# A comparison of diversity of marine fungi on three co-habiting mangrove plants

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A comparison was made of the diversity of marine fungi on three mangrove plants (*Avicennia marina*, *Rhizophora apiculata*, *Acanthus ilicifolius*) co-habiting in an estuary in Kerala State, India. Twenty-two species comprising 15 ascomycetes, 1 basidiomycete and 6 anamorphic fungi were recorded. Only five species were common to all three hosts examined: *Lignincola laevis Verruculina enalia*, *Zopfiella latipes*, *Halocyphina villosa* and *Periconia prolifica*. *Halorosellinia oceanica*, *Lignincola tropica*, *Saagaromyces glitra*, *Savoryella lignicola*, *Harpographium* sp. and *Zalerion maritima* were found only on *Avicennia*. *Dactylospora haliotrepha*, *Leptosphaeria* sp., *Payosphaeria minuta*, *Savoryella paucispora*, *Hydea pygmea* and *Trichocladium achrasporum* occurred only on *Rhizophora*. *Aniptodera chesapeakensis* was the only species found exclusively on *Acanthus*. Jaccard and Sørensen similarity indices between host species were low indicating low similarity between these fungal communities. A list of fungi observed on each mangrove host is given and most of them are illustrated. *Harpographium* sp. is recorded as new for the marine milieu. *Saagaromyces glitra* is a new record for Kerala State.

**Key words** – aquatic – biodiversity – ecology – mycota – species composition

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## Introduction

Mangroves are intertidal plants composed of medium-sized trees and shrubs seen in estuaries and lagoons where they are protected from strong wave action; they are common in tropical or subtropical coastal regions. Their prop roots, pneumatophores and fallen viviparous seedlings are periodically submerged in saline water and are inhabited by several marine fungi. Much information has been accumulated in the last three decades on the diversity, taxonomy and ecology of intertidal mangrove fungi (Sarma & Hyde 2001, Alias & Jones 2009). However, there is little data available on differences in the diversity of marine fungi occurring on different mangrove species growing side by side in a single location exposed to the same physical factors such as temperature, rainfall, salinity, tides, moisture and aeration (e.g. Hyde 1990, Sarma & Vittal 2001, Maria & Sridhar 2003). In this paper we present our observations on the diversity of marine fungi on two mangrove species and a mangrove associate growing in an estuarine location in Kerala State, India.

## Methods

Plant material was collected from Valapattanam Estuary near Valapattanam, Kannur District, Kerala State, India (Fig. 1a). This location, on the west cost of peninsular India, enjoys a tropical humid climate with a dry season extending from December to May and a rainy (monsoonal) season from June to November. It is a typical estuarine location where salinities range from that of sea water to

that of fresh water, due to tidal and seasonal fluctuations in water flow. Mangroves such as *Rhizophora*, *Avicennia* and *Bruguiera*, and mangrove associates such as *Acanthus ilicifolius* grow luxuriantly in this estuary. The lower parts of these mangrove vegetations are periodically inundated with salt water during high tide.

Plant material was collected on 19 May 2004, during low tide. Dead twigs still attached to the submerged portions of *Avicennia marina* (Forsk.) Vierh (Avicenniaceae, Fig. 1b), *Rhizophora apiculata* Bl. (Rhizophoraceae, Fig. 1c) and *Acanthus ilicifolius* L. (Acanthaceae, Fig. 1d) were collected. One hundred twigs were collected from each of the three selected hosts and were cut into appropriate sizes. Samples were immediately washed in estuarine water to remove debris, put in sterile polythene bags and taken to the laboratory. After preliminary examination, samples were incubated in sealed polythene bags at room temperature. Moisture content was maintained in the polythene bags by spraying sterilized tap water once a week and then resealing the bags. The incubated twigs were periodically examined for sporulating marine fungi under a stereomicroscope. Sporulating structures seen were picked off with sharp needles or fine tipped forceps. Immersed fruit bodies were located by randomly slicing away the surface layers of wood with a razor blade. The sporulating structures were mounted in natural seawater on glass slides for microscopic observation. Incubation and observation of the samples continued for 6 months.

Jaccard Index of species similarity was calculated pair-wise among the hosts based on the presence or absence of each fungal species using the formula $JI = a/(a + b + c)$ where $a$ is the number of fungal species occurring in both hosts, $b$ is the number of fungal species unique to the first host and $c$ is the number of fungal species unique to the second host. For comparing the similarity of species composition between mangrove hosts, Sørensen index was also calculated pair-wise using the formula $Cs = 2j/(a + b)$, where $j$ is the number of species common to both the species, $a$ is the number of species recorded on first host and $b$ is the number of species recorded on the second host.

## Results

The marine fungi observed during this study are listed in Table 1 together with the host on which they were observed. Most species are illustrated in Fig. 1e–x. Table 2 lists the Jaccard and Sørensen indices of species similarity calculated pair-wise among the hosts. These indices between host species were low, indicating low similarity between fungal communities on the three hosts.

A total of 22 species were recorded from all the three hosts examined. This comprised 15 ascomycetes, 1 basidiomycete and 6 anamorphic fungi. All these species except *Harpographium* sp. have been previously recorded from the marine environment.

Fourteen marine fungal species (9 ascomycetes, 1 basidiomycete, 4 anamorphic fungi) were found on *Av. marina*. Thirteen marine fungi were found on *R. apiculata* (8 ascomycetes, 1 basidiomycete, 4 anamorphic fungi), and 8 species were observed on *Ac. ilicifolius* (6 ascomycetes, 1 basidiomycete, 1 anamorphic fungus).

Only five species were common to all three hosts examined: *Lignincola laevis Verruculina enalia*, *Zopfiella latipes*, *Halocyphina villosa* and *Periconia prolifica*. The following species were found only on *Av. marina*: *Halorosellinia oceanica*, *Lignincola tropica*, *Saagaromyces glitra*, *Savoryella lignicola*, *Harpographium* sp. and *Zalerion maritima*. *Dactylospora haliotrepha*, *Leptosphaeria* sp., *Payosphaeria minuta*, *Savoryella paucispora*, *Hydea pygmea* and *Trichocladium achrasporum* occurred only on *R. apiculata*. *Aniptodera chesapeakensis* was the only species found exclusively on *Ac. ilicifolius*. The most common species encountered on the three hosts also differed. *Periconia prolifica* and *Verruculina enalia* were the most common fungi on *Av. marina*. *Hydea pygmea* was the most common fungus on *R. apiculata*; and *Aniptodera chesapeakensis*, a species found only on *Ac. Ilicifolius* was also the species most commonly occurring on this host.

## Discussion

The results of this study reveal differences in the diversity of higher marine fungi on co-habiting mangrove species exposed to

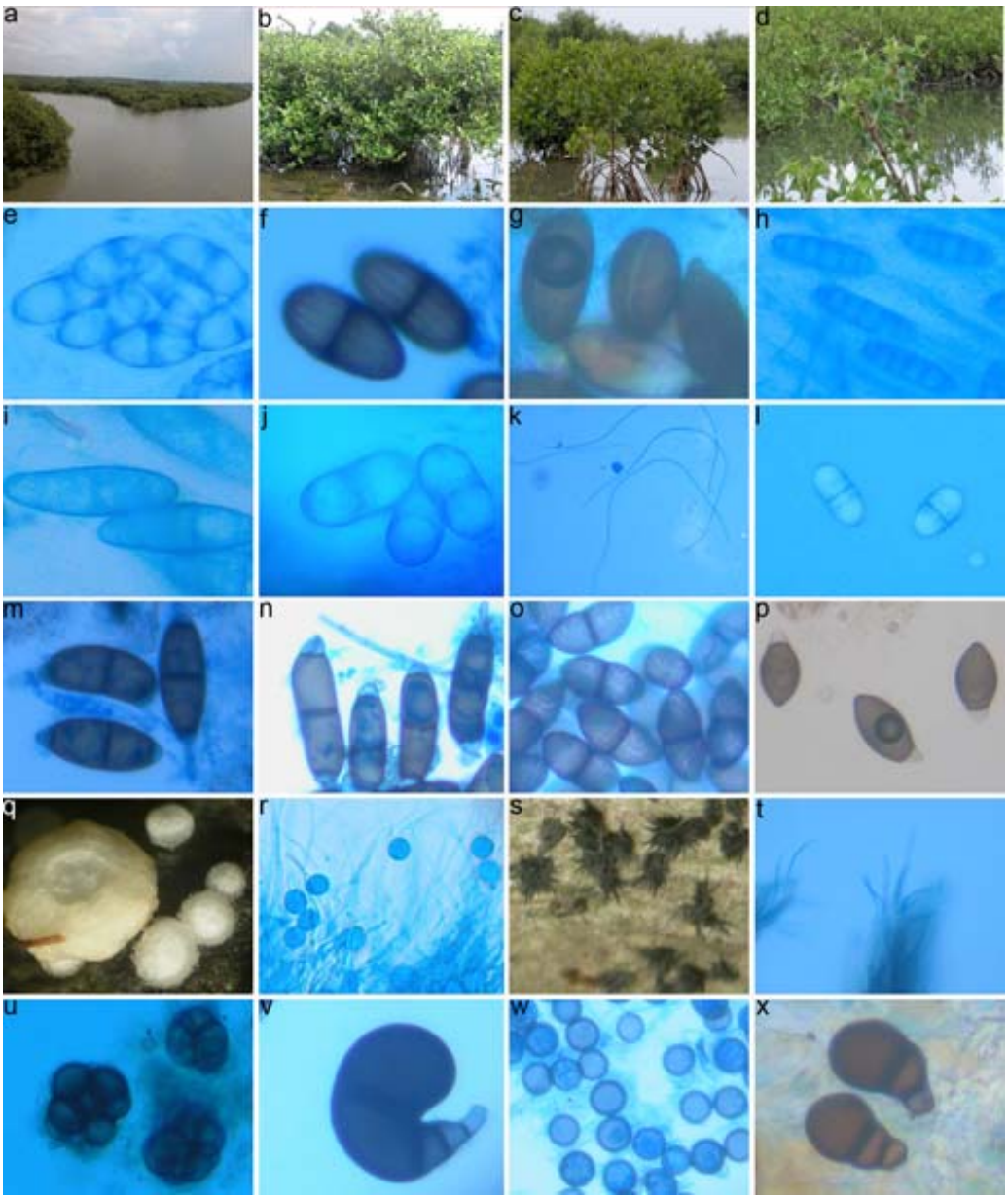


**Fig. 1** – Mangrove hosts and the associated marine fungi, **a** Valapattanam estuary, **b** *Avicennia marina*, **c** *Rhizophora apiculata*, **d** *Acanthus ilicifolius*. Ascospores of **e** *Aniptodera chesapeakensis*, **f** *Dactylospora haliotrepha*, **g** *Halorosellinia oceanica*, **h** *Leptosphaeria* sp., **i** *Lignincola laevis*, **j** *Lignincola tropica*, **k** *Lulworthia grandispora*, **l** *Saagaromyces glitra*, **m** *Savoryella lignicola*, **n** *Savoryella paucispora*, **o** *Verruculina enalia*, **p** *Zopfiella latipes*. Basidiomata of **q** *Halocyphina villosa*. Basidiospores of **r** *Halocyphina villosa*. Conidiomata of **s** *Harpographium* sp. Conidia of **t** *Harpographium* sp., **u** *Halenospora varia*, **v** *Hydea pygmea*, **w** *Periconia prolific*, **x** *Trichocladium achrasporum*.

the same physical factors in an estuary. Of the 21 species found, only five were seen on all three hosts examined. Similar variations in the composition of fungi on individual host species growing in a single locality have been previously reported by Hyde (1990), Sarma & Vittal (2001) and Maria & Sridhar (2003).

Although host specificity of mangrove fungi has been addressed by several workers (e.g. Hyde 1990, Hyde & Lee 1995, Alias & Jones 2000), except for a few species, little evidence of host specificity has been reported. In this study, none of the host-specific species observed by these researchers were seen. Also, several of the marine fungi observed on each of the three hosts in the present study have already been recorded on the other hosts as well. The diversity and abundance of mangrove

**Table 1** Occurrence of marine fungi on three co-habiting mangrove plants.

| Fungus | *Avicennia marina* | *Rhizophora apiculata* | *Acanthus ilicifolius* |
|---|---|---|---|
| **Ascomycota** | | | |
| *Aniptodera chesapeakensis* Shearer & M.A. Mill. | - | - | + |
| *Dactylospora haliotrepha* (Kohlm. & E. Kohlm.) Hafellner | - | + | - |
| *Halorosellinia oceanica* (S. Schatz) Whalley, E.B.G. Jones, K.D. Hyde & Læssøe | + | - | - |
| *Leptosphaeria* sp. | - | + | - |
| *Lignincola laevis* Höhnk | + | + | + |
| *Lignincola longirostris* (Cribb & J.W. Cribb) Kohlm. | + | + | - |
| *Lignincola tropica* Kohlm. | + | - | - |
| *Lulworthia grandispora* Meyers | + | - | + |
| *Lulworthia* sp. | - | - | + |
| *Saagaromyces glitra* (J.L. Crane & Shearer) K.L. Pang & E.B.G. Jones | + | - | - |
| *Savoryella lignicola* E.B.G. Jones & R.A. Eaton | + | - | - |
| *Savoryella paucispora* (Cribb & J.W. Cribb) J. Koch | - | + | - |
| *Payosphaeria minuta* H.Y.M. Leung | - | + | - |
| *Verruculina enalia* (Kohlm.) Kohlm. & Volkm.-Kohlm. | + | + | + |
| *Zopfiella latipes* (N. Lundq.) Malloch & Cain | + | + | + |
| **Basidiomycota** | | | |
| *Halocyphina villosa* Kohlm. & E. Kohlm. | + | + | + |
| **Anamorphic fungi** | | | |
| *Halenospora varia* (Anastasiou) E.B.G. Jones | + | + | - |
| *Harpographium* sp. | + | - | - |
| *Hydea pygmea* (Kohlm.) K.L. Pang & E.B.G. Jones | - | + | - |
| *Periconia prolifica* Anastasiou | + | + | + |
| *Trichocladium achrasporum* (Meyers & R.T. Moore) M. Dixon ex Shearer & J.L. Crane | - | + | - |
| *Zalerion maritima* (Linder) Anastasiou | + | - | - |

**Table 2** Comparison of species similarity of marine fungi from three co-habiting mangrove plants.

| Paired host species | Fungi common to both hosts | Jaccard Index | Sørensen Index |
|---|---|---|---|
| *Avicennia marina*/*Acanthus ilicifolius* | 6 | 0.38 | 0.55 |
| *Avicennia marina*/*Rhizophora apiculata* | 7 | 0.35 | 0.52 |
| *Rhizophora apiculata*/*Acanthus ilicifolius* | 5 | 0.31 | 0.48 |

fungi are influenced by a consortium of factors (Jones 2000, Sarma & Hyde 2001, Alias & Jones 2009, Alias et al. 2010) and Sakayaroj et al (2011), and include the type of mangrove community, type of substrata available for colonization, quality of substrata, length of time the substrata has been exposed to conditions conducive to fungal colonization, competition between fungi and various physical factors mentioned earlier. In the present study, because several of these influencing factors including the physical factors were the same for each host plant, differences in the observed diversity of fungi on the three mangrove species may be due to the type of substrata, the texture of substrata (hard, medium or soft) as well as the length of time the substrata had been exposed for fungal colonisation. For example, the number of fungal species found on *Ac. ilicifolius* was fewer than that found on *Av. marina* and *R. apiculata*. This is understandable as *Ac. ilicifolius* is essentially a shrub with light and slender twigs that decay rather quickly giving less time and ligno-cellulosic

materials for many fungi to colonize. It is also possible that some inhibitory substances may be present, thus preventing some fungi from colonizing it.

When the results of the present short-term study confined to a single locality are juxtaposed with those of Raveendran & Manimohan (2007), who studied the manglicolous marine fungi of the Kerala coast in a much larger scale (both in time and space), some interesting observations can be made. Raveendran & Manimohan (2007) recorded many more species on *Avicennia* spp. (56), *Rhizophora* spp. (47) and *Ac. ilicifolius* (33), including most of the fungi recorded in the present study on the respective genera. However, in spite of our study being of short duration, several species were found on each of the mangrove hosts that were not recorded by Raveendran & Manimohan (2007). Raveendran & Manimohan (2007) found the maximum number of fungi on *Avicennia* spp., then on *Rhizophora* spp. and the least number on *Ac. ilicifolius*, a pattern similar to what we found in the present study. Remarkably, Raveendran & Manimohan (2007) also found *A. Chesapeakensis* as the most frequent fungus on *Ac. ilicifolius*. However, the most frequent species found by Raveendran & Manimohan (2007) on *Avicennia* spp. (*Halocyphina villosa*) and *Rhizhophora* spp. (*Halosarpheia marina*) were different.

The most common fungi found in the present study were not common in those hosts located in several other geographical locations including other parts of peninsular India. For example, the dominant fungi *Dactylospora haliotrepha* and *Verruculina enalia* on the wood of *R. apiculata* (Sarma & Vittal, 2000), and *Lophiostoma mangrovei* and *Verruculina enalia* on the wood of *Rhizophora* spp. from the east coast of India (Ravikumar & Vittal 1996) are not dominant on *R. apiculata* in our study. Similarly, *Aniptodera chesapeakensis*, the most common fungus on *Ac. ilicifolius* in the present study was not recorded on that host by Sarma & Vittal (2001) from the east coast of India. Remarkably, dominant *Verruculina enalia* on wood of *Avicennia* spp. from the east coast (Sarma & Vittal 2000) was dominant on *Av. marina* in the present study as well. However, unlike the present study, uniformity in sampling size of different hosts was not maintained in most of these studies making comparisons difficult. As pointed out by Alias et al (2010), mangrove ecosystems of different geographical locations differ considerably in physical attributes, composition and age of host trees, substrata available for colonization and salinity. These local environmental factors may have a larger role in deciding the dominant fungi on each host.

*Harpographium* sp. recovered from *Av. marina* is a new record for the marine milieu. This synnematous genus has been previously considered as a terrestrial saprobe, but the conidia of the present species germinated and produced mycelium in seawater agar indicating that it could be a true marine species. *Saagaromyces glitra* is a new record for Kerala.

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