Maejo Int. J. Sci. Technol. **2012**, *6*(01), 47-61

Maejo International Journal of Science and Technology

ISSN 1905-7873
Available online at www.mijst.mju.ac.th

Full Paper

Fourteen new records of cercosporoids from Thailand

Pheng Phengsintham[1,2], Ekachai Chukeatirote[1], Eric H. C. McKenzie[3], Mohamed A. Moslem[4], Kevin D. Hyde[1, 4, *] and Uwe Braun [5]

[1] School of Science, Mae Fah Luang University, Chiang Rai 57100, Thailand
[2] Department of Biology, Faculty of Sciences, National University of Laos, Laos
[3] Landcare Research, Private Bag 92170, Auckland, New Zealand
[4] King Saud University, College of Science, Department of Botany and Microbiology, P.O. Box: 2455, Riyadh 1145, Saudi Arabia
[5] Martin-Luther-Universität, Institut für Biologie, Bereich Geobotanik und Botanischer Garten, Herbarium, Neuwerk 21 D-06099 Halle/S, Germany

[*] Corresponding author: kdhyde3@gmail.com

Received: 24 July 2010 / Accepted: 27 January 2012 / Published: 1 February 2012

Abstract: Comprehensive examination of cercosporoid leaf-spotting hyphomycetes was carried out in northern Thailand. Fourteen species assigned to the genera *Cercospora* (5), *Passalora* (3), *Pseudocercospora* (5) and *Zasmidium* (1) are new records for Thailand. *Cercospora verniciferae* and *Zasmidium cassiicola* are poorly known species and are fully described.

Keywords: anamorphic fungi, cercosporoid hyphomycetes, South-East Asia, taxonomy, new records

INTRODUCTION

Cercospora sensu lato is one of the largest genera of hyphomycetes and is almost cosmopolitan in distribution. It causes leaf-spots and other lesions on a wide range of host plants. Species of this genus are important pathogens responsible for severe damage to beneficial plants such as maize, rice, grasses, vegetables, forest trees and ornamentals [1-3].

There have been several recent comprehensive accounts of the fungi of Thailand which are among the best documented in the region [4, and references therein]. In Thailand, the study of *Cercospora* and allied genera can be traced back to 1980 [5, 6]. Sixty cercosporoids were listed, including 13 unidentified species of *Cercospora* in the host index of plant diseases in Thailand [5],

Maejo Int. J. Sci. Technol. **2012**, *6*(01), 47-61

whereas 21 species of *Cercospora* were specified as plant pathogens [6]. In 1989, 49 cercosporoid species were further identified in southern Thailand [7]. These reports, however, were based on the old generic characters, i.e. *Cercospora sensu lato*. Subsequently, 112 species of *Cercospora* as well as their synonyms were recorded in 'The host index of plant diseases in Thailand' [8]. It should also be noted that, according to the list, species names used were ambiguous since the criteria used for classification were based on both old and new criteria. In 2007, three new species of *Cercospora* were discovered; these included 11 species that were new to Thailand [9]. Forty-three cercosporoid species were included in an annotated list of cercosporoid fungi in northern Thailand [10], and two taxa associated with necrotic leaflets of an areca palm (*Areca cathecu*) were reported [11]. A PhD thesis on "Diversity and phylogeny of true cercosporoids fungi from northern Thailand" available in 2009 encompassed 166 cercosporoids [12]. Recently, many new *Cercospora* species have been discovered, including *Cercospora cristellae*, a new cercosporoid species associated with the weed *Cristella parasitica* from northern Thailand [13], and three new records of cercosporoid fungi (*Cercospora diplaziicola, Pseudocercospora duabangae* and *Pseudocercospora trematicola*) from Thailand [14].

The genus *Cercospora* Fresen. *s. lat.*, which is one of the largest genera of hyphomycetes, has been monographed with over 3000 names [15]. Similar to other fungal group, the classification and identification of *Cercosporoid* fungi are mainly based on morphological characteristics. Currently, an identification key of *Cercosporoid* proposed in 2003 has been widely accepted [16]. In this present study, we explored the diversity of *Cercospora* and allied genera by using this identification key. The objectives of this paper are to investigate the cercosporoid fungi of Thailand and Laos, and to provide data on Thailand's fungi in comparison with the diversity of these fungal groups in neighbouring countries.

MATERIALS AND METHODS

Sample Collections and Examination of Fungal Structures

Plants leaves with leaf spots or other lesions were collected during field trips in northern Thailand. Photographs of symptoms, including fungal colonies or fruiting bodies, were taken.

Macroscopic characters were observed using a stereomicroscope to check lesions/leaf spots (shape, size, colour, margin) and colonies/caespituli (with details, i.e. amphigenous/epiphyllous, punctiform/pustulate/inconspicuous, effuse, loose, dense, brown/blackish, and others.)

Microscopic examination, measurement, description and presentation of drawings followed the standard procedures [16,17]. In the illustrations, thin-walled structures were depicted by a single line, thick-walled ones by double lines, and stippling was used to accentuate shape and pigmentation.

Identification of Fungi

The species of cercosporoid hyphomycetes were determined using the key available in the current taxonomic publications cited in the list of references.

Maejo Int. J. Sci. Technol. **2012**, *6*(01), 47-61

Dried specimens were prepared and stored at the herbarium of the School of Science, Mae Fah Luang University (MFU). Duplicates were preserved at the herbarium of the Institute of Biology, Geobotany and Botanical Garden, Halle (Saale), Germany (HAL).

RESULTS AND DISCUSSION

Fourteen cercosporoid hyphomycetes were identified and assigned to species of the genera *Cercospora* (5), *Passalora* (3)*, Pseudocercospora* (5) and *Zasmidium* (1). The cercosporoid species and their habitats are listed in Table 1.

Table 1. Cercosporoid species examined in this study

Fungal species	F	DD	G	U
Cercospora malloti	×			
Cercospora senecionicola	×			
Cercospora sidicola	×			
Cercospora verniciferae				×
Cercospora zizphigena		×		
Passalora broussonetiae	×			
Passalora fusimasculans	×		×	
Passalora graminis	×			
Pseudocercospora cycleae	×			
Pseudocercospora malloticola	×			
Pseudocercospora olacicola		×		
Pseudocercospora paederiae	×			
Pseudocercospora polysciatis				×
Zasmidium cassiicola				×

Note: F = fallow land; DD = dry dipterocarp forest; G = garden; U = urban area

Cercospora malloti [18]

Notes: The collection no. MFLU10-0310 from Tadsak waterfall, Ching Rai province agrees well with *Cercospora malloti* as previously circumscribed [15,16] (conidiophores 10–50 × 3–5 µm and conidia 40–75 × 1.5–3 µm). *C. malloti* is part of the *C. apii* Fesen. complex from which it is morphologically barely distinguishable [16]. The collection from Thailand has conidiophores which are 32–140 × 5–6 µm, and conidia which are 20–146 × 2–4 µm.

Known hosts: *Mallotus apelta* (Lour.) Müll. Arg., *M. japonicus* (L. f.) Müll. Arg., and *M. repandus* (Rotter) Müll. Arg. (Euphorbiaceae) [15,16].

Known distribution: **Asia** - China, Japan [15,16], Thailand (this paper); **North America** - USA (MS) [15,16].

Maejo Int. J. Sci. Technol. **2012**, *6*(01), 47-61

Material examined: Phengsintham (MFLU10-0310) on leaf of *Mallotus repandus* (Euphorbiaceae) (Thailand: Chiang Rai province, Wiang Chiang Rung district, Tadsak waterfall), 23 December 2009.

Cercospora senecionicola [19]

Notes: The collection no. MFLU10-0318 from Sri Pangsang village, Chiang Rai province agrees with *Cercospora senecionicola* as circumscribed in Chupp [15]. Brief description of the collection from Thailand: **Leaf spots/Lesions** circular to slightly irregular, 2–3 mm diam., at first dark green, later becoming brown to dark brown in the centre, dark brown margin. **Caespituli/Colonies** amphigenous, conspicuous, scattered, dark brown. **Conidiophores** single or fasciculate, arising from stromata (1–8 per fascicle), 0–5-geniculate, cylindrical, straight to curved, 67–170 × 5–6 µm, 0–8-septate. **Conidia** acicular to obclavate, straight to curved, 17–82 × 4–7 µm, 0–8-sepate, slightly constricted at the septa, hyaline to subhyaline, smooth, wall 0.3–0.5 µm thick, apex acute, based truncate to subtruncate, hila 2–3 µm wide, wall of the hila 0.5 µm wide, darkened.

Known hosts: *Senecio aureus* L., *S. aureus* var. *balamitea* Toir. & Gray, and *S. walkeri* Arn. (Compositae = Asteraceae) [15,16].

Known distribution: **Asia -** China, Laos, Thailand [15].

Material examined: 1) Phengsintham (MFLU10-0318) on leaf of *Senecio walkeri* (Asteraceae) (Thailand: Chiang Rai province, Muang district, Sri Pangsang village), 11 August 2009; 2) Phengsintham (P567) on leaf of *Senecio walkeri* (Asteraceae) (Laos: Bokeo province, Phimonsine village), 20 February 2010.

Cercospora sidicola [20]

Notes: The collection no. MFLU10-0312 from Tadsak waterfall, Chiang Rai province agrees with *Cercospora sidicola* as circumscribed by Chupp [15], but differs in formation of leaf spots.

Known hosts: *Sida acuta* Burm. F., *S. cordifolia* (DC.) Fryxell , *S. mysorensis* Wight & Arn., *S. rhombifolia* L., *S. spinosa* L., and *Sida* sp. (Malvaceae) [15,16].

Known distribution: **Asia** - China, India, Thailand (this paper); **North America** - Cuba, Dominican Republic, Panama, Puerto Rico, USA (FL, LA, TX), Virgin Islands; **South America** - Argentina, Brazil [16].

Material examined: Phengsintham (MFLU10-0312) on leaf of *Sida mysorensis* (Malvaceae) (Thailand: Chiang Rai province, Wiang Chiang Rung district, Tadsak waterfall), 23 December 2009.

Cercospora verniciferae [21] (Figure 1; Redescribed because this species is poorly known.)

Leaf spots/Lesions small to medium, suborbicular to irregular, 1–4 mm in diam., brown in the centre, and with brown-yellow margin. **Caespituli/Colonies** hypophyllous, scattered, dark brown. **Mycelium** internal; **hyphae** branched, 3–5 µm wide ($\bar{x}$ = 3.57 µm, n = 7), septate, constricted at the septa, distance between septa 7–12 µm ($\bar{x}$ = 8.42 µm, n = 7), brownish or green-hyaline, wall 0.5–0.8 µm wide ($\bar{x}$ = 0.54 µm, n = 7), smooth, forming plate-like plectenchymatous stromatic hyphal aggregations. **Stromata** developed, small to medium-sized, globular to subglobular, substomatal and intraepidermal, 16–33 µm in diam. ($\bar{x}$ = 23.6 µm, n = 8), dark brown to black in

Maejo Int. J. Sci. Technol. **2012**, *6*(01), 47-61

mass, composed of swollen hyphal cells, subglobose, rounded to angular in outline, 5–10 µm wide ($\bar{x}$ = 7.9 µm, n = 13), brown to dark brown, wall 0.5–0.8 µm wide ($\bar{x}$ = 0.68 µm, n = 13), smooth. **Conidiophores** fasciculate, arising from stromata (1–4 per fascicle), emerging through stomata, not branched, straight to curved, cylindrical, 45–89 × 5–7 µm ($\bar{x}$ = 71.2 × 5.4 µm, n = 5), 2–5-septate, distance between septa 5–30 µm ($\bar{x}$ = 16.2 µm, n = 16), medium brown, paler at the apex, wall 0.5–0.8 µm wide ($\bar{x}$ = 0.63 µm, n = 16), smooth, 0–2-times geniculate. **Conidiogenous cells** integrated, terminal, cylindrical, 16–30 × 4–5 µm ($\bar{x}$ = 24.5 × 4.5 µm, n = 4), pale brown; **conidiogenous loci** conspicuous, subcircular, 2–2.5 µm wide ($\bar{x}$ = 2.12 µm, n = 4), wall 0.5–0.8 µm thick ($\bar{x}$ = 0.57 µm, n = 4), thickened and darkened. **Conidia** solitary, acicular to obclavate, straight to curved, 23–105 × 2–4 µm ($\bar{x}$ = 64 × 2.8 µm, n = 5), 5–12-septate, hyaline to subhyaline, thin-walled 0.3–0.5 µm ($\bar{x}$ = 0.31 µm, n = 5), smooth; tip acute; base truncate, hila thickened and darkened 1–1.5 µm wide ($\bar{x}$ = 1.1 µm, n = 5), wall of the hila 0.3–0.35 µm ($\bar{x}$ = 0.31 µm, n = 5) thick.

Known hosts: *Rhus vernicifera* DC., *Spondias dulcis* Parkinson, and *S. pinnata* (L. F.) Kurz (Anacardiaceae) [15,16].

Known distribution: **Asia** - Thailand (this paper); **Oceania** - American Samoa; **South America** - Brazil [15,16].

Material examined: Phengsintham (MFLU10-0313) on leaf of *Spondias pinnata* (Anacardiaceae) (Thailand: Chiang Rai province, Muang district, Sri Pangsang village), 22 December 2009.

Notes: The collection from Thailand agrees well with *Cercospora verniciferae* as circumscribed by Chupp [15]. *C. verniciferae* has conidiophores that are 45–89 × 5–7 µm and conidia that are 23–105 × 2–4 µm. *C. verniciferae* is part of the *C. apii* Fesen. complex from which it is morphologically barely distinguishable [16].

Cercospora ziziphigena [22]

Notes: The collection no. MFLU11-0019 from Mae Puem National Park, Pha Yao province (conidiophores 40–320 × 4–6 µm and conidia 163–195 × 2.5–3 µm) having a long conidia, differs from the *Cercospora ziziphigena* previously described [22] (conidiophores 13.8–92.5 × 3.5–6.3 µm and conidia 17.5–76.8 × 3.1–5.3 µm). A true *Cercospora s. str.* is quite distinct from *Cercospora apii s. lat.* [16].

Known hosts: *Ziziphus incurva* Roxb. and *Ziziphus* sp. (Rhamnaceae) [16, 22].

Known distribution: **Asia** - China [16, 22], Thailand (this paper).

Material examined: Phengsintham (MFLU11-0019) on leaf of *Ziziphus* sp. (Rhamnaceae) (Thailand: Pha Yao province, Mae Jai district, Mae Puem National Park), 22 August 2010.

Maejo Int. J. Sci. Technol. **2012**, *6*(01), 47-61

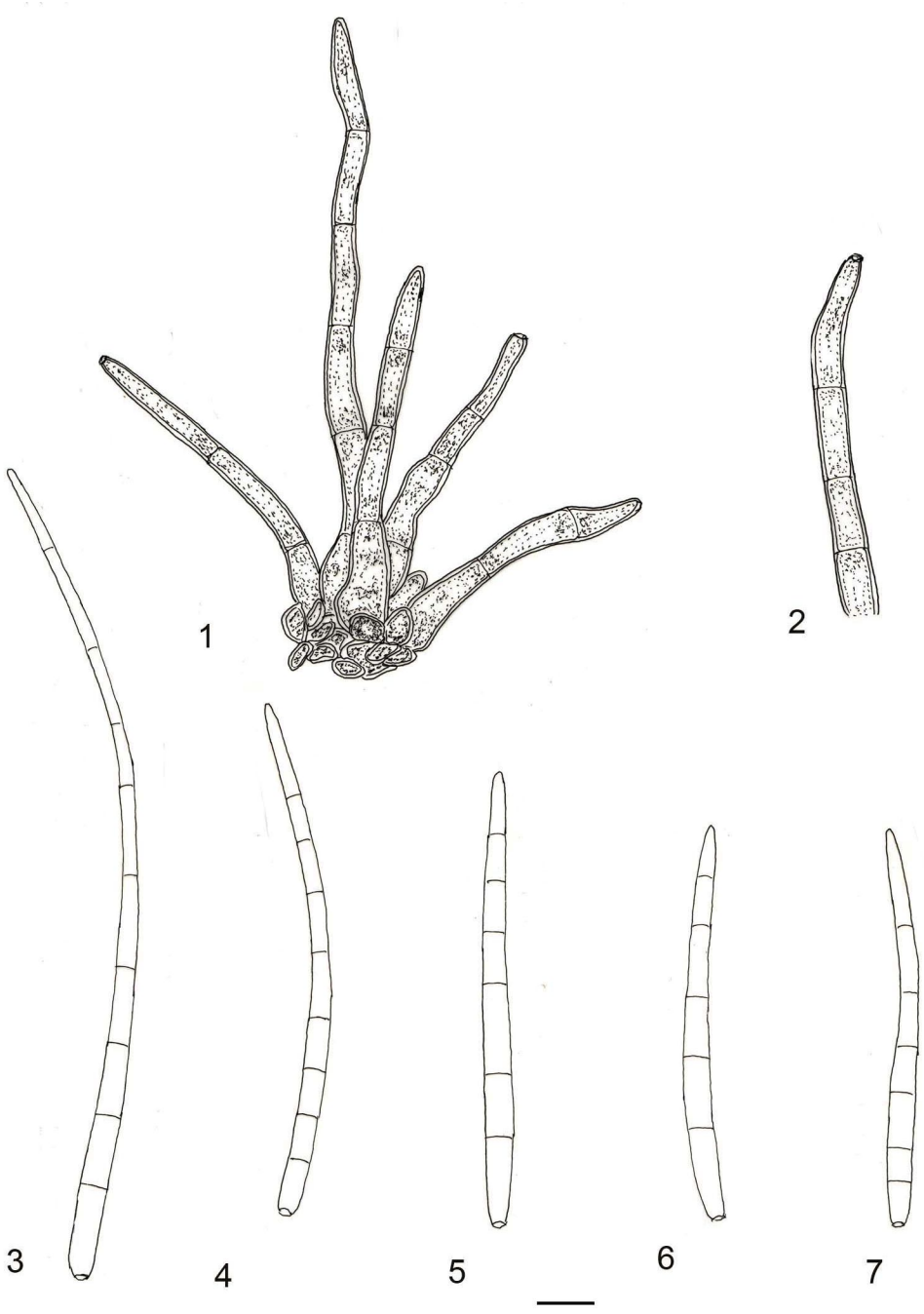

Figure 1(a). *Cercospora verniciferae* on *Spondias pinnata* from leaf spots: 1. Stroma with attached conidiophores; 2. Conidiophore; 3–7. Conidia. (Scale bar = 10 μm)

Maejo Int. J. Sci. Technol. **2012**, *6*(01), 47-61

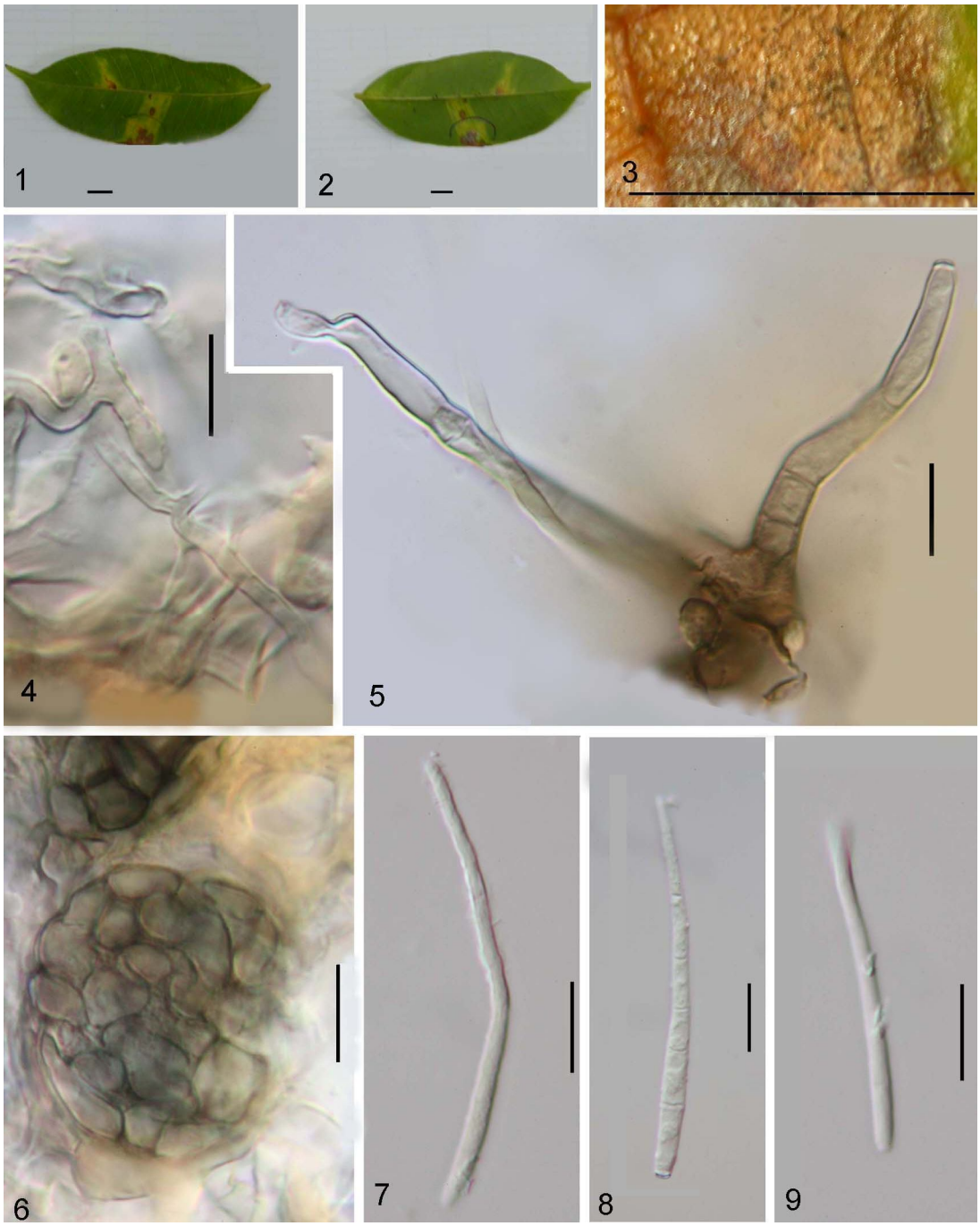

Figure 1(b). *Cercospora verniciferae* on *Spondias pinnata* from leaf spots: 1–2. Lesions on host leaves (1. upper surface and 2. lower surface); 3. Caespituli; 4. Internal mycelium; 5. Stroma with attached conidiophores; 6. Stroma; 7–9. Conidia. (Scale bar: 1–2. = 10 mm; 3. = 3 mm; 4–9. = 10 µm)

Maejo Int. J. Sci. Technol. **2012**, *6*(01), 47-61

Passalora broussonetiae [16]

Notes: The collection no. MFLU10-0314 from Tadsak waterfall, Chiang Rai province agrees well with *Passalora broussonetiae* [16], but the hyphae are smooth to distinctly verruculose (described to be smooth by Hsieh and Goh [3]). Brief description of *Passalora broussonetiae* from Thailand: **Leaf spots/Lesions** irregular, 1–9 mm diam., at first reddish brown, later becoming dark brown in the centre, gray to reddish brown margin. **Caespituli/Colonies** amphigenous, conspicuous. **Conidiophores** 170–390 × 2–5 µm, 5–17-septate. **Conidia** 6–28 × 4–6 µm, 0–3-septate.

Known host: *Broussonetia papyrifera* (L.) L'Hér. ex Vent.[3, 23].

Known distribution: **Asia** - Taiwan [3,16], Thailand (this paper).

Material examined: Phengsintham (MFLU10-0314) on leaf of *Broussonetia papyrifera* (Moraceae) (Thailand: Chiang Rai province, Wiang Chiang Rung district, Tadsak waterfall), 23 December 2009.

Passalora fusimaculans [16] ≡ *Cercospora fusimaculans* [24]

Notes: The collection no. MFLU10-0315 from Sri Pangsang village garden and no. MFLU10-0316 from Huay Kang Pah National Park, Chiang Rai province agree well with *Passalora fusimaculans* as circumscribed previously [3, 15, 25], but differ in having rather long conidiophores (up to 130 µm) and shorter conidia (up to 85 µm).

Known hosts: *Agrostis*, *Brachiaria*, *Brachia, Beckeropsis, Chasmopodium, Digitaria, Echinochloa*, *Eleusine, Entolasia*, *Ichnanthus, Leptoloma, Oplismenus, Panicum, Paspalidium*, *Pennisetum*, *Rottboellia*, *Setaria*, *Sorghum*, *Stenotaphrum*, *Urochloa*, and *Zea* (Poaceae) [16].

Known distribution: **Africa** - Botswana, Ethiopia, Ghana, Guinea, Ivory Coast, Kenya, Malawi, Nigeria, Rwanda, Sierra Leone, South Africa, Sudan, Tanzania, Togo, Uganda, Zambia, Zimbabwe; **Asia** - Brunei, China, India, Japan, Malaysia, Philippines, Taiwan, Thailand (this paper); **Europe** - Azerbaijan, France, Georgia; **North America** - Costa Rica, Cuba, Dominican Rep., El Salvador, Guatemala, Honduras, Jamaica, Mexico, Nicaragua, Panama, Trinidad & Tobago, USA (AL, PL, IA, ID, KS, NC, ND, OK, OR, TX, VA, WI); **Oceania** - Australia, Fiji, New Zealand, Palau, Papua New Guinea, Samoa, Solomon Islands, Vanuatu; **South America** - Bolivia, Brazil, Colombia, Ecuador, Guyana, Peru, Venezuela [16].

Material examined: 1) Phengsintham (MFLU10-0315) on leaf of *Echinochloa esculenta* (Poaceae) (Thailand: Chiang Rai province, Muang district, Sri Pangsang village), 15 September 2009; 2) Phengsintham (MFLU10-0316) on leaf of *Echinochloa esculenta* (Poaceae) (Thailand: Chiang Rai province, Huay Kang Pah National Park), 4 December 2009.

Passalora graminis [26]

Notes: The collection no. MFLU10-0317 from Doi Tung National Park, Chiang Rai province agrees well with *Passalora graminis* as circumscribed previously [15, 23]. *Passalora graminis* has conidiophores of 10–52 × 3–5 µm and conidia of 18–38 × 1.5–2 µm.

Known hosts: *Agrobardeum*, *Agropyron, Agrositanion*, *Agrostis*, *Alopecurus*, *Ammophila*, *Anthoxanthum, Arctagrostis*, *Arrhenatherum, Arundinaria, Avena, Beckmannia, Bromus*,

Maejo Int. J. Sci. Technol. **2012**, *6*(01), 47-61

Calamagrostis, Cinna, Cynodon, *Cynosurus*, *Dactylis, Danthonia, Deschampsia*, *Digitaria, Elymus*, *Elysitanion, Elytrigia, Egagrostis, Festuca, Glyceria, Hierochloe, Hordeum, Hystrix, Koeleria, Leersia, Leucopoa, Lolium*, *Melica*, *Milium*, *Miscanthus*, *Muhlenbergia, Oryzopsis*, *Panicum*, *Pennisetum, Phleum*, *Phragmities, Poa, Puccinella, Roegneria, Secale, Sitanion*, *Sparlina*, *Stenotaphrum, Stipa, Trisetum,* and *Zea* (Poaceae) [16].

Known distribution: **Asia** - Thailand (this paper) and worldwide [16].

Material examined: Phengsintham (MFLU10-0317) on leaf of *Agrostis* sp. (Poaceae) (Thailand: Chiang Rai province, Doi Tung National Park), 18 August 2009.

Pseudocercospora cycleae [23]

Notes: The collection no. MFLU10-0319 from Khun Korn waterfall, Chiang Rai province agrees with the previous description of this species [27], but differs in having longer conidiophores.

Known hosts: *Cyclea fissicalyx* Dunn, *C. peltata* Hook. f. & Thomson, and *Cyclea* sp. (Menispermaceae) [27].

Known distribution: **Asia** - China, India [27], Thailand (this paper).

Material examined: Phengsintham (MFLU10-0319) on leaf of *Cyclea peltata* (Menispermaceae) (Thailand: Chiang Rai province, Khun Korn waterfall), 18 December 2009.

Pseudocercospora malloticola [3]

Notes: The collection no. MFLU10-0320 from Sri Pangsang village, Chiang Rai province (Thailand) and no. NUOL P588 from Naloumai village, Savannakhet province (Laos) are similar to *Pseudocercospora malloticola* from Taiwan previously described [3]. Brief description of the collection from Thailand: **Leaf spots/Lesions** discoid to irregular, 1–6 mm diam., at first yellowish, later becoming brown or dark brown, and with yellowish margin. **Conidiophores** fasciculate, arising from stromata (2–11 per fascicle), emerging through stomata, nearly straight, cylindrical, unbranched, 10–40 × 3–5 µm. **Conidia** formed singly, cylindric, straight to slightly curved, 33–75 × 3–4 µm.

Known hosts: *Mallotus barbatus* (Wall.) Müll. Arg., *M. japonicus* (L. F.) Müll. Arg., and *M. thorelii* Gagnep [3].

Known distribution: **Asia** - Laos (this paper), Taiwan [3], Thailand (this paper).

Material examined: 1) Phengsintham (MFLU10-0320) on leaf of *Mallotus barbatus* (Euphorbiaceae) (Thailand: Chiang Rai province, Muang district, Sri Pangsang village), 30 August 2009; 2) Phengsintham (P588) on leaf of *Mallotus thorelii* (Euphorbiaceae) (Laos: Savannakhet province, Vilaboury district, Naloumai village), 23 June 2010.

Pseudocercospora olacicola [28]

Notes: The collection no. MFLU11-0020 from Mae Puem National Park, Pha Yao province (conidiophores 12–35 × 3–5 µm and conidia 11–58 × 2–3 µm) agrees with *Pseudocercospora olacicola* previously described [28] (conidiophores 10.5–40.5 × 2.5–5 µm and conidia 16–30.5 × 2.5–4 µm).

Maejo Int. J. Sci. Technol. **2012**, *6*(01), 47-61

Known hosts: *Olax scandens* Roxb., *Olax wightiana* Wall. ex Wight & Arn., *O. zeylanica* L., *Olax* sp., and *Ximenia* sp. (Olacaceae) [16, 28].

Known distribution: **Asia** - India [16, 28], Thailand (this paper).

Material examined: Phengsintham (MFLU11-0020) on leaf of *Olax scandens* (Olacaceae) (Thailand: Pha Yao province, Mae Jai district, Mae Puem National Park), 22 August 2010.

Pseudocercospora paederiae [3]

Notes: The collection no. MFLU10-0321 from Tadsak waterfall, Chiang Rai province (conidiophores 5–20 × 3–5 µm and conidia 42–75 × 2–3 µm) is similar to the original description of this species, based on material from Taiwan, but there are slight differences in the size of the conidiophores and conidia. The collection from Taiwan has conidiophores that are densely fasciculate, 20–120 × 3–4 µm, subhyaline to pale brown and conidia that are obclavate, straight to moderately curved, 30–80 × 3.5–5 µm and medium olivaceous [3, 15, 27].

Known hosts: *Paederia chinensis* Hance, *P. foetida* L., *P. scandens* (Lour.) Merr., and *P. tomentosa* Blume (Rubiaceae) [3,27].

Known distribution: **Asia** - China, Japan, Korea, Taiwan [3, 27], Thailand (this paper).

Material examined: Phengsintham (MFLU10-0321) on leaf of *Paederia tomentosa* (Rubiaceae) (Thailand: Chiang Rai province, Wiang Chiang Rung district, Tadsak waterfall), 23 December 2009.

Pseudocercospora polysciatis [29]

Notes: The collection no. MFLU10-0322 from Sri Pangsang village, Chiang Rai province agrees well with *Pseudocercospora polysciatis* described previously [3, 27] but differs in having distinct constriction at the septa.

Known hosts: *Polyscias balfouriana* (André) L.H. Bailey, *P. guilfoylei* (W. Bull) L.H. Bailey, and *Polyscias* sp. (Araliaceae) [3, 16, 27].

Known distribution: **Africa** - Mauritius, Ivory Coast; **Asia** - Brunei, Philippines, Taiwan, Thailand (this paper); **North America** - Cuba; **Oceania** - American Samoa, Cook Islands, Fiji, Kiribati, Marshall Islands, Micronesia, Niue, Samoa, Solomon Islands, Tonga [16].

Material examined: Phengsintham (MFLU10-0322) on leaf of *Polyscias balfouriana* (Araliaceae) (Thailand: Chiang Rai province, Muang district, Sri Pangsang village), 16 January 2010.

Zasmidium cassiicola [30] ≡ *Stenella cassiicola* [31] (Figure 2; Redescribed because this species is poorly known.)

Leaf spots/Lesions variable, more or less irregularly orbicular, 1–8 mm diam., typically deep brown. **Caespituli/Colonies** hypophyllous, conspicuous. **Mycelium** external; **hyphae** branched, 2–4 µm wide ($\bar{x}$ = 3.2 µm, n = 9), septate, constricted at the septa, distance between septa 8–30 µm ($\bar{x}$ = 18.56 µm, n = 9), pale olivaceous-brown, thin-walled 0.3–0.5 µm wide ($\bar{x}$ = 0.41 µm, n = 9), verruculose. **Stromata** absent. **Conidiophores** borne on external mycelial hyphae, unbranched, cylindrical, 30 – 117 × 3 – 4 µm ($\bar{x}$ = 65.9 × 3.17 µm, n = 18), 3 – 8-septate, distance between

Maejo Int. J. Sci. Technol. **2012**, *6*(01), 47-61

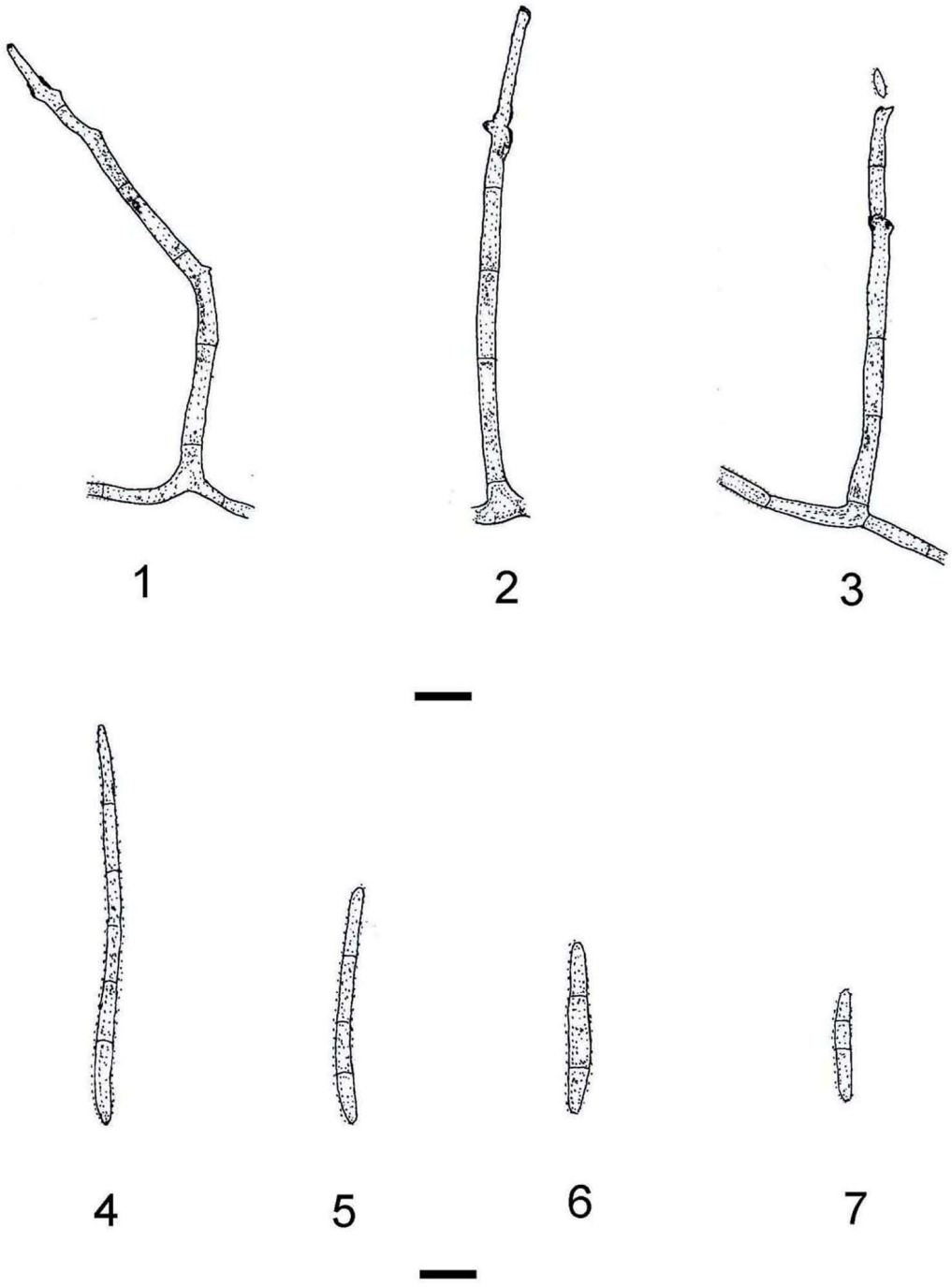

Figure 2(a). *Zasmidium cassiicola* on *Cassia fistula*: 1–3. External mycelia with attached conidiophores; 4–7. Conidia. (Scale bar = 10 µm)

Maejo Int. J. Sci. Technol. **2012**, *6*(01), 47-61

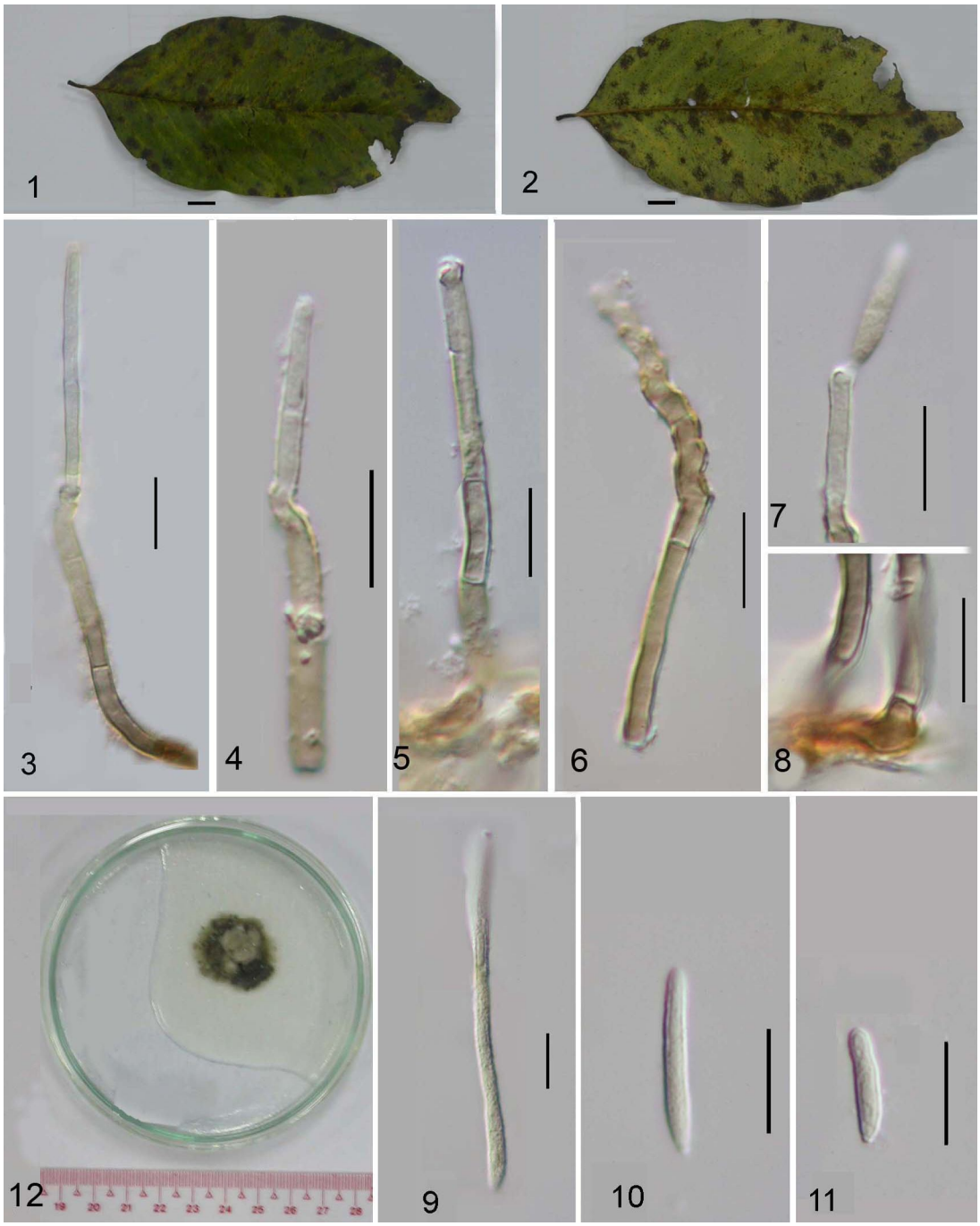

Figure 2(b). *Zasmidium cassiicola* on *Cassia fistula* from leaf spot: 1–2. Lesions on host leaves (1. upper surface and 2. lower surface); 3–6. Conidiophores; 7. Apex with attached conidium; 8. External mycelium; 9–11. Conidia; 12. Living culture. (Scale bars: 1–2. = 10 mm, 3–11. = 10 µm)

septa 7–25 µm ($\bar{x}$ = 15.8 µm, n = 30), mid pale golden brown, wall 0.5–0.8 µm ($\bar{x}$ = 0.48 µm, n = 30), smooth. **Conidiogenous cells** integrated, terminal or intercalary, 7–20 × 2–4 µm ($\bar{x}$ = 13 × 2.63 µm, n = 8), cylindrical, swollen and curved at the apex; **conidiogenous loci** forming minute, dark or refractive scars on lateral and terminal denticles, 1–2 µm diam. ($\bar{x}$ = 1.4 µm, n = 7), giving rise to branched conidial chains, wall 0.3–0.5 µm wide ($\bar{x}$ = 0.4 µm, n = 7), thickened, darkened.

Maejo Int. J. Sci. Technol. **2012**, *6*(01), 47-61

Conidia solitary or catenate, sometimes ellipsoidal-ovoid or subcylindrical, but mostly slightly obclavate, straight or slightly curved or sinuous, 11–70 × 2–4 µm ($\bar{x}$ = 34.16 × 2.9 µm, n = 24), 1–5-septate, pale olivaceous, wall 0.3–0.5 µm wide ($\bar{x}$ = 0.33 µm, n = 24), smooth or finely verruculose; apex rounded or subtruncate, 1–1.5 µm wide, wall 0.3–0.5 µm wide; base short tapered at the base to the hilum, 1–2 µm wide ($\bar{x}$ = 1.3 µm, n = 9), wall 0.3–0.5 µm wide ($\bar{x}$ = 0.41 µm, n = 9), thickened and darkened.

Known host: *Cassia fistula* L. (Leguminosae) [31].

Known distribution: **Asia** - India [31], Thailand (this paper).

Material examined: Phengsintham (MFLU10-0324) on leaf of *Cassia fistula* (Leguminosae) (Thailand: Chiang Rai province, Muang district, Sri Pangsang village), 16 January 2010.

Cultural characteristics: **Colonies** on potato dextrose agar after three weeks at 25°C with spreading mycelium, surface ridged, black and wavy in the centre and gray margin, reaching 5–15 mm diam.; **hyphae** often constricted at the septa, distances between septa 6–16 × 3–5 µm ($\bar{x}$ = 10.5 × 3.6 µm, n = 30), thin-walled, 0.3–0.5 µm wide ($\bar{x}$ = 0.45 µm, n = 30), hyaline, smooth or verruculose; **Conidiophores** and **conidia** not formed in culture.

Notes: The collection from Thailand agrees well with the Indian *Zasmidium cassiicola* (*Stenella cassiicola* [13, 31]. This is the first record outside India. *Zasmidium cassiae-fistulae* is a similar species but differs in forming its conidia consistently singly [32].

CONCLUSIONS

Cercosporoid fungi are one of the largest groups of pathogenic hyphomycetes causing leaf spots on a wide range of crops, fruit trees and other plants. The damage to living leaves and fruits may cause reduced yield. Fourteen species assigned to the genera *Cercospora* (5), *Passalora* (3), *Pseudocercospora* (5) and *Zasmidium* (1) are new records for Thailand. *Cercospora verniciferae* and *Zasmidium cassiicola* are poorly known species and are fully described.

ACKNOWLEDGEMENTS

The authors would like to thank the Global Research Network for Fungal Biology and King Saud University and the Mushroom Research Foundation (MRF) for supporting this research. Special thanks also go to the Mushroom Research Foundation.

REFERENCES

1. G. N. Agrios, "Plant Pathology", 5th Edn., Academic Press, San Diego, **2005**.
2. P. W. Crous, "Taxonomy and phylogeny of the genus *Mycosphaerella* and its anamorphs", *Fungal Divers.*, **2009**, *38*, 1-24.
3. W. H. Hsieh and T. K. Goh, "*Cercospora* and Similar Fungi from Taiwan", Maw Chang Book Co., Taipei, **1990**.
4. E. B. G. Jones, M. Tanticharoen and K. D. Hyde (Ed.), "Thai Fungal Diversity", Biotec, Bangkok, **2005**.

5. P. Giatgong, "Host Index of Plant Diseases in Thailand", Ministry of Agriculture and Cooperatives, Bangkok, **1980**.
6. P. Sontirat, P. Pitakpraiwan, W. Choonbamroong and U. Kueprakone, "Plant Pathogenic Cercosporoids in Thailand", Ministry of Agriculture and Cooperatives, Bangkok, **1980**.
7. V. Petcharat and M. Kajanamaneesathian, "Species of plant pathogenic *Cercospora* in southern Thailand", *Thai J. Phythopathol.*, **1989**, *9*, 23-27.
8. P. Sontirat, P. Pitakpraivan, T. Khamhangridthrirong, W. Choonbamroong and U. Kueprakone, "Host Index of Plant Diseases in Thailand", Ministry of Agriculture and Cooperatives, Bangkok, **1994**.
9. C. Nakashima, K. Motohashi, J. Meeboon and C. To-anun, "Studies on *Cercospora* and allied genera in northern Thailand", *Fungal Divers.*, **2007**, *26*, 257-270.
10. J. Meeboon, I. Hidayat and C. To-anun, "An annotated list of cercosporoid fungi in northern Thailand", *J. Agric. Technol.*, **2007**, *3*, 51-63.
11. C. To-anun, J. Nguenhom, J. Meeboon and I. Hidayat, "Two fungi associated with necrotic leaflets of areca palms (*Areca catechu*)", *Mycol. Prog.*, **2009**, *8*, 115-121.
12. J. Meeboon, "Diversity and phylogeny of true cercosporoid fungi from northern Thailand", *PhD Thesis*, **2009**, Chiang Mai University, Thailand.
13. C. To-anun, I. Hidayat and J. Meeboon, "*Cercospora cristellae*, a new cercosporoid fungus associated with weed *Cristella parasitica* from northern Thailand", *J. Agric. Technol.*, **2010**, *6*, 331-339.
14. P. Phengsintham, E. Chukeatirote, K. A. Abdelsalam, K. D. Hyde and U. Braun, "*Cercospora* and allied genera from Laos 3", *Cryptogamie Mycol.*, **2010**, *31*, 305-322.
15. C. Chupp, "A Monograph of the Fungus Genus *Cercospora*", Charles Chupp, Ithaca (New York), **1954**.
16. P. W. Crous and U. Braun, "*Mycosphaerella* and Its Anamorphs: 1. Names Published in *Cercospora* and *Passalora*", Centraalbureau voor Schimmelcultures, Utrecht, **2003**.
17. U. Braun, "A Monograph of *Cercosporella, Ramularia* and Allied Genera (Phytopathogenic Hyphomycetes)", Vol. 1, IHW Verlag, Eching (Germany), **1995**.
18. J. B. Ellis and B. M. Everhart, "New species of fungi from various localities", *J. Mycol.*, **1888**, *4*, 113-118.
19. J. J. Davis, "Notes on parasitic fungi in Wisconsin XX", *Trans. Wisc. Acad. Sci.*, **1937**, *30*, 1-16.
20. J. B. Ellis and B. M. Everhart, "New species of hyphomycetes fungi", *J. Mycol.*, **1889**, *5*, 68-72.
21. A. P. Viegas, "Alguns fungos do Brasil, Cercosporae", *Bol. Soc. Bras. Agron.*, **1945**, *8*, 1-160.
22. L. Xu and Y. L. Guo, "Studies on *Cercospora* and allied genera in China XIII", *Mycosystema*, **2003**, *22*, 6-8.
23. F. C. Deighton, "Studies on *Cercospora* and allied genera. VI. *Pseudocercospora* Speg., *Pantospora* Cif. and *Cercoseptoria* Petr.", *Mycol. Papers*, **1976**, *140*, 1-168.
24. G. F. Atkinson, "Some Cercosporae from Alabama", *J. Elisha Mitchel Sci. Soc.*, **1891**, *8*, 33-67.

Maejo Int. J. Sci. Technol. **2012**, *6*(01), 47-61

25. M. B. Ellis, "More Dematiaceous Hyphomycetes", Commonwealth Mycological Institute, Kew, Surrey, **1976**.
26. P. Srivastava, "Recombinations in genus *Passalora* Fries", *J. Living World*, **1994**, *1*, 112-119.
27. Y. L. Guo and W. H. Hsieh, "The Genus *Pseudocercospora* in China", International Academic Publishers, Beijing, **1995**.
28. Kamal, M. K. Khan and R. K. Verma, "New species and combinations in *Pseudocercospora* from India", *Mycol. Res.*, **1990**, *94*, 240-242.
29. U. Braun and A. Sivapalan, "Cercosporoid hyphomycetes from Brunei", *Fungal Divers.*, **1999**, *3*, 1-27.
30. Kamal, "Cercosporoid Fungi of India", Bishen Singh Mahendra Pal Singh, Dehradun (India), **2010.**
31. S. Misra, A. K. Srivastava and Kamal, "Further additions to *Stenella* from India and Nepal", *Mycol. Res.*, **1999**, *103*, 268-270.
32. U. Braun, P. Crous and Kamal, "New species of *Pseudocercospora, Pseudocercosporella, Ramularia* and *Stenella* (cercosporoid hyphomycetes)", *Mycol. Prog.*, **2003**, *2*, 197-208.