

Myxomycetes of Thailand

T. W. Ko Ko¹, T. T. M. Hanh², S. L. Stephenson³, D. W. Mitchell⁴,
C. Rojas³, K. D. Hyde^{5,6} & S. Lumyong¹ & A. H. Bahkali⁶

¹ Department of Biology, Chiang Mai University, Chiang Mai 50200, Thailand

² School of Biotechnology, Ho Chi Minh International University,
Ho Chi Minh City, Vietnam

³ Department of Biological Sciences, University of Arkansas, Fayetteville,
Arkansas, 72701, United States

⁴ Walton Cottage, Upper Hartfield, East Sussex TN7 4AN, England

⁵ School of Science, Mae Fah Luang University, Chiang Rai 57100, Thailand

⁶ Botany and Microbiology Department, College of Science,
King Saud University, Riyadh 1145, Saudi Arabia

Ko Ko, T. W., Hanh, T. T. M., Stephenson, S. L., Mitchell, D. W., Rojas, C.,
Hyde, K. D., Lumyong, S. & Bahkali, A. H. (2010) Myxomycetes of Thailand. –
Sydowia 62 (2): 243–260.

After the first report of myxomycetes from Thailand in 1902, there were only a few papers dealing specifically with these organisms over the following 85 years. In 2004, intensive ecological studies of myxomycetes began at the Mushroom Research Centre north of Chiang Mai. These studies, which considered specimens that had fruited under natural conditions in the field as well as those appearing in moist chamber cultures prepared with various types of dead plant material, yielded numerous new records for Thailand. At least 132 species of myxomycetes in 30 genera are now known to occur in the country. This total includes 23 species not previously reported, including several examples known from only a few other localities worldwide. An annotated checklist based on all published and unpublished records is provided herein.

Keywords: biota, plasmodial slime molds, Southeast Asia, tropical forests.

The myxomycetes (plasmodial slime molds or myxogastrids) are a group of fungus-like organisms usually present and sometimes abundant in terrestrial ecosystems (Martin & Alexopoulos 1969), where they are commonly associated with such substrates as decaying wood, forest floor litter and other dead plant parts, the bark surface of living trees, and the dung of herbivorous animals (Kosheleva *et al.* 2008, Wrigley de Basanta *et al.* 2008, Novozhilov *et al.* 2008, Rojas & Stephenson 2008, Ko Ko *et al.* 2010). The exact evolutionary affinities of the myxomycetes are still debated, but these organisms constitute a well-defined and homogenous group of approximately 900 species (Lado 2001). The reproductive, or spore-producing, stage in the myxomycete life cycle can achieve macroscopic dimensions and be collected and preserved for study in much the same way as the fruiting structures of

fungi (Stephenson & Stempen 1994, Everhart & Keller 2008). However, most myxomycetes tend to be rather inconspicuous or sporadic in their occurrence and thus not always easy to detect in the field. Moreover, fruiting bodies of most species are relatively ephemeral and do not persist in nature for very long. Myxomycetes also spend a portion of their life cycle as true eukaryotic microorganisms, when their very presence in a given microhabitat can be exceedingly difficult if not impossible to determine. Because of their life history strategy and inconspicuous nature, myxomycetes provide an immense challenge in biodiversity assessments and, consequently, often have been neglected in such studies.

The first report of myxomycetes from Thailand appears to be that of Rostrup (1902), who listed *Lycogala epidendrum* and *Stemonitis fusca* from Koh Chang Island in the Gulf of Thailand. Heim (1962) briefly referred the abundance of these organisms in Thailand, but the first significant contribution to our knowledge of the myxomycete biota was a series of specimens collected in April to June of 1967 by Emory Simmons and deposited in the National Fungus Collections (BPI) in Beltsville, Maryland. These specimens, along with a number of additional specimens collected by Don Reynolds in Thailand during the summer of 1967, were reported by Reynolds & Alexopoulos (1971). The total number of species they listed was 42. All of these records were from localities in central and southern Thailand. Siwasin & Ing (1982) reported 34 species of myxomycetes, mostly from northern Thailand, and 16 of these were new records for the country. Later, Ing *et al.* (1987) listed 17 species that had been collected in dipterocarp forests in central Thailand, but all of these had been reported previously. In 2004, intensive studies of myxomycetes began at the Mushroom Research Centre north of Chiang Mai. These studies, which considered both specimens that had fruited under natural conditions in the field as well as those appearing in moist chamber cultures prepared with various types of dead plant material, yielded a considerable body of information on the distribution and occurrence of myxomycetes in the forests of northern Thailand (Tran *et al.* 2006, 2008; Ko Ko *et al.* 2009, 2010) as well as a number of new records for the country. Several of these are species reported from only a few localities worldwide. The purpose of this paper is to provide an annotated checklist of all myxomycetes now known to occur in Thailand. We hope that this effort will prompt future studies to document more completely the myxomycete biota of other neighboring countries in Southeast Asia.

Thailand, with at total area of 514 000 km², is comparable in size to France and somewhat larger than the state of California in the United States. The country is home to several distinct geographic regions. The northern part of the country is mountainous, with the highest point being Doi Inthanon at 2 565 m (8 415 ft). The northeastern part of Thailand consists of the Khorat Plateau, bordered to the east by the

Mekong River. The center of the country is dominated by the predominantly flat Chao Phraya River Valley, which runs into the Gulf of Thailand. The southern part consists of the narrow Kra Isthmus that widens into the Malay Peninsula. The climate throughout the country is tropical and characterized by monsoons. The northeast monsoon extends from October/November to February/March, whereas the southwest monsoon lasts from April/May to October. Northern Thailand has three distinct seasons (rainy from May to October, cool-dry from November to February, and hot-dry from March through April). The southern isthmus is always hot and humid. Temperatures vary considerably with the season, latitude and elevation. Frost can occur in the northern mountains but afternoon temperatures can exceed 40 °C in other parts of the country. No comprehensive and generally accepted classification of the vegetation of Thailand exists, but forest types that have been recognized include such diverse examples as tropical rain forest, evergreen monsoon forest, deciduous monsoon forest, dry forest, pine-oak forest and coastal mangrove forest. Total forest cover has steadily declined over the past century as a result of such factors as urban expansion and the demand for agricultural land, and only about 15 % of the country is still forested (Maxwell 2004). However, overall botanical biodiversity in Thailand is high, and it would be anticipated that this would be accompanied by high levels of biodiversity in other groups of organisms, including myxomycetes.

Annotated List of Species

In the list that follows, myxomycetes recorded from Thailand are arranged alphabetically by genus and then species. Information is provided on the source(s) of each record, along with comments on particularly noteworthy examples. Nomenclature essentially follows Lado (2005–2010) except for *Stemonitis nigrescens* and *S. smithii*, where the treatment followed is that of Martin & Alexopoulos (1969). The abbreviation ‘cf.’ in the name of a species indicates that the specimen representing the source of the record could not be identified with certainty. This usually indicates scanty or aberrant material. Specimens of species not reported previously in print as occurring in Thailand are deposited in the herbaria of Chiang Mai University (CMU) or the University of Arkansas (UARK). Collection numbers are those of coauthors Ko Ko (TWKK), Stephenson (SLS), Mitchell (DWM) and Rojas (CR).

Arcyria cf. *afroalpina* Rammeloo

First reported from Thailand by Tran *et al.* (2008). The single most distinctive macroscopic feature of this species is the exceedingly long stalk. Some forms of the very variable *Arcyria cinerea* can have a long stalk but the latter is relatively straight, whereas the usual situation in *A. afroalpina* is for the stalk to be flexuous. The material from Thailand is limited but does seem to fit the concept of the latter species.

***Arcyria cinerea* (Bull.) Pers.**

First reported from Thailand by Reynolds & Alexopoulos (1971) and also listed by Siwasin & Ing (1982), Ing *et al.* (1987), Tran *et al.* (2006, 2008) and Ko Ko *et al.* (2010).

***Arcyria denudata* (L.) Wettst.**

First reported from Thailand by Reynolds & Alexopoulos (1971) and also listed by Siwasin & Ing (1982), Ing *et al.* (1987) and Tran *et al.* (2006, 2008).

***Arcyria globosa* Schwein.**

First reported from Thailand by Tran *et al.* (2006, 2008).

***Arcyria incarnata* (Pers. ex J. F. Gmel.) Pers.**

First reported from Thailand by Tran *et al.* (2008).

***Arcyria insignis* Kalch. & Cooke**

First reported from Thailand by Reynolds & Alexopoulos (1971) and also listed by Siwasin & Ing (1982).

***Arcyria magna* Rex**

First reported from Thailand by Reynolds & Alexopoulos (1971).

***Arcyria oerstedtii* Rostaf.**

First reported from Thailand by Siwasin & Ing (1982).

***Badhamia cf. melanospora* Speg.**

First reported from Thailand by Tran *et al.* (2006).

***Ceratiomyxa fruticulosa* (O.F. Mull.) T. Macbr.**

First reported from Thailand by Reynolds & Alexopoulos (1971) and also listed by Siwasin & Ing (1982), Tran *et al.* (2006, 2008) and Ko Ko *et al.* (2010). This species is usually considered along with the myxomycetes, but results from molecular studies (Fiore-Donno *et al.* 2010) indicate that the genus *Ceratiomyxa* is actually a sister group to the myxomycetes. However, it shares many of the same features and occurs in some of the same habitats as the “true” myxomycetes. There are two other macroscopic members of the genus that appear to be restricted to the tropics, but neither has been recorded thus far from Thailand.

***Clastoderma debaryanum* Blytt.**

First reported from Thailand by Reynolds & Alexopoulos (1971) and also listed by Ko Ko *et al.* (2010).

***Collaria arcyrionema* (Rostaf.) Nann.-Bremek. ex Lado**

First reported (as *Lamproderma arcyrionema* Rostaf.) from Thailand by Reynolds & Alexopoulos (1971) and also listed by Siwasin & Ing (1982), Ing *et al.* (1987), Tran *et al.* (2006, 2008) and Ko Ko *et al.* (2010).

Comatricha alta Preuss

First reported from Thailand by Tran *et al.* (2008).

Comatricha elegans (Racib.) G. Lister

First reported from Thailand by Reynolds & Alexopoulos (1971) and also listed by Tran *et al.* (2006, 2008).

Comatricha laxa Rostaf.

First reported from Thailand by Reynolds & Alexopoulos (1971) and also listed by Tran *et al.* (2006, 2008).

Comatricha nigra (Pers. ex. J.F. Gmel.) J. Schröt.

First reported from Thailand by Tran *et al.* (2006, 2008) and also listed by Ko Ko *et al.* (2010).

Comatricha pulchella (C. Bab.) Rostaf.

First reported from Thailand by Tran *et al.* (2006).

Comatricha tenerrima (M.A. Curtis) G. Lister.

First reported from Thailand by Reynolds & Alexopoulos (1971) and also listed by Tran *et al.* (2008) and Ko Ko *et al.* (2010).

Cornuvia serpula (Wigand) Rostaf.

Not reported in print as occurring in Thailand but collected from forest floor litter in a montane tropical forest at the Mushroom Research Centre north of Chiang Mai (19° 34' N, 99° 26' E), 8 July 2007, TWKK 530. *Cornuvia serpula* is a rare species known from only scattered localities throughout the world.

Craterium atrolucens Flatau

Not reported in print as occurring in Thailand but recorded on forest floor litter in a montane tropical forest, Ban Pha Dang Village north of Chiang Mai (19° 07' N, 98° 44' E), 28 June 2007, TWKK 525.

Craterium aureum (Schumach.) Rostaf.

First reported from Thailand by Tran *et al.* (2006, 2008).

Craterium concinnum Rex

First reported from Thailand by Tran *et al.* (2006, 2008).

Craterium leucocephalum (Pers. ex J.F. Gmel.) Ditmar

First reported from Thailand by Tran *et al.* (2006, 2008) and also listed by Ko Ko *et al.* (2010).

Craterium minutum (Leers) Fr.

First reported from Thailand by Tran *et al.* (2006, 2008).

***Cribraria aurantiaca* Schrad.**

First reported from Thailand by Tran *et al.* (2006, 2008).

***Cribraria cancellata* (Batsch) Nann.-Bremek.**

First reported (as *Dictydium cancellatum* [Batsch] T. Macbr.) from Thailand by Reynolds & Alexopoulos (1971) and also listed by Siwasin & Ing (1982), Ing *et al.* (1987) and Tran *et al.* (2006, 2008).

***Cribraria constata* Dhillon & Nann.-Bremek.**

Not reported in print as occurring in Thailand but recorded from decaying wood in a montane tropical forest in Phu Kradung National Park (16° 52' N, 101° 44' E), 20 October 2006, TWKK 202.

***Cribraria languescens* Rex**

First reported from Thailand by Siwasin & Ing (1982).

***Cribraria microcarpa* (Schard.) Pers.**

First reported from Thailand by Reynolds & Alexopoulos (1971) and also listed by Ing *et al.* (1987), Tran *et al.* (2006, 2008) and Ko Ko *et al.* (2010).

***Cribraria minutissima* Schwein.**

Not reported in print as occurring in Thailand but appearing in moist chamber culture on bark from *Pinus merkusii* collected in Doi Inthanon National Park (18° 31' N, 98° 29' E), January 2008, DWM 7242a.

***Cribraria rufa* (Roth) Rostaf.**

First reported from Thailand by Siwasin & Ing (1982).

***Cribraria tenella* Schrad.**

First reported from Thailand by Tran *et al.* (2006). As pointed out by Farr (1976), this species and *Cribraria intricata* Schrad. are morphologically very close, and the two species sometimes seem to be connected by intermediate forms. However, *C. tenella* tends to be relatively smaller and has a peridial net with few free ends, two features that characterize our material.

***Cribraria violacea* Rex.**

First reported from Thailand by Reynolds & Alexopoulos (1971) and also listed by Tran *et al.* (2006, 2008) and Ko Ko *et al.* (2010).

***Diachea bulbillosa* (Berk. & Broome) Lister**

First reported from Thailand by Tran *et al.* (2006).

***Diachea leucopodia* (Bull.) Rostaf.**

First reported from Thailand by Siwasin & Ing (1982) and also listed by Tran *et al.* (2006, 2008).

Diachea radiata G. Lister & Petch

First reported from Thailand by Reynolds & Alexopoulos (1971).

Diachea splendens Peck

First reported from Thailand by Tran *et al.* (2006, 2008).

Diachea subsessilis Peck

Not reported in print as occurring in Thailand but recorded from forest floor litter in a montane tropical forest on the grounds of the Mushroom Research Centre north of Chiang Mai (19° 34' N, 99° 26' E), 18 May 2007, TWKK 406.

Diderma effusum (Schwein.) Morgan

First reported from Thailand by Tran *et al.* (2006, 2008).

Diderma hemisphaericum (Bull.) Hornem.

First reported from Thailand by Tran *et al.* (2006, 2008).

Diderma radiatum (L.) Morgan

First reported from Thailand by Siwasin & Ing (1982).

Diderma rimosum Eliasson & Nann.-Bremek.

Not reported in print as occurring in Thailand but recorded from forest floor in a montane tropical forest in Mae Sae National Park (19°15' N, 99° 26' E), 4 July 2007, TWKK 498. Our collection consists of only a few sporocarps, but these are characterized by a peridium that falls away in plates, the most important distinguishing feature of *Diderma rimosum*.

Diderma rugosum (Rex) T. Macbr.

First reported from Thailand by Tran *et al.* (2006, 2008).

Didymium anellus Morgan

Not reported in print as occurring in Thailand but recorded on forest floor litter in a montane tropical forest, Wongthong Waterfall near Lampang (19° 05' N, 99° 43' E), 27 May 2007, TWKK 425.

Didymium bahiense Gottsb.

First reported from Thailand by Siwasin & Ing (1982) and also listed by Tran *et al.* (2008). Prior to the description of this species by Gottsberger & Nannenga-Bremekamp (1971), collections of *Didymium bahiense* would have been reported as *D. iridis* or possibly *D. nigripes*.

Didymium clavus (Alb. & Schwein.) Rabenh.

First reported from Thailand by Reynolds & Alexopoulos (1971) and also listed by Siwasin & Ing (1982), Tran *et al.* (2006, 2008) and Ko Ko *et al.* (2010).

***Didymium difforme* (Pers.) Gray**

First reported from Thailand by Tran *et al.* (2008).

***Didymium flexuosum* Yamash.**

Not reported in print as occurring in Thailand but collected from forest floor litter in a montane tropical forest, Mushroom Research Centre north of Chiang Mai (19° 34' N, 99° 26' E), 28 June 2007, TWKK 494.

***Didymium iridis* (Ditmar) Fr.**

First reported from Thailand by Reynolds & Alexopoulos (1971) and also listed by Tran *et al.* (2006, 2008) and Ko Ko *et al.* (2010).

***Didymium leoninum* Berk. & Broome**

First reported from Thailand by Tran *et al.* (2006).

***Didymium minus* (Lister) Morgan**

First reported from Thailand by Tran *et al.* (2006, 2008). This species is sometimes difficult to define, and some reports of *Didymium minus* in the literature probably represent atypical forms of *D. nigripes* or possibly even *D. squamulosum*.

***Didymium nigripes* (Link) Fr.**

First reported from Thailand by Siwasin & Ing (1982) and also listed by Tran *et al.* (2006, 2008).

***Didymium ochroideum* G. Lister**

Not reported in print as occurring in Thailand but appearing in moist chamber culture on a sample of aerial litter collected in a dry deciduous forest, Sakaerat Environmental Research Station, Nakorn Rachisima (14° 29' N, 101° 55' E), summer 2004, SLS 21379.

***Didymium squamulosum* (Alb. & Schwein.) Fr.**

First reported from Thailand by Reynolds & Alexopoulos (1971) and also listed by Siwasin & Ing (1982), Ing *et al.* (1987), Tran *et al.* (2006, 2008) and Ko Ko *et al.* (2010).

***Echinostelium minutum* de Bary**

First reported from Thailand by Reynolds & Alexopoulos (1971) and more recently appearing in moist chamber culture on bark collected from an unidentified tree growing in a montane tropical forest, Mushroom Research Centre north of Chiang Mai (19° 34' N, 99° 26' E), January 2008, DWM observed but not collected. *Echinostelium minutum* is exceedingly common in the bark microhabitat in temperate forests of the northern hemisphere, but the species seems to be rare in the same microhabitat of tropical forests such as those in Thailand.

***Fuligo aurea* (Penz.) Y. Yamam.**

First reported from Thailand (as *Erionema aureum* Penz.) by Reynolds & Alexopoulos (1971).

***Fuligo septica* (L.) F.H. Wigg.**

First reported from Thailand by Siwasin & Ing (1982) and also listed by Tran *et al.* (2006, 2008).

***Hemitrichia calyculata* (Speg.) M.L. Farr**

First reported (as *Hemitrichia stipata*) from Thailand by Reynolds & Alexopoulos (1971) and also listed by Siwasin & Ing (1982), Ing *et al.* (1987) and Tran *et al.* (2006, 2008).

***Hemitrichia pardina* (Minakata) Ing**

Not reported in print as occurring in Thailand but appearing in moist chamber culture on a sample of forest floor litter collected in a dry deciduous forest, Sakaerat Environmental Research Station, Nakorn Rachisima (14° 29' N, 101° 55' E), summer 2004, SLS 19323.

***Hemitrichia serpula* (Scop.) Rostaf. ex. Lister**

First reported from Thailand by Reynolds & Alexopoulos (1971) and also listed by Siwasin & Ing (1982), Tran *et al.* (2006, 2008) and Ko Ko *et al.* (2010).

***Lamproderma scintillans* (Berk. & Broome) Morgan**

First reported from Thailand by Siwasin & Ing (1982) and also listed by Tran *et al.* (2006, 2008).

***Licea biformis* Morgan**

First reported from Thailand by Reynolds & Alexopoulos (1971) and also listed by Tran *et al.* (2008) and Ko Ko *et al.* (2010).

***Licea bulbosa* Nann.-Bremek. & Y. Yamam.**

Not reported in print as occurring in Thailand but appearing in a moist chamber culture prepared with bark from an unidentified tree, montane tropical forest on the grounds of the Mushroom Research Centre north of Chiang Mai (19° 34' N, 99° 26' E), January 2008, DWM 7253. Our collection extends the known distribution of this species to Southeast Asia. It appears to be rare, since no more than about a dozen collections are known worldwide (Wrigley de Basanta & Lado 2005).

***Licea erecta* K.S. Thind & Dhillon**

First reported from Thailand by Reynolds & Alexopoulos (1971) and also listed by Tran *et al.* (2006). This species, described originally from Japan (Thind & Dhillon 1967), is known from fewer than half a dozen localities worldwide (Wrigley de Basanta & Lado 2005). These limited data suggest a distribution centered in the tropics, but our collection is the first from Southeast Asia.

***Licea floriformis* T.N. Lakh. & K. Chopra**

Not reported in print as occurring in Thailand but recorded from the bark surface of an orchid root collected from the Bai Orchid Farm near Chiang Mai (18° 93' N, 98° 85' E), 27 July 2007, TWKK 435. Described originally from Europe, this is another rare species of *Licea* known from fewer than a dozen localities worldwide

(Wrigley de Basanta & Lado 2005). Our collections are the first from Southeast Asia.

Licea operculata (Wingate) G.W. Martin

Not reported in print as occurring in Thailand but appearing in moist chamber culture on aerial litter collected from a premontane moist seasonal forest dominated by *Quercus eumorpha* in Doi Inthanon National Park (18° 31' N and 98°29' E), January 2008, CR 2117.

Licea pedicellata (H.C. Gilbert) H.C. Gilbert

Not reported in print as occurring in Thailand but appearing in moist chamber culture on pieces of a dead liana collected in a montane tropical forest in Doi Suthep near Chiang Mai (18° 48' N, 98° 55' E), May 2007, TWKK 580.

Lycogala epidendrum (L.) Fr.

First reported from Thailand by Rostrup (1902) and also listed by Tran *et al.* (2006, 2008).

Lycogala exiguum Morgan

First reported from Thailand by Reynolds & Alexopoulos (1971) and also listed by Siwasin & Ing (1982) and Tran *et al.* (2006, 2008).

Macbrideola cornea (G.Lister & Cran) Alexop.

Not reported in print as occurring in Thailand but appearing in moist chamber culture on *Pinus kesiya* bark collected from a premontane moist seasonal forest in Doi Inthanon National Park (18°31' N and 98°31' E), January 2008, CR 2125.

Macbrideola scintillans H.C. Gilbert

Not reported in print as occurring in Thailand but appearing in moist chamber culture on the bark of *Lagerstroemia* sp. in a montane tropical forest on the grounds of the Mushroom Research Centre north of Chiang Mai (19° 34' N, 99° 26' E), January 2008, DWM 7261. Our material represents *Macbrideola scintillans* var. *verrucosa* (Nann.-Bremek. & Y. Yamam.) Y. Yamam.

Perichaena chrysosperma (Curr.) Lister

First reported from Thailand by Reynolds & Alexopoulos (1971) and also listed by Siwasin & Ing (1982), Tran *et al.* (2008) and Ko Ko *et al.* (2010).

Perichaena corticalis (Batsch) Rostaf.

Not reported in print as occurring in Thailand but appearing in moist chamber culture on the bark of *Juniperus* sp. collected in a montane tropical forest near the summit of Doi Inthanon (18° 34' N, 98° 29' E), January 2008, DWM observed but not collected.

Perichaena depressa Lib.

First reported from Thailand by Tran *et al.* (2008) and also listed by Ko Ko *et al.* (2010).

Perichaena dictyonema Rammeloo

First reported from Thailand by Ko Ko *et al.* (2010).

Perichaena microspora Penz. & Lister

First reported from Thailand by Tran *et al.* (2008).

Perichaena pedata (Lister & G. Lister) G. Lister ex E. Jahn

First reported from Thailand by Tran *et al.* (2008).

Perichaena quadrata T. Macbr.

First reported from Thailand by Tran *et al.* (2008).

Perichaena vermicularis (Schwein.) Rostaf.

First reported from Thailand by Tran *et al.* (2008).

Physarina echinocephala Höhn.

First reported from Thailand by Reynolds & Alexopoulos (1971).

Physarella oblonga (Berk. & M.A. Curtis) Morgan

First reported from Thailand by Reynolds & Alexopoulos (1971) and also listed by Siwasin & Ing (1982), Ing *et al.* (1987) and Tran *et al.* (2006). Both the typical form and the white form are known from Thailand (Ing *et al.* 1987).

Physarum aeneum (Lister) R.E. Fr.

First reported from Thailand by Ko Ko *et al.* (2010).

Physarum album (Bull.) Chevall

First reported (as *Physarum nutans* Pers.) from Thailand by Reynolds & Alexopoulos (1971) and also listed by Siwasin & Ing (1982), Ing *et al.* (1987) and Tran *et al.* (2006, 2008).

Physarum bivalve Pers.

First reported from Thailand by Tran *et al.* (2006).

Physarum bogoriense Racib.

First reported from Thailand by Tran *et al.* (2006).

Physarum cinereum (Batsch) Pers.

First reported from Thailand by Tran *et al.* (2006, 2008).

Physarum compressum Alb. & Schwein.

First reported from Thailand by Reynolds & Alexopoulos (1971) and also listed by Siwasin & Ing (1982), Tran *et al.* (2006, 2008) and Ko Ko *et al.* (2010).

Physarum crateriforme Petch

First reported from Thailand by Tran *et al.* (2008).

Physarum decipiens M.A. Curtis

First reported from Thailand by Tran *et al.* (2008).

Physarum didermoides (Pers.) Rostaf.

First reported from Thailand by Ko Ko *et al.* (2010).

Physarum echinosporum Lister.

First reported from Thailand by Tran *et al.* (2008).

Physarum flavicomum Berk.

First reported from Thailand by Reynolds & Alexopoulos (1971) and also listed by Siwasin & Ing (1982), Ing *et al.* (1987) and Tran *et al.* (2006).

Physarum galbeum Wingate

First reported from Thailand by Tran *et al.* (2006, 2008).

Physarum globuliferum (Bull.) Pers.

First reported from Thailand by Tran *et al.* (2006).

Physarum cf. gyrosum Rostaf.

Not reported in print as occurring in Thailand but appearing in moist chamber culture on a sample of aerial litter collected in a tropical dry forest at the Sakaerat Environmental Research Centre, Nakorn Rachisiama (14° 29' N, 101° 55' E), August 2004, SLS 23574.

Physarum hongkongense Chao H. Chung

First reported from Thailand by Tran *et al.* (2006, 2008).

Physarum lakhanpalii Nann.-Bremek. & Y. Yamam.

Not reported in print as occurring in Thailand but appearing in moist chamber culture on a bark sample collected from an unidentified tree in a montane tropical forest, Doi Inthanon National Park near Chiang Mai (18° 32' N, 98° 33' E), April 2007, TWKK 369.

Physarum cf. lateritium (Berk. & Ravenel) Morgan

First reported from Thailand by Tran *et al.* (2006).

Physarum melleum (Berk. & Broome) Massee

First reported from Thailand by Reynolds & Alexopoulos (1971) and also listed by Ing *et al.* (1987) and Tran *et al.* (2006, 2008).

***Physarum nucleatum* Rex**

First reported from Thailand by Reynolds & Alexopoulos (1971) and also listed by Tran *et al.* (2008).

***Physarum oblatum* T. Macbr.**

First reported from Thailand by Reynolds & Alexopoulos (1971) and also listed by Siwasin & Ing (1982), Ing *et al.* (1987) and Tran *et al.* (2007).

***Physarum penetrale* Rex**

First reported from Thailand by Tran *et al.* (2006).

***Physarum pezizoideum* (Jungb.) Pavill. & Lagarde**

First reported from Thailand by Siwasin & Ing (1982).

***Physarum pusillum* (Berk. & M.A. Curtis) G. Lister**

First reported from Thailand by Tran *et al.* (2006, 2008) and also listed by Ko Ko *et al.* (2010).

***Physarum retisporum* G.W. Martin, K.S. Thind & Rehill**

First reported from Thailand by Tran *et al.* (2008).

***Physarum rigidum* (G. Lister) G. Lister**

First reported from Thailand by Reynolds & Alexopoulos (1971).

***Physarum roseum* Berk. & Broome**

First reported from Thailand by Tran *et al.* (2006, 2008) and also listed by Ko Ko *et al.* (2010).

***Physarum serpula* Morgan**

First reported from Thailand by Tran *et al.* (2006, 2008) and also listed by Ko Ko *et al.* (2010).

***Physarum stellatum* (Massee) G.W. Martin**

First reported from Thailand by Siwasin & Ing (1982) and also listed by Ing *et al.* (1987).

***Physarum straminipes* Lister**

First reported from Thailand by Tran *et al.* (2008) and also listed by Ko Ko *et al.* (2010).

***Physarum superbum* Hagelst.**

First reported from Thailand by Tran *et al.* (2008) and also listed by Ko Ko *et al.* (2010).

***Physarum tenerum* Rex**

First reported from Thailand by Reynolds & Alexopoulos (1971) and also listed by Ing *et al.* (1987).

***Physarum viride* (Bull.) Pers.**

First reported from Thailand by Reynolds & Alexopoulos (1971) and also listed by Ing *et al.* (1987), Tran *et al.* (2006, 2008) and Ko Ko *et al.* (2010).

***Stemonaria longa* (Peck) Nann.-Bremek., R. Sharma & Y. Yamam.**

First reported (as *Comatricha longa* Peck) from Thailand by Reynolds and Alexopoulos (1971).

***Stemonitis axifera* (Bull.) T. Macbr.**

First reported from Thailand by Tran *et al.* (2006).

***Stemonitis flavogenita* E. Jahn**

Not reported in print as occurring in Thailand but collected from decaying wood in a montane tropical forest, Tung Joaw Village, Chiang Mai (19° 08' N, 99° 38' E), 9 July 2007, TWKK 534.

***Stemonitis fusca* Roth**

First reported from Thailand by Rostrup (1902) and also listed by Reynolds & Alexopoulos (1971) and Tran *et al.* (2006).

***Stemonitis herbatica* Peck**

First reported from Thailand by Reynolds & Alexopoulos (1971) and also listed by Siwasin & Ing (1982).

***Stemonitopsis cf. microspora* (Lister) Nann.-Bremek.**

Not reported in print as occurring in Thailand but recorded from the bark of a dead tree and on decaying wood in a montane tropical forest on the grounds of the Mushroom Research Centre (19° 34' N, 99° 16' E), 13 August 2006, TWKK 42 and 45. Our material is only provisionally referred to this species, since the spores are larger than given in published descriptions of what appears to be a rarely collected myxomycete.

***Stemonitis mussooriensis* G.W. Martin, K.S. Thind & Sohi**

Not reported in print as occurring in Thailand but appearing in moist chamber culture on aerial litter collected from a premontane moist seasonal forest in Doi Inthanon National Park (18°31' N and 98°31' E), January 2008, CR 2120.

***Stemonitis nigrescens* Rex.**

First reported from Thailand by Tran *et al.* (2006, 2008) and also listed by Ko Ko *et al.* (2010). *Stemonitis nigrescens* is not always considered as distinct from *S. fusca*, but the former is appreciably smaller and tends to occur on litter instead of wood. The latter is the usual substrate for *S. fusca*.

***Stemonitis smithii* T. Macbr.**

First reported from Thailand by Siwasin & Ing (1982) and also listed by Ing *et al.* (1987).

***Stemonitis splendens* Rostaf.**

First reported from Thailand by Reynolds & Alexopoulos (1971) and also listed by Siwasin & Ing (1982) and Ing *et al.* (1987).

***Stemonitis cf. virginiensis* Rex**

First reported from Thailand by Tran *et al.* (2006, 2008).

***Stemonitopsis aequalis* (Peck) Y. Yamam.**

First reported from Thailand by Tran *et al.* (2008).

***Stemonitopsis gracilis* (G. Lister) Nann.-Bremek.**

First reported from Thailand by Siwasin & Ing (1982).

***Stemonitopsis typhina* (F.H. Wigg.) Nann.-Bremek.**

First reported from Thailand by Reynolds & Alexopoulos (1971) and also listed by Ing *et al.* (1987).

***Symphytocarpus impexus* Ing & Nann.-Bremek.**

Not reported in print as occurring in Thailand but recorded from mushroom compost in Chiang Dao (19° 32' N, 98° 57' E), 26 September 2006, TWKK 163.

***Trichia affinis* de Bary**

First reported from Thailand by Siwasin & Ing (1982).

***Trichia verrucosa* Berk.**

First reported from Thailand by Siwasin & Ing (1982).

***Tubulifera microsperma* (Berk. & M.A. Curtis) Lado**

First reported from Thailand by Siwasin & Ing (1982) and also listed by Tran *et al.* (2008).

***Willkommlangea reticulata* (Alb. & Schwein.) Kuntze**

First reported from Thailand by Tran *et al.* (2008) and also listed by Ko Ko *et al.* (2010).

Discussion

The new records listed herein bring the total number of myxomycetes reported from or known to occur in Thailand to at least 132 species in 30 different genera. This total includes 23 species not previ-

ously reported from the country, including several examples known from only a few other localities worldwide. Several specimens obtained during the surveys we carried out consisted of very limited or possibly aberrant material and were impossible to determine beyond genus. It is possible that some of these represent additional species, but there is no way of verifying this unless more material becomes available. Although 132 species is lower than the totals reported a number of other countries throughout the world, this figure is higher than those recorded for any other country in Southeast Asia.

Two of the authors of this paper (Stephenson and Rojas) have been involved in studies of the myxomycetes of Costa Rica. Costa Rica (51 100 km²) is much smaller than Thailand (513 115 km²), but both countries occur in the tropics (Costa Rica is located between 8° and 11° N, whereas Thailand occurs between 5° and 20° N). As a result of a more intensive collecting effort carried out over a longer period of time and extending over much of the entire country, 213 species of myxomycetes in 37 genera have been recorded for Costa Rica (Rojas *et al.* 2010). This total reflects approximately 5000 specimens collected in the field or from moist chamber cultures over a period of more than 35 years. Conversely, the 132 species now known from Thailand are based upon only about 600 specimens, with the majority of these obtained since 2004. Interestingly, although the species totals are different, the taxonomic distribution of the species represented in the myxomycete biotas of Costa Rica and Thailand are remarkably similar (Tab. 1). In both instances, members of the Physarales are the predominant order, making up 43.0 % of the species from Costa Rica and 48.1 % of those from Thailand. Moreover, the relative rankings of the Liceales, Stemonitales and Trichiales are comparable in both countries. The correlation between the percentages in the two data sets was high ($r^2 = 0.98$), which suggests that the pattern is real and not likely to be the product of randomly generated data.

Tab. 1. – Taxonomic distribution: percentage of the total number of species represented in the myxomycete biotas of Costa Rica and Thailand.

| Order | Costa Rica | Thailand |
|-----------------|------------|----------|
| Ceratiomyxales | 1.4 | 0.7 |
| Echinosteliales | 2.3 | 1.5 |
| Liceales | 16.4 | 13.7 |
| Physarales | 43.0 | 48.1 |
| Stemonitales | 22.0 | 19.1 |
| Trichiales | 15.0 | 16.8 |

The genus *Physarum* was represented by the greatest number of species (43 in Costa Rica and 32 in Thailand) in both countries, and the general pattern was for particular genera to have comparable levels of diversity. For example, at least six species were recorded for *Arcyria*,

Comatricha, *Cribraria*, *Didymium*, *Licea*, *Perichaena* and *Stemonitis* in both Costa Rica and Thailand. However, there were some exceptions. *Diderma* was represented by 16 species in Costa Rica but only five species in Thailand, whereas the corresponding figures for *Trichia* and *Lamproderma* were 10 versus two and 10 versus one, respectively. One hundred and two species (47 % of the total for Costa Rica and 77 % of the total for Thailand) were shared between the two biotas. The higher percentage of shared species for Thailand was reflected in the correspondingly lower percentage of unique species (only 22 %, as opposed to 52 % for Costa Rica). Presumably, the number of unique species in Costa Rica would decrease as an increasing number of specimens were collected in Thailand. Interestingly, 132 species recorded from 600 specimens projects to about 0.21 new species per specimen collected, whereas 213 species recorded from 5000 specimens projects to about 0.04 new species per specimen. Clearly, these figures indicate that additional collecting in Thailand is warranted.

In summary, the number of species of myxomycetes now known from Thailand has been increased to at least 132, a total that is higher than those reported for any other country in Southeast Asia. However, when numbers of species and collections are compared with similar data sets for Costa Rica, a country that has been subjected to a more intensive sampling effort for myxomycetes, it seems rather apparent that additional surveys in Thailand will generate many more records. We hope that the information presented herein will prompt future studies to document more completely the myxomycete biota of both Thailand and other neighboring countries in Southeast Asia.

Acknowledgements

This study was supported in part by two grants from the National Science Foundation (to SLS). Appreciation is extended to Jacques Hill, Nathan Missel and Michelle Jenkins for sending us some samples of dead plant material collected in Thailand.

References

- Everhart S. E., Keller, H. W. (2008) Life history strategies of corticolous myxomycetes: the life cycle, fruiting bodies, plasmodial types, and taxonomic orders. *Fungal Diversity* **29**: 1–16.
- Farr M. L. (1976) *Flora Neotropica Monograph No. 16 (Myxomycetes)*. The New York Botanical Garden, New York.
- Fiore-Donno A. M., Nikolaev S. I., Nelson M., Pawlowski J., Cavalier-Smith T., Baldauf S. L. (2010) Deep phylogeny and evolution of slime moulds (Mycetozoa). *Protist* **161**: 55–70.
- Gottsberger G., Nannenga-Bremekamp N. E. (1971) A new species of *Didymium* from Brazil. *Proceedings, Koninklijke Nederlandse Akademie van Wetenschappen, Series C, Biological and Medical Sciences* **74**: 264–268.

- Heim, R. (1962) Contribution à la flore mycologique de la Thaïlande I. *Revue de Mycologie* **27**: 124–158.
- Ing B., Siwasin J., Samarnpan S. (1987) Myxomycetes from Thailand II. *Mycotaxon* **30**: 197.
- Kosheleva A. P., Novozhilov Yu. K., Schnittler M. (2008) Myxomycete diversity of the state reserve “Stolby” (south-eastern Siberia, Russia). *Fungal Diversity* **31**: 45–62.
- Ko Ko T.W., Stephenson S. L., Hyde K. D., Rojas C., Lumyong S. (2010) Patterns of occurrence of myxomycetes on lianas. *Fungal Ecology* doi:10.1016/j.funeco.2009.11.005.
- Ko Ko T. W., Stephenson S. L., Jeewon R., Lumyong S., Hyde K. D. (2009) Molecular diversity of myxomycetes associated with decaying wood and forest floor leaf litter. *Mycologia* **101**: 592–598.
- Lado C. (2001) Nomenmyx, a nomenclatural taxabase of Myxomycetes. *Cuadernos de Trabajo de Flora Micológica Ibérica* **16**: 1–221.
- Lado C. (2005–2010) An on line nomenclatural information system of Eumycetozoa. <http://www.nomen.eumycetozoa.com> (4 April 2010).
- Martin G. W., Alexopoulos, C. J. (1969) *The Myxomycetes*. University of Iowa Press.
- Maxwell J. F. (2004) A synopsis of the vegetation of Thailand. *The Natural History Journal of Chulalongkorn University* **4**: 19–29.
- Novozhilov Yu. K., Schnittler M. (2008) Myxomycete diversity and ecology in arid regions of the Great Lake Basin of western Mongolia. *Fungal Diversity* **30**: 97–119.
- Reynolds D. R., Alexopoulos C. J. (1971) Southeast Asian myxomycetes. I. Thailand and Burma. *Pacific Science* **25**: 33–38.
- Rojas C., Stephenson S. L. (2008) Myxomycete ecology along an elevation gradient on Cocos Island, Costa Rica. *Fungal Diversity* **29**: 117–127.
- Rojas C., Schnittler M., Stephenson S. L. (2010) A review of the Costa Rican myxomycetes (Amebozoa). *Brenesia* (in press).
- Rostrup E. (1902) Flora of Koh Chang: Fungi. *Botanisk Tidsskrift* **24**: 355.
- Siwasin, J., Ing, B. (1982) Myxomycetes from Thailand. *Nordic Journal of Botany* **2**: 369–370.
- Stephenson S. L., Stempen H. (1994) *Myxomycetes: a Handbook of Slime Molds*. Timber Press, Portland, Oregon.
- Thind K. S., Dhillon S. S. (1967) The myxomycetes of India–XVIII. *Mycologia* **59**: 463–266.
- Tran H. T. M., Stephenson S. L., Hyde K. D., Mongkolporn O. (2006) Distribution and occurrence of myxomycetes in tropical forests of northern Thailand. *Fungal Diversity* **22**: 227–242.
- Tran H. T. M., Stephenson S. L., Hyde K. D., Mongkolporn O. (2008) Distribution and occurrence of myxomycetes on agricultural ground litter and forest floor litter in Thailand. *Mycologia* **100**: 181–190.
- Wrigley de Basanta D., Lado C. (2005) A taxonomic evaluation of the stipitate *Licea* species. *Fungal Diversity* **20**: 261–314.
- Wrigley de Basanta D., Stephenson S. L., Lado C., Estrada-Torres A., Nieves-Rivera A. M. (2008) Lianas as a microhabitat for myxomycetes in tropical forests. *Fungal Diversity* **28**: 109–125.

(Manuscript accepted 28 July 2010; Corresponding Editor: R. Pöder)

ZOBODAT - www.zobodat.at

Zoologisch-Botanische Datenbank/Zoological-Botanical Database

Digitale Literatur/Digital Literature

Zeitschrift/Journal: [Sydowia](#)

Jahr/Year: 2010

Band/Volume: [062](#)

Autor(en)/Author(s): Ko Ko Thida W., Hanh T. T. M., Stephenson Steven Lee, Mitchell David W., Rojas C., Hyde Kevin D., Lumyong S., Bahkali Ali H.

Artikel/Article: [Myxomycetes of Thailand. 243-260](#)