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Diversity of foliicolous fungi in Vagamon Hills- an ecologically vulnerable area in Western Ghats of Kerala state

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During the survey of foliicolous fungi of Vagamon Hills in Kerala state for, 65 fungal species representing 18 fungal genera inhabiting 38 different angiospermic host plants belonging to 27 families were recorded. Out of the 18 fungal genera, 12 fungal genera belong to Ascomycetes, 4 belong to Deuteromycetes and 2 fungal genera belong to Basidiomycetes. *Asterina* and *Meliola* were by far the most species rich genus with 16 and 15 different species respectively. Out of the infected 27 angiosperm families, Lauraceae and Rutaceae members showed highest number of infection. Therefore, above studies were designed to characterize foliicolous fungi that would further help in the conservation and management of biological resources and also increase the agriculture wealth of our nation.

Key words: Ascomycetes, *Asterina,* foliicolous, *Meliola*

INTRODUCTION

The most diverse habitats of our globe is known to be comprised within tropics with high rainfall, humidity and temperature. Thus it serves as a major repository for plants, animals and microorganisms (Tomao *et al*. 2020). Fungi are the most crucial living components among those (Pratibha *et al*. 2012) and they grow on substrates such as soil, wood, decaying organic matter, living plants and other organisms. Fungi growing on leaves as parasites are termed as foliicolous fungi which are either biotrophs or necrotrophs causing damage to host plants by penetrating the host cells by producing specially adapted cells called appressoria and haustoria meant for nutrient absorption (Gebrie, 2016). Symptoms such as discoloration, rust, black mildew, downy mildew, powdery mildew, smut, sooty mold, tar spot etc are the results of pathogenic phase of these fungi. Knowledge about the taxonomy of foliicolous fungi and their harmful interactions present on wild plants are relevant because they may spread to agriculture and horticulture plants.

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MATERIALS AND METHODS

The present study area 'Vagamon' (9°66' and 9°73'N latitude and 76°86' to 76°98'E longitude) falls within Western Ghats and is a natural landscape rich in endemic flora and fauna. Serious efforts to document foliicolous fungi were not made in Vagamon. Therefore, this work becomes the manual for the identification of the foliicolous fungi of this area.

In the present study, plant specimens with clearly visible disease symptoms were observed and collected in different seasonsfrom the study area during the year 2017-2019.Infection pattern such as pathogenicity, nature of colonies, nature of infection etc and geographical data such as locality and altitude were recorded in the field notes. Collected samples were transferred separately into the polythene bags along with the host twig to facilitate the identity of host plant. Host plants were identified as far as possible in the field or in the laboratory with the help of experts in taxonomy. Further processing of the infected sample were carried out in the laboratory. The samples were pressed neatly and placed in between blotting

papers until dryness is attained. To study the entire colony in its natural condition, Nail polish technique were used. To avoid the colonies with hyperparasites, the infected leaf were examined under stereo microscope (Magnus). To the selected colonies under the stereo microscope, a drop of high quality transparent nail polish were applied so that the colonies will get firmly embedded on it and can be easily peeled out from the leaf when it dries. A drop of DPX was spread on a clear slide and the peeled out colorless flip were spread properly on it. Over it one or two drops of DPX were addedand a clean cover glass was placed over it and a gentle pressure were applied on it so as to remove the excess DPX after drying. The prepared permanent slides were labeled and placed in a dust free chamber for 1-2 days for drying.Detailed taxonomic description of the Hina Mohamed and Jacob Thomas specimen was written by studying the micro-morphological characters using different magnifications of a binocular compound microscope Olympus (CX21iLED) with MagVision image analyzer software for the final confirmation of the identity of foliicolous fungi. Morphotaxonomic determinations were made with the help of standard literature (Hina and Jacob, 2020; Hosagouder, 1996; 2008; 2011; 2012; 2013a; 2013b). Finally, the materials were deposited in the Mar Thoma College Tiruvalla Herbarium (MTCTH), Kerala, India. This article lists the most prevalent fungi collected and aims to find out the species rich genusfrom the study area.

RESULTS AND DISCUSSION

The results presented in this paper are based on an extensive survey conducted from a period from July 2017 to July 2019. In the present study, fungi occurring on leaves of plant species have been collected and studied in detail. A total of 210 specimens of foliicolous fungi were collected during various field trips conducted to the study area between July 2017 and July 2019. Microscopic identification resulted in the recovery of 65 different species of foliicolous fungi on 38 different host plants belonging to 27 different angiosperm families. Diagnostic characters of microfungi such as morphology, colour and size of the colony and sporulating structures, such as ascomata, asci and ascospores in case of Ascomycetes and conidiomata, conidiophores and conidia in case of Deuteromycetes, formed the basis for identification. Out of the 65 different species, 18 fungal genera belonging to 9 families are documented in this study. Out of these, 12 fungal genera belong to Ascomycetes (black mildews and tar spot), 4 belong to Deuteromycetes (Hyphomycetes) and 2 fungal genera belong to Basidiomycetes (rust fungi). Among the 9 families recorded, Meliolaceae and Hyphomycetes group showed the highest number of fungal genera followed by Englerulaceae, Lembosiaceae and Pucciniaceae. The rest of the four fungal families were represented by only one genera (Table 1). Ascomycetes was found to be the dominant group in the present study. Similar kinds of work was carried out by several workers in many parts of Western Ghats of India (Prabhugaonkar, 2011).

Table 2 lists the host plants, its family and their respective foliicolous fungi. The infected 27 angiosperm host families can be categorized in to 4 categories. The first category has Lauraceae and Rutaceae family with 4 parasitized host plants each whereas second category consist of Rubiaceae and Verbenaceae by 3 parasitized host plants each. Category third is represented by Oleaceae with two parasitized host plants. Rest of the 22 families are being represented by only one parasitized host. Lauraceae has been found to be the most susceptible family which is parasitized by 10 fungal species followed by Rutaceae and Oleaceae which is parasitized by 6 and 5 fungal species respectively. Foliicolous fungi are considered to be host specific.

Lauraceae family showed the highest number of infection. This indicates that certain plant species are favored by fungi that occupy similar ecological niches. Those plants may exhibit specific leaf topologies or weak defense responses that facilitate growth of biotropic foliicolous fungi. There are a number of the hosts which had been collected infected with the same fungus either in different season or in different locality or simultaneously both having different ecological condition showing the adaptability of the fungus.

Table 1 : Fungal genera and its class

Fungal genera	Fungal Family	Symptom	Class
Asterina	Asterinaceae		
Meliola	Meliolaceae		
Asteridiella			
Irenopsis			
Amazonia			
Schiffnerula	Englerulaceae	Black mildew	Ascomycetes
Sarcinella			
Armatella	Armatellaceae		
Echidnodella	Lembosiaceae		
Eupelte			
Microthyria	Microthyriaceae		
Phyllachora	Phyllachoraceae	Tar spot	
Puccinia	Pucciniaceae	Rust	Basidiomycetes
Zaghounia			
Isthmophora	Hyphomycetes	Hyphomycetes	Deuteromycetes
Hansfordiellopsis			
Spiropes			
Zygosporium			

Table 2: List of host with their respective foliicolous fungi

Name of the family and host	Name of fungus
Anacardiaceae	
Mangifera indica L.	*Meliola mangifera* Earle, *Spiropes* sp.
Asteraceae	
Vernonia travancorica Hook.f.	*Asteridiella cyclopoda (*Stev.)Hansf.
Elaeocarpaceae	
Elaeocarpus sp.	*Asterinae laeocarpi* Sydow var. *ovalis* Kar&Maity
Euphorbiaceae	
Macaranga peltata (Roxb.) Mueller	*Asteridiella* sp.
Clusiaceae	
Garcinia sp.	*Asterina morellae* Hosag., C.K. Biju& Abraham
Cyperaceae	
Cymbopogon citrates (DC.) Stapf	*Meliola tibigirica* Hosag. & Abraham
Lamiaceae	*Asteridiella anastomosans* (G.Winter) Hansf.
Callicarpa sp.	
Lauraceae	
Cinnamomum sp.	*Asterina munnarensis* Hosag. & C.K. Biju
	Asterina cinnamomi Sydow
	Armatella cinnamomicola Hansf.
*Actinodaphne*sp.	*Schiffnerula actinodaphnes* Hosag., Archana., Harish, Riju& Agarwal
	Armatella actinodaphne Hosag., C.K. Biju& Abraham
	Meliola sp.
Neolitsea sp.	*Armatella* sp.

Contd.

	Armatella sp.
	Meliola litseae Sydow&Sydow
Litsea sp.	*Spiropes* sp.
Magnoliaceae	
Michelia champaca L.	*Asteridiella michelifolia* Hosag., Archana. & Agarwal var. *macrospora* Jacob Thomas and Hina Mohamed
Malvaceae	
Triumfetta sp.	*Asterinatrium fetticola* Yamam.
	Irenopsis triumfettae (Stev.) Hansf. &Deight.
Melastomaceae	
Memecylon sp.	*Meliola* sp.
Moraceae	
Ficus sp.	*Phyllachora* sp.
Myrsinaceae	
Maesaindica (Roxb.) A.DC.	*Meliola groteana var. maesa* Hosag., C.K. Biju& Abraham
	Amazonia peregrine Sydow&Sydow
	Isthmophora sp.
Myrtaceae	*Meliolaranganathi* Hansf.
Syzigium sp.	*Asteridiella brahmagiriensis* Hosag., Archana & D.K.Agarwal
	Asterina claviflori Kar&Maity
	Asterina jambolana Kar&Maity
Oleaceae	
Jasminum sp.	*Asterinaponga laparensis*Hosag., C.K. Biju& Abraham
	Meliola jasmine Hansf. &Stev.
Oleadioica Roxb.	*Eupelteamicta* Sydow
	Melioladaviesii Hansf.*var. kodaikanalensis*Hosag., Dhivaharan & Riju
	Zaghoniaoleae (E.J. Butler) Cummins
Polygonaceae	
Polygonumchinense L.	*Puccinia solmsii* P.Henn.
Rhamnaceae	
*Zizyphus*sp.	*Meliola ziziphy* Hansf. &Thirum.
Rubiaceae	
Wendlandia sp.	*Meliola wendlantiae*Hosag.
Canthium sp.	*Meliolaplectroniae*Hansf.
Coffee sp.	*Spiropes*sp.
Rutaceae	
Citrus sp.	*Meliolabutleri*S ydow
*Atalantiae*sp.	*Isthmophora* sp.
	Hansfordiellopsis sp.
	Asterinaatalantiae Hosag. & Agarwal
*Toddaliae*sp.	*Asterinatoddaliae* Kar& Ghosh
*Acronychiae*sp.	*Asterinaacronychiae* Hosag. &Goos
Sabiaceae	
Meliosma sp.	*Asterina meliosmae simplicifoliae* Hosag., C.K. Biju& Abraham
Sapindaceae	

Contd.

Allophyles cobbe (L.) Raeusc	*Meliola capensis* (Kalch. & Cooke) Theiss. *var. allophylicola* Hansf. &Deight.
	Sarcinellaallophyli Hosag.
Symplocaceae	
Symplocos sp.	*Asterina indica* Sydow& Butler
	Asterina suttoni Hosag., C.K. Biju& Abraham
	Microthyria sp.
Theaceae	
Camellia sinensis (L.) Kuntze	*Schiffnerula camelliae* (Sydow, Sydow& Butler) Hughes
	Spiropes sp.
	Microthyria sp.
	Asterina cannonni Hosag. & C.K. Biju
Ulmacaea	
Tremaorientalis	*Asterina dallasica* Petrak
	Asteridiella tremae(Speg.) Hansf.
	Zygosporium minus S. Hughes
Urticaceae	
Urtica sp.	*Spiropes* sp.
Verbenaceae	
*Clerodendrum*s p.	*Asteridiella vivekandandani* Hosag.
	Meliola clerodendricola Henn.
Stachytarpheta sp.	*Asteridiella depokensis* Hans f.
Citharexylem sp.	*Spiropes* sp.
Xanthophyllaceae	
Xanthophyllum sp.	*Schiffnerula*s p.
	Spiropes sp.
	Echidnodella sp.

The results showed that the particular fungus was able to infect the same plant in distantly located areas, indicating that foliicolous fungi infect mostly its associative hosts. Therefore their diversity is thought to be closely related to the diversity of hosts. Parasitic relationship between fungi and host plants results from complex developmental programs and coordinated signaling processes in both the pathogen and its host (Hahn and Mendgen, 2001). To overcome host plant resistance, these fungal parasites evolve diverse structural and chemical compounds and plants elaborate different defensive tool against their attack. This results in a co evolutionary struggle between pathogens and potential hosts and may explain the host specificity present in biotrophs (Ferreira *et al*. 2006).

In Vagamon, *Asterina* and *Meliola* were by far the most species rich genus with 16 and 15different speciesrespectively. *Asterina* parasitized 13 different host plants belonging to 11 host plant families. Three different *Asterina* spp. were found on Rutaceae, two *Asterina* spp. were found on Myrtaceae and Lauraceae and the rest of the host families were only parasitized by one *Asterina* species (Theaceae, Sabiaceae, Malvaceae, Oleaceae, Clusiaceae, Symplocaceae, Elaeocarpaceae and Ulmaceae). *Meliola* parasitized 14 different host plants belonging to 12 host plant families. Two different *Meliola* spp. were found on Rubiaceae, Lauraceae and Oleaceae and the rest of the host families was only parasitized by one *Meliola* species (Myrtaceae, Sapindaceae, Verbenaceae, Rhamnaceae, Meliaceae, Anacardiaceae, Cyperaceae and Melastomaceae). It is followed by *Asteridiella* spp. and *Armatella* spp. which represent 8 and 4 different species respectively. *Schiffnerula* represents 3 different species. *Spiropes* and *Isthmophora* could not be identified up to species level. The rest of 10 fungal genera represented

only one species (Fig. 1).A review of the magnitude of fungal biodiversity stresses the potentially high species number in the tropics, based on the assumption that many species can be associated with a single host. Therefore, intense field work in unexplored regions of tropical countries is necessary to obtain more details on plant parasitic fungi(Taylor*et al*. 2014).

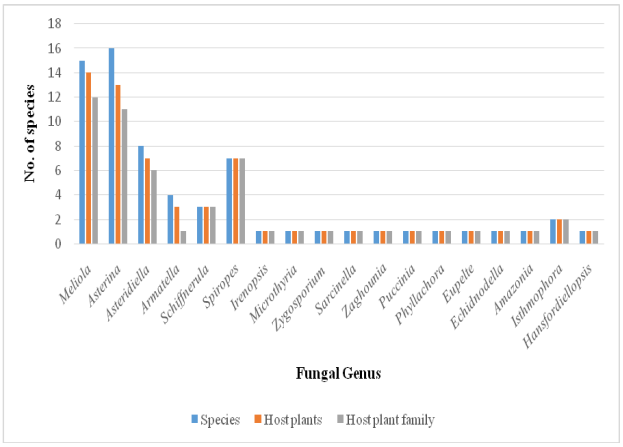

Fig 1. Species richness in each fungal genus

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