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 Breeën *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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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, mono-conidial isolates were established according to the protocols of Nakashima and Kobayashi (1997). Dried specimens and cultures are maintained in the FLORA
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, intraepidermici, usque 67 µm diam., brunneis, subglobosis vel globosis. Conidiophoris laxe vel dense fasciculatis, erumpentibus, brunneis, valde 1-10-geniculata, 15-63 × 2.8-3.6 µm, 2-7-septata, raro ramosa; 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 truncata, leviter incrassatis, brunneis, 1-7-septata, 24-80 × 2.7-5 µm.

Leaves of *Haldina cordifolia* (Roxb.) Rids. (Rubiaceae) 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 & Alféns (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. pseudocapnodiooides* O.L. Pereira & R.W. Barreto (Pereira and Barreto, 2005), and *P. ubatubensis* (Chupp & Viégas) Crous, Alféns & 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 (conidiogenous cells), and conidia formed singly.
Passalora gmeliniicola C. Nakash. & Meeboon, sp. nov.

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, prolificationibus percurrentibus, geniculatis, 39-45 × 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 subobtuse, ad basim obconice truncatis et leviter incrassatis, 3-16-septatis, raro pauci-distoseptatis, 16-80 × 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, substomal to intraepidermal, well-developed, composed of swollen brown to dark brown hyphal cells, 25-57.5 μm diam. *Conidiophores* densely fascicule, dark brown, thick-walled, pale toward the apex, asperulate, percurrently proliferating, geniculate, 1-5-septate, 39-45 × 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, 16-80 × 5.6-7.8 µm, 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-arboreae* (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 µm.

atro-brunneis, 24-45 µm 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 µm. *Locis conidiogenis* inconspicuis, non incrassatis, non pigmentiferis. *Conidia* 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 µm.

*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 µm 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 µm. *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 µm, 3-7-septate.

*Habitat*: On leaves of *Holmskioldia sanginea* 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


*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).


*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).


*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).


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

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


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

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


*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).


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

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


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

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

Fungal Diversity


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*.


**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).


**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


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.

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

Habitat: On leaves of Zantedeschia sp. (Araceae).
Note: This is the first record of the present species from Thailand.

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

Habitat: On leaves of Talinum triangulare Willd. (Portulacaceae).
Notes: This is the first report of this species from Thailand and from Asian countries at all.

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

*Known distribution:* Widespread (Crous and Braun, 2003).


*Notes:* *Cercospora stizolobii*, which is a synonym of *P. stizolobii*, was already recorded on *Stizolobium 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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**References**


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