Diversity of saprobic fungi on *Magnoliaceae*

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The diversity of fungi found on woody litter of three genera of plants in the family *Magnoliaceae* is reported and the communities are compared. Saprobic fungi were investigated from 150 samples of decaying woody litter of *Magnolia liliifera*, *Manglietia garrettii* and *Michelia baillonii*. Two-hundred and thirty-nine fungi were identified comprising 92 ascomycetes, 4 basidiomycetes and 143 anamorphic fungi. *Corynespora cassiicola* (60% frequency of occurrence) was the most common taxon found on *Magnolia liliifera* samples. *Ellisembia opaca* and *Phaeoisaria clematidis* with 27.5% frequency of occurrence were the dominant species from *Manglietia garrettii*, while *Annellophora phoenicis* and *Ellisembia adscendens* (18%) were the most commonly encountered species from *Michelia baillonii*. Distinct fungal communities were found on samples of the three tree species. In terms of the numbers of taxa recovered, fungi were more diverse on *Michelia baillonii* than on the other two genera, although the common genera of fungi obtained from woody litter of each host were similar. Seasonal effect on the fungal communities was investigated. Dry season samples supported a significantly more diverse fungal community than samples from the wet season. Relatively few species of woody fungi recorded in this study had been previously recorded from wood samples by other researchers.

Key words: lignicolous fungi, *Magnolia*, *Manglietia*, *Michelia*, *Magnoliaceae*, saprobe

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Introduction

Studies on fungal diversity have increased over the past decade partly due to the fact that fungi have great potential in industrial and biotechnological applications (Hawksworth, 1991; Lodge, 1997; Pointing and Hyde, 2001; Bills *et al*., 2002; Sánchez Márquez *et al*., 2007). However, many fungi in tropical forests are yet to be discovered (Hyde, 1997; Rodrigues and Petrini, 1997; Rossman, 1997; Lovelock *et al*., 2003; Hyde *et al*., 2007; Hyde and Soytong, 2007). Most of the earlier studies were in temperate regions, however knowledge and interest in microfungi in tropical regions have grown. There have been several reports of microfungi on plants in the tropics (Photita *et al*., 2002; 2003a, b; Hyde *et al*., 2002a, b; Bussaban *et al*., 2003; 2004; Thongkantha *et al*., 2003; Promputtha *et al*., 2003; 2004a, b, c; 2005). Numerous novel fungi have been discovered in these studies (e.g. Photita *et al*., 2002; 2003a; Bussaban *et al*., 2003; Promputtha *et al*., 2003; 2004a, b; 2005; Kodsueb *et al*., 2006; 2007a, b; Pinnoi *et al*., 2003a, b; 2004; 2006; 2007; Pinruan *et al*., 2004a, b, c, 2008).

Previous investigations on parasitic and saprobic fungi have discussed host-specificity or host-recurrence (Hooper *et al*., 2000; Zhou and Hyde, 2001; Santana *et al*., 2005). There are many examples of fungal taxa being recorded as common on a single plant host, family or order (e.g. Francis, 1975; Hawksworth and Boise, 1985; Gonzales and Rogers, 1989; Læssøe and Lodge, 1994; Tokumasu *et al*., 1994; Fröhlich and Hyde, 1995; Ju and Rogers, 1996; Polishook *et al*., 1996; Huhndorf and Lodge, 1997; Lodge, 1997; Bucheli *et al*. 2000, 2001; Burnett, 2003). However, saprobic fungi are thought to be less host-specific when compared to pathogens and endophytes (Zhou and Hyde, 2001).

Several new and interesting saprobic fungi have been described from leaf litter of *Magnolia liliifera* by Promputtha *et al*. (2003, 2004b, c; 2005), while *Cheiromyces magnoliae* was described from *M. liliifera* wood (Promputtha *et al*., 2004a). Consequently, it is likely that woody litter of this plant and also other plants in tropical forests should contain many interesting fungi that await discovery. Plant litter of each host comprises different chemical contents which may influence the fungi on a particular host (Hyde *et al*., 2007). This assumption has been supported by several recent studies, particularly on leaf litter (Tang *et al*., 2005; Paulus *et al*., 2006).

There are no previous reports on saprobic fungi on woody litter of *Magnoliaceae* and therefore a study was initiated to investigate biodiversity of saprobic fungi. We recorded the fungi on decaying wood from three hosts (*Magnolia liliifera*, *Manglietia garrettii* and *Michelia baillonii*) to establish 1) whether the fungi on each host differed, 2) whether dry and wet seasons affected the fungal communities and 3) whether fungi on woody litter are host-specific or host-recurrent.

Materials and Methods

Study sites

This study was undertaken in an evergreen forest nearby the Medicinal Plant Garden in Doi Suthep-Pui National Park, Chiang Mai Province, northern Thailand. The 26,106 hectare national park is covered by tropical rain forest and is home to a wealth of biodiversity. The wet season is from May to October, while the dry season is between November and April. August and September are the wettest months with daily rainfall. The monthly rainfall varies between 200 and 400 mm during rainy season, but averages only 30 mm per month in the dry season. The mean air temperature is 20-23°C (Dobias, 1982), but temperatures can drop to 6°C in February. The average minimum temperature is 12°C (January) and average maximum temperature is 25°C (April). The average relative humidity ranges from 58% in March to 89% in September (source: Proceedings of the CTFS-AA International Field Biology Course 2005).

Sample collection and examination

Woody litter of three magnoliaceous species (*Magnolia liliifera* (L.) Baill., *Manglietia garrettii* Craib and *Michelia baillonii* (Pierre) Fin. & Gagnep.) was selected. During each collection trip about 30 dead wood samples of each tree species were randomly collected and returned to the laboratory where they were each separately incubated in plastic bags. The fungi present on the samples were examined after one week of incubation and periodically examined for up to 1 month. The fungi were identified, recorded, photographed and fully described if new. Herbarium material is maintained at CMU. Fungi were identified, based on morphological characters, using relevant texts and references (e.g. Ellis, 1971; 1976; Carmichael *et al*., 1980; Sutton, 1980; Sivanesan, 1984; Fröhlich and Hyde, 2000; Hyde *et al*., 2000; Lu and Hyde, 2000; Grgurinovic, 2003; Taylor and Hyde, 2003; Tsui and Hyde, 2003; Wang *et al*., 2004; Wu and Zhuang, 2005; Cai *et al*., 2006; Zhao *et al*., 2007) based on morphological character.

Statistical analyses

A 3-dimensional correspondence analysis (JMP) was performed to examine the differences in fungal communities at different times of decay (Anonymous, 1995). The results of this study are presented in terms of percentage occurrence of fungi. Fungal taxa with a percentage occurrence higher than 10 are regarded as dominant species. These fungal taxa were used to plot changes in the dominant species throughout the experimental period. Shannon indices (H') were used to express species diversity of a community (Shannon and Weaver, 1949), while species accumulation curves were used to determine the adequacy of the sampling size. The relative similarities of microfungal assemblages from woody litter at different host and season were identified by cluster analysis. A cluster dendrogram was produced from PC-ORD version 4.0 (McCune and Mefford, 1999). Calculations were based on Sørensen distance and group average as the cluster distance measure and linkage method, respectively.

$$\text{Percentage Occurrence} = \frac{\text{Number of wood samples on which each fungus was detected}}{\text{Total number of wood samples examined}} \times 100$$

Shannon index (H') = $- \Sigma$ Pi $\log_2$ Pi

Where Pi is the probability of finding each taxon in a collection.

Sorensen's similarity index = 2c/a + b

Where a = the number of species in host sp. 1
b = the number of species in host sp. 2
c = the number of species in common in both hosts.

Results

Fungal taxonomic composition

A total of 150 magnoliaceous wood samples (60 from *Magnolia liliifera*, 40 from *Manglietia garrettii* and 50 from *Michelia baillonii*) were examined for fungi. Of the 852 fungal collections, 239 taxa (Table 1) were identified including 92 ascomycetes (representting 38% of all taxa), 143 anamorphic taxa (60%) and 4 basidiomycetes (2%). Species numbers and composition were unique for each host species. The list of taxa from each collection and their frequency of occurrence are given in Table 1. Species richness, species evenness, number of fungi per sample, Shannon–Weiner diversity index (H) and Simpson diversity index (D) of each collection were calculated (Table 3). Number of overlapping taxa between the three hosts is shown in Table 2. Genera represented by at least two different species were *Acrodictys*, *Berkleasmium*, *Canalisporium*, *Dactylaria*, *Dictyochaeta*, *Diaporthe*, *Diatrypella*, *Ellisembia*, *Eutypella*, *Helicomyces*, *Helicosporium*, *Hypoxylon*, *Massarina*, *Phomopsis* and *Tubeufia*. Species overlapping between different seasons and hosts include *Dactylaria hyalina*, *Lasiodiplodia theobromae*, *Phaeoisaria clematidis* and *Sporoschisma saccardoi* (Table 1).

Dominant fungi on the woody litter, with over 10% percentage occurrences are listed in Table 1 (indicated by number of occurrence in bold). Only one dominant species, *Phaeoisaria clematidis*, overlapped between the three hosts. The number of overlapping species over the two seasons on each host was low (see Table 2).

Fungal communities on different hosts and seasons

Three-dimensional correspondence analysis (Fig. 1) of fungi obtained from three magnoliaceous genera showed that there were at least three distinct fungal communities, corresponding to each of the three hosts. For each host the wet and dry season communities overlapped. The first community represented fungal community on *Magnolia liliifera* (MLD and MLW), while the second and third community represented fungal community on *Michelia baillonii* (MBD and MBW) and *Manglietia garrettii* (MGD and MGW), respectively. The cluster analysis produced one dendogram, which divided the fungal communities into three groups (Fig. 2).

Abundance of fungi on different magnoliaceous hosts during wet and dry seasons

In terms of the numbers of taxa recovered from the different hosts, fungi were slightly more diverse in *Michelia baillonii* (93 taxa) than in *Magnolia liliifera* (82 taxa) and *Manglietia garrettii* (83 taxa). Samples collected in dry seasons supported greater diversity of fungi than wet season samples and this is also indicated by the greater Shannon diversity index (Table 3).

Abundance of fungi on woody litter of Magnolia liliifera

In total, 82 fungi were found from *Magnolia liliifera* wood, comprising 37 ascomycetes, 2 basidiomycetes and 43 anamorphic fungi. Fifty-eight taxa (28 ascomycetes, 1 basidiomycete, 29 anamorphic fungi) were recorded from dry season samples, while 41 taxa (14 ascomycetes, 1 basidiomycete, 26

Table 1. Overall percentage occurrence of fungi found on woody litter of *Magnolia liliifera*, *Manglietia garrettii* and *Michelia baillonii* collected during dry and wet seasons.

Taxa	Host								
	Magnolia liliifera			*Manglietia garrettii*			*Michelia baillonii*		
	Dry	Wet	Overall	Dry	Wet	Overall	Dry	Wet	Overall
Acanthostigma minutum		3.3	1.7						
Acrodictys deightonii	3.3		1.7	5		2.5			
Acrodictys denisii								4	2
Acrodictys globulosa		13.3	6.7				8		4
Acrodictys micheliae							12	4	8
Acrodictys sp.		3.3	1.7						
Amphisphaeria sp.	10		5						
Annellophora phoenicis							**24**	**12**	**18**
Annulatascus velatisporus							4		2
Anthostomella cf. *limitata*	3.3		1.7						
Anthostomella ludoviciana	**26.7**	**6.7**	**16.7**						
Aquaphila albicans	3.3		1.7						
Aquaticola ellipsoidea	3.3		1.7						
Aquaticola hyalomura	3.3		1.7						
Arthrobotrys sp.								4	2
Ascotaiwania wulai	6.7		3.3						
Bactrodesmium longispora				5		2.5			
Bactrodesmium sp.							4	16	10
Basidiomycete sp.		6.7	3.3						
Beltrania rhombica					5	2.5			
Beltrania/*Beltraniella* sp.				5	15	10			
Berkleasmium corticola				5	15	10			
Berkleasmium inflatum				**40**		**20**			
Berkleasmium nigroapicale				10	5	7.5			
Bisporella sp.		3.3	1.7						
Bitunicate ascomycete sp. 1	13.3		6.7						
Bitunicate ascomycete sp. 2		3.3	1.7						
Bitunicate ascomycete sp. 3	6.7		3.3						
Bitunicate ascomycete sp. 4				10	5	7.5			
Bitunicate ascomycete sp. 5				15		7.5			
Bitunicate ascomycete sp. 6							**12**	**12**	**12**
Bitunicate ascomycete sp. 7								12	6
Botryosphaeria australis				5		2.5			

Note: bold indicates overall percentage occurrence of more than 10%.

Table 1 (continued). Overall percentage occurrence of fungi found on woody litter of *Magnolia liliifera*, *Manglietia garrettii* and *Michelia baillonii* collected during dry and wet seasons.

Taxa	**Host**								
	Magnolia liliifera			***Manglietia garrettii***			***Michelia baillonii***		
	Dry	**Wet**	**Overall**	**Dry**	**Wet**	**Overall**	**Dry**	**Wet**	**Overall**
Botryosphaeria sp.				5		2.5			
Brachydesmiella caudata	**10**	**16.7**	**13.3**						
Caloplaca cerina								8	4
Canalisporium caribense	**10**	**23.3**	**16.7**						
Canalisporium* cf. *caribense				**10**	**15**	**12.5**			
Canalisporium exiguum							**12**	**16**	**14**
Canalisporium pallidum		3.3	1.7						
Candelabrum brocchiatum		6.7	3.3						
Catenosynnema micheliae							8	8	8
Cercophora sp.	3.3		1.7						
Chaetosphaeria sp. 1	13.3		6.7						
Chaetosphaeria sp. 2							8		4
Chaetosphaerulina sp.							4		2
Chalara sp.								20	10
Chloridium chlamydosporum								**28**	**14**
Chloridium virescens				10		5			
Coelomycete sp. 1	3.3		1.7						
Coelomycete sp. 2	10		5						
Coelomycete sp. 3	3.3		1.7						
Coelomycete sp. 4				5	5	5			
Coelomycete sp. 5				5	5	5			
Coelomycete sp. 6					5	2.5			
Coelomycete sp. 7					5	2.5			
Coelomycete sp. 8							8		4
Coelomycete sp. 9							4		2
Coelomycete sp. 10								12	6
Coprinus sp.	6.7		3.3						
***Cordana* sp.**							**12**	**12**	**12**
Corynespora cassiicola	**96.7**	**23.3**	**60**				8	4	6
Curvularia sp.				5		2.5			
Dactylaria biseptatum		10	5						
Dactylaria cf. *hyalina*							12		6
Dactylaria hyalina		**6.7**	**3.3**	**15**		7.5	12	8	10

Note: bold indicates overall percentage occurrence of more than 10%.

Table 1 (continued). Overall percentage occurrence of fungi found on woody litter of *Magnolia liliifera*, *Manglietia garrettii* and *Michelia baillonii* collected during dry and wet seasons.

Taxa	Host								
	Magnolia liliifera			***Manglietia garrettii***			***Michelia baillonii***		
	Dry	**Wet**	**Overall**	**Dry**	**Wet**	**Overall**	**Dry**	**Wet**	**Overall**
Dactylaria sp. 1		3.3	1.7						
Dactylaria sp. 2							12	4	8
Dactylaria sp. 3							8	12	10
Dactylella cf. *cylindrospora*							8	4	6
Delortia aquatica							4		2
Dendryphion cubense					10	5			
Diaporthe sp. 1	3.3		1.7						
***Diaporthe* sp. 2**	**33.3**		**16.7**						
Diaporthe sp. 3		3.3	1.7						
Diaporthe sp. 4					20	10			
Diatrype disciformis					5	2.5			
Diatrypella borassi							**12**	**12**	**12**
Diatrypella sp. 1					10	5			
Diatrypella sp. 2					5	2.5			
Diatrypella sp. 3							4		2
Dictyochaeta simplex					15	7.5			
Dictyosporium manglietiae				**30**	**10**	**20**			
Didymosphaeria futilis		3.3	1.7						
Didymosphaeria sp. 1					10	5			
Didymosphaeria sp. 2							12		6
Diplococcium spicatum							**4**	**20**	**12**
Diplodia sp.				10		5			
Dischloridium sp.				5		2.5			
Discomycete sp. 1				15		7.5			
Discomycete sp. 2				5		2.5			
Discomycete sp. 3							8	12	10
Discomycete sp. 4								16	8
Dokmaia monthadangii	3.3		1.7						
Dothidotthia sp.	3.3		1.7						
Edmundmasonia pulchra				**35**		**17.5**	16		8
Ellisembia adscendens	3.3	16.7	10				**24**	**12**	**18**
Ellisembia brachyphus	**3.3**	**20**	**11.7**	5		2.5			
Ellisembia cf. *brachyphus*				5	15	10			

Note: bold indicates overall percentage occurrence of more than 10%.

Table 1 (continued). Overall percentage occurrence of fungi found on woody litter of *Magnolia liliifera*, *Manglietia garrettii* and *Michelia baillonii* collected during dry and wet seasons.

Taxa	**Host**								
	Magnolia liliifera			***Manglietia garrettii***			***Michelia baillonii***		
	Dry	**Wet**	**Overall**	**Dry**	**Wet**	**Overall**	**Dry**	**Wet**	**Overall**
Ellisembia cf. *magnibrachypus*							12		6
Ellisembia magnibrachypus							12		6
Ellisembia opaca				**55**		**27.5**			
Ellisembia sp. 1	13.3		6.7						
***Ellisembia* sp. 2**				**30**		**15**			
Ellisembia sp. 3				5		2.5			
Ellisembia sp. 4							8	8	8
Endophragmia sp. 1							8	12	10
Endophragmia sp. 2							4		2
Endophragmiella sp.								4	2
Eutypa sp.					15	7.5			
Eutypella sp. 1				15		7.5			
Eutypella sp. 2								4	2
Fenestella sp.							4		2
Gliomastix masseei					5	2.5			
Gonytrichum macrocladum								20	10
Gonytrichum sp.		13.3	6.7						
Graphina acharii				20		10			
Graphis asterizans				15		7.5			
Halotthia posidoniae	3.3		1.7						
Harpographium sp.	6.7		3.3						
Helicoma ambiens							12	4	8
Helicoma dennisii							4	8	6
Helicoma viridis	3.3	6.7	5						
Helicomyces bellus	6.7		3.3						
Helicomyces roseus							12	4	8
Helicosporium griseum				20		10	**16**	**16**	**16**
Helicosporium pallidum		16.7	8.3						
Helicosporium vegetum	3.3		1.7					12	6
Helicosporium velutinum		6.7	3.3						
Helicosporium virescens							8		4
Heteroconium sp.							4		2
Hyalosynnema micheliae							12		6

Note: bold indicates overall percentage occurrence of more than 10%.

Table 1 (continued). Overall percentage occurrence of fungi found on woody litter of *Magnolia liliifera*, *Manglietia garrettii* and *Michelia baillonii* collected during dry and wet seasons.

Taxa	Host								
	Magnolia liliifera			***Manglietia garrettii***			***Michelia baillonii***		
	Dry	**Wet**	**Overall**	**Dry**	**Wet**	**Overall**	**Dry**	**Wet**	**Overall**
Hyphomycete sp. 1				5	15	10			
Hyphomycete sp. 2				5		2.5			
Hyphomycete sp. 3				10		5			
Hyphomycete sp. 4				5		2.5			
Hyphomycete sp. 5							4		2
Hyphomycete sp. 6								4	2
Hyponectriaceae							4		2
Hypoxylon cohaerens cf. *section annulatum*							8		4
Hypoxylon multiforme							8		4
Hypoxylon sp. 1				15		7.5			
Hypoxylon sp. 2								8	4
Hysterium sp. 1				5	5	5			
Hysterium sp. 2							4	4	4
Idriella mycoyonoidea		10	5						
Keissleria montaniensis		3.3	1.7						
Keissleria xantha							8	12	10
Keissleriella fusispora	13.3		6.7						
Kirschsteiniothelia thujina	3.3		1.7						
Kostermansinda minima					15	7.5			
Lachnum sp.		10	5						
Lachnum virgineum	13.3		6.7						
Lasiodiplodia cf. *theobromae*	10	3.3	6.7	5		2.5	12		6
Leptosphaeria sp.				5		2.5			
Linkosia sp.							4	4	4
Massarina cf. *walkerii*	3.3	3.3	3.3						
***Massarina* sp. 1**	**26.7**		**13.3**						
Massarina sp. 2				10		5			
Melanochaeta hemipsila	6.7		3.3	5		2.5			
Melanographium palmicolum				5		2.5			
Menisporella assamica							**20**	**4**	**12**
Microporus xanthopus								8	4
Monochaetia sp.					10	5			
Monodictys sp. 1					10	5			
Monodictys sp. 2							4	12	8

Note: bold indicates overall percentage occurrence of more than 10%.

Table 1 (continued). Overall percentage occurrence of fungi found on woody litter of *Magnolia liliifera*, *Manglietia garrettii* and *Michelia baillonii* collected during dry and wet seasons.

Taxa	**Host**								
	Magnolia liliifera			***Manglietia garrettii***			***Michelia baillonii***		
	Dry	**Wet**	**Overall**	**Dry**	**Wet**	**Overall**	**Dry**	**Wet**	**Overall**
Monodictys sp. 3							12		6
Monodisma fragilis				5		2.5			
Mycena sp.								16	8
Mycomicrothelia sp.							4		2
Mycosphaerella sp.							8		4
Nectria coccinea	3.3	16.7	10						
Nectria sp.							12	8	10
Oedemium micheliae							8		4
Ophioceras sp.					5	2.5			
Ophiochaeta lignicola	3.3		1.7						
Penicillium sp. 1	10		5						
Penicillium sp. 2	3.3		1.7	5	15	10			
***Penicillium* sp. 3**							**12**	**12**	**12**
Penicillium sp. 4								4	2
Periconia byssoides				5		2.5			
Periconia sp. 1					5	2.5			
Periconia sp. 2							8		4
Phaeoisaria clematidis	**10**	**30**	**20**	**40**	**15**	**27.5**	**24**		**12**
Phaeoisaria sp.				10		5			
Phaeosphaeria cf. *canadensis*	10	6.7	8.3						
Phaeosphaeria sp. 1	10		5						
Phaeosphaeria sp. 2							12		6
Phaeosphaeria sp. 3								8	4
Phaeostalagmus cyclosporus							8	8	8
Phoma sp.	20		10						
***Phomopsis* sp. 1**	**23.3**		**11.7**						
Phomopsis sp. 2					5	2.5			
Phomopsis sp. 3					5	2.5			
Pithomyces chatarum				5		2.5			
Pleurophragmium acutum	3.3	10	6.7						
Pleurophragmium sp.							8	4	6
Pseudospiropes loturus							4	4	4
Pseudospiropes sp.							8		4
Pseudospiropes subuliferus				10		5			

Note: bold indicates overall percentage occurrence of more than 10%.

Table 1 (continued). Overall percentage occurrence of fungi found on woody litter of *Magnolia liliifera*, *Manglietia garrettii* and *Michelia baillonii* collected during dry and wet seasons.

Taxa	**Host**								
	Magnolia liliifera			***Manglietia garrettii***			***Michelia baillonii***		
	Dry	**Wet**	**Overall**	**Dry**	**Wet**	**Overall**	**Dry**	**Wet**	**Overall**
Pyrenochaeta sp.				5		2.5			
Quintaria sp.				5		2.5			
Rhinocladiella cf. *intermedia*	3.3		1.7						
Saccardoella sp. 1		6.7	3.3						
Saccardoella sp. 2				10		5			
Solosympodiella cylindrospora					5	2.5			
Sporidesmiella hyalosperma		6.7	3.3						
Sporidesmiella intermedia					5	2.5			
***Sporidesmium* sp. 1**	**20**	**6.7**	**13.3**						
Sporidesmium sp. 2		3.3	1.7						
Sporidesmium sp. 3				5		2.5			
Sporidesmium sp. 4					5	2.5			
Sporidesmium sp. 5							4		2
Sporoschisma saccardoi	3.3		1.7	5	5	5		12	6
Stachybotrys chlorohalonata	3.3		1.7						
Stilbella aciculosa		6.7	3.3						
Stilbohypoxylon moelleri							12		6
Stilbohypoxylon quisquiliarum	3.3		1.7						
Taeniolella stilbospora							8		4
Tetraploa biformis				10		5			
Togninia sp.							4		2
Torula herbarum				5		2.5			
Torula sp.					5	2.5			
Trichoderma sp.								12	6
Tubeufia cerea							8		4
Tubeufia cylindrothecia	3.3	6.7	5						
Tubeufia paludosa		6.7	3.3				4	4	4
Tubeufiaceous fungi							4	4	4
Unitunicate ascomycete sp. 1	3.3		1.7						
Unitunicate ascomycete sp. 2	3.3		1.7						
Unitunicate ascomycete sp. 3				**30**		**15**			
Unitunicate ascomycete sp. 4				5	5	5			
Unitunicate ascomycete sp. 5				5	5	5			
Unitunicate ascomycete sp. 6							16	4	10

Note: bold indicates overall percentage occurrence of more than 10%.

anamorphic fungi) were identified from wet season samples. Five ascomycetes and 12 anamorphic taxa overlapped between the two seasons (Table 1). The most common taxon was *Corynespora cassiicola*, with 60% frequency of occurrence. Other dominant species were *Anthostomella ludoviciana* (16.7%), *Canalisporium caribense* (16.7%), *Diaporthe* sp. 2 (16.7%), *Brachydesmiella caudata* (13.3%), *Massarina* sp. (13.3%), *Sporidesmium* sp. 1 (13.3%), *Ellisembia brachyphus* (11.7%), *Phaeoisaria clematidis* (20%) and *Phomopsis* sp. (11.7%) (Table 1).

Table 2. Overlapping taxa on woody litter of three hosts (the number in brackets represents the similarity index).

	Manglietia garrettii	***Michelia baillonii***
Magnolia liliifera	8 (0.1)	8 (0.09)
Manglietia garrettii	-	6 (0.07)

*overlapping between all host = 4 species

Table 3. Diversity indices of saprobic fungi recovered from wood of three magnoliaceous hosts during dry and wet seasons.

Sampling	Fungi per sample	Species richness	Species evenness	Shannon-Wiener indices	Simpson indices
MLD	1.9	58	0.873	3.546	0.9477
MLW	1.4	41	0.941	3.496	0.9637
MGD	2.9	60	0.921	3.773	0.9688
MGW	2	40	0.964	3.556	0.9679
MBD	2.9	72	0.969	4.145	0.9822
MBW	2.2	56	0.962	3.872	0.9764
Average	2.2	54.5	0.939	3.731	0.9678

*Notes: ML = *Mangnolia liliifera*, MG = *Manglietia garrettii*, MB = *Michelia baillonii*, D = Dry season and W = Wet season.

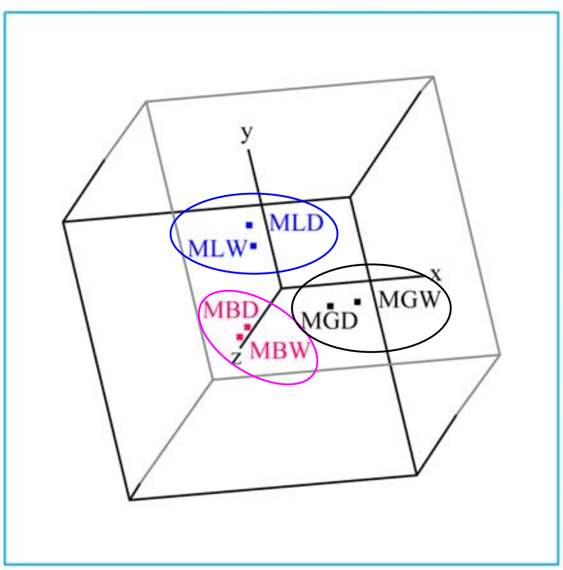

Fig. 1. Three-dimensional correspondence analysis of fungal taxa occurring on woody litter of *Magnolia liliifera*, *Manglietia garrettii* and *Michelia baillonii* during the wet and dry seasons (ML = *Magnolia liliifera*, MG = *Manglietia garrettii*, MB = *Michelia baillonii*, W = wet season samples, D = dry season samples).

Abundance of fungi on woody litter of Manglietia garrettii

Eighty-three taxa were identified from *Manglietia garrettii* wood comprising 27 ascomycetes and 56 anamorphic fungi. Sixty-four taxa (20 ascomycetes, 44 anamorphic fungi) were recorded from dry season samples, while 40 taxa (16 ascomycetes, 26 anamorphic fungi) were obtained from wet season samples. Four ascomycetes and 12 anamorphic fungi overlapped between the two seasons (Table 1). One anamorphic fungus, *Dictyosporium manglietiae*, has been described as new to science (Kodsueb *et al*., 2006). The most common taxa were *Ellisembia opaca* and *Phaeoisaria clematidis* with 27.5% frequency of occurrence. Other common species were *Berkleasmium inflatum* (20%), *Dictyosporium manglietiae* (20%), *Edmundmasonia pulchra* (17.5%), *Ellisembia* sp. 1 (15%), Unitunicate Ascomycete sp. 2 (15%), *Canalisporium* sp. (12.5%) and *Verticillium* sp. (12.5%) (Table 1).

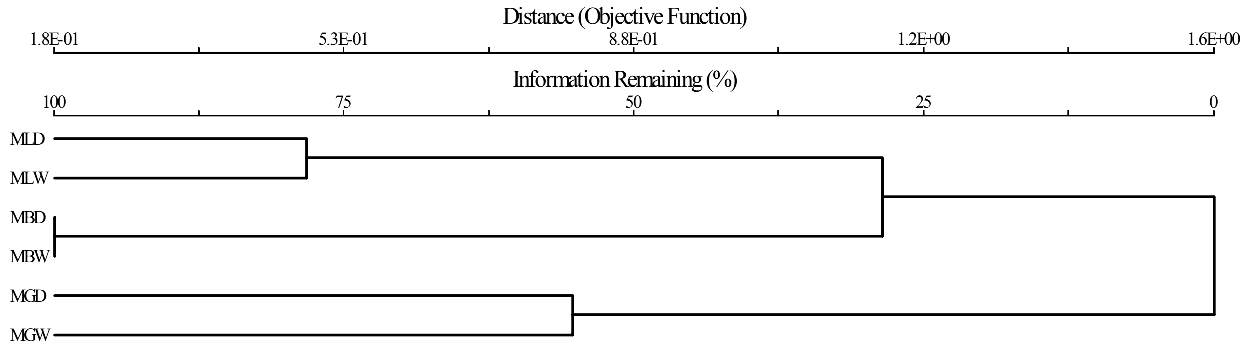

Fig. 2. Cluster analysis of saprobic fungi on *Magnoliaceae* woody litter based on Sørensen distance and the group average method (ML= *Magnolia liliifera*, MG= *Manglietia garrettii*, MB= *Michelia baillonii*, D= Dry season samples and W= Wet season samples).

Abundance of fungi on woody litter of Michelia baillonii

Ninety-three taxa were identified on *Michelia baillonii* wood comprising 30 ascomycetes, 2 basidiomycetes and 61 anamorphic fungi. Fifty-five taxa (14 ascomycetes, 2 basidiomycetes and 39 anamorphic fungi) were recorded from wet season samples, while 72 taxa (25 ascomycetes and 47 anamorphic fungi) were obtained from dry season samples. Nine ascomycetes and 26 anamorphic fungi overlapped between the two seasons (Table 1). Two anamorphic fungi were new to science, one of which could not be accommodated in any existing genera. Therefore, the new genus *Catenosynnema* was erected (Kodsueb *et al*., 2007b) with inclusion of a new species of *Oedemium*, *O. micheliae*. The most common taxa were *Annellophora phoenicis* and *Ellisembia adscendens*, with 18% frequency of occurrence. Other common species were *Helicosporium griseum* (16%), *Canalisporium exiguum*, *Chloridium chlamydosporum* (14%) and bitunicate Ascomycete sp. 1, *Cordana* sp., *Dictyochaeta* sp., *Diplococcium* sp., *Eutypella* sp., *Penicillium* sp. 1, *Phaeoisaria clematidis*, (12%) (Table 1).

Similarity of fungi on different hosts and season

Cluster analysis (Fig. 2) indicates that the fungal communities on woody litter of *Michelia baillonii* collected during the dry and wet seasons were more similar to each other than to those on the other two hosts. The fungal community on woody litter of *Magnolia liliifera* appeared to be a sister group to the one from *Mi*. *baillonii*. The fungal community on both the wet and dry season samples of *Manglietia garrettii* clustered together, distant from the other two hosts. Similarity index of fungi between the three magnoliaceous woods collected in dry and wet seasons are shown in Table 2. Eight overlapping taxa (SI = 0.1) were obtained from *Magnolia liliifera* and *Manglietia garrettii*. Eight and 6 taxa overlapped between *M. liliifera* and *Michelia baillonii* and *Man*. *garrettii* and *Mi*. *baillonii* (similarity index of 0.09 and 0.07), respectively.

Discussion

Fungal diversity and colonization

This is one of only a few studies of fungi occurring on decaying terrestrial wood in the tropics and it is the first study to address fungal diversity on magnoliaceous wood in Thailand. Investigation of fungi on terrestrial wood in Thailand began in 1902 (Schumacher, 1982). Additional studies on fungi on wood have been reported (Sihanonth *et al*., 1998; Chatanon, 2001; Inderbitzin *et al*., 2001; Inderbitzin and Berbee, 2001). However, knowledge of terrestrial lignicolous fungi is still poorly understood and requires further study. Studies by Thienhirun (1997) and Chatanon (2001) who investigated the ascomycetes on decaying wood in Thailand, are the most intensive studies on non specific terrestrial wood.

In this study we investigated the fungal diversity on terrestrial magnoliaceous wood and identified 239 taxa from 150 wood samples. Fungal diversity is high when compared to other studies on wood worldwide

Table 4. Comparison of studies of fungi on wood of different host species and in different habitats and regions.

References	Number of fungi obtained	Substrate	Habitat	Geographical area
Tan *et al*., 1989	20	*Avicennia alba*	Marine-mangrove	Tropic
Tan *et al*., 1989	21	*A. lanata*	Marine-mangrove	Tropic
Kane *et al*., 2002	40	*Fagus sylvatica*	Freshwater	Temperate
Kane *et al*., 2002	28	*Pinus sylvestris*	Freshwater	Temperate
Ho *et al*., 2002	155	Natural occurring submerged wood	Freshwater	Tropic
Ho *et al*., 2002	58	*Machilus velutina*	Freshwater	Tropic
Ho *et al*., 2002	58	*Pilus massoniana*	Freshwater	Tropic
Sivichai *et al*., 2002	48	*Dipterocarpus alatus*	Freshwater	Tropic
Sivichai *et al*., 2002	47	*Xylia dolabriformis*	Freshwater	Tropic
Maria and Sridhar, 2004	36	*Avicennia officinalis*	Freshwater	Tropic
Maria and Sridhar, 2004	37	*Rhizophora mucronata*	Freshwater	Tropic
Huhndorf and Lodge, 1997	157	30 sp. of natural occurring wood and one palm	Terrestrial	Tropic
Crites and Dale, 1998	19	*Populus tremuloides*	Terrestrial	Temperate
Allen *et al*., 2000	80 (spring) and 151 (autumn)	*Nothofagus solandri* var. *cliffortioides*	Terrestrial	Temperate
Van Ryckegem and Verbeken (2005)	46	*Phragmites australis*	Marine	Temperate

(e.g. submerged wood: Tan *et al*., 1989; Ho *et al*., 2002; Kane *et al*., 2002; Sivichai *et al*., 2002; Maria and Sridhar, 2004; Van Ryckegem and Verbeken, 2005; Vijaykrishna and Hyde, 2006: terrestrial wood: Huhndorf and Lodge, 1997; Crites and Dale, 1998; Allen *et al*., 2000—Table 4). In terms of number of fungi (species richness and number of fungi per wood), *Michelia baillonii* had the greatest number of taxa (93), followed by *Manglietia garrettii* (83) and *Magnolia liliifera* (82). This may result from the bigger size and taller height of *Michelia* trees compared to *Magnolia liliifera* and *Manglietia garrettii* (Kodsueb, pers. obs.). Differences in wood composition may also play a part (Boddy and Watkinson, 1995). The dominant or most common fungi of each host (Table 1) differ significantly from those usually found to be common on terrestrial wood (Huhndorf and Lodge, 1997; Crites and Dale, 1998; Allen *et al*., 2000).

Seasonal effect on the fungal community

Seasonality is one factor believed to affect the fungal community (Hagn *et al*., 2003; Nikolcheva and Bärlocher, 2005; Kennedy *et al*., 2006). However, there is no evidence to clarify how season affects fungal communities. Nikolcheva and Bärlocher (2005) concluded that the presence/absence of aquatic hyphomycetes is regulated primarily by season, presumably through temperature.

Surprisingly, in this study, samples collected in the dry season provided greater species richness and Shannon diversity index than the samples collected in the wet season. The same result applied to all three hosts. A possible reason for this might be differences in humidity, or an unsuitable ratio between moisture content and aeration of wood with quite high moisture and low aeration during the wettest period (Rayner and Todd, 1979).

A possible reason for this might be differences in humidity which is vary within wet and dry season. Since humidity is needed for the germination and disposal of fungi (Pinnoi *et al*., 2006), consequently, the fungal communities of wet season samples which higher humidity are believed to be more diverse. Surprisingly, according to current study, the result showed that the fungal community during the dry season has been supported greater fungal taxa (see Table 1). The reason on this result may be the effect of unsuitable ratio between moisture content and aeration of wood sample with quite high moisture and low in aeration during the wettest period (Rayner and Todd, 1979).

Host specificity

Generally, different plant species have a different chemical composition, and this may affect the microbial community composition and biomass (Boddy and Watkinson, 1995; Mille-Lindblom *et al*., 2006). Many fungi are considered to be host-specific or host-recurrent. Although saprobic fungi are not believed to be host-specific or host-recurrent (Zhou and Hyde, 2001), there are several examples of saprobic fungi that have been recorded on only a single host and may be host-specific (Zhou and Hyde, 2001). The factors that rule certain saprobes to occur regularly or uniquely on a host are poorly understood (Zhou and Hyde, 2001).

According to the similarity index between each host and the identical results from cluster and 3D-correspondence analyses which divided the fungal communities into three different groups, results from this study suggest a dissimilarity of fungal communities between the three different hosts. The overlapping taxa between the three hosts were very low, only 4 out of 239 taxa. Comparison of fungi obtained from this study with previous studies showed low similarity in species level although overlap of gerera on wood is common. For example, *Anthostomella*, *Ascotaiwania*, *Cercophora*, *Chaetosphaeria*, *Diatrype*, *Didymosphaeria*, *Eutypa*, *Hypoxylon*, *Melanochaeta*, *Nectria*, *Stilbohypoxylon*, *Tubeufia* and *Xylaria* occurred in the present study and in other studies (Huhndorf and Lodge, 1997; Thienhirun, 1997; Crites and Dale, 1998; Chatonon, 2001; Allen *et al*., 2000). A possible explanation maybe that of endophytes, which are growing in living wood, and continue to grow as saprobes after the wood dies. The presence of fungi on leaf litter that then grow into wood may also result in different fungal communities suggesting host-specific or host-recurrent.

Conclusion

Different magnoliaceous species supported different assemblages and numbers of fungal taxa. *Michelia baillonii* had the greatest diversity of wood litter fungi among the three tree species. Seasonality also appeared to affect the fungal community with a low number of overlapping taxa between dry and wet season samples. However, the host species had a greater affect on the fungal community with only four fungal taxa overlapping between the three different hosts. *Magnolia liliifera*, which is morphologically similar to *Manglietia garrettii*, supported a fungal community that was more similar to that found on *Michelia baillonii*. The reason for this result is unclear. None of the basidiomycetes overlapped between the differrent hosts and seasons. Many factors can affect changes in the communities of fungi, for instance, physical and chemical properties of the tree, the microclimate of the growth site and biological interaction within woody substrate (Rayner and Boddy, 1988; Renvall, 1995; Holmer and Stenlid, 1996), effects of endophytes growing on living wood and leaf litter fungi that may thrive in wood after it is dead.

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