Distribution and occurrence of myxomycetes in tropical forests of northern Thailand

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The fruiting phenology and substrate relationships of myxomycetes in mid-elevation forests of northern Thailand were investigated in five 100 m^2 study plots during the period of October 2004 to October 2005. Collectively, 62 species representing 18 genera were collected. Thirty seven of these are new records for northern Thailand, and one of the species collected (*Licea erecta* var. *erectoides*) is known from only a few other localities throughout the world. Few fruitings occurred during the dry season (which extends from November through May), but fruitings were prominent in the rainy season, especially during June and July. Numbers of species recorded for these two months were 45 and 33, respectively. Forest floor litter derived from two trees (*Dipterocarpus* sp. and *Macaranga denticulata*) seemed to represent an especially favorable substrate for many of the species of myxomycetes collected in the five study areas.

Key words: ecology, myxomycetes, northern Thailand, substrates, tropical forests

Introduction

The myxomycetes (plasmodial slime molds or myxogastrids) are a small group of fungus-like organisms, with approximately 875 species described worldwide (Lado, 2001). The majority of species are probably cosmopolitan, but a few species appear to be confined to the tropics or subtropics and some others have been collected only in temperate regions of the world

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(Alexopoulos, 1963; Farr, 1976; Martin *et al*., 1983). Most of what is known about the assemblages of myxomycetes associated with particular types of terrestrial ecosystems has been derived from studies carried out in temperate regions of the Northern Hemisphere. Only recently have studies been carried out in the tropics and subtropics, and the majority of these have involved areas of the Neotropics in Central and South America or the Caribbean (Stephenson *et al*., 2004). Relatively little is known about the myxomycetes associated with tropical forests in Southeast Asia, and most of the published information is found in species lists (e.g., Reynolds and Alexopoulos, 1971; Siwasin and Ing, 1982; Ing *et al*. 1987) compiled from limited surveys.

Environmental conditions (especially temperature and moisture, with pH of the substrate also important) and the food source (primarily bacteria) available within a particular microhabitat have a considerable influence upon both trophic stages in the myxomycete life cycle. As the result of these factors, the distribution of myxomycetes in nature is not random, and these organisms neither occur with equal abundance throughout the year nor are they found equally on all types of substrates (Stephenson and Stempen, 1994). The primary objective of study reported herein was to investigate the occurrence of myxomycetes in the forests of northern Thailand in order to develop a better understanding of their distribution and ecology in this region of the world. Most studies of myxomycetes in tropical forests have been based on short-term, often cursory visits to particular localities (Farr, 1976; Stephenson *et al*., 2004). In many instances, myxomycetes were collected only in the context of a project in which primary emphasis was directed towards some other group, such as the higher fungi. Our study is the first example of which we are aware in which collections and observations were made in the same locality over a period of an entire year.

Materials and methods

Study area

The present study was carried out in the general vicinity of the Mushroom Research Centre (19° 07.123’ N, 98° 44.009’ E), which is located about 70 km from the city of Chiang Mai in northern Thailand. The forests surrounding the Centre are representative of the mid-elevation (*ca*. 900 m) tropical forests that occur throughout the entire region, and some of the more common genera of trees are *Cinnamomum, Dipterocarpus* and *Macaranga*.

Climate

In northern Thailand, there are two distinct seasons each year, a dry season that extends from November to May and a rainy season that begins in June and lasts until October (Table 1). The dry season can be divided further into a cool/dry period (October to February) and a hot/dry period (March to April). Annual precipitation ranges from 1100 to 1500 mm, but the months of December, January and February are virtually without rain (Gardon *et al*., 2002). The average annual temperature is 26.2°C. In the rainy season, temperatures in the lowlands are around 32°C in the mid-afternoon and drop to about 23°C at night. From June until the first two weeks of July, it rains on most days, although rarely continuously. On a typical day, it is often bright and sunny in the morning, but in the afternoon clouds build up, and then a heavy rain occurs for one or two hours. Clear conditions return in the evening. From the last two weeks of July until September, rains rarely occur but are heavy and continuous when they do. In the cool period, the temperature is above 28°C during the afternoon, but following sunset the temperature drops rapidly, frequently to below 10°C, so that early mornings are quite cool and misty. The sky is generally cloudless all day, and rain is very rare, perhaps only one time each month, and then light. In the hot period, daytime temperatures approach 40°C, and humidity increases.

Study plots

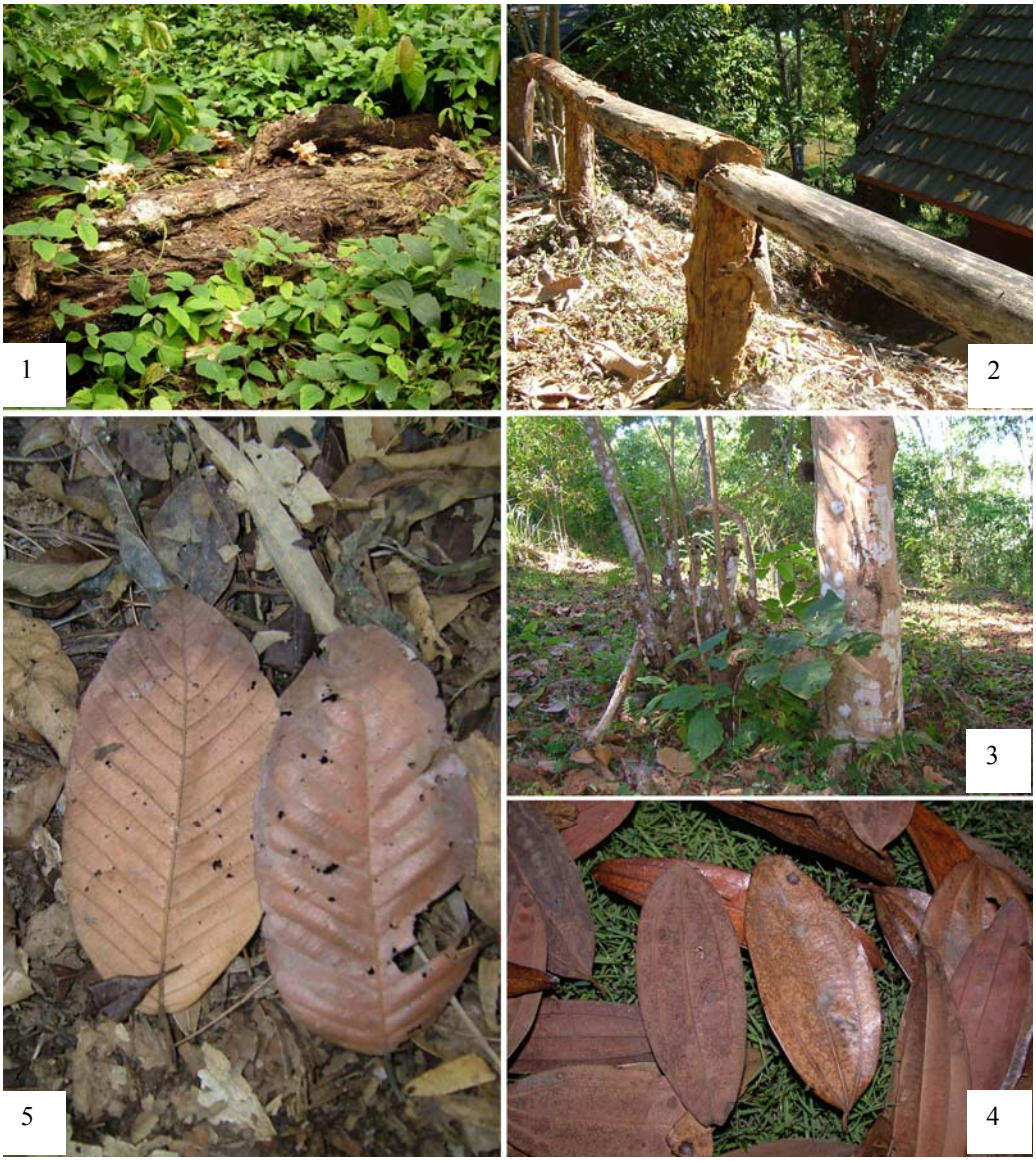
Five study plots, each measuring 10 by 10 m (100 m^2), were established (Figs. 1-5). Each of the plots was placed in a different ecological setting, based on the presence of different kinds of trees and/or substrates potentially available to myxomycetes. Plot 1 was in an area with a large amount of decaying wood present, plot 2 was in an area with an abandoned fence and dominated by plants characteristic of recently disturbed sites, plot 3 was in an area dominated by *Macaranga denticulata*, plot 4 was in an area dominated by *Cinnamomum iners*, and plot 5 was in an area dominated by *Dipterocarpus* sp. In plots 3, 4 and 5, the leaves from the dominant trees present made up the litter layer on the forest floor.

Sampling

Each plot was visited weekly for a period of one year. On each visit, all fruitings of myxomycetes were collected or recorded. Collected specimens were wrapped gently in foil paper before being transported to the laboratory. In the laboratory, specimens were dried at room temperature and then placed into

Table 1. Average values recorded for temperature, humidity and rainfall throughout northern Thailand In each of the seasons of the year.

	DRY-HOT			**RAINY**					**DRY-COOL**				**ANNUAL**
	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	
Average Temperature (C)	27.4	29.4	29.1	28.1	28.0	28.3	27.6	23.6	23.0	22.5	22.0	25.6	26.2
Mean Max. Temperature (C)	38.5	38.4	36.2	34.0	33.6	34.2	33.0	33.2	31.9	32.0	32.9	36.2	34.5
Mean Min. Temperature (C)	16.3	20.5	22.0	22.3	22.4	22.4	22.3	14.0	14.2	13.0	11.2	15.1	17.9
Rainfall in (cm)	18.2	2.3	20.0	12.9	14.6	33.3	25.8	7.5	4.8	4.8	<1.0	<1.0	144.2
Mean Max. Relative Humidity (%)	32.0	35.5	32.8	31.4	31.0	29.7	31.3	30.8	30.2	28.8	31.3	34.0	31.5
Mean Min. Relative Humidity (%)	20.0	22.9	23.6	23.8	23.5	23.2	23.1	20.5	17.6	16.6	15.0	17.1	20.3



Figs. 1-5. Plots and litter: **1.** Plot 1. Decaying wood. **2.** Plot 2. Abandoned fence. **3.** Plot 3. Beneath *Macaranga denticulata.* **4.** Plot 4. Litter of *Cinnamomum iners*. **5.** Plot 5. Litter of *Dipterocarpus* sp.

small paper boxes for storage. Myxomycete identification was based upon the overall morphological characteristics of the fruiting bodies (Stephenson, 2003b). Spore size was measured under a 100× oil immersion objective; the ornamental portion of spore was not included in these measurements. Acetic acid was used to test for the presence of lime (calcium carbonate). Except for

Stemonitis nigrescens, which we consider as a distinct species and not just a variety of *Stemonitis fusca*, nomenclature used herein follows Lado (2001) and Hernández-Crespo and Lado (2005), with the conserved names of several genera (Lado *et al*. 2005) approved recently by the Committee for Fungi (Gams 2005) of the IAPT. All specimens were deposited in the herbarium of the Mushroom Research Foundation, 128 Moo 3, Bahn Pha Deng, T. Pa Pae, A. Mae Taeng Chiang Mai 50150, Thailand.

Statistical analysis of the data compiled on the occurrence of myxomycete fruitings in the five study plots was carried with the SPSS program (Field, 2000), and the Friedman test was used to compare mean rank positions of the numbers of species recorded for each month. The mean number of species per genus (S/G) was calculated from the data sets obtained for each of the plots. As noted by Stephenson *et al*. (1993), a biota in which the species are divided among many genera is intuitively more "diverse" in a taxonomic sense than one in which most species belong to only a few genera. Consequently, a low value for S/G implies a higher overall taxonomic diversity than a high value.

Abundance indices were assigned to all of the species represented among the collections from a particular plot in the manner described by Stephenson *et al*. (1993). As used herein, the indices were "Rare" (for species represented by <0.5% of the total number of collections), "Occasional" (species represented by >0.5% but <1.5% of the total). "Common" (species represented by >1.5% but <3.0% of the total), and "Abundant" (species represented by >3.0% of the total).

Results and discussion

Fruiting phenology

Field collections made from the five plots during the period of October 2004 to October 2005 yielded a total of 62 species of myxomycetes representing 18 genera (Table 2). All of the material collected had fruited in the field under natural conditions. Data on the number of species collected from each plot and the total number of species recorded for each month are given in Table 3. The rank positions of the monthly totals based on the number of species of myxomycetes collected from all five plots in each month are given in Table 4. December, January, February, March and April have the lowest (and same) rank position because no myxomycetes were collected during these months. June had the highest total number of species (45), and in June each plot also was characterized by the highest total (when compared with

Table 2. Species of myxomycetes recorded from the five plots.

Species	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5
Arcyria cinerea (Bull.) Pers.	C	C	C	C	A
Arcyria denudata (L.) Wettst.	O	O	-	-	C
Arcyria globosa Schwein.	-	-	C	-	-
Badhamia cf. melanospora Speg.	-	-	-	-	R
Ceratiomyxa fruticulosa (O.F. Müll.) T. Macbr.	C	-	O	O	C
Collaria arcyrionema (Rostaf.) Nann.-Bremek. Ex Lado	O	-	O	-	O
Comatricha elegans (Racib.) G. Lister.	-	-	O	-	-
Comatricha laxa Rostaf.	-	-	O	-	O
Comatricha nigra (Pers. ex J.F. Gmel.) J. Schröt.	-	-	O	O	-
Comatricha pulchella (C. Bab.) Rostaf.	-	-	-	-	O
Craterium aureum (Schumach.) Rostaf.	-	-	O	-	-
Craterium concinnum Rex	-	-	C	-	-
Craterium leucocephalum (Pers. ex J.F. Gmel.) Ditmar	-	-	O	-	O
Craterium minutum (Leers) Fr.	-	-	O	A	C
Cribraria aurantiaca Schrad.	C	-	-	-	-
Cribraria cancellata (Batsch) Nann.-Bremek.	R	-	-	-	-
Cribraria microcarpa (Schrad.) Pers.	C	-	-	-	-
Cribraria tenella Schrad.	-	-	R	-	-
Cribraria violacea Rex	-	-	R	-	-
Diachea bulbillosa (Berk. & Broome) Lister.	-	-	O	-	R
Diachea leucopodia (Bull.) Rostaf.	-	-	R	R	O
Diachea splendens Peck	-	-	O	-	O
Diachea sp. A	-	-	-	-	R
Diderma effusum (Schwein) Morgan	-	-	R	-	R
Diderma hemisphaericum (Bull.) Hornem.	-	-	O	O	C
Diderma rugosum (Rex) T. Macbr.	-	-	R	-	-
Didymium clavus (Alb. & Schwein.) Rabenh	-	-	O	O	O
Didymium iridis (Ditmar) Fr.	-	-	C	O	C
Didymium minus (Lister) Morgan	-	-	C	C	C
Didymium nigripes (Link) Fr.	-		A	O	A
Didymium squamulosum (Alb. & Schwein.) Fr.	-	-	C	-	C
Fuligo septica (L.) F.H. Wigg.	O	-	-	-	-
Hemitrichia calyculata (Speg.) M.L. Farr	R	R	-	-	-
Hemitrichia serpula (Scop.) Rostaf. ex Lister	R	-	O	O	O
Lamproderma scintillans (Berk. & Broome) Morgan	O	-	C	-	C
Lamproderma sp. A	-	-	-	-	R
Licea erecta var. *erectoides* (Nann.-Bremek. & Y. Yamam.) Y. Yamam.	-	R	-	-	-
Lycogala epidendrum (L.) Fr.	A	-	-	-	-
Lycogala exiguum Morgan	O		-	-	-
Physarella oblonga (Ber. & M.A. Curtis) Morgan	-	-	-	-	R

Table 2 continued. Species of myxomycetes recorded from the five plots.

Species	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5
Physarum album (Bull.) Chevall.	C	O	-	-	-
Physarum bivalve Pers.	-	-	-	-	O
Physarum bogoriense Racib.	-	-	-	-	O
Physarum cinereum (Batsch) Pers.	-	-	R	-	A
Physarum compressum Alb. & Schwein.	-	-	-	-	C
Physarum cf. *flavicomum* Berk.	-	-	-	-	R
Physarum cf. *galbeum* Wingate	-	-	-	-	R
Physarum globuliferum (Bull.) Pers.	-	-	-	-	O
Physarum hongkongense Chao H. Chung.	-	-	-	-	O
Physarum cf. lateritium(Berk. & Ravenel) Morgan	-	-	-	-	R
Physarum melleum (Berk. & Broome) Massee	-	O	O	C	C
Physarum penetrale Rex	-	-	-	-	O
Physarum pusillum (Berk. & M.A. Curtis) G. Lister	-	-	R	-	C
Physarum serpula Morgan	-	-	-	-	O
Physarum roseum Berk. & Broome	-	C	-	-	-
Physarum viride (Bull.) Pers.	-	C	-	-	-
Physarum sp. A	-	-	-	-	O
Physarum sp. B	-	-	-	-	O
Stemonitis axifera (Bull.) T. Macbr.	C	-	-	-	-
Stemonitis fusca Roth	C	-	-	-	-
Stemonitis nigrescens Rex	C	-	-	-	-
Stemonitis cf. *virginiensis Rex*	O	-	-	-	-

Table 3. Number of species of myxomycetes collected from each plot in each month.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Plot 1	0	0	0	0	2	10	7	4	3	2	1	0
Plot 2	0	0	0	0	1	9	8	3	1	0	0	0
Plot 3	0	0	0	0	2	14	11	4	10	4	1	0
Plot 4	0	0	0	0	2	7	6	2	1	1	0	0
Plot 5	0	0	0	0	2	35	20	3	1	1	0	0
Total	0	0	0	0	2	45	33	7	12	4	1	0

the same plot in the other months). Remarkably, 35 species were collected from plot 5 alone in June. In July, both the total number of species and number of species collected from each plot were still quite high, with a total 33 species collected during the month.

From August onwards, the number of species appearing as fruitings in the field decreased, even though the total number of species collected in September (12) was higher than the total recorded for August (7). In terms of mean rank position, September was lower than August because the distribution of numbers of species in each plot was not equal. A single plot (plot 3)

Table 4. Rank positions of the numbers of species of myxomycetes collected each month from the five plots.

Months	Mean Rank	Months	Mean Rank
January	3.4	July	11
February	3.4	August	9.6
March	3.4	September	8.5
April	3.4	October	7
May	8.3	November	4.6
June	12	December	3.4

produced a relatively high number of species, but the totals recorded for the other plots were much lower in comparison with the corresponding plots in August.

During the period of December to April, there were no records of either fruiting bodies of myxomycetes or any evidence (e.g., slime tracks) of plasmodia in any of the plots. Presumably, this was because the period was very dry and sunny, with almost no rain. Myxomycete spores require favourable conditions of moisture and temperature for germination, and even if by chance spores are exposed to enough water to germinate, any amoeboid cells and plasmodia that might result would not remain active under such harsh conditions. Instead, it is likely that they would survive as one of the resistant structures (e.g., microcysts or macrocysts) produced by myxomycetes.

Two species (*Arcyria cinerea* and *Ceratiomyxa fruticulosa*) were collected in May, but these fruitings did not appear until the very last week of May. As soon as the rains began, the two species were present in all of the study plots except for plot 2. However, fruitings were relatively small. It seems likely that the amount of rainfall received in May was not sufficient to permit the growth and development of most myxomycetes

In June, when rainy and sunny periods alternated daily, spore germination should have been stimulated. Moreover, the other microorganisms upon which myxomycetes feed would be expected to flourish under such conditions. This combination of factors probably explains why fruitings collected during this period of time often were quite large. Common species during June were *Arcyria cinerea, Ceratiomyxa fruticulosa Didymium iridis*, *D. minus*, *D. squamulosum*, *D. clavus*, *D. nigripes*, *Diachea splendens*¸ *Dia. leucopodia*, *Diderma hemisphaericum, Lycogala epidendrum*, *Physarum melleum*, and *Ph. pusillum*.

In July, numbers of fruitings of myxomycetes were lower than in June. Moreover, the majority of collections were made during the two first weeks of July. Common species of myxomycetes during the the month were *Craterium*

aureum, *C. leucocephalum*, *C. minutum*, *Diachea bulbillosa*, *Lamproderma arcyrionema*, *L. scintillans*, *Stemonitis axifera*, *S. fusca* and *S. nigrescens*.

From mid-July until September, the rain did not occur almost every day as had been the case in June; rains became rarer but sometimes were heavy and continuous, so the forest floor was generally either relatively dry or very wet. The number of species collected decreased considerably. In August, numbers of records and species were remarkably lower in every plot. For example, only three species were collected in plot 5, whereas the total recorded for July was 20. All of the species collected during August also were recorded in June and July. A few species, including *Arcyria cinerea* and *Stemonitis nigrescens*, seemed especially prominent in this period.

In September, the only species recorded in plot 1 were *Arcyria cinerea*, *Cribraria aurantiaca* and *C. microcarpa*, and only *Arcyria cinerea* was present in plots 2, 4 and 5. However, a number of other species were collected in plot 3, where they occurred on the litter from *Macaranga denticulata*. However, except for *Craterium concinnum*, all of these species also were recorded in June. The most common species during September were *Arcyria globosa*, *Craterium concinnum*, *Cribraria aurantiaca*, *C. microcarpa*, and *Hemitrichia serpula*. The reasons for the greater number of myxomycete species appearing in plot 3 during this month possibly can be attributed to the presence of a layer of grass on the ground and the timing of leaf fall for *Macaranga denticulata*. From the end of August onwards, a thick cover of dead leaves from *M. denticulata* was present in this plot, and the combination of the two types of plant debris may have provided for a more favorable microclimate (e.g., higher levels of moisture) than was the case for the other plots, where the ground cover was less apparent.

October was sunny and cold, with almost no rain. The forest floor appeared totally dry. Only a few species such as *Cribraria aurantiaca* and *C. microcarpa* were recorded, and these were associated with the decayed wood in plot 1. The apparent fruiting season for myxomycetes ended in November, and no fresh fruitings were observed for almost half a year. This same pattern was noted in another study carried out by the senior author (Tran, unpubl. data) during the same period of time as the present study. In this second study, in which the occurrence of myxomycetes in northern Thailand was investigated in six study sites (three in forests and three in agricultural areas), only three species were collected from the field during the dry season (all in May), but 52 species were collected during the rainy season. However, the number of species obtained from moist chamber cultures prepared with samples collected in the dry season was much higher (47) when compared with the total (16) from the rainy season. As a result, the total number of species recorded for the

dry season (48) was not appreciably lower than the total (59) recorded for the rainy season. These data provide additional evidence that any effort to assess the total biodiversity of myxomycetes in a particular locality should include both field collections and collections obtained with the use of the moist chamber culture technique, as has been recommended in a number of recent studies (e.g., Stephenson *et al*., 2004).

Studies that have involved direct observation of myxomycetes in the field over a period of time have been limited almost exclusively to temperate regions of the world. In perhaps the most intensive of these studies, Stephenson (1988) carried out a comparative study of five study areas in a mountainous region of eastern North America. Collections and observations made over a period of five years indicated that myxomycetes displayed seasonal patterns of absolute abundance, species richness and species diversity. All three measures were low early in the field season (May), but increased to their highest levels in late summer (August) and then declined throughout the remainder of the season (September and October). Allowing for the major differences in climate (temperate versus tropical), the pattern observed by Stephenson in this earlier study is not unlike the pattern noted in the present study. Other field-based ecological studies of myxomycetes that have extended over a period of more than just a few days or weeks include those by Maimoni-Rodella and Gottsberger (1980) and Eliasson (1981). The former study involved a comparison of the myxomycetes occurring in two different tropical vegetation types (an evergreen forest and a semideciduous xeromorphic woodland) in Brazil. In the latter study, patterns of occurrence of selected species of myxomycetes were investigated in a spruce forest in Sweden. The vegetation types considered in these two studies are very different from those examined in the present study, but the results were similar in that both the assemblages of species present and their relative abundance were found to vary from one place to another, on different substrates and in different times of the year.

Most of the published information relating to the total number of species of myxomycetes associated with tropical forests at a particular locality has been derived from studies carried out in the Neotropics of Central and South America. We are not aware of any previous study in Southeast Asia, although Stephenson *et al*. (1993) included data from southern India in a comparative biogeographical study of myxomycetes in the mid-Appalachians of eastern North America and two regions of India. The data set from southern India was compiled over a period of several years and most of the collections were made in parks, coffee plantations, and in wooded areas surrounding towns and villages rather than in forests. However, the climate of southern India is fairly comparable to that of northern Thailand, although there are two definite rainy

Table 5. Numbers of genera and species of myxomycetes and the value of S/G calculated for each plot.

	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5
No. of species	18	8	29	12	39
No. of genera	10	4	12	9	14
S/G value	1.80	2.00	2.42	1.33	2.79

seasons and not just one as is the case in Thailand. In southern India, at least some fruitings of myxomycetes can be collected throughout the entire year. As the data presented herein indicate, this is different from the situation in northern Thailand. The total number of species reported from southern India (99) was higher than what we recorded. For the Neotropics, Lado *et al*. (2003) reported 76 species for a study area (El Eden) in the Yucatan Peninsula of Mexico and 63 species for a tropical forest reserve (Los Tuxtlas) in Veracruz, Mexico. Schnittler *et al*. (2002) listed a total of 77 species from three cloud forest study sites in Ecuador. However, all three of these totals were based on results obtained from field collecting as well as collections from moist chamber cultures. When only field collections have been considered, the totals tend to be much lower, and Novozhilov *et al*. (2001) reported just 44 species from a survey carried out in Puerto Rico. As such, the total (62) recorded in the present study, which was based only on field collections, is lower than the total reported for southern India but as high or even higher than those known for other tropical forests in which comparable studies have been carried out.

Substrate relationships

An examination of the data in Table 2 reveals that more than half (39/62) of the species of myxomycetes collected were recorded from plot 5 (which was dominated by *Dipterocarpus* sp.) and almost a half (29/62) were recorded from plot 3 (dominated by *Macaranga denticulata*). This suggests that the litter derived from these two trees is an especially favorable substrate for myxomycetes. However, the S/G value (Table 5) calculated for plot 5 also was higher than for any other plot, so overall biodiversity in plot 5 was low, with relatively fewer genera contributing to the species present. Some of the more common species for this plot were *Diderma hemisphaericum, Didymium clavus*, *D. iridis*, *D. minus*, *D. nigripes*, *D. squamulosum Physarum melleum* and *Ph. pusillum*.

With an S/G value of 2.42, the assemblage of myxomycetes associated with plot 3 was more diverse than the assemblage recorded for plot 5 but was not as low as plots 1, 2 and 4. The occurrence of myxomycetes in plot 3

differed from that of the other plots. In plots 1, 2, 4 and 5, the numbers of species were highest in June and then decreased dramatically over the next three months. In contrast, in plot 3 the numbers followed the same pattern in July and August but then become high again in September. Plot 3 had a different ground cover (consisting largely of grasses) than any of the other plots and it is possible this grass layer allowed favorable conditions for myxomycetes when the other plots were either too dry or very wet. A difference in the decomposition rate and nutrient status of the litter (mostly fallen leaves of *Macaranga denticulata*) also may have been a factor. Common species in plot 3 were *Arcyria globosa*, *Craterium concinnum***,** *Comatricha laxa, Didymium nigripes*, *Lamproderma scintillans*, and *Physarum melleum*.

Plot 4, in which the ground litter was derived largely from *Cinnamomum iners*, yielded the lowest number of species (only 12). However, in contrast with plot 5, the S/G value calculated for plot 4 was only 1.33, the smallest value for any plot, which indicates that the overall biodiversity was actually highest. *Craterium minutum* and *Physarum melleum* were the most common species in this plot.

The differences noted in the assemblages of species recorded for the three plots (3, 4 and 5) dominated by a single type of tree is a clear indication that the nature of the litter present (e.g., such factors as leaf surface, size, texture, and nutrient status) plays a major role in determining the distribution and occurrence of myxomycetes. Just how these factors come into play is not known, but a leaf with a rough or pubescent surface (which is the case for *Dipterocarpus* sp. and *Macaranga denticulata*) would appear to have a higher potential for trapping myxomycete spores from the air than a leaf with a smooth surface (Stephenson, 1989). Leaf size is possibly an important influence on loss of moisture from the litter layer, with a layer of overlapping larger leaves retaining more moisture than a similar layer of small leaves. A difference in the rate of decomposition certainly represents a factor that needs to be considered, with thin and soft leaves decaying much faster than their thicker and harder counterparts (Stephenson, unpub. data). The leaves of *Cinnamomum iners* were smaller, smoother and thicker than those of both *Dipterocarpus* sp. and *Macaranga denticulata*, and it is interesting to note that the plot (4) in which this tree was dominant supported the fewest species of myxomycetes.

Relatively few studies have examined the ecological associations of particular species of myxomycetes with certain types of substrates, but the limited data available from these studies suggest that the morphological differences that exist between *Dipterocarpus* sp. and *Macaranga denticulata* are of sufficient magnitude to influence distributional relationships of these

organisms. For example, in a study carried out in the temperate forests of eastern North America, Stephenson (1989) examined the assemblages of myxomycetes associated with the bark microhabitat of 13 species of trees, four of which (all members of the genus *Quercus*) belong to the same family (the *Fagaceae*) as *Castanopsis* sp., found that different trees supported quite different assemblages of myxomycetes. In another study in which the myxomycetes associated with palm fronds were investigated in the forests of northern New Zealand, Stephenson (2003a) reported that many of the species commonly collected from palm fronds were encountered rarely or not at all on other substrates in the same locality. Clearly, myxomycetes are not found with equal abundance on all of the substrates potentially available to them.

The assemblage of myxomycetes associated with plot 1 was different from those of the other plots. This plot was not particularly high in term of either the number of species present or overall taxonomic biodiversity, but many of the common myxomycetes recorded from the plot 1 were not found in any other plot. Prominent examples include *Cribraria aurantiaca*, *C. microcarpa*, *Fuligo septica*, *Lycogala epidendrum*, *L. exiguum*, *Stemonitis axifera, S. fusca,* and *S.* cf. *virginiensis*. This difference can be attributed, at least in part, to the presence of a large amount of coarse woody debris in this plot, and all of the species listed above are considered to be lignicolous (Martin and Alexopoulos, 1949).

Plot 2 was characterized by the lowest number of myxomycetes, with only eight species being recorded from this plot. However, one of these was *Licea erecta* var. *erectoides***,** which is known from only a few other localities throughout the world (Wrigley de Basanta and Lado, 2005). Our collection is the first from Southeast Asia. Because of the lack of canopy cover, this plot was subject to wide fluctuations in microclimate, which may have attributed, at least in part, to the paucity of fruitings. *Physarum viride* and *P. roseum* were two most common species in this plot.

Based on the data obtained in this study, the distribution of myxomycetes in the forests of northern Thailand is not random. Major differences were noted for both the time of occurrence and the substrates upon which fruitings occur. Myxomycetes were most common during the period of the year (June through early July) during which rainy and sunny periods alternated and overall conditions were neither too wet nor too dry. In the months that followed, numbers of fruitings declined, and from December to April no fruitings were observed. Forest floor litter derived from trees of *Dipterocarpus* sp. and *Macaranga denticulata* appear to be particularly favorable substrates for many different species of myxomycetes. The project described herein also demonstrated the feasibility of monitoring assemblages of myxomycetes

directly in the field with the use of a series of plots that represent the different habitats (and combinations of substrate and microclimate) found within a particular region of the world. Moreover, the body of data that we were able to generate from these plots suggests that the plot size (10 × 10 m) used is adequate for assessing differences in species composition and abundance.

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