International Letters of Natural Sciences *Online: 2015-09-11*
ISSN: 2300-9675, Vol. 46, pp 84-91
doi:10.56431/p-f11sj1

Wood Decay Fungi Associated with Tamarind tree in Gujarat, India

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Keywords: Tamarind decay, Canker rot, white rot, Irpex hydnoides, Flavodon flavus,

ABSTRACT. Fungi may cause internal decay, cankers, loosening of tissue and cell walls result into weak forks in the trunk and large branches. Tree rot may be associated with root decay, damage to foliage and fruits. Wood decay fungi isolated from *Tamarindus indica* were *Daldinia concentrica*, *Schizophyllum commune*, *Flavodon flavus, Irpex hydnoides*, and *Phellinus fastuosus,* in which *D. concentrica* causing canker rot is reported for the first time from India and *F. flavus* and *I. hydnoides P. fastuosus* are recorded for the first time on *T. indica* wood causing white rot. During canker rot, formation of bark canker and extensive internal decay of wood was observed; as a result the tree growing in the M.S. University campus became structurally unstable and broken off at the canker face. Early detection and removal of such hazardous branches of trees is advocated to avoid loss of life and property.

1. INTRODUCTION

Wood deteriorating Fungi cause three different types of wood decay. They are white rot, brown rot and soft rot. In brown rot – cellulose and hemicellulose are broken down in the wood substrate while lignin remains preserved in slightly modified form (Green and Highley 1997). It is caused by family *Polyporaceae* usually in conifers (Schwaze *et al.,* 2000). The term white rot has been used to describe forms of wood decay in which the wood assumes bleached appearance and where lignin is also broken down with cellulose. Members causing white rot include members of *Basidiomycetes* and *Ascomycetes* particularly *Xylariaceae* (Sutherland and Crawford 1981). Third type of decay is termed as soft rot, members of *Deuteromycetes* and *Ascomycetes* cause it. Fungus produces cavities in secondary wall; these are oriented longitudinally to the cell axis. Soft rot is usually superficial and generally occurs in the wooden pieces with high moisture.

Tamarindus indica L. is an economically important multi-use tree, found in several countries of Asia, Africa and South America. It is a source of timber, fruit, seeds, fodder, medicinal extracts and potential industrial components. The heartwood is dark in colour and is very hard, durable and resistant. The sapwood is yellow in colour and is far less durable than the heartwood. Wood deteriorating fungi belonging to *Aphyllophorales* in which polypores and corticioid fungi included are immensely important in natural ecosystem as decomposers of wood, recycling the nutrients and minerals in the wood and releasing them over a long period of time (Natarajan and Kolandavelu 1998). Many species are associated act as mild to severe pathogens of living forest trees (Natarajan and Kolandavelu 1998). The wood decay by *Polyporus luteo-umbrinus* Romell on root and dead fallen branches of *Heritiera minor* was reported from Baroda (Bakshi, 1971). Arya (2004) reported wood decay fungi like *Ganoderma lucidum* (Fr.) Ryv., *Phellinus nilgheriensis* (Mont.) Cunn., *Trametes cingulata* Fr., and *T. varians* van der Bij. from Baroda and Shoolpaneshwar wildlife sanctuary. Arya et al (2008) reported *Lenzites sterioides* for the first time on *T. grandis*. Randhawa et al. (2000) reported Cryptococcus neoformans and other yeast like fungi from decaying tree trunk of *Butea monosperma* and *T. indica.* Some fungi already reported on tamarind tree, there part and authority was given in Table 2.

2. MATERIALS AND METHODS

During 2006 - 2014 a study was undertaken near D.N. Hall ground of the Maharaja Sayajirao University of Baroda to find out the association of wood decay fungi on five *T. indica* trees and also how the breaking of branches from the main stem took place ?. The breaking pattern, cavities, decay and fungal growth were recorded. The morphological characters like colour, texture, shape, size and the host trees were noted in the field. All the specimens like the fungi, decomposed wood, etc. were collected in clean polythene bags and brought to the laboratory for examination and isolation of fungi. They were kept in the brown paper packets provided with the naphthalene balla to avoide insect attack. For microscopic studies thin sections of dried materials were mounted in 2% KOH solution. For staining the hyphae thin sections were placed in cotton blue mixed with lactophenol. For amyloidy test melzer's reagent was used. All the mesurements were taken three time and the average values were given. All the collections have been deposited in the department of botany museum, M.S. University of baroda, Vadodara (Bakshi 1971, Ryvarden 1991). Isolations were made on malt extract agar medium and they were identified.

3. RESULTS AND DISCUSSION

Wood decay fungi associated with *T. indica* belonged Basidiomycotina, Ascomycotina, and Deuteromycotina. The isolated fungi can be classified into families like Xylariaceae, Schizophyllaceae, Polyporaceae and Hymenochaetaceae. Wood decay fungi associate with tamarind tree were 4 Ascomycotina members in which *Aspergilus niger* causing sap rot, *Chaetomium globosum* and *Xylaria polymorpha* causing soft rot and *Daldinia concentric* causes canker rot. Basidiomycotina members were 4 in which *Flavodon flavus, Phellinus fastuosus, Irpex hydnoides Schizophyllum commune* caused white rot on stem. Deuteromycotina members were 6 in which *Alternaria alternata Phomopsis tamarindii, Pestalotiopsis* sp. causes leaf spot in leaves, *Botryospaeria ribis, Curvularia prasadii* and *Lasiodiplodia theobromae* causes soft rot in dead and living stem (Table 1). Based on the morphological and anatomical characters, the detailed descriptions of the five wood degrading fungal species were given below.

Table 1: Showing the fungi associated with Tamarind tree causing different types of rots

S.No	Fungi	Part	Type of rot
I	**Ascomycotina**		
1	*Aspergilus niger* van Tiegh	Dead stem	Sap rot
2	*Chaetomium globosum* Kunje	"	Soft rot
3	*Daldinia concentrica* (Bolton) Cesati and de Notaris	"	Canker rot
4	*Xylaria polymorpha* (Pers.) Grev.	"	
II	**Basidiomycotina**		
5	*Flavodon flavus* (Kl.) Ryv.	Stem	White rot
6	*Phellinus fastuosus* (Lev.) Ryv.	"	"
7	*Irpex hydnoides* Y.W.Lim and H.S. Jung	"	"
8	*Schizophyllum commune* Fr.	"	"
III	**Deuteromycotina**		
9	*Alternaria alternata* Fr. Kiesler	Leaves	Leaf spot
10	*Botryospaeria ribis* Grossenb and Dugg	Dead stem	Soft rot
11	*Curvularia prasadii* Mathur and Mathur	"	"
12	*Lasiodiplodia theobromae* Pat	Living stem	"
13	*Phomopsis tamarindii* Arya et al.	Leaves and living atem	Leaf spot and soft rot
14	*Pestalotiopsis* sp.	Leaves	Leaf spot

Table 2: Showing the fungi already reported fro Tamarindus tree

S. No	Fungi reported from tamarind tree	part	Authority
1	*Axhaetomium globosum*	On Tamarindus indica	Rai et al 1964
2	*Ampelomyces quiaqualis*	leaf	Patwardhan 1964
3	*Bartalinia robillardes*	leaf	Aharma and Agrwal 1975
4	*Erysiphe polygoni*	leaf	Narayanaswamy and Ramakrishna 1967
5	*Exosporium tamarindi*	leaves	Sydow 1913
6	*Fracchiaea indica*	On Tamarindus indica	Talde 1970
7	*Hendersonia tamarindii*	Living leaves	Sydow and Butler 1916
8	*Hyalotiella subramaniani*	bark	Agnihothrudu and Luke 1970
9	*Hystrerium tamarindi*	Dead stem	Narasimhan and Thirunalachar 1961
10	*Hysterographium awardii*	Dead bark	Tilak and Jadav 1970
11	*Lepiota epicharis* var. *indica*	On soil under Tamarindus indica	Narayanappa and Mustaffa 1985
12	*Meliola tamarindi*	On Tamarindus indica	Butler and Bisbv 1931
13	*Mollisia cornea*	On Tamarindus indica	Rao and Verghese 1988
14	*Myriangium tamarindii*	Bark	Tendulkar 1970
15	*Otthia tamarindi*	Dead stem	Tilak and Rao 1967
16	*Oidium tamarindi*	On Tamarindus indica	Sharma and Khare 1993
17	*Oidium* sp	Leaves	Uppal et al 1935
18	*Pestalotia poonensis*	"	Rao 1962
19	*Pestalotia* sp	On Tamarindus indica	Dube and Bilgrami 1966
20	*Phomopsis tamarindii*	Leaf spot	Arya et al 1999
21	*Pholiota gollani*	Living trunk	Hennings 1901
22	*Phyllostica tamarindina*	leaves	Rao 1963
23	*P. tamarindicola*	"	Rao 1966
24	*Prathigada tamarindi*	"	Muthappa 1967
25	*Rhynchosphaeria tamarindi*	Dead bark	Tilak and Jadav 1969
26	*Sphaceloma* sp	leaves	Das and Mohanty 1972
27	*Stigmina tamarindi*	"	Munjula and Kulshreshtha 1968

Illustration of Photographs

Plate I.

Figure A: Ascocarp of *Dldinia concentrica* showing brown ball shaped body
B: Longitudinal section of Daldinia showing concentric layers.
C: L.S of Daldinia showing the perithecia and ascospores
D: Basidiocarp of *Schizophyllum commune* showing grayish villose upper Surface
E: Sporophore of *Flavodon flavus* showing yellow margin on upper surface
F: Sporophore of the *Irpex hydnoides* showing toothed hymenium surface

Plate II

Figure A: Breakage of two side branches at forking in *Tamarindus* due to canker rot.
B: Breakage at forking in *Tamarindus indica* tree due to canker rot by *Daldinia concentrica*
C: Cubical white rot of stem with mycelium patch (arrow)
D: Hear rot in trunk of *Tamarindus* tree

Plate I

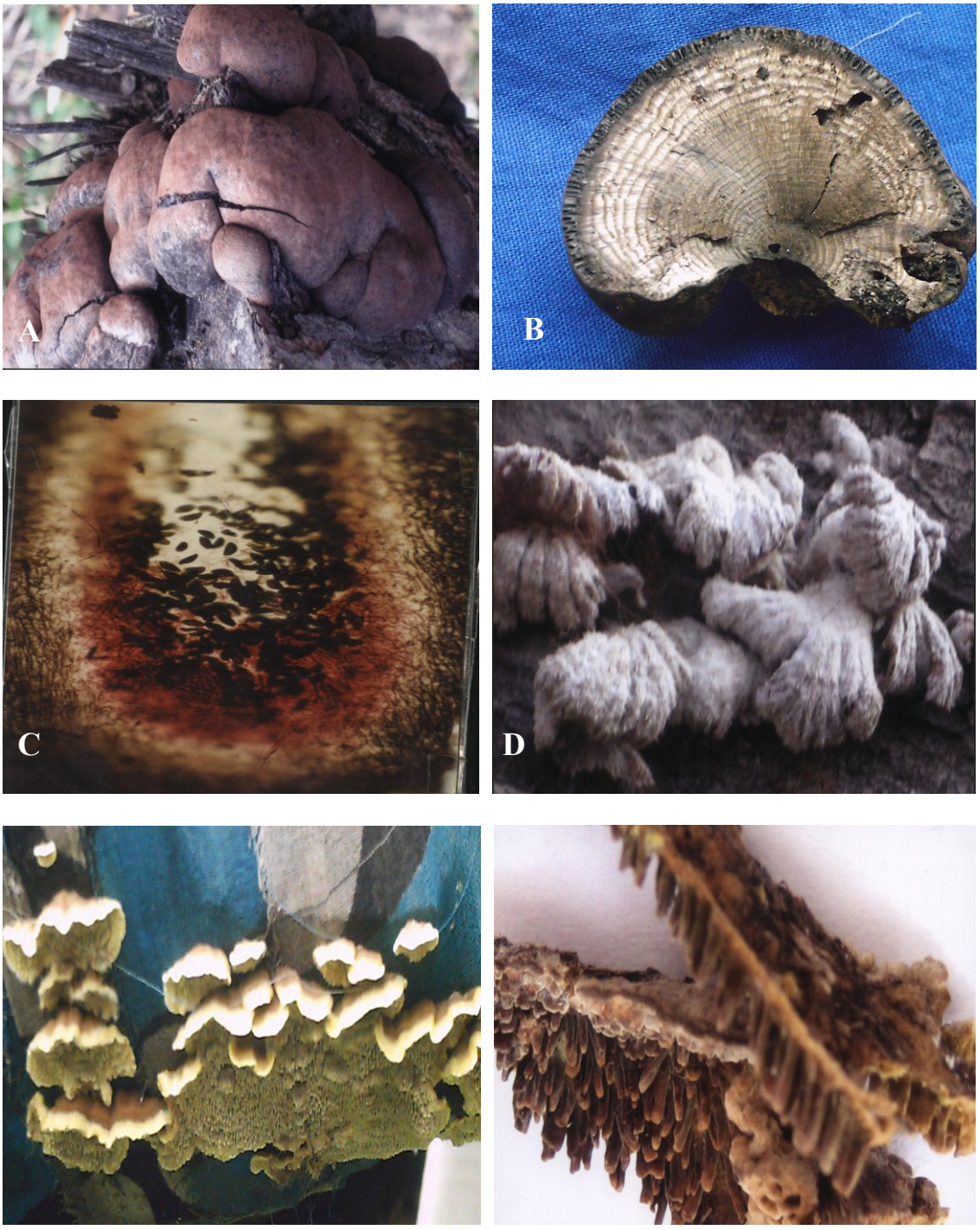

Plate II

The ascocarps of ***Daldinia concentrica*** **(Bolton) Cesati and de Notaris** were ball-shaped, with a hard, shiny black fruiting bodies up to 6 cm in size (Plate I. Fig. A). It resembles a chunk of coal, which gives it several of its common names, including coal fungus and carbon balls. The flesh of the fungus was brown and silvery-black inside, and is arranged in concentric layers (Plate I Fig. B). Each layer represents a season of reproduction. The asci are cylindrical and arranged inside the flask-shaped perithecium. When each ascus becomes engorged with fluid it extends outside the

perithecium and releases spores. Perithecium shows attachment of asci with 8 inequilaterally ascospores (Plate I. Fig. C).

The basidiocarp of ***Schizophyllum commune*** **Fr.** was shell-shaped, without stipe, narrow, laterally attached to substrate, 1 – 4 cm broad; gray-white; surface densely covered with hairs (Plate I. Fig D), radialy wrinkled, grooved; margin acute, incurved, with thick hairs. Lamellae radilly divergent from point of attachment, gray, when dry edges split into two, moistened convergent; distant. Flesh thin, white, tough, elastic; Dry specimens after rain revive. Spores cylindric, smooth, colourless, 6.3 x 2.5 µm in size.

The fruting body of ***Flavodon flavus*** **(Kl.) Ryv.** was annual, turning reddish brown with KOH, mostly resupinate, some times effuso-reflexe (Plate I. Fig E), tough and flexible. Pileus tomentosed, concentrically zoned, glabrous, cream coloured, but soon grey, the latter colour persists along the edge which is paper-thin 4 x 0.5 cm thick. Hymenium surface first poroid, but soon becoming irpicoid with subulate, cylindrical irregular teeth, up to 5 mm long, bright yellowish, Context fibrous, yellow, indistinctly duplex, 2 mm thick, hyphal system dimitic, Cystidia dominating in the hymenium, apically encrusted, 20 x 4-6 µm wide. Spores broadly ellipsoid, smooth, hyaline, thin-walled and non-amyloid, 6.3 x 3.1 µm.

Basidiocarps of ***Irpex hydnoides*** Y.W. Lim & H.S. Jung was annual, resupinate up to 15 x 5 cm wide, upper surface yellow; hymenophore reddish brown, hydnoid (Plate I. Fig.F), teeth up to 4 mm long, mostly flattened, denticulate at the apex; margin distinctly bounded. Hyphal system dimitic; Cystidia conspicuous, abundant, thick-walled, incrusted, 25 - 35 x 6.3 -11 µm, Basidia clavate, 25.2 x 6.3 µm, Basidiospores ellipsoid, hyaline, smooth, 6.3 x 3.5.

Basidiocarps of ***Phellinus fastuosus*** (Lev.) Ryv. was perennial, imbricate, sessile, broadly attached applanate, up to 16 x 25 x 6 cm thick; upper surface rusty brown, matted, tomentose in narrow concentric zones, up to 1mm thick black crust; margin usually thick and obtuse, velutinate, golden yellow, sterile underneath; pore surface golden yellow reddidh brown in older specimens, tubes concolorous, distinctly stratified, 2-4 mm thick in each layer; pores round, 8-10 per mm; context golden brown up to 3 cm thick, limited on upper surface with black thin line. Hyphal system dimitic; hyphal seate absent; basidia clavate 6-12 x 6.35 µm thick, spores broadly ellipsoidal, rusty brown, 6.3 x 4.5 µm, thin-walled. The fungus was earlier reported on *Shorea rubusta* and causes decay in the heartwood at butt region (Bakshi 1971)

Tamarind heartwood was considered to be a very durable timber and was used in furniture making as it takes on a good polish (Jayaweera, 1981). The wood is hard, heavy and dark brown. It was highly wind-resistant, with strong, supple branches, gracefully drooping at the ends, and has dark-gray, rough, fissured bark (Jayaweera, 1981). Different types of rots causing damage to tamarind wood were saprot by *Xylaria euglossa*, brownish sap rot by *Polyporus calcuttensis*, white rot by *Trametes floccose*, Stem rot by *Pholiota gollani*, Stem canker by *Hypoxlon nectriodes,* Trunk and Root rot by *Stereum nitidulum* and root and wood rot *by Ganoderma lucidum* (Bakshi 1971 and Natarajan and Kolandavelu 1998).

Many fruiting bodies of *D. concetrica* were found associated with decaying tree and causing canker rot was recorded for the first time from India (Bilgrami et al. 1979, 1981, Jamaluddin et al. 2004 and Bakshi 1971). More fruiting bodies of *S. commune* and less fruiting bodies *F. flavus I. hydnoides* were found associated with it and were causing white rot. It is evident from Plate II Fig. A,B,C that tamarind tree was broken during high velocity winds where the wood was degraded by wood decay fungi. The tamarind tree was observed broken two-side branch at forking in August 2007 (Plate II. Fig. A.) and one more side branch in July 2008 due to 50kmph velocity of wind. The branch attached to trunk become weak due to decay of heart wood where it creates cavity (Plate II Fig B). Heart wood rotting area shows the mycelial patches and with cubical breaking of degraded wood on drying (Plate II Fig. C). Infected heart wood of plant secreted a gummy substance which changed colour of heart wood from brown to black (Plate II Fig. D). Present study report occurrence of *F. flavus*, *I. hydnoides* and *Phellinus fastuosus* were recorded for the first time on *T. indica*. It is known that many wood decay fungi penetrate into the stem via injuries in which heart wood or ripe wood has been exposed. The probability of infection increases with increasing size of

the wound. In addition, fungi have numerous other strategies to evade the protective bark of the tree and penetrate into the interior of the stem. (Rayner and Boddy, 1988). The majority of wood decay fungi which impair the stability and fracture-safety of trees belong to the heat-rot pathogens (Schwarze and Engels, 1997). In the present paper also the wood decaying fungi like *F. flavus, I. hydnoides* and *P. fastuosus* causes white rot which leads to the lose of stability and resistance to wind blow of tamarind tree. The white rot pathogens *S. commune* causes selective utilization of lignin (Blanchette et al., 1988). Basidiocarps of *S. commune* were seen on tamarind branches which may degrade the lignin also resulting in the lose of stability and resistant to wind blow. The physiology of wood degrading fungi has been studied. It was found that when basidiomycetes produce sporophores, endocellulae production can increase up to 10 fold (Wood and Leatham, 1983) and stored nutrients are transported to the wood surface for sporophore production (Gruen and Wu, 1972) and this makes wood weak and brittle. *Fomes fomentarius* (*P. fomentarius*) caused 21% weight lose in beech and 23% in oak tree (Schwarze et al. 2000). In the present paper the white rot fungi formed sporophores on the tamarind trees causing the stems weak and brittle. Reiess (1986) reported that various fungal spores present in air germinate and colonize sap wood. These fungi were present on injured area of tree. This is because availability of food in injured part. Mold causes structural changes in wood and do not impair mechanical properties. In the present paper also the sap rot and soft rot fungi were isolated from the tamarind dead stem which is using the sap wood (Table 1).

4. CONCLUSIONS

The tree breakage in the present study was found to be associated with canker rot and white rot. The infected tree became structurally unstable and broke off at the canker face. Canker rots and white rot are known to cause trunk breakage due to extensive internal decay in the tree (Tattar 1989). *T. indica* tree is highly wind resistant but the branches were broken at forking due to canker rot caused by *D. concentrica* and white rot fungi i.e. *S. commune, F. flavus I. hydnoides and P. fastuosus* cause white rot which weakens the living stem. Breakage of tree during high velocity winds and storms causes damage to life and property is prevalent in man made forests and urban plantations. Such damage due to hazardous trees can be prevented if early detection through symptoms of canker rot and signs of fruit bodies are made. Such cases need to be investigated in detail in order to avoid their recurrence in cities.

Acknowledgements

The authors are thankful to the Head, Department of Botany, The M. S. University of Baroda for laboratory facilities, and to Dr. N.S.K. Harsh from Forest Research Institute Dehradun for conforming the identity of the fungi.

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