Colonization of mangrove wood by marine fungi at Kuala Selangor mangrove stand, Malaysia

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Test blocks of *Avicennia marina* and *Bruguiera parviflora* were exposed at Kuala Selangor mangrove stand for 90 weeks and examined at regular intervals to determine colonization patterns. Sixty-one fungi were identified from 486 test blocks. The most common fungi on *Avicennia marina* blocks were *Halosarpheia marina*, *Lignincola laevis*, *L. longirostris*, *Lulworthia grandispora*, *Periconia prolifica*, *Savoryella lignicola* and *Trichocladium achrasporum*. On *Bruguiera parviflora* blocks the most common fungi were *Halosarpheia marina*, *H. ratnagiriensis*, *H. retorquens*, *Lignincola laevis*, *Lulworthia grandispora*, *Savoryella lignicola* and *Trichocladium achrasporum*. A Jaccard similarity index of 0.5-0.8 showed the species composition on *Avicennia marina* and *Bruguiera parviflora* to be relatively similar at each stage of colonization. Although a succession of fungi on the wood was not observed, there was a clear pattern of colonization. Early colonizers (6-18 weeks) on both timbers and at all stands include *Halosarpheia marina*, *H. retorquens*, *Lignincola laevis*, *L. longirostris* and *Lulworthia grandispora*. Intermediate colonizers (26-54 weeks) included *Dictyosporium pelagicum*, *Halocyphina villosa*, *Halosarpheia ratnagiriensis*, *Periconia prolifica*, *Savoryella lignicola*, *Trichocladium achrasporum*, *T. alopallonellum* and *Verruculina enalia*. Late colonizers (60-96 weeks) were *Aigialus parvus*, *Leptosphaeria australiensis*, *Nais glitra*, *Quintaria lignatilis*, *Saccardoella marinospora* and *Tirispora unicaudata*. A lower number of fungi and percentage of colonization was observed at the early stage of colonization than at the intermediate and late colonization stages. The percentage occurrence of fungi on wood was very high (100%) at all stages, with the number of fungi per sample: 1.8-4.2 (early stage), 6-8 (intermediate stage) and 4-7 (late stage). The data is compared with other studies.

Key words: colonization, ecology, mangrove fungi, species diversity.

Introduction

Alias (1996) listed 339 fungi known from mangroves with the majority (151 species in 84 genera) of ascomycetes. The basidiomycetes form the least represented group with only 3 genera, while 37 species in 29 genera are mitosporic fungi. Fifty-five mangrove trees and their associates are now reported to support 191 higher marine fungi (Alias, 1996).

Early collections of mangrove fungi involved collation of data or reports and production of lists of the fungi collected (Kohlmeyer, 1969, 1980, 1984; Kohlmeyer and Kohlmeyer, 1979; Aleem, 1980). These gave information only on the presence or absence of fungi at selected geographical locations. Hyde and Jones (1988) and Jones and Hyde (1988) proposed that this data gave an indication of the common, frequent and the fungi occurring rarely in mangroves. However, Volkmann-Kohlmeyer and Kohlmeyer (1993) discussed the difficulties in determining the frequencies of marine fungi as only sporulating fungi can be identified. They also stated that the mangrove substrata collected are usually not uniform, consisting of uneven lengths and diameter of wood, with and without bark.

A number of techniques have been employed to study the ecology of mangrove fungi and these depend on the objectives of each study. To obtain a general indication of species composition and diversity at a certain locality, salinity or position on a shore, a direct observation of fungal fruiting bodies on randomly collected submerged substrata and driftwood from nature can be employed. Jones and Hyde (1988) discussed the disadvantage of this method. Only sporulating species can be identified, the method does not give good quantitative data and the substratum cannot be assigned to species unless subject to anatomical examination.

Meyers and Reynolds (1958) introduced baiting of substrata to investigate the colonization and the succession of marine fungi. Jones and Hyde (1988) discussed the advantages of examining baited samples. These include the fact that (i) sequence of colonization and sporulating stages can be followed, (ii) fungi present at specific locations and species or type of substrata can be determined, and (iii) physical and physiological activities of fungi can be measured. Kohlmeyer and Kohlmeyer (1979) and Jones and Hyde (1988) discussed this method and noted that they often yielded fewer fungi than the direct methods of examination of substrata from nature. However, Hughes (1975) stated that studies of intertidal wood gives a better estimate of species diversity and distribution of lignicolous fungi in a certain area than trapping experiments with wood panels.

In the freshwater system, fungi are considered to be of primary importance in the breakdown and degradation of materials (Kaushik and Hynes, 1971; Willoughby and Archer, 1974). Willoughby and Archer (1974) exposed presterilized wood in a fresh water stream, and a large number of species were identified, many playing some role in the colonization of the substratum. Similarly, in the mangrove ecosystem, marine fungi (and bacteria) have been shown to be essential in the breakdown of leaves and preconditioning of wood by boring organisms (Fell and Master, 1973; Leightley, 1980; Kohlmeyer *et al.*,

1995).

The objective of this study was to determine the colonization of mangrove baits by marine fungi in Kuala Selangor mangrove in Malaysia and to compare the fungal population on two different mangrove timbers.

Materials and methods

Preparation of test blocks

Sterilized test blocks of *Avicennia marina* and *Bruguiera parviflora* (5 × 1 × 1) were assembled together and placed in nylon mesh bag. For each mangrove wood, 12 replicates carrying 9 wood blocks were prepared.

Exposure of test blocks

Strings of test blocks were attached to substrata 5-10 m apart at Kuala Selangor mangrove stand. The test blocks were exposed for up to 90 weeks. Three mesh bags containing the test blocks were retrieved at intervals of six to eighteen weeks, cleaned of fouling organisms, washed with sterile seawater, incubated in sterile moist chambers and examined at regular intervals for fungi.

Results

Fungi colonizing the test blocks were divided into three groups: early colonizers that appeared on the test blocks between 6-18 weeks (I), intermediate colonizers that appeared on the test blocks within 26-54 weeks (II) and late colonizers that appeared within 72-90 weeks of exposure (III). Percentage occurrence for each fungus was used instead of the actual number of occurrences since the number of test blocks recovered at each exposure period differed.

Table 1 lists the species collected, their frequency of occurrence, total numbers of fungi collected, number of samples examined, percentage colonization and the number of fungi per sample on each timber. A total of 61 fungi were collected on both timbers with 46 species recorded on *Avicennia marina* and 54 on *Bruguiera parviflora*.

A lower number of fungi and percentage of colonization was observed at the early stages of colonization than in the intermediate and late stages. Twenty-five species were collected on 108 test blocks of both timbers. The ascomycetes were the largest group of fungi recorded on both timbers, with 17 species, followed by the basidiomycetes (2) and the mitosporic fungi (7). The number of fungi per sample was relatively low: 1:1 to 2:1.

The highest number of fungi, percentage colonization and number of fungi per sample was observed at the intermediate colonization stage. Forty-eight

Table 1. Frequency of occurrence of fungi on *Avicennia marina* and *Bruguiera parviflora* at different exposure time.

Fungal Species	*Avicennia marina*			*Bruguiera parviflora*		
	I	II	III	I	II	III
Lignincola laevis Höhnk	64	79	37	62	78	19
Savoryella lignicola E.B.G. Jones and R.A. Eaton	14	74	54	28	47	80
Trichocladium achrasporum (Meyers and R.T. Moore) Dixon	14	50	45	6	65	63
Halosarpheia retorquens Shearer and J.L. Crane	28	70	13	19	30	35
Dyctiosporum pelagicum G.C. Hughes	6	51	69	16	25	43
Periconia prolifica Anastasiou	14	56	24	6	22	13
Lignincola longirostris (Cribb and J.W. Cribb) Kohlm.	39	57	58	17	11	7
Trichocladium linderi J.L. Crane and Shearer	11	25	30	11	43	15
Savoryella paucispora (Cribb and J.W. Cribb) Koch	16	48	21	6	43	15
Halosarpheia marina (Cribb and J.W. Cribb) Kohlm.	30	55	56	22	15	12
H. ratnagiriensis Patil and Borse	39	29	22	36	45	11
Lulworthia grandispora Meyers	33	43	7	33	17	-
Marinosphaera sp.	11	21	15	50	18	13
T. alopallonellum (Meyers and R.T. Moore) Kohlm. and Volkm.-Kohlm.	-	24	21	6	14	19
Halosarpheia sp. 11	8	20	4	6	7	-
Verruculina enalia (Kohlm.) Kohlm. and Volkm.-Kohlm.	33	25	48	33	37	63
Halocyphina villosa Kohlm.	-	8	19	16	24	17
Cirrenalia pygmea Kohlm.	-	5	20	-	24	17
C. tropicalis Kohlm.	16	17	15	6	24	8
Phoma sp.	6	-	4	6	53	11
Ascomycete sp. 21	6	15	4	11	10	4
Savoryella longispora K.D. Hyde and E.B.G. Jones	11	7	4	16	8	37
Xylomyces sp.	-	14	-	-	19	-
Tirispora unicaudata E.B.G. Jones and Vrijmoed	-	3	22	-	14	28
Dactylospora mangrovei E.B.G. Jones, Alias, Abdel-Wahab, and Hsieh	-	4	-	-	17	4

Table 1. (continued).

Fungal Species	*Avicennia marina*			*Bruguiera parviflora*		
	I	II	III	I	II	III
Lignincola tropica Kohlm.	6	-	15	-	-	4
Marinosphaera mangrovei K.D. Hyde	-	-	-	-	-	7
Dactylospora haliotrepha (Kohlm. and E. Kohlm.) Hafellner	-	-	-	-	10	18
Halosphaeria c.f. *cucullata*	11	19	-	-	-	-
Leptosphaeria australiensis (Cribb and J.W. Cribb) C.G. Hughes	11	3	15	-	7	21
Cucullosporella sp.	-	34	-	-	19	4
Massarina c.f. *armatispora*	-	-	4	-	17	7
Belizeana-like	-	-	7	-	15	7
Cirrenalia sp.	-	-	-	-	15	-
Aniptodera mangrovei K.D. Hyde	-	-	-	-	15	-
Callathella mangrovei E.B.G. Jones and Agerer	-	-	4	-	15	-
Cucullosporella mangrovei (K.D. Hyde and E.B.G. Jones) K.D. Hyde and E.B.G. Jones	14	15	4	19	-	-
Kallichroma tethys (Kohlm. and E. Kohlm.) Kohlm. and Volkm.-Kohlm.	-	-	-	-	13	-
Leptosphaeria sp. 1	-	-	-	-	3	-
Leptosphaeria sp. 2	-	-	11	-	8	9
Antennospora quadricornuta (Cribb and J.W. Cribb) T.W. Johnson	-	6	67	-	-	4
Halosarpheia c.f. *cincinnatula*	-	3	-	-	3	-
Halosarpheia c.f. *viscidula*	-	-	-	-	3	-
Aigialus parvus S. Schatz and Kohlm.	-	-	4	-	-	-
Phaeosphaeria sp.	-	-	-	-	6	-
Rhabdospora sp.	-	-	-	-	6	-
Halosarpheia minuta W.F. Leong	-	3	-	-	-	7
Nectria sp.	-	3	-	-	-	-
Phaeosphaeria minuta W.F. Leong	-	-	6	-	3	4
SM62	-	-	-	-	3	-
Massarina ramunculicola K.D. Hyde	-	-	-	-	3	-
Aniptodera c.f. *salsuginosa*	-	-	7	-	-	26

Table 1. (continued).

Fungal Species	*Avicennia marina*			*Bruguiera parviflora*		
	I	II	III	I	II	III
Nais glitra J.L. Crane and Shearer	-	-	11	-	-	11
Lulworthia sp. (< 300 µm)	-	-	11	-	-	-
Lulworthia sp. (median size)	-	-	11	-	-	-
Swampomyces triseptatus K.D. Hyde	-	-	-	-	-	7
Cirrenalia pseudomacrocephala Kohlm.	-	-	-	-	-	7
Halorosellinia oceanica Whalley, E.B.G. Jones, K.D. Hyde and Laessøe	-	-	4	-	-	-
Antennospora salina (Meyers) Yusoff, E.B.G. Jones and S.T. Moss	-	-	4	-	-	-
Quintaria lignatilis Kohlm. and Volkm.-Kohlm.	-	-	-	-	-	4
Saccardoella marinospora K.D. Hyde	-	-	-	-	-	4
Total number of species at each stage of colonization	24	33	38	24	42	37
Percentage colonization	50%	100%	100%	50%	100%	100%
No. of fungi per sample	2:1	7:1 – 8:1	4:1 – 7:1	1:1 – 2:1	6:1 – 7:1	5:1 – 7:1
Total number of wood examined	54	108	81	54	108	81
Wood colonized	27	108	81	27	108	81
Total number of fungi on each timber		46			54	
Total number of fungi collected at Kuala Selangor mangrove				61		

I: 6-18 weeks of exposure; II: 26-54 weeks of exposure; III: 72-90 weeks of exposure.

Table 2. Early, intermediate and late colonizers (Frequency of occurrence more than 30%).

Early colonizer	Intermediate colonizer	Late colonizer
*Lignincola laevis**	*Lignincola laevis**	*Savoryella lignicola**
*Lulworthia grandispora**	*Savoryella lignicola**	*Trichocladium achrasporum**
*Halosarpheia ratnagiriensis**	*Trichocladium acharasporum**	***Halosarpheia marina***
Aniptodera mangrovei	*Halosarpheia retorquens**	***Lignincola laevis***
Lignincola longirostris	*Savoryella paucispora**	***Lignincola longirostris***
H. marina	*Trichocladium alopallonellum**	***Trichocladium linderi***
H. retorquens	*Halosarpheia* sp. 11*	*Verruculina enalia*
Marinosphaera sp.	*Halocyphina villosa**	*Halosarpheia retorquens*
Verruculina enalia	*Cirrenalia pygmea**	
	*C. tropicalis**	
	Dyctiosporium pelagicum*	
	Periconia prolifica**	
	Lignincola longirostris*	
	Halosarpheia marina*	
	Lulworthia grandispora*	
	*Verruculina enalia**	
	*Trichocladium linderi**	
	*H. ratnagiriensis**	
	Phoma sp.	

* Occur on both timbers
Bold Common on *Avicennia marina* test blocks
Common on *Bruguiera parviflora* test blocks

species were recorded on both timbers, with the highest number recorded on *Bruguiera parviflora* test blocks (42 species). The ascomycetes were the largest group encountered, followed by mitosporic fungi and basidiomycetes, 35, 11 and 2 respectively. Percent colonization on both timbers was 100% and the number of fungi per sample was considered high at 6 to 8.

A greater number of fungi were recorded at the intermediate stage (48 species) with 18 as common (occurring at more than 30%) compared to the early exposure period. Six species were restricted to the intermediate stage (*Anipotodera mangrovei*, *Calathella mangrovei*, *Halosapheia cincinnatula*-like, *H. viscidula*-like, *Kallichroma tethys*, *Massarina ramunculicola*). Some species which occurred with a low percentage of occurrence as early colonizers, i.e. *Cirrenalia pygmea*, *C. tropicalis*, *Dictyosporium pelagicum*, *Halocyphina villosa*, *Halosarpheia* sp. 11, *Lignincola laevis*, *Periconia prolifica*, *Savoryella lignicola*, *S. paucispora*, *Trichocladium alopallonellum* and *T. linderi* (Table 2) became prevalent as intermediate colonizers (percentage occurrence more than 30%).

The total number of fungi collected at the late stage was 48 species with the ascomycetes as the largest group (36 species), followed by the mitosporic fungi

(9 species) and basidiomycetes (2 species). Percent colonization was 100% and the number of fungi per sample was 4.1 to 7.1. At this exposure period 24 species were categorized as late colonizers, which include 16 common species and 8 species that was restricted to this stage. *Savoryella lignicola* and *Trichocladium* spp. were the common late colonizers on both timbers. *Halosarpheia marina*, *Lignincola laevis*, *L. longirostris* and *Trichocladium linderi* were common on *Avicennia marina* test blocks, while *Verruculina enalia* and *Halosarpheia retorquens* were common on *Bruguiera parviflora* test blocks (Table 2).

The fungi that are classified as early, intermediate and late colonizers based on their frequency of occurrence: i.e more than 30%, or occur restrictedly at certain stages of colonization are summarized in Table 2. *Aniptodera mangrovei*, *Halosarpheia marina*, *H. ratnagiriensis*, *Lignincola laevis*, *L. longirostris*, *Lulworthia grandispora* and *Verruculina enalia* can be identified as early colonizers. *Lignincola laevis* and *L. grandispora*, which occurred on both timbers with high percentage of occurrence, can be considered as the main early colonizers.

Cirrenalia tropicalis, *Dictyosporium pelagicum*, *Halosarpheia marina*, *H. ratnagiriensis*, *H. retorquens*, *Lignincola laevis*, *L. longirostris*, *Marinosphaera sp.*, *Periconia prolifica*, *Savoryella lignicola*, *S. longispora*, *S. paucispora*, *Trichocladium achrasporum*, *T. linderi* and *Verruculina enalia* occurred with a relatively high percentage of occurrence at the intermediate stage. No definite sequence of colonization was observed, however, some species showed a greater percentage occurrence at certain stages of colonization or occur only at a specific stage. For example *Lignincola laevis* and *Lulworthia grandispora* were dominant at early and intermediate stages.

Discussion

A number of factors affect the ecology of fungi colonizing wood in the marine environment including physical and chemical parameters, different substrata, chemical composition of the wood and the presence or absence of bark (Meyers and Reynolds, 1958; Nakagiri, 1993; Hyde and Lee, 1995).

The method employed for recording species diversity is unlikely to record all species present as not all fungi will be sporulating on recovery from the sea. Thus moist chamber incubation has been widely used to partly overcome this problem. Hyde (1992) and Prasannarai and Sridhar (1997) have shown that species diversity is affected by incubation in moist chambers. Hyde (1992) discussed the differences in occurrence of fungi following up to one month and after 6 months incubation of samples collected from Brunei. He concluded that there were differences in percentages occurrence and the number of fungi identified during these two periods, with incubation being more favorable to

samples from beach, lake and rocky shorelines, than those from mangrove sites. He suggested that the moist chamber is probably a less favorable environment than the mangrove itself. On the other hand Prasannarai and Sridhar (1997) showed that 70% of all mangrove species sporulated on the wood after 6 months incubation in their study. They recommend that 18 months is required for most fungi to sporulate on the wood.

Development of a community leading to the establishment of "new" species is termed as succession, recognized by the progressive changes during ecological time in the species composition of the community (Hudson, 1962). The classical theory of succession is that species replace one another because at each stage, the species modify the environment to make it less suitable for themselves and more for others (Hudson, 1962). Hudson (1962) stated that some species are competitively superior and that these eventually predominate in the climax community, while many of the pioneer species in the succession appear first because they have evolved characters such as rapid growth, abundant spore production and dispersal.

Limited information is available on the colonization and succession of marine fungi on exposed timbers in the sea. Studies on the succession of marine fungi on exposed mangrove wood have been undertaken by a few workers. Tan *et al.* (1989) exposed test blocks of *A. marina* and *A. lanata* at Mandai mangrove in Singapore, while Leong *et al.* (1991) exposed *Bruguiera cylindrica* and *Rhizophora apiculata* test blocks. Hyde (1991a) exposed *R. apiculata* and *Xylocarpus granatum* poles at a Brunei mangrove and more recently Kohlmeyer *et al.* (1995) exposed *Conocarpus erectus*, *Laguncularia racemosa*, *Rhizophora apiculata* and *X. granatum* test blocks at the Belize coast. However, all used different sized test blocks and different exposure times in defining species as early, intermediate and late colonizers. Pointing *et al.* (2000) have suggested that standardised baits should be used in future studies.

In Table 3 the fungi reported by various workers on mangrove wood at different time intervals are compared. It is not easy to make a detailed comparison of species composition encountered in each study as different time intervals were used for the three stages in the colonization sequences. Only a few species recorded in the present study were present as early, intermediate and late colonizers in the study by Tan *et al.* (1989), Leong *et al.* (1991) and Hyde (1991). The three species used and the size of exposed wood were also different. It is therefore not surprising that there is little similarity in the fungi colonizing the wood as shown by the low Jaccard similarity indices (0.1-0.3) presented in Table 3. However, the similarity indices between the fungal community on *A. marina* and *B. parviflora* was high (0.5-0.8).

Table 3. Jaccard similarity index of the fungal community on exposed *Avicennia marina* and *Bruguiera parviflora* test blocks in the present study and previous reports (Tan *et al.*, 1989; Hyde, 1991; Leong *et al.*, 1991; Kohlmeyer *et al.*, 1995).

	Early exposure stage	Intermediate exposure stage	Late exposure stage
	Number of species		
Belize (Kohlmeyer *et al.*, 1995)	11	6	6
Brunei (Hyde, 1991)	5	16	18
Singapore (Tan *et al.*, 1989; Leong *et al.*, 1991)	14	23	25
Malaysia (present study)	22	59	58
	Jaccard Similarity Index		
Belize and Malaysia	0.2	0.1	0.1
Brunei and Malaysia	0.1	0.1	0.2
Singapore and Malaysia	0.3	0.2	0.2
Malaysia (present study)	0.5	0.8	0.5

In the present study few species were found to be persistent throughout the entire exposure period which either occurred at a low or high frequency of occurrence. *Halosarpheia retorquens*, *Leptosphaeria australiensis*, *Lignincola laevis*, *Periconia prolifica*, *Trichocladium achrasporum*, *T. linderi* and *Verruculina enalia* were present at a high percentage occurrence (more than 30%) and also throughout the exposure period. These species can be considered as prevalent species that are able to grow on young to fully decomposed substratum. However, many species on exposed timbers at Kuala Selangor were present at a low frequency of occurrence. These have also been recorded as rare in other mangroves, e.g. *Massarina ramunculicola*, *Quintaria lignatilis*, *Savoryella longispora* and *Swampomyces triseptatus* (Kohlmeyer, 1984; Jones and Alias, 1997).

Apart from the differences in species composition reported in previous studies, the number of species recorded and their frequency of occurrence at each colonization stage was different in this study. In Table 3 the total number of species recorded at each exposure period in the present study and those reported by others are listed. Species diversity was low at all stages for the Belize and Brunei data (Hyde, 1991; Kohlmeyer *et al.*, 1995) when compared with data for Singapore and Malaysia (Tan *et al.*, 1989; Leong *et al.*, 1991; present study). In most cases, species diversity increased with exposure period, with the exception of Belize.

Succession of fungi on various terrestrial plants have been observed by many workers (Hudson, 1962; Aoki *et al.*, 1990; Aoki and Tokumasu, 1995). Hudson (1962) generalized the process of fungal succession phenomena on various plant substrata. He classified the fungi involved in the succession into

groups based on the time of first colonization of the substratum, i.e. parasites, primary saprobes, secondary saprobes. However the scheme proposed by Hudson (1962) cannot be adapted there. Firstly, the function of the marine mycota in mangrove ecosystems, as parasites or saprobes is still poorly understood. Secondly, the majority of the fungi found at an early stage of exposure, which generally can be considered as a primary saprobes according to Hudson's scheme are either frequently isolated as a dominant species at this stage or persistent throughout the whole period.

Jones and Hyde (1988) stated that baiting techniques were important in the study of the ecology of aquatic fungi as this allows the examination of samples at various periods during the decay of the wood. Kohlmeyer and Kohlmeyer (1979) and Jones and Hyde (1988) recognized that fewer species are identified from baits than randomly collected samples. However, these observations are qualitative rather than quantitative.

Host and substrate specificity of marine fungi have been addressed by many workers (Kohlmeyer, 1969; Hyde and Jones, 1988; Hyde, 1990; Alias *et al*., 1995; Jones and Alias, 1997). The majority of fungi collected on *A. marina* and *B. parviflora* test blocks were not host specific, but present on both timbers. Only three species were found to be restricted to *Avicennia marina*: *Halosarpheia marina*, *Nectria* sp. and *Lulworthia* sp. (>300μm). Therefore, the data obtained in the present study, shows little evidence of host specificity and confirms the observation of Hyde and Lee (1995) and Jones and Alias (1997).

The number of fungi per sample in the present study differed significantly from those of other workers, i.e. from 1 to 8 compared to the 2.8 to 3.3 reported by Tan *et al*. (1989) and Leong *et al*. (1991). Percentage colonization was also higher than that reported by other workers. The differences observed could be attributed to the total number of samples exposed. In the present study a higher number of samples were exposed than in other studies (486 samples) and also a longer exposure period was used. Hughes (1975) stated that length of submergence is very important in governing the degree of fungal infestation. Thus, this may have contributed to the higher number of species per sample collected in the present study.

While randomly collected mangrove wood yielded greater species diversity and a higher number of fungi per sample (9.1) (Alias *et al*., 1995), the exposure method gave a better overview of the very frequent species, their role in wood degradation and sequence of colonization of substrata. For example, *Halosarpheia marina*, *Lignincola laevis*, *Lulworthia grandispora* and *Verruculina enalia*, which were present at relatively high percentages of occurrence throughout the exposure period can be considered as species that must play an important role in wood degradation. The method also allows us to

follow the sequence of colonization of each species thus giving an insight into the species that play a major role as early, intermediate and late colonizers. In the present study, the technique employed involved a long incubation period in a moist chamber, which resulted in the development of many species. This indicates that they may have been present earlier in the substratum as mycelium. Thus, the succession process is not only a process of replacement of one species by another but also as an expression of differential fruiting time.

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