

Survey of Stream Spora of Penang Island and the Malay Peninsula

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Abstract Stream spora collected from streams in Penang Island and Malaysian Peninsula are recorded with illustrations. Twenty-five species among 21 genera and 4 unidentified taxa were recognized, and their differences in occurrence in relation to the sites were noted.

Key words: freshwater hyphomycetes, fungal biodiversity, Ingoldian fungi, Malaysia, stream spora.

Introduction

Fungal diversity in tropical areas where enormous biodiversity is known, is one of the intriguing topics in taxonomy and ecology. In most areas of Southeast Asia where fungal inventory is still insufficient, much attention has been paid to accumulate data on local mycobiota.

Aquatic hyphomycetes are a remarkable group of fungi that are characterized by artistic conidial morphology considered to be an adaptation to aquatic habitat. Most of them are also known as “Ingoldian fungi” or “freshwater hyphomycetes”, but the authors here treat them in a wider concept to include aero-aquatic hyphomycetes. Studies on aquatic hyphomycetes have been carried out in many areas for the following reasons: 1) Because many conidia are known to be accumulated in water foam and scum, thus sampling is relatively easy, 2) Due to the characteristic spore morphology, identification can be done instantly to some extent (usually to the genus rank, sometimes up to the species rank) by observing the morphology of the spores. About 300 taxa of aquatic hyphomycetes have been known, but tropical areas are less surveyed (Goh, 1997; Marvanová, 1997).

In an expedition trip to the Malay Peninsula,

some water foam samples were collected to survey the diversity of aquatic hyphomycetes. Isolation of spores from the samples was also carried out. Some of the samples were fixed for direct spore observation. Although aquatic hyphomycetes have been enthusiastically investigated by Nawawi and his colleagues in Malaysia (e.g. Nawawi, 1973a, b, c; Nawawi, 1985; Nawawi and Kuthubutheen, 1988, 1989), a comprehensive comparison of biodiversity in local areas has not been presented. To further elucidate local mycobiota in Malaysia, the results of a preliminary observation on the spore diversity in the fixed water foam samples are presented in the present paper.

Materials and Methods

Water foam samples were collected in streams in the following four sites in three localities (Fig. 1). 1) Titi Kerawang Waterfall, Penang Isl. (5°24'N, 100°47'E) on Sept. 6, 2004, 2) Bukit Gatang, Padang Rengas, Perak (4°46'N, 100°48'E) on Sept. 9, 2004, and 3) two streams in Bukit Larut, Perak (4°52'N, 100°45'E alt. 220 m) on Sept. 13, 2004. The foam samples were scooped up by a spoon and collected into

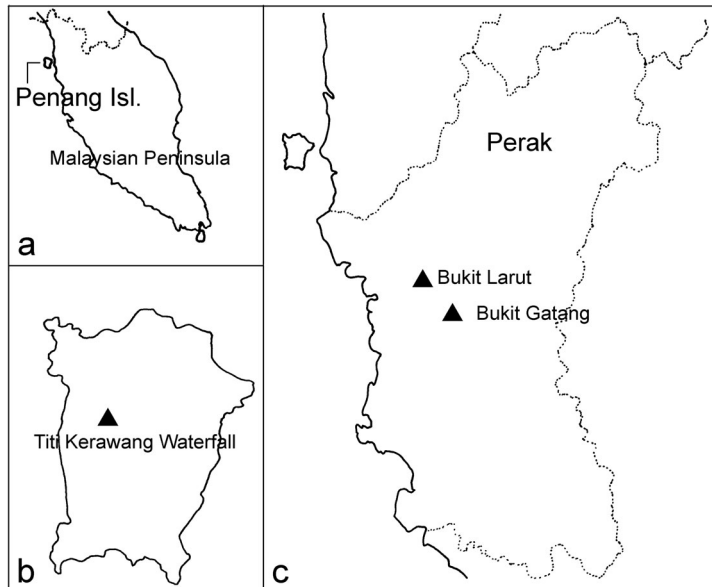


Fig. 1. Map of Malay Peninsula and collection sites. a. Map of Malay Peninsula. b. Penang Island. c. Perak State.

plastic containers, fixed with formalin immediately after collection. Phloxine B was added to the samples to stain the spores, and the samples were kept in room temperature until observation. A drop of the samples was placed on a slide glass and scanned for fungal spores. Because of the three dimensional morphology of the conidia, adjusting focus in a single frame in the photograph was difficult. Hence, line drawings were prepared to draw the morphology using the Olympus BX-51 microscope equipped with U-DA drawing tubes and an $\times 100$ objective lens.

Results and Discussion

The spores observed and identified are listed in Table 1, the representative of which are shown in Figs. 2 and 3. In total, 25 species of 21 genera and 4 unidentified taxa were recognized. The sample contained spores of several ecological groups. Most of them were Ingoldian fungi with typical tetrad radiating or sigmoid to filiform conidia, but terrestrial hyphomycetes with appendages (e.g. *Beltrania*, *Pestalotiopsis*) or longer spores without appendages (e.g.

Fusarium, *Pseudospiropes*) were also frequently observed. Helicoid spores of aero-aquatic fungi were also observed. The frequency of occurrence differed from site to site, *Clavatospora tentacula* being the most frequent in all sites. Spores typical in the tropics (e.g. *Tricladium brunneum*, *Condylospora*) were also frequently observed, while some of the common fungi in temperate zones were not observed (e.g. *Heliscus*). Although the decisive conclusion should not be drawn until the establishment of quantitative assessment of the biodiversity, the mycobiota in the stream of Malaysia were equally or even more diverse in comparison to those of Japan. Dematiaceous spores seemed to be more frequent than those in Japan (Miura, 1974).

Although basidiomycetous anamorphs are relatively common in tropics (Nawawi, 1973c), the fungi were not observed in the current survey.

Because filiform to sigmoid spores are less characteristic in their morphology, decisive identification is not easily done. The present survey, however, included some unidentified spores in sigmoid to filiform morphology (Figs. 3e, f, i). Unidentified spores of filiform shape may be

Table 1. Comparisons of the stream spora in three sites.

Name	Site*			
	#1	#2	#3	#4
<i>Anguillospora</i> sp. (Fig. 3c)			+	+
<i>Articulospora</i> sp. (Fig. 2j)				+
<i>Beltrania</i> sp. (Fig. 2h)		+	+	+
<i>Camposporium</i> sp. (Fig. 2c)		+		+
<i>Campylospora chaetocladia</i> Ranzoni		++	+	+
<i>Campylospora</i> sp.(Fig. 2l)				+
<i>Clavatospora tentacula</i> Sv. Nilsson	+	++		++
<i>Condylospora gigantea</i> Nawawi & Kuthubutheen				+
<i>Culicidospora aquatica</i> R.H. Petersen		+		+
<i>Diplocradiella scalaroides</i> G. Arnaud	+			
<i>Flabellospora multiradiata</i> Nawawi	+	+		+
<i>Helicomycetes</i> sp. (Fig. 3h)	+	+		+
<i>Isthmotricladia gombakiensis</i> Nawawi				+
<i>Lateriramulosa uni-infulata</i> Matsush.		+	+	+
<i>Lunulospora curvula</i> Ingold	+			+
<i>Lunulospora cymbiformis</i> K. Miura				+
<i>Miladina lecithina</i> (Cooke) Svrček	+			
<i>Nawawia filiformis</i> (Nawawi) Marvanová	+			
<i>Phalangispora constricta</i> Nawawi & J. Webster				+
<i>Tetraploa aristata</i> Berk. & Broome	+			
<i>Tricladium aciculum</i> Nawawi				+
<i>Tricladium brunneum</i> Nawawi	+			+
<i>Triramulispora</i> sp. (Fig. 2n)	+	+	+	+
<i>Triramulispora</i> sp. (Fig. 2o)			+	+
<i>Trisulcosporium acerinum</i> H.J. Huds. & B. Sutton				
unidentified (Fig. 2a)				+
unidentified (Fig. 3e)		+	+	+
unidentified (Fig. 3f)		+		+
unidentified (Fig. 3i)				+

*Sites: #1, Titi Kerawang Waterfall, Penang Isl.; Site #2, Bukit Gatang; Sites #3 and #4, two streams in Bukit Larut.

those of ostropalean or helotialean ascomycetes. Cultural studies are essential to further detailed analysis for these spores.

A number of discomycete teleomorphs have been connected along with freshwater hyphomycetes (Marvanová, 1997; Sivichai and Jones, 2003). In the present expedition trip, the authors attempted to collect discomycetes in the places adjacent to the streams, but no teleomorphic states have been found.

Substrate, seasonality and water temperature are known to affect spore occurrence and production in aquatic fungi (Nilson, 1964). In the present observation, one of the samples from Bukit Larut contained the highest biodiversity, while the diversity of other samples were not so rich. The biodiversity would be largely affected by the

density of the spores in the samples, which may differ by sampling methods and environmental factors. Factors that may affect the biodiversity such as seasonality and host preference require repeated investigations.

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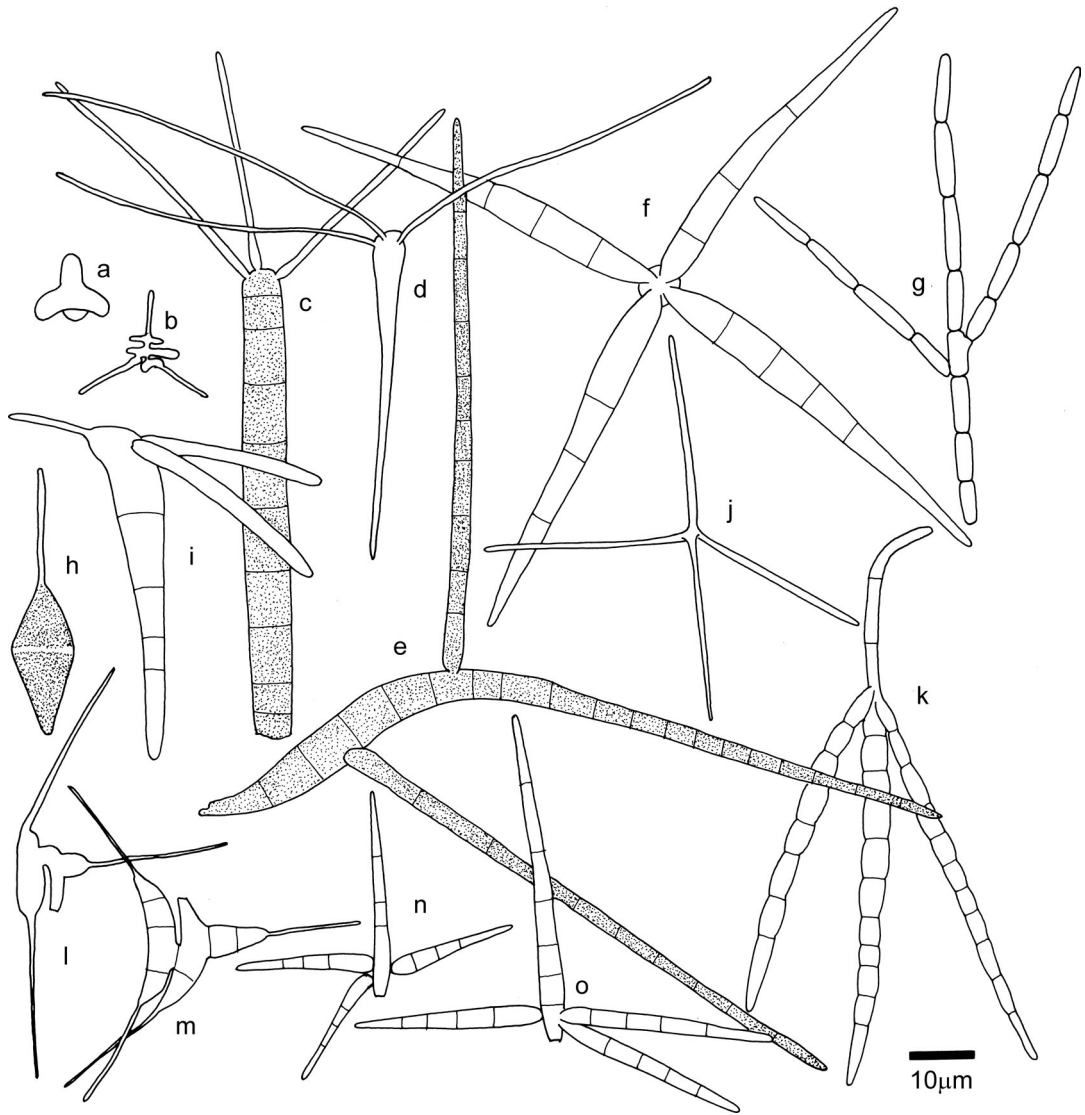


Fig. 2. Representatives of stream spora (mainly tetra-radiating spores). a, unidentified. b, *Lateriramulosa uni-infulata*. c, *Camposporium* sp. d, *Clavatospora tentacula*. e, *Tricladium brunneum*. f, *Flabellospora multiradiata*. g, *Phalangispora constricta*. h, *Beltrania* sp. i, *Culicidospora aquatica*. j, *Articulospora* sp. k, *Isthmotri-cladia gombakiensis*. l, *Campylospora* sp. m, *Campylospora chaetocladia*. n, *Triramulispora* sp. o, *Triramulispora* sp.

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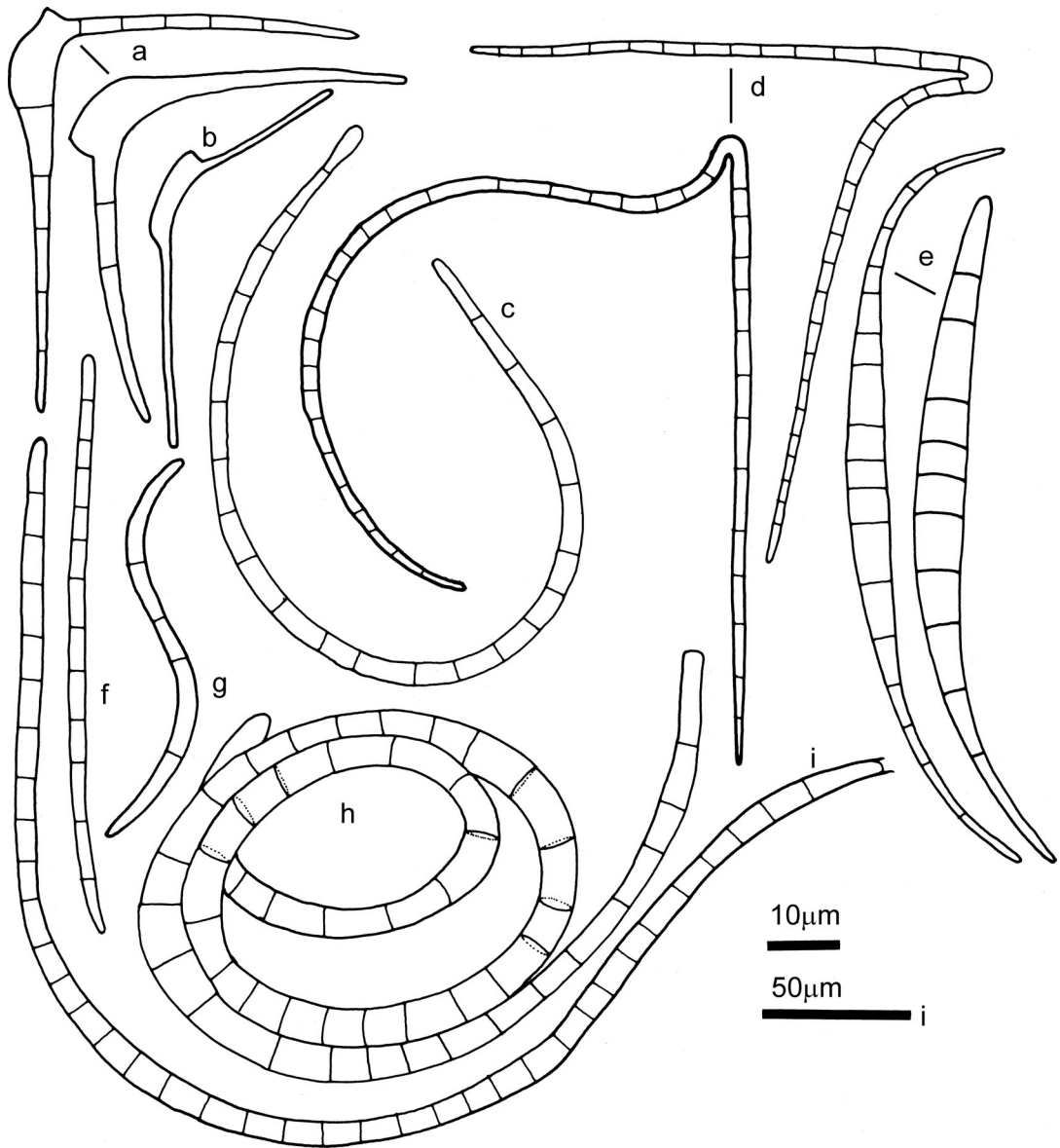


Fig. 3. Representatives of the stream spora (mainly sigmoid to filiform spores). a, *Lunulospora curvula*. b, *Lunulospora cymbiformis*. c, *Anguillospora* sp. d, *Condylospora gigantean*. e, unidentified. f, unidentified. g, *Anguillospora* sp. h, *Helicomyces* sp. i, unidentified.

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