
Studies on *Cercospora* and allied genera in northern Thailand

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New collections of *Cercospora* species and allied genera from the northern part of Thailand are described and illustrated. These include three new species *Passalora haldiniae*, *Passalora gmeliniicola* and *Pseudocercospora holmskioldiae* as well as 11 records that are species new to Thailand. Furthermore, two species hitherto known from Thailand are briefly discussed.

Key words: Cercosporoid hyphomycetes, mycota, new species, southeast Asia.

Introduction

Cercospora was established by Fresenius in 1863 (Braun, 1995). The number of species has increased yearly, because most species are plant pathogenic and appear to be highly host-specific (Den Breeÿen *et al.*, 2006; Hunter *et al.*, 2006; Periera and Barreto, 2006). According to Crous and Braun (2003), the number of species of cercosporoid fungi exceeds 5500. In recent years, the genus was divided into several genera based on new criteria, such as conidiomatal structure, mycelium, conidiophores, conidiogenous cells and conidial pigmentation, as proposed by Braun, Crous, Deighton and Sutton (Crous and Braun, 2003). These criteria have been accepted among most investigators. Various phylogenetic studies, however, have shown criteria to be partly unreliable at the generic level, again leading to a reduction in genera (Crous *et al.*, 2000, 2001a,b, 2004, 2006b,c; Schubert and Braun, 2005; Ayala-Escobar *et al.*, 2006).

There have been studies on cercosporoid taxa in East Asian countries. Katsuki (1965) published a monograph of Japanese species of *Cercospora s.*

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lat. ('Cercosporae of Japan'), based on Chupp's (1954) previous criteria. Regional monographs and papers for *Cercospora* and allied genera were published based on current generic criteria, namely in Brunei (Braun and Sivapalan, 1999), mainland China (Guo and Hsieh, 1995), mainland China and Taiwan (Hsieh and Goh, 1990; Kirschner *et al.*, 2004), Indonesia (Braun, 2001), Japan (Kobayashi *et al.*, 1998, 2002; Nakashima, 2004a,b; Nakashima and Kobayashi, 2000; Nakashima *et al.*, 1999, 2002, 2004, 2006), Korea (Shin and Kim, 2001), Myanmar (Thaung, 1984) and Singapore (Yen and Lim, 1980).

Species of *Cercospora* and allied genera however, have been poorly studied in Thailand. Sontirat *et al.* (1980) enumerated 22 species of *Cercospora* in Thailand. Petcharat and Kanjanamaneesathian (1989) reported on 48 species of *Cercospora* on diseased plants in southern Thailand. Their reports however, were based on the old generic criteria, *i.e.* *Cercospora sensu lato*. Sontirat *et al.* (1994) listed 112 species of *Cercospora* and allied genera including synonyms in 'The Host Index of Plant Diseases in Thailand'. In this list, nevertheless, species names based on old and new criteria were mingled. Braun *et al.* (2006) described *Stenella anthuricola* U. Braun & C.F. Hill which was imported on *Anthurium* sp. from Thailand and Hunter *et al.* (2006) described a new *Pseudocercospora* from *Eucalyptus* leaves. Further progress in the exploration of cercosporoid hyphomycetes of Thailand has been rather limited, although a rich diversity of this fungal group has to be anticipated. Therefore, re-examination of the hitherto known species, based on the new taxonomic criteria, and attempts to collect new specimens have been initiated. New collections of cercosporoid fungi from northern Thailand, comprising some new species, are listed in this paper so as to contribute towards a better know of *Cercospora* and allied genera.

Materials and methods

The specimens were collected in the Sak Yai National Park (latitude 17°40'00", longitude 100°41'00") of the Uttradit Province, Suthep-Pui National Park (latitude 18°48'00", longitude 98°56'00"), Queen Sirikit Botanical Garden (latitude 18°92'00", longitude 98°94'00") in the Chiang Mai Province and Nam Nao National Park (latitude 16°40'00", longitude 101°33'00") in the Phetchabun Province in the northern part of Thailand. Slides for microscopic examination were prepared by hand sections from freshly collected materials. Specimens were mounted in Shear's medium. To obtain living cultures, monoconidial isolates were established according to the protocols of Nakashima and Kobayashi (1997). Dried specimens and cultures are maintained in the FLORA

OF THAILAND CMU Herbarium, Faculty of Science, Chiang Mai University, Thailand (CMU).

Results

Passalora haldiniae C. Nakash. & Meeboon, **sp.nov.** (Fig. 1)
MycoBank: 510508

Etymology: haldiniae, derived from the genus name of the host plant.

Maculis in foliis vivis subcirculibus vel irregularibus, pallide brunneis vel atro-brunneis, margine indefinitis, 1-14 mm diam.; caespitulis praecipue epiphyllis. *Stromatibus* praecipue epiphyllis, parvis vel bene evolutis, intraepidermicis, usque 67 μm diam., brunneis, subglobosis vel globosis. *Conidiophoris* laxae vel dense fasciculatis, erumpentibus, brunneis, valde 1-10-geniculatis, 15-63 \times 2.8-3.6 μm , 2-7-septatis, raro ramosis; locis conidiogenis parvis, distinctis, leviter incrassatis, 0.8-1.3 μm diam. *Conidiis* solitariis, cylindricis vel obclavatis, rectis, laevibus, ad apicem obtusis, ad basim obconice truncatis, leviter incrassatis, brunneis, 1-7-septatis, 24-80 \times 2.7-5 μm .

Leaf spots subcircular to irregular, pale brown to dark brown, with indefinite margins, 1-14 mm wide. *Caespituli* mainly epiphyllous. *Stromata* small or well-developed, intraepidermal, up to 67 μm diam., subglobular to globular, brown. *Conidiophores* loosely to densely fasciculate, erumpent through the cuticle, brown, strongly 1-10-geniculate, occasionally branched, 15-63 \times 2.8-3.6 μm , 2-7-septate. *Conidigenous cell* integrate, intercalary or terminal, proliferating sympodially, with small, distinct and slightly thickened conidigenous loci, 0.8-1.3 μm diam. *Conidia* solitary, cylindrical to obclavate, brown, straight, smooth, apex obtuse, base obconically truncated, with a slightly thickened hilum, 24-80 \times 2.7-5 μm , 1-7-septate.

Habitat: On leaves of *Haldina cordifolia* (Roxb.) Rids. (Rubiaceae).

Material examined: Thailand, Uthradit Province, Sak Yai National Park, 25 November 2004, Chiharu Nakashima and Jamjan Meeboon (CMU 27886; **holotype**).

Notes: The species of *Cercospora* and allied genera on hosts of the genus *Haldina* are not yet known. Six species of *Passalora* have been recorded on other hosts belonging to the *Rubiaceae*, viz. *Passalora cephalanti* (Ellis & Kellerm.) U. Braun & Crous (Crous and Braun, 2003), *P. diodiae* (Cooke) Crous, U. Braun & Alfenas (Crous *et al.*, 1999), *P. mitracari-hirti* O.L. Pereira & R.W. Barreto (Pereira and Barreto, 2005), *P. okinawaensis* (Tak. Kobay. & T. Nishijima) U. Braun (Crous and Braun, 2003), *P. pseudocapnodioides* O.L. Pereira & R.W. Barreto (Pereira and Barreto, 2005), and *P. ubatubensis* (Chupp & Viégas) Crous, Alfenas & R.W. Barreto (Crous *et al.*, 1997). Compared with the morphological characteristics of these species, *Passalora haldiniae* is distinguished by having strongly geniculate, occasionally branched conidiophores (conidigenous cells), and conidia formed singly.

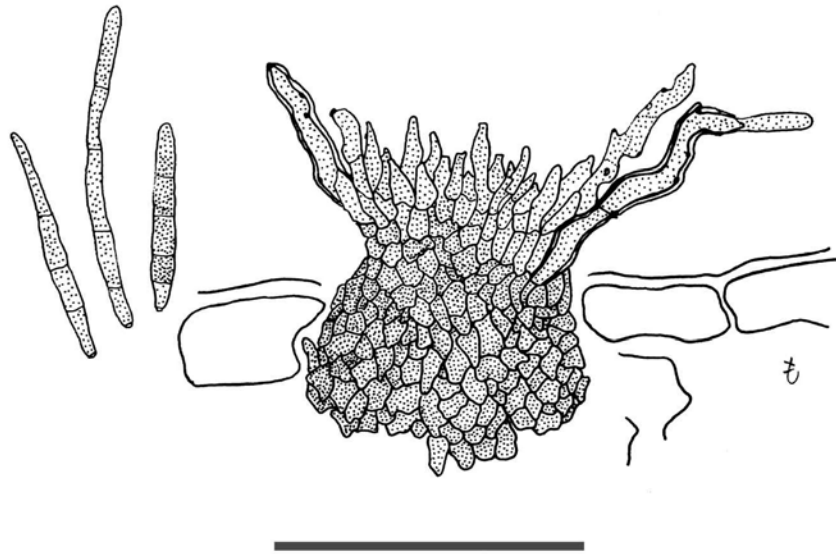


Fig. 1. *Passalora haldinae* (from holotype). Stromata, conidiophores, and conidia. Bar: = 50 μm

Passalora gmeliniicola C. Nakash. & Meeboon, **sp. nov.** (Fig. 2)
 MycoBank: 510509

Etymology: gmeliniicola, derived from the genus name of the host plant.

Maculis in foliis vivis dispersis, irregularibus vel angularibus, per venas limitatis, atro-brunneis, centro pallide brunneis, 1-9 mm diam., ultimo confluentibus, griseo-albidis; stromatibus epiphyllis, substomaicis vel intraepidermicis, bene evolutis, brunneis vel atro-brunneis, 25-57.5 μm diam. *Conidiophoris* dense fasciculatis, atro-brunneis, pachydermis, apicem versus pallide brunneis, asperulatis, proliferationibus percurrentibus, geniculatis, 39-45 \times 3-3.7 μm , 1-5-septatis. *Locis conidiogenis* parvis, distinctis, incrassatis, 0.9-1.7 μm diam. *Conidiis* solitariis, raro catenatis, brunneis, cylindricis vel obclavatis, pachydermis, rectis vel paulo curvatis, asperulatis, ad apicem obtusis vel subobtusis, ad basim obconice truncatis et leviter incrassatis, 3-16-septatis, raro pauci-distoseptatis, 16-80 \times 5.6-7.8 μm .

Leaf spots scattered, distinct, irregular to angular, vein-limited, dark brown, centre pale brown, 1-9 mm wide, later coalescing to large spots, grayish white. *Stromata* epiphyllous, substomatal to intraepidermal, well-developed, composed of swollen brown to dark brown hyphal cells, 25-57.5 μm diam. *Conidiophores* densely fasciculate, dark brown, thick-walled, pale toward the apex, asperulate, percurrently proliferating, geniculate, 1-5-septate, 39-45 \times 3-3.7 μm . *Conidiogenous cell* integrated, terminal, sympodial, with distinct, darkened and thickened conidiogenous loci, 0.9-1.7 μm diam. *Conidia* solitary,

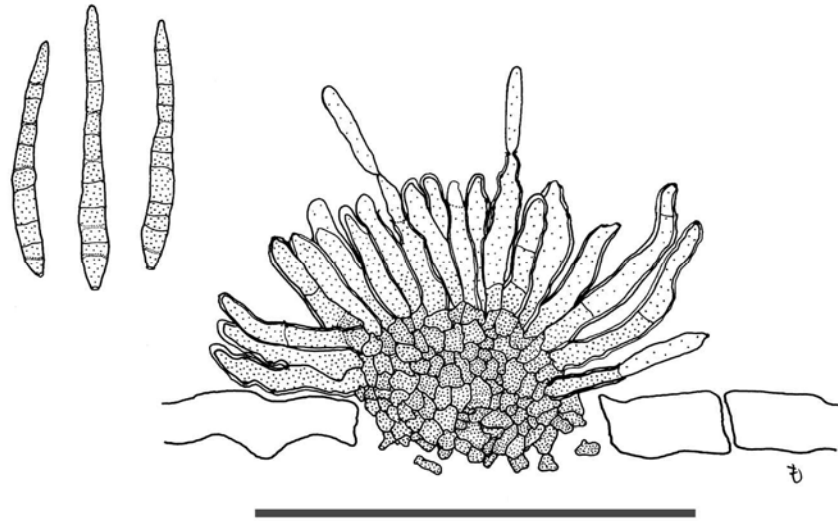


Fig. 2. *Passalora gmeliniicola* (from holotype). Stromata, conidiophores, and conidia. Bar: = 100 μm .

brown, occasionally catenulate, cylindro-obclavate to obclavate, thick-walled, straight to mildly curved, asperulate, $16\text{--}80 \times 5.6\text{--}7.8 \mu\text{m}$, 3-16-euseptate, rarely with a few additional distosepta, obtuse to subobtuse at the apex, obconically truncate and slightly thickened at the base.

Habitat: On leaves of *Gmelina arborea* Roxb. (*Labiatae*).

Material examined: Thailand, Chiang Mai Province, Suthep-Pui National Park, 21 November 2004, Chiharu Nakashima and Jamjan Meeboon (CMU 27953; **holotype**); 10 December 2006, Ikumitsu Araki and Jamjan Meeboon (CMU 28047).

Notes: *Passalora gmelinae-arborea* (A.K. Sarbhoy, Hosag. & N.Ahmad) U. Braun & Crous (Sarbhoy *et al.*, 1985; Crous and Braun, 2003), previously belonging in the *Mycovellosiella*, is different from the present new species by having superficial mycelium with solitary conidiophores, longer and wider, branched conidiophores and lacking stromata.

***Pseudocercospora holmskioldiae* C. Nakash. & Meeboon, sp. nov.** (Fig. 3)
Mycobank: 510510

Etymology: holmskioldiae, derived from the genus name of the host plant.

Maculis in foliis vivis, circularibus, angularibus vel irregularibus, dispersis, 3-23 mm diam., cinereo-brunneis, in epiphylo margine atro-brunneis cinctis, in hypophyllo margine indistinctis, pallide viridulis cinctis. *Stromatibus* amphigenis, substmaicis vel intraepidermicis,

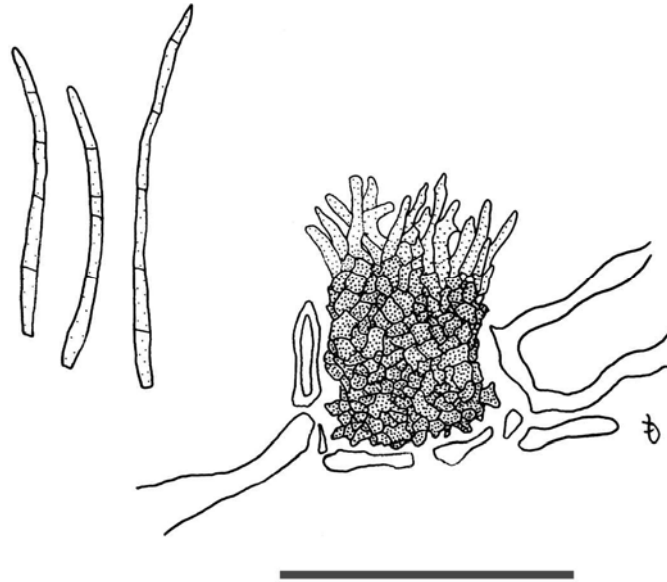


Fig. 3. *Pseudocercospora holmskioldiae* (from holotype). Stromata, conidiophores, and conidia. Bar: = 50 μ m.

atro-brunneis, 24-45 μ m diam., hyphis internis et externis, superficialibus praeditis. *Conidiophoris* laxe vel dense fasciculatis, ex cellulis stromatibus emergentis, vel solitariis, ex hyphis superficialibus oriundis, pallide olivaceo-brunneis, laevibus, rectis vel geniculatis, simplicibus, 10-23 \times 2.5-3 μ m. *Locis conidiogenis* inconspicuis, non incrassatis, non pigmentiferis. *Conidiis* solitariis, acicularibus vel obclavatis, rectis vel leniter curvatis, laevibus, ad apicem acutis, ad basim truncatis, hilis non incrassatis, pallide olivaceis, 3-7-septatis, 50-72 \times 1.8-2.5 μ m.

Leaf spots circular, angular to irregular, scattered, 1-2 mm wide, later coalescing to large spots, 3-23 mm diam., grayish-brown with blackish-brown border on the upper leaf surface, and pale greenish, indistinct border on the lower leaf surface. *Caespituli* amphigenous. *Stromata* substomatal to intraepidermal, distinct, small to well-developed, dark brown, 24-45 μ m diam., hyphae internal and external. *Conidiophores* arising from the upper part of stromata as well as external hyphae, pale olivaceous-brown, loosely to densely fasciculate, simple, straight or geniculate, smooth, 10-23 \times 2.5-3 μ m. *Conidiogenous loci* inconspicuous, unthickened, not darkened. *Conidia* solitary, acicular to obclavate, straight or slightly curved, smooth, pale olivaceous, with unthickened and truncate basal end, tip acute, 50-72 \times 1.8-2.5 μ m, 3-7-septate.

Habitat: On leaves of *Holmskioldia sanguinea* Retz. (*Verbenaceae*).

Material examined: Thailand, Chiang Mai Province, Suthep-Pui National Park, 21 November 2004, Chiharu Nakashima and Jamjan Meeboon (CMU 27952; **holotype**).

Notes: On the plant genus *Holmskioldia*, *Cercospora holmskioldiae* Lall & Gill (Lall and Gill, 1963) is recognized as a species of *Cercospora* (Crous and Braun, 2003). In this survey, *C. holmskioldiae* is also observed on the same specimen as *P. holmskioldiae*. However, *P. holmskioldiae* is easily distinguishable from *C. holmskioldiae* by having well-developed stromata, superficial hyphae with solitary conidiophores and, above all, unthickened conidiogenous loci and conidial hilum, and pigmented, narrow conidia.

List of cercosporoid species new to the mycota of Thailand

Passalora bougainvilleae (Munt.-Cvetk.) R.F. Castañeda & U.Braun, in Braun & Castañeda, Cryptog. Bot. 2/3: 291 (1991).

Habitat: On leaves of *Bougainvillea spectabilis* Willd. (*Nyctaginaceae*).

Known distribution: Argentina, Brazil, Brunei, China, Cuba, El Salvador, India, Indonesia, Jamaica, Japan, USA, Venezuela (Crous and Braun, 2003).

Material examined: Suthep-Pui National Park, Chiang Mai Province, 21 November 2004, Chiharu Nakashima and Jamjan Meeboon (CMU 27955); Chiang Mai University, Chiang Mai Province, 1 November 2006, Jamjan Meeboon (CMU 28048); 6 December 2006, Ikumitsu Araki (CMU 28049); 10 December 2006, Ikumitsu Araki and Jamjan Meeboon (CMU 28050).

Passalora mucunicola Crous, U. Braun & Alfenas, Mycotaxon 72: 181 (1999).

Habitat: On leaves of *Mucuna bracteata* DC. (*Leguminosae*).

Known distribution: Brazil (Crous and Braun, 2003).

Material examined: Queen Sirikit Botanical Garden, Chiang Mai Province, 20 November 2004, Chiharu Nakashima and Jamjan Meeboon (CMU 27954).

Passalora tithoniae (R.E.D. Baker & W.T. Dale) U. Braun & Crous, *Mycosphaerella* and its anamorphs: 1. Names published in *Cercospora* and *Passalora*: 404 (2003).

Habitat: On leaves of *Tithonia diversifolia* A. Gray (*Asteraceae*).

Known distribution: Barbados, Cuba, Hong Kong, India, Ivory Coast, Mauritius, Singapore, Taiwan, Trinidad and Tobago (Crous and Braun, 2003).

Material examined: Queen Sirikit Botanical Garden, Chiang Mai Province, 20 November 2004, Chiharu Nakashima and Jamjan Meeboon (CMU 27957); 9 October 2005, Jamjan Meeboon (CMU 28052).

Pseudocercospora bauhiniae (Syd. & P.Syd.) Deighton, Mycol. Pap. 140: 140 (1976).

Teleomorph: *Mycosphaerella piliostigmatis* Tak. Kobay. & F.D. Guzman, Bull. For. & For. Prod. Res. Inst. 351: 157 (1988).

Habitat: On leaves of *Bauhinia racemosa* Lam. (*Leguminosae*).

Known distribution: Brazil, Colombia, Ethiopia, Ghana, India, Philippines, Singapore, South Africa, USA, Venezuela (Crous and Braun, 2003).

Material examined: Queen Sirikit Botanical Garden, Chiang Mai Province, 20 November 2004, Chiharu Nakashima and Jamjan Meeboon (CMU 27956).

Pseudocercospora buddleiae (W. Yamam.) Goh & W.H. Hsieh, Trans. Mycol. Soc. R.O.C. 2: 114 (1987).

Habitat: On leaves of *Buddleja asiatica* Lour. (*Buddlejaceae*).

Known distribution: China, India, Japan, Philippines, Taiwan (Crous and Braun, 2003).

Material examined: Num Nao National Park, Phetchabun Province, 24 November 2004, Chiharu Nakashima and Jamjan Meeboon (CMU 27951).

Pseudocercospora carbonacea (L.E. Miles) N. Pons & B. Sutton, Mycol. Pap. 160: 26 (1988).

Habitat: On leaves of *Dioscorea glabra* Roxb. var. *glabra* (*Dioscoreaceae*).

Known distribution: widespread.

Material examined: Queen Sirikit Botanical Garden, Chiang Mai Province, 20 November 2004, Chiharu Nakashima and Jamjan Meeboon (CMU 27958).

Pseudocercospora dalbergiae (S.H. Sun) J.M. Yen, Bull. Soc. Mycol. France 94: 386 (1979).

Habitat: On leaves of *Dalbergia stipulacea* Roxb. (*Leguminosae*).

Known distribution: China, Taiwan (Crous and Braun, 2003).

Material examined: Queen Sirikit Botanical Garden, Chiang Mai Province, 20 November 2004, Chiharu Nakashima and Jamjan Meeboon (CMU 27960).

Pseudocercospora houttuyniae (Togashi & Katsuki) Y.L. Guo & W.X. Zhao, Acta Mycol. Sinica 8: 118 (1989).

Habitat: On diseased leaves of *Houttuynia cordata* Thunb. (*Saururaceae*).

Known distribution: China, Japan, Taiwan (Crous and Braun, 2003).

Material examined: Suthep-Pui National Park, Chiang Mai Province, 21 November 2004, Chiharu Nakashima and Jamjan Meeboon (CMU 27959).

Pseudocercospora phyllitidis (H.H. Hume) U. Braun & Crous, in Crous & Braun, *Mycosphaerella* and its anamorphs: 1. Names published in *Cercospora* and *Passalora*: 321 (2003).

Leaf spots subcircular to irregular, usually vein-limited, pale brown to brown, with pale yellowish halo, 1-4 mm wide. *Colonies* amphigenous. *Stromata* epiphyllous, intraepidermal, 24-74 µm diam., brown, hyphae internal and external. *External hyphae* emerging from stomata, developed, smooth to asperulate. *Conidiophores* arising from stromata and external hyphae, pale brown, geniculate to slightly curved, densely fasciculate or solitary, wall somewhat thickened, with indistinct, unthickened and non refractive conidial scars, 1-2-septate, 4-34 × 2-3 µm. *Conidia* solitary, acicular to obclavate, subhyaline to pale olivaceous brown, straight to mildly curved, smooth, tip acute, base truncate, hila unthickened, 36-118 × 1.8-3.7 µm, 2-10-septate.

Habitat: on leaves of *Nephrolepis biserrata* (Sw.) Schott (*Oleandraceae*).

Known distribution: Canada, Great Britain, India, Puerto Rico, USA, Virgin Islands (Crous and Braun, 2003).

Material examined: Suthep-Pui National Park, Chiang Mai Province, 21 November 2004, Chiharu Nakashima and Jamjan Meeboon (CMU 27962); 10 December 2006, Ikumitsu Araki and Jamjan Meeboon (CMU 28058).

Notes: This species was described on a wide range of ferns, including *Nephrolepis exaltata* (Crous and Braun, 2003). The material from Thailand on *Nephrolepis biserrata*, a new host for this species, is morphologically indistinguishable from *P. phyllitidis*.

Pseudocercospora tecomae-heterophyllae (J.M. Yen) Y.L. Guo & X.J. Liu, Acta Mycol. Sinica 12: 30 (1993).

Habitat: On diseased leaves of *Tecoma stans* (L.) H.B. & K. (*Bignoniaceae*).

Known distribution: China, India, Singapore (Crous and Braun 2003).

Material examined: Suthep-Pui National Park, Chiang Mai Province, 21 November 2004, Chiharu Nakashima and Jamjan Meeboon (CMU 27961).

Pseudocercospora viticicola (J.M. Yen & Lim) J.M. Yen, Gard. Bull., Singapore 33: 190 (1980).

Habitat: On leaves of *Vitex quinata* (Lour.) Will. (*Verbenaceae*).

Known distribution: Brazil, China, Cuba, India, Japan, Philippines, Puerto Rico, Singapore, Taiwan, USA, Virgin Islands (Crous and Braun, 2003).

Material examined: Suthep-Pui National Park, Chiang Mai Province, 21 November 2004, Chiharu Nakashima and Jamjan Meeboon (CMU 27964).

Additional records of species already known from Thailand

Cercospora apii Fresen. *sensu lato*, emend. Crous and Braun, *Mycosphaerella* and its anamorphs: 1. Names published in *Cercospora* and *Passalora*: 35. 2003.

Crous and Braun (2003) proposed the criteria for *Cercospora apii sensu lato* in which species indistinguishable from *C. apii* are reduced to synonymy with the latter species. In this study, we accept their treatment. The following species collected from Thailand were recognized as part of as *Cercospora apii sensu lato* species complex. However, as shown by some investigators (Crous *et al.*, 2006a; Groenewald *et al.*, 2006), several phylogenetic species reside within this morphologically similar species complex.

Cercospora bidentis Tharp, *Mycologia* 9: 108, 1917.

Habitat: On leaves of *Bidens pilosa* L. (*Compositae*).

Material examined: Num Nao National Park, Phetchabun Province, 24 November 2004, Chiharu Nakashima and Jamjan Meeboon (CMU 27963).

Cercospora richardiicola G.F. Atk. ‘*richardiaecola*’, J. Elisha Mitchell Sci. Soc. 8(2): 19 (1892).

Habitat: On leaves of *Zantedeschia* sp. (*Araceae*).

Material examined: Num Nao National Park, Phetchabun Province, 24 November 2004, Chiharu Nakashima and Jamjan Meeboon (CMU 27966).

Note: This is the first record of the present species from Thailand.

Cercospora physalidis Ellis, *Amer. Naturalist* 16: 810 (1882), emend. Braun & Melnik, *Trudy Bot. Inst. im V.L. Komarova* 20: 79 (1997).

Habitat: On leaves of *Capsicum frutescens* L. (*Solanaceae*).

Material examined: Num Nao National Park, Phetchabun Province, 24 November 2004, Chiharu Nakashima and Jamjan Meeboon (CMU 27965); Sarapee, Chiang Mai Province, 28 November 2006, Jamjan Meeboon (CMU 28065).

Notes: Bird Chili (*Capsicum frutescens*) is an important crop in Thailand, and its ‘Leaf spot disease’ caused by *C. capsici* Heald & W.A. Wolf (Sontirat *et al.*, 1994) is recognized as an important disease in Thailand. However, *C. capsici* was treated as synonym of *C. physalidis* by Braun and Melnik (1997).

Cercospora talini Syd. & P. Syd., *Mém. Herb. Boissier* 8: 2. (1900).

Habitat: On leaves of *Talinum triangulare* Willd. (*Portulacaceae*).

Material examined: Suthep-Pui National Park, Chiang Mai Province, 21 November 2004, Chiharu Nakashima and Jamjan Meeboon (CMU 27968).

Notes: This is the first report of this species from Thailand and from Asian countries at all.

Pseudocercospora stizolobii (Syd. & P. Syd.) Deighton, Mycol. Pap. 140: 153 (1976).

Habitat: On leaves of *Mucuna bracteata* DC. (*Leguminosae*).

Known distribution: widespread (Crous and Braun, 2003).

Material examined: Queen Sirikit Botanical Garden, Chiang Mai Province, 20 November 2004, Chiharu Nakashima and Jamjan Meeboon (CMU 27967).

Notes: *Cercospora stizolobii*, which is a synonym of *P. stizolobii*, was already recorded on *Stizolbium deeringianum* Bort, (Florida Velvet Bean) from Thailand (Sontirat *et al.*, 1994). However, the collection on *Mucuna bracteata* represents a new host record from Thailand.

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