

Fungal flora of tropical riverbanks: indicator for quality running water resources

Abstract

River banks of tropics are treasure house of biodiversity. Sacred groves are a part of tradition, which are locations with minimal human interaction in homesteads and hence it is known to be rich in biodiversity from historic time. Taxonomical and ecological studies on different groups of fungi from ten selected sacred groves sites of Central Kerala were studied. Twenty species of fungi were identified from these conserved patches of land. Of these eight were wood rotting fungi and twelve were litter fungi, all indicates their role in bio-geochemical cycle of these regions. *Helminthosporium velutinum* was a new species record to this region. *Torula herbarum* found on a new host *Ervatamia coronaria*. Present studies project that the presence of macro-fungal flora is an indication of limited interaction in the riverbanks as and hence the quality of running water will be considerably good.

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Introduction

Sacred Groves are forest patches managed informally as a part of religious and cultural tradition, without ample interference from Government and State Forest Departments.¹ Studies on sacred groves recently started with pioneer works done.² India comprises about 50,000 sacred groves and around 2000 sacred groves had been reported from Kerala.³ Number of groves is reducing drastically now days. From 2011 onwards sacred groves in Kerala are diminishing not due to decline in religious belief but due to religious strategies removing greenery and clear the grove for other purpose.³ Literally, sacred groves represent an in situ conservation method of biodiversity in ancient India. Many species which are rare and extinct in other parts of the country are protected in these groves. They are believed to be the treasure house of medicinal plants, rare and endemic plants, as refugee for relic flora and harbor for seed dispersal.⁴ Groves are vital parts of life support system and justified as 'lungs' of the country by Amruthalingam.⁵ Four major forest types, namely evergreen, semi-evergreen, moist deciduous and mangrove forests were found in different sacred groves of Kerala by Chandrashekar.⁶ The general floristic composition and physiognomy of vegetation of the sacred groves are typically like the low level evergreen forest with numerous angiosperms, gymnosperms, bryophytes, pteridophytes, algae and fungi. Floral diversity studies in 577 sacred groves of Kerala by CWRDM⁷ identified 737 plant species of which 609 were dicotyledons, 122 monocotyledons, 4 pteridophytes and 2 gymnosperms. Studies in sacred groves of Thrissur district recorded 25 threatened species.⁸ Studies on herbaceous flora of Iringole kavu reported 68 angiosperms belonged to 28 families and 9 pteridophytes belonged to 5 families.⁹ Floral survey of Vallikattu kavu in Kozhikode district recorded 245 species of flowering plants belonged to 209 genera and 77 families of which thirty four plants were threatened.¹⁰ Survey of lichens in four sacred groves of central Western Ghats recorded 53 species of epiphytic lichen belonging to 30 genera and 15 families.¹¹ Studies on 28 sacred groves of Kerala by Chandrashekar⁶ identified 670 angiosperm species of which 133 were endemic. The forests of Kerala state is rich in different types of evergreen vegetation and thus provides favorable condition for growth and development of various fungi.¹² recorded 1044 taxa of fungi belonging to 414 genera from the state of Kerala. Sankaran et al.,¹³ recorded 1223 spp. belonging to 464 genera. A documentation made by Maria Florence¹⁴ includes a total of 1990 spp. of fungi belonging to 583 genera. The fungal flora

of Kerala especially of the Kerala forests remained unexplored except for a few brief surveys carried out by Subramanian & Ramakrishnan,¹⁵ Subramanian & Vittal,¹⁶ Mani Varghese,¹⁷ Hosagouder,^{18,19} Mohanan,²⁰ etc. Survey of mushrooms flora from Western Ghats were conducted by Thiribhuvanamala et al.²¹ Marofungal inventory in Western Ghats of Kerala was carried out by Mohanan.²²

Perusal of literature clearly indicates that not much work has been carried out on fungal flora of these regions. Ten such sacred groves are selected from Central Kerala. Therefore diversity studies and ecological aspects are included. The possibility of finding wood rotting and litter fungi is mainly investigated and taxonomical grouping are also incorporated in the study. The present study has its aim to document the fungal flora in the study sites and to establish the possibilities of conservation of fresh water resources and riverbanks to conserve the biodiversity of different life forms.

Materials and methods

Study area includes ten sacred groves of Central Kerala located near river banks. They are Iringole kavu, Chovvazcha kavu, Koozhpilly kavu, Panichayam kavu, Kuzhupilly kavu, Chakarakattu kavu, Palakkattu kavu, Chorian kavu, Vallikattu kavu and Alpara kavu (Table 1) (Figure 1). The largest among the study site Iringole kavu (size of 16 Ha.) to the smallest Panichayam kavu (size of 20 cents), all are well protected by religious view as a part of rituals and hence remain as virgin areas for micro and macro fungi. Fungal fruiting bodies were collected from sample plots of one metre square from ten locations at each study sites during summer seasons from 2007-2010 and 2015-2017. Periodic collection of fungi were made from the above ten sacred groves during summer season from February to April. For field collections, vasculum, lens, knife, scissors, tag were used. Most of the host plants were identified in the field itself.

Macro fungal fruit bodies especially of wood rotting fungi were collected as far as possible with the supporting wood. General macro characters of fruit body including colour of different tissues and the type of rot were noted in the field itself. Fruit bodies were wrapped in paper bags and brought to laboratory. Spore prints were taken on micro slides/paper by keeping the fresh fruit body in humid condition. Measurement and detailed observation of fruit body were made in the laboratory and the materials dried in a hot air oven at 70 c. Representative portions of the dried specimens were used for

microscopic studies. The rest of the fruit body along with rotten wood were treated with mercuric chloride against mites and moulds and stored with moth balls in paper as voucher specimens. The specimens were brought to the laboratory and infected regions were critically examined using dissection microscope for symptomatology. Tease mounts and scratch mounts were made for microscopic observations. Hand sections were also made. Mounting was done on slide using 5%KOH and lactophenol, as general mounting media. Cotton blue were used for staining. Sections were observed under a research microscope (Olympus trinocular) for studying detailed morphological characters. Measurements of all microscopic structures were taken using micrometer. Drawings were made using a camera lucida (Prism type) attached to the microscope. All the materials collected during this period of investigation were deposited at the Mycological herbarium, Dept of Botany, Union Christian College, Aluva.

Table 1 Location and area of ten selected sacred grooves

Sl. No.	(SG)	Site	Area	Coordinates
1	Iringole kavu	SG1	16 ha	10.1091 76.50041
2	Chovvazcha kavu	SG2	0.12 ha	10.1406 76.4587
3	Koozhupilly kavu	SG3	0.10 ha	10.1195 76.4349
4	Panichayam kavu	SG4	0.08 ha	10.1071 76.5634
5	Kuzhupilly kavu	SG5	0.61 ha	10.117 76.4717
6	Chakarakattu kavu	SG6	0.10 ha	10.1279 76.4776
7	Palakattu kavu	SG7	0.20 ha	10.1139 76.4625
8	Chorian kavu	SG8	0.12 ha	10.1058 76.5888
9	Vallikattu kavu	SG9	0.20 ha	10.1323 76.4756
10	Aalpara kavu	SG10	0.40 ha	10.1867 76.4904

Results and discussions

Fungi collected and studied from the present project are classified based on habitat into wood rotting fungi and litter fungi. After critical microscopic observation the materials were assigned to the respective species.

Table 2 Distribution of wood rotting fungi in study area

Sl. No.	Fungus	Host	Site
1	<i>Corioloopsis caperata</i> (Berk) Murr.	<i>Hopea parviflora</i> Bedd	SG1
		<i>Terminalia catta</i> Linn.	SG5
2	<i>Ganoderma lucidum</i> (Curt. ex Fr.) Karst. <i>Gymnopilus</i> sp. Karsten.	<i>Hydnocarpus pentagyna</i> Slooten.	SG1
		unidentified (dicot)	SG8
		decaying wood	
3	<i>Hexagonia tenuis</i> (Hook.) Fr.	<i>Calycopteris floribunda</i>	SG1
		Lam.	
4	<i>Lenzites acuta</i> Berk.	<i>Artocarpus heterophyllus</i>	SG9
		Lam.	
5	<i>Microporus xanthopus</i> (Fr.) Kuntze.	<i>Tectona grandis</i> L. and.	SG1
		<i>Terminalia paniculata</i>	
		Roth	
6	<i>Phellinus rimosus</i> (Berk.) Pilat.	<i>Ficus benghalensis</i> L.	SG9
		<i>Artocarpus hirsutus</i> Lam	SG1
7	<i>Polyporus hemicapnodes</i> Berk. & Br	unidentified branches	SG1



Figure 1 Sacred grooves (A) Chakarakattu kavu; (B) Panichayam kavu; (C) Kuzhupilly kavu; (D) Palakkattu kavu.

Wood rotting fungi

Eight species of fungi were collected from living, fallen and decaying woods from these sacred grooves (Table 2). All of them belong to the class Basidiomycotina. Among them seven species belonged to order Aphyllophorales and one belonged to Agaricales. *Phellinus rimosus* and *Hexagonia tenuis* were perennial species. All other six species were annuals. Pores were not extending to the margin in *Polyporus hemicapnodes*. *Ganoderma lucidum* was collected from the base of trunk of living *Hydnocarpus pentagyna*. But earlier it was reported as basal culm decay of *Bambusa bambos*, *Dendrocalamus strictus*, white rot of *Artocarpus hirsutus*, white spongy rot of *Anacardium occidentale* etc. from Malappuram, Thrissur, Idukki, and Palakkad districts of Kerala.²³⁻²⁶ *Phellinus rimosus* was collected from *Artocarpus hirsutus* while it was reported from *A.heterophyllus* by Mohanan.²³

Litter fungi

Twelve species of fungi were collected from fallen, decaying

leaves and twigs (Table 3). All of these fungi belonged to class Duteromycotina and order Moniliales.

Table 3 Distribution of litter fungi in study area

Sl. No.	Fungus	Host	Site
1	<i>Arthrinium sacchari</i> (Speg.) Ellis.	<i>Bambusa bambos</i> (L.) Voss	SG9
2	<i>Beltrania rhombica</i> O. Penzing.	<i>Artocarpus hirsutus</i> Lam. <i>Mesua ferrea</i> L.	SG4 SG1
3	<i>Cordella johnstonii</i> Ellis.	unidentified monocot Stem	SG10
4	<i>Dictyoarthrinium sacchari</i> (Stev. In Johnst. & Stev) Damon.	<i>Cocos nucifera</i> L.	SG4
5	<i>Gyrothrix circinata</i> (Berk. & Curt.) Hugues.	<i>Artocarpus hirsutus</i> Lam. <i>Cocos nucifera</i> L.	SG3 SG2
6	<i>Helminthosporium velutinum</i> Link. ex Ficus & Schubert	unidentified twigs	SG5
7	<i>Memnoniella levispora</i> Subram	<i>Allamanda cathartica</i> L.	SG2
8	<i>Pithomyces maydicus</i> (Sacc.) Ellis.	<i>Bridelia retusa</i> (L.)A.Juss. <i>Bambusa bambos</i> (L.) Voss	SG6 SG1
9	<i>Sporidesmium adscendens</i> Berk.	unidentified dead leaves of dicot plant	SG9
10	<i>Sporoschisma mirabile</i> Berk. & Br.	<i>Alstonia scholaris</i> (L.)R.Br.	SG10
11	<i>Tetraploa aristata</i> Berk. & Br.	<i>Bambusa bambos</i> (L.) Voss.	SG9 SG8
12	<i>Torula herbarum</i> f. quaternella Sacc.	<i>Ervatamia coronaria</i> (Jacq.)Stapf. unidentified dicot leaf	SG7 SG1

Setae were present in *Beltrania rhombica*, *Gyrothrix circinata*, (branched setae), *Sporoschisma mirabile* (scattered setae) and *Cordella johnstoni* (single unbranched). Conidia was found in chains in *Torula herbarum*, *Sporoschisma mirabile* and *Memnoniella levispora*. Conidia septate in *Torula herbarum* (up to 3), *Beltrania rhombica*, *Tetraploa aristata* ((longitudinal and transverse), *Pithomyces maydicus* ((transverse and oblique), *Helminthosporium velutinum* (6-15 pseudoseptate), *Sporoschisma mirabile* (up to 3), *Sporidesmium adscendens* (16-60 pseudoseptate), *Dictyoarthrinium sacchari* (cruciate septate) and *Cordella johnstonii* (transverse septa). Septate appendage was observed in *Tetraploa aristata*. Conidia was formed on groups of phialides in *Memnoniella levispora*. Conidia was provided with an appendage in *Beltrania rhombica*. *Helminthosporium velutinum* was a new report to fungi of Kerala. *H. velutinum* was reported from monuments of Madanpur, India.²⁷ Another species of this genus, *H. dalbergiae* was reported from Cherai, Kerala on dead twigs of *Tabernaemontana*.²⁸ *Torula herbarum* was found on a new host, *Ervatamia coronaria* in Kerala. This species was earlier reported from Malayatoor, Kerala, on dead stems of *Ichnocarpus frutescens* and from dead stems of a dicot plant at Idamalayar, Kerala,²⁸ (Figure 2).

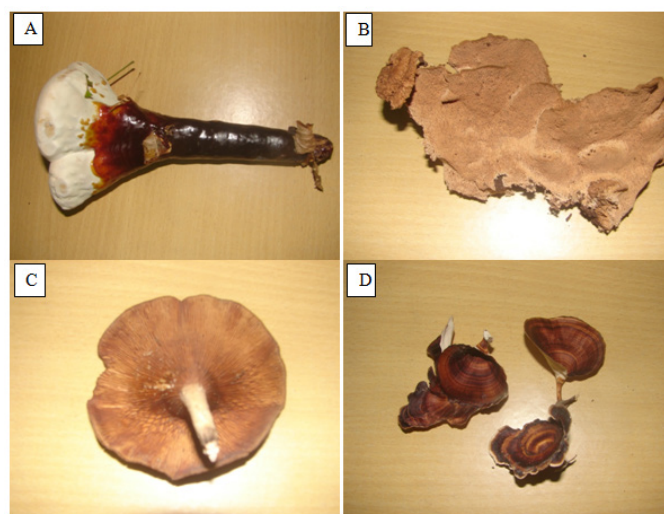


Figure 2 Fruiting body of (A) *Ganoderma lucidum* (Curt. ex Fr.) Karst; (B) *Corioloopsis caperata* (Berk) Murr; (C) *Gymnopilus* sp. Karsten; (D) *Microporus xanthopus*; (F) Kuntze.

Conclusion

Through the present study the river bank protection is projected to have more importance in protecting the biodiversity especially fungal macro-flora which maybe of various economic interests. Sacred groves from time immemorial were known to be centers of limited human interaction and are treasure house of species diversity. The largest Sacred Grove among the study site Iringole kavu to the smallest Panichayam kavu are well protected by religious view as a part of rituals and hence remain as virgin area for micro and macro fungi. For quality water in the river resources of tropics river bank protection is a must. The present concept may lead to protection of fresh water resources as well as conservation of biodiversity in the future hydro based exploration and utilization.

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Conflicts of interest

The author declares that there are no conflicts of interest.

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