FUNGAL FLORA OF TROPICAL SACRED GROVES: INDICATOR FOR BALANCED ERVERGREEN ECOSYSTEMS

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Abstract: ***Sacred groves of tropics are treasure houses of biodiversity are part of tradition, 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 sacred groves and hence the quality of land resources will be considerably good.***

IndexTerms – Sacred groves, wood rotting fungi, litter fungi, central Kerala

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I. 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 (Boraiah et al, 2001). Studies on sacred groves recently started with pioneer works done by Gadgil and Vartak (1976). India comprises about 50,000 sacred groves and around 2000 sacred groves had been reported from Kerala. 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 (Notermans et al, 2016).

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 (Chandran et al, 1998). Groves are vital parts of life support system and justified as 'lungs' of the country by Amruthalingam (2016). Four major forest types, namely evergreen, semi-evergreen, moist deciduous and mangrove forests were found in different sacred groves of Kerala by Chandrashekara (2011).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 CWRDM (2007) identified 737 plant species of which 609 were dicotyledons, 122 monocotyledons, 4 pteridophytes and 2 gyymnosperms. Studies in sacred groves of Thrissur district recorded 25 threatened species (Sujana et al, 2006). Studies on herbaceous flora of Iringole kavu reported 68 angiosperms belonged to 28 families and 9 pteridophytes belonged to 5 families (Jayaram and Nisha, 2016). 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 (Sreeja and Unni, 2016).Survey of lichens in four sacred groves of central Western Ghats recorded 53 species of epiphytic lichen belonging to 30 genera and 15 families (Dudani et al, 2015). Studies on 28 sacred groves of Kerala by Chandrashekara (2011) 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. Hosagoudar et al (1996) recorded 1044 taxa of fungi belonging to 414 genera from the state of Kerala. Sankaran et al (1997) recorded 1223 spp. belonging to 464 genera. A documentation made by Maria Florence (2004) 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 and Ramakrishnan (1956), Subramanian and Vittal (1974), Mani Varghese (1979), Hosagouder (1989), (2003) Mohanan (2003) etc. Survey of mushrooms flora from Western Ghats were conducted by Thiribhuvanamala et al (2011). Macrofungal inventory in Western Ghats of Kerala was carried out by Mohanan (2014).

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.

II MATERIALS AND METHODS

Study area includes ten sacred groves of Central Kerala located near river banks. They are Iringole kavu, Chovvazcha kavu, Koozhipilly 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. 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.

Table 1: Location and area of ten selected sacred grooves

Sl. No.	Sacred groves	Site (SG)	Area (ha.)	Coordinates
1	Iringolekavu	SG1	16	10.10912 76.50041
2	Chovvazchakavu	SG2	0.12	10.14063 76.45865
3	Koozhipillykavu	SG3	0.10	10.11952 76.43488
4	Panichayamkavu	SG4	0.08	10.1071 76.56339
5	Kuzhupillykavu	SG5	0.61	10.11696 76.47166
6	Chakkarakattukavu	SG6	0.10	10.12786 76.47761
7	Palakattukavu	SG7	0.20	10.11391 76.46252
8	Choriankavu	SG8	0.12	10.10581 76.58877
9	Vallikattukavu	SG9	0.20	10.13225 76.47555
10	Aalparakavu	SG10	0.40	10.1867 76.49038

Figure 1: Sacred groves (a) Chakarakattu kavu (b) Panichayam kavu (c) Kuzhupilly kavu (d)Palakkattu kavu

The specimens were brought to the laboratory and infected regions were critically examined using dissection microscope for symptamatology. 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.

III RESULTS AND DISCUSSION

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

Wood rotting fungi: Eight species of fungi were collected from living, fallen and decaying woods from these sacred groves (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 (Mohanan , 1994), (Florence and Yesodharan , 1997), (Florence and Yesodharan, 2000), (Leelavathy and Ganesh, 2000). *Phellinus rimosus* was collected from *Artocarpus hirsutus*while it was reported from *A. heterophyllus* by Mohanan (1994).

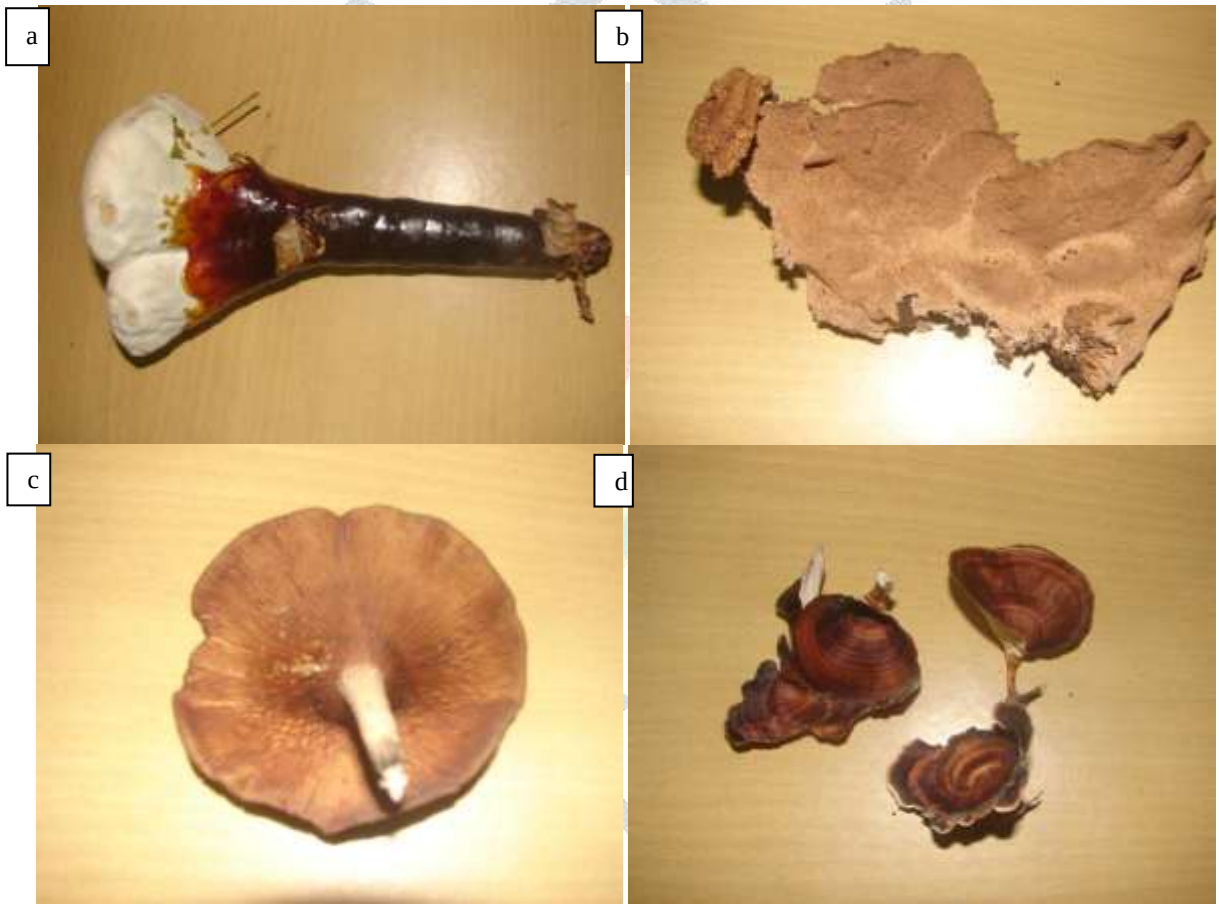

Figure. 2: Fruiting body of (a)*Ganoderma lucidum* (Curt.ex Fr.) Karst. (b) *Coriolopsis caperata*(Berk) Murr. (c) *Gymnopilus* sp. Karsten. (d) *Microporus xanthopus* (Fr.)Kuntze.

Table 2: Distribution of wood rotting fungi in study area.

Sl.No.	Fungus	Host	Site
1	*Coriolopsis caperata* (Berk) Murr.	*Hopea parviflora* Bedd. *Terminalia cattapa* Linn.	SG1 SG5
2	*Ganoderma lucidum* (Curt. ex Fr.) Karst.	*Hydnocarpus pentagyna* Slooten.	SG1
3	*Gymnopilus* sp. Karsten.	unidentified (dicot) decaying wood	SG8

4	*Hexagonia tenuis* (Hook.) Fr.	*Calycopteris floribunda* Lam.	SG1
5	*Lenzites acuta* Berk**.**	*Artocarpus heterophyllus* Lam.	SG9
6	*Microporus xanthopus* (Fr.) Kuntze.	*Tectona grandis* L. *Terminalia paniculata* Roth	SG1
7	*Phellinus rimosus* (Berk.) Pilat.	*Ficus benghalensis* L. *Artocarpus hirsutus* Lam.	SG 9 SG 1
8	*Polyporus hemicapnodes* Berk & Br.	unidentified branches	SG 1

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	*Arthrinium sacchari* (Speg.) Ellis.	*Bambusa bambos* (L.) Voss	SG9
2	*Beltrania rhombica* O. Penzing.	*Artocarpus hirsutus* Lam. *Mesua ferrea* L.	SG4 SG1
3	*Cordella johnstonii* Ellis.	unidentified monocot Stem	SG10
4	*Dictyoarthrinium sacchari* Johnst. & Stev) Damon.	*Cocos nucifera* L.	SG4
5	*Gyrothrix circinata* (Berk. &Curt.) Hugues**.**	*Artocarpus hirsutus* Lam. *Cocos nucifera* L.	SG3 SG2
6	*Helminthosporium velutinum* nk. ex Ficinus &Schubert	unidentified twigs	SG5
7	*Memnoniella levispora* Subram	*Allamanda cathartica* L.	SG2
8	*Pithomyces maydicus* (Sacc.) Ellis.	*Bridelia retusa*(L.)A.Juss. *Bambusa bambos* (L.) Voss	SG6 SG1
9	*Sporidesmium adscendens* Berk.	unidentified dead leaves of dicot plant	SG9
10	*Sporoschisma mirabile* Berk. & Br.	*Alstonia scholaris* (L.)R.Br.	SG10
11	*Tetraploa aristata* Berk. &Br.	*Bambusa bambos* (L.) Voss.	SG8, SG9
12	*Torula herbarum* f. quaternella Sacc.	*Ervatamia coronaria* (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* (cruciately septate) and *Cordella johnstonii* (transverse septa).Septate appendage was observed in *Tetraploa aristata*. Conidia were formed on groups of phialides in *Memnoniella levispora*. Conidia were 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 (Gupta, 2012). Another species of this genus, *H. dalbergiae* was reported from Cherai, Kerala on dead twigs of *Tabernae Montana* (Mani Varghese and Rao, 1980). *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 frutescents* and from dead stems of a dicot plant at Idamalayar, Kerala (Mani Varghese and Rao, 1980).

IV 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 land resources as well as conservation of biodiversity in the future hydro based exploration and utilization.

ACKNOWLEDGMENTS

Authors are grateful to the Principal and head of the Department of Botany, Union Christian College, Aluva for providing all laboratory facilities. We are also thankful to the private management and owners of sacred groves for permitting fungal collections.

REFERENCES

[1] Amirthalingam M. 2016.Sacred Groves of India – An Overview. Int. J. Curr. Res. Biosci. Plant Biol., 3(4): 64-74
[2] Boraiah, K.T., Bhapat, S.A., Kushalappa, C.G., Vasudeva, R. 2001. Regeneration of woody flora in the sacred landscapes of Kodagu, Karnatalta, South India. In: K.N. Ganeshaiah, R. Uma Shaanker and K.S. Bawa (eds.) *Tropical Ecosystems: Structure, Diversity and Human Welfare*. Oxford and IBH Publishing, New Delhi. 561-564.
[3] Chandran, M.S., Gadgil, M. and Hughes, J.D., 1998. Sacred groves of the Western Ghats of India.*Conserving the sacred for biodiversity management*, .210-231.
[4] Chandrashekara, U. M. 2011.*Conservation and Management of Sacred Groves in Kerala (Project funded by the Biodiversity Cell, Department of Forests and Wildlife, Government of Kerala)* (No. 412). Kfri research report.
[5] CWRDM. 2007. Hydrology, Nutrient Dynamics and Biodiversity of Sacred Groves of Malabar. Final Project Report, Centre for Water Resources Development & Management (CWRDM), Kozhikode, Kerala, India, 275.
[6] Dudani, S. N., Nayaka, S., Mahesh, M. K., Chandran, M. D. S., and Ramachandra, T. V. 2015. Lichen diversity in the sacred forest fragments of central Western Ghats. *J Biodivers Manage Forestry 4*(*2*):2.
[7] Florence, E.J.M, and K Yesodharan.1997. Status survey of macrofungal flora of Peechi-Vazhani Wildlife Sanctuary.Proc. Ninth Kerala Sci. Cong., STEC, Trivandrum. 477- 479.
[8] Florence, E.J.M, and K Yesodharan. 2000. Macrofungalflora of Peechi-Vazhani Wildlife Sanctuary, KPRI Research report No.19127.
[9] Gadgil. M and Vartak V.D. 1976.Sacred groves of Western Ghats of India. Economic Botany, 30: 152-160.
[10] Gupta, S.P., 2012. Microbiological impacts and their chemical conservation of cultural heritage with reference to Chhoti-Bari Kacheries temples at Madanpur (India). *Int. J. Curr. Sci.*, *4*:.90-95.
[11] Hosagoudar, V.B**.** 1989. The genus *Phyllachora* Nki in Fckl. In Kerala State. J. Econ, Taxon.Bot, 13(1): 121-124.
[12] Hosagoudar, V.B. 2003. Meliolaceous fungi on rare medicinal plants in S. India. Zoos Point J, 18(7): 1147-1154.
[13] Hosagoudar, V.B., Abraham, T.K. and Pushpangadan, P. 1996. Fungi of Kerala. TBGRI, Palode, Tvm, Kerala, India, 151.
[14] Jayaram, J., and Nisha, P. 2016. Herbaceous Flora of Iringol Kavu, Perumbavoor, Ernakulam District, Kerala.*South Indian Journal of Biological Sciences*, *2*(1): 110-114.
[15] Leelavathy, K.M and P.N Ganesh, 2000. *Polyporus* of Kerala. Daya Publishing House, Delhi.
[16] Mani Varghese, K.I**,** 1979.Studies into some Indian Ascomycetes and fungi Imperfecti. Ph.D. Thesis. Univ. of Poona
[17] Mani Varghese, K.I and V.G Rao,1980. An undescribed species of *Heteroconium* Petr. (Hyphomycetes) from India. Curr. Sci., 49:359.
[18] Maria Florence, E.J.2004. Bio div. documentation for Kerala. Part 2: Microorganisms (Fungi), KFRI, Peechi
[19] Mohanan, C. 1994. Decay of standing trees in natural forest, KFRI, Research Report No: 97.
[20] Mohanan, C. 2003. Mycorrhiza in forest plantation: Association, Diversity and Exploitation in planting improvement. KFRI Research Report No:252
[21] Mohanan, C. 2014. Macrofungal diversity in the Western Ghats, Kerala, India: members of Russulaceae. *Journal of Threatened Taxa*, *6*(4): 5636-5648
[22] Notermans, C., Nugteren, A., and Sunny, S. 2016. The changing landscape of sacred groves in Kerala (India): A critical view on the role of religion in nature conservation. *Religions*, *7*(4): 38.
[23] Sankaran, K.V, Florence, E.J.M, Balasundaran, M. and K.I Nawshad, 1997. Fungal Diversity, 140-148. In: The Natural Resourses of Kerala(Eds.) Balchandran, Thampi,K., Nayar, N.M and Nair C.S, World Wide fund for nature India.TVM.
[24] Sreeja, K., and Unni, P. N. 2016. Floristic diversity of Vallikkaattu Kaavu, a sacred grove of Kozhikode, Kerala, India.*Journal of Ecology and The Natural Environment*, *8*(10): 175-183.
[25] Subramanian, C.V. and K. Ramkrishnan, 1956. List of Indian fungi. 1952-1956. J. Madras Univ. B. 26(2): 327-341

[26] Subramanian, C.V. and B.P.R Vittal, 1974. Hyphomycetes on litter from India. I. Proc. Indian Acad. Sci. 80: 216-221.
[27] Sujana KA, Sivaperuman C, Padmanabhan P. 2006. Diversity of threatened flora in selected sacred groves in coastal Kerala.Proc. Natl. Conf. on Forest Biodiversity Resources: Exploitation, Conservation and Management, Kerala, India, 105. (Abstracts).
[28] Thiribhuvanamala, G., Prakasam, V., Chandrasekar, G., Sakthivel, K,, Veeralakshmi, S., Velazhahan, R. and Kalaiselvi, G. 2011. Biodiversity, conservation and utilization of mushroom