0.3 cm; stipe lateral, expanding into pileus above, 1-2 cm long & broad; upper surface white when fresh, ochraceous or reddish brown when dry, usually with fine striations, smooth or minutely scaly, margin smooth, entire or wavy; context light buff, hard, 1-2 mm thick; hymenial surface white when fresh, yellow to brown, silky; margin fertile; pores round, regular or irregular, 2-3 per mm; pore tubes concolourous, 0.5-1 mm long; hyphal system dimitic; generative hyphae hyaline, thin walled, branched with occasional clamp connections, often collapsing, 2.0-5.0 µm in diam.; skeletal hyphae hyaline, thick walled with narrow lumen, flexuous, unbranched, 3-5 µm broad; basidia clavate, 4-sterigmate, 12-14 X 3-5 µm; basidiospores hyaline, round, 4-7.5 X 2.2-3 µm.

Remarks: This species is being reported for the first time from the study area and district Mandi (H.P.)**.**

Collection examined- CPUH 109, on the bark of *Bambusa vulgaris*, Place: Mohin, Date: 19-02-2017.

PLATE – I

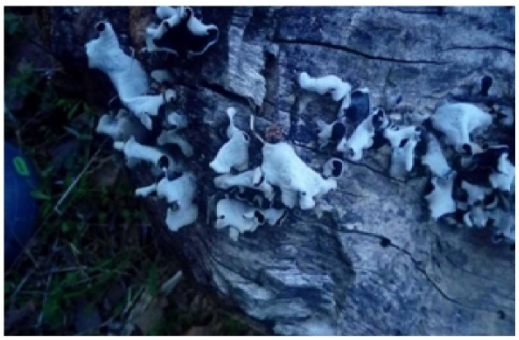

Fig. A: *Auricularia auricula-judae* (L.:Fr.) Schroet.

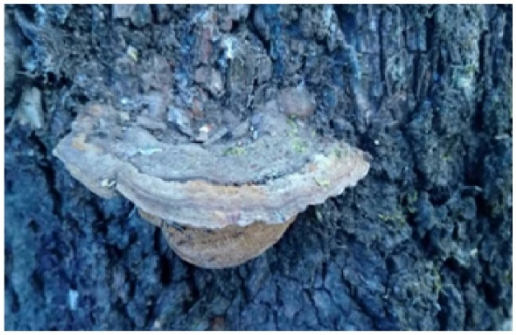

Fig. B: *Fomitopsis dochmia* (Berk & Broome) Ryv

Fig. C: *Ganoderma lucidum* (Leyss.-Curt.:Fr.) Karst.

Fig. D: *Phellinus fastulosus* (Lev.) Ryv.

Fig. E: *Hexagonia sulcata* Berk.

Fig. F: *Polyporus grammocephalus* Berk.

Polyporus hirsutus Wulf. ex Fr.
Sys. Mycol. **1**: 367, 1821
(PLATE II, Fig. A)

Basidioma annual, lignicolous, sessile or effused-reflexed, imbricate, dimidiate, applanate or flabelliform, occasionally reniform, coriaceous when fresh, hard on drying, 2-5 X 3-8 X 0.5-1.5 cm; pileus surface yellowish to yellowish brown, occasionally greyish, coarsely hirsute to velvety tomentose, concentrically zonate, margin even, occasionally incurved on drying; context white to light yellow, floccose, 0.3-1 cm, thick at the base; hymenial surface white when fresh, light yellow to yellowish brown on drying; pores regular, 2-3 per mm; pore tubes 2-3 mm long; hyphal system dimitic; generative hyphae hyaline, thin walled, branched, septate, clamped, 1.5-3 µm in diam.; skeletal hyphae arboriform, hyaline, thin walled, much branched, aseptate, 2-3 µm in diam.; hyphal pegs present; basidia clavate, 4-sterigmate, 11-15 X 4-5 µm; basidiospores cylindrical-straight to slightly curved, hyaline, smooth, 4.5-6 X 1.5-2.5 µm.

Remarks: This species is being reported for the first time from the study area and district Mandi (H.P.)**.** It is a promising fungus for biological treatment because it efficiently degrades lignin at high temperature and develops an efficient transformation system.[45, 46]

Collection examined- CPUH 110, on the bark of *Albizia chinensis*, Place: Fatehpur, Date: 03-03-2017.

PLATE – II

Fig. A: *Polyporus hirsutus* Wulf. ex Fr.

Fig. B: *Trametes gibbosa* (Pers.:Fr.) Fr.

Fig. C: *Trametes versicolour* (L.:Fr.) Pilat

Fig. D: *Trametes versicolour* (L.:Fr.) Pilat

Fig. E: *Schizophyllum commune* Fr.:Fr.

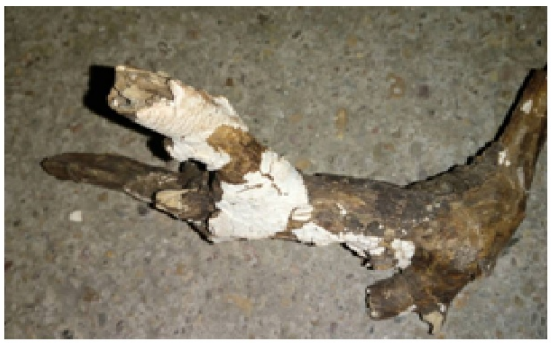

Fig. F: *Xylobolus frustulatus* (Pers.) Boidin

Key to the species of *Trametes* Fr.

1 Pores radially elongated.***T. gibbosa*** (Pers.:Fr.) Fr.
1' Pores rounded …… ***T. versicolor*** (L.:Fr.) Pilat

Trametes gibbosa (Pers.:Fr.) Fr.
Epicr. Syst. Mycol. : 492, 1838
(PLATE II, Fig. B)

Basidioma annual, lignicolous, sessile, applanate, single, 8-12 X 5-12 X 1-2 cm; pileus surface white when fresh, turning yellowish on drying, pubescent to tomentose, soft, delicately zonate, margin even, thick; context white, soft when fresh, corky on drying, 0.5-1.5 cm, rounded near the margin; pores radially elongated; pore tubes light brown; hyphal system trimitic; generative hyphae hyaline, thin walled, clamped, branched, 2-3 µm in diam.; skeletal hyphae hyaline, thick walled, flexuous, unbranched, 3.5-5.5 µm in diam.; binding hyphae hyaline, thick walled, branched, flexuous, 2-3 µm in diam.; basidia clavate, 4-sterigmate, 14-16 X 4-5 µm; basidiospores hyaline, thin walled, subcylindrical, 3.5-4.5 X 2-2.5 µm.

Remarks: Whereas this species is already reported from other parts of district Mandi, however, it is being reported for the first time from the study area. It is medicinal and stimulates immune system.

Collection examined- CPUH 111, on bark of *Pyrus pashia*, Place: Rakhoh, Date: 12-03-2017.

Trametes versicolor (L.:Fr.) Pilat
Atl. Champ. Eur. **3**: 261, 1939
(PLATE II, Fig. C&D)

Basidioma annual, lignicolous, sessile or effused-reflexed, thin, substipitate, usually imbricate, dimidiate to applanate, coriaceous when fresh, rigid on drying, 3-8 X 2-6 X 0.1-0.5 cm; pileus surface of various shades of yellowish, yellow brown, greyish brown, concentrically zonate with multicoloured zones, velvety tomentose, becoming glabrous at places and occasionally on entire surface, margin thin, incurved on drying; context white to pale; pores circular, 3-4 per mm; hyphal system trimitic; generative hyphae hyaline, thin walled, clamped, branched, 2.2-3.5 µm in diam., occasionally thick walled, pale brown, 2.2-3.0 µm in diam., closely compacted in brown zones on the pileus surface; skeletal hyphae hyaline, thick walled, unbranched, straight, aseptate, 3.5-5 µm in diam.; binding hyphae hyaline, thick walled, branched, 2.2-3.2 µm in diam.; hyphal pegs present; basidia clavate, 4-sterigmate, 10-15 X 3.5-4.5 µm; basidiospores hyaline, subcylindric, thin walled, smooth, slightly curved on one side, 5-6 X 1.5-2 µm.

Remarks: This species is being reported for the first time from the study area and district Mandi (H.P.)**.** It has medicinal properties and have been hypothesizes to improve immune response in women with breast cancer after standard chemotherapy and radiotherapy.[47]

Collection examined- CPUH 112, on the bark of *Mangifera indica*,Place: Bakarta, Place: Bakarta, Date 23-02-2017; CPUH 113, on the bark *Albizia chinensis*, Place:Tataher, Date: 24-02-2017; CPUH 114, on the bark of *Albizia chenensis*, Place: Mohin, Date: 26-02-2017; CPUH 115, on the bark of *Syzygium cumini*, Place: Bakarta, Date: 27-02-2017.

Family – **Schizophyllaceae** Qúel.
Fl. Mycol. France (Paris): 365, 1888

Basidioma annual, lignicolous, pleurotoid; hymenophore of compressed radiate cupules appearing split-lamellate; lignicolous, rarely parasitic.

Remarks: A single genus (*Schizophyllum* Fr.) of this family is being reported for the first time from the study area.

Schizophyllum Fr.
Observ. Mycol. (Havniae) **1**: 103, 1815

Basidioma annual to perennial, terricolous, sessile, solitary to gregariously to clustered, flabelliform; upper surface covered with small hairs, dry, white to greyish or tan; hymenial surface gilled, whitish to greyish; basidiospores cylindrical to elliptical, smooth.

Remarks: Whereas this genus is already reported from other parts of district Mandi (H.P.), however, it is being reported for the first time from the study area and a single species of this genus is being reported for the first time from the study area.

Schizophyllum commune Fr.:Fr.
Syst. Mycol. **1**: 330, 1821
(PLATE II, Fig. E)

Basidioma perennial, lignicolous, thin, flabelliform, 1.0-3.5 cm in diam., villose, margin lobed, often deeply incised, stipe absent, occasionally attached by a lateral extension of the pileal margin; context thin, 0.5-1.5 mm thick, brownish; hyphal system monoimitic; hyphae hyaline, thick walled, aseptate, unbranched, 3-4.5 µm in diam.; basidia narrowly clavate, 4-sterigmate, 12-19 X 3-6 µm; basidiospores allantoid cylindric, hyaline, thin walled, smooth, 5-8 X 2-3 µm.

Remarks: Whereas this species is already reported from other parts of district Mandi (H.P.), however, it is being reported for the first time from the study area. The fungus is common throughout the world and very popular as an edible mushroom in some regions.[48]

Collection examined- CPUH 116, on the bark of, *Bauhinia variegata*, Place: Tataher, Date: 21-02-2017;

CPUH 117, on the bark of *Albizia chinensis*, Place: Bakarta, Date: 02-03-2017; CPUH 118, on the bark of *Mangifera indica*, Date: 08- March-2017.

Family- **Stereaceae** Pilat
Hedwigia Beibl. **70**: 34, 1930

Basidioma annual or perennial, terricolous to lignicolous, appressed, effused-reflexed or stalked, pileus often zoned; dimitic (rarely trimitic), typically differentiated into a trichoderm, a closely woven cortex and loose hyphae curving up to the hymenium; hymenophore smooth to tuberculate; spores hyaline, smooth, amyloid or nonamyloid.

Remarks: A single genus of this family (*Xylobolus* Karst.) have been reported for the first time from district Mandi (H.P.) and the study area.

Xylobolus Karst.
Meddn Soc. Fauna Flora Fenn. **6**: 11, 1881

Basidioma annual to perennial, lignicolous, resupinate to effused reflexed or pileate, stratose, woody; hymenial surface smooth to finely tuberculate or cracked; abhymenial surface concentrically zonate, hard and bark like; hyphal system dimitic; generative hyphae branched, septate, with or without clamps; skeletal hyphae subhyaline to light brown, thick walled; acanthohyphidia abundant; cystidia encrusted, acanthophysoid encrusted cystidia, pseudocystidia present or absent; basidiospores ellipsoid, subhyaline, thin walled, smooth, amyloid.

Remarks: A single species (*Xylobolus frustulatus* (Pers.) Boidin) of this genus is being reported for the first time from the study area and district Mandi (H.P.).

Xylobolus frustulatus (Pers.) Boidin
Revue Mycol. **23**: 341, 1958
(PLATE 39, Fig. C; PLATE 74, Fig. U)

Basidioma annual or perennial, lignicolous, resupinate, thick, stratose, woody; hymenium surface breaking into frustules, 8-15 X 7-9 X 0.2.0.5 cm; abhymenial surface concentrically zonate, hard and bark like; context brown; hyphal system dimitic; generative hyphae branched, septate, with or without clamps, 3-6 µm in diam.; skeletal hyphae subhyaline to light brown, thick walled, 2-5 µm in diam.; acanthophysoid, encrusted cystidia absent; basidia clavate, 4 sterigmate, 9-12 X 3-4 µm; basidiospores ellipsoid, subhyaline, thin walled, smooth, amyloid, 5-9 X 3-4 µm.

Remarks: This species is being reported for the first time from the study area and district Mandi (H.P.).

Collections examined- CPUH 116, on the bark of *Bauhinia variegata*, Place: Paunta, Date: 09-03-2017; CPUH 117, on the bark of *Grewia asiatica*, Place: Fatehpur, Date: 20-03-2017; CPUH 118, on the bark of *Syzygium cumini*, Place: Bakarta, Date: 28-03-2017.

Table 2: Host Specificity of Wood Inhabiting Fungi of Sarkaghat, District Mandi (H.P.).

Sr. No.	Host Plant	Species
1	*Mangifera indica*	*Auricularia auricula-judae* *Schizophyllum commune* *Trametes versicolor* *Fomitopsis dochmia*
2	*Pyrus pashia*	*Trametes gibbosa* *Fomitopsis dochmia* *Hexagonia sulcata* *Phellinus fastulosus*
3	*Albizia chinensis*	*Trametes versicolor* *Schizophyllum commune* *Polyporus hirsutus*
4	*Grewia asiatica*	*Xylobolus frustulatus* *Auricularia auricula-judae* *Trametes versicolor*
5	*Bauhinia variegate*	*Xylobolus frustulatus* *Schizophyllum commune*
6	*Syzygium cumini*	*Auricularia auricula-judae* *Xylobolus frustulatus* *Trametes versicolor* *Ganoderma lucidum*
7	*Bambusa vulgaris*	*Polyporus grammocephalus*

Table 3: New Records of Wood Inhabiting Fungi from District Mandi (H.P.).

Family	Genus	Species
Auriculariaceae Fr.	*Auricularia* Bull.	*A. auricula-judae* (L.:Fr.) Schroet.
Fomitopsidaceae Jülich	*Fomitopsis* Karst.	*F. dochmia* (Berk & Broome) Ryv.
Hymenochaetaceae Imazeki & Toki	*Phellinus* Quél.	*P. fastulosus* (Lev.) Ryv.
Polyporaceae Fr. Ex Corda	*Hexagonia* Fr.	*H. sulcata* Berk.
	Polyporus (Pers.) Gray	*P. grammocephalus* Berk.
		P. hirsutus Wulf. ex Fr.
Stereaceae Pilat	*Xylobolus* Karst.	*X. frustulatus* (Pers.) Boidin

Table 4: List of wood inhabiting fungi already recorded from district Mandi (H.P.).

Sr. No.	Family	Genus	Species
1.	*Botryobasidiaceae*	*Botryobasidium*	*B. leave*
2.	*Corticiaceae*	*Dendrothele*	*D. incrustans*
3.	*Fomitopsidaceae*	*Antrodia*	*A. serialis*
4.		*Daedalea*	*D. flavida*
5.			*D. quercina*
6.		*Fomitopsis*	*F. lilacinogilva*
7.		*Laetiporus*	*L. sulphureus*
8.		*Pycnoporellus*	*P. fulgens*
9.	*Ganodermataceae*	*Ganoderma*	*G. applanatum*
10.			*G. lucidum*
11.			*G. philippii*
12.			*G. resinaceum*
13.	*Gloeophyllaceae*	*Gloeophyllum*	*G. sepiarium*
14.			*G. striatum*
15.	*Hymenochaetaceae*	*Fomitiporia*	*F. punctata*
16.			*F. melleoporus*
17.		*Hymenochaete*	*H. tabacina*
18.		*Inonotus*	*I. pachyphloeus*
19.		*Phellinus*	*P. allardii*
20.			*P. caryophylli*
21.			*P. gilvus*
22.			*P. igniarius*
23.			*P. linteus*
24.			*P. rimosus*
25.	*Meruliaceae*	*Irpex*	*1. lacteus*
26.		*Phlebia*	*P. livida*
27.	*Phanerochaetaceae*	*Grammothele*	*G. fuligo*
28.		*Lenzites*	*L betulina*
29.			*L. elegans*
30.			*L. eximia*
31.		*Perenniporia*	*P. fraxinophila*
32.			*P. martia*
33.		*Poria*	*P. auricoma*
34.		*Porostereum*	*P. spadiceum*
35.		*Trametes*	*T. gibbosa*
36.			*T. leonina*
37.			*T. versicolor*
38.	*Polyporaceae*	*Hexagonia*	*H. tenuis*
39.	*Schizophyllaceae*	*Schizophyllum*	*S. commune*
40.	*Stereaceae*	*Acanthophysellum*	*A. lividocoeruleum*
41.		*Stereum*	*S. ostrea*

Table 5: Checklist of wood inhabiting fungi of district Mandi (H.P.).

Sr. No.	Family	Genus	Species
1.	Auriculariaceae Fr.	*Auricularia* Bull.	*A. auricula-judae*
2.	*Botryobasidiaceae*	*Botryobasidium*	*B. leave*
3.	*Corticiaceae*	*Dendrothele*	*D. incrustans*
4.	*Fomitopsidaceae*	*Antrodia*	*A. serialis*
5.		*Daedalea*	*D. flavida*
6.			*D. quercina*
7.		*Fomitopsis*	*F. dochmia*
8.			*F. lilacinogilva*
9.		*Laetiporus*	*L. sulphureus*
10.		*Pycnoporellus*	*P. fulgens*
11.	*Ganodermataceae*	*Ganoderma*	*G. applanatum*
12.			*G. lucidum*
13.			*G. philippii*
14.			*G. resinaceum*
15.	*Gloeophyllaceae*	*Gloeophyllum*	*G. sepiarium*
16.			*G. striatum*
17.	*Hymenochaetaceae*	*Fomitiporia*	*F. punctata*
18.			*F. melleoporus*
19.		*Hymenochaete*	*H. tabacina*
20.		*Inonotus*	*I. pachyphloeus*
21.		*Phellinus*	*P. allardii*
22.			*P. caryophylli*
23.			*P. fastulosus*
24.			*P. gilvus*
25.			*P. igniarius*
26.			*P. linteus*
27.			*P. rimosus*
28.	*Meruliaceae*	*Irpex*	*1. lacteus*
29.		*Phlebia*	*P. livida*
30.	*Phanerochaetaceae*	*Grammothele*	*G. fuligo*
31.		*Lenzites*	*L betulina*
32.			*L. elegans*
33.			*L. eximia*
34.		*Perenniporia*	*P. fraxinophila*
35.			*P. martia*
36.		*Poria*	*P. auricoma*
37.		*Porostereum*	*P. spadiceum*
38.		*Trametes*	*T. gibbosa*
39.			*T. leonina*
40.			*T. versicolor*
41.	*Polyporaceae*	*Hexagonia*	*H. sulcata*
42.			*H. tenuis*
43.		*Polyporus*	*P. grammocephalus*
44.			*P. hirsutus*
45.	*Schizophyllaceae*	*Schizophyllum*	*S. commune*
46.	*Stereaceae*	*Acanthophysellum*	*A. lividocoeruleum*
47.		*Stereum*	*S. ostrea*
48.		*Xylobolus*	*X. frustulatus*

CONCLUSIONS: The wood inhabiting fungi of the study area prefer a variety of hosts (Table 2). Whereas 41 species of wood inhabiting fungi were recorded from district Mandi by earlier researchers (Table 4), however of the total eleven species recorded during the present study, six species and three genera are new records of wood inhabiting fungi from district Mandi of Himachal Pradesh (Table 3). A checklist of 48 wood inhabiting fungi of district Mandi (H.P.) has been documented on the basis of present investigations and review of literature (Table 5).

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