

Checklist of freshwater fungi in Thailand

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Abstract – The Thai freshwater fungi are reviewed. Substrates range from baits (*Dipterocarpus alatus*, *Licuala longicalycata* and *Xylia dolabriformis*) to submerged natural wood, collected in northern (Chiang Mai and Chiang Rai), and southern (Narathiwat) and northeastern (Nakorn Ratchassima) parts of the kingdom. The checklist comprises 173 identified species (including 34 Ingoldian fungi) published up to the end of 2010 and is supported with references. The taxa belong to 112 genera, including 30 *Sordariomycetes*, 12 *Dothi-deomycetes* and 70 anamorphic genera. The most frequently collected genera are the hyphomycetes *Biflagellospora*, *Canalisporium*, *Dactylaria*, *Dictyosporium* and *Xylomyces*. Five new genera and 26 new species were first described from Thai freshwater habitats. Fungal diversity in different substrates and Sørensen's index in different sites are discussed.

Substrate / new species / Sørensen's index / lignicolous freshwater fungi

INTRODUCTION

Freshwater fungi are a complicated group because of their broad definition — “fungi that for the whole or part of their life cycle rely on freshwater” (Thomas, 1996). Lignicolous freshwater fungi comprise freshwater ascomycetes (Cai *et al.*, 2003b) and anamorphic fungi known as hyphomycetes and coelomycetes (Goh & Tsui, 2003) while Ingoldian fungi are usually found in river foam and occur on decaying submerged leaves. For methods to study freshwater fungi refer to Tsui *et al.* (2003).

Until the end of the last century, freshwater fungi have been reported from locations where mycologists were based or had visited and mainly including Australia (Hyde, 1992a, 1992b, 1993a, 1993b, 1995a, 1995b, 1995c, 1996; Hyde & Goh, 1998, 1999b; Hyde & Seifert, 1992; Hyde & Wong, 1999; Hyde *et al.*, 1996a, 1996b, 1997) and the USA (Shearer, 1989; Shearer & Crane, 1986) and UK (Hyde & Goh, 1999a; Kane *et al.*, 2002). Researchers have more recently focused on the other areas, such as Brunei (Fryar *et al.*, 2004; Ho *et al.*, 2001; Hyde *et al.*, 2002), China (Cai *et al.*, 2002, 2005; Luo *et al.*, 2004), Hong Kong (Tsui & Hyde,

2004; Tsui *et al.*, 2000, 2001, 2002) and Malaysia (Ho *et al.*, 2001). There have also been several papers on lignicolous freshwater fungi from Thailand (e.g. Jones *et al.*, 1999; Marvanová & Hywel-Jones, 2000; Sivichai & Boonyuen, 2010; Sivichai & Hywel-Jones, 1999; Sivichai *et al.*, 1998, 2000a; Sri-indrasutdhi *et al.*, 2010).

Tubaki was the first mycologist to survey the freshwater fungi in Thailand. He found 40 Ingoldian fungi from foam-samples (Tubaki *et al.*, 1983). Eighty species and 73 species were reported from the baited timbers (*Dipterocarpus alatus* and *Xylia dolabriformis*) respectively from two sites of northeastern Thailand (Sivichai *et al.*, 2000b, 2002). Sivichai & Boonyene (2004) reviewed freshwater higher fungi in Thailand and listed 158 identified genera. Subsequent studies on natural submerged wood were carried out in northern Thailand (Hu *et al.*, 2010; Kurniawati *et al.*, 2010). There is no publication that brings together all of these records. In this paper information on Thai freshwater fungi is therefore collated and reviewed. A checklist of identified Thai freshwater fungi published until 2010 is provided.

RESULTS

The collection plots

Most records of freshwater fungi were from the north (Chiang Mai and Chiang Rai), south (Narathiwat) and northeast (Nakorn Ratchassima) of Thailand (Fig. 1). Ingoldian fungi were surveyed from Kanchanaburi and Songkhla. Besides these provinces, collections of *Canalisporium* spp. have been made in Lop Buri, Petchaburi, Nakhon Nayok, Chanthaburi, Prachuap Khiri Khan and Krabi provinces (Sri-indrasutdhi *et al.*, 2010), while *Berkleasium typhae* Somrith. & E.B.G. Jones was collected in Pathum Thani (Somrithipol & Jones, 2003). Collection sites include mountain parks (Hu *et al.*, 2010; Kurniawati *et al.*, 2010) and peat swamp forests (Pinnoi *et al.*, 2006; Pinruan *et al.*, 2002, 2007). Habitats include lentic (e.g. lake: Hu *et al.*, 2010) and lotic sites (e.g. streams: Hu *et al.*, 2010; Kurniawati *et al.*, 2010; Sivichai *et al.*, 2000b) (Table 3).

Diversity of freshwater fungi in Thailand

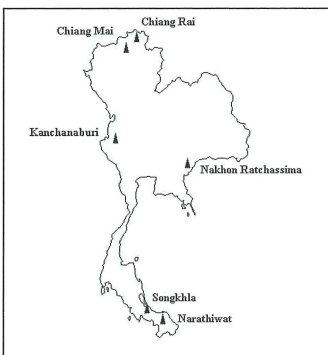


Fig. 1. The collection plots (<http://www.maps-gps-info.com/mp-th.html>).

A list of 173 Thai freshwater fungi which have been identified to species level until 2010 is provided alphabetically in Table 1. They belong to 112 genera, including species in 30 genera (25.9%) belonging to the *Sordariomycetes*, species in 12 genera (10.7%) belonging to the *Dothideomycetes* and 70 anamorphic genera (63.4%). The largest family is Annulatascaceae with 6 genera and 9 species (taxonomy based on Lumbsch & Huhndorf, 2010). The most frequent hyphomycetes are *Canalisporium* (7 species), *Dactylaria* (5 species), *Biflagellospora* (4 species) *Dictyosporium* (4 species) and *Xylomyces* (4 species).

Eighty-eight species have been reported from Nakorn Ratchassima, 57 species from Chiang Mai, 51 species from Narathiwat, 25 species from

Table 1. Checklist of Thai freshwater fungi reported to species level until the end of 2010, with host substrate, locations and references (**Bold** = New genera described from Thailand. * = New species described from Thailand)

<i>Species</i>	<i>Host/Substrate</i>	<i>Location</i>	<i>References</i>
<i>Acrogenospora</i>	Submerged wood	Chiang Mai	(Hu <i>et al.</i> , 2010)
<i>sphaerocephala</i> (Berk. & Broome) M.B. Ellis	Submerged wood <i>Xylia dolabriformis</i>	Chiang Rai Nakorn Ratchassima	(Kanamara <i>et al.</i> , 2010) (Sivichai <i>et al.</i> , 2000)
<i>Anguillospora gigantea</i> Ranzoni	Foam	Kanchanaburi	(Tubaki <i>et al.</i> , 1983)
<i>Anguillospora longissima</i> (Sacc. & P. Syd.) Ingold	Submerged wood Foam	Chiang Mai Kanchanaburi	(Hu <i>et al.</i> , 2010) (Tubaki <i>et al.</i> , 1983)
<i>Annulatascus aquaticus</i> W.H. Ho, K.D. Hyde & Hodgkiss	<i>Licuala longicalycata</i>	Narathiwat	(Pinruan <i>et al.</i> , 2007)
<i>Annulatascus velatispora</i> K.D. Hyde	<i>Licuala longicalycata</i> Submerged wood Submerged wood	Narathiwat Chiang Mai Chiang Rai	(Pinruan <i>et al.</i> , 2007) (Hu <i>et al.</i> , 2010) (Kanamara <i>et al.</i> , 2010)
<i>Annulusmagnus triseptatus</i> (S.W. Wong, K.D. Hyde & E.B.G. Jones) J. Campb. & Shearer	Submerged wood	Chiang Mai	(Hu <i>et al.</i> , 2010)
<i>Anthostomella aquatica</i> K.D. Hyde & Goh	<i>Dipterocarpus alatus</i> <i>Dipterocarpus alatus</i>	Nakorn Ratchassima Nakorn Ratchassima	(Sivichai <i>et al.</i> , 2002) (Sivichai <i>et al.</i> , 2000)
<i>Aquaphila albicans</i> Goh, K.D. Hyde & W.H. Ho	Submerged wood <i>Dipterocarpus alatus</i> <i>Xylia dolabriformis</i> Submerged wood <i>Dipterocarpus alatus</i>	Chiang Mai Nakorn Ratchassima Chiang Rai Nakorn Ratchassima	(Hu <i>et al.</i> , 2010) (Sivichai <i>et al.</i> , 2002) (Kanamara <i>et al.</i> , 2010) (Sivichai <i>et al.</i> , 2000)
<i>Aquasphaeria dimorphospora</i> K.D. Hyde	<i>Dipterocarpus alatus</i>	Nakorn Ratchassima	(Sivichai <i>et al.</i> , 2002)
<i>Aquaticola hyalomura</i> W.H. Ho, K.M. Tsui, Hodgkiss & K.D. Hyde	Submerged wood	Chiang Mai	(Hu <i>et al.</i> , 2010)
<i>Aquaticola longicolla</i> K.M. Tsui, Hodgkiss & K.D. Hyde	Submerged wood	Chiang Mai	(Hu <i>et al.</i> , 2010)
<i>Arecomyces epigenus</i> K.D. Hyde	<i>Licuala longicalycata</i>	Narathiwat	(Pinruan <i>et al.</i> , 2007)
<i>Ascominuta lignicola</i> Ranghoo & K.D. Hyde	<i>Licuala longicalycata</i> Submerged wood	Narathiwat Chiang Mai	(Pinruan <i>et al.</i> , 2007) (Hu <i>et al.</i> , 2010)
<i>Ascotaiwania sawadae</i> H.S. Chang & S.Y. Hsieh*	Submerged wood	Nakorn Ratchassima	(Sivichai <i>et al.</i> , 1998)
<i>Ascothailandia grenadoidea</i> Sri-Indrasutdhi, Boonyuen, Sivichai & E.B.G. Jones*	<i>Wrightia tomentosa</i>	Narathiwat	(Sri-Indrasutdhi <i>et al.</i> , 2010)
<i>Astrocystis eleiodoxae</i> A. Pinnoi, E.B.G. Jones & K.D. Hyde*	<i>Eleiodoxa conferta</i>	Narathiwat	(Pinnoi <i>et al.</i> , 2010)
<i>Astrosphaeriella angustispora</i> J. Fröhl. & K.D. Hyde	<i>Licuala longicalycata</i>	Narathiwat	(Pinruan <i>et al.</i> , 2007)

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<i>Species</i>	<i>Host/Substrate</i>	<i>Location</i>	<i>References</i>
<i>Astrosphaeriella stellata</i> (Pat.) Sacc.	Submerged wood	Chiang Rai	(Kanamara <i>et al.</i> , 2010)
<i>Astrosphaeriella striatasporea</i> (K.D. Hyde) K.D. Hyde	Submerged wood	Chiang Rai	(Kanamara <i>et al.</i> , 2010)
<i>Bactrodesmium longisporum</i> M.B. Ellis	Submerged wood	Chiang Mai	(Hu <i>et al.</i> , 2010)
Baipadspora <i>spathulosporea</i> Pinruan*	<i>Licuala longicalycata</i>	Narathiwat	(Pinruan <i>et al.</i> , 2007)
<i>Beltrania rhombica</i> Penz.	Foam	Songkhla	(Sakayaroj <i>et al.</i> , 2005)
<i>Berkleasium typhae</i> Somrith. & E.B.G. Jones*	<i>Typha angustifolia</i>	Pathum Thani	(Somrithipol & Jones, 2003)
	<i>Licuala longicalycata</i>	Narathiwat	(Pinruan <i>et al.</i> , 2007)
<i>Biflagellospora gracilis</i> Sivichai & Hywel-Jones*	Submerged wood	Nakorn Ratchassima	(Sivichai & Hywel-Jones, 1999)
	<i>Xylia dolabriformis</i>	Nakorn Ratchassima	(Sivichai <i>et al.</i> , 2000)
<i>Biflagellospora japonica</i> Matsush.	<i>Xylia dolabriformis</i>	Nakorn Ratchassima	(Sivichai <i>et al.</i> , 2002)
	<i>Xylia dolabriformis</i>	Nakorn Ratchassima	(Sivichai <i>et al.</i> , 2000)
<i>Biflagellospora papillata</i> Sivichai & Hywel-Jones*	<i>Typha angustifolia</i>	Nakorn Ratchassima	(Sivichai & Hywel-Jones, 1999)
	<i>Xylia dolabriformis</i>	Nakorn Ratchassima	(Sivichai <i>et al.</i> , 2002)
	<i>Xylia dolabriformis</i>	Nakorn Ratchassima	(Sivichai <i>et al.</i> , 2000)
<i>Biflagellospora siamensis</i> Sivichai & Hywel-Jones*	Submerged wood	Nakorn Ratchassima	(Sivichai & Hywel-Jones, 1999)
	<i>Xylia dolabriformis</i>	Nakorn Ratchassima	(Sivichai <i>et al.</i> , 2002)
	<i>Xylia dolabriformis</i>	Nakorn Ratchassima	(Sivichai <i>et al.</i> , 2000)
<i>Brachiosphaera tropicalis</i> Nawawi	Submerged wood	Chiang Rai	(Kanamara <i>et al.</i> , 2010)
	Foam	Songkhla	(Sakayaroj <i>et al.</i> , 2005)
	Foam	Chiang Mai Kanchanaburi	(Tubaki <i>et al.</i> , 1983)
<i>Brachydesmiella caudate</i> V. Rao & de Hoog	<i>Dipterocarpus alatus</i>	Nakorn Ratchassima	(Sivichai <i>et al.</i> , 2002)
	<i>Dipterocarpus alatus</i>	Nakorn Ratchassima	(Sivichai <i>et al.</i> , 2000)
<i>Brachydesmiella biseptata</i> G. Arnaud ex S. Hughes	<i>Anisoptera oblonga</i>	Nakorn Ratchassima	(Sivichai <i>et al.</i> , 1998)
<i>Brachydesmiella orientalis</i> (V. G. Rao & de Hoog) Goh	<i>Anisoptera oblonga</i>	Nakorn Ratchassima	(Sivichai <i>et al.</i> , 1998)
<i>Brachydesmiella verrucosa</i> Goh, Sivichai, K.D. Hyde & Hywel-Jones	<i>Dipterocarpus alatus</i>	Nakorn Ratchassima	(Sivichai <i>et al.</i> , 2002)
<i>Brachysporiella gayana</i> Bat.	Submerged wood	Chiang Rai	(Kanamara <i>et al.</i> , 2010)
<i>Camposporium cambrense</i> S. Hughes	Submerged wood	Chiang Rai	(Kanamara <i>et al.</i> , 2010)
<i>Campylospora chaetocladia</i> Ranzoni	Foam	Songkhla	(Sakayaroj <i>et al.</i> , 2005)
	Foam	Chiang Mai Kanchanaburi	(Tubaki <i>et al.</i> , 1983)

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<i>Campylospora filicladia</i> Nawawi	Foam	Songkhla	(Sakayaroj <i>et al.</i> , 2005)
<i>Canalisporium caribense</i> (Hol.-Jech. & Mercado) Nawawi & Kuthub.	Submerged wood	Chiang Mai	(Hu <i>et al.</i> , 2010)
	Submerged wood	Chiang Rai	(Kanamara <i>et al.</i> , 2010)
	Submerged wood	Narathiwat	(Sri-indrasutdhi <i>et al.</i> , 2010)
	Submerged wood	Lop Buri	(Sri-indrasutdhi <i>et al.</i> , 2010)
	<i>Xylia dolabriformis</i>	Nakorn Ratchassima	(Sivichai <i>et al.</i> , 2000)
<i>Canalisporium exiguum</i> Goh & K.D. Hyde	Submerged wood	Chanthaburi	(Sri-indrasutdhi <i>et al.</i> , 2010)
	<i>Dipterocarpus alatus</i> <i>Xylia dolabriformis</i>	Nakorn Ratchassima	(Sivichai <i>et al.</i> , 2000)
<i>Canalisporium pallidum</i> Goh, W.H. Ho & K.D. Hyde	<i>Xylia dolabriformis</i>	Nakorn Ratchasima	(Sri-indrasutdhi <i>et al.</i> , 2010)
	<i>Xylia dolabriformis</i>	Nakorn Ratchassima	(Sivichai <i>et al.</i> , 2000)
<i>Canalisporium variabile</i> Goh & K.D. Hyde	<i>Licuala longicalycata</i>	Narathiwat	(Pinruan <i>et al.</i> , 2007)
<i>Canalisporium elegans</i> Nawawi & Kuthub.	<i>Xylia dolabriformis</i> , <i>Stereospermum</i> <i>neuranthum</i>	Nakorn Ratchasima	(Sri-indrasutdhi <i>et al.</i> , 2010)
	<i>Dipterocarpus alatus</i> <i>Xylia dolabriformis</i>	Nakorn Ratchassima	(Sivichai <i>et al.</i> , 2000)
<i>Canalisporium</i> <i>jinghongensis</i> L. Cai, K.D. Hyde & McKenzie	Submerged wood	Prachuap Khiri Khan	(Sri-indrasutdhi <i>et al.</i> , 2010)
	Submerged wood	Ratchaburi	(Sri-indrasutdhi <i>et al.</i> , 2010)
<i>Canalisporium pulchrum</i> (Hol.-Jech. & Mercado) Nawawi & Kuthub.	Submerged wood	Krabi	(Sri-indrasutdhi <i>et al.</i> , 2010)
	<i>Alstonia scholaris</i>	Nakorn Ratchassima	(Sri-indrasutdhi <i>et al.</i> , 2010)
	Submerged wood	Nakhon Nayok	(Sri-indrasutdhi <i>et al.</i> , 2010)
	Submerged leaf	Narathiwat	(Sri-indrasutdhi <i>et al.</i> , 2010)
	<i>Dipterocarpus alatus</i> <i>Xylia dolabriformis</i>	Nakorn Ratchassima	(Sivichai <i>et al.</i> , 2000)
<i>Cancellidium applanatum</i> Tubaki	<i>Licuala longicalycata</i>	Narathiwat	(Pinruan <i>et al.</i> , 2007)
	<i>Dipterocarpus alatus</i> <i>Xylia dolabriformis</i>	Nakorn Ratchassima	(Sivichai <i>et al.</i> , 2002)
<i>Candelabrum brocchiatum</i> Tubaki	<i>Licuala longicalycata</i>	Narathiwat	(Pinruan <i>et al.</i> , 2007)
	Submerged wood	Chiang Mai	(Hu <i>et al.</i> , 2010)
	<i>Dipterocarpus alatus</i> <i>Xylia dolabriformis</i>	Nakorn Ratchassima	(Sivichai <i>et al.</i> , 2002)
	<i>Dipterocarpus alatus</i> <i>Xylia dolabriformis</i>	Nakorn Ratchassima	(Sivichai <i>et al.</i> , 2000)
<i>Caryospora minima</i> Jeffers	Submerged wood	Chiang Mai	(Hu <i>et al.</i> , 2010)

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<i>Cataractispora aquatica</i> K.D. Hyde, S.W. Wong & E.B.G. Jones	Submerged wood	Chiang Rai	(Kanamara <i>et al.</i> , 2010)
<i>Cercophora terricola</i> S. Ueda	Submerged wood	Chiang Mai	(Hu <i>et al.</i> , 2010)
<i>Chaetopsina fulva</i> Rambelli	<i>Dipterocarpus alatus</i> <i>Xylia dolabriformis</i>	Nakorn Ratchassima Nakorn Ratchassima	(Sivichai <i>et al.</i> , 2002) (Sivichai <i>et al.</i> , 2000)
<i>Chaetopsina penicillata</i> Samuels	<i>Xylia dolabriformis</i> <i>Xylia dolabriformis</i>	Nakorn Ratchassima Nakorn Ratchassima	(Sivichai <i>et al.</i> , 2002) (Sivichai <i>et al.</i> , 2000)
<i>Chaetospermum camelliae</i> Agnihotr.	<i>Licuala longicalycata</i> Foam	Narathiwat Songkhla	(Pinruan <i>et al.</i> , 2007) (Sakayaroj <i>et al.</i> , 2005)
<i>Clavariopsis aquatica</i> De Wild.	Foam	Chiang Mai	(Tubaki <i>et al.</i> , 1983)
<i>Clavatospora filiformis</i> Nawawi	<i>Xylia dolabriformis</i> Submerged wood	Nakorn Ratchassima Chiang Rai	(Sivichai <i>et al.</i> , 2002) (Kanamara <i>et al.</i> , 2010)
<i>Clavatospora tentacula</i> Sv. Nilsson	Foam	Chiang Mai Kanchanaburi	(Tubaki <i>et al.</i> , 1983)
<i>Condylospora spumigena</i> Agnihotr.	Foam	Songkhla	(Sakayaroj <i>et al.</i> , 2005)
<i>Cosmospora chaetopsinae</i> (Samuels) Rossman & Samuels	<i>Xylia dolabriformis</i>	Nakorn Ratchassima	(Sivichai <i>et al.</i> , 2002)
<i>Cosmospora chaetopsinae</i> - polyblastiae (Samuels) Rossman & Samuels	<i>Xylia dolabriformis</i> <i>Xylia dolabriformis</i>	Nakorn Ratchassima Nakorn Ratchassima	(Sivichai <i>et al.</i> , 2002) (Sivichai <i>et al.</i> , 2000)
<i>Cryptophiale manifesta</i> B. Sutton & Hodges	<i>Licuala longicalycata</i>	Narathiwat	(Pinruan <i>et al.</i> , 2007)
<i>Cryptophiale udagawae</i> Pirozynski & Ichinoe	<i>Dipterocarpus alatus</i>	Nakorn Ratchassima	(Sivichai <i>et al.</i> , 2002)
<i>Curvularia robusta</i> Kilp. & Luttr.	Submerged wood	Chiang Mai	(Hu <i>et al.</i> , 2010)
<i>Custingophora undulatistipes</i> Pinnoi*	<i>Eleiodoxa conferta</i>	Narathiwat	(Pinnoi <i>et al.</i> , 2003a)
<i>Dactylaria triseptata</i> (Matsush.) R.F. Castañeda & W.B. Kendr.	Submerged wood	Chiang Mai	(Hu <i>et al.</i> , 2010)
<i>Dactylaria lakebarrinensis</i> Goh & K.D. Hyde	<i>Dipterocarpus alatus</i>	Nakorn Ratchassima	(Sivichai <i>et al.</i> , 2000)
<i>Dactylaria uliginicola</i> Pinnoi, E.B.G. Jones, Mckenzie, & K.D. Hyde*	<i>Eleiodoxa conferta</i>	Narathiwat	(Pinnoi <i>et al.</i> , 2003b)
<i>Dactylaria palmae</i> Pinnoi, E.B.G. Jones, Mckenzie, & K.D. Hyde*	<i>Eleiodoxa conferta</i>	Narathiwat	(Pinnoi <i>et al.</i> , 2003b)
<i>Dactylaria flammuli-</i> <i>cornuta</i> Pinnoi, E.B.G. Jones, Mckenzie, & K.D. Hyde*	<i>Eleiodoxa conferta</i>	Narathiwat	(Pinnoi <i>et al.</i> , 2003b)

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<i>Dactylella passalopaga</i> Drechsler	Submerged wood	Chiang Mai	(Hu <i>et al.</i> , 2010)
<i>Delortia palmicola</i> Pat. & Gaillard	<i>Licuala longicalycata</i>	Narathiwat	(Pinruan <i>et al.</i> , 2007)
<i>Dendrospora tenella</i> Descals & J. Webster	Foam	Kanchanaburi	(Tubaki <i>et al.</i> , 1983)
<i>Dendrosporium lobatum</i> <i>Plakidas</i> & Edgerton ex J.L. Crane	<i>Xylia dolabriformis</i> <i>Dipterocarpus alatus</i>	Nakorn Ratchassima Nakorn Ratchassima	(Sivichai <i>et al.</i> , 2002) (Sivichai <i>et al.</i> , 2000)
<i>Dictyochaeta gyrosetula</i> Kuthub., Nawawi & G.M. Liew	<i>Xylia dolabriformis</i> <i>Xylia dolabriformis</i>	Nakorn Ratchassima Nakorn Ratchassima	(Sivichai <i>et al.</i> , 2002) (Sivichai <i>et al.</i> , 2000)
<i>Dictyochaetopsis</i> <i>gonytrichoides</i> (Shearer & J.L. Crane) Whitton, McKenzie & K.D. Hyde	Submerged wood	Chiang Mai	(Hu <i>et al.</i> , 2010)
<i>Dictyosporium digitatum</i> J.L. Chen, Hwang & S.S.Tzean	<i>Dipterocarpus alatus</i>	Nakorn Ratchassima	(Sivichai <i>et al.</i> , 2002)
<i>Dictyosporium elegans</i> Corda	<i>Dipterocarpus alatus</i>	Nakorn Ratchassima	(Sivichai <i>et al.</i> , 2002)
<i>Dictyosporium nigroapice</i> Goh, W.H. Ho & K.D. Hyde	<i>Dipterocarpus alatus</i>	Nakorn Ratchassima	(Sivichai <i>et al.</i> , 2002)
<i>Dictyosporium</i> <i>subramanianii</i> B. Sutton	<i>Dipterocarpus alatus</i> Submerged wood	Nakorn Ratchassima Chiang Rai	(Sivichai <i>et al.</i> , 2002) (Kanamara <i>et al.</i> , 2010)
<i>Didymella aptrootii</i> K.D. Hyde & S.W. Wong	Submerged wood	Chiang Rai	(Kanamara <i>et al.</i> , 2010)
<i>Didymosphaeria</i> <i>bisphaerica</i> (Cooke & Ellis) Scheinpflug	<i>Licuala longicalycata</i>	Narathiwat	(Pinruan <i>et al.</i> , 2007)
<i>Diplocladiella</i> <i>appendiculata</i> Nawawi	Foam	Songkhla	(Sakayaroj <i>et al.</i> , 2005)
<i>Diplocladiella scalaroides</i> G. Arnaud ex M.B. Ellis	Foam	Songkhla	(Sakayaroj <i>et al.</i> , 2005)
<i>Ellisembia brachypus</i> (Ellis & Everh.) Subram.	<i>Dipterocarpus alatus</i> <i>Dipterocarpus alatus</i> <i>Xylia dolabriformis</i>	Nakorn Ratchassima Nakorn Ratchassima	(Sivichai <i>et al.</i> , 2002) (Sivichai <i>et al.</i> , 2000)
<i>Ellisembia opaca</i> (Cooke & Harkn.) Subram.	<i>Dipterocarpus alatus</i> <i>Xylia dolabriformis</i>	Nakorn Ratchassima	(Sivichai <i>et al.</i> , 2000)
<i>Exserticlava globosa</i> V. Rao & de Hoog	Submerged wood	Chiang Mai	(Hu <i>et al.</i> , 2010)
<i>Exserticlava yunnanensis</i> L. Cai & K.D. Hyde	Submerged wood	Chiang Mai	(Hu <i>et al.</i> , 2010)
<i>Flabellospora crassa</i> <i>crassa</i> Alas.	Foam	Songkhla	(Sakayaroj <i>et al.</i> , 2005)

Table 1. Checklist of Thai freshwater fungi reported to species level until the end of 2010, with host substrate, locations and references (**Bold** = New genera described from Thailand. * = New species described from Thailand) (*continued*)

<i>Species</i>	<i>Host/Substrate</i>	<i>Location</i>	<i>References</i>
<i>Flabellospora multiradiata</i> Nawawi	Foam	Songkhla	(Sakayaroj <i>et al.</i> , 2005)
<i>Flabellospora verticillata</i> Alas.	Foam Foam	Songkhla Kanchanaburi	(Sakayaroj <i>et al.</i> , 2005) (Tubaki <i>et al.</i> , 1983)
<i>Flammispora</i> <i>bioteca</i> Pinruan, Sakay., K.D. Hyde & E.B.G. Jones*	<i>Licuala longicalycata</i>	Narathiwat	(Pinruan <i>et al.</i> , 2004b) (Pinruan <i>et al.</i> , 2007)
<i>Fluminicola bipolaris</i> S.W. Wong, K.D. Hyde & E.B.G. Jones	<i>Licuala longicalycata</i> Submerged wood	Narathiwat Chiang Rai	(Pinruan <i>et al.</i> , 2007) (Kanamara <i>et al.</i> , 2010)
<i>Goidanichiella fusiformis</i> K.D. Hyde, Yanna, Pinnoi & E.B.G. Jones*	<i>Eleiodoxa conferta</i>	Narathiwat	(Hyde <i>et al.</i> , 2002)
<i>Gonytrichum macro-</i> <i>cladum</i> (Sacc.) S. Hughes	Submerged wood	Chiang Rai	(Kanamara <i>et al.</i> , 2010)
<i>Halosarpehia aquadulcis</i> S.Y. Hsieh, H.S. Chang et E. B. G. Jones	<i>Dipterocarpus alatus</i> <i>Xylia dolabriformis</i> Submerged wood <i>Xylia dolabriformis</i>	Nakorn Ratchassima Chiang Rai Nakorn Ratchassima	(Sivichai <i>et al.</i> , 2002) (Kanamara <i>et al.</i> , 2010) (Sivichai <i>et al.</i> , 2000)
<i>Helicomycetes roseus</i> Link	<i>Dipterocarpus alatus</i> <i>Xylia dolabriformis</i> Submerged wood <i>Dipterocarpus alatus</i> <i>Xylia dolabriformis</i>	Nakorn Ratchassima Chiang Mai Nakorn Ratchassima	(Sivichai <i>et al.</i> , 2002) (Hu <i>et al.</i> , 2010) (Sivichai <i>et al.</i> , 2000)
<i>Helicosporium griseum</i> Berk. & M.A. Curtis	Submerged wood	Chiang Mai	(Hu <i>et al.</i> , 2010)
<i>Helicosporium guianense</i> Linder	Submerged wood	Chiang Mai	(Hu <i>et al.</i> , 2010)
<i>Hymenoscyphus</i> <i>tetracladius</i> Abdullah, Descals & J. Webster	Foam	Chiang Mai	(Tubaki <i>et al.</i> , 1983)
<i>Hymenoscyphus</i> <i>varicosporoides</i> Tubaki	<i>Dipterocarpus alatus</i> <i>Xylia dolabriformis</i>	Nakorn Ratchassima	(Sivichai <i>et al.</i> , 2002)
<i>Ingoldiella hamata</i> D.E. Shaw	Foam	Songkhla	(Sakayaroj <i>et al.</i> , 2005)
<i>Isthmotricladia</i> <i>gombakiensis</i> Nawawi	Foam Foam	Songkhla Kanchanaburi	(Sakayaroj <i>et al.</i> , 2005) (Tubaki <i>et al.</i> , 1983)
<i>Isthmotricladia laeensis</i> Matsush.	Foam Foam	Songkhla Kanchanaburi	(Sakayaroj <i>et al.</i> , 2005) (Tubaki <i>et al.</i> , 1983)
<i>Jaculispora submersa</i> H.J. Huds. & Ingold	<i>Dipterocarpus alatus</i>	Nakorn Ratchassima	(Sivichai <i>et al.</i> , 2000)
<i>Jahnula appendiculata</i> Pinruan, K.D. Hyde & E.B.G. Jones*	<i>Licuala longicalycata</i>	Narathiwat	(Pinruan <i>et al.</i> , 2002) (Pinruan <i>et al.</i> , 2007)
<i>Jahnula morakotii</i> Sivichai & Boonyuen*	<i>Licuala longicalycata</i>	Narathiwat	(Sivichai & Boonyuen, 2010)

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<i>Species</i>	<i>Host/Substrate</i>	<i>Location</i>	<i>References</i>
<i>Jahnula siamensis</i> Sivichai & E.B.G. Jones*	Submerged twigs	Nakorn Ratchassima	(Pang <i>et al.</i> , 2002)
<i>Lemonniera cornuta</i> Ranzoni	Foam	Kanchanaburi	(Tubaki <i>et al.</i> , 1983)
<i>Leptosphaeria ginimia</i> K.M. Tsui, K.D. Hyde & Hodgkiss	Submerged wood	Chiang Mai	(Hu <i>et al.</i> , 2010)
<i>Lichenopeltella</i> <i>quinquecladiopsis</i> (E.B.G. Jones, Sivichai & Hywel-Jones) E.B.G. Jones & D. Hawksw.*	Submerged twigs	Chiang Mai	(Jones and Hawksworth 2001)
<i>Lindgomyces ingoldianus</i> (Shearer & K.D. Hyde) K. Hirayama, Kaz. Tanaka & Shearer	<i>Dipterocarpus alatus</i>	Nakorn Ratchassima	(Sivichai <i>et al.</i> , 2002)
<i>Lophiostoma</i> <i>armatisporum</i> (K.D. Hyde, Vrijmoed, Chinnaraj & E.B.G. Jones) E.C.Y. Liew, Aptroot & K.D. Hyde	Submerged wood	Chiang Mai	(Hu <i>et al.</i> , 2010)
<i>Lophiostoma</i> <i>frondisubmersum</i> (K.D. Hyde) E.C.Y. Liew, Aptroot & K.D. Hyde	<i>Licuala longicalycata</i> Submerged wood	Narathiwat Chiang Rai	(Pinruan <i>et al.</i> , 2007) (Kanamara <i>et al.</i> , 2010)
<i>Lunulospora curvula</i> Ingold	Foam	Kanchanaburi	(Tubaki <i>et al.</i> , 1983)
<i>Lunulospora cymbiformis</i> K. Miura	Foam Foam	Songkhla Chiang Mai	(Sakayaroj <i>et al.</i> , 2005) (Tubaki <i>et al.</i> , 1983)
<i>Mariannaea aquaticola</i> L. Cai & K.D. Hyde	Submerged wood Submerged wood	Chiang Mai Chiang Rai	(Hu <i>et al.</i> , 2010) (Kanamara <i>et al.</i> , 2010)
<i>Massarina bipolaris</i> K.D. Hyde	<i>Licuala longicalycata</i> <i>Dipterocarpus alatus</i>	Narathiwat Nakorn Ratchassima	(Pinruan <i>et al.</i> , 2007) (Sivichai <i>et al.</i> , 2000)
<i>Massarina thalassioidea</i> K.D. Hyde & Aptroot	Submerged wood	Chiang Rai	(Kanamara <i>et al.</i> , 2010)
<i>Megalohypha aqua-dulces</i> A. Ferrer et Shearer	Submerged wood	Krabi	(Ferrer <i>et al.</i> , 2007)
<i>Melanochaeta garethjonesii</i> Sivichai & Hywel-Jones*	Submerged wood	Nakorn Ratchassima	(Sivichai <i>et al.</i> , 2000)
<i>Melanochaeta hemipsila</i> (Berk. & Broome) E. Müll., Harr & Sulmont	<i>Dipterocarpus alatus</i> Submerged wood <i>Dipterocarpus alatus</i>	Nakorn Ratchassima Chiang Mai Nakorn Ratchassima	(Sivichai <i>et al.</i> , 2002) (Hu <i>et al.</i> , 2010) (Sivichai <i>et al.</i> , 2000)
<i>Monacrosporium</i> <i>tentaculatum</i> A. Rubner & W. Gams	Foam	Songkhla	(Sakayaroj <i>et al.</i> , 2005)

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<i>Monodictys fluctuata</i> (Tandon & Bilgrami) M.B. Ellis	Submerged wood	Chiang Mai	(Hu <i>et al.</i> , 2010)
<i>Monodictys melanocephaloides</i> Goh & K.D. Hyde	Submerged wood	Chiang Mai	(Hu <i>et al.</i> , 2010)
<i>Monodictys paradoxa</i> (Corda) S. Hughes	Submerged wood	Chiang Mai	(Hu <i>et al.</i> , 2010)
<i>Monotosporella setosa</i> var. <i>macrospora</i> S. Hughes	<i>Xylia dolabriformis</i>	Nakorn Ratchassima	(Sivichai <i>et al.</i> , 2000)
<i>Monotosporella rhizoidea</i> V. Rao & de Hoog	<i>Licuala longicalycata</i>	Narathiwat	(Pinruan <i>et al.</i> , 2007)
<i>Monotosporella setosa</i> (Berk. & M.A. Curtis) S. Hughes	Submerged wood	Chiang Mai	(Hu <i>et al.</i> , 2010)
<i>Mukhakesa lignicola</i> Udaiyan & V.S. Hosag.	Submerged wood	Chiang Mai	(Hu <i>et al.</i> , 2010)
<i>Nectria chaetopsinae</i> Samuels	<i>Xylia dolabriformis</i>	Nakorn Ratchassima	(Sivichai <i>et al.</i> , 2000)
<i>Ophioceras commune</i> Shearer, J.L. Crane & W. Chen	Submerged wood	Chiang Rai	(Kanamara <i>et al.</i> , 2010)
<i>Ophioceras dolichostomum</i> (Berk. & M.A. Curtis) Sacc.	<i>Dipterocarpus alatus</i> <i>Dipterocarpus alatus</i> <i>Xylia dolabriformis</i>	Nakorn Ratchassima Nakorn Ratchassima	(Sivichai <i>et al.</i> , 2002) (Sivichai <i>et al.</i> , 2000)
<i>Ophioceras leptosporum</i> (S.H. Iqbal) J. Walker	Submerged wood	Chiang Mai	(Hu <i>et al.</i> , 2010)
<i>Oxydothis frondicola</i> K.D. Hyde	<i>Licuala longicalycata</i>	Narathiwat	(Pinruan <i>et al.</i> , 2007)
<i>Phaeoisaria clematidis</i> (Fuckel) S. Hughes	<i>Licuala longicalycata</i> <i>Dipterocarpus alatus</i> Submerged wood	Narathiwat Nakorn Ratchassima Chiang Mai	(Pinruan <i>et al.</i> , 2007) (Sivichai <i>et al.</i> , 2002) (Hu <i>et al.</i> , 2010)
<i>Phalangispora constricta</i> Nawawi & J. Webster	Foam Foam	Songkhla Chiang Mai	(Sakayaroj <i>et al.</i> , 2005) (Tubaki <i>et al.</i> , 1983)
<i>Phruensis brunneispora</i> Pinruan*	Submerged palm	Narathiwat	(Pinruan <i>et al.</i> , 2004a)
<i>Pseudofuscophialis lignicola</i> Sivan. & H.S. Chang	Submerged wood	Chiang Mai	(Hu <i>et al.</i> , 2010)
<i>Pseudohalonectria lignicola</i> Minoura & T. Muroi	Submerged wood	Chiang Rai	(Kanamara <i>et al.</i> , 2010)
<i>Rhexoacrodictys erecta</i> (Ellis & Everh.) W.A. Baker & Morgan-Jones	Submerged wood	Chiang Rai	(Kanamara <i>et al.</i> , 2010)

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<i>Species</i>	<i>Host/Substrate</i>	<i>Location</i>	<i>References</i>
<i>Rosellinia corticium</i> (Schwein.) Sacc.	<i>Licuala longicalycata</i>	Narathiwat	(Pinruan <i>et al.</i> , 2007)
<i>Savoryella aquatica</i> K.D. Hyde	<i>Dipterocarpus alatus</i> <i>Xylia dolabriformis</i>	Nakorn Ratchassima	(Sivichai <i>et al.</i> , 2002)
	<i>Dipterocarpus alatus</i> <i>Xylia dolabriformis</i>	Nakorn Ratchassima	(Sivichai <i>et al.</i> , 2000)
<i>Savoryella lignicola</i> E.B.G. Jones & R.A. Eaton	Submerged wood Submerged wood	Chiang Mai Chiang Rai	(Hu <i>et al.</i> , 2010) (Kanamara <i>et al.</i> , 2010)
<i>Savoryella verrucosa</i> Minoura & T. Muroi	<i>Dipterocarpus alatus</i> <i>Xylia dolabriformis</i>	Nakorn Ratchassima	(Sivichai <i>et al.</i> , 2002)
<i>Scutisporus brunneus</i> K. Ando & Tubaki	<i>Xylia dolabriformis</i> <i>Xylia dolabriformis</i>	Nakorn Ratchassima Nakorn Ratchassima	(Sivichai <i>et al.</i> , 2002) (Sivichai <i>et al.</i> , 2000)
<i>Sigmoidea contorta</i> Marvanová & Hywel-Jones*	Submerged wood	Thailand	(Marvanová and Hywel-Jones 2000)
<i>Speiropsis irregularis</i> R.H. Petersen	Foam	Kanchanaburi	(Tubaki <i>et al.</i> , 1983)
<i>Spirosphaera carici-graminis</i> Voglmayr	Submerged wood	Chiang Mai	(Hu <i>et al.</i> , 2010)
<i>Spirosphaera floriformis</i> Beverw.	Submerged wood	Chiang Mai	(Hu <i>et al.</i> , 2010)
<i>Sporidesmiella hyalosperma</i> (Corda) P.M. Kirk	<i>Dipterocarpus alatus</i> <i>Xylia dolabriformis</i> Submerged wood	Nakorn Ratchassima Chiang Mai	(Sivichai <i>et al.</i> , 2002) (Hu <i>et al.</i> , 2010)
<i>Sporidesmium tropicale</i> M.B. Ellis	Submerged wood Foam	Chiang Mai Songkhla	(Hu <i>et al.</i> , 2010) (Sakayaroj <i>et al.</i> , 2005)
<i>Sporoschisma uniseptatum</i> Bhat & W.B. Kendr.	<i>Dipterocarpus alatus</i> Submerged wood <i>Dipterocarpus alatus</i> <i>Xylia dolabriformis</i>	Nakorn Ratchassima Chiang Mai Nakorn Ratchassima	(Sivichai <i>et al.</i> , 2002) (Hu <i>et al.</i> , 2010) (Sivichai <i>et al.</i> , 2000)
<i>Stilbella holubovae</i> Seifert, S.J. Stanley & K.D. Hyde	<i>Xylia dolabriformis</i>	Nakorn Ratchassima	(Sivichai <i>et al.</i> , 2002)
<i>Submersisphaeria aquatica</i> K.D. Hyde	<i>Licuala longicalycata</i>	Narathiwat	(Pinruan <i>et al.</i> , 2007)
<i>Submersisphaeria palmae</i> A. Pinnoi*	<i>Eleiodoxa conferta</i>	Narathiwat	(Pinnoi <i>et al.</i> , 2004)
<i>Tetracladium marchalianum</i> De Wild.	Foam	Chiang Mai	(Tubaki <i>et al.</i> , 1983)
<i>Tetraploa aristata</i> Berk. & Broome = <i>Tetraplophaeria tetraploa</i> (Scheuer) Kaz. Tanaka & K. Hirayama	Submerged wood	Chiang Rai	(Kanamara <i>et al.</i> , 2010)
<i>Thailandiomyces</i> <i>bisetulosus</i> Pinruan, Sakay., K.D. Hyde & E.B.G. Jones*	<i>Licuala longicalycata</i>	Narathiwat	(Pinruan <i>et al.</i> , 2008)

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<i>Thozetella nivea</i> (Berk.) Kuntze	<i>Dipterocarpus alatus</i> <i>Xylia dolabriformis</i>	Nakorn Ratchassima	(Sivichai <i>et al.</i> , 2002)
	<i>Dipterocarpus alatus</i> <i>Xylia dolabriformis</i>	Nakorn Ratchassima	(Sivichai <i>et al.</i> , 2000)
<i>Tricladium aciculium</i> Nawawi	Foam	Songkhla	(Sakayaroj <i>et al.</i> , 2005)
<i>Trinacrium subtile</i> Riess	Foam	Kanchanaburi	(Tubaki <i>et al.</i> , 1983)
<i>Tripospermum prolongatum</i> R.C. Sinclair & Morgan-Jones	Foam	Kanchanaburi	(Tubaki <i>et al.</i> , 1983)
<i>Triscelophorus acuminatus</i> Nawawi	Foam Foam	Songkhla Chiang Mai Kanchanaburi	(Sakayaroj <i>et al.</i> , 2005) (Tubaki <i>et al.</i> , 1983)
<i>Thozetella radicata</i> (E.F. Morris) Piroz. & Hodges	<i>Licuala longicalycata</i>	Narathiwat	(Pinruan <i>et al.</i> , 2007)
<i>Tubeufia cylindrothecia</i> (Seaver) Höhn.	<i>Dipterocarpus alatus</i>	Nakorn Ratchassima	(Sivichai <i>et al.</i> , 2000)
<i>Tubeufia clasphisphaeria</i> Kodsueb	<i>Licuala longicalycata</i> <i>Dipterocarpus alatus</i>	Narathiwat Nakorn Ratchassima	(Pinruan <i>et al.</i> , 2007) (Sivichai <i>et al.</i> , 2002)
<i>Unichaetosphaeria penguinoidea</i> Pinnoi, E.B.G. Jones, Mckenzie & K.D. Hyde*	<i>Eleiodoxa conferta</i>	Narathiwat	(Pinnoi <i>et al.</i> , 2003b)
<i>Vanakripa minutiellipsoidea</i> Pinnoi*	<i>Eleiodoxa conferta</i>	Narathiwat	(Pinnoi <i>et al.</i> , 2003a)
<i>Varicosporium giganteum</i> J.L. Crane	Foam	Songkhla	(Sakayaroj <i>et al.</i> , 2005)
<i>Varicosporium macrosporum</i> Nawawi	Foam	Songkhla	(Sakayaroj <i>et al.</i> , 2005)
<i>Vermispora spermato-phaga</i> (Drechsler) J. Chen, L.L. Xu, B. Liu & Xing Z. Liu	Submerged wood	Chiang Mai	(Hu <i>et al.</i> , 2010)
<i>Wiesneriomyces laurinus</i> (Tassi) P.M. Kirk	<i>Licuala longicalycata</i> <i>Dipterocarpus alatus</i> <i>Xylia dolabriformis</i>	Narathiwat Nakorn Ratchassima	(Pinruan <i>et al.</i> , 2007) (Sivichai <i>et al.</i> , 2000)
<i>Xenokylindria ciliata</i> Onofri & Rambelli	Submerged wood	Chiang Mai	(Hu <i>et al.</i> , 2010)
<i>Xylomyces aquaticus</i> (Dudka) K.D. Hyde & Goh	<i>Dipterocarpus alatus</i> <i>Xylia dolabriformis</i> <i>Licuala longicalycata</i>	Nakorn Ratchassima Narathiwat	(Sivichai <i>et al.</i> , 2002) (Pinruan <i>et al.</i> , 2007)
<i>Xylomyces chlamydosporus</i> Goos, R.D. Brooks & Lamore	Submerged wood <i>Dipterocarpus alatus</i>	Chiang Rai Nakorn Ratchassima	(Kanamara <i>et al.</i> , 2010) (Sivichai <i>et al.</i> , 2000)
<i>Xylomyces elegans</i> Goh, W.H. Ho, K.D. Hyde & K.M. Tsui	<i>Dipterocarpus alatus</i> <i>Xylia dolabriformis</i> <i>Dipterocarpus alatus</i> <i>Xylia dolabriformis</i>	Nakorn Ratchassima Nakorn Ratchassima	(Sivichai <i>et al.</i> , 2002) (Sivichai <i>et al.</i> , 2000)
<i>Xylomyces giganteus</i> Goh, W.H. Ho, K.D. Hyde & K.M. Tsui	Submerged wood	Chiang Mai	(Hu <i>et al.</i> , 2010)

Chiang Rai, 22 species from Songkhla and 15 species from Kanchanaburi provinces. This may indicate that the fungal diversity in northeast Thailand is more abundant than other parts, but is more likely to represent intensity of studies. Interestingly, some common freshwater species such as *Canalisporium caribense* (Hol.-Jech. & Mercado) Nawawi & Kuthub. can be found at nearly every site investigated, no matter test blocks or naturally submerged wood, except for being absent in one artificial lake in Chiang Mai. *Acrogenospora sphaerocephala* (Berk. & Broome) M.B. Ellis, *Annulatasacus velatispora* K.D. Hyde, *Aquaphila albicans* Goh, K.D. Hyde & W.H. Ho, *Canalisporium pulchrum* (Hol.-Jech. & Mercado) Nawawi & Kuthub., *Candelabrum brocciatum* Tubaki, *Helicomycetes roseus* Link and *Phaeoisaria clematidis* (Fuckel) S. Hughes were found at least at three different sites.

Another 87 taxa were only reported to generic level and are not included in Table 1 but are listed in Table 2. The species identities of these collections await future study. Totally, 199 genera were reported from Thailand until 2010 and 36 genera are new reports since 2004 (Sivichai & Boonyene, 2004).

Table 2. Generic names of Thai freshwater fungi not included in Table 1

<i>Acanthophysis</i> -like	<i>Dinemasporium</i>	<i>Lateriramulosa</i>	<i>Pleospora</i>
<i>Alatospora</i>	<i>Elegantimyces</i>	<i>Linocarpon</i>	<i>Potamomyces</i>
<i>Aniptodera</i>	<i>Erynia</i>	<i>Lophiotrema</i>	<i>Pseudobeltrania</i>
<i>Apostemidium</i>	<i>Flabellocladia</i>	<i>Mamillisphaeria</i>	<i>pseudospiropes</i>
<i>Articulospora</i>	<i>Flagellospora</i>	<i>Margaritispora</i>	<i>Pycnidial</i>
<i>Basipetospora</i>	<i>Fusarium</i>	<i>Melanocephala</i>	<i>Robillarda</i>
<i>Bionectria</i>	<i>Gangliostilbe</i>	<i>Melanomma</i>	<i>Scorpiosporium</i>
<i>Boerlagiomyces</i>	<i>Geniculospora</i>	<i>Menisporopsis</i>	<i>Septosporium</i>
<i>Bombardia</i>	<i>Geniculosporium</i>	<i>Microascus</i>	<i>Spadicoides</i>
<i>Centrospora</i>	<i>Gnomonia</i>	<i>Micropeltis</i>	<i>Taeniolella</i>
<i>Chloridium</i>	<i>Helicoma</i>	<i>Microthyrium</i>	<i>Teichospora</i>
<i>Cirrenalia</i>	<i>Helicoon</i>	<i>Mirandina</i>	<i>Tetrachaetum</i>
<i>Coniochaeta</i>	<i>Heliscus</i>	<i>Mycocalia</i>	<i>Tirisporella</i>
<i>Coprinms</i>	<i>Helminthosporium</i>	<i>Neurospora</i>	<i>Trematosphaeria</i>
<i>Corynesporium</i>	<i>Hypocrea</i>	<i>Obeliospora</i>	<i>Trichocladium</i>
<i>Culicidospora</i>	<i>Hysterium</i>	<i>Olpitrichum</i>	<i>Trichoderma</i>
<i>Cylindrocarpon</i>	<i>Hysterographium</i>	<i>Ophiobolus</i>	<i>Trichosphaeria</i>
<i>Delitschia</i>	<i>Kionochaeta</i>	<i>Penicillium</i>	<i>Verticillium</i>
<i>Diaporthales</i>	<i>Kirschsteiniotelia</i>	<i>Pestalotiopsis</i>	<i>Volutella</i>
<i>Dicranidion</i>	<i>Lachnum</i>	<i>Phaeodothis</i>	<i>Xenophium</i>
<i>Didymostilbe</i>	<i>Laridospora</i>	<i>Phialospora</i>	<i>Zanclospora</i>
<i>Diluvicola</i>	<i>Lasiophaeria</i>	<i>Phomatospora</i>	

Comparison of freshwater fungi in different substrates

Substrates can be divided into three types: naturally submerged wood (Hu *et al.*, 2010; Kurniawati *et al.*, 2010; Sivichai *et al.*, 2002), naturally submerged palm material such as *Licuala longicalyca* (Pinruan *et al.*, 2007) and baited test blocks of wood and palms such as *Xylia dolabriformis* and *Dipterocarpus alatus* (Sivichai *et al.*, 2000b, 2002) (Table 3). Ninety-two species have been reported from submerged palm material and 81 species from naturally submerged wood. Twenty-four species (26% of the total for palm and 29% of the total for wood)

Table 3. Bio-diversity index of four diversity studies (*D* = *Dipterocarpus alatus*, *X* = *Xylia dolabroformis*, S = stream, L = lake, R = river)

	<i>Khao Yai stream</i> (Sivichai et al. 2000)		<i>Tad Ta Phu Stream</i> (Sivichai et al. 2002)		<i>MRC Stream & lake</i> (Hu et al. 2010)		<i>Mae Chan streams</i> (Kumiawati et al. 2010)	
Substrates	Baited test		Baited test		Natural Submerged wood		Natural Submerged wood	
Species richness	89		74		S: 54 L: 23		S1: 39 S2: 52 R:25	
average number of taxa per sample	<i>D</i> : 5.6 <i>X</i> : 7.1		<i>D</i> : 6.4 <i>X</i> : 5.6		<i>S</i> : 1.1 <i>L</i> : 0.69		<i>S1</i> : 3.2 <i>S2</i> : 4.5 <i>R</i> : 2	
Mitosporic fungi/ascomycetes	<i>D</i> : 3.4 <i>X</i> : 2.3		<i>D</i> : 2.1 <i>X</i> : 2.3		3		0.9	
Dominant species	<i>D</i>		<i>D</i>		<i>S</i>		<i>S1</i>	
	<i>Trematosphaeria</i> sp.	95%	<i>Helicomyces roseus</i>	83.3%	<i>Annulataascus</i>	12%	<i>Corynesporium</i> sp.	9.20%
	<i>Helicomyces roseus</i>	81%	<i>Halosarpheia aquadulcis</i>	66.6%	<i>velatisporus</i>		<i>Savoryella lignicola</i>	8.04%
	Ascomycete sp.	66%	<i>Tricladium anamorph</i>	60%	<i>Xylomyces giganteus</i>	9%	<i>Helicomyces roseus</i>	7.47%
	Coelomycete sp.	60%	of <i>Hymenoscyphus</i>		<i>Curvularia robusta</i>	6%		
	Teleomorph of coelomycete sp.	60%	<i>varicosporoides</i>					
	<i>X</i>		<i>Eluviespora bipolaris</i>	48.3%				
	<i>Savoryella aquatica</i>	90%	<i>X</i>		<i>L</i>		<i>S2</i>	
	<i>Helicomyces roseus</i>	63%	<i>Helicomyces roseus</i>	63.3%	<i>Annulataascus</i>	29%	<i>Fluminicola</i>	10.23%
	<i>Ellisembia opaca</i>	62%	<i>Savoryella aquatica</i>	53.3%	<i>velatisporus</i>		<i>bipolaris</i>	
	<i>Biflagellospora siamensis</i>	54%	<i>Scutisporus brunneas</i>	53.3%	<i>Sporoschisma</i>	6%	<i>Halosarpheia aquadulcis</i>	6.98%
	<i>Biflagellospora gracilis</i>	54%	<i>Stilbella holubovae</i>	53.3%	<i>uniseptatum</i>		<i>Didymella aptrootii</i>	6.51%
					<i>Spirosphaera</i> sp.	5%		
							<i>R</i>	
							<i>Acrogenospora sphaerocephala</i>	12.39%
							<i>Corynesporium</i> sp.	12.39%
							<i>Diaporthe</i> sp.	7.08%

were shared between submerged wood and palm material. The low percentage of overlap shows that fungal diversity is different on submerged palm material and wood. Sivichai (2002) thought key factors include surface available area for colonisation, the presence of bark or treatment of the baits by autoclaving before exposure. That different substrates support different fungal diversity has also been reported by Cai *et al.* (2003a). They studied freshwater fungi in the Philippines and found submerged bamboo supports a different and diverse group of fungi in comparison to submerged wood.

As opposed to naturally occurring wood, the average number of fungal taxa occurring per sample on submerged baits is higher (5.6-7.1 vs. 0.69-4.5) (Table 3). Ho (1998) reported that the average number of fungal species occurring on baits of *Machilus velutina* and *Pinus massoniana* were 4.3 and 3.8, which is higher than on natural wood (2.9, 2.9 and 0.7). Cai *et al.* (2003a) found that freshwater fungi on natural wood and bamboo in the Liput River in the Philippines had a relatively high average of 2.28 species per sample, while Luo *et al.* (2004) reported 1.68 per sample from Lake Dianchi, China. These figures are generally lower than on baits.

Comparison of Sørensen's index in different sites

Biodiversity index of four diversity papers are compared in Table 3. Hu *et al.* (2010) studied a lake and a stream in Chiang Mai and showed that lotic habitats have a higher fungal diversity than lentic habitats. The reason is probably low oxygen availability and perhaps affects of damming and lower substrate variety. Sørensen's indexes from four studies on freshwater diversity are listed in Table 4. Ignoring the sites appearing in the same paper, the highest Sørensen's index is between Khao Yai stream and Tad Ta Phu Stream (0.245). That is because both of the sites are in Khao Yai National Park. It also shows high similarity between three collections in Mae Chan and MRC stream (all are more than 0.1). This coincides with our intuition because both of the sites are in northern Thailand. The lowest Sørensen's index is 0.053, which is between a stream in Mae Chan and Tad Ta Phu Stream. The Sørensen's index between MRC Lake and other sites is no more than 0.09, while between MRC stream and other sites is no less than 0.09.

New freshwater fungi from Thailand

Studies on the freshwater fungi in the Thailand have yielded five new genera and 26 new species, of which 15 are from submerged palm material and eleven are from submerged wood and leaves (Table 1).

CONCLUSION

Our information concerning Thai freshwater fungi is far from complete. Future collections are needed, particularly in less studied regions. Even water bodies in Chiang Rai should be studied further as only 25 species have so far been reported. As more sites are studied, more taxa will be reported. New taxa will also

Table 4. Comparison of Sørensen's index of four diversity studies (Sørensen's index of similarity (S') = $2c / (a+b)$; a = total number of species from site 1; b = total number of species from site 2; c = number of common species to both sites)

		<i>Khao Yai stream</i> (Sivichai et al., 2000)	<i>Tad Ta Phu Stream</i> (Sivichai et al., 2002)	<i>MRC Stream</i> (Hu et al., 2010)	<i>MRC lake</i> (Hu et al., 2010)	<i>Mae Chan</i>		
						<i>Stream 1</i>	<i>Stream 2</i>	<i>River</i>
						<i>(Kumiawati et al., 2010)</i>		
S'	Khao Yai stream	1						
	Tad Ta Phu Stream	0.245	1					
	MRC Stream	0.097	0.093	1				
	MRC lake	0.089	0.062	0.233	1			
	Mae Chan							
	stream 1	0.078	0.053	0.129	0.064	1		
	stream 2	0.085	0.080	0.133	0.081	0.644	1	
	river	0.070	0.060	0.126	0.083	0.593	0.552	1
	Sample size	78	78	90	100	60	60	60
	Evenness	–	0.8	–	–	0.6	0.7	0.6
	Shannon index	4.7 & 4.9	4.5 & 4.6	3.68	2.34	0.04	0.03	0.05

inevitably be found. There are two reasons for this: a) 217 species have been reported from Hong Kong (<http://fungi.life.illinois.edu/>). Both Thailand and Hong Kong belong to tropical/subtropical areas and Thailand is very much larger than Hong Kong with a much higher plant diversity; b) there are 87 taxa reported to generic level only and once these are studied further it is likely that many will be found to be new species.

Cai *et al.* (2003) compared freshwater fungi on submerged bamboo and wood and found a different and diverse group of fungi in comparison to wood and bamboo. The same conclusion is likely to be found in Thailand but this has not been studied.

In summary, we hope that the information presented herein will prompt future studies to document freshwater fungi of Thailand.

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