CHAPTER 4

SAPROBIC FUNGI ON PALMS

4.1 Introduction

Fungi have evolved three life strategies as parasites, endophytes and saprobes, according to their mode of nutrition (Cooke and Rayner, 1984; Dix and Webster, 1995; Kendrick, 2000). Most fungi are saprobic living on dead organic matter (Kirk *et al*., 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). However, saprobic fungi are thought to be less host-specific when compared to pathogens and endophytes (Zhou and Hyde, 2001).

Recent intensive studies of fungi on plants in the tropics (Cai *et al*., 2002, 2006; McKenzie *et al*., 2002; Shenoy *et al*., 2005; Tang *et al*., 2005). Also several taxonomic studies have been carried out on fungi collected on palms (Yanna *et al*., 2001b, c; Pinnoi *et al*., 2006, 2009; Pinruan *et al*., 2007). The ratio of palm hosts to fungal species (1:26) appears to be higher than the generally accepted ratio of 1:6 for other plants (Hyde, 1996a).

The present study continues our long standing studies of saprobic fungi on palms in southern Thailand by examining and comparing the fungi on different tissues of two wild and one cultivated palm species. The objective is to establish whether the saprobes differ between palm host species, especially between wild and cultivated taxa, and determine if the fungi on palms differ from those in other tropical hosts. It is also to enhance our knowledge of fungal diversity for Thailand, and as an aid to establishing global fungal numbers.

4.2 Materials and methods

4.2.1 Study site

This study examines the saprophytic fungi of *Elaeis guineensis,* and *Licuala spinosa* with a comparison of data obtained for *Licuala longicalycata* from a previous study (Pinruan, 2004). The study was undertaken in southern Thailand. Decaying fronds of *Elaeis guineensis* and *Licuala spinosa* were collected from the same sites as that of the endophytic fungi study (Chapter 3). Each palm was collected 2 times. The fan palm *Licuala longicalycata* was studied in Sirindhorn peat swamp forest, Narathiwat province.

4.2.2 Sample collection:

Ninety pieces of each palm was divided into 3 parts: palm leaves, rachides and petioles, all randomly collected from decaying palm material lying on the forest ground (15 pieces/parts/times). Samples were placed in separate plastic bags and taken back to the laboratory. On return to the laboratory the material was incubated in plastic boxes on a layer of sterile moist tissue. The material was kept moist and examined periodically for fungal fruiting structures. Fungi collected were identified and isolated into axenic culture using a single spore technique (Choi *et al*., 1999).

4.2.3 Examination of samples

4.2.3.1 Isolation of fungi:

Single spore isolation was made from sporulating structures on material incubated in the laboratory or from fresh material when isolated in the field laboratory. The isolation medium was Corn Meal Agar (CMA), with added antibiotics (Streptomycin 0.5 g/l, Penicillin G 0.5 g/l), and germinating spores were transferred to Potato Dextrose Agar (PDA), and incubated at room temperature until growth was observed.

4.2.3.2 Dry specimen:

For herbarium specimens, a piece of the substrate containing fungal fruiting structures was cut and dried in a hot air oven (35–50 C) for 2–3 days and deposited at the BIOTEC Bangkok Herbarium (BBH). Collecting information (e.g., date, locality, substrate, and collector) is recorded on each herbarium packet.

4.2.4 Identification and nomenclature of the fungi collected:

Fungi were identified based on their morphology and sporulation on fresh palm material or on agar media. Key references used for identification are listed in Chapter 3.

4.2.5 Data analyses:

Percentage abundance of taxa were calculated according to the following formula:

Percentage abundance of taxon A = $\frac{\text{Occurrence of taxon A} \times 100}{\text{Occurrence of all taxon}}$

Frequency of occurrence (%)

$= \frac{\text{total number of collections of particular taxon encountered}}{\text{total number samples examined}} \times 100$

Very frequent ≥ 10%, Infrequent = 1−5%, Frequent = 5−10%, Rare ≤ 1%

4.3 Results

A total of 240 palms samples (120 from *Elaeis guineensis*, 120 from *Licuala spinosa*) were examined for fungi. Of the 213 fungal collections, 107 taxa (Table 4.1) were identified including 48 ascomycetes (representing 45% of all taxa), and 59 anamorphic taxa (55%) (Table 4.1).

Microfungi associated with the oil palm (*Elaeis guineensis*) yielded 67 species, with 29 ascomycetes (43.3%), and 38 anamorphic taxa (56.7%) from 122 collections (Figure 4.1). The most common fungi were *Delortia palmicola* (9 collections, 7.4%), *Nawawia fusiformis* (8 collections, 6.5%), *Trichoderma* sp. (7 collections, 5.7%), *Massarina bipolaris* (7 collections, 5.7%), and *Stilbohypoxylon moelleri* (6 collections, 4.9%) (Table 4.2). The percentage of fungi occuring on dry versus damp material were 59% and 41%, respectively (Figure 4.2), with 56.6% of the fungi occurring on rachides, 38.5% on petioles, and 4.9% on leaves (Figure 4.3).

Sixty fungal species (91 collections) were found on *Licuala spinosa*, comprising 27 ascomycetes (45%) and 33 anamorphic fungi (55%) (Table 4.1). The most common species were *Linocarpon livistonae* (11 collections, 12%), *Oxydothis licualae* (7 collections, 7.7%), *Linocarpon* sp. (6 collections, 6.6%), *Helicosporium* *gigasporum* (4 collections, 4.4%), and *Endocalyx melanoxanthus* (4 collections, 4.4%) (Table 4.3). The percentage of fungi occuring on dry versus damp materilal were 57.1% and 42.9%, respectively (Figure 4.2), with 81.3% of fungi occurring on petioles, and 18.7% on leaves (Figure 4.3).

Overlap of taxa between the two palms was 15.9% with 17 species being found on both palms. When this data is compared to that on *Licuala longicalycata* (from my M.S. Thesis), the overlap of taxa from the three palm species was 3.3% (Table 4.1) with only 6 species found on all palms.

The different palm species, supported different assemblages and numbers of fungal taxa. In term of the numbers of taxa recovered fungi were more diverse in palm in the peat swamp forest than on terrestrial palm species (Table 4.1).

Table 4.1 A comparison of the total fungal taxa recovered from selected palm species in Thailand.

Taxa	***Licuala longicalycata***[1]	***Elaeis guineensis***[2]	***Licuala spinosa***[2]
Acrodyctis sp.		+	
Acrospeira-like	+		
Annulatascus aquaticus	+		
Annulatascus palmae	+		
Annulatascus sp.		+	
Annulatascus velatisporus	+	+	+
Anthostomella palmiria	+		
Arecomyces bruneiensis	+		
Arecomyces epigeni	+		
Arecomyces frondicola	+		
Arecophila striatispora	+		
Arthrinium arundinis	+		+
Arthrobotrys oligospora	+		
Ascominuta lignicola	+		
Aspergillus sp.	+		+

Table 4.1 Continued.

Taxa	*Licuala longicalycata*[1]	*Elaeis guineensis*[2]	*Licuala spinosa*[2]
Astrocystis rachidis	+		
Astrocystis sp.	+	+	
Astrosphaeriella	+		
Astrosphaeriella aquatica	+	+	
Astrosphaeriella fronsicola	+		
Astrosphaeriella livistonicola	+		+
Astrosphaeriella lophiostomopsis	+		
Astrosphaeriella malayensis	+		+
Astrosphaeriella papillata	+		
Astrosphaeriella sp.1	+		
Astrosphaeirella sp.2			+
Astrosphaeirella sp.3			+
Baipadsphaeria spathulospora	+		
Berkleasmium typhae	+	+	
Berkleasmium sp.			+
Boerlagiomyces sp.	+		
Brachysporiella gayana		+	+
Canalisporium caribense		+	+
Canalisporium eliguum			+
Canalisporium exiguum		+	+
Canalisporium variable	+		
Cancellidium applanatum	+	+	
Candelabrum brocchiatum		+	+
Carinispora nypae	+		
Caryospora sp.	+		
Chaetospermum camelliae	+		
Chaetosphaeria sp.	+	+	
Chalara siamense	+		
Chalara sp.	+	+	
Ciliclopodium-like	+		
Craspedodidymum licuala	+		
Craspedodidymum microsporum	+		
Craspedodidymum siamense	+		
Cryptophailoidea manifesta	+		
Cylindrocladium sp. 1		+	

Table 4.1 Continued.

Taxa	***Licuala longicalycata***[1]	***Elaeis guineensis***[2]	***Licuala spinosa***[2]
Cylindrocladium sp.2		+	
Dactylaria hemibeltranioidea	+		
Dactylaria sp. 1			+
Dactylaria sp. 2			+
Dactylaria sp. 3		+	
Delortia palmicola	+		
Dictyochaeta gyrosetula	+		
Dictyochaeta ramulosetula	+		
Dictyochaeta sp. 1		+	
Dictyochaeta sp. 2		+	+
Dictyochaeta sp. 3			+
Dictyochaeta sp. 4		+	+
Dictyosporium digitatum	+		+
Dictyosporium elelgans		+	+
Dictyosporium palmae	+		
Didymosphaeria bisphaerica	+		
Didymosphaeria sp.			+
Endocalyx melanoxanthus	+	+	
Eutypa sp.		+	
Falciformispora sp.		+	
Flammispora bioteca	+		
Sarocladium-like	+		
Gliocladium sp.	+		+
Glomerella sp.	+		
Gonytrichum macrocladum	+	+	
Guignadia manokwaria	+		
Helicoma sp. 1		+	+
Helicoma sp. 2	+		+
Helicoma-like 2	+		
Helicosporium gigasporum	+		+
Jahnula appendiculata	+		
Koorchaloma bambusae	+		
Lanceispora amphibia	+		
Lasiodiplodia sp.	+	+	
Lasiodiplodia theobromae	+	+	
Leptosphaeria sp. 1		+	
Leptosphaeria sp. 2		+	+

Table 4.1 Continued.

Taxa	***Licuala longicalycata*[1]**	***Elaeis guineensis*[2]**	***Licuala spinosa*[2]**
Linocarpon sp.	+		+
Linocarpon elaeidis	+	+	
Linocarpon livistonae	+		+
Linocarpon pandani	+	+	
Lophiostoma frondisubmersa	+		+
Lophiostoma-like	+		
Lophodermium licualae	+		
Massariana sp. nov.	+		
Massarina sp. 1		+	
Massarima sp. 2		+	
Massarina bipolaris	+	+	+
Massarina corticola	+		
Massarina-like		+	
Melanographium palmicola	+	+	+
Microthyrium sp.	+		
Monotosporella rhizoidea	+	+	
Myelosperma tumidum	+		
Nawawia fusiformis	+	+	+
Nectria sp. 1	+	+	
Nectria sp. 2	+		
Neolinocarpon sp.		+	+
Niesslia sp.	+	+	
Ophioceras sp.	+		+
Orbilia sp.	+	+	
Oxydothis angustispora	+		+
Oxydothis atypical	+		
Oxydothis frondicola	+	+	
Oxydothis grisea	+		+
Oxydothis hoehnelii	+		
Oxydothis licualae	+		+
Oxydothis livistonae	+	+	
Oxydothis oraniopsis	+		
Penicillium sp.	+	+	+
Petrakiopsis sp.	+		
Phaeodothis sp.	+		
Phaeoisaria clematidis	+	+	+
Phomatospora berkleyi	+		

Table 4.1 Continued.

Taxa	*Licuala longicalycata*[1]	*Elaeis guineensis*[2]	*Licuala spinosa*[2]
Phruensis brunneispora	+		
Pseudorobillarda sojae	+		
Rosellinia corticum	+		
Solheimia costaspora	+		
Spadicoides klotzchii	+		
Spadicoides obovatum	+	+	
Spadicoides sp.	+		+
Sporidesmiella oraniopsis	+		+
Sporochisma nigroseptatum		+	
Sporodesmiella sp.		+	
Sporodesmiella sp.			+
Stachybotrys bambusicola	+		
Stachybotrys palmae	+		
Stilbohypoxylon moelleri	+	+	
Stilbohypoxylon sp.		+	
Submersisphaeria aquatica	+		+
Submersisphaeria palmae	+		
Tetraploa aristata			+
Thailandiomyces bisetulasus	+		
Thozetella nivea	+	+	+
Thozetella radicata	+		+
Trichoderma harzianum	+		
Trichoderma sp.		+	+
Tubeufia claspisphaeria		+	+
Unidentified Ascomycete		+	
Unidentified Ascomycete		+	
Unidentified Ascomycete		+	
Unidentified Ascomycete		+	
Unidentified Ascomycete			+
Unidentified Ascomycete			+
Unidentified Ascomycete			+
Unidentified Ascomycete			+
Unidentified Ascomycete			+
Unidentified Ascomycete			+
Unidentified Ascomycete			+
Unidentified Ascomycete			+
Unidentified Ascomycete	+		

Table 4.1 Continued.

Taxa	***Licuala longicalycata***[1]	***Elaeis guineensis***[2]	***Licuala spinosa***[2]
Unidentified Basidiomycete	+		
Unidentified Basidiomycete	+		
Unidentified Basidiomycete	+		
Unidentified Anamorphic fungus	+		
Unidentified Anamorphic fungus		+	
Unidentified Anamorphic fungus		+	
Unidentified Anamorphic fungus		+	
Unidentified Anamorphic fungus		+	
Unidentified Anamorphic fungus		+	
Unidentified Anamorphic fungus		+	
Unidentified Anamorphic fungus			+
Unidentified Anamorphic fungus			+
Unidentified Anamorphic fungus			+
Unidentified Anamorphic fungus			+
Vanakripa sp. 1		+	
Vanakripa sp. 2		+	
Vanakripa sp. 3		+	
Verticillium sp.	+		
Wiesneriomyces javanicus	+		
Xylomyces aquaticus	+		
Zalerion-like	+		
Basidiomycetes (3)	**3**	**-**	**-**
Ascomycetes (89)	**79**	**29**	**27**
Anamorphic fungi (89)	**65**	**38**	**33**
Total taxa (179)	**147**	**67**	**60**
Total collections (571)	**358**	**122**	**91**

Note: [1] = Pinruan, 2004

[2] = This study

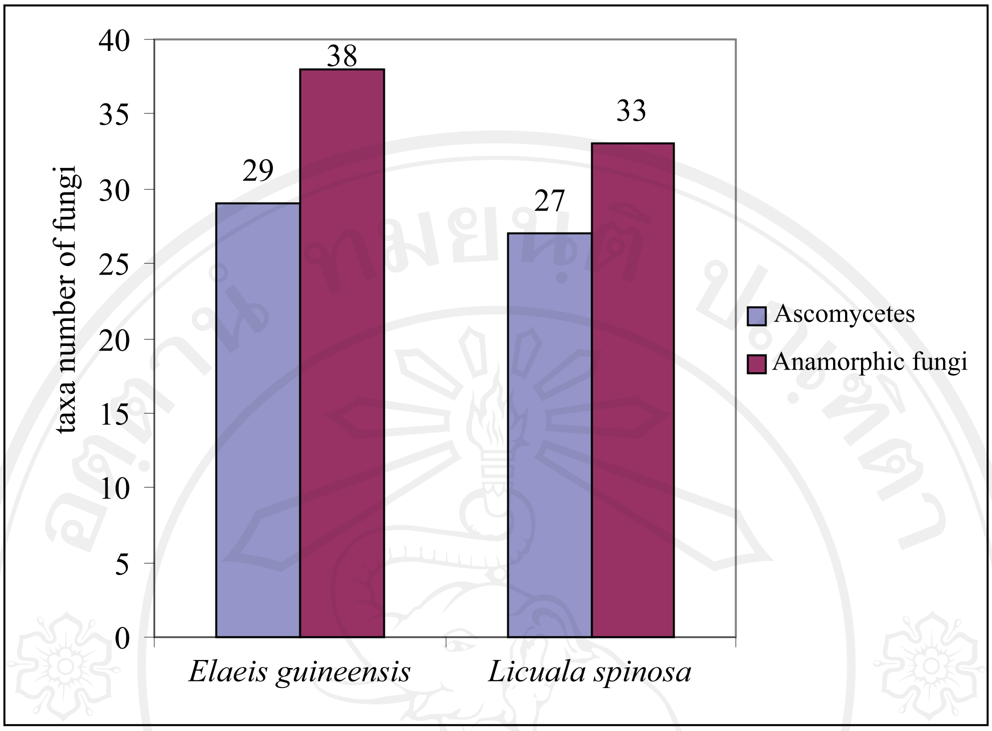

Figure 4.1 The occurrence of ascomycetes, and anamorphic fungi recorded on palm species.

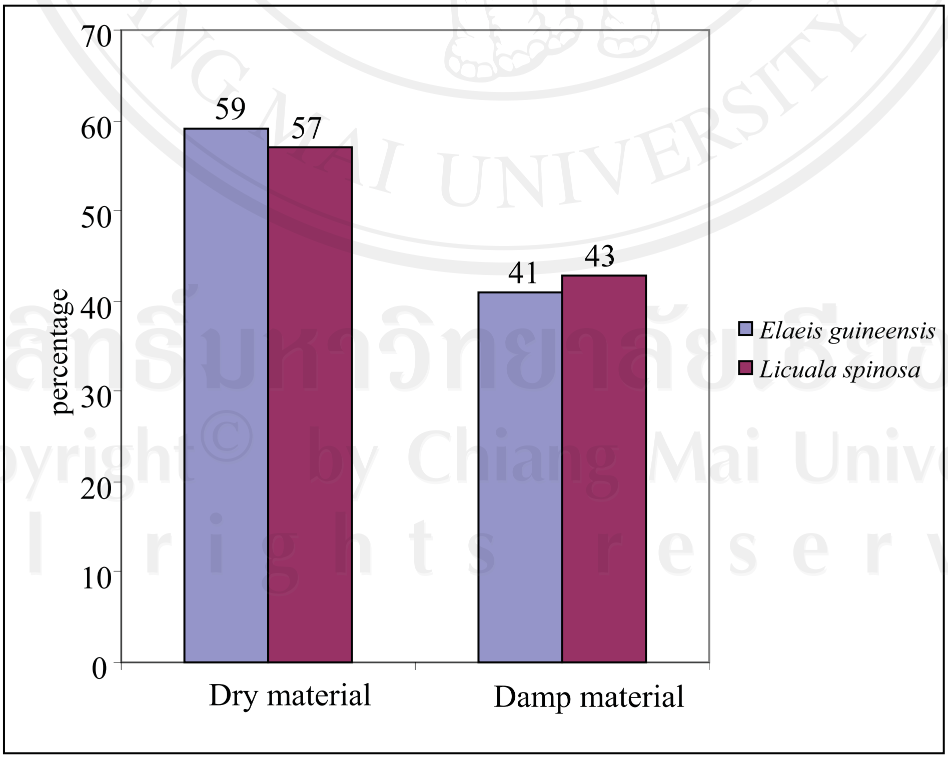

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Figure 4.2 Percentage occurrence of fungi occurring under different conditions.

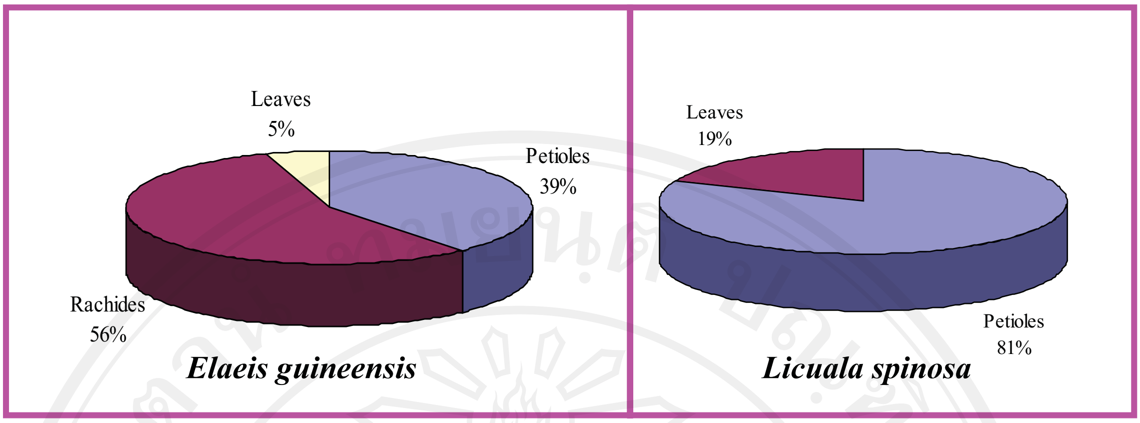

Figure 4.3 Percentage of fungi occurring on different parts of palm material.

Table 4.2 Percenteage occurrence of saprobic fungi on the palm *Elaeis guineensis.*

Taxa	**Number collection**	**Percentage occurrence**
Delortia palmicola	9	7.3
Nawawia fusiformis	8	6.5
Trichoderma sp.	7	5.7
Massarina bipolaris	7	5.7
Stilbohypoxylon moelleri	6	4.9
Brachysporiella gayana	5	4.1
Annulatascus velatisporus	5	4.1
Cylindrocladium sp. 1	4	3.3
Helicoma sp. 1	3	2.5
Melanographium palmicola	3	2.5
Neolinocarpon sp.	3	2.5
Sporodesmiella sp.	2	1.6
Candelabrum brocchiatum	2	1.6
Falciformispora sp.	2	1.6
Thozetella nivea	2	1.6
Tubeufia claspisphaeria	2	1.6
Astrocystis sp.	2	1.6
Annulatascus sp.	1	0.8
Astrocystis sp.	1	0.8
Astrosphaeriella aquatica	1	0.8
Canalisporium caribense	1	0.8
Canalisporium exiguum	1	0.8
Chaetosphaeria sp.	1	0.8

Table 4.2 Continued.

Taxa	**Number collection**	**Percentage occurrence**
Chalara sp.	1	0.8
Cylindrocladium sp. 1	1	0.8
Cylindrocladium sp.2	1	0.8
Dactylaria sp. 3	1	0.8
Dictyochaeta sp. 1	1	0.8
Dictyochaeta sp. 2	1	0.8
Dictyochaeta sp. 4	1	0.8
Dictyosporium elelgans	1	0.8
Endocalyx melanoxanthus	1	0.8
Eutypa sp.	1	0.8
Gonytrichum macrocladum	1	0.8
Helicoma sp. 1	1	0.8
Lasiodiplodia sp.	1	0.8
Lasiodiplodia theobromae	1	0.8
Leptosphaeria sp.	1	0.8
Leptosphaeria sp.	1	0.8
Linocarpon elaeidis	1	0.8
Linocarpon livistonae	1	0.8
Linocarpon pandani	1	0.8
Massarina sp. 1	1	0.8
Massarima sp. 2	1	0.8
Massarina-like	1	0.8
Monotosporella rhizoidea	1	0.8
Nectria sp. 1	1	0.8
Neolinocarpon sp.	1	0.8
Niesslia sp.	1	0.8
Orbilia sp.	1	0.8
Oxydothis frondicola	1	0.8
Oxydothis livistonae	1	0.8
Penicillium sp.	1	0.8
Phaeoisaria clematidis	1	0.8
Spadicoides obovatum	1	0.8
Sporochisma nigroseptatum	1	0.8
Sporodesmiella sp.	1	0.8
Stilbohypoxylon sp.	1	0.8
Thozetella nivea	1	0.8
Tubeufia claspisphaeria	1	0.8
Unidentified Ascomycete	1	0.8
Unidentified Ascomycete	1	0.8
Unidentified Ascomycete	1	0.8
Unidentified Ascomycete	1	0.8

Table 4.2 Continued.

Taxa	**Number collection**	**Percentage occurrence**
Unidentified Anamorphic fungus	1	0.8
Unidentified Anamorphic fungus	1	0.8
Unidentified Anamorphic fungus		
Unidentified Anamorphic fungus	1	0.8
Unidentified Anamorphic fungus	1	0.8
Unidentified Anamorphic fungus	1	0.8
Vanakripa sp. 1	1	0.8
Vanakripa sp. 2	1	0.8
Vanakripa sp. 3	1	0.8

Table 4.3 Percenteage occurrence of saprobic fungi on the palm *Licuala spinosa*.

Taxa	**Number collection**	**Percentage occurrence**
Annulatascus velatisporus	11	12.1
Brachysporiella gayana	7	7.7
Canalisporium caribense	6	6.6
Candelabrum brocchiatum	4	4.4
Massarina bipolaris	4	4.4
Nawawia fusiformis	3	3.3
Berkleasmium sp.	2	2.2
Helicosporium gigasporum	2	2.2
Arthrinium arundinis	1	1.1
Aspergillus sp.	1	1.1
Astrosphaeriella livistonicola	1	1.1
Astrosphaeriella malayensis	1	1.1
Astrosphaeirella sp.2	1	1.1
Astrosphaeirella sp.3	1	1.1
Canalisporium eliguum	1	1.1
Canalisporium exiguum	1	1.1
Dactylaria sp. 1	1	1.1
Dactylaria sp. 2	1	1.1

Table 4.3 Continued.

Taxa	**Number collection**	**Percentage occurrence**
Dictyochaeta sp. 2	1	1.1
Dictyochaeta sp. 3	1	1.1
Dictyochaeta sp. 4	1	1.1
Dictyosporium digitatum	1	1.1
Dictyosporium elelgans	1	1.1
Didymosphaeria sp.	1	1.1
Gliocladium sp.	1	1.1
Helicoma sp. 1	1	1.1
Helicoma sp. 2	1	1.1
Leptosphaeria sp.	1	1.1
Linocarpon sp.	1	1.1
Linocarpon livistonae	1	1.1
Lophiostoma frondisubmersa	1	1.1
Melanographium palmicola	1	1.1
Neolinocarpon sp.	1	1.1
Ophioceras sp.	1	1.1
Oxydothis angustispora	1	1.1
Oxydothis grisea	1	1.1
Oxydothis licualae	1	1.1
Penicillium sp.	1	1.1
Phaeoisaria clematidis	1	1.1
Spadicoides sp.	1	1.1
Sporidesmiella oraniopsis	1	1.1
Sporodesmiella sp.	1	1.1
Submersisphaeria aquatica	1	1.1
Tetraploa aristata	1	1.1
Thozetella nivea	1	1.1
Thozetella radicata	1	1.1
Trichoderma sp.	1	1.1
Tubeufia claspisphaeria	1	1.1
Unidentified Ascomycete	1	1.1
Unidentified Ascomycete	1	1.1
Unidentified Ascomycete	1	1.1
Unidentified Ascomycete	1	1.1
Unidentified Ascomycete	1	1.1
Unidentified Ascomycete	1	1.1

Table 4.3 Continued.

Taxa	**Number collection**	**Percentage occurrence**
Unidentified Ascomycete	1	1.1
Unidentified Ascomycete	1	1.1
Unidentified Hyphomycete	1	1.1
Unidentified Hyphomycete	1	1.1
Unidentified Hyphomycete	1	1.1
Unidentified Hyphomycete	1	1.1

4.4 Discussion

4.4.1 Biodiversity and host specificity

In this study, 107 fungi were identified from 240 samples of the two palm species. The data can be compared with results from a similar study in Sirindhon peat swamp forest, where Pinruan *et al*. (2007) identified 147 species from *Licuala longicalylata* (79 ascomycetes, 65 anamorphic fungi, and 3 basidiomycete species). In the same area Pinnoi *et al*. (2006) investigated the saprobic fungi occurring on decaying palm material of *Eleiodoxa conferta*, 462 fungal records yielded 43 ascomycetes, 67 anamorphic fungi and, 2 basidiomycetes. The overlap in taxa occurring on *Licuala longecalycata, L. spinosa,* and *Elaeis guineensis* is low at 3.3% (6 species). This indicates the great variation that occurs between the different palms and their habitats as documented in previous studies (Fröhlich and Hyde, 2000; Taylor and Hyde, 2003; Pinnoi *et al*., 2009).

Ascomycetes are common on palms in this study as in the terrestrial palms *Oraniopsis appendiculata* and *Livistona australis* (Taylor and Hyde, 2003), *Calamus* spp. (Pinnoi *et al*., 2009) with *Linocarpon* and *Oxydothis*, generally common on terrestrial palms, and a dominant group on *Licuala spinosa*. Comparisons of the ten dominant fungi on terrestrial palms and those in this study showed little overlap in species and a variety of factors may account for the differences observed, habitats, host-specificity, location, temperature, and rainfall (Fröhlich and Hyde, 2000; Taylor and Hyde, 2003). Fungi common to palms are often non-specific in their host species associations, however, not only are cases of host species specificity notable (e.g. *Oxydothis alexandrarum* is commonly collected on, and thus far exclusive to *Archontophoenix alexandrae*), but also differences in the composition of assemblages of different palms has been noted (Yanna *et al*., 2001b, c; Taylor and Hyde, 2003). At which level specificity occurs, e.g. host genus, subtribe, tribe, subfamily, is not yet known, but should become apparent as the mycota of more palm hosts are systemically investigated.

The fungi recorded in the present study can be compared with those recorded on other monocotyledonus plants. Photita *et al*. (2001b, 2003b) identified 46 fungi from *Musa acuminata* in Hong Kong and 80 on the same host in Thailand (Doi Suthep-Pui National Park). Only two of these taxa from Hong Kong and ten from Thailand were found on palm species in the present study (*Canalisporium caribense*, and *Tetaploa aristata*). *Canalisporium caribense* was also found on Pandanaceae (McKenzie *et al*., 2002) and zingiberaceous species by Bussaban *et al*. (2001a).

Several studies, of different habitats and hosts show dissimilar fungal communities (Goh and Hyde, 1996a, b; Wong *et al*., 1998; Ho *et al*., 2000; Kane *et al*., 2002; Tsui and Hyde, 2003; Tsui *et al*., 2003; Shearer *et al*., 2007; Kodsueb *et al*., 2008a, b). Of key importance is the low overlap between different habitats (Cai *et al*., 2006; Pinnoi *et al*., 2006, Pinruan *et al*., 2007; Kodsueb *et al*., 2008a, b). Fungal colonization may depend on environmental conditions such as climate, temperature, humidity, and these usually differ between different habitats and locations (Baker and Meeker, 1972).

Pinruan (2004) indicated that many factors affect fungal diversity including number of samples collected, portion of plant material sampled (such as rachis, petiole or leaves), collecting times, different hosts, different habitats, climate, nutrient status of host, presence of inhibitory compounds, fungal competition for resource, and the status of the host in the country.

4.4.2 Tissue specificity

Different fungal communities were found on leaves, petioles and rachides of decaying palms in this study. Tissue-specificity has been widely observed and possible reasons for tissue-specificity, or recurrence, has been suggested for saprobic microfungi from palms (Fröhlich and Hyde, 2000; Yanna *et al*., 2001b, c). The recurrence of fungi on certain tissue types has been shown with *Livistona chinensis, Oncosperma horridium,* and *Oraniosis appendiculatum* (Yanna *et al*., 2001b, c). The petioles of palms differ from leaves as they have a more concentrated supportive tissue and the outer region is composed of a sclerenchyma with associated xylem bundles (Tomlinson, 1990). These structural differences may account for the fungi confined to specific tissues as some fungi may have enzyme systems that can degrade the sclerenchyma tissues containing lignin, while other only degrade cellulose.

The different plant tissues and organs may in fact resemble distinct microhabitats (Petrini *et al*., 1992). Tsoumis (1991) reported various components and quantities of cellulose, hemicellulose and pectin in different plant tissue types. Moisture retention and humidity in the substratum will help fungi to grow (Dix and

Webster, 1995) and may affect fungal colonization. Fungal tissue recurrence has been reported with other hosts, and it has been shown that the fungi on standing hosts were vertically distributed (Sadaba *et al*., 1995; Poon and Hyde, 1998; Hyde *et al*., 2001). Different fungal communities were also found on leaves and pseudostems of dead zingiberaceous species. More fungi occurred on the pseudostem than on the leaf, and on leaves most fungi occurred along the midvien (Bussaban, 2005). Poon and Hyde (1998) reported that there were more ascomycetes on the lower culm tissues of *Phragmites australis* comprising sclerenchyma, and more anamorphic taxa on the upper herbaceous tissues. Sadaba *et al*. (1995) found different fungal communities on herbaceous and woody parts of *Acanthus ilicifolius*, with more ascomycetes occurring on the lower woody part and more anamorphic taxa on the upper herbaceous parts. Different fungal communities were found on leaves, petioles and pseudostems of *Musa acuminata* (Photita *et al*., 2001b), while Hyde *et al*. (2001) also found different fungal communities on the basal, middle and apical portions of bamboo culms.

The recurrence of certain fungi on different tissue types may be due to differences in nutrition requirements, or the ability of the fungi to utilize different substrates (Adaskaveg *et al*., 1991; Ingold and Hudson, 1993).

Palm petioles and rachides are more robust in terms of structure than leaves and do not decompose as rapidly, thus allowing time for a more complex fungal population to form and for a succession of different fungi to develop (Fröhlich and Hyde, 2000). Furthermore, endophytes have been shown to be tissue-recurrent (Kumar and Hyde, 2004) and therefore may account for tissue recurrent saprobes if they change lifestyles on plant senescence.

4.4.3 Abundance of anamorphic fungi

Most taxa recovered in the present study were anamorphic fungi, and this has also been reported for other monocotyledonous hosts e.g. bamboo (Hyde *et al*., 2001); grasses (Wong and Hyde, 2001); palms (Yanna *et al*., 2001a, b, c; Pinnoi *et al*., 2006); Pandanaceae (McKenzie and Hyde, 1997; McKenzie *et al*., 2002), *Musa acuminata* (Photita *et al*., 2001b, c), and zingiberaceous species (Bussaban, 2005). The fungal community on the palms *Licuala longicalycata* and *Calamus* spp. (Pinruan *et al*., 2007; Pinnoi *et al*., 2009) differ from palms in this study in having more ascomycetes than anamorphic fungi. These differences in the colonizing fungi may be attributed to in part by the habitat the palms grown in *L. longicalycata* and *Calamus* spp. are found in peat swamp or moist forests, respectively, while *E. guineensis* and *L. spinosa* are found in more open communities, which dry out more quickly. *E. guineensis* is grown in open plantation where the environment is drier, conditions that may favorite anamorphic fungi. Generally, anamorphic fungi sporulate more readily than ascomycetes, the latter requiring more nutrients and take longer to form fruit bodies.