THE DISTRIBUTION OF WOOD-INHABITING FUNGI IN PENINSULAR MALAYSIA

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SALMIAH, U., JONES, E. B. G. & WATLING, R. 2002. The distribution of wood-inhabiting fungi in Peninsular Malaysia. The distribution of wood-inhabiting fungi, concentrating on some pileate polypores and agarics, based on the presence of basidiomes lying on the forest floor, on twigs, branches and standing dead spars at various forest reserves and plantation forests, was investigated. A total of 54 species assigned to 29 genera was recorded during the visits. Fewer fungi were recorded in plantation forests compared with forest reserves. *Earliella scabrosa, Lenzites elegans, Microporus xanthopus, Pycnoporus sanguineus, Schizophyllum commune* and *Trametes feei* were amongst the wood-inhabiting fungi present at all sites examined.

Key words: Tropical fungi - forest reserve - plantation forest - Malaysia

SALMIAH, U., JONES, E. B. G. & WATLING, R. 2002. Taburan kulat yang hidup pada kayu di Semenanjung Malaysia. Kajian dijalankan terhadap taburan kulat yang hidup pada kayu di pelbagai hutan simpan dan hutan ladang, dengan tumpuan kepada beberapa pileat polipor dan agarik berdasarkan kehadiran basidiom di lantai hutan, ranting, dahan dan batang mati. Sejumlah 54 spesies daripada 29 genus direkodkan semasa lawatan. Kulat tidak banyak direkodkan di hutan ladang berbanding di hutan simpan. *Earliella scabrosa, Lenzites elegans, Microporus xanthopus, Pycnoporus sanguineus, Schizophyllum commune* dan *Trametes feei* adalah antara kulat yang dijumpai di semua tapak yang dikaji.

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Introduction

The forests of Southeast Asia display the greatest systematic diversity in the world. Although fungi represent a large part of this diversity, they, particularly the wood-inhabiting fungi, have not been well studied. The least explored areas, geographically and ecologically, are those of the tropics (Pegler 1997). Corner (1981, 1983, 1984, 1987, 1989a, b, 1991), who can be considered as the foremost authority on Malesian fungi, has recorded the presence of 487 Malaysian lignicolous fungi. The vast region of Malesian (extending from the Malay peninsula to the Solomon Islands) holds the richest but least known fungus biota (Corner 1993). This is particularly true since there is lack of information and not much published data on the wood-inhabiting fungi in Malaysia (Salmiah 1997).

The presence of basidiomes (fruiting bodies) provides information on distribution, seasonal abundance, habitat and substratum preference of species. Direct examination of the presence of basidiomes is beneficial in the sense that a wide range of species can be observed and sporulating stages can be identified to species. However disadvantages include: (1) only sporulating species can be identified; fungi as mycelia cannot be recorded, (2)basidiomes are sometimes difficult to spot on wood samples, and (3) no information is available on the length of basidiome exposure on the substratum. Nevertheless, using this approach, information on species distribution over a wide area can be obtained quickly, and relatively cheaply. Furthermore, it gives a broader picture of the organisms involved in the colonisation of substrate. However, the time of appearance of lignicolous basidiomes is variable. Species of *Ganoderma* and *Phellinus*, for instance, are perennial and may survive on the substratum for several years. Although the basidiomes are present, the basidiospores may not be produced throughout the year.

Hence, this broad survey was undertaken to investigate the distribution of wood-inhabiting fungi, with emphasis on lignicolous pileate polypores and agarics, at six different forest locations comprising both forest reserves and plantation forests in Peninsular Malaysia. In addition the effects of conversion of natural forests to plantations on fungal population will be expounded.

Materials and methods

Experimental sites

The distribution of fungi was investigated at selected forest reserves and plantation forests. The chosen sites were the Forest Research Institute of Malaysia's (FRIM) forest grounds; Pasoh Forest Reserve, Negeri Sembilan; *Acacia mangium* plantation forest in Kemasul, Pahang; teak plantation forest in Mata Ayer, Perlis; *Acacia mangium* plantation forest in Ulu Sedili, Johore; and Jeram Lenang Forest Reserve in Kelantan. The sites were chosen as representatives of various areas in Peninsular Malaysia (Figure 1). The different localities may give an insight on the distribution of fungal species. A brief summary on the locations are given in Table 1. The forest reserves and plantation forests differ in floristic composition by having dipterocarp tree species in the lowland rainforest and monoculture in the plantations.

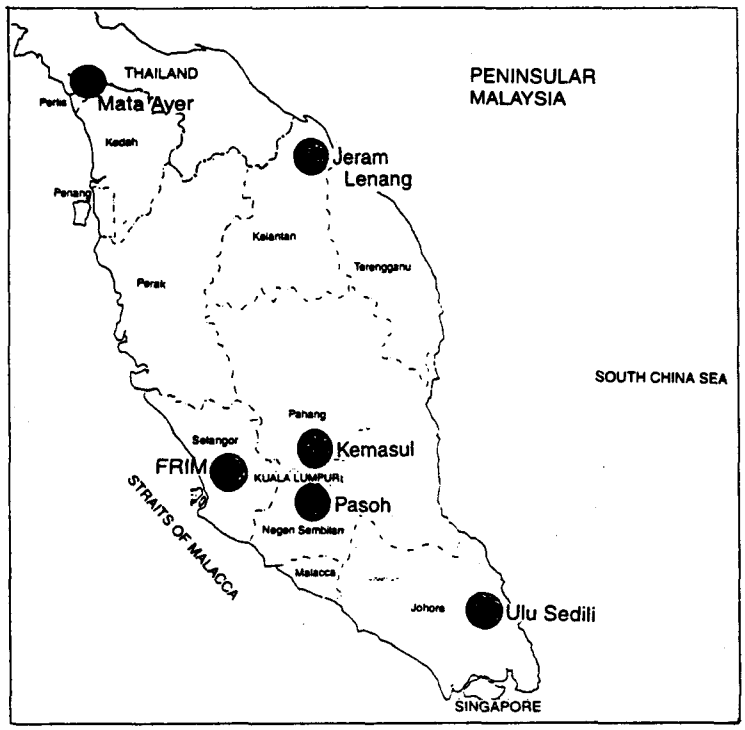

Figure 1 Map of Peninsular Malaysia showing the sites where the wood-inhabiting fungi were collected

Table 1 Description of the selected forest locations

Experimental site	Rainfall (mm)	Vegetation	Location
FRIM	2761	Dipterocarp	3° 14' N, 101° 38' E
Pasoh	1800	Lowland mixed dipterocarp	2° 58' N, 102° 20' E
Kemasul	1700	*Acacia mangium*	3° 25' N, 102° 16' E
Ulu Sedili	2820	*A. mangium*	2° N, 103° 5' E
Mata Ayer	1621	Teak	6° 38' N, 100° 14' E
Jeram Lenang	3700	Mixed dipterocarp forest	5° 44' N, 102° 22' E

Basidiomes

The determination of the distribution of fungi was based on the presence of their basidiomes in the field. Observations and collections of these basidiomes were made during visits in the months of January to August 1993. All sites were visited twice except for the Pasoh Forest Reserve and the FRIM dipterocarp forest and arboretum, which had an extra visit each. Collecting and examining small number of basidiomes at a time ensured minimum disturbance to the mycoflora of the test sites. For fungal species identification, the basidiomes were brought back to the laboratory for detailed examination as outlined in Watling (1981), and kept as voucher specimens at the wood mycology laboratory, FRIM.

Results and discussion

The data on the distribution of fungi at the study sites from January to August 1993 are tabulated in Table 2. A total of 54 species assigned to 29 genera was recorded from all the sites. Twenty-five of these species occurred only once at one particular site. There were fewer species recorded from teak and *A. mangium* plantation forests compared with the forest reserves. The largest number of species (29) was collected at Pasoh Forest Reserve and the lowest number was collected at Mata Ayer teak plantation forest (10).

Table 2 The distribution of wood-inhabiting fungi recorded at six sites in Peninsular Malaysia

Species	FRIM	Pasoh	Kemasul	Mata Ayer	Ulu Sedili	Jeram Lenang
Fungus recorded at all sites						
Earliella scabrosa (Pers.) Gilb. & Ryv.	+	+	+	+	+	+
Lenzites elegans (Spreng: Fr.) Pat.	+	+	+	+	+	+
Microporus xanthopus (Fr.) Kuntze	+	+	+	+	+	+
Pycnoporus sanguineus (Fr.) Murr.	+	+	+	+	+	+
Schizophyllum commune Fr.	+	+	+	+	+	+
Trametes feei (Fr.) Pat.	+	+	+	+	+	+
Fungus recorded at four sites						
Amauroderma rugosum (Bl. & Nees) Torrend	+	+	+	–	–	+
Lentinus sajorcaju (Fr.) Fr.	+	–	+	–	+	+
Microporus affinis (Bl. & Nees: Fr.) Kuntze	+	+	–	+	+	–
Nigroporus vinosus (Berk.) Murr.	+	+	+	–	–	+
Fungus recorded at three sites						
Lentinus squarrosulus Mont.	+	–	+	–	+	–
Lentinus strigosus (Schw.) Fr.	+	–	+	–	–	+
Lenzites acuta Berk.	–	+	+	–	–	+
Polyporus dictyopus Mont.	+	+	–	–	–	+
Trametes modesta (Fr.) Ryv.	+	–	–	+	+	–
Fungus recorded at two sites						
Coriolopsis sp.	+	+	–	–	–	–
Ganoderma applanatum (Pers. Ex Wallr.) Pat.	+	+	–	–	–	–
Ganoderma australe (Fr.) Pat	–	+	–	–	+	–
Gymnopilus sp.	+	+	–	–	–	–
Hexagonia tenuis (Hook.) Fr.	+	+	–	–	–	–
Pleurotus djamor (Fr.) Boedijn	+	–	–	–	–	+
Polyporus grammocephalus Berk.	+	–	–	–	–	+
Polyporus hirsutus Corner	–	+	–	–	–	+
Stereum ostrea (Bl. & Nees) Fr.	+	–	–	–	–	+
Trametes menziesii (Berk.) Ryv.	+	–	+	–	–	–
Trametes villosa (Fr.) Kreisel	+	+	–	–	–	–
Trichaptum biformes (Fr.) Ryv	–	+	–	–	+	–
Tyromyces nemorosus Corner	–	+	–	–	–	+
Lentinus polychrous Lev.	+	–	–	+	–	–

(continued)

Table 2 (continued)

Species	FRIM	Pasoh	Kemasul	Mata Ayer	Ulu Sedili	Jeram Lenang
Fungus recorded at only one site						
Antrodia sp.	–	–	–	–	+	–
Coriolopsis retropicta (Lloyd) Teng.	–	+	–	–	–	–
Flavodon flavus (Kl.) Ryv.	–	+	–	–	–	–
Ganoderma lucidum complex	–	–	+	–	–	–
Gloeophyllum striatum (Fr.) Murr.	–	–	+	–	–	–
Gyrodontium versicolor (Berk. & Br.) Maas. G.	–	+	–	–	–	–
Hexagonia apiaria Pers.	–	–	–	–	+	–
Lenzites flaccida (Bull.) Fr.	–	+	–	–	–	–
Lenzites vespacea (Pers.) Ryv.	+	–	–	–	–	–
Microporellus inusitatus (Lloyd) Corner	–	–	–	–	–	+
Phellinus lamaensis (Murr.) Heim	–	+	–	–	–	–
Phellinus setulosus (Lloyd) Imaz.	–	+	–	–	–	–
Phellinus sp.	–	–	–	–	–	+
Phellinus umbrinellus (Bres.) Ryv.	–	+	–	–	–	–
Piptoporus soloniensis (Dub.: Fr.) Pil.	–	+	–	–	–	–
Phellinus sp.	–	+	–	–	–	–
Pyroformes sp.	–	+	–	–	–	–
Rigidoporus microporus (Fr.) v. Ov.	–	–	–	–	–	+
Trametes carneo-nigra (Berk.) Corner	–	–	–	–	–	+
Trametes corrugata (Pers.) Bres.	–	–	+	–	–	–
Trametes sp.	+	–	–	–	–	–
Trametes incana Fr.	–	–	–	–	–	+
Trametes pocas (Berk.) Ryv.	–	–	–	+	–	–
Trametes socotrana Cooke	–	–	–	–	+	–
Tinctoporellus epimiltinus (Berk. & Br.) Ryv.	–	+	–	–	–	–

+ = present
– = absent

The genus *Trametes* had the highest number of recorded species (10) followed by *Phellinus* (5) and *Lentinus* (4). *Pycnoporus sanguineus, Microporus xanthopus, Schizophyllum commune, Lenzites elegans, Earliella scabrosa* and *Trametes feei* were species common to all the six sites. However, *P. sanguineus* and *S. commune* were found growing only in the open areas or clearings. The moist forest floors in the grounds of forest reserves such as FRIM, Pasoh and Jeram Lenang were also rich in wood-inhabiting fungi, particularly *M. xanthopus* and other woody perennial members of the polyporaceaous fungi. The plantation forests of Mata Ayer, Ulu Sedili and Kemasul were rather poor in numbers of fungi and those that were found, occurred mostly on old fallen trunks or branches.

The investigation done indicated that the terrestrial biomycota varied in geographical regions. Fungi that grew on fallen trunks of *A. mangium* and teak in plantation forests were also found to exist on other fallen logs in forest reserves that were different from these two tree hosts. Fungi discovered to be common on *A. mangium* in Kemasul and Ulu Sedili were *S. commune, P. sanguineus, E. scabrosa, T. feei, Lenzites elegans, Lentinus sajorcaju* and *L. squarrosulus.*

The differences in the distribution, species diversity and similarity seen in this study can be attributed to several factors such as rainfall (the drier the area, the fewer fungi were found), quantities of suitable substrata (mainly branches and fallen trunks), damp forests with constant high air humidity and types of forest. Seasonality of basidiome production in Malaysia, which may be affected by rainfall, has only been recorded for agarics (Corner 1935, Watling 1994). However, there is an indication that some fungi involved in wood decay are seasonally affected by rainfall, possibly as a result of the latter modifying the water potential of the fallen wood. Only one third of the total species were collected on the first visit to Kemasul because of the dry season and the other two-thirds were collected when the forest floor was wet, subsequent to a rainy period. The continuous humid conditions are suitable for the development of basidiomes on woody debris in the forests and this pattern was observed at all the sites.

Distribution of wood-inhabiting fungi is difficult to determine (Rayner & Boddy 1988, Zabel & Morel 1992, Ingold & Hudson 1993). Direct observation only allows us to identify fungi that sporulate. Those present as mycelia may go undetected. The absence of basidiomes on rotting wood may be attributed to these factors: the absence of fungal mycelium in the wood; the mycelium that is present may still be in the early colonisation stage and may have insufficient metabolic reserves to enable fruiting to occur; and possibly there is a presence of an active mycelium but in a permanently vegetative state that produces no basidiomes. The presence of the fungal basidiome is the easiest and most immediate way to identify and record fungal species in the field. However, regardless of the method used for assessing fungal diversity, the presence of basidiomes does not give an accurate indication of species present or activity of the species identified. Clearly further detailed studies based on regular and more frequent visits and selecting other locations are necessary to determine the occurrence of fungal species. Random collections of the basidiomes will hopefully enable us to assess the fungal community in Malaysia. Species diversity increased with increased number of visits over a longer period (Corner 1981, 1983, 1984, 1987, 1989a, b, 1991).

Three *Ganoderma* species were recorded in this study compared with 23 species collected by Corner (1983). *Ganoderma* spp. are particularly damaging in the tropics and in Malaysia, *G. boninense* Pat. has been reported to affect rubber trees (Lim 1977, Varghese & Chew 1984) and oil-palm (Ho & Nawawi 1986, Singh 1991). *Ganoderma* spp. cause root, butt and top rots of a wide range of angiospermous trees (Rayner & Boddy 1988). In this study, it was found that *G. australe* thrived well on decayed standing *A. mangium* in Ulu Sedili. High incidence of heart rot in *A. mangium* plantations has been reported and the rot was correlated with the age of trees, not the sites (Lee *et al*. 1996).

Trametes is a cosmopolitan genus which prefers deciduous woods (Ryvarden & Johansen 1980, Ryvarden 1993) and this genus is so common that the basidiomes can be found throughout the year (Corner 1989a, Salmiah 1997). *Trametes carneo-nigra, T. corrugata, T. insularis, T. menziesii, T. modesta, T. pocas, T. socotrana, T. villosa* and *Trametes* sp. were collected a number of times from all sites. The basidiomes

were short-lived and encountered in groups and in large numbers. Corner (1989a) recorded the largest number of species for this genus (close to 80 species altogether), which shows how widespread and adapted they are in this region.

Lentinus spp. were encountered in large numbers and at various development stages of its life cycle. Species recorded were *L. sajorcaju, L. polychrous, L. squarrosulus* and *L. strigosus.* All these species were found at all sites except Pasoh. Malaysia is rich in *Lentinus* spp. (Chin 1981, Corner 1981, Oldridge *et al.* 1986, Lee *et al.* 1995). Only one species of *Pleurotus* (*P. djamor)* was recorded each at FRIM and Jeram Lenang during the study, which is poor in comparison to the 20 *Pleurotus* spp. documented by Corner (1981).

The monoculture plantation forests in Kemasul, Mata Ayer and Ulu Sedili are totally different from the forest reserve in Jeram Lenang and lowland dipterocarp forest at FRIM and Pasoh. Old, mature forests generally support richer fungi communities, especially where fallen, dead wood and partly buried timber are left on the forest floor. Monoculture plantations like *A. mangium* in Kemasul and Ulu Sedili, and teak in Mata Ayer contain less decaying wood and, hence, are extremely poor in lignocellulosic material. This may change with plantation age as some mortality of trees would be expected. Humid conditions and high rainfall are very conducive to the growth and infection of wood-inhabiting fungi.

The reason for the low number of fungal species recorded in this study was most likely due to the lower frequency of visits; 25 species were recorded only once at one site. Differences in species composition and the number of fungal species can be attributed to different tree species in the various forests studied. This somewhat explains the effects of fungal population on the conversion of natural forests to plantations and this preliminary study offers a good contrast on fungal population in the two different forests. In addition, the age of the wood and the stage of colonisation at the time of collection may greatly influence the type of fungi obtained and this needs to be investigated.

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