

# **BIODIVERSITY OF PLANT PATHOGENIC FUNGI IN THE KERALA PART OF THE WESTERN GHATS**

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## **EXECUTIVE SUMMARY**

### **Introduction**

The recorded forest area of the Kerala State, by legal status is 1.1223 million ha. The effective forest area in the State is estimated at 0.94 million ha, which constitutes 24.2% of the State's geographical area. Most of the forests in the State are natural and although nearly 150 years of conservancy and protection have improved their stocking to some degree, the overall density of these forests is by no means optimum. Dense forest (crown density above 40 per cent) constitutes over 81 per cent of the actual forest cover, the balance being largely open forest with a crown density of 10 to 40 per cent.

The extensive dispersion of forest over the Western Ghats is accompanied by considerable richness and diversity in composition. The various forest ecosystems support rich flora and fauna. However, there is no comprehensive account that would give a realistic estimate of the number of species and their bio-geographic distribution in the State. It is estimated that the flora of the Kerala part of the Western Ghats comprise as many as 3700 vascular plants. However, our knowledge on the diversity of lower plants including pathogenic fungi is disappointing, despite their economic, and ecological

potential. No serious efforts have ever been made to understand the biodiversity of phytopathogenic fungi in the Kerala part of the Western Ghats.

Studies on pathogenic fungi and diseases of forest stands have been systematically and intensively carried out in developed countries. In India, Bakshi initiated inventory of forest diseases during 1970s. In the Kerala part of the Western Ghats, Sharma and Mohanan initiated problem-oriented researches on prime forestry species like teak, eucalypts, etc. during 1980s. Epidemiological studies on major diseases in man-made forests and forest nurseries in the Western Ghats and their management have also been worked out to avoid catastrophe. However, in natural stands, so far, no systematic inventory on phytopathogenic fungi, except on heart rot fungi by Mohanan during 1990s has been carried out. The present study was undertaken with the following objectives:

- ❑ To undertake a comprehensive disease survey in natural forests, forest plantations and nurseries in the Kerala part of the Western Ghats and to document the fungal pathogens associated with various diseases of forestry species, their distribution, and economic significance.
  
- ❑ To prepare an illustrated document on plant pathogenic fungi, their association and distribution in various forest ecosystem in this region.

## **Material and Methods**

A reconnaissance survey in natural stands and forest plantations throughout the Western Ghats in the State was made and 237 study areas in different forest ecosystems, viz., wet evergreen, evergreen, semi-evergreen forests, shola forests, moist deciduous and dry deciduous forests, forest plantations and forest nurseries which fall under 96 Forest Ranges including Protected Areas (Pas) were selected. An extensive survey on plant pathogenic fungi was made during 2001-2004. Disease assessment was made in different forest ecosystems, disease specimens were collected, pathogenic fungi were isolated and

identified; identity of host plants was made and pathogenic status of the isolates was confirmed by inoculation trials.

## Results

The survey revealed a rich flora of plant pathogenic fungi harboring the plants in different forest ecosystems. A total of 4101 fungal isolates were obtained from the disease specimens collected and processed from 237 sample plots. The fungal isolates fall under 99 fungal genera and 226 species. Of these, fungi belong to the Hyphomycetes and Coelomycetes classes (Fungi Imperfecti) were the most widespread and predominant ones (Table 1).

Table 1: Plant pathogenic fungi recorded from the different forest ecosystems in the Western Ghats

Fungous Class	Genera	Species
Ascomycetes	13	30
Basidiomycetes	18	41
Coelomycetes	32	76
Hyphomycetes	33	74
Agonomycetes ( <i>Mycelia sterilia</i> )	2	3
Oomycetes	1	2
Total	99	226

Among the 4101 fungal isolates obtained in the study, 60 pathogenic fungi were given the status of new species. A total of 143 fungal pathogens were found new record from the Western Ghats and 102 fungal pathogens are reporting for the first time from India (Fig. 1). By following the existing practices in assigning new species status to a pathogenic fungi based on their association with particular host species/family, hundreds of new taxa can be erected from the isolates obtained in the present study. However, detailed taxonomic investigations are required and hence most of the isolates are treated merely as species of the respective genus.

Altogether 639 plant species belonging to 395 genera were found infected with the fungal pathogens in various forest ecosystems. Of these, 166 plant species were found as new host record for different pathogens. It is interesting to note that more than 26% of the plant species studied from different forest ecosystems are found new host record from India.

Among the 237 study sites surveyed, 109 study sites belonging to the moist deciduous forests located in different parts of the Western Ghats, recorded maximum number of pathogenic fungi (1237 isolates) which is about 30.16% of the total isolates of fungal pathogens obtained in the study (Table 2).

Fig.1: Fungal pathogens in WG and their status

Representative study sites in 59 localities in semi-evergreen forests, falling in 36 Forest Ranges in the State, yielded 892 pathogenic fungi which are about 21.75% of the total fungal isolates retrieved from the disease specimens collected and processed. In evergreen forests, including a *Myristica* swamp in the Western Ghats, a total of 605 pathogenic fungi were found associated with diseased plants in the systems.

Interestingly, exploration made from two study sites in the wet evergreen forests yielded 47 phytopathogenic fungi. From the shola forests (6 study sites), altogether 142 pathogenic fungi (3.46%) and from the dry deciduous forests (2 study sites), 50 pathogenic fungi were obtained. Study sites in forest plantations (19) selected in different

Forest Divisions in the Western Ghats recorded a total of 546 pathogenic fungi, which is about 18.97% of the total fungal isolates obtained (Table 2).

Table 2: Distribution of pathogenic fungi in different forest ecosystems

Sl.No.	Forest ecosystem	No. of sample plots studied	No. of fungal pathogen recorded	Per cent to total
1	Wet evergreen forests	10	582	14.14
2	Evergreen forests	30	605	14.75
3.	Shola forests	6	142	3.46
4.	Semi evergreen forests	59	892	21.75
5.	Moist deciduous forests	109	1237	30.16
6.	Dry deciduous forests	2	50	1.22
7.	Forest plantations	19	546	0.133
8.	Nurseries	10	582	14.19
	Total	237	4101	

From the ten forest nurseries (root trainer nurseries and conventional nurseries) surveyed, 582 pathogenic fungi were isolated from 154 plant species. Among the different forest ecosystems studied, forest plantations support a rich pathogenic fungal flora and the plant - fungal ratio is 1: 14.75. In moist deciduous forests and semi-evergreen forests, the plant-fungal ratio is 1:3.1 and 1:3.48 respectively. In shola forests and wet evergreen forests, the ratio is 1: 1.65 and 1: 1.46 respectively.

In forest nurseries, though a large number of host plants (154) are found affected with the fungal pathogens, the plant-fungal ratio is only 1: 3.77 and this is mainly because of the technological change in the seedling production system employing the root trainers, where only soil-less or soil free potting media (growing media) are used and there by most of the soil-borne nursery pathogens are excluded from the seedling production system.

The distribution of pathogenic fungi in the forest ecosystems is largely depended on various climatic and edaphic factors as well as host pathogen interrelationship.

Moreover, disturbances caused by anthropogenic factors also influence to a great extent in the build up of pathogen inoculum potential and thereby development and spread of disease(s) even to an epidemic proportion. Diseases affecting the plants in different ecosystems include foliage diseases, stem cankers, wilt, heart rot, root rot, etc. The foliage diseases include leaf spots, leaf blotches, leaf blight, powdery mildews, black mildews, and leaf rust. Among the diseases affecting the forest stands and nurseries, foliage diseases are the most predominant.

Foliage disease, including rust infections, powdery mildews and black mildews, account for about 95.90% of the total fungal infections in the different forest ecosystems studied. The obligate parasite, rust fungi, caused 3.04% of the total fungal infection, while the figures for powdery mildews and black mildews are 0.43% and 2.65% respectively. Only 2.43% stem diseases were recorded in all the sample plots studied, while root infection including wilt disease was only 0.85%. The results show that Mitosporic fungi, which belong to 65 genera and 150 species, are widely distributed in the different forest ecosystems and harbor the host substratum, mostly the foliage, for their growth and survival.

Ecosystem specificity as well as host specificity was recorded in fungal pathogens and also periodicity in occurrence and spread. Definite patterns of incidence of various fungal diseases in different host species could be observed during pre-monsoon, post-monsoon and during the dry period (February-April) in all the forest systems investigated. Pathogenic fungi isolated from various host plants in the Western Ghats and their details on distribution, disease(s) caused, symptoms, associated hosts, taxonomical characteristics, etc. are provided. Taxonomic concept (s) developed on the particular taxa as well as taxonomic criteria currently following, etc. are also mentioned. Fungi are treated here alphabetically, irrespective of their taxonomic position and pathogenic status. Brief description on cultural and morphological characteristics of the isolates, occurrence, nature and intensity of disease, plant parts affected, symptoms caused, etc. are given. KFRI Herbarium accession number for the disease specimens and KFRI Culture Collection number for the fungal isolate are provided for each disease specimen/isolate.

Fungal taxa differ from the reported ones are treated as new species. Photographic plates showing disease symptoms on affected plants, fungal pathogens, etc. (23 Nos.) are provided. Information on forest type, Forest Range, host affected, disease, severity of disease, etc. for selected pathogens, viz., *Coniella*, *Cylindrocladium*, *Fusarium*, *Myrothecium*, *Pestalotiopsis* is provided separately (Appendices II,III,IV,V,VI).A separate list of host plants and a check list of host-pathogen (genus-wise) are also provided (Appendices VII, VIII).

### **Conclusion**

The forests in the Kerala part of the Western Ghats support a rich pathogenic fungal flora. The distribution and level of parasitism of various fungi in different forest ecosystems are governed mostly by the climatic and edaphic factors as well as host parasite interrelationships. Among the forest ecosystems explored, maximum fungal diversity was observed in forest plantations, which was followed by semi-evergreen forests and moist deciduous forests. Forest plantations support a rich pathogenic fungal flora and the plant fungal ratio recorded in this ecosystem is as high as 1: 14.75. In moist deciduous forests and semi-evergreen forests, the plant-fungal ratio is 1:3.1 and 1:3.48 respectively- The results show that mono culture plantations support a large number of pathogenic fungi, which cause root, stem, and foliage diseases and thrive well under conducive environmental conditions. Build up of inoculum of different pathogens occurs and the disease caused by them may even spread to an epidemic proportion. In forest plantations, eucalypts dominate the system and a single host species (*Eucalyptus tereticornis*) harbor more than 25 genera of pathogenic fungi. This is almost 25% of the total fungal genera encountered in the study. The recently introduced exotic plant, *Acacia mangium* also harbor 21 genera of pathogenic fungi.. and was found severely affected with vascular wilt pathogen, *Fusarium solani* and root rot pathogen *Ganoderma lucidum*.

The results show that exotic host species are more vulnerable to the indigenous fungal pathogens and the monoculture plantations serve as reservoir of inoculum of different phytopathogenic fungi. In forest nurseries the plant-fungal ratio is only 1: 3.77. Earlier, conventional seedbed nurseries supported a large number of pathogenic fungi and the

recent technological change in the seedling production system using root trainers and high input management in nurseries excluded many nursery pathogens.

Disturbances caused by anthropogenic factors including forest fires seem to be the important factor for incidence and spread of diseases and thereby the pathogenic fungi. More fungi were encountered in disturbed stands than less disturbed stands in evergreen and wet evergreen forests. In evergreen and wet evergreen forests, though fungal pathogens are found causing foliage infections, they are not probably making any serious damage to the system. Diversity of obligate parasites like rust fungi is found more in evergreen, wet evergreen and semi-evergreen forests.

With regard to the community and species composition, almost same fungal flora was observed in moist deciduous forests, semi-evergreen forests and forest plantations, however, fungal species dominance occurred depending on the environmental conditions as well as host plants. Among the fungal groups, Mitosporic fungi were found widely distributed in all the forest ecosystems and exhibit wide host range. Fungus (*Cylindrocladium quinqueseptatum*) causing diseases in forest nurseries and eucalypt plantations was found associated with more than 25 indigenous host species in wet evergreen, evergreen, semi-evergreen to moist deciduous forests, which reveals the adaptability of the pathogen in different ecosystems. Pathogenic fungi viz., *Colletotrichum* state of *Glomerella*, *Curvularia*, *Phomopsis*, *Guignardia*, *Phyllosticta*, *Calonectria*, *Corynespora*, *Fusarium*, *Myrothecium*, *Pestalotiopsis*, *Phoma*, *Cylindrocladium*, *Coniella* are the most widely distributed ones in different forest ecosystems in the Western Ghats. Monoculture plantations in the Western Ghats serve as reservoir of a large number of phytopathogenic fungi which may become threat to other crops in due course.