
Diversity and abundance of marine fungi on driftwood collected from Kerala State and Lakshadweep Islands, India

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Twenty three marine fungi (17 ascomycetes and 6 mitosporic fungi) associated with driftwood are documented from coastal locations of Kerala State and Lakshadweep Islands of India. Out of 494 samples scanned, 50 (10.1%) had sporulating marine fungi. All species were infrequent (< 4%). The average number of species per sample was 0.04. The percent colonization was higher (16.6%) in the samples from the Lakshadweep Islands than in those from Kerala coast (9.5). While all 23 species were recorded from Kerala coast, only four species were recovered from the islands. *Etheiophora bijubata*, *Halosphaeria appendiculata*, *Remispora quadri-remis* (ascomycetes) and *Robillarda rhizophorae* (mitosporic fungus) are new records for India.

Key words – aquatic – biodiversity – mycota – new records – tropics

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Introduction

Marine fungi play an important role in decomposition of organic matter in the sea. Lignicolous marine fungi inhabit various types of woody substrata available in the marine environment. Wood in the sea may originate from sources such as salt marshes and mangroves or it may be terrestrial wood reaching the sea by various means (Pointing et al. 2000). Wood available on the coastline for fungal colonization is either intertidal wood or driftwood. Intertidal wood is relatively rigidly fixed wood in the intertidal zone, such as wooden structures along the shore and wood partially buried in sand or wedged between rocks. Driftwood is floating pieces of wood or wood that is washed ashore by the sea and found loose on the shore (Kohlmeyer & Kohlmeyer 1979). The presence of fruiting bodies or spores on the surface of the wood, either at the time of collection or following incubation, indicates the occurrence of marine fungi.

Currently about 530 species of higher marine fungi (ascomycetes, basidiomycetes and anamorphic fungi) are known from different parts of the world (Jones et al. 2009). Several studies have been made on marine mycota of India in the last two decades. Sridhar & Prasannarai (2001) enumerated 89 species of marine fungi belonging to 53 genera (71 ascomycetes, 3 basidiomycetes, 15 anamorphic fungi) that are known from the Indian Peninsula. About 80 marine fungi from the coastal waters of Kerala State were found in a preliminary study focusing on mangrove fungi (Raveendran & Manimohan 2007). A recent checklist of marine fungi known from Kerala State (Nambiar & Raveendran 2008) listed 115 species (83 ascomycetes in 41 genera, two basidiomycetes in two genera, 30 anamorphic fungi in 17 genera). Here, we present the diversity of marine fungi found on driftwood samples collected from various locations on the coastline of Kerala and four islands of the Lakshadweep

Islands along with some quantitative data. Lakshadweep Islands are a group of about 36 islands and islets in the Arabian Sea, 200 to 440 km off the coast of Kerala State. All of them are coral islands and have fringing coral reefs very close to their shores (atolls). Ten of the islands are inhabited and these include the four islands from where driftwood samples were collected during this study: Kalpeni, Chetlat, Bitra and Amini.

Methods

Driftwood samples were collected from 21 locations on the coastline of Kerala and 4 locations (1 each) from four islands of Lakshadweep Islands between April and July of 2008. All of the locations are sandy beaches. Driftwood samples that had been washed ashore were collected. Samples collected were immediately washed in sea 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 driftwood samples were subjected to periodical examination for sporulating marine fungi under a stereomicroscope. Any sporulating structures seen were picked up with sharp needles or fine-tipped forceps. Immersed fruit bodies were located by randomly slicing away the surface layers of driftwood with a razor blade. The sporulating structures were mounted in natural seawater on glass slides for microscopic observation. Incubation and observation of the driftwood samples was continued for 6 months.

The number of samples colonized by a specific fungus, the percent colonization of collected samples, and the average number of species per sample were determined. Percent frequency was determined for each species by dividing the number of driftwood samples supporting a particular species by the total number of driftwood samples examined and multiplying by 100. Jaccard Index of species similarity between Kerala coast and the islands was calculated using the formula $JI = a/(a + b + c)$ where a is the number of species found in both the Kerala coast and the islands, b is the number found in only Kerala coast and c is the

number of species found only in the islands. For comparing the similarity of species composition in the Kerala coast and the islands Sørensen index was also calculated using the formula $Cs = 2j/(a + b)$, where j is the number of species common to both the Kerala coast and the islands, a is the number of species recorded from Kerala coast and b is the number of species recorded from the islands (this index is equal to 1 in case of complete similarity and 0 if the locations have no species in common).

Results

Of the 494 driftwood samples collected, only 50 samples were colonized by marine fungi (Table 1). Other quantitative information is also provided in Table 1 for comparing the distribution of marine fungi in the mainland locations with that in the islands. A total of 23 species of marine fungi were observed on driftwood samples collected from Kerala and the Lakshadweep Islands (Table 2), comprising 17 ascomycetes and 6 anamorphic fungi. No basidiomycetes were seen. All 23 fungal species have been previously recorded from the marine environment. The spore morphology of all species encountered is shown in Figs 1 and 2.

Three ascomycetes (*Etheiophora bijubata*, *Halosphaeria appendiculata*, and *Remispora quadri-remis*) and one anamorphic fungus (*Robillarda rhizophorae*) are first records for India. The ascomycetes *Didymosphaeria lignomaris* and *Kirschsteiniothelia maritima* are first records for Kerala State, while all four species collected from the Lakshadweep Islands are new records for these islands.

The four species of *Corollospora* (*C. gracilis*, *C. filiformis*, *C. pulchella* and *C. trifurcata*) are arenicolous fungi seen attached to sand grains sticking to the driftwood. Interestingly, these four species occurred together in a single sample collected from Calicut Beach.

Trichocladium achrasporum, *Corollospora gracilis* and *Hydea pygmea*, in that order, were the most frequently noticed species. *Kirschsteiniothelia maritima*, *Lignincola laevis*, *Marinosphaera mangrovei*, *Torpidospora radiata*, *Halosphaeria appendiculata*, *Crinigeria maritima*, *Remispora quadriremis*, *Antenno-spora quadricornuta*, *Robillarda rhizophorae* were each isolated from only one sample.

Table 1 Comparison of occurrence of marine fungi on driftwood collected from the Kerala coast and the Lakshadweep Islands.

	Kerala State	Lakshadweep Islands	Total
Number of driftwood samples examined	452	42	494
Number of samples possessing fungi	43	7	50
Percent colonization	9.5	16.6	10.1
Number of species recovered	23	4	23
Average number of species per sample	0.05	0.09	0.04
Jaccard Index: 0.17			
Sørensen index: 0.3			

Table 2 Marine fungi collected from all localities, together with total number of isolates and overall frequency of occurrence of each species.

Species	Location ^a	No. of driftwood samples supporting the species	FO ^b (%)
<i>Aniptodera chesapeakensis</i> Shearer & MA. Mill.	11,13	2	0.40
<i>Antennospora quadricornuta</i> (Cribb & JW. Cribb) TW. Johnson	16	1	0.20
<i>Corollospora filiformis</i> Nakagiri	8, 10, 12	4	0.81
<i>Corollospora gracilis</i> Nakagiri & Tokura	10,12, 14, 15, 19, 22, 23	17	3.43
<i>Corollospora pulchella</i> Kohlm., I. Schmidt & NB. Nair	5, 6, 12, 20	6	1.20
<i>Corollospora trifurcata</i> (Höhnk) Kohlm.	6, 21	2	0.40
<i>Crinigera maritima</i> I. Schmidt.	6	2	0.40
<i>Didymosphaeria lignomaris</i> Strongman & JD. Mill ^d .	4, 6, 13, 24, 25	9	1.81
<i>Etheiophora bijubata</i> Kohlm. & Volkm.-Kohlm. ^c	16	2	0.40
<i>Halosphaeria appendiculata</i> Linder ^c .	16	1	0.20
<i>Kirschsteiniothelia maritima</i> (Linder) D. Hawksw ^d .	14	2	0.40
<i>Lignincola laevis</i> Höhnk.	13	3	0.61
<i>Lulworthia lindroidea</i> Kohlm.	16, 17	6	1.20
<i>Marinosphaera mangrovei</i> K.D. Hyde	21	4	0.81
<i>Remispora quadri-remis</i> (Höhnk) Kohlm. ^c	6	1	0.20
<i>Savoryella lignicola</i> E.B.G. Jones & R.A. Eaton	3, 13, 23	4	0.81
<i>Torpedospora radiata</i> Meyers	14	2	0.40
<i>Alternaria</i> sp.	1, 4	2	0.40
<i>Cladosporium algarum</i> Cooke & Masee	12	2	0.40
<i>Halenospora varia</i> (Anastasiou) E.B.G. Jones	2, 18, 20, 23	4	0.81
<i>Hydea pygmaea</i> (Kohlm.) E.B.G. Jones	7, 12, 13	13	2.62
<i>Robillarda rhizophorae</i> Kohlm. ^c	3	3	0.61
<i>Trichocladium achrasporum</i> (Meyers & R.T. Moore)	13, 14, 17	18	3.63
M. Dixon ex Shearer & J.L. Crane			

^a1, Sanghumugham; 2, Varkala; 3, Chavara; 4, Vallikkunnam; 5, Thrikkunnappuzha; 6, Arattupuzha; 7, Cherai; 8, Chavakkad; 9, Parappanangadi; 10, Chettyppadi; 11, Kadalundi; 12, Calicut; 13, Chaliyam; 14, Beypore; 15, Kappad; 16, Payyambalam; 17, Meenkunnu; 18, Dharmadam; 19, Muzhupilangad; 20, Bekkal; 21, Pallikere; 22, Kalpeni Island; 23, Chetlat Island; 24, Bitra Island; 25, Amini Island.

^bFrequency of occurrence (FO): Number of driftwood samples supporting a particular species divided by total number of driftwood samples examined \times 100.

^cNew record for Indian coast

^dNew record for Kerala coast.

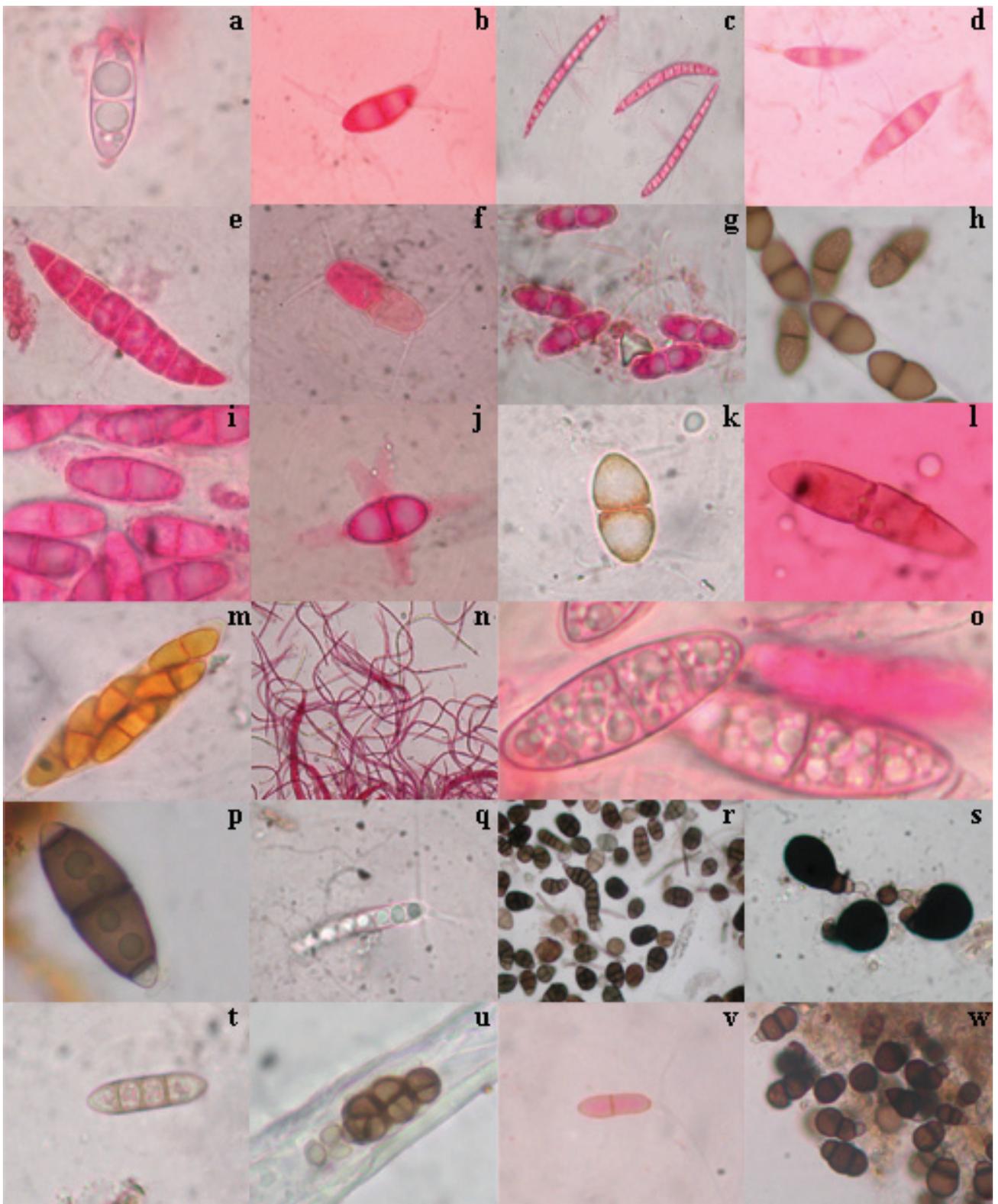


Fig. 1 – Ascospores of **a.** *Aniptodera chesapeakensis*; **b.** *Antennospora quadricornuta*; **c.** *Corollospora filiformis*; **d.** *Corollospora gracilis*; **e.** *Corollospora pulchella*; **f.** *Corollospora trifurcata*; **g.** *Crinigera maritima*; **h.** *Didymosphaeria lignomaris*; **i.** *Etheiophora bijubata*; **j.** *Halosphaeria appendiculata*; **k.** *Remispora quadri-remis*; **l.** *Kirschsteiniothelia maritima*; **m.** *Lignicola laevis*; **n.** *Lulworthia lindroidea*; **o.** *Marinosphaera mangrovei*; **p.** *Savoryella lignicola*; **q.** *Torpedospora radiata*; **Conidia** of **r.** *Alternaria* sp.; **s.** *Hydea pygmaea*; **t.** *Cladosporium algarum*; **u.** *Halenospora varia*; **v.** *Robillarda rhizophorae*; **w.** *Trichocladium achrasporum*.

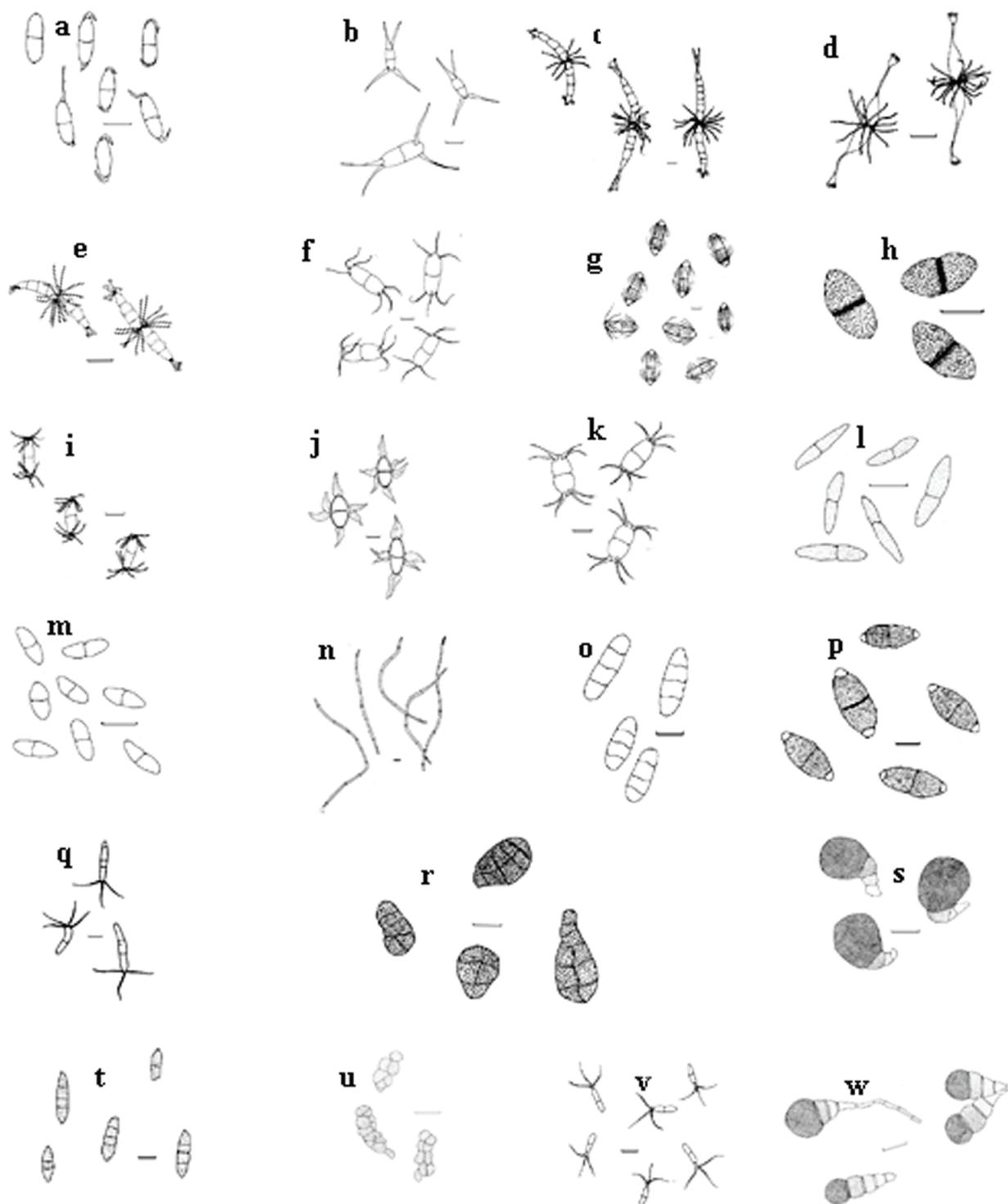


Fig. 2 – Ascospores of **a.** *Aniptodera chesapeakensis*; **b.** *Antennospora quadricornuta*; **c.** *Corollospora filiformis*; **d.** *Corollospora gracilis*; **e.** *Corollospora pulchella*; **f.** *Corollospora trifurcata*; **g.** *Crinigera maritima*; **h.** *Didymosphaeria lignomaris*; **i.** *Etheiophora bijubata*; **j.** *Halosphaeria appendiculata*; **k.** *Remispora quadri-remis*; **l.** *Kirschsteiniothelia maritima*; **m.** *Lignincola laevis*; **n.** *Lulworthia lindroidea*; **o.** *Marinosphaera mangrovei*; **p.** *Savoryella lignicola*; **q.** *Torpedospora radiata*; **Conidia** of **r.** *Alternaria* sp.; **s.** *Hydea pygmea*; **t.** *Cladosporium algarum*; **u.** *Halenospora varia*; **v.** *Robillarda rhizophorae*; **w.** *Trichocladium achrasporum*. Scale bars = 10 μ m.

Only four species were observed on the collections from Lakshadweep Islands including three ascomycetes (*Savoryella lignicola*, *Didymosphaeria lignomaris* *Corollospora gracilis*) and one anamorphic fungus (*Halenospora varia*). All four also were noticed on driftwood from Kerala.

Discussion

This study adds to the knowledge of diversity of marine fungi of India. Also, it reveals some differences in the composition of the marine mycota of the Kerala coast and some islands in the Arabian Sea.

Our study supports several earlier observations that ascomycetes are the most predominant component of the marine mycota, however, the most frequently observed fungus in our study was *Trichocladium achrasporum*, an anamorphic fungus. Interestingly, *T. achrasporum* was the third most common species in a recent report on the diversity of mangrove fungi of Malaysia (Alias et al. 2010).

In the present study, all species were infrequent (<4%) and the average number of species per sample was only 0.04. These values are much less when compared to those from mangrove locations (Alias et al. 2010, Besitulo et al. 2010). The extreme environmental conditions, including exposure to high temperatures, abrasion, desiccation and variation in salinity, of the exposed sandy beaches from where samples were collected in the present study can have a major effect on the frequency and density of fungi colonizing driftwood.

Because of the pristine marine environment of the Lakshadweep Islands, it was expected that more marine fungi would have been found there than in the polluted coastal waters of Kerala. While the percent colonization was higher in the islands, the number of species found was very low. A previous study on the diversity of marine fungi along the west coast of India (Prasannarai & Sridhar 2001) had found higher species diversity in islands than in coastal locations. Surprisingly, however, in the present study, few species were obtained from the islands. One reason for this could be the uneven sampling. Another reason could be the lack of diversity in the vegetation (flora) that provides the substrate for these fungi. Coconut palms constitute more than 90% of the vegetation in the Lakshadweep Islands and all of the

wood samples collected from the islands for this study were parts of these palms. Apart from the availability and diversity of substrata, several other factors such as salinity, temperature, quantity of propagules in the water, the nutrient status of the water, sampling frequency and intensity, geographical locations and host specificity may also have an effect on species occurrence (Jones & Alias 1997, Jones 2000, Alias et al. 2010). Further studies, therefore, are needed to explain the apparent lack of diversity of marine fungi in the Lakshadweep Islands.

The discovery of several new records of marine fungi during this short-term study highlights the need for further studies to unravel the full extent of the biodiversity of marine fungi of Kerala and Lakshadweep Islands.

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