
Genus *Cercospora* in Thailand: Taxonomy and Phylogeny (with a dichotomous key to species)

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Cercospora Fresen. is one of the most importance genera of plant pathogenic fungi in agriculture and is commonly associated with leaf spots. The genus is a destructive plant pathogen and a major agent of crop losses worldwide as it is nearly universally pathogenic, occurring on a wide range of hosts in almost all major families of dicotyledonous, most monocotyledonous families, some gymnosperms and ferns. The information regarding *Cercospora* leaf spots in Thailand is scattered and mainly based on Chupp's generic concepts. Therefore, this paper provides an update that includes synonyms, morphological descriptions, illustrations, host range, geographical distribution and literature related to the species. This will benefit mycologists, plant pathologists and quarantine officials who need to study this group of fungi. The present study represents a compilation of 52 species of *Cercospora s. str.* associated with 29 families of host plants collected from several provinces in Thailand between 2004 and 2008. Twenty-four species represent *C. apii s. lat.* Plant families of *Asteraceae*, *Amaranthaceae*, *Convolvulaceae*, *Euphorbiaceae*, *Fabaceae*, *Lamiaceae* and *Solanaceae*, are commonly found infected with *Cercospora s. str.* Three species, *Cercospora arecearum*, *C. habenariicola* and *C. neobougainvilleae*, have been validity published as new species from Thailand.

Key words – diversity – hyphomycetes – leaf spot – taxonomy – Thailand.

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Introduction

Overview of Genus *Cercospora*

Cercospora, established by Fresenius (1863), is one of the most important genera of pathogenic fungi in agricultural field. The genus is a destructive plant pathogen throughout the world. Members of this genus are nearly universally pathogenic, occurring on a wide range of hosts in almost all major families of dicotyledonous, most monocotyledonous fa-

milies, some gymnosperms and ferns (Pollack, 1987). *Cercospora* species are commonly associated with leaf spots, but can also cause necrotic lesions on flowers, fruits, bracts, seeds and pedicels of numerous hosts in most climatic regions (Agrios 2005). In addition, several species of this genus are also known to be hyperparasites of other plant pathogenic fungi (Shin & Kim 2001), and are employed as biocontrol agents of alien weeds (Morris & Crous 1994).

The genus *Cercospora* (type species: *C. penicillata* (Ces.) Fresen.) is one of the largest genera of hyphomycetes (Crous & Braun 2003). The name *Cercospora*, which is derived from a combination of the Greek “*kerkok*” (tail) and “*sporos*” (seed), designates the filiform conidia of the fungus (Crous & Braun 2003). The teleomorph state is *Mycosphaerella* Johanson (Dothidiomycetes, Capnodiales, Mycosphaerellaceae), a genus that has been linked with at least 30 different coelomycetes or hyphomycetes anamorph genera (Crous et al. 2007).

Since Fresenius (1863) did not give the genus *Cercospora* a clear-cut definition, Saccardo (1880) defined it as having brown conidiophores and vermiform conidia which are brown, olivaceous or rarely subhyaline, but he did not mention the type species (*C. apii*) which has hyaline conidia. Saccardo considered *C. ferruginea* Fuckel as typical of *Cercospora* and repeated this definition in *Sylloge Fungorum* (1886). Since then, two anomalous groups of *Cercospora* are found to exist, i.e., those with colored conidia and those with hyaline conidia.

Spegazzini (1910) was the first to split the genus *Cercospora* and published a new generic name *Cercosporina* Speg. to accommodate those species with hyaline conidia (i.e. with the characters of *C. apii*), but no type species was indicated for the new genus. Saccardo (1913) agreed with the establishment of *Cercosporina*, and transferred 89 species from *Cercospora* (including some with colored conidia as well as those with hyaline ones) to *Cercosporina*. This caused confusion among these species. Miura (1928) transferred *C. apii* to *Cercosporina* and also proposed the genus *Cercosporiopsis* Miura to accommodate certain *Cercospora*-like species with coloured cylindrical conidia, but this genus is superfluous and illegitimate. Solheim (1930) proposed 21 sections of *Cercospora* by considering the presence or absence of external mycelium and prominent stromata, branching of conidiophores, as well as the shapes of conidia in order to make clear-cut morphology delimitation among species of *Cercospora* at that time. Later, Solheim & Stevens (1931) reconsidered their reclassification of *Cercospora* by adding the character of conidial scars, divided the genus into 38 sections and proposed the genus

Ragnhildiana Solheim for the species intermediate between *Cladosporium* Link and *Cercospora* based on these characters.

Chupp (1954), in his monograph of genus *Cercospora*, made no attempt to subdivide the genus, however, the monograph provided a very valuable source of reference to almost all *Cercospora* species published up to 1954, but excluded those names other than *Cercospora* or *Cercosporina*. In Chupp's monograph, the character of conidial scars are taken into account, either distinctly visible or obscured, and for those prominent scars, their sizes are noted as either large, medium or small.

Deighton (1967, 1971, 1973, 1974, 1976, 1979, 1983, 1987) continued study on *Cercospora* and allied genera, and reclassified numerous species. Deighton (1987) also stressed the characteristic of the conidial scars as an important character. Several genera of the cercosporoid fungi were redefined or newly proposed, which fall into two distinct taxonomic categories – those in which the conidial scars are conspicuously thickened (appearing as black rims when views under light microscopy) and those in which the conidial scars are unthickened (Deighton 1987). The hilum at the base of a conidium is thickened or unthickened in correspondence with the scars left on the conidiogenous cell (Deighton 1987). Thickened scars are present in *Cercospora* and allied genera such as *Camptomeris* Syd., *Cercosporrella* Sacc., *Cercosporidium* Earle, *Fusicladium* Bonord., *Mycovellosiella* Rangel, *Passalora* Fr., *Phaeoisariopsis* Ferraris, *Phaeoramularia* Muntk.-Cvetk., *Sirosporium* Bubák & Serebrian., *Stenella* Syd., unthickened conidial scars occur in genera such as *Cercoseptoria* Petr., *Mycocentrospora* Deighton, *Pseudocercospora* Speg., and *Stigmina* Sacc. (Deighton 1967, 1971, 1973, 1974, 1976, 1979, 1983, 1987).

The character of conidial scars, stressed by Deighton as an unambiguous taxonomic criterion, has been adopted by other mycologists in the classification of *Cercospora* and allied genera, e.g. Pons & Sutton (1988) and Braun (1988a,b, 1989, 1990, 1993). Braun (1993) insisted that the *Cercospora* generic conception adopted by Chupp (1954) was too wide, and this genus could be safely redefined into various additional genera to provide a

better workable system. Braun (1993) also established generic separation of *Cercospora* on diverse criteria including ontogeny, pigmentation and ornamentation of conidia, conidiophores and conidiomata. Pons & Sutton (1988) described *Distocercospora* for *Cercospora*-like hyphomycetes with distoseptate, scolecosporous conidia. On the other hand, Braun (1993) separated *Pseudocercospora*-like species with percurrently proliferating conidiogenous cells and *Mycosphaerella* teleomorphs from *Stigmima*, and published the new genus *Cercostigmima* U. Braun. Although Deighton (1967) separated *Passalora* and *Cercosporidium* on account of the presence or absence of a substomatal stroma, Braun (1995) redefined *Cercospora*, *Passalora* and *Phaeoisariopsis*. Braun (1995) discussed the status of these genera and noted that small stromata were also developed in the type species of *Passalora*. Therefore, the degree of the development of stroma-like hyphal aggregations in the substomatal cavities should not be used for generic differentiations within *Cercospora* and allied genera (Braun 1995).

Crous & Braun (2003) re-examined and presented a compilation of more than 3,000 names published in the genus *Cercospora* and 550 names in the genus *Passalora*. They separated the cercosporoid genera mainly based on a combination of characters, of which the structure of conidiogenous loci (scars) and hila, the presence and absence of pigmentation in conidiophores and conidia, and other characters described above (Crous & Braun 2003). A key to the true hyphomycetous cercosporoid fungi and related genera was also provided by Crous & Braun (2003). Based on these morphological categories, Crous & Braun (2003) re-treated and re-examined 5,720 names that related to *Cercospora s. str. (sensu stricto)*, and proposed 455 taxonomic novelties within 10 genera including *Cercospora*, *Dactylaria* Sacc., *Fusicladium*, *Mycosphaerella* (teleomorph), *Passalora*, *Scolecostigmima* U. Braun, *Semipseudocercospora* J.M. Yen, *Sirosporium*, *Sporidesmium* Link and *Stenella* Syd. Crous & Braun (2003) recognized only 659 names in the genus *Cercospora* with a further 281 being referred to *C. apii s. lat.* They also stated the need of a “compound species”, a species that is formed when two or more species join together

because of indistinguishable morphologically/genetically/physiologically, named *C. apii s. lat.* comprising all cercosporoid hyphomycetes indistinguishable from the *Cercospora* on *Apium graveolens* L. Introduction of new names for morphologically indistinguishable *Cercospora* collections detected on new host genera and families, should be avoided, and should simply be referred to *C. apii s. lat.* (Crous & Braun 2003).

In Thailand, there have been only a few reports of cercosporoid fungi. These include Sontirat et al. (1980) who enumerated 21 species of *Cercospora*; a list of 47 identified and 13 unidentified species of *Cercospora* in *The Host Index of Plant Diseases in Thailand*; by Giatgong (1980); and a report on 49 species by Petcharat & Kanjanamaneesathian (1989). These reports were based on the generic concept introduced by Chupp (1954). Further additional records of cercosporoid fungi in Thailand were also published by Ellis (1976), Manoch et al. (1986), Pons & Sutton (1988), Barreto & Evans (1994), Crous (1998), Crous & Braun (2003), Lumyong et al. (2003), Braun et al. (2006) and Hunter et al. (2006). As of this group of fungi in Thailand is little known, the information is scattered and based on Chupp's generic concept, a survey on diversity based on more recent taxonomic concepts introduced by Deighton (1967, 1971, 1973, 1974, 1976, 1979, 1983, 1987), Pons & Sutton (1988), Braun (1988a,b, 1989, 1990, 1993, 1994, 1995, 1996, 1998, 1999), Crous & Braun (2003) and Crous et al. (2001, 2006, 2007) is for this group of fungi in this region.

Morphology Characteristics

Deighton (1967, 1971, 1973, 1974, 1976, 1979, 1983), Pons & Sutton (1988), Braun (1993), Braun & Melnik (1997) and other authors divided *Cercospora s. lat.* into numerous smaller genera based on morphological characteristics. Later, a combination of morphology and molecular analysis were also carried out by Crous et al. (2000, 2001). From their intensive research on this group of fungi, Crous & Braun (2003) published the compilation of the names in *Cercospora* and *Passalora*, and re-defined the morphological characteristics of *Cercospora s. lat.* based on morphology and molecular analysis. The following

description and illustration are the common items used to identify cercosporoid fungi, in particular the genus *Cercospora*.

A. Symptoms

Symptoms caused by *Cercospora* species are variable (Fig. 1). Leaf spots may be absent or present in every degree of distinctiveness from a faint discoloration on both leaf surfaces to well defined and conspicuous leaf spots with colored borders, eye-spot diseases or vein-limited lesions (Chupp 1954). Often effuse caespituli (or fruit bodies) are visible on the lower leaf surface when no leaf spots are visible, and the fungi may also be so minute that a hand lens is required to detect it (Chupp 1954). When the disease reaches a certain stage of severity, the leaf may curl, dry and often drop from the plant (Chupp 1954).

Many species of *Cercospora* also affect the blossoms, fruits, succulent petioles and young stems, for examples, *C. agavicola* Ayala-Escobar on *Agave tequilana* F.A.C. Weber and *C. caricae-papayae* P.K. Rajak & S.P. Gautam on *Carica papaya* L. Frequently, one to numerous spots may turn the entire leaf yellow or brown, after which it shrivels and dies (Chupp 1954). Only the leaf symptoms as they show in freshly collected (or herbarium) material are taken into account in describing the symptoms of the individual *Cercospora* species.

B. Caespituli (Fruit Bodies)

Caespituli of *Cercospora*, are turfs of conidiophores as seen under a microscope or hand lens (Fig. 2). Caespituli may be distributed on the upper surface (epiphyllous), lower surface (hypophyllous), both surfaces (amphigenous); evenly distributed on the spot or aggregated along the margin of the spot (Chupp 1954). Caespituli often appear velvety, floccose or arachnoid as effuse patches (Chupp 1954). The colours are variable but mostly grey, olivaceous to whitish (Chupp 1954).

C. Conidiophores, Conidiogenous Cells, and Conidiogenesis

A conidiophore, defined as the entire system of fertile hyphae bearing conidia, may be either simple or branched, and includes the

conidiogenous cell (s) (Ulloa & Hanlin 1999). It can be reduced to a single fertile cell if the conidiophore and the conidiogenous cell are identical, or the conidiophore is composed of a single conidiogenous cell and a single or several supporting cells, or it consists of a system of conidiogenous cells with or without differentiated supporting structure (hyphal cells, stipe) (Gams et al. 1987). Some authors, for instance Hawksworth et al. (1995) and Pons & Sutton (1988), preferred to confine the term conidiophore to complex structures composed of two or more cells. In the present study, a wider concept of the term conidiophore is applied as a one-celled conidium-bearing structures can either be called conidiogenous cell or conidiophore, depending on the particular case.

In the cercosporoid fungi, there are numerous species with tufts of mixed conidiophores. Some of them are continuous and one-celled (e.g. some species of *Passalora*), other conidiophores are septate, composed of two or more cells (e.g. species of *Cercospora*). Conidiophores may be colorless (hyaline) or variously pigmented, and the pigmentation is an important taxonomic feature (Crous & Braun 2003). Conidiophores may be formed singly, erumpent through the substratum or arising from hyphae as lateral branchlets, or they are caespitose, i.e. arranged in loose or dense fascicles (Gams et al. 1987) (Figs 3a–d). Conidiogenous cells can be formed as part of an undifferentiated hypha, and they also can form a unicellular conidiophore or they can mostly form part of a pluricellular conidiophores (Hennebert & Sutton 1994). In the latter case, they can be either terminal, intercalary or pleurogenous (Hennebert & Sutton 1994). If they are formed laterally or terminally but not in continuity with the main axis, they are called discrete (Hennebert & Sutton 1994). A conidiogenous cell may be unilocal/single locus (Figs 3–b, d) or multilocal/more than two loci (Figs 3a, c). The loci can be apical, lateral or circumspersed (all around the conidiogenous cell) (Hennebert & Sutton 1994).

A conidial scar, the minute structure at the end of a conidiogenous cell results from conidiogenesis, and is a recognizable portion where the conidium has been liberated (Hennebert & Sutton 1994). Conidia scars

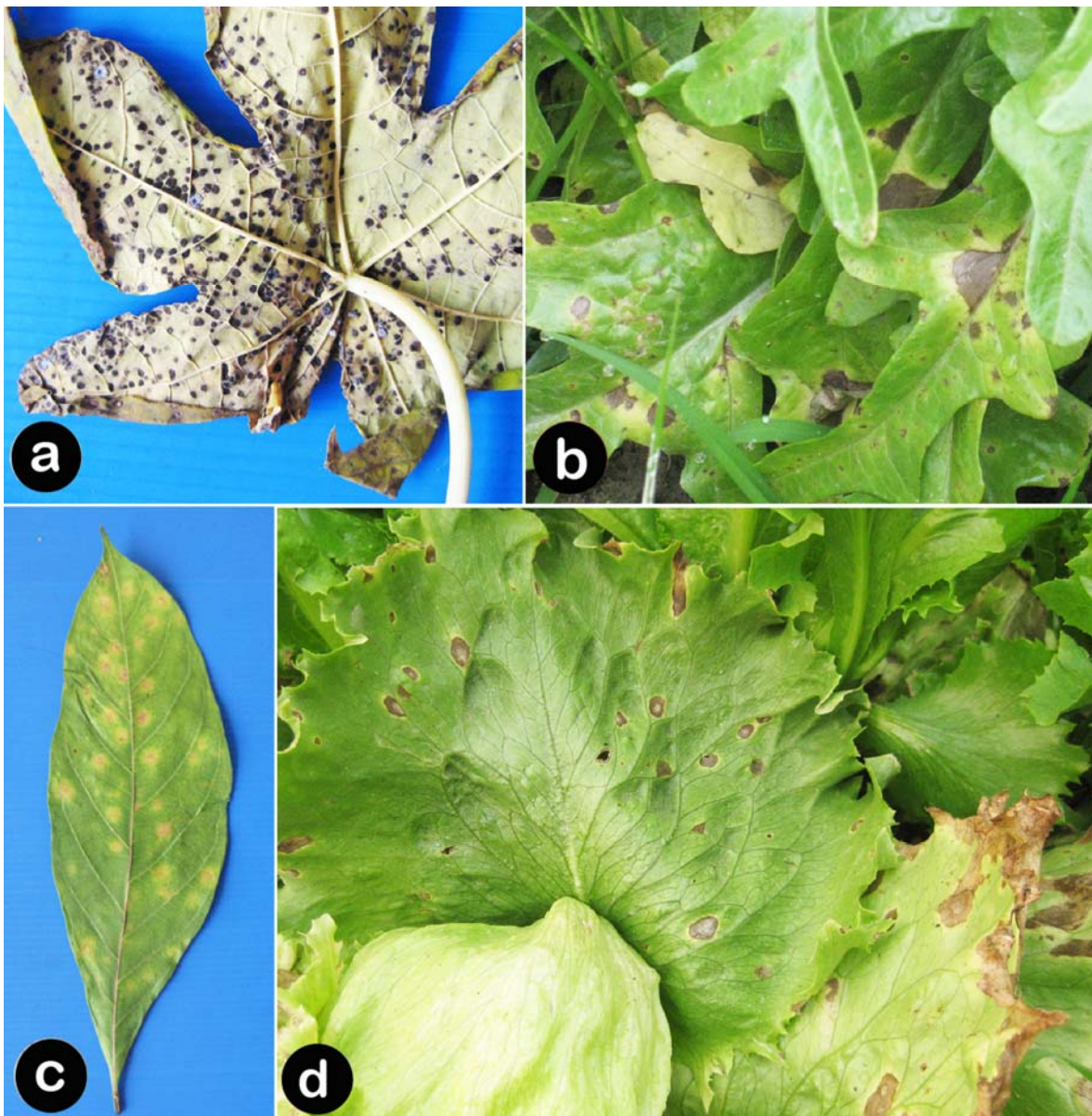


Fig. 1 – Various types of cercospora leaf spot symptoms on leaves: **a.** *Carica papaya*, **b.** *Lactuca sativa*, **c.** *Kopsia fruticosa* and **d.** *Lactuca sativa* (cultivar head lettuce). (Meeboon et al. 2007c).

may be conspicuous by thickened walls with dark coloration (Figs 3c–d) or inconspicuous (Hennebert & Sutton 1994). A scar on a conidium at the point of former attachment to the conidiophore is termed the hilum (Hennebert & Sutton 1994). The genus *Cercospora* is characterized by conspicuous, thickened and darkened scars and hila (Crous & Braun 2003).

The development of a conidium from the conidiogenous cell or conidiophore is called conidiogenesis (Hennebert & Sutton 1994). Cercosporoid fungi conidiogenesis is characterized by blastic, sometimes determinate but

often sympodial proliferation, mostly schizolytic conidial secession with single or conidia in chains. Blastic conidiogenesis is characterized by an elastic wall of the conidiogenous cells, bulging out to form a conspicuous, enlarged conidium initial (Hennebert & Sutton 1994). It may be holoblastic [all wall layers of the conidiogenous cells contribute towards the formation of the conidium (blastoconidia)] or enteroblastic (only the inner wall of the conidiogenous cell contributes towards the formation of the conidium) (Hennebert & Sutton 1994). Blastic conidiogenous cells may be monoblastic (only with a single conidiogenous



Fig. 2 – Appearance of caespituli (as turfs of conidiophores) of genus *Cercospora* on the leaf spot of *Coccinia grandis* (L.) Voigt. (Meeboon 2009).



Fig. 3 – Various types of conidiophores and conidiogenous cells of the cercosporoid fungi (40×). **a.** Fasciculate and non-divergent. **b.** Fasciculate, non-divergent and conidiogenous loci not darkened. **c.** Fasciculate, divergent, polyblastic, sympodial proliferation, with dark conidiogenous loci. **d.** Fasciculate, distinctly divergent, non-sympodial proliferation with dark conidiogenous loci. (Meeboon 2009).

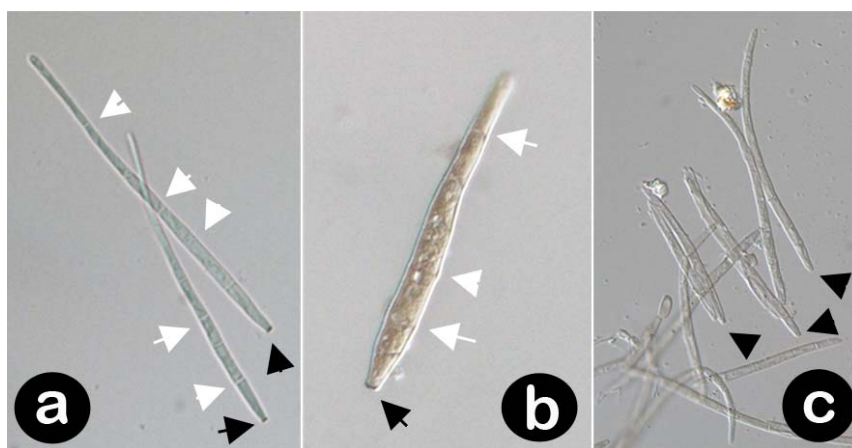


Fig. 4 – Various types of conidia of the true cercosporoid fungi sensu Crous & Braun (2003) found in this study (40×) (black arrows: conidia hila, white arrows: septation). **a.** Conidia of genus *Cercospora* s. str. **b.** Conidium of genus *Passalora*. **c.** Conidia of genus *Pseudocercospora*. (Meeboon 2009).

locus or unilocal) or polyblastic (with two or more conidiogenous loci or multilocal), formed either synchronously or, mostly; in a sympodial succession (Hennebert & Sutton 1994). Conidiophores (or conidiogenous cells) can be determinate (growth ceasing with the production of a terminal conidium or conidial chain) or they can proliferate [indeterminate, proliferation being sympodial or percurrent (through the open end left when the first conidium becomes detached)] (Hennebert & Sutton 1994). *Cercospora* is characterized by having blastic (monopolyblastic), schizolytic, and sympodial proliferation (Crous & Braun 2003).

C. Conidia

The important characters of conidia of the genus *Cercospora* are mostly related to the shape, septation, pigmentation and surface (Figs 4a–c), similar to the Saccardoan system (Crous & Braun 2003). The conidia of *Cercospora* species are either straight to curved, and acicular, filiform, obclavate or a combination of shapes (Crous & Braun 2003). There are two basic types of septation, viz, euseptate (septa formed by all existing wall layers) and distoseptate/pseudoseptate (septa formed only by the innermost layer) (Hennebert & Sutton 1994). The term septum (septate) without specification is usually applied to euseptate (Hennebert & Sutton 1994).

Hyaline and pigmented conidial structures are usually well separated in certain taxa (genera, species) of the cercosporoid fungi, but

transitional phenomena are not uncommon (Crous & Braun 2003). However, taxa with subhyaline to pale (yellowish green, pale olivaceous, etc.) structures often cause serious taxonomic problems (Crous & Braun 2003). The conidia of *Cercospora* are characterized by hyaline or pale olivaceous pigmentation and euseptate conidial septation (Crous & Braun 2003)

Collection and Observation

Specimen collection involved an observation of the presence/absence of the fruiting bodies/caespituli on the leaf. The observation was usually conducted using a 10× or 20× magnifying lens. Specimens that are positively showed the presence of *Cercospora* fruiting bodies/caespituli were placed in plastic bags. The collecting bags were sealed and labeled: *Name of host plants, Collection site, Collector /s, and Collection date.*

Detailed observations of morphological characters were generally carried out by means of a dissecting microscope, followed by light compound microscope using oil immersion (1000×). Specimens for microscopic observation were prepared by hand sectioning or fine forceps. Water is very good as mounting medium. Shear's solution or lactophenol was usually used as a media for permanent slides. Thirty conidia, hila, conidiophores, conidiogenous loci and 10 stromata were commonly measured for each specimen. Line drawings were prepared at a magnification of 400×, or

1000×, if necessary. Dried herbarium specimens were deposited at herbarium at CMU Herbarium (CMU), Biology Department, Faculty of Science, Chiang Mai University, Chiang Mai, Thailand, and BIOTEC Herbarium (BBH), Bangkok, Thailand. Living cultures have been deposited at BIOTEC culture collection (BCC), Bangkok, and Molecular of Plant Pathology Laboratory, Department of Plant Pathology, Chiang Mai University.

Single Spore Isolation

Single spore isolation of each species followed the method outlined by Choi et al. (1999), with a modification (Fig. 5).

A glass slide was sterilized with ethanol and wiped with a tissue on which ethanol (70%) had been sprayed. A sterilized pipette was then used to transfer 1–2 drops of sterilized water onto the glass slide. Flame sterilized fine forceps were used to take conidia from the specimen and to suspend the conidia with sterilized water on the glass slide. A triangle line was marked on the bottom of the water agar plate. The prepared homogenous spore suspension was then transferred with a sterilized loop, onto the surface of the water agar plate, and smeared following the drawn lines. The unsealed plate was incubated at room temperature for approximately 24 hours. The plate was not sealed as this allows some of the surface water to dry out, and thus reduce the chance of contamination. The conidia were usually checked within 24 hours to establish germination. Once the conidia had germinated, a sterilized glass needle was used to pick up a small piece of agar containing a conidium. In order to establish that the conidium is the one desired, and to maintain quality control, a slide was prepared and examined under the compound microscope. If the conidia do not germinate after 24 hours, the plate was then sealed with PARAFILM “M”[®] (Chicago, USA) and examined periodically. Approximately 10–20 germinated conidia were transferred and distributed evenly onto two PDA plates and incubated at room temperature until their colony diameter was about 1 to 2 cm. A small piece of mycelium with agar could then be cut

and transferred to another PDA plate. The culture was checked after a few days.

Preservation of Specimens

Once fully examined, the host-plant tissue was spread out on folded drying paper or newspaper along with a collection-number tag and dried.

Identification Procedures

Identification of species was mainly based on the recent concepts of Deighton (1967, 1971, 1973, 1974, 1976, 1979, 1983, 1987), Pons & Sutton (1988), Braun (1988a,b, 1989, 1990, 1993, 1994, 1995, 1996, 1998, 1999), Crous & Braun (2003), and Crous et al. (2001, 2006, 2007). In most cases the specimen could be identified to at least genus level with the above references, further identification required examination of the relevant literatures. Sources are often suggested in the above references and the Dictionary of Fungi (Kirk et al. 2008), the ‘searchable’ Index Fungorum (<http://www.indexfungorum.org/Names/Names.asp>) and Systematic Mycology and Microbiology Laboratory (SMML) Database (<http://nt.ars-grin.gov/fungalatabases/fungushost/fungushost.cfm>) on the internet are also invaluable.

The following is dichotomous key to the four genera of the true cercosporoid fungi adopted from Crous & Braun (2003).

1. Conidiogenous loci inconspicuous or subdenticulate, but always unthickened and not darkened or subconspicuous, i.e., unthickened, but somewhat refractive or rarely very slightly darkened, or only outer rim slightly darkened and refractive (visible as minute rings) *Pseudocercospora*
1. Conidiogenous loci conspicuous, i.e., thickened and darkened throughout, only with a minute central pore..... **2**
2. With verruculose superficial secondary mycelium; conidia amero- to scolecosporous, mostly verruculose *Stenella*
2. If superficial secondary mycelium present, hyphae smooth or almost so..... **3**

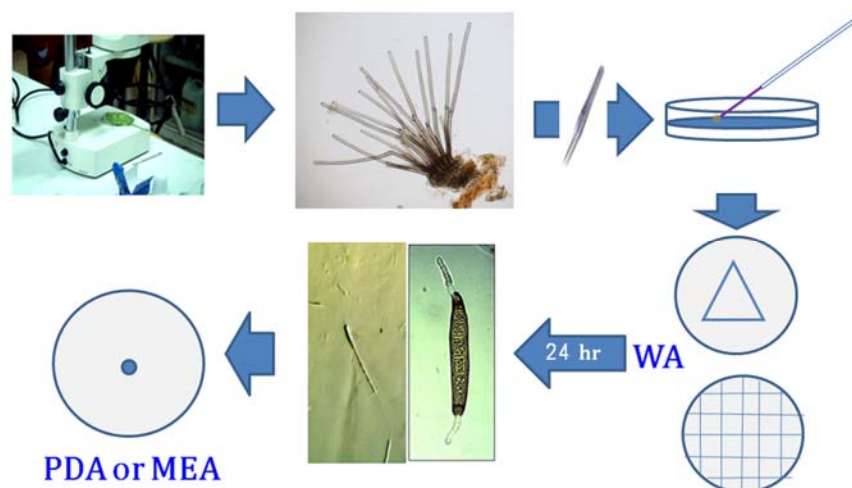


Fig. 5 – Diagram of single spore isolation employed in the isolation of *Cercospora* species. (modified from Choi et al. 1999).

3. Conidia hyaline or subhyaline, scolecosporous, acicular, obclavate-cylindrical, filiform, usually pluriseptate *Cercospora*

3. Conidia pigmented or, if subhyaline, conidia non-scolecosporous, ellipsoid-ovoid, short cylindrical, fusoid and only few septa *Passalora*

Presentation of Results

Cercospora species described and illustrated in this book are presented in alphabetical order according to plant families. All species are fully described and illustrated. The following data are provided:

- Names of species with reference
- Synonyms
- Full description
- Specimen examined
- Habitat (host range)
- Distribution with countries in alphabetical order
- Notes (if necessary)

Molecular Phylogenetic Analysis

A. DNA Extraction, Polymerase Chain Reaction (PCR) and Sequencing

Molecular characterization was carried out in order to elucidate the phylogenetic relationship of the members of genus *Cercospora*, and the relationship with other related genera

within anamorphic taxa of *Mycosphaerella* the teleomorph. Total genomic DNA was extracted from fungal mycelia cultured on MEA (Difco, USA) following a 2× cetyltrimethylammoniumbromide (CTAB) protocol (Rogers & Bendich, 1994). DNA amplification of ITS region of nrDNA (Fig. 6) was performed by polymerase chain reaction (PCR) using ITS4 (5'-TCCTCCGCTTATTGATATGC-3') and ITS5 (5'-GGAA- GTAAAAGTCGTAACAA GG-3') primers (White et al. 1990) to generate about 580 nucleotides from the complete ITS, including 5.8S rDNA region. The amplification condition was performed in a 50 mL reaction volume as follows: 1× PCR buffer, 0.2 mM each dNTP, 0.3 mM of each primer, 1.5 mM MgCl₂, 0.8 units Amplitaq Taq Polymerase (Perkin-Elmer, Foster City, CA, USA), and 10 ng DNA. PCR parameters for all the regions were performed as follows: initial denaturation at 94°C for 3 min, followed by 30 cycles of 94°C for 1 min, 52°C for 50 s, 72°C for 1 min, and final extension of 72°C for 10 min.

The characterization of PCR products was performed via agarose gel electrophoresis on a TAE 1% agarose gel containing EB (EtBr) as the staining agent. The PCR product was purified using Qiaquick purification kit (Qiagen) and DNA concentration of the PCR products was subjected to automatic sequencing (ABI PRISM Dye Terminator Cycle Sequencing and ABI PRISM Sequencer model 377, Perkin Elmer).

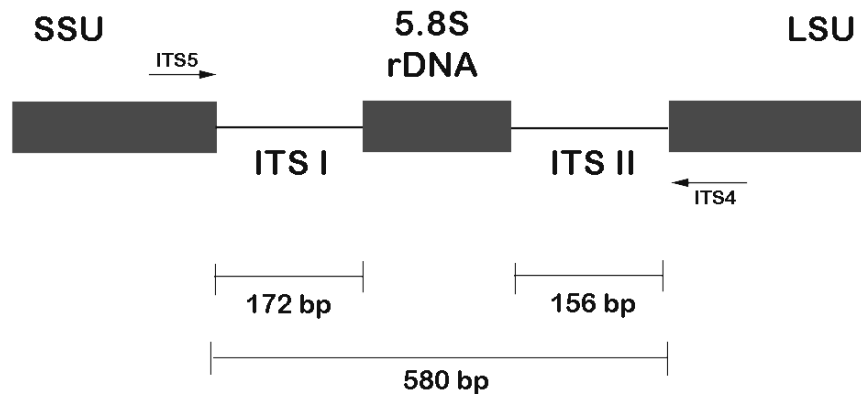


Fig. 6 – Diagrammatic illustration of Internal Transcribed Spacer (ITS) region of ribosomal DNA (rDNA). Primers positions, ITS5 and ITS4, in highly conserved small subunit (SSU) 18S and large subunit (LSU) 28S ribosomal DNA gene sequences flanking the spacer regions, ITS I and ITS II, are shown.

B. Sequence Alignment and Phylogenetic Analysis

Sequences obtained from the respective primers (ITS5 and ITS4) were aligned in Clustal X (Thomson et al. 1997) and BioEdit (Hall 1999). The sequence alignments were also refined by direct examination. Regions designated as ambiguously aligned were excluded from the analysis. Gaps were treated as missing data. Phylogenetic analyses were performed in PAUP version 4.0b10 (Swofford 2002).

Unweighted Maximum Parsimony (UMP) analysis was performed in order to confirm the phylogenetic relationship with related taxa. Trees were inferred using the heuristic search option with 1000 random sequence additions. Maxtrees were unlimited, branches of zero length were collapsed and all multiple parsimonious trees were saved. Descriptive tree statistics (tree length [TL], consistency index [CI], retention index [RI], related consistency index [RC], homoplasy index [HI] and log likelihood [-ln L]) were calculated for trees generated under different optimality criteria. The Kishino-Hasegawa (KH) likelihood test (Kishino & Hasegawa 1989) was carried out using PAUP to compare the best tree topology obtained by the nucleotide sequence data with a constrained tree. Clade stability was assessed in bootstrap analyses with 1000 replicates, each with 1000 replicates of random stepwise addition of taxa.

Random sequence addition was used in the bootstrap analysis. Trees were figured in TreeView (Page 1996).

Phylogenetic Affinities of *Cercospora* and Allied Genera Based on ITS nrDNA Sequence Analysis

Current Understanding on Phylogeny of *Cercospora* and Allied Genera

Every living organism contains DNA, RNA and proteins. Closely related organisms generally have a high degree of agreement in the molecular structure of these substances, while the molecules of organisms distantly related usually show a pattern of dissimilarity. With the advent of molecular technique, particularly since the finding of fungal ribosomal RNA genes amplification and direct sequencing technique by White et al. (1990), nucleotide sequences sampled from genome have been commonly employed in recent years by systematists to investigate the phylogeny of various groups of fungi, and consequently, the progress in molecular phylogenetic of Kingdom Fungi has accelerated rapidly.

In *Cercospora* and allied genera, until the present time, only a few molecular phylogeny analyses have been published. One of the first significant phylogenetic analyses was published by Stewart et al. (1999) who reported the monophylogeny of *Cercospora*, *Passalora* and

Pseudocercospora based on ITS region of partial rDNA sequence analysis, and reaffirmed that *Ramulispora* Miura and *Mycocentrospora* Deighton are not related to *Mycosphaerella* teleomorph. Stewart et al. (1999) also reduced *Paracercospora* Deighton to a synonym of *Pseudocercospora*. However, because of limited taxa, no other species linked to *Mycosphaerella* teleomorph were included in their analysis, and it was not possible to determine the phylogenetic relationship of the *Cercospora* species to other anamorphs genera.

Similar to the anamorphic state, the taxonomy and phylogenetic of *Mycosphaerella* (teleomorphic state) is also complicated (von Arx 1983, Crous et al. 2000). Due to the large number of associated anamorphs, Crous & Wingfield (1996) noted that *Mycosphaerella* was a polyphyletic assemblage of presumably monophyletic anamorphic genera. Goodwin et al. (2001), based on the analysis of a large number of anamorphs of *Mycosphaerella* using ITS region of rDNA sequence, also found that *Mycosphaerella* was not monophyletic. However, Goodwin et al. (2001) noted that *Cercospora s. str.* formed a highly supported monophyletic group, and the *Cercospora* species that produced the toxin cercosporin were suggested to have a single evolutionary origin. Crous et al. (2007), based on the analysis of Large Sub Unit (LSU) region of ribosomal DNA (28SrDNA), reaffirmed that *Mycosphaerella* was polyphyletic.

Although the *Mycosphaerella* complex encompasses thousands of names, studies on the phylogenetic relationship among taxa in this group are still rare compared with other fungal groups. This is probably due to the fact that these organisms are relatively difficult to isolate on artificial medium (Crous et al. 2007). In fact, most taxa belonging to *Mycosphaerella* and anamorphs (the cercosporoid fungi) which are seen successfully cultivated on the artificial medium grow relatively slower than other fungi.

Phylogeny of *Cercospora* Species from Thailand

A phylogenetic tree of 42 representative sequences of *Cercospora* and allied genera from Thailand and other sequences obtained from NCBI (National Center for Biotechnology

Information) GenBank database, obtained from unweighted maximum parsimony (UMP) analysis method are shown in Fig. 7.

Based on this analysis, 6 genera of the cercosporoid fungi included in the analysis, namely, *Cercospora*, *Septoria*, *Pseudocercospora*, *Stigmina*, *Ramularia* and *Passalora* appear as monophyletic groups with 60%, 53%, 95%, 100%, 100% and 79% bootstrap support, respectively (Fig. 7). *Cladosporium* was used as an out group. This result shows that morphological definitions of all these genera are also well-defined phylogenetically. A similar finding was also reported by Crous et al. (2001) with the exception of genus *Stigmina*. The general morphological characteristics among these six genera and other cercosporoid fungi are also briefly illustrated in Fig. 7. This diagram shows the differences among taxa within cercosporoid fungi which are mainly separated by distinct structures of conidia, conidiophores, conidiogenous cells, hila and scars.

The *Cercospora* species formed a monophyletic clade with 60% bootstrap support (Fig. 7). This clade appeared as a sister group to *Septoria* clade with 89% bootstrap support which indicates a close relationship between the two genera. *Septoria*, a coelomycetous fungus, shares similar morphology characteristics to *Cercospora* in having holoblastic and sympodial conidiophore proliferation, as well as hyaline, filiform to acicular and multiseptate conidia (Sutton 1980). However, the two genera are morphologically separated due to *Septoria* producing pycnidial conidiomata (Figs 7–8). These genera are maintained as separate taxa, although Verkley & Starink-Willemse (2004) noted that conidiomatal structure seems to have little predictive value for phylogenetic relatedness, but phylogenetically analysis showed that *Cercospora* and *Septoria* are not monophyletic within *Mycosphaerella* and its anamorphs. It was probably because of the presence of intermediate species between *Cercospora* and *Septoria*, therefore, more genes loci or taxa are required to analyze the relationship between the two genera.

Passalora clade appeared as a basal group in the phylogenetic tree with 79% bootstrap support. This genus was introduced by Fries (1849) with *Passalora bacilligera* (Mont.

minimum possible length = 215
 maximum possible length = 762

CI = 0.717
 RI = 0.845
 RC = 0.605
 HI = 0.283

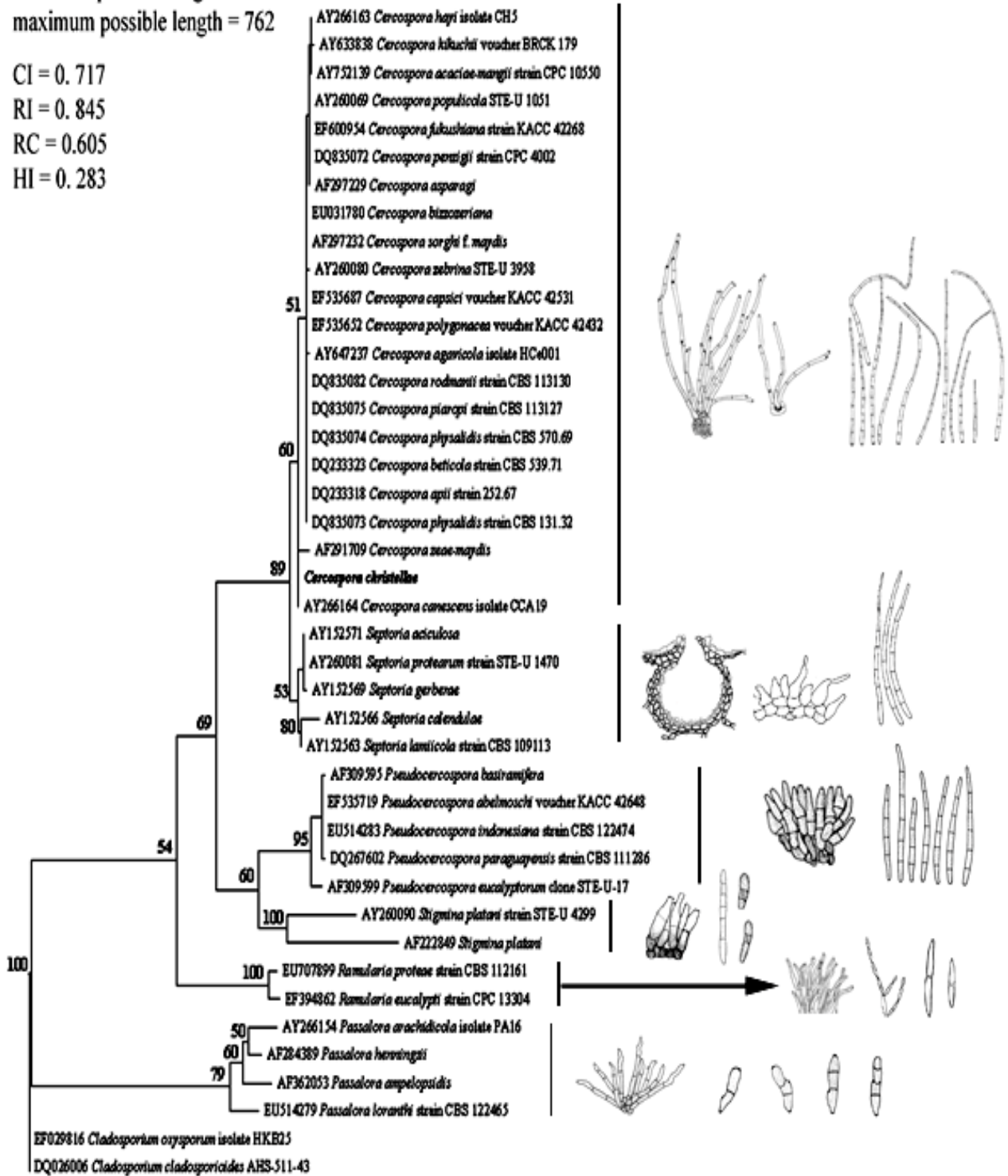


Fig. 7 – Best parsimonious tree (300 steps) based on ITS nrDNA sequence data representing phylogenetic affinities of *Cercospora* with closely related genera representatives of the *Mycosphaerella* anamorphs. The analysis yielded 486 total characters of which 327 characters were constant, 31 characters were variable and parsimony-uninformative and 128 characters were parsimony-informative Bootstrap values (>50%) from 1000 replicates of parsimony analysis are shown above internodes (To-anun et al. 2009).

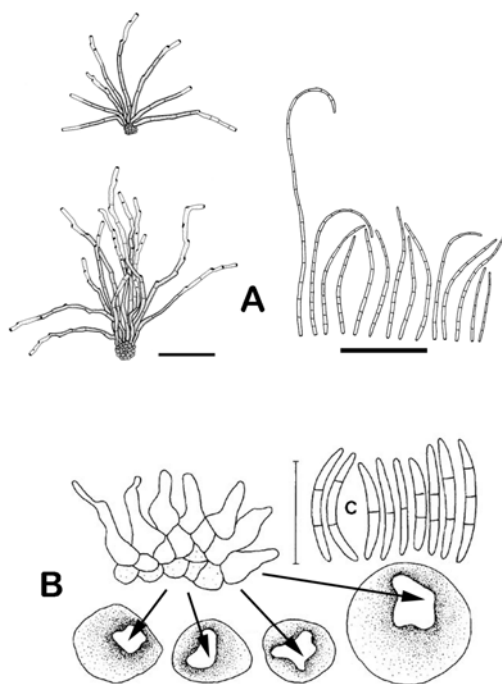


Fig. 8 – Illustration of morphological structures between *Cercospora* and *Septoria*. A. *Cercospora christellae* (To-anun et al. 2009). B. *Septoria violae-patrinii* (Shin & Sameva 2002) (arrows show the location of conidiophores inside conidiomata).

& Fr.) Mont. & Fr. (\equiv *Cladosporium bacilligerum*) as type species. This species was characterized by having pigmented conidiophores, and ellipsoid-fusiform, obclavate-subcylindric, pigmented conidia with (0-)1(-3)-septa (basal clade, Fig. 7). The basal position of *Passalora* clade indicated that species in *Passalora* hold more plesiomorphic characters or ancestral state characters than other cercosporoid fungi clades. This indication was also reported earlier by Stewart et al. (1999).

On the other hand, species within *Pseudocercospora s. str.* form a monophyletic clade with 95% bootstrap support and appear as a sister group to *Stigmina* clade with 60% bootstrap support (Fig. 7). Morphologically, these two genera are similar in having holoblastic and terminal conidia. proliferation, as well as obclavate to filiform-acicular with truncate base and multiseptate conidia. However, they differs due to the conidia of *Stigmina* being verrucose, dark brown and sometimes producing longitudinal septa, which is quite distinct to *Pseudocercospora s. str.* which has smooth and subhyaline conidia with only transverse septation, and unthickened conidial loci and hila. *Pseudocercospora s. lat.* is morphologically highly variable, and accommodates a

wide range of cercosporoid hyphomycetes with pigmented conidiophores and inconspicuous, unthickened and not darkened conidiogenous loci. It includes *Paracercospora*, *Phaeoisariopsis*, *Stigmina* and *Pseudophaeoramularia* (Crous et al. 2001). Crous et al. (2000) showed *Pseudocercospora s. lat.* to be polyphyletic within *Mycosphaerella* anamorphs, having evolved more than once from different *Mycosphaerella* holomorphs, and in several occasions having lost the teleomorph (Crous & Braun 2003). This complex includes genera with single to synnemate conidiophores, solitary or catenate (*Pseudophaeoramularia*) conidia, eu- (*Pseudocercospora*) or distoseptate (*Stigmina*), and scars which are inconspicuous to denticle-like (*Denticularia* and *Semipseudocercospora*), unthickened to slightly pigmented conidia (*Paracercospora*) (Crous & Braun 2003).

Within *Cercospora* species (*Cercospora s. str.*), Crous & Braun (2003) stated the need of a “compound species”, a species that is formed when two or more species join together because of indistinguishable in morphology or genetic or physiology characteristics, named *C. apii s. lat.*, comprising all cercosporoid hyphomycetes indistinguishable from the *Cercospora*

on *Apium graveolens* L. Introduction of new names for morphologically indistinguishable *Cercospora* collections detected on new host genera and families, respectively, should be avoided, and should simply be referred to *C. apii s. lat.* Crous & Braun (2003) also revised these species and redispersed many of them. A total of 659 *Cercospora* species were recognized, with a further 281 being referred to synonymy under *C. apii s. lat.*

Unfortunately, only a few species belonging to *C. apii s. lat.* have been cultured and molecular data addressing the phylogenetic relationship within this complex and related species is still lacking. Thus, it is necessary to examine phylogenetically whether the species within this complex are monophyletic or not. If the *C. apii s. lat.* complex forms a monophyletic group, it is possible that a single species of *Cercospora* (*C. apii*) occurs on a wide host range.

The phylogenetic tree generated from unweighted maximum parsimony analysis of ITS nrDNA region showed the monophyletic origin of *Cercospora s. str.* with 100% bootstrap support (Fig. 9). The short branch lengths among species within the *Cercospora* cluster indicate that they all shared a common ancestor relatively recently. The species belonging to *C. apii s. lat.* such as *C. apii* (on *Apium*), *C. beticola* (on *Beta*), *C. hayi* (on *Musa*), *C. kikuchii* (on *Lycine*), *C. penzigii* (on *Citrus*), *C. physalidis* (on *Solanum*) are polyphyletic (Fig. 9). To date, only Ayala-Escobar et al. (2005) reported the monophyletic of *C. apii s. lat.* by combining five genes loci, namely, internal transcribed spacer (ITS) nrDNA, elongation factor 1- α (EF), actin (ACT), calmodulin (CAL) and histone H3 (HIS), even though with a few sequences included in their analysis (2 species of *C. apii s. lat.* and 2 species of *Cercospora s. str.* non *C. apii s. lat.*). Groenewald et al. (2006) found molecular evidence that *C. apii* has a wider host range than had been accepted by Chupp (1954) and Ellis (1976), but has narrower host range than that proposed by Crous & Braun (2003). The host range data of *C. apii s. lat.* obtained in Thailand illustrate that *C. apii* is not entirely host specific, and it is not possible to identify this species (and *C.*

apii complex) solely based on host, morphology and/or geographic location. Therefore, this has to be further investigated by conducting pathogenicity studies on all the hosts previously listed for these species.

Although the monophylogeny of *C. apii* has been reported using a combination of five genes loci (Ayala-Escobar et al. 2005), often all the five genes loci sequenced are not congruent and can not be used in particular when a large number of sequences included. In order to overcome this problem, Groenewald et al. (2005) used sequence data of the same five genes as Ayala-Escobar et al. (2005) in combination with other features such as growth rate to establish species boundaries for *C. apii*, *C. apiicola* (as *Cercospora* sp.) and *C. beticola*. From these established species boundaries, species-specific primers were designed in polymorphic areas of the calmodulin gene for the three species. This combined approach probably represents the most reliable way to characterize and identify species within this complex.

One possible explanation of *C. apii*-complex occurrence on various host plants is probably due to host jumping events in which *C. apii* occurs on “atypical” hosts in the process of reaching their real hosts. However, the reason why host jumping by *C. apii* occurs remains unknown. Perhaps under stress (a shortage of host tissue or unsuitable weather) the new species might be able to jump from celery onto other hosts (Crous & Groenewald 2005). Thus, it would be interesting to determine whether the *C. apii* that exist on “atypical” hosts are able to cause disease on those hosts or not. At the moment, the information of *Cercospora* isolates from Thailand have shown that *C. apii*-complex from “atypical” hosts do not produce pigmentation (cercosporin) on agar medium. Therefore, the ability to produce cercosporin on medium seems to be one of important factors in revealing the phylogenetic relationships among the *Cercospora s. str.* as it was also previously found by Goodwin et al. (2003) that *Cercospora* producing pigment on agar medium are monophyletic in the phylogenetic tree generated from beta tubulin gene analysis.

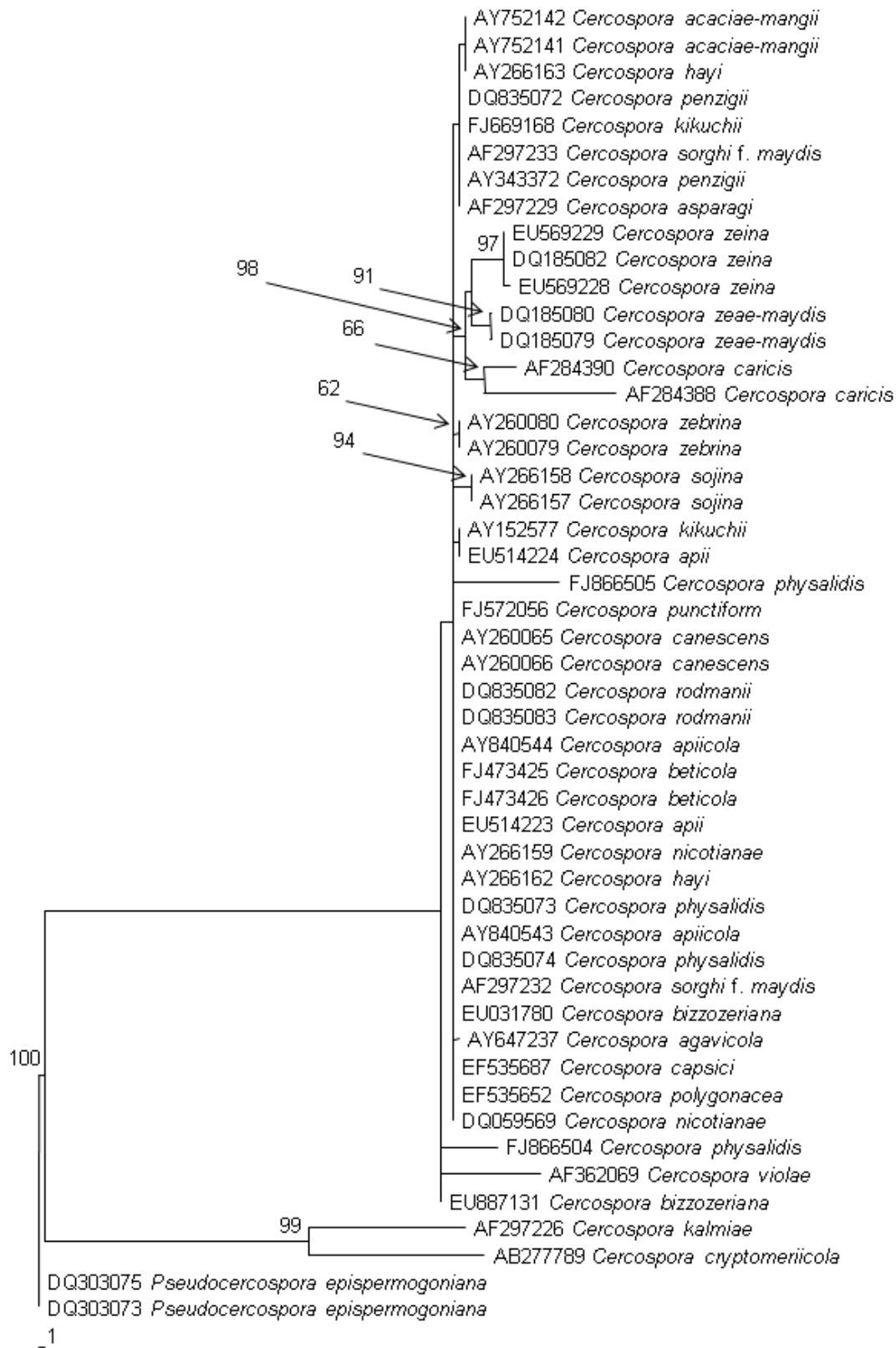


Fig. 9 – Single parsimonious tree based on ITS nrDNA sequence data representing phylogenetic affinities of *Cercospora s. str.* The tree is obtained from heuristic search with 1000 random taxon addition of the sequences alignment. Bootstrap values (>50%) from 1000 replicates of Unweighted Maximum Parsimony (UMP) analysis are shown above internodes.

TTC GTGGGGAC CCG GAC CGT ATG T ATG GCC ACC TTC TCC GTC ATG CCA TCT
Phe IVS* Pro Asp Arg Met Met Ala Thr Phe Ser Val Met Pro Ser
CCA AAG GTT TCC GAC ACC GTC GTC GAG CCA TAC AAC GCC ACC CTG TCC GTC
Pro Lys Val Ser Asp Thr Val Val Glu Pro Tyr Asn Ala Thr Leu Ser Val
CAC CAG CTC GTC GAG AAC TCC GAC GCG ACT TTC TGT ATC GAC AAC GAG GCT
His Gln Leu Val Glu Asn Ser Asp Ala Thr Phe Cys Ile Asp Asn Glu Ala
CTC TAC GAC ATT TGC ATG CGC ACT CTG AAG CTC AAC AAC CCA TCG TAC GGC
Leu tyr Asp Ile Cys Met Arg Thr Leu Lys Leu Asn Asn Pro Ser Tyr Gly
GAC TTG AAC CAC CTC GTC TCT GCC GTC ATG TCC GGT GTG ACA ACC TGT CTG
Asp Leu Asn His Leu Val Ser Ala Val Met Ser Gly Val Thr Thr Cys Leu
CGT TTC CCA GGT CAG CTC AAC AGC GAT CTG CGC AAG CTT GCC GTG AAC ATG
Arg Phe Pro Gly Gln Leu Asn Ser Asp Leu Arg Lys Leu Ala Val Asn Met
GTG CCG TTC CCA CGT CTC CAC
Val Pro Phe Pro Arg Leu His

*IVS = Intervening region sequence: the one or more segments of a split gene that are transcribed but not included in the final messenger ribonucleic acid; each is flanked by two exons. Also known as intron.

Fig. 10 – Partial nucleotide sequence of the β -tubulin of a *Cercospora lactucae-sativae* Ben^R strain between codon 159 to 264.

Fungus	Strain	Type	Alignment
			195 196 197 198 199 200 201 202 203 204 205
<i>C. lactucae-sativae</i>	CCR-18	R	AAC TCC GAC GCG ACT TTC TGT ATC GAC AAC GAG
<i>C. beticola</i>	C-3	S	AAC TCC GAC GAG ACC TTC TGT ATC GAC AAC GAG
<i>C. beticola</i>	AD-762	R	AAC TCC GAC GCG ACC TTC TGT ATC GAC AAC GAG
<i>M. fijiensis</i>	020501	S	AAC TCT GAC GAG ACC TTC TGT ATC GAC AAC GAG
<i>M. fijiensis</i>	020301	R	AAC TCT GAC GCG ACC TTC TGT ATC GAC AAC GAG
<i>C. kikuchii</i>	JC-203	R	AAC TCC GAC GCG ACC TTC TGT ATC GAC AAC GAG

Fig. 11 Sequence alignment for *C. lactucae-sativae* β -tubulin predicted codons 195-205 compared with sequences of Ben^R of *C. beticola*, *C. kikuchii*, and *M. fijiensis* and Ben^S of *C. beticola* and *M. fijiensis*.

Taxonomy

Cercospora Fresenius, in Fuckel, Hedwigia 1 (15): 133 (1863) and Fungi Rhen., exs, Fasc. II, No. 117 (1863) *s. str.*

Non-original description (Ellis 1971, Dematiaceous Hyphomycetes: 275).

Colonies effuse, greyish, tufted. *Mycelium* mostly immersed. *Stroma* often present, but not large. *Setae* and *hyphopodia* absent. *Conidiophores* macronematous, mononematous, caespitose, straight or flexuous, sometimes geniculate, unbranched or rarely branch-

ed, olivaceous brown or brown, paler towards the apex, smooth. *Conidiogenous cells* integrated, terminal, polyblastic, sympodial, cylindrical, cicatrized, scars usually conspicuous. *Conidia* solitary, acropleurogenous, simple, obclavate or subulate, colourless or pale, pluriseptate, smooth.

Holotype species – *Cercospora penicillata* (Ces.) Fresen
= *Cercospora depazeoides* (Desm.) Sacc.
Lectotype species – *Cercospora apii* Fres.
Teleomorph – *Mycosphaerella* Johanson

**Key to the treated species in Thailand,
arranged by host family**

Acanthaceae

1. Stromata lacking or rudimentary; conidiophores relatively short, $16-60 \times 3-6.5 \mu\text{m}$, geniculate; on *Andrographis*
..... ***C. andrographidicola***
1. Stromata small, $20-24 \mu\text{m}$ diam.; conidiophores long, $85-209 \times 3-4 \mu\text{m}$, slightly geniculate near the apex; on *Barleria*
..... ***C. barleriicola***

Adiantaceae

- A single species, on *Doryopteris*
..... ***C. adiantigena***

Amaranthaceae

1. Caespituli hypophyllous; stromata often lacking, if present, small, up to $8 \mu\text{m}$ diam.; conidiophores up to 5 in loose fascicles, long, $90.5-192 \times 3-4 \mu\text{m}$; conidia acicular, $8-316 \times 3-4 \mu\text{m}$, 10-22-septate; on *Iresine* and *Celosia* ***Cercospora canescens***
1. Caespituli amphigenous **2**
2. Conidiophores up to 13 in moderately dense fascicles, $34-85 \times 2.5-5 \mu\text{m}$; conidia acicular, $12-67 \times 2.5-3.5 \mu\text{m}$, 4-7-septate; on *Celosia*..... ***Cercospora celosiae***
2. Stromata small, $12-26 \mu\text{m}$ diam.; conidiophores 5-9 in loose and divergent fascicles, $47-125 \times 3-5 \mu\text{m}$; conidia narrowly obclavate to subacicular, $29-168.5 \times 2.5-3.5 \mu\text{m}$, 2-12-septate; on *Ricinus*
..... ***Cercospora ricinella***

Apocynaceae

- A single species, on *Pentalino*
..... ***Cercospora peregrina***

Areaceae

- A single species, on *Areca*
..... ***Cercospora areacearum***

Asteraceae

1. Caespituli hypophyllous **2**

1. Caespituli amphigenous **4**
2. Conidiophores sometimes branched, $55-181 \times 4-5.5 \mu\text{m}$; on *Artemisia*.....
..... ***Cercospora artemisiae***
2. Conidiophores unbranched..... **3**
3. Conidiophores $79-184 \times 3-5 \mu\text{m}$, geniculate; conidia $120-215 \times 3-4 \mu\text{m}$, narrowly obclavate to acicular, 8-20-septate, obconically truncate at the base; on *Helianthus*
..... ***Cercospora helianthicola***
3. Conidiophores $25-102 \times 25-4 \mu\text{m}$, not geniculate; conidia $46-87 \times 2.5-3 \mu\text{m}$, acicular, 7-10-septate, truncate at the base; on *Dahlia*..... ***Cercospora dahliicola***
4. On *Zinnia* **5**
4. On other hosts **6**
5. Conidiophores unbranched, $54-100 \times 2.5-5 \mu\text{m}$; conidia $24.5-93.5 \times 2.5-3.5 \mu\text{m}$, filiform to narrowly obclavate, 7-18-septate; on *Zinnia elegans* ***Cercospora zinniicola***
5. Conidiophores sometimes branched, $40-152 \times 3-5.5 \mu\text{m}$; conidia $24-175 \times 2-3.5 \mu\text{m}$, narrowly obclavate to subacicular, 4-13-septate; on *Zinnia grandiflora*.....
..... ***Cercospora zinniae***
6. Conidiophores not geniculate or rarely geniculate, $32.5-220 \times 3-8 \mu\text{m}$; conidia $45-196 \times 1.5-3 \mu\text{m}$, acicular, 13-19-septate, truncate at the base; on *Cynara*.....
..... ***Cercospora cynarae***
6. Conidiophores distinctly geniculate..... **7**
7. Conidia obclavate or subacicular **8**
7. Conidia acicular **9**
8. Conidia obclavate, $80-96 \times 3.5-4 \mu\text{m}$; on *Conyza*..... ***Cercospora nilghirensis***
8. Conidia narrowly obclavate to subacicular, $60-198 \times 2-4 \mu\text{m}$; on *Gerbera*.....
..... ***Cercospora gerberae***
9. Conidia truncate at the base, $23-190 \times 2-4 \mu\text{m}$, 3-10-septate; on *Chrysanthemum*
..... ***Cercospora chrysanthemi***
9. Conidia obconically truncate at the base, $36-182 \times 3-6.5 \mu\text{m}$, 7-13-septate; on *Lactuca*
..... ***Cercospora lactucae-sativae***

Balsaminaceae

1. Conidiophores $52-129 \times 2-3.5 \mu\text{m}$, unbranched; conidia obclavate with obconically truncate at the base, $35-73 \times 4-5 \mu\text{m}$, 3-11-septate; on *Impatiens walleriana*
..... ***Cercospora balsaminiana***
1. Conidiophores $49-112 \times 4-6.5 \mu\text{m}$, sometimes branched; conidia narrowly obclavate to subacicular with truncate to obconically truncate at the base, $60-120 \times 2.5-5 \mu\text{m}$, 5-18-septate; on *Impatiens balsamina*
..... ***Cercospora fukushiana***

Basellaceae

- A single species, on *Basella*
..... ***Cercospora basellae-albae***

Brassicaceae

- A single species, on *Brassica* and *Cichorium*
..... ***Cercospora brassicicola***

Caricaceae

- A single species, on *Carica*
..... ***Cercospora papayae***

Convolvulaceae

1. Conidiophores sometimes branched, $13.5-134 \times 3-5 \mu\text{m}$; conidia $44.5-143 \times 3-3.5 \mu\text{m}$, narrowly obclavate to subacicular, 6-15-septate, base obconically truncate; on *Ipomoea* and *Argyreia*
..... ***Cercospora ipomoeae***
1. Conidiophores unbranched **2**
2. Conidia $80-240 \times 3-4 \mu\text{m}$, 9-14-septate, acicular to long obclavate, base obconically truncate; on *Ipomoea*
..... ***Cercospora citrullina***
2. Conidia $22.5-96 \times 3-3.5 \mu\text{m}$, 6-9-septate, acicular, sometimes obclavate, truncate at the base; on *Operculina*
..... ***Cercospora operculinae***

Cucurbitaceae

1. Caespituli amphigenous; conidiophores $52-106.5 \times 2.5-5 \mu\text{m}$, not geniculate; conidia

acicular, $63-296.5 \times 2.5-4.5 \mu\text{m}$, 8-26-septate, truncate at the base; on various genera of *Cucurbitaceae*

- ***Cercospora citrullina***
1. Caespituli epiphyllous; conidiophores $18-108.5 \times 3-5.5 \mu\text{m}$, strongly geniculate; conidia obclavate-cylindric, $41-102 \times 2.5-5 \mu\text{m}$, 5-10-septate, obconically truncate at the base; on *Coccinia*
..... ***Cercospora cocciniae***

Euphorbiaceae

1. Conidiophores sometimes branched, $48.5-83.5 \times 4-6 \mu\text{m}$, slightly geniculate; conidia $44-256 \times 1.5-3 \mu\text{m}$, narrowly obclavate to subacicular, 4-18-septate, base obconically truncate; on *Acalypha*
..... ***Cercospora acalyphae***
1. Conidiophores unbranched **2**
2. Conidiophores $56-213 \times 4-5.5 \mu\text{m}$, slightly geniculate; conidia $29-160 \times 3-4.5 \mu\text{m}$, acicular, rarely obclavate, 3-10-septate, truncate at the base; on *Codiaeum*
..... ***Cercospora codiaei***
2. Conidiophores $36-66 \times 3-5 \mu\text{m}$, sometimes constrict at the septate, rough wall, geniculate, mostly near the apex; conidia $51-133 \times 3-4.5 \mu\text{m}$, obclavate to acicular, 5-11-septate, obconically truncate at the base; on *Phyllanthu* ***Cercospora phyllanthicola***

Fabaceae

1. Caespituli hypophyllous; conidiophores $76-129 \times 3.5-5 \mu\text{m}$, rarely branched; conidia $80-132 \times 3-3.5 \mu\text{m}$, narrowly obclavate to subacicular, 6-11-septate; on *Glycine*
..... ***Cercospora kikuchii***
1. Caespituli amphigenous **2**
2. Stromata well-developed, $26.5-67 \mu\text{m}$ diam.; conidia $56-113.5 \times 3-4.5 \mu\text{m}$, narrowly obclavate to subacicular, 3-9-septate; on various genera of *Fabaceae*
..... ***Cercospora canescens***
2. Caespituli amphigenous; stromata small, $25-30.75 \mu\text{m}$ diam.; conidia $39-206 \times 2-4 \mu\text{m}$, narrowly obclavate to subacicular, 5-17-septate; on *Crotalaria*
..... ***Cercospora crotalariae***

Hydrangeaceae

- A single species, on *Hydrangea*.....
..... *Cercospora hydrangeae*

Lamiaceae

1. Caespituli epiphyllous; stromata small, 12–32 μm diam.; conidiophores 36–127.5 \times 2.5–4 μm , rarely branched, geniculate to sinuous; conidia 40–87 \times 2–3 μm , narrowly obclavate to subacicular, 3–10-septate, base obconically truncate; on *Clerodendrum fragrans*..... *Cercospora volkameriae*
1. Caespituli amphigenous 2
2. Stromata lacking; conidiophores 78–185 \times 3–5 μm , rarely branched, geniculate; on *Solenostemon*..... *Cercospora kabatiana*
2. Stromata small to well developed, 14–30 μm diam.; conidiophores 20–70 \times 3–6 μm , unbranched, often not geniculate; on *Clerodendrum paniculatum*.....
..... *Cercospora physostegiae*

Malvaceae

- A single species, on *Alcea*.....
..... *Cercospora althaeina*

Moraceae

1. Caespituli hypophyllous; conidiophores 42–229 \times 3–6 μm , branched; conidia 42.5–161 \times 2–4.5 μm , narrowly obclavate to subacicular, 7–14-septate, base obconically truncate; on *Ficus religiosa*.....
..... *Cercospora ficina*
1. Caespituli epiphyllous; conidiophores 63–139 \times 3–4 μm , not branched; conidia 120–160 \times 3 μm , acicular, 8–13-septate, truncate at the base; on *Ficus carica*.....
..... *Cercospora elasticae*

Nyctaginaceae

- A single species, on *Bougainvillea*.....
..... *Cercospora neobougainvilleae*

Orchidaceae

- A single species, on *Habenaria*.....
..... *Cercospora habenariicola*

Oxalidaceae

- A single species, on *Oxalis*.....
..... *Cercospora oxalidis*

Polypodiaceae

- A single species, on *Platyterium*.....
..... *Cercospora platyterii*

Pteridaceae

- A single species, on *Pteris*.....
..... *Cercospora cyclosori*

Rosaceae

- A single species, on *Rosa*.....
..... *Cercospora scharifii*

Rubiaceae

- A single species, on *Coffea*.....
..... *Cercospora coffeicola*

Saururaceae

- A single species, on *Houttuynia*.....
..... *Cercospora houttuyniicola*

Solanaceae

1. Caespituli epiphyllous, conidiophores relatively short, 27–79.5 \times 2–4.5 μm , not branched, not geniculate; conidia 30–71.5 \times 3–3.5 μm , narrowly obclavate, 3–6-septate; on *Solanum torvum* .. *Cercospora solanacea*
1. Caespituli amphigenous 2
2. Conidiophores 27.5–54 \times 2.5–5.5 μm , unbranched, strongly geniculate; conidia 46.5–160 \times 2–4 μm , obclavate to acicular, 7–15-septate; on various genera of *Solanaceae*.....
..... *Cercospora physalidis*
2. Caespituli amphigenous, chiefly hypophyllous; conidiophores 39.5–127 \times 3–4 μm , branched, geniculate to sinuous; conidia 64–165 \times 2–5 μm , long obclavate to subacicular, 6–19-septate; on *Solanum indicum*..... *Cercospora puyana*

Verbenaceae

A single species, on *Tectona*
 *Cercospora tectonae*

Zingiberaceae

A single species, on *Alpinia*
 *Cercospora alpiniicola*

Acanthaceae

Cercospora andrographidicola S.Q. Chen & P.K. Chi, J. South China Agric. Univ. 11: 61 (1990). (Fig. 12)

Leaf spots 2–5 mm diam., amphigenous, subcircular to irregular, distinct on the upper surface, brown with dark margin, without definite margin on the lower surface. *Caespituli* amphigenous. *Stromata* often lacking, rudi-

mentary to poorly developed, if present small, up to 29.5 µm diam., composed of a few subglobose and dark brown cells. *Conidiophores* 16–74 × 3–6.5 µm, arranged in loose fascicles, 1–9-septate, arising from stromata, straight or flexuous, simple, thick walled, brown to dark brown or paler towards the apex, unbranched, geniculate near the apex. *Conidiogenous cell* integrated, holoblastic, monoblastic or polyblastic, sympodially proliferating. *Conidiogenous loci* 1.5–3 µm diam., conspicuous, thickened and darkened. *Conidia* 30.5–91 × 2–4 µm, obclavate to acicular, 3–15-septate, hyaline, straight to curved, truncate at the base with subacute apex, smooth, hila 1.5–2.5 µm diam., conspicuous, thickened and darkened.

Specimen examined – THAILAND, Uttradit Province, Sak Yai National Park, on

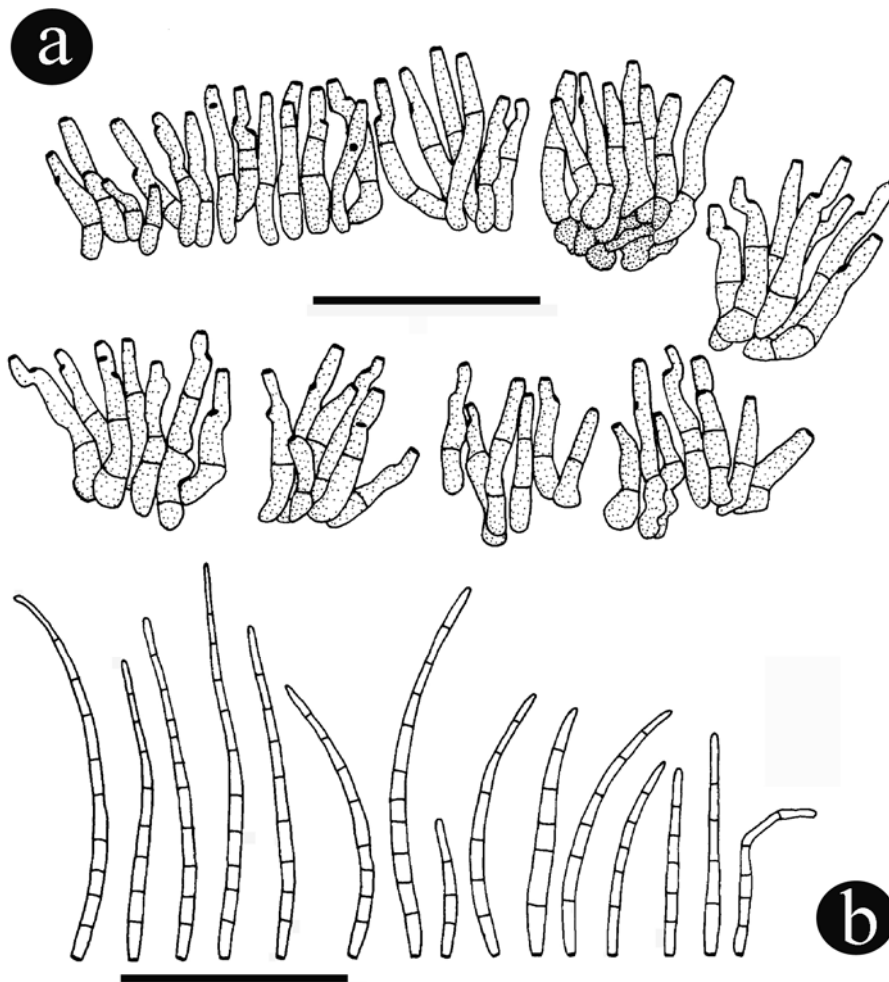


Fig. 12 – Line drawings of *Cercospora andrographidicola* on *Andrographis paniculata*. **a.** Stromata and conidiophores. **b.** Conidia. Bars = 50 µm. (Meeboon et al. 2007c).

leaves of *Andrographis paniculata* Nees (*Acanthaceae*), 25 November 2004, Jamjan Meeboon (CMU 27924).

Hosts – *Andrographis paniculata* (*Acanthaceae*) (Crous & Braun 2003, Meeboon et al. 2007c).

Distribution – China, Thailand (Crous & Braun 2003, Meeboon et al. 2007c).

Notes – The first report of this species from Thailand was made by Meeboon et al. (2007c).

Cercospora barleriicola Payak & Thirum., Indian Phytopath. 2: 191 (1949).

= *Cercospora barleriae-cristatae* Govindu & Thirum., Sydowia 10: 273 (1957).

(= *C. apii* s. lat.) (Fig. 13)

Leaf spots 5 – 8 mm diam., amphigenous, dark to yellowish, only leaf decoloration. *Caespituli* amphigenous. *Stromata* 20–24 μm diam., small, substomatal, composed of a few subglobose, and dark brown cells. *Conidiophores* 85–209 \times 3–4 μm , 5–7 in loose fascicles, 5–8-septate, arising from stromata, straight, unbranched, cylindrical, slightly geniculate near

the apex, smooth, brown at the base, paler towards the apex. *Conidiogenous cells* integrated, holoblastic, polyblastic, sympodially proliferating. *Conidiogenous loci* 2–3 μm diam., conspicuous, thickened, and darkened. *Conidia* 61–91 \times 2–3 μm , solitary, acicular, straight, hyaline, 6–13-septate, smooth, truncate at the base, tapering toward a subacute apex, hila 1.5–2 μm diam., conspicuous, thickened and darkened.

Specimens examined – THAILAND, Chiang Mai Province, Chiang Dao District, Huay Luek Royal Project, on leaves of *Barleria cristata* L. (*Acanthaceae*), 6 February 2008, Jamjan Meeboon and Iman Hidayat (BBH 23592); Uttradit Province, A. Nam Pad, Sak Yai National Park, same host, 25 November 2004, Chiharu Nakashima and Jamjan Meeboon (CMU 27885).

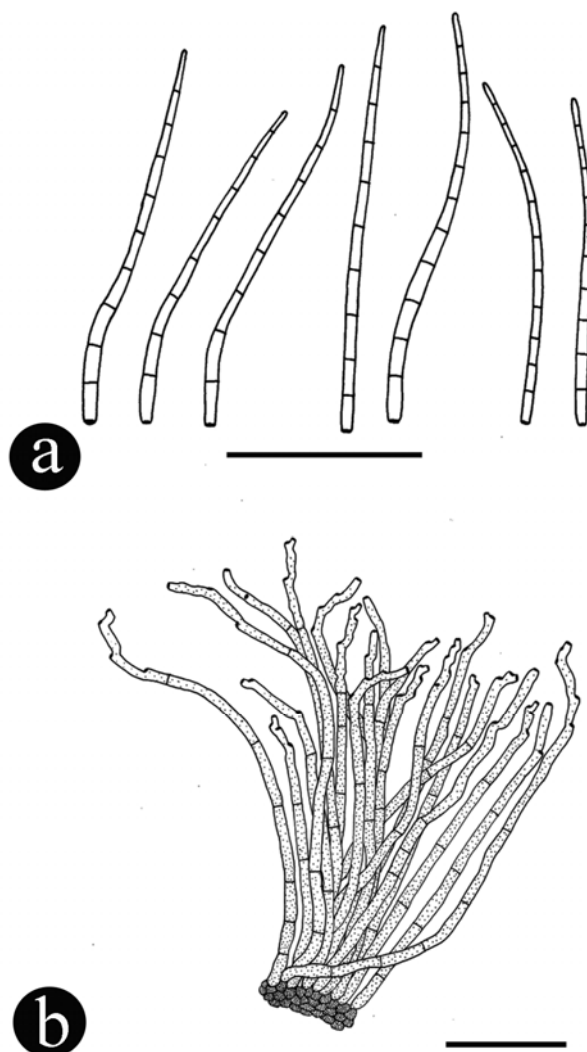


Fig. 13 – Line drawings of *Cercospora barleriicola* on *Barleria cristata*. **a.** Conidia. **b.** Stromata and conidiophores. Bars = 25 μm . (Meeboon et al. 2007b).

Hosts – *Barleria cristata*, *B. prionitis*, *Barleria* sp. (*Acanthaceae*) (Crous & Braun 2003, Meeboon et al. 2007b).

Distribution – India, Jamaica, Thailand (Crous & Braun 2003, Meeboon et al. 2007b).

Notes – This species belongs to *C. apii* s. lat. fide Crous & Braun (2003). The first report of this species from Thailand was carried out by Meeboon et al. (2007b).

Literature – Chupp (1954, p. 22).

Adiantaceae

Cercospora adiantigena U. Braun & Crous, CBS Biodiversity Series 1: 44–45 (2003).

(Fig. 14)

Leaf spots – 5–15 mm diam., amphigenous, solitary, circular, brown to dark brown, with dark margin and grey at the center. *Caespituli* amphigenous. *Stromata* 9–43 µm

diam., substomatal to intraepidermal, small to well-developed, composed of few subglobose, brown to blackish brown cells. *Conidiophores* 74–106 × 3–4 µm, 6–11 in loose fascicles, 1–3-septate, arising from stromata, straight to decumbent, smooth, brown at the base, and paler toward the apex, cylindrical, unbranched, geniculate. *Conidiogenous cells* integrated, terminal, holoblastic, mostly polyblastic, sympodially proliferating. *Conidiogenous loci* 1.5–2.5 µm diam., conspicuous, thickened and darkened. *Conidia* 53–60 × 2–3 µm, solitary, obclavate, straight to slightly curved, hyaline, 7–16-septate, smooth, obconically truncate at the base, tapering toward a subacute apex, hila 1.5–2 µm diam., thickened and darkened.

Specimen examined – THAILAND, Chiang Mai Province, A. Mae Rim, Nong Hoi Royal Project Foundation, on leaves of *Doryopteris ludens* J. Sm. (*Adiantaceae*), 12 September 2007, Parin Noiruang (BBH 23634)

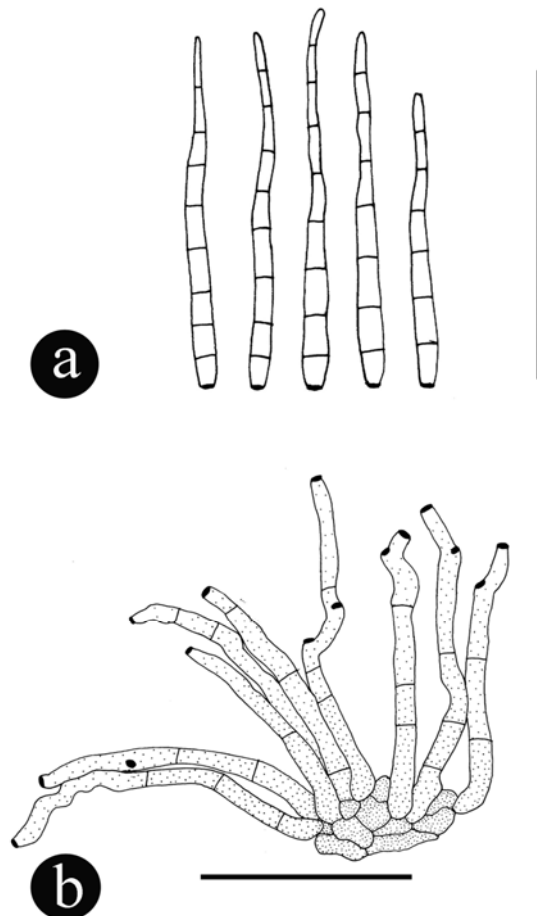


Fig. 14 – Line drawings of *Cercospora adiantigena* on *Doryopteris ludens*. **a.** Conidia. **b.** Stroma and conidiophores. Bars = 50 µm. (Meeboon 2009).

Hosts – *Adiantum philippense*, *Doryopteris ludens* (*Adiantaceae*) (Crous & Braun 2003, Meeboon 2009).

Distribution – Tanzania (Crous & Braun 2003), Thailand (Meeboon 2009).

Notes – *Doryopteris ludens* is a fern belonging to family *Adiantaceae*. Three species of *Cercospora* s. str. have been reported from *Adiantum* spp., viz, *C. adianticola* R.K. Srivast., A.K. Srivast. & Kamal (*C. apii* s. lat.), *C. adiantigena* U. Braun & Crous, and *C. pteridigena* M.K. Khan, R.K. Verm & Kamal. This specimen is identified as *C. adiantigena* due to short and obclavate conidia ($53\text{--}60 \times 2\text{--}3 \mu\text{m}$ vs $40\text{--}90 \times (4) 5\text{--}8 \mu\text{m}$ *C. adiantigena*). It is distinct form for *C. pteridigena* due to the later species having very long conidiophores and large conidiogenous loci ($4\text{--}5 \mu\text{m}$ diam.). This specimen was first reported from Thailand by (Meeboon 2009).

Amaranthaceae

Cercospora canescens Ellis & G. Martin, Amer. Naturalist 16: 1003 (1882).

≡ *Cercosporiopsis canescens* (Ellis & G. Martin) Miura, Flora of Manchuria and East Mongolia 3: 529 (1928).

= *Cercospora vignicaulis* Tehon, Mycologia 29: 436 (1937).

(= *C. apii* s. lat.) (Fig. 15)

Leaf spots – 3–6 mm diam., amphigenous, dark to yellowish. *Caespituli* hypophyllous, dark to yellowish. *Stromata* mostly lacking, if present small, up to 8 μm diam., composed of 4–5 globose to subglobose, brown to dark brown cells. *Conidiophores* $90.5\text{--}192 \times 3\text{--}4 \mu\text{m}$, up to 5 in loose fascicles, 3–7-septate, arising from stomata, straight, smooth, brown at the base and paler toward the apex, unbranched, cylindrical, geniculate. *Conidiogenous cells* integrated, holoblastic, polyblastic, sympodially proliferating. *Conidiogenous loci* $2.5\text{--}3.5 \mu\text{m}$ diam., conspicuous, thickened and darkened

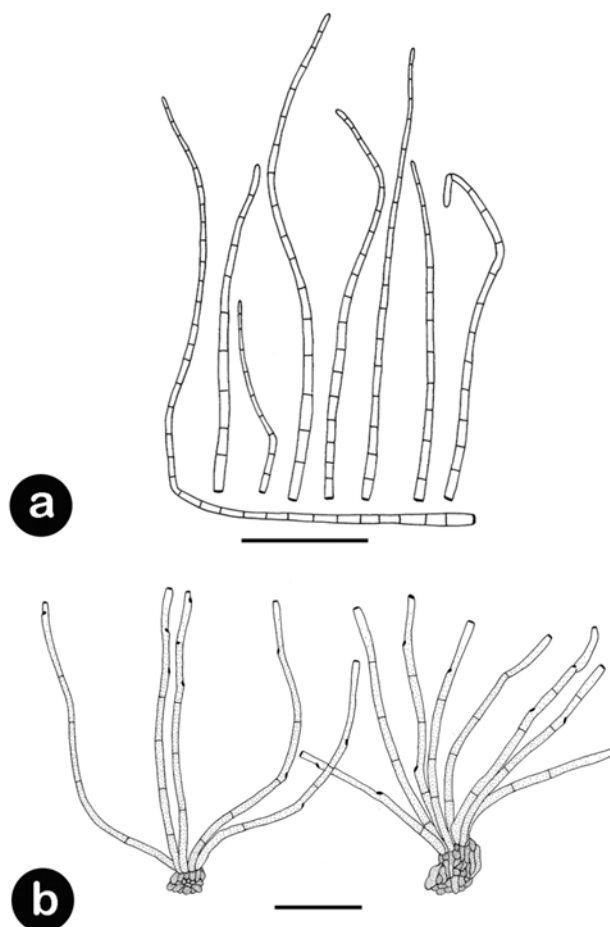


Fig. 15 – Line drawings of *Cercospora canescens* on *Celosia argentea*. **a.** Conidia. **b.** Conidiophores and stromata. Bars: = 50 μm . (Meeboon 2009).

Conidia 8–316 × 3–4 μm, solitary, acicular, straight, hyaline, 10–22-septate, smooth, truncate at the base, tapering toward a subacute apex, hila 2.5–3 μm diam., conspicuous, thickened and darkened.

Specimens examined – THAILAND, Chiang Mai Province, Chiang Mai University, Multiple Cropping Centre, on leaves of *Celosia argentea* L. (Amaranthaceae), 14 August 2008, Jamjan Meeboon (BBH 23725); Chiang Rai Province, Mae Fah Luang, Mae Jan, Doi Tung Development, on leaves of *Iresine herbstii* Hook. (Amaranthaceae), 16 August 2008, Jamjan Meeboon (BBH 23586).

Hosts – *Amaranthus* sp., *Celosia argentea* (Amaranthaceae), *Annona odorata*, *A. squarrosa* (Annonaceae), *Rauvolfia serpentina* (Apocynaceae), *Verschaffeltia splendida* (Arecaceae), *Aster novibelgii* (Asteraceae), *Bixa orellana* (Bixaceae), *Raphanus sativus* (Brassicaceae), *Rhynchosia aurea*, *R. minima*, *Ricinus communis* (Euphorbiaceae), *Arachis hagenbeckii*, *A. hypogaea*, *Alysicarpus* sp., *Bauhinia alba*, *B. variegata*, *Cajanus cajan*, *Calopogonium mucunoides*, *Canavalia ensiformis*, *C. gladiata*, *C. maritima*, *Cassia alata*, *C. lathyroides*, *Cassia* sp., *Centrosema acutifolium*, *C. arenarium*, *C. brasilianum*, *C. macrocarpum*, *C. plumieri*, *C. pubescens*, *C. virginianum*, *Clitoria ternatea*, *Codariocalyx gyroides*, *Crotalaria juncea*, *C. mucronata*, *C. mysorensis*, *C. retusa*, *C. spectabilis*, *C. usaramoensis*, *C. verrucosa*, *C. zanzibarica*, *Crotalaria* spp., *Cyamopsis psoralioides*, *Desmodium canum*, *D. gyrans*, *D. gyroides*, *D. incanum*, *D. intortum*, *D. lycioides* ssp. *guerkei*, *D. repandum*, *D. turtuosum*, *D. uncinatum*, *Dolichos biflorus*, *D. daltonii*, *D. lablab*, *D. lignosus*, *D. trilobus*, *D. turtuosum*, *D. uniflorus*, *Erythrina addisoniae*, *E. suberosa*, *E. subumbrans*, *E. variegata*, *Flemingia macrophylla*, *Gliricidia sepium*, *Glycine max*, *G. soja*, *G. ussuriensis*, *G. wightii*, *Heylandia latebrosa*, *Indigofera astragalina*, *Kotschyia* sp., *Lablab niger*, *L. purpureus*, *Lespedeza* sp., *Lathyrus odoratus*, *Leucaena leucocephala*, *Lotononis bainesii*, *Lupinus* sp., *Macroptilium atropurpureum*, *M. lathyroides*, *M. daltonii*, *M. uniflorum*, *Medicago sativa*, *Mimosa invisa*, *Mucuna pruriens*, *Neonotonia wightii*, *Phaseolus aconitifolius*, *P. angularis*, *P. atropurpureus*, *P. aureus*, *P. calcaratus*, *P. lathyroides*, *P. limensis*, *P. lunatus*, *P. minimus*,

P. panduratus, *P. radiatus*, *P. trilobus*, *P. vulgaris*, *Pistia stratiotes*, *Pisum sativum*, *Psophocarpus tetragonolobus*, *Psoralea bituminosa*, *P. drupacea*, *Pterocarpus marsupia*, *Pueraria hirsuta*, *P. lobata*, *P. phaseoloides*, *P. trilobam*, *Senna alata*, *S. tora*, *Shuteria involucrata*, *Stylosanthes guianensis*, *S. humilis*, *Vicia unguiculata*, *Vigna angularis*, *V. catjang*, *V. luteola*, *V. marina*, *V. mungo*, *V. parkeri*, *V. radiata*, *V. repens*, *V. reticulata*, *V. sesquipedalis*, *V. sinensis*, *V. umbellata*, *V. vexillata*, *Voandzeia subterranea* (Fabaceae), *Quercus* sp. (Fagaceae), *Vitis vinifera* (Vitaceae), *Coleus* sp., *Ocimum basilicum*, *Plectranthus* sp. (Lamiaceae), *Tetramnus labialis*, *T. uncinatus* (Malphiaceae), *Artocarpus integrifolia* (Moraceae), *Boerhavia erecta*, *Commicarpus* sp. (Nyctaginaceae), *Lycopersicon esculentum*, *Solanum laciniatum* (Solanaceae) (Crous & Braun 2003, Meeboon 2009).

Distribution – Worldwide, including Australia, Bangladesh, Barbados, Brazil, Bolivia, Brunei, Cambodia, China, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, Fiji, Georgia, Ghana, Guyana, Haiti, Hong Kong, India, Indonesia, Iran, Japan, Kenya, Korea, Malawi, Malaysia, Malawi, Mauritius, Myanmar, Nepal, New Caledonia, New Zealand, Nigeria, Pakistan, Panama, Papua New Guinea, Peru, Philippines, Puerto Rico, Russia, Senegal, Sierra Leone, Solomon Islands, Somalia, South Africa, Saint Vincent and the Grenadines, Sudan, Tadzhikistan, Taiwan, Tanzania, Thailand, Trinidad and Tobago, Togo, Uganda, USA, Uzbekistan, Vanuatu, Venezuela, Virgin Islands, Zambia and Zimbabwe (Crous & Braun 2003).

Notes – This species was first reported from Thailand by Sontirat et al. (1980) who found *C. canescens* on *Vigna radiata*. Crous & Braun (2003) assigned this species to *C. apii* s. lat. *Iresine herbstii* was reported as a new host of *C. canescens* by Meeboon (2009).

Cercospora celosiae Syd., Ann. Mycol. 27: 430 (1929). (Fig. 16)

Leaf spots – up to 3 mm diam., amphigenous, circular to subcircular, brown at central area (somewhat grey-brown in the centre of larger spots), with dark brown margin. *Cae-spituli* amphigenous, chiefly hypophyllous.

Stromata 19–29 μm diam., small, composed of a few globose to subglobose, dark brown cells. *Conidiophores* 34–85 \times 2.5–5 μm , up to 13 in moderately dense fascicles, 1–3-septate, straight to decumbent, unbranched, light brown to brown, paler and narrower towards the apex, plainly geniculate with 1–5 geniculation near the apex. *Conidiogenous cells* integrated, terminal, holoblastic, polyblastic, sympodially proliferating. *Conidiogenous loci* 2–3 μm diam., conspicuous, thickened and darkened. *Conidia* 12–67 \times 2.5–3.5 μm , 4–7-septate, hyaline, acicular, obconically truncate at the base, with acute apex, hila 2–3 μm in diam., thickened and darkened.

Specimens examined – THAILAND, Chiang Rai Province, Wiang Pa Pao, on leaves of *Celosia argentea* L., 25 November 2005, Jamjan Meeboon (CMU27902); same locality, on *C. argentea* var. *crispata* (L.) Kuntze, 25 November 2005, Jamjan Meeboon (CMU 27893).

Hosts – *Celosia argentea*, *C. argentea* var. *crispata*, *C. aristata*, *C. laxa*, *C. plumosa*, *C. trigyna*, *Celosia* spp. (Amaranthaceae) (Crous & Braun 2003, Meeboon 2009).

Distribution – Bangladesh, Brazil, Brunei, Cambodia, China, Cuba, India, Indonesia, Japan, Malaysia, Myanmar, Nigeria, Pakistan, Papua New Guinea, Sabah, Sri Lanka, Sudan, Taiwan, Thailand, Uganda, USA, and Venezuela (Crous & Braun 2003).

Notes – *Cercospora celosiae* on *C. argentea* and *C. argentea* var. *crispata* was reported from Thailand by Petcharat & Kanjanamaneesathian (1989), Sontirat et al. (1980) and Meeboon (2009).

Cercospora ricinella Sacc. & Berl., Atti Reale 1st. Ven. Sci. Lett. Art. 6, Ser. 3: 721 (1885).

\equiv *Cercosporina ricinella* (Sacc. & Berl.) Speg., Anales Mus. Nac. Hist. Nat. Buenos Aires 20: 429 (1910).

$=$ *Cercospora albido-maculans* G. Winter, Hedwigia 24: 202 (1885); also in J. Mycol. 1: 124 (1885). (Fig. 17)

Leaf spots – 2–9 mm diam., distinct, amphigenous, circular or subcircular, greyish brown, with reddish brown margins. *Caespituli* amphigenous. *Stromata* 12–26 μm diam., intra-epidermal, small, composed of globular to angular, brown to blackish brown cells. *Conidiophores* 47–125 \times 3–5 μm , 5–9 in loose and divergent fascicles, 1–4-septate, arising from stromata, erect to decumbent, smooth, pale yellow to pale brown, unbranched, subcylindrical, strongly geniculate. *Conidiogenous cells* integrated, terminal to intercalary, holoblastic, polyblastic, sympodially proliferating. *Conidiogenous loci* 2.5–3 μm diam., conspicuous, thickened and darkened. *Conidia* 29–168.5 \times 2.5–3.5 μm , solitary, narrowly obclavate to subacicular, 2–12-septate, straight to curved, hyaline, smooth, base obconically

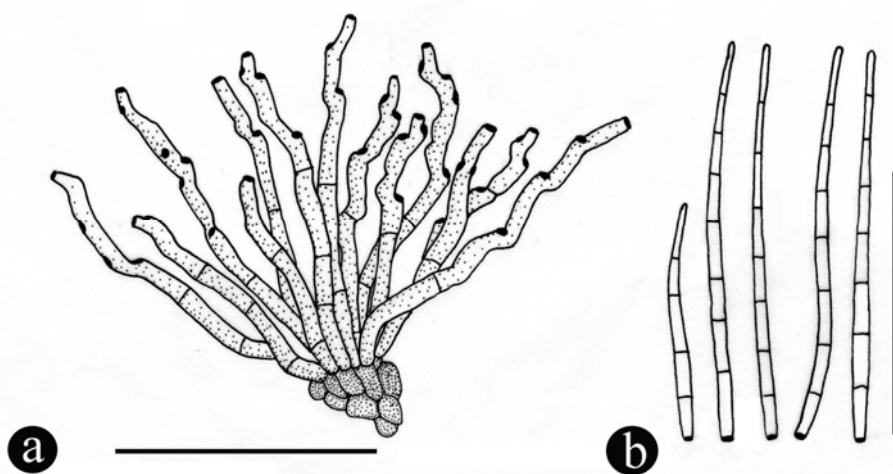


Fig. 16 – Line drawings of *Cercospora celosiae* on *Celosia argentea*. **a.** Conidiophores and stroma. **b.** Conidia. Bars = 50 μm . (Meeboon 2009).

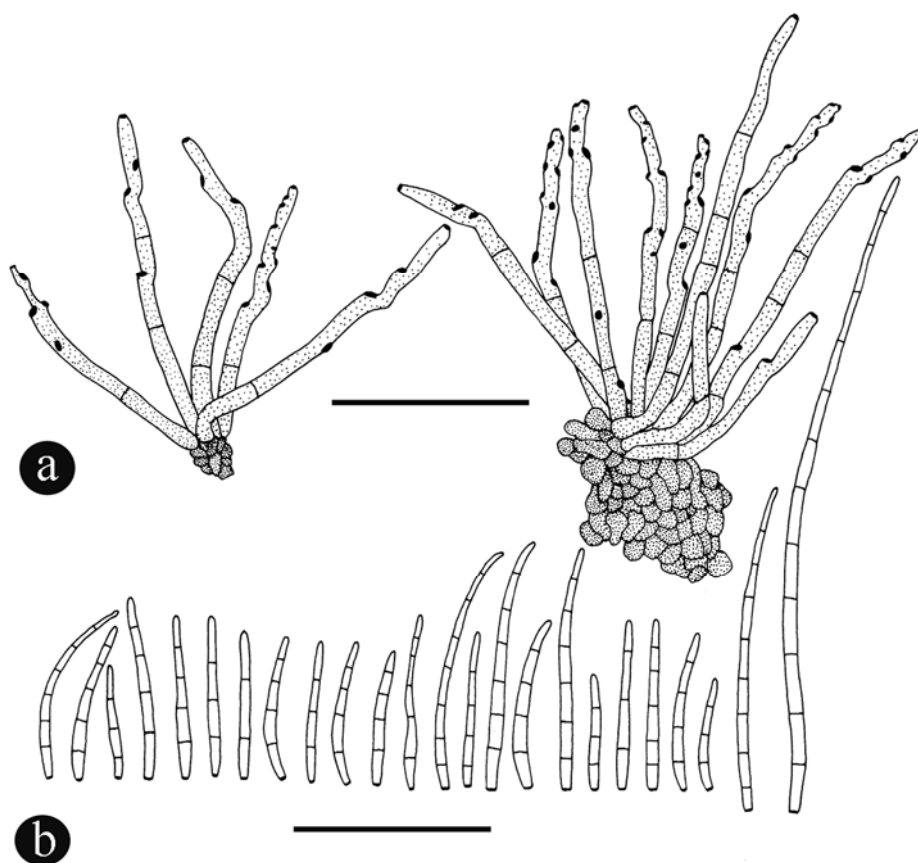


Fig. 17 – Line drawings of *Cercospora ricinella* on *Ricinus communis*. **a.** Conidiophores and stromata. **b.** Conidia. Bars = 50 μm . (Meeboon 2009).

truncate, with subacute apex, hila 2–2.5 μm diam., thickened and darkened.

Specimen examined – THAILAND, Chiang Mai Province, San Sai, Mae Fag, on leaves of *Ricinus communis* L. (*Euphorbiaceae*), 3 August 2008, Jamjan Meeboon (BBH 23755).

Hosts – *Ricinus communis* (*Euphorbiaceae*) (Crous & Braun 2003).

Distribution – Worldwide, including Angola, Argentina, Australia, Bangladesh, Barbados, Brazil, Bulgaria, Cambodia, China, Colombia, Cuba, Dominican Republic, Egypt, El Salvador, Ethiopia, French Polynesia, Georgia, Ghana, Guatemala, Haiti, India, Indonesia, Iran, Jamaica, Japan, Kazakhstan, Kenya, Korea, Malawi, Malaysia, Mauritius, Morocco, Mozambique, Myanmar, Nepal, New Caledonia, Nigeria, Pakistan, Panama, Philippines, Puerto Rico, Russia (European part), Sierra Leone, Somalia, South Africa, Sri Lanka, Sudan, Tahiti, Taiwan, Tanzania, Thailand, Togo, Trinidad and Tobago, Uganda,

Ukraine, USA, Vanuatu, Venezuela, Zimbabwe (Crous & Braun 2003).

Notes – This species was first reported from Thailand by Sontirat et al. (1980).

Literature – Chupp (1954, p. 229), Sontirat et al. (1980), Meeboon (2009).

Apocynaceae

Cercospora peregrina Chupp, Monograph of *Cercospora*: 49 (1954).

(= *C. apii* s. lat)

(Fig. 18)

Leaf spots 2–5 mm diam., distinct, amphigenous, circular to subcircular, scattered, dull brown, often paler at the centre, with dark brown margins. *Caespituli* epiphyllous. *Stromata* 25–37 μm diam., intraepidermal, well-developed, composed of globular to angular, brown to blackish brown cells. *Conidiophores* 38–139 \times 3–4.5 μm , 7–12 in loose to dense fascicles, 2–4-septate, often divergent, arising from stromata, simple, erect to decumbent,

smooth, pale brown to brown, unbranched, subcylindrical, slightly geniculate. *Conidiogenous cells* integrated, terminal, holoblastic, monoblastic to polyblastic, sympodially proliferating. *Conidiogenous loci* 2–3 μm diam., conspicuous, thickened, and darkened. *Conidia* 25–170 \times 3–3.5 μm , solitary, narrowly obclavate to subacicular, 3–12-septate, straight, hyaline, smooth, base obconically truncate, with acute apex, hila 2–3 μm diam., thickened and darkened.

Specimen examined – THAILAND, Chiang Mai Province, Royal Flora, on leaves of *Pentalinon luteum* (L.) B.F. Hansen & Wunderlin (*Apocynaceae*), 27 July 2008, Jamjan Meeboon (BBH 23762).

Hosts – *Tabernamontana coronaria*, *T. divaricata* (*Apocynaceae*) (Crous & Braun 2003), *Pentalinon luteum* (Meeboon 2009).

Distribution – India, Mexico, Pakistan, Thailand, USA (Crous & Braun 2003, Meeboon 2009).

Notes – This specimen is a typical of *C. apii s. lat.* fide Crous & Braun (2003) due to long and slightly geniculate conidiophores, and long acicular conidia with truncate base and acute apex. *Cercospora peregrina* is the only one *C. apii s. lat.* reported from plants family *Apocynaceae*. This specimen was first reported from Thailand by Meeboon (2009).

Areaceae

Cercospora areacearum Hidayat & Meeboon, Mycol. Prog. 8: 115-121 (2009a). MycoBank 510616 (Fig. 19)

Leaf spots – 1–10 cm diam., amphigenous, irregular, brown to dull greyish brown, finally pale greyish with a white center and dark margins, spots usually overlapping. *Cae-spituli* amphigenous, scattered, dark yellowish. *Stromata* 30–100 μm diam., substomatal to intraepidermal, well-developed, subglobular, brown to blackish brown. *Conidiophores* 68.5–310 \times 4–5 μm , variable in length, in dense fascicles, 2–8-septate, arising from stromata, smooth, pale yellowish to brownish throughout, sometimes paler at the apex, cylindrical, but narrowed towards the apex, straight, branched, strongly geniculate. *Conidiogenous cells* 24.5–67 \times 4–5 μm , integrated, terminal, sympodially

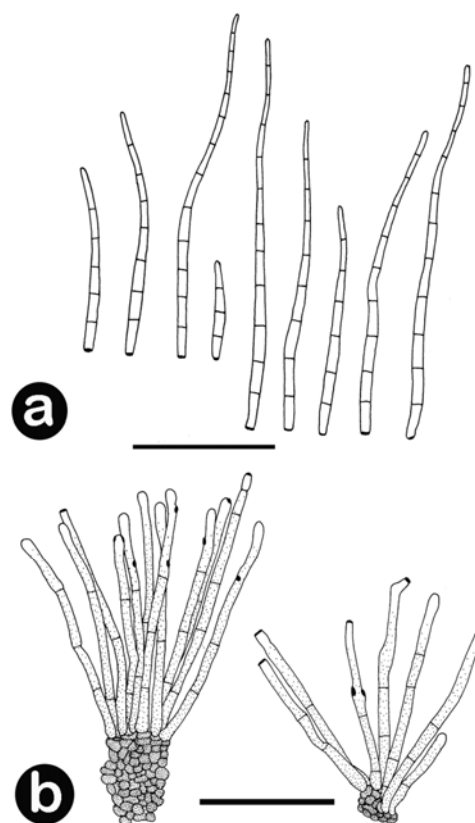


Fig. 18 – Line drawings of *Cercospora peregrina* on *Pentalinon luteum*. **a.** Conidia. **b.** Stromata and conidiophores. Bars: **a** = 50 μm , **b** = 40 μm . (Meeboon 2009).

proliferating. *Conidiogenous loci* 2.5–3 μm diam., conspicuous, thickened and darkened. *Conidia* 140–320 \times 4–5 μm , acicular, straight, often curved at the apex, hyaline, 9–25-septate, thin-walled, smooth, tapered towards a subacute apex, base truncate, hila 2–3 μm diam., thickened and darkened.

Specimen examined – THAILAND, Chiang Mai province, Mae Taeng District, T. Pa Pae, Mushroom Research Centre, on leaf spots of *Areca catechu* L. (*Areaceae*), 17 November 2006, Iman Hidayat (CMU 27946: **Holotype**).

Habitat – *Areca catechu* (*Areaceae*) (To-anun et al. 2009).

Distribution – Thailand (type locality) (To-anun et al. 2009).

Notes – According to Crous & Braun (2003), this species belongs to *Cercospora s. str.*, which is characterized by having pigmented conidiophores, thickened and darkened conidiogenous loci, and hyaline scolecoïd conidia. This fungus is distinct from the

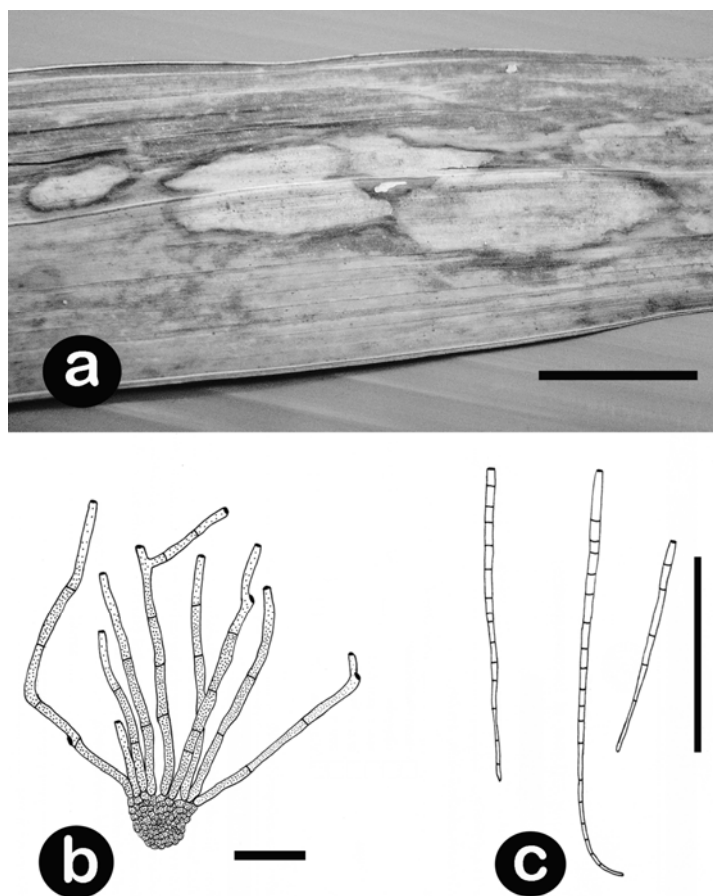


Fig. 19 – Symptoms, conidiophores, stroma and conidia of *Cercospora arecacearum* (from holotype). **a.** Symptoms. **b.** Stroma and conidiophores. **c.** Conidia. Bars: **a** = 5 cm; **b** = 50 μm ; **c** = 150 μm . (To-anun et al. 2009).

plurivorous *C. apii* s. lat. by having well-developed, large stromata, and strongly geniculate, branched conidiophores in dense fascicles (Crous & Braun 2003).

Currently, only three species have been maintained in *Cercospora* s. str. on *Arecaceae*, viz, *C. palmae-amazonensis* Bat. & Cavalc., *C. raphiae* Deighton and *C. nucifera* R.K. Srivast., S. Narayan & A.K. Srivast. (Crous & Braun 2003). The later species, however, is now classified as *C. apii* s. lat. (Crous & Braun 2003).

Cercospora arecacearum is distinct from *C. raphiae* by having amphigenous caespituli, branched and strongly geniculate conidiophores as well as much narrower acicular conidia. Deighton (1985) characterized *C. raphiae* by having hypophyllous caespituli, unbranched, non-geniculate conidiophores and obclavate-cylindrical conidia with slightly thickened hila. *Cercospora arecacearum* is also easily distinguishable from *C. palmae-amazonensis* by its large stromata, branched and strongly geniculate

conidiophores with hyaline acicular conidia.

Asteraceae

Cercospora artemisiae Y.L. Guo & Y. Jiang, Mycosystema 19: 445 (2000). Fig. 20

Leaf spots – 15–30 mm diam., amphigenous, circular to subcircular, at first pale greenish to ochraceous, later becoming brown to dark brown, finally with greyish brown at the centre, surrounded by a dark margin or brown halo. *Caespituli* hypophyllous. *Stromata* 18–25 μm diam., substomatal, small to well-developed, composed of a few globose to subglobose, brown to blackish brown cells.

Conidiophores 55–181 \times 4–5.5 μm , 3–10 in a loose fascicle, 2–7-septate, arising from stromata, erect to decumbent, smooth, pale yellow to pale brown, simple, straight, sometimes branched, subcylindrical, geniculate to sinuous. *Conidiogenous cells* integrated, terminal,

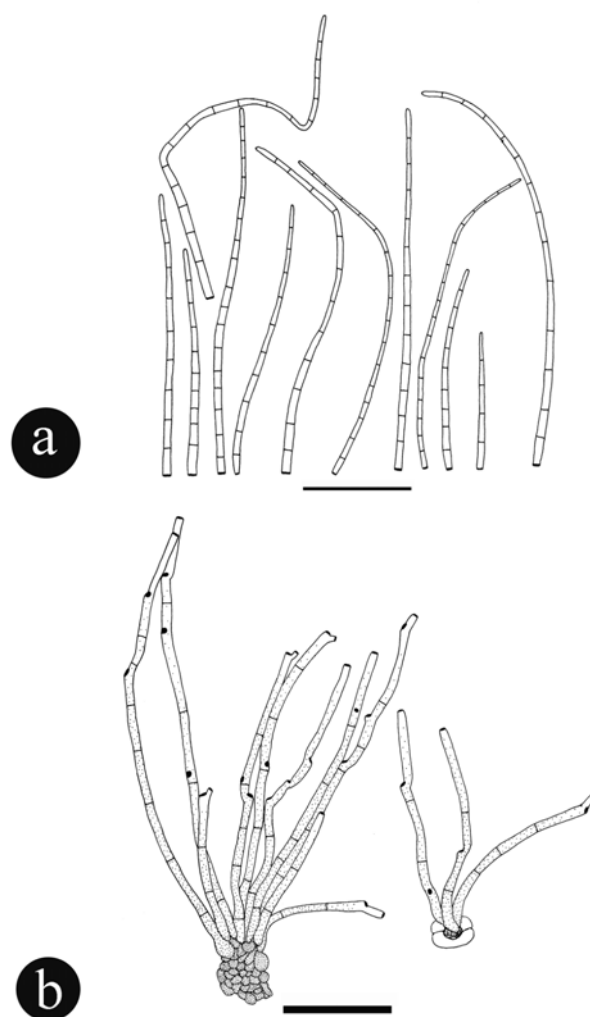


Fig. 20 – Line drawings of *Cercospora artemisiae* on *Artemisia indica*. **b.** Conidiophores and stromata. **a.** Conidia. Bars = 50 μm . (Meeboon 2009).

holoblastic, monoblastic or polyblastic, sympodially proliferating. *Conidiogenous loci* 2.5–3 μm diam., conspicuous, thickened and darkened. *Conidia* 43.5–207.5 \times 2–4 μm , solitary, narrowly obclavate to subacicular, straight, hyaline, 4–17-septate, smooth, base obconically truncate, with subacute apex, hila 2–2.5 μm diam., thickened and darkened.

Specimen examined – THAILAND, Chiang Mai Province, Chiang Mai University, Multiple Cropping Centre, on leaves of *Artemisia indica* Willd. (*Asteraceae*), 14 August 2008, Jamjan Meeboon (BBH 23726).

Hosts – *Artemisia lactiflora* (*Asteraceae*) (Guo & Jiang 2000), *Artemisia indica* (Meeboon 2009).

Distribution – China, Thailand (Guo & Jiang 2000, Meeboon 2009).

Notes – Crous & Braun (2003) noted this

species is probably a synonym of *C. apii* s. lat., but further investigation is needed to justify this preliminary comment. This species was first reported from Thailand by Meeboon (2009).

Cercospora chrysanthemi Heald & F.A. Wolf, *Mycologia* 3: 15 (1911).

= *Cercospora chrysanthemi* Puttemans, *Bull. Soc. Roy. Bot. Belgique* 48: 244 (1912) (*nom. illeg.*), homonym *C. chrysanthemi* Heald & F.A. Wolf (1911).

≡ *Cercosporina chrysanthemi* Sacc., *Syll Fung.* 25: 898 (1931) (*nom. nov.*), as '(Puttemans) Sacc.'

= *Cercospora chrysanthemi-coronarii* Sawada, *Rep. Dept. Agric. Gov. Res. Inst. Formosa* 2: 147 (1922).

(= *C. apii* s. lat.)

Fig. 21

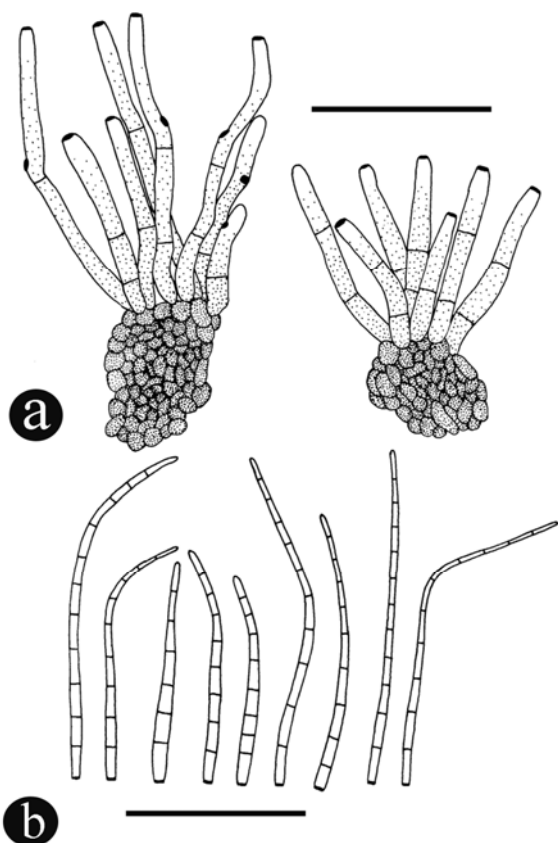


Fig. 21 – Line drawings of *Cercospora chrysanthemi* on *Chrysanthemum* sp. **a.** Conidiophores and stromata. **b.** Conidia. Bars = 50 μm . (Meeboon 2009).

Leaf spots 5–25 mm diam., amphigenous, irregular, greyish brown, with dark brown margin. *Caespituli* amphigenous. *Stromata* 34–40.5 μm diam., well-developed, substomatal, composed of a few subglobose, brown to dark brown cells. *Conidiophores* 35–212 \times 3–4.5 μm , 3–11 in fascicles arising from stromata, straight, smooth, brown at the base, paler towards the apex, 1–10-septate, unbranched, cylindrical, strongly geniculate. *Conidiogenous cells* integrated, holoblastic, polyblastic, sometimes monoblastic and terminal, sympodially proliferating. *Conidiogenous loci* 2–3.5 μm diam., conspicuous, thickened and darkened. *Conidia* 23–190 \times 2–4 μm , solitary, acicular, straight, hyaline, 3–10-septate, smooth, truncate at the base, tapering toward a subacute apex, hila 1.5–2 μm diam., conspicuous, thickened and darkened.

Specimen examined – THAILAND, Chiang Mai Province, Chiang Dao District, Huay Luek Royal Project, on leaves of

Chrysanthemum sp. (Asteraceae), 6 February 2008, Jamjan Meeboon and Iman Hidayat (BBH 23577).

Hosts – *Callistephus chinensis*, *Centratherum anthelminticum*, *Chrysanthemum balsamita*, *C. coronarium*, *C. hortorum*, *C. indicum*, *C. maximum*, *C. morifolium* hybrid, *C. segetum*, *C. sinense*, *Chrysanthemum* sp. (Asteraceae) (Crous & Braun 2003).

Distribution – Bermuda, Brazil, China, Georgia, Hong Kong, India, Jamaica, Japan, Korea, Mauritius, Myanmar, New Zealand, Panama, Philippines, Taiwan, Thailand, USA (Crous & Braun 2003, Meeboon 2009).

Notes – This species was first reported from Thailand by Meeboon (2009).

Cercospora cynarae Y.L. Guo & Y. Jiang, Mycosystema 20: 26 (2001). Fig. 22

Leaf spots 2–10 mm diam., amphigenous, distinct, circular to subcircular, pale brown to tan, centre greyish brown to greyish white, with dark brown margins. *Caespituli* amphigenous. *Stromata* often lacking, if present, up to 28 μm diam., composed of a few globose, brown to dark brown cells. *Conidiophores* 32.5–220 \times 3–8 μm , variable in length, loosely fasciculate, 3–12-septate, emerging from stromata through the cuticle or secondary mycelium, straight to slightly curved, pale brown or sometimes paler towards the apex, unbranched, rarely geniculate. *Conidiogenous cells* integrated, terminal, often monoblastic, sympodially proliferating. *Conidiogenous loci* 2.5–3 μm diam., conspicuous, thickened and darkened. *Conidia* 45–196 \times 1.5–3 μm , solitary, acicular, curved, hyaline, 13–19-septate, smooth, truncate at the base, apex acute, hila \pm 1 μm diam., conspicuous, thickened and darkened.

Specimen examined – THAILAND, Chiang Mai Province, Mae-jam District, Mae-hae Royal Project Area, on leaves of *Cynara scolymus* L. (Asteraceae), 12 February 2008, Jamjan Meeboon and Iman Hidayat (BBH 23674).

Hosts – *Cynara scolymus* (Asteraceae) (Jiang & Guo 2001, Meeboon 2009).

Distribution – China, Thailand (Jiang & Guo 2001, Meeboon 2009).

Notes – This species was first reported from Thailand by Meeboon (2009).

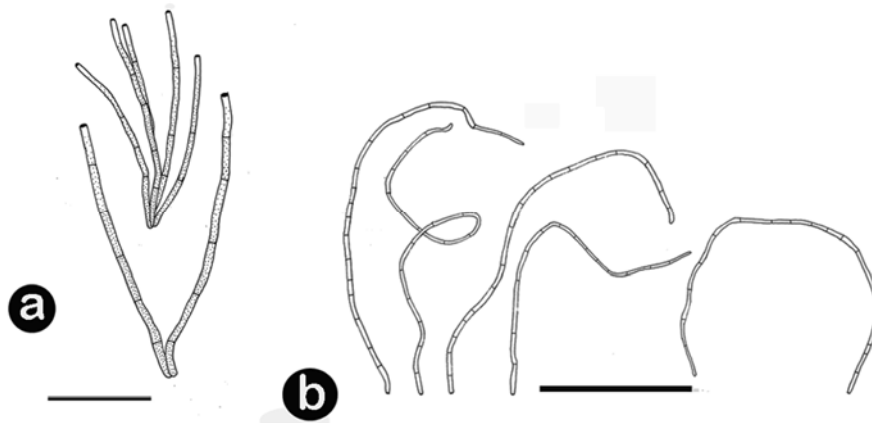


Fig. 22 – Line drawings of *Cercospora cynarae* on *Cynara scolymus*. **a.** Conidiophores. **b.** Conidia. Bars = 50 μm . (Meeboon 2009).

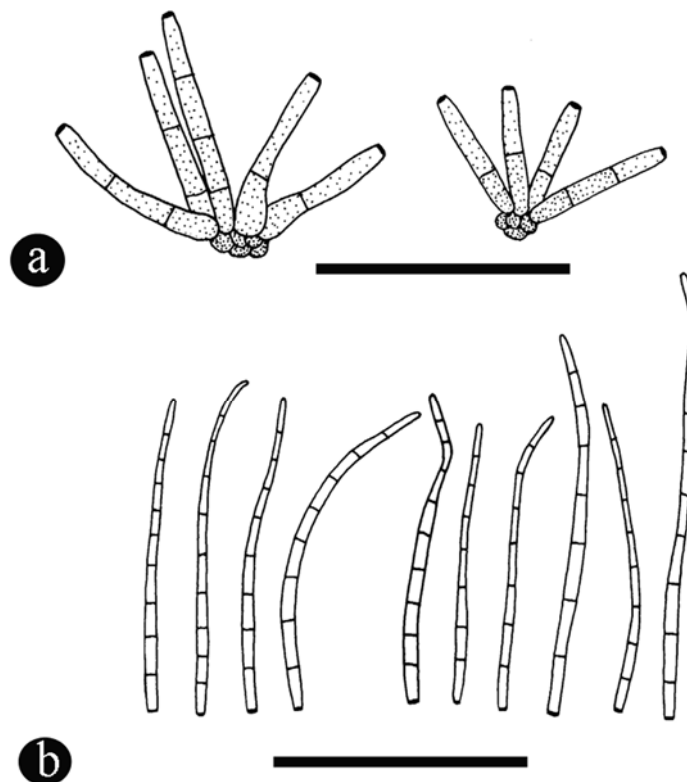


Fig. 23 – Line drawings of *Cercospora dahliicola* on *Dahlia* sp. **a.** Conidiophores and stromata. **b.** Conidia. Bars = 50 μm . (Meeboon 2009).

Cercospora dahliicola M.A. Salam & P.N. Rao,
J. Indian Bot. Soc. 36: 424 (1957).
(= *C. apii* s. lat.)

Fig. 23

Leaf spots 3–5 mm diam., amphigenous, dark to yellowish, only leaf decoloration. *Caespituli* hypophyllous. *Stromata* 19–21 μm diam., small to well-developed, composed of a

few globose to subglobose, brown to blackish brown cells. *Conidiophores* 25–102 \times 25–4 μm , 3–5 in a loose and divergent fascicle, 1–3-septate, arising from stromata, straight, smooth, brown at the base, paler towards the apex, cylindrical, unbranched, not geniculate. *Conidiogenous cells* integrated, holoblastic, monoblastic, sympodially proliferating. *Conidioge-*

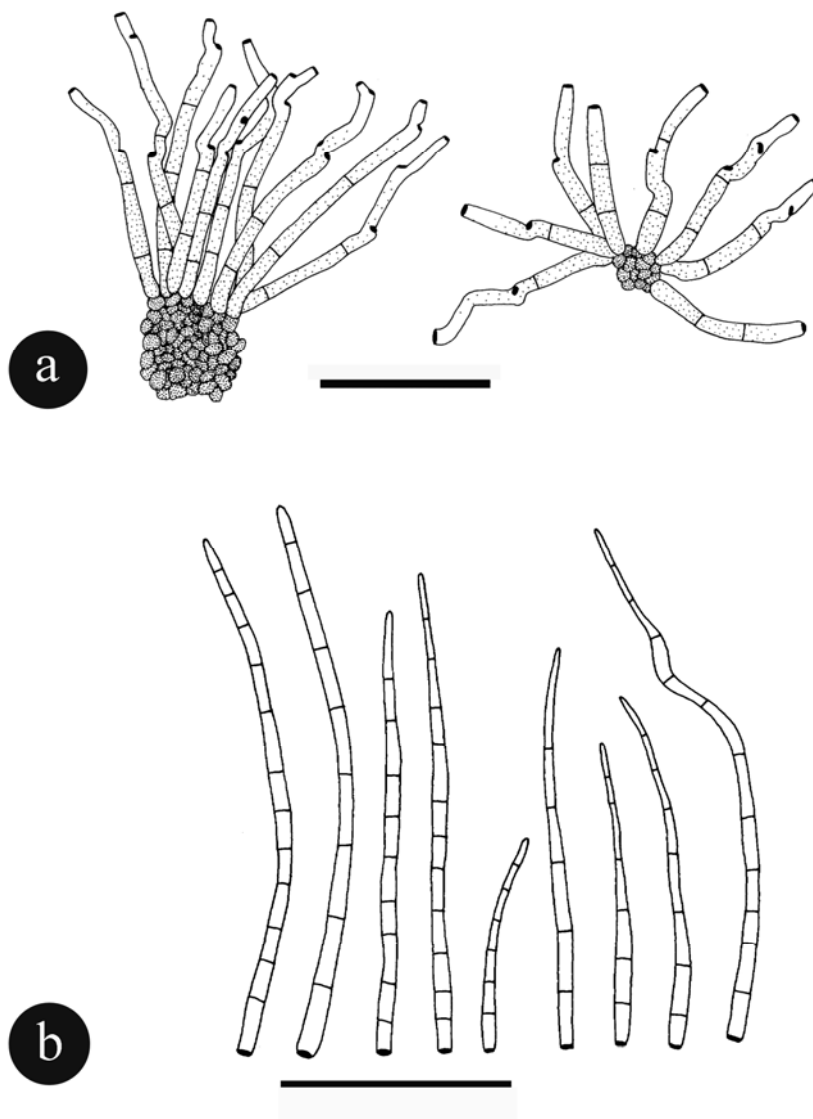


Fig. 24 – Line drawings of *Cercospora gerberae* on *Gerbera jamesonii*. **a.** Conidiophores and stromata. **b.** Conidia. Bars = 50 μm . (Meeboon 2009).

nous loci 2.5–3 μm diam., conspicuous, thickened and darkened. *Conidia* 46–87 \times 2.5–3 μm , solitary, acicular, straight, hyaline, 7–10-septate, smooth, truncate at the base, tapering toward a subacute apex, hila 2–2.5 μm diam., conspicuous, thickened and darkened.

Specimen examined – THAILAND, Chiang Rai Province, Mae Fah Luang, Mae Jan, Doi Tung Development, on leaves of *Dahlia* sp. (*Asteraceae*), 16 August 2008, Jamjan Meeboon (BBH 23587).

Hosts – *Dahlia variabilis*, *Dahlia* sp. (*Asteraceae*) (Salam & Rao 1957, Meeboon 2009).

Distribution – India, Thailand (Salam & Rao 1957, Meeboon 2009).

Notes – This species was first reported from Thailand by Meeboon (2009). Crous & Braun (2003) assigned this species as *C. apii* s. lat.

Cercospora gerberae Chupp & Viégas, Bol. Soc. Brasil. Agron. 8: 27 (1945).
(= *C. apii* s. lat.)

Fig. 24

Leaf spots 15–30 mm diam., amphigenous, circular or subcircular, pale greenish to ochraceous when young, becoming brown to dark brown, finally greyish brown at the centre, surrounded by a dark margin. *Caespituli* amphigenous. *Stromata* 20.5–39 μm diam., well-developed, intraepidermal, composed of a few

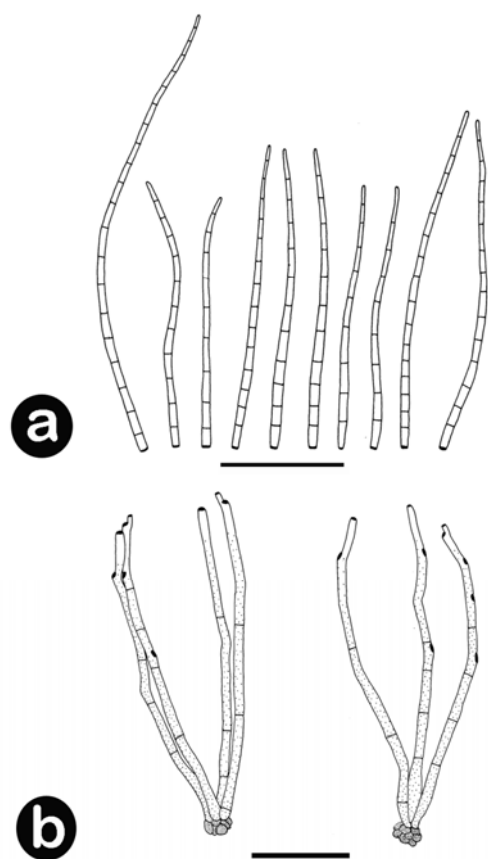


Fig. 25 – Line drawings of *Cercospora helianthicola* on *Helianthus annuus*. **a.** Conidia. **b.** Stromata and conidiophores. Bars = 50 μm . (Meeboon 2009).

subglobose, brown to blackish brown cells. *Conidiophores* 36–163 \times 3–6 μm , numerous, in loose to dense fascicles, 1–3-septate, arising from stromata, simple, straight, erect to decumbent, smooth, pale yellow to pale brown, unbranched, subcylindrical, strongly geniculate to sinuous. *Conidiogenous cells* integrated, terminal, polyblastic, sympodially proliferating. *Conidiogenous loci* 2–3 μm , conspicuous, thickened and darkened. *Conidia* 60–198 \times 2–4 μm , solitary, narrowly obclavate to subacicular, straight, hyaline, 5–12-septate, smooth, base obconically truncate, with subacute apex, hila 2–2.5 μm , thickened and darkened.

Specimens examined – THAILAND, Chiang Rai Province, A. Wiang Pa Pao, on leaves of *Gerbera jamesonii* Adlam cultivar (*Asteraceae*), 9 March 2005, Jamjan Meeboon (CMU 28219); Chiang Mai Province, A. Muang, Suthep, Chang Khian, same host, 2 August 2008, Jamjan Meeboon (BBH 23690); Chiang Mai Province, Mae Jo, San Sai Farming

area, same host, 9 August 2008, Jamjan Meeboon (BBH 23702).

Hosts – *Gerbera jamesonii*, *Gerbera* sp. (*Asteraceae*) (Crous & Braun 2003).

Distribution – Australia, Bangladesh, Bermuda, Brazil, Brunei, Cuba, Cambodia, Ghana, Hong Kong, India, Indonesia, Iran, Jamaica, Kenya, Malawi, Malaysia, Pakistan, Philippines, Puerto Rico, Sierra Leone, Singapore, Solomon Islands, Taiwan, Tanzania, Thailand, Uganda, USA, Virgin Islands (Crous & Braun 2003).

Notes – The first report of this species in Thailand was by Sontirat et al. (1980).

Literature – Chupp (1954, p. 138).

Cercospora helianthicola Chupp & Viégas, Bol. Soc. Brasil. Agron. 8: 29 (1945).

(= *C. apii* s. lat.)

Fig. 25

Leaf spots 2–26 mm diam., distinct, amphigenous, variable in shapes, from minute spot to large necrosis on the leaves, dark brown, with indistinct margins. *Caespituli* hypophyllous. *Stromata* 12–15 μm diam., intraepidermal, small, composed of a few globose to subglobose, brown to blackish brown cells. *Conidiophores* 79–184 \times 3–5 μm , 3–6 in loose and divergent fascicles, 2–4-septate, arising from stromata, erect to decumbent, smooth, pale yellow to pale brown, unbranched, subcylindrical, geniculate to sinuous. *Conidiogenous cells* integrated, terminal to intercalary, holoblastic, monoblastic or polyblastic, sympodially proliferating. *Conidiogenous loci* 1.5–3 μm diam., conspicuous, thickened and darkened. *Conidia* 120–215 \times 3–4 μm , solitary, narrowly obclavate to acicular, 8–20-septate, straight to curved, hyaline, smooth, base obconically truncate, with subacute apex, hila 1.5–2.5 μm diam., thickened and darkened.

Specimens examined – THAILAND, Chiang Mai Province, Suthep-Pui National Park, on leaves of *Helianthus annuus* L. (*Asteraceae*), 30 November 2004, Jamjan Meeboon (CMU 27879); Chiang Mai Province, Chiang Mai University, Faculty of Agriculture, on same host, 14 August 2008, Jamjan Meeboon (BBH 23610).

Hosts – *Helianthus annuus*, *H. doronicoides*, *H. hirsutus*, *H. maximiliani*, *H. occi-*

dentalis, *H. rigidus*, *H. strumosus*, *H. tuberosus* (*Asteraceae*) (Crous & Braun 2003).

Distribution – Brazil, Cambodia, China, India, Mauritius, Pakistan, Panama, Thailand (Crous & Braun 2003).

Notes – In Thailand, this fungus was first reported by Petcharat & Kanjanamaneesathian (1989). Crous & Braun (2003) noted *C. helianthicola* as *C. apii* s. lat.

Literature – Chupp (1954, p. 141).

Cercospora lactucae-sativae Sawada, Report of the Department of Industry, Government Research Institute, Formosa 85: 111 (1943).

= *Cercospora longispora* (Cugini) Trav., *Malpighia* 17: 217 (1902) (*nom. illeg.*), homonym of *C. longispora* Peck (1884).

≡ *Cercospora longissima* Trav., *Malpighia* 17: correzione (correction slip) to p. 217 (1903) (*nom. illeg.*), homonym of *C. longissima* Cooke & Ellis (1889).

≡ *Cercospora longissima* (Cugini) Sacc., *Syll. Fung.* 18: 607 (1906) (*nom. illeg.*), homonym of *C. longissima* Cooke & Ellis (1889).

= *Cercospora lactucae* J.A. Stev., *J. Dept. Agric. Puerto Rico* 1: 105 (1917) (*nom. illeg.*), homonym of *C. lactucae* Henn. (1902).

= *Cercospora lactucae* Welles, *Phytopathology* 13: 289 (1923) (*nom. illeg.*), homonym of *C. lactucae* Henn. (1902).

= *Cercospora ixeridis-chinensis* Sawada, *Rep. Gov. Agric. Res. Inst. Taiwan* 86: 171 (1943) (*nom. inval.*).

= *Cercospora lactucae-indicae* Sawada, *Rep. Gov. Agric. Res. Inst. Taiwan* 86: 172 (1943) (*nom. inval.*). Fig. 26

Leaf spots 2–10 mm diam., amphigenous, circular or subcircular, brown to dark brown, greyish brown at the centre, surrounded by dark margins. *Caespituli* amphigenous. *Stromata* 17–36 µm diam., intraepidermal, moderately small to well-developed, composed of subglobular, and brown to dark brown cells. *Conidiophores* 47–128 × 3–6.5 µm, 3–8 in loose fascicles, 1–4-septate, arising through stomata, straight to decumbent, smooth, brown at the base, paler towards the apex, unbranched, cylindrical, strongly geniculate near the apex. *Conidiogenous cells* 19–40 × 2–3.5 µm,

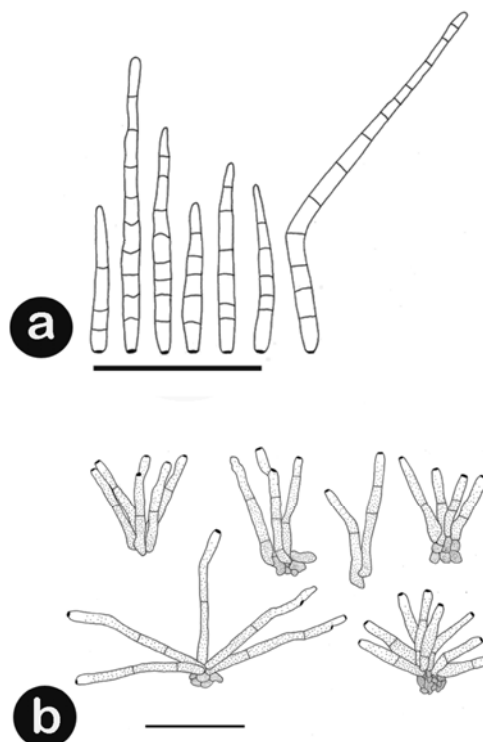


Fig. 26 – Line drawings of *Cercospora lactucae-sativae* of *Lactuca sativa* cv. red leaf lettuce. **a.** Conidia. **b.** Conidiophores and stromata. Bars = 50 µm. (Meeboon 2009).

integrated, terminal, monoblastic or polyblastic, sympodially proliferating. *Conidiogenous loci* 2–3 µm diam., conspicuous, thickened and darkened. *Conidia* 36–182 × 3–6.5 µm, solitary, acicular to narrowly obclavate, straight (occasionally curved), hyaline, 7–13-septate, smooth, obconically truncate at the base, tapering towards a subacute apex, hila 1.5–3 µm diam., thickened and darkened.

Specimen examined – THAILAND, Chiang Mai Province, Chiang Mai University, on leaves of *Lactuca sativa* L. (*Asteraceae*), 31 October 2004, Jamjan Meeboon (CMU 27900); the same province, Amphur Samoeng, Pang Da Royal Project, on leaves of *Lactuca sativa* cv. *butter head lettuce*, 7 February 2008, Jamjan Meeboon and Iman Hidayat (BBH 23572); cv. *red leaf lettuce*, Jamjan Meeboon and Iman Hidayat (BBH 23573); and cv. *green corol*, Jamjan Meeboon and Iman Hidayat (BBH 23572); the same province Amphur Sanpatong, Tambol Mae Win, Ban Mae Sapok, Mae Sapok Royal Project, 8 February 2008, cv. *red corol*, Jamjan Meeboon and Iman Hidayat (BBH 23569) and cv. *red oak leaf*, Jamjan Meeboon

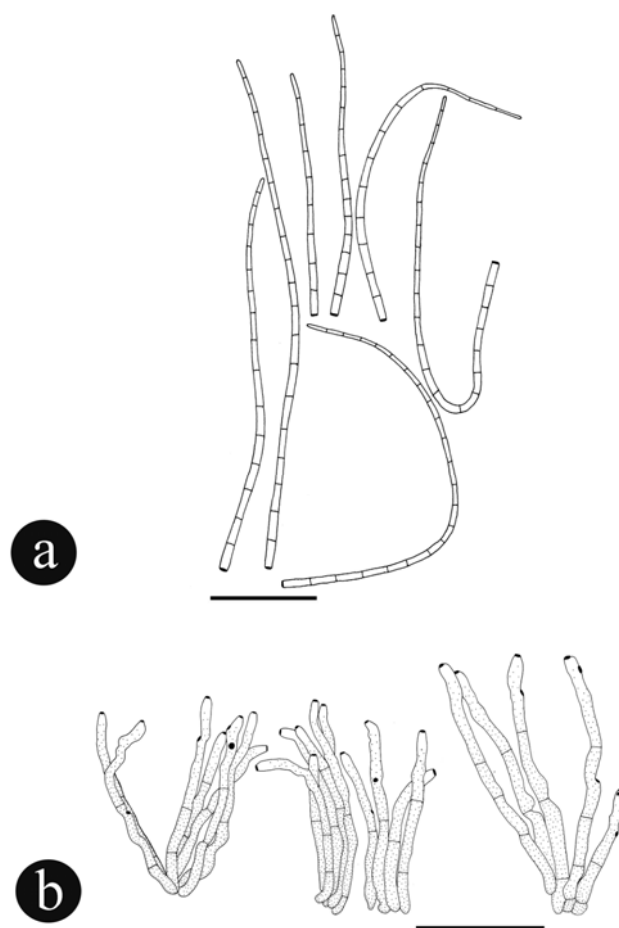


Fig. 27 – Line drawings of *Cercospora nilghirensis* on *Conyza sumatrensis*. **a.** Conidia. **b.** Conidiophores and stromata. Bars: **a** = 25 μm , **b** = 50 μm . (Meeboon 2009).

and Iman Hidayat (BBH 23570); cv. *ice berg*, Jamjan Meeboon and Iman Hidayat (BBH 23633); cv. *lettuce green oak leaf*, Jamjan Meeboon and Iman Hidayat (BBH 23597); and cv. *lettuce sweet chart*, Jamjan Meeboon and Iman Hidayat (BBH 23631)

Hosts – *Cichorium endivia*, *C. intybus* L., *Lactuca chinensis*, *L. denticulata*, *L. indica*, *L. paradoxa*, *L. saligna*, *L. scariola*, and *L. sativa* (*Asteraceae*) (Crous & Braun 2003, Meeboon et al. 2007c).

Distribution – Worldwide, wherever the host is grow, including China, Japan, Korea, Taiwan, Thailand (Crous & Braun 2003, Meeboon et al. 2007c).

Notes – The first report of this species from Thailand was made by Meeboon et al. (2007c). The first report of *C. lactucae-sativae* infecting *Cichorium endivia*, and various cultivars of *L. sativa*, viz, cv. butter head lettuce, cv. red leaf lettuce, cv. green corol, cv. red corol, cv. red oak leaf, cv. ice berg, cv.

lettuce green oak leaf, and cv. lettuce sweet chart, in Thailand was by Meeboon (2009).

Cercospora nilghirensis Govindu & Thirum., Sydowia 9: 224 (1955). Fig. 27

Leaf spots 2–5 mm diam., amphigenous, distinct, circular to subcircular, pale to whitish at the center with dark margin. *Caespituli* amphigenous. *Stromata* up to 12 μm diam., small, often lacking, intraepidermal, composed of a few globose to subglobose, brown cells. *Conidiophores* 88–118 \times 4–6 μm , 4–9 in loose to dense fascicles, 2–5-septate, arising from stromata, straight to decumbent, smooth, brown at the base, paler toward the apex, unbranched, cylindrical, geniculate, mostly near the apex. *Conidiogenous cells* integrated, terminal or intercalary, frequently monoblastic, sometimes polyblastic, sympodially proliferating. *Conidiogenous loci* 2–2.5 μm diam., conspicuous thickened and darkened. *Conidia* 40–96 \times 3.5–

4 µm, solitary, obclavate, straight, slightly curved, hyaline, 6–12-septate, smooth, obconically truncate at the base, tapering towards a subacute apex, hila 2–2.3 µm diam., conspicuous, thickened and darkened.

Specimen examined – THAILAND, Chiang Mai Province, Mae Jam District, Mae Hae Royal Project, on leaves of *Conyza sumatrensis* (Retz.) E. Walker (*Asteraceae*), 12 February 2008, Jamjan Meeboon and Iman Hidayat (BBH 23775).

Hosts – *Conyza ambigua*, *C. stricta*, *C. sumatrensis* (*Asteraceae*) (Crous & Braun 2003, Meeboon 2009).

Distribution – India, Thailand (Crous & Braun 2003, Meeboon 2009).

Notes – This specimen is much close to *C. nilghirensis* than to *C. bidentis* Tharp. due to distinct and amphigenous leaf spot, amphigenous caespituli, stromata small to lacking, unbranched and geniculation of conidiophores near the apex, and the conidia frequently obclavate. In *C. bidentis*, the leaf spot is indefinite as the lower surfaces and caespituli epiphyllous. The first report of *C. nilghirensis* from Thailand was by Meeboon (2009).

Cercospora zinnicola A. Pande, Kavaka 3: 55 (1975). Fig. 28–29

Leaf spots 1–10 mm diam., amphigenous, irregular, pale, with dark red margin, numerous and scattered through the leaf surface. *Caespituli* amphigenous. *Stromata* 32.5–46 µm diam., intraepidermal, well-developed, composed of globose to subglobose, brown to blackish brown cells. *Conidiophores* 54–100 × 2.5–5 µm, 9–16 in dense fascicles, not divergent, 3–6-septate, arising from stromata, smooth, brown at the base, paler toward the apex, straight to decumbent, unbranched, cylindrical, geniculate to sinuous, mostly near the apex. *Conidiogenous cells* 7.5–20 × 2.5–5 µm, integrated, terminal, holoblastic, mostly polyblastic, sympodially proliferating. *Conidiogenous loci* 2–2.5 µm diam., conspicuous, thickened and darkened. *Conidia* 24.5–93.5 × 2.5–3.5 µm, solitary, filiform to narrowly obclavate, straight, hyaline, 7–18-septate, smooth, obconically truncate at the base, tapering toward a subacute apex, hila 2–2.5 µm diam., thickened and darkened.

Specimens examined – THAILAND, Chiang Rai Province, A. Wiang Pa Pao, T. Wiang Ga Long, Moo11, Bahn Tung Ruang Tong, on leaves of *Zinnia elegans* Jacq (*Asteraceae*), 31 July 2007, Jamjan Meeboon (BBH 23563); Chiang Mai Province, Mae Rim, Queen Sirikit Botanical Garden, on leaves of *Z. elegans*, 5 August 2008, Jamjan Meeboon, (BBH 23731).

Hosts – *Zinnia elegans* (*Asteraceae*) (Crous & Braun 2003, Meeboon 2009).

Distribution – India, Thailand (Crous & Braun 2003, Meeboon 2009).

Notes – Both of these specimens are apparently distinct from *C. apii* s. lat. due to well developed stromata, very densely fasciculate conidiophores and obclavate conidia with obconically truncate base. Both of them are characterized by having amphigenous caespituli as well as having relatively short conidiophores (up to 100 µm long) and conidia. The conidiophores of the first specimen are not divergent, but the second one is divergence and conidia of the second specimen are only up to 4 septate. Since these collections are not *C. apii* s. lat., therefore, we assigned them to *C. zinnicola* due to the similarity of morphological characteristics, and being recorded from *Zinnia elegans*. *Cercospora zinnicola* was firstly found in Thailand by Meeboon (2009).

Literature – Crous & Braun (2003, p. 434).

Cercospora zinniae Ellis & G. Martin, J. Mycol. 1: 20 (1885).

= *Cercospora atricineta* Heald & F.A. Wolf, Mycologia 3: 14 (1911).

= *Cercospora zinniae* Takah. & Yosh., Pl. Protect. Tokyo 7: 17 (1953).

(= *C. apii* s. lat.)

Fig. 30

Leaf spots 15–30 mm diam., amphigenous, circular or subcircular, at first pale greenish to ochraceous, later brown to dark brown, finally with greyish brown centre, surrounded by a dark margins. *Caespituli* amphigenous, effuse. *Stromata* 17–25 µm diam., intraepidermal, small to well-developed, composed of globose to subglobose, brown to blackish brown cells. *Conidiophores* 40–152 × 3–5.5 µm, 9–13 in dense fascicles, often

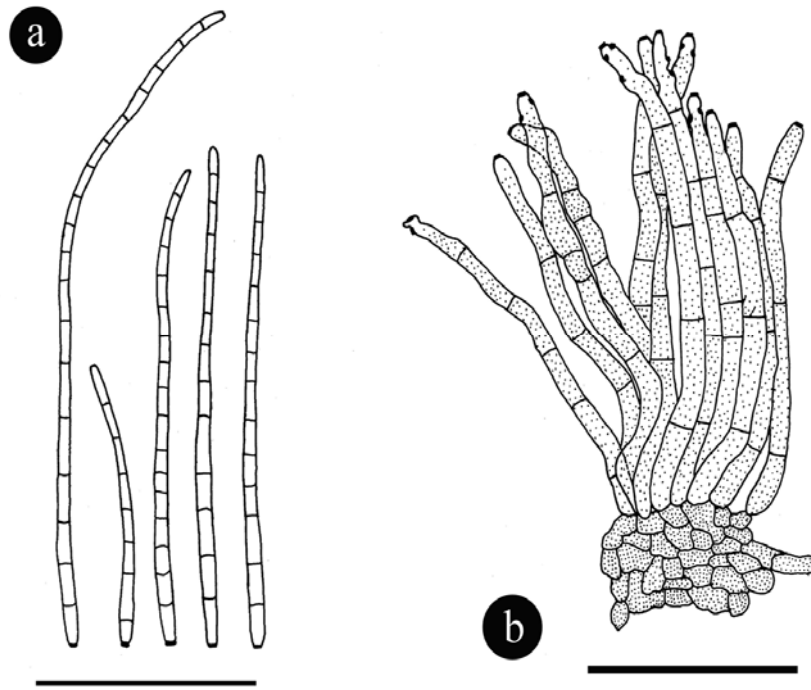


Fig. 28 – Line drawings of *Cercospora zinniicola* on *Zinnia elegans*. **a.** Conidia. **b.** Conidiophores and stroma. Bars = 50 μ m. (Meeboon 2009).

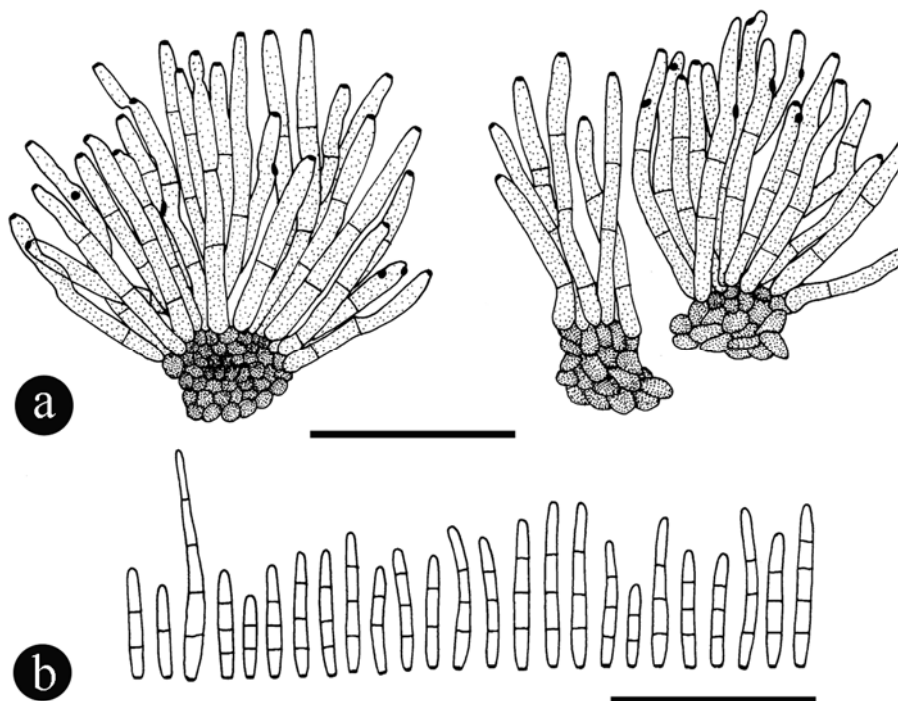


Fig. 29 – Line drawings of *Cercospora zinniicola* on *Zinnia elegans*. **a.** Conidiophores and stromata. **b.** Conidia. Bars = 50 μ m. (Meeboon 2009).

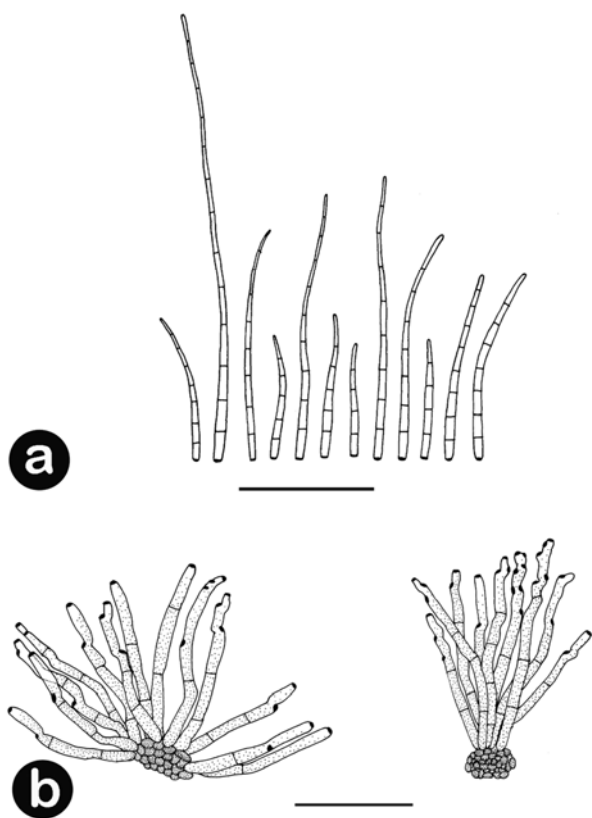


Fig. 30 – Line drawings of *Cercospora zinniae* on *Zinnia grandiflora*. **a.** Conidia. **b.** Conidiophores and stromata. Bars = 50 μm . (Meeboon 2009).

divergent, 1–4-septate, arising from stromata, simple, straight, erect to decumbent, smooth, pale yellow to pale brown, rarely branched, subcylindrical, geniculate to sinuous. *Conidiogenous cells* integrated, terminal, holoblastic, polyblastic, sympodially proliferating. *Conidiogenous loci* 1.5–3 μm diam., conspicuous, thickened and darkened. *Conidia* 24–175 \times 2–3.5 μm , solitary, narrowly obelovate to subacicular, straight, hyaline, 4–13-septate, smooth, obconically truncate at the base, with subacute apex, hila 1.5–2.5 μm diam., thickened and darkened.

Specimen examined – THAILAND, Chiang Mai Province, Mae Rim, Queen Sirikit Botanical Garden, on leaves of *Zinnia grandiflora* Nutt. (Asteraceae), 5 August 2008, Jamjan Meeboon (BBH 23730).

Hosts – *Cosmos* sp., *Zinnia elegans*, *Z. multiflora*, *Z. pauciflora*, *Z. peruviana*, *Z. violacea*, *Zinnia* sp. (Asteraceae) (Crous & Braun 2003).

Distribution – American Samoa, Bangladesh, Bhutan Brazil, Brunei, China,

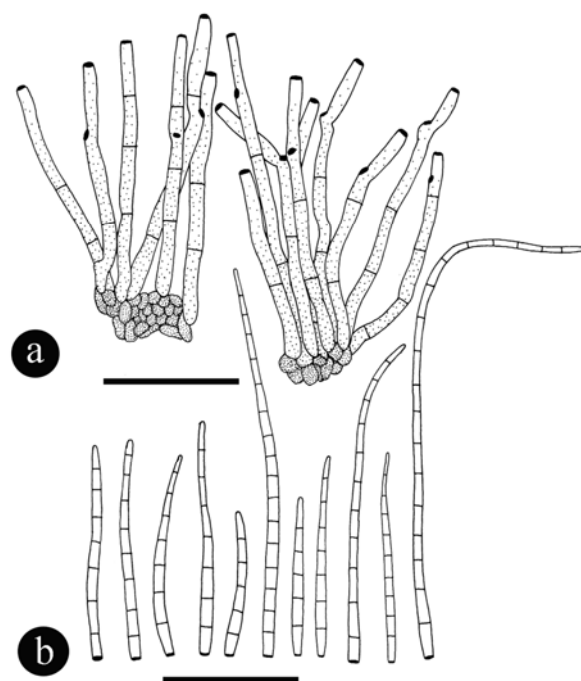


Fig. 31 – Line drawings of *Cercospora balsaminiana* on *Impatiens walleriana*. **a.** Conidiophores and stromata. **b.** Conidia. Bars: **a** = 50 μm , **b** = 40 μm . (Meeboon 2009).

Colombia, Cook Islands, Cuba, Dominican Republic, El Salvador, Fiji, Ghana, Guam, Guatemala, Haiti, Hong Kong, India, Indonesia, Jamaica, Japan, Korea, Lithuania, Malawi, Malaysia, Mauritius, Mexico, Micronesia, Myanmar, Nepal, New Caledonia, Nigeria, Pakistan, Panama, Papua New Guinea, Philippines, Puerto Rico, Samoa, Singapore, Solomon Islands, South Africa, Sudan, Taiwan, Tanzania, Thailand, Togo, Tonga, Trinidad and Tobago, Tuvalu, Uganda, USA, Vanuatu, Venezuela, Virgin Islands, Zambia and Zimbabwe (Crous & Braun 2003, Meeboon 2009).

Notes – *Cercospora zinniae* was first reported from Thailand by Meeboon (2009).

Literature – Chupp (1954, p. 168), Meeboon (2009).

Balsaminaceae

Cercospora balsaminiana J.M. Yen & Lim, Cah. Pacifique 14: 91 (1970). Fig. 31

Leaf spots 3 – 10 mm diam., amphigenous, circular to subcircular, brown to dark brown, pale at the center, with dark margin. *Caespituli* amphigenous. *Stromata* 10 – 15 μm

diam., substomatal to intraepidermal, small, composed of a few globose to subglobose, brown cells. *Conidiophores* 52–129 × 2–3.5 µm, 6–8 in loose fascicles, 2–4-septate, arising from stromata, straight to decumbent, smooth, brown at the base, paler toward the apex, unbranched, cylindrical, geniculate, mostly near the apex. *Conidiogenous cells* integrated, holoblastic, polyblastic, sometimes monoblastic, sympodially proliferating. *Conidiogenous loci* 1–2 µm, conspicuous, thickened and darkened. *Conidia* 35–73 × 4–5 µm, solitary, obclavate, slightly curved, hyaline, 3–11-septate, smooth, obconically truncate at the base, with tapering toward a subacute apex, hila 1–2.3 µm diam., thickened and darkened.

Specimen examined – THAILAND, Chiang Mai Province, A. Mueang, Sri Pum, Chiang Mai Public Garden, on leaves of *Impatiens walleriana* Hook. f. (*Balsaminaceae*), 15 August 2008, Jamjan Meeboon (BBH 23582).

Hosts – *Impatiens balsamina* (*Balsaminaceae*) (Yen & Lim 1980), *Impatiens walleriana* (Meeboon 2009).

Distribution – Singapore, Thailand (Yen & Lim 1980, Meeboon 2009).

Notes – The symptoms, stromata and conidiophores of this specimen are close to *C. apii* s. lat. fide Crous & Braun (2003), but the conidia are obclavate with an obconically truncate base. We decide to assign this specimen to *C. balsaminiana*. The first report of *C. balsaminiana* from Thailand was by Meeboon (2009).

Literature – Yen & Lim (1980, p. 155).

Cercospora fukushiana (Matsuura) W. Yamam., J. Soc. Trop. Agric. 6: 601 (1934).

≡ *Cercospora fukushiana* Matsuura, J. Pl. Prot. 14: 699 (1927).

= *Cercospora balsaminae* Mend. Philipp. J. Sci. 75: 166 (1941).

= *Cercospora balsaminae* Kellerm. & Swingle, fide Chupp (1954).

(= *C. apii* s. lat.)

Fig. 32

Leaf spots 15 – 30 mm diam., amphigenous, circular or subcircular, at first pale greenish to ochraceous, later brown to dark brown, finally with greyish brown centre, surrounded by a dark margin. *Caespituli*

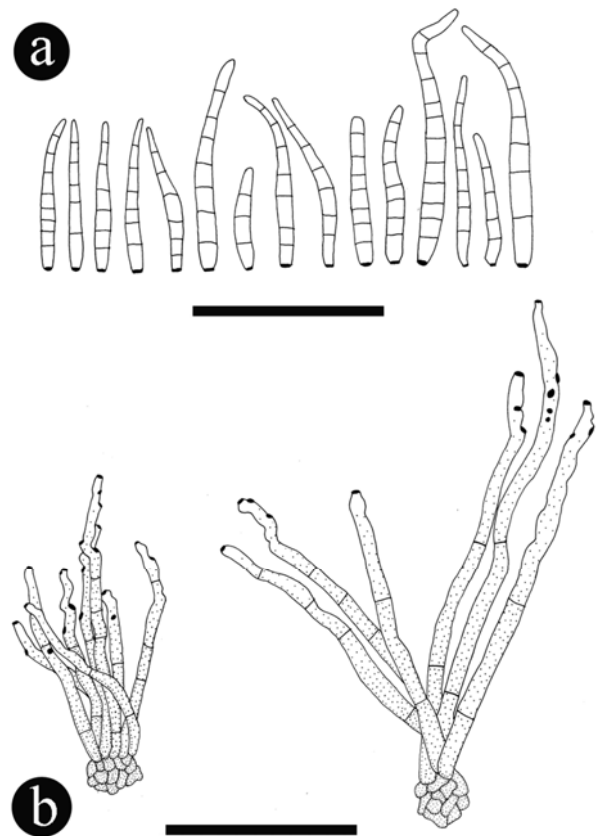


Fig. 32 – Line drawings of *Cercospora fukushiana* on *Impatiens balsamina*. **a.** Conidia. **b.** Conidiophores and stromata. Bars: **a** = 100 µm, **b** = 40 µm. (Meeboon 2009).

amphigenous. *Stromata* 25–32 µm diam., small to well-developed, composed of globose to subglobose, brown to blackish brown cells. *Conidiophores* 49–112 × 4–6.5 µm, 6–8 in loose to dense fascicles, arising from stromata, simple, straight, 1–4-septate, erect to decumbent, smooth, subcylindrical, pale yellow to pale brown, sometimes branched, geniculate to sinuous. *Conidiogenous cells* integrated, terminal, holoblastic, monoblastic or polyblastic, sympodially proliferating. *Conidiogenous loci* conspicuous, thickened, and darkened. *Conidiogenous loci* 2–3 µm diam., conspicuous, thickened, and darkened. *Conidia* 60–120 × 2.5–5 µm, solitary, narrowly obclavate to subacicular, 5–18-septate, straight, hyaline, smooth, base truncate to obconically truncate, with subacute apex, hila 1.5–2.5 µm diam., thickened and darkened.

Specimens examined – THAILAND, Phetchabun Province, Nam Nao National Park, on leaves of *Impatiens balsamina* L.

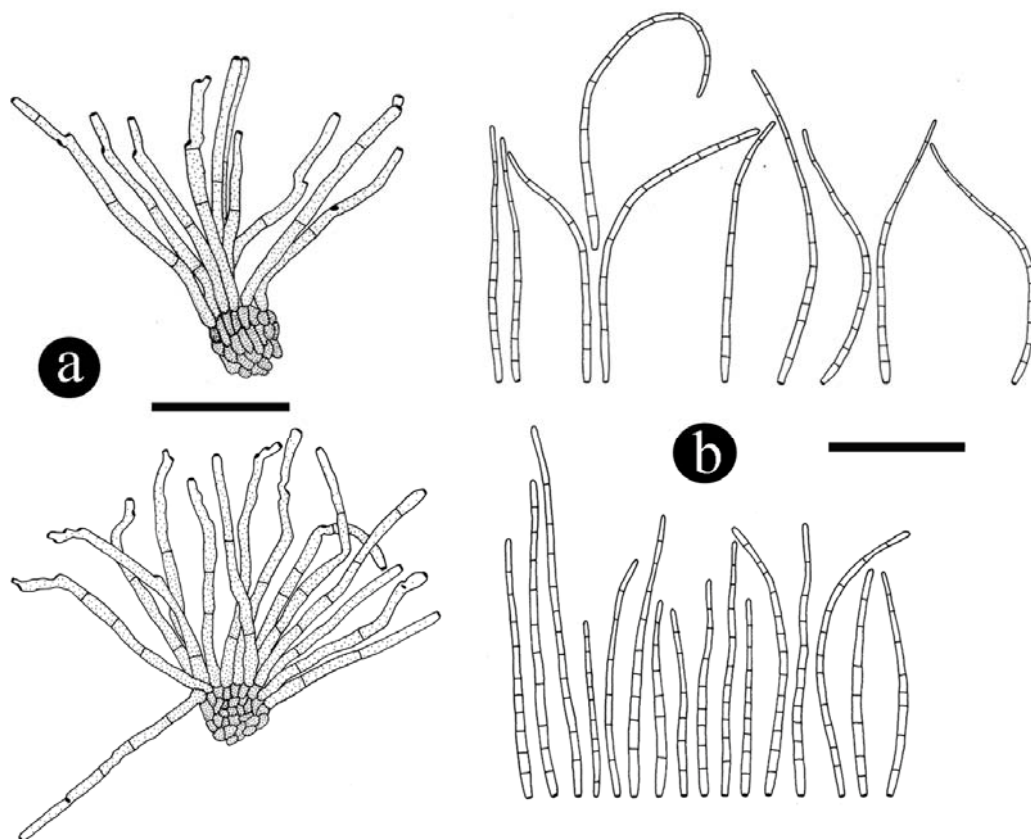


Fig. 33 – Line drawings of *Cercospora basellae-albae* on *Basella alba*. **a.** Conidiophores and stromata. **b.** Conidia. Bars = 50 µm. (Meeboon 2009).

(*Balsaminaceae*), 24 November 2004, Jamjan Meeboon (CMU 27917); Chiang Mai Province, Samerng District, Pang Da Royal Project, on leaves of *I. balsamina*, 7 February 2008, Jamjan Meeboon (BBH 23616).

Hosts – *Impatiens acaulis*, *I. balsamina*, *I. biflora*, *I. chinensis*, *I. gigantea*, *I. hawkeri*, hybrid, *I. noli-tangere*, *Impatiens* sp. (*Balsaminaceae*) (Crous & Braun 2003, Meeboon 2006, 2009).

Distribution – Bangladesh, Bhutan Brazil, Brunei, China, Cuba, Estonia, Hong Kong, India, Indonesia, Iran, Japan, Korea, Lithuania, Korea, India, Indonesia, Malaysia, Mauritius, Myanmar, Nepal, New Caledonia, Papua New Guinea, Philippines, Sierra Leone, South Africa, Sudan, Taiwan, Tanzania, Thailand, USA (Crous & Braun 2003, Meeboon 2006, 2009).

Notes – In Thailand, *C. fukushiana* on *I. balsamina* was first reported by Meeboon (2006, 2009).

Literature – Chupp (1954, p. 78).

Basellaceae

Cercospora basellae-albae R.K. Srivast., S. Narayan & A.K. Srivast., Indian Phytopathol. 47: 229 (1994). Fig. 33

Leaf spots 2–8 mm diam., amphigenous, subcircular to irregular, pale brown to dingy grey in the center with reddish brown to purplish brown margin on the upper surface, pale brown to olivaceous brown on the lower surface. *Caespituli* amphigenous. *Stromata* 13–53 µm in diam., small to well-developed, rarely lacking, irregular, composed of a few globose to subglobose, dark brown cells. *Conidiophores* 25–70 × 3–6 µm, 10–15 in divergent fascicles, 1–4-septate, emerging through stomata and the cuticle, light brown, paler towards the apex, straight to slightly curved, unbranched, plainly geniculate near the apex. *Conidigenous cells* integrated, terminal or intercalary, holoblastic, monoblastic or polyblastic, sympodially proliferating. *Conidigenous loci* 2–3 µm, conspicuous, thickened and darkened.

Conidia 17–93 × 3–5 µm, solitary, acicular to obclavate, hyaline, 6–12-septate, non-constricted at the septa, acute to obtuse at the apex, truncate at the base, hila 1–3 µm in diam., conspicuous, thickened and darkened.

Specimen examined – THAILAND, Chiang Mai province, Chiang Mai University, on leaves of *Basella alba* L. (*Basellaceae*), 27 November 2005, Jamjan Meeboon (CMU 28214).

Hosts – *Basella alba* (*Basellaceae*) (Srivastava et al. 1994, Meeboon et al. 2007d).

Distribution – India, Thailand (Srivastava et al. 1994, Meeboon et al. 2007d).

Notes – *Cercospora basellae-albae* on *Basella alba* has been previously recorded in India. The first report of this species from Thailand was by Meeboon et al. (2007d). Crous & Braun (2003) noted that this species is a true *Cercospora s. str.*, close to or identical with *C. apii s. lat.*

Brassicaceae

Cercospora brassicicola Henn., Bot. Jahrb. Syst. 37: 166 (1906).

= *Cercospora brassicae-campestris* Rangel, Arq. Mus. Nac., Rio de Janeiro 18: 163 (1917).

≡ *Cercosporina brassicae-campestris* (Rangel) Sacc., Syll. Fung. 25: 899 (1931).

= *Cercospora brassicae-junceae* Sawada (*brassicae-yunciae*), Special Publ. Coll. Agric. Natl. Taiwan Univ. 8: 212 (1959) (*nom. nud.*).

= *Cercospora bloxami auct. sensu* E. Young, Mycologia 8: 43 (1916). Fig. 34

Leaf spots 2–15 mm diam., amphigenous, irregular, brown to dark brown, pale at the center, with dark margin, and limited by vein of the leaf. *Caespituli* amphigenous. *Stromata* 12.5–19.5 µm diam., substomatal to intraepidermal, small, composed of a few globose to subglobose, brown cells. *Conidiophores* 24.5–64 × 3.5–5 µm, 6–11 in loose to dense fascicles, 1–3-septate, arising from stomata, straight to decumbent, smooth, unbranched, cylindrical, geniculate near the apex, brown at the base, paler toward the apex. *Conidiogenous cells* integrated, terminal or intercalary, phyloblastic, sympodially proliferating. *Conidiogenous loci* 2.5–5 µm diam., conspicuous, thickened and

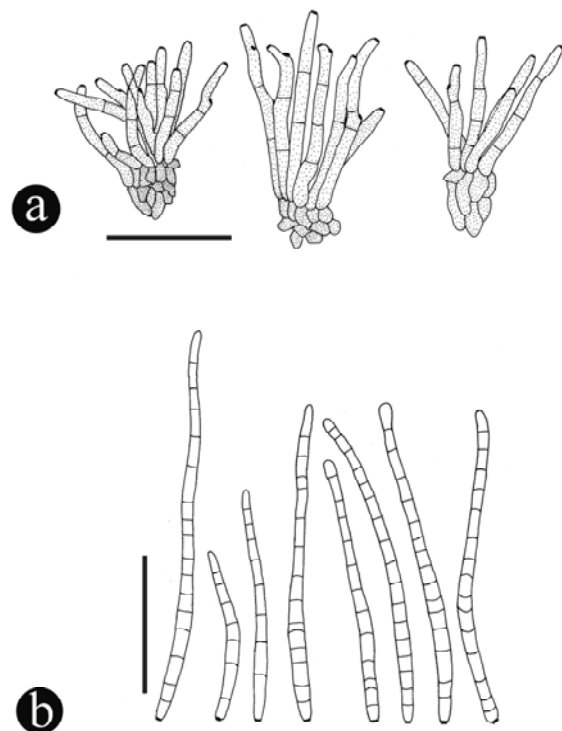


Fig. 34 – Line drawings of *Cercospora brassicicola* on *Raphanus sativus*. **a.** Conidiophores and stromata. **b.** Conidia. Bars = 50 µm. (Meeboon 2009).

darkened. *Conidia* 54–135 × 2.5–5 µm, solitary, obclavate to subacicular, straight, slightly curved, hyaline, 7–16-septate, smooth, obconically truncate at the base, tapering toward a subacute apex, hila 2.5–4.5 µm diam., thickened and darkened.

Specimens examined – THAILAND, Faculty of Agriculture, Chiang Mai University, Chiang Mai Province, on leaves of *Brassica pekinensis* Skeels (*Brassicaceae*), 31 October 2004, Jamjan Meeboon (CMU 27891); on leaves of *B. campestris* L. (*Brassicaceae*), 15 October 2004, Jamjan Meeboon (CMU 27887); on leaves of *B. rapa* L. (*Brassicaceae*), 9 November 2005, Jamjan Meeboon (CMU 27905); Suthep-Pui National Park, Chiang Mai Province, on leaves of *B. juncea* (L.) Czern. (*Brassicaceae*), 21 November 2004, Chiharu Nakashima and Jamjan Meeboon (CMU 27901); Chiang Rai Province, A. Wiang Pa Pao, on leaves of *B. oleracea* L. (*Brassicaceae*), 19 October 2005, Jamjan Meeboon (CMU 28218); Chiang Mai Province, A. Mae Rim, Nong Hoi Royal Project, on leaves of *Raphanus sativus* L. (*Brassicaceae*), 12 September 2007, Jamjan Meeboon and Iman Hidayat (BBH 23639);

same locality, on leaves of *Cichorium endivia* L. (*Asteraceae*), 6 June 2007, Jamjan Meeboon and Iman Hidayat (JMC 29).

Hosts – *Brassica alba*, *B. alboglabra*, *B. campestris*, *B. chinensis*, *integrifolia*, *juncea*, *B. kaber*, *B. napus*, *B. nigra*, *B. oleracea*, *B. pekinensis*, *B. petsai*, *B. rapa*, *Brassica* spp., *Matthiola incana*, *Raphanus sativus* (*Brassicaceae*) (Crous & Braun 2003).

Distribution – Worldwide, including Angola, Armenia, Australia, Belarus, Brazil, China, Colombia, Cuba, Dominican Republic, Estonia, Great Britain, India, Indonesia, Jamaica, Japan, Kazakhstan, Kenya, Korea, Latvia, Lithuania, Malaysia, Malawi, Mauritius, Myanmar, Nigeria, Niue, Papua, New Guinea, Peru, Philippines, Puerto Rico, Russia, Sierra Leone, South Africa, Solomon Islands, Somalia, Sri Lanka, Sudan, Taiwan, Tanzania, Thailand, Togo, Trinidad and Tobago, Togo, Uganda, Ukraine and USA (Crous & Braun, 2003).

Notes – Reports of *C. brassicicola* on *Brassica* from Thailand were published by Puckdeedindan (1966), and Petcharat & Kanjanamaneesathian (1989). *Raphanus sativus* was first reported by Meeboon (2009) as a new host of *C. brassicicola*.

Literature – Chupp (1954, p. 180).

Caricaceae

Cercospora papayae Hansf., Proc. Linn. Soc. London 155: 58 (1943).

= *Cercospora papayae* Chupp & Viégas, Arq. Mus. Nac. Rio de Janeiro 8: 42 (1945).

≡ *Cercospora mamaonis* Viégas & Chupp, Monograph of *Cercospora*: 107 (1954).

≡ *Pseudocercospora mamaonis* (Viégas & Chupp) Tak. Kobay. & Tokash., Ann. phytopath. Soc. Japan 61: 51 (1995).

(= *C. apii* s. lat.)

Fig. 35

Leaf spots 2–5 mm diam., amphigenous, scattered to confluent, distinct, circular to subcircular, pale brown, centre greyish, with dark brown margins. *Caespituli* amphigenous. *Stromata* 12–34 µm in diam., small to well-developed, often rudimentary to poorly developed, intraepidermal, composed of a few sub-globular to irregular, brown cells. *Conidiophores* 46–202 × 3–5.5 µm, very variable in

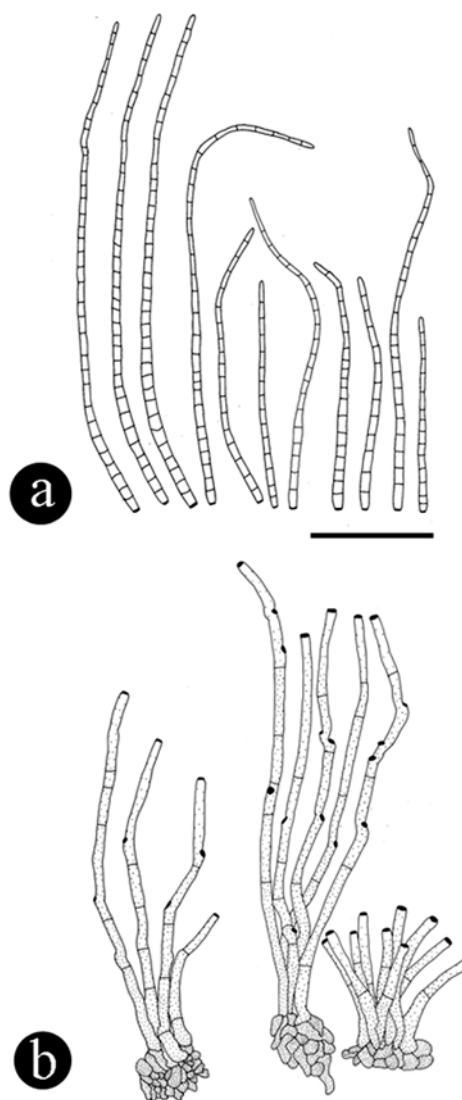


Fig. 35 – Line drawings of *C. papayae* (*C. apii* s. lat.) on *Carica papaya*. **a.** Conidia. **b.** Conidiophores and stromata. Bars = 50 µm. (Meeboon 2009).

length, 4–13 in divergent fascicles, 1–9-septate, emerging from stromata and through the cuticle, pale olivaceous brown or sometimes paler towards the apex, smooth, straight to slightly curved, mostly strongly geniculate. *Conidiogenous cells* integrated, terminal, sympodially proliferating. *Conidiogenous loci* 2.5–3.5 µm diam., conspicuous, thickened and darkened. *Conidia* 81–201 × 3–4 µm, solitary, acicular, straight to mildly curved, hyaline, 14–36-septate, smooth, obconically truncate at the base, tapering toward a subacute apex, hila, 1–2.5 µm diam., thickened and darkened.

Specimen examined – THAILAND, Chiang Mai Province, A. Sarapee, on leaves of

Carica papaya L. (*Caricaceae*), 12 September 2007, Jamjan Meeboon and Iman Hidayat (BBH 23650).

Hosts – *Carica monoica*, *C. papaya* (*Caricaceae*) (Crous & Braun 2003).

Distribution – Barbados, Brazil, Cambodia, China, Cuba, Guatemala, India, Indonesia, Malawi, Mauritius, Myanmar, Nepal, Pakistan, Panama, Papua New Guinea, Philippines, Seychelles, Somalia, Sudan, Thailand, Togo, Tonga, Uganda, USA, Venezuela, Zimbabwe (Crous & Braun 2003, Meeboon 2009).

Note – *Cercospora papayae* was first reported from Thailand by Meeboon (2009).

Literature – Chupp (1954, p. 107), Ellis (1976, p. 247).

Convolvulaceae

Cercospora citrullina Cooke Grevillea 12: 31 (1883).

= *Cercospora cucurbitae* Ellis & Everh., J. Mycol. 4: 3 (1883).

= *Cercospora sechii* J.A. Stev., Puerto Rico Agric. Exp. Sta. Rep.: 137 (1919).

= *Cercospora momordicae* McRae, Ann. Cryptog. Exot. 2: 267 (1929).

= *Cercospora trichosanthis* McRae, Ann. Cryptog. Exot. 2: 270 (1929).

= *Cercospora luffae* Hara, Diseases of cultivated plants: 228 (1928).

= *Cercospora chardoniana* Chupp, Monogr. Univ. Puerto Rico, B, 2: 245 (1934).

= *Cercospora momordicae* Mend., Philipp. J. Sci. 75: 173 (1941). (*nom. illeg.*), homonym of *C. momordicae* McRae (1929).

= *Cercospora momordicae* Sawada, Rep. Gov. Agric. Res. Inst. Taiwan 86: 173 (1943), (*nom. inval.*), homonym of *C. momordicae* McRae 1929.

(= *C. apii* s. lat.)

Fig. 36

Leaf spots 1–5 mm in diam., amphigenous, scattered to confluent, distinct, circular to subcircular, pale brown, greyish brown to greyish white at the center, with dark brown margins. *Caespituli* amphigenous. *Stromata* 7–41.5 µm in diam., small, to well-developed, irregular, composed of a few globose to subglobose, brown to dark brown cells. *Conidiophores* 62–148 × 3–5 µm, 4–12 in divergent

fascicles, 2–3-septate, emerging from stromata and through the plant cuticle, pale olivaceous brown or sometimes paler towards the apex, straight to slightly curved, unbranched, geniculate. *Conidiogenous cells* integrated, terminal, holoblastic, polyblastic, sympodially proliferating. *Conidiogenous loci* 2.5–3.5 µm diam., conspicuous, thickened and darkened. *Conidia* very variable in length, 80–240 × 3–4 µm, solitary, acicular to long obclavate, straight to mildly curved, hyaline, 9–14-septate, smooth, obconically truncate at the base, tapering toward a subacute apex, hila 2.5–3.5 µm diam., hila thickened and darkened.

Specimens examined – THAILAND, Chiang Rai Province, A. Wiang Pa Pao, T. Wiang Ga Long, Bahn Tung Ruang Tong, Moo11, on leaves of *Ipomoea nil* (L.) Roth (*Convolvulaceae*), 8 September 2007, Jamjan Meeboon (BBH 23594); Chiang Mai Province, Mae Jo, Sansai, Farming area, on leaves of *I. aquatica* Forssk. (*Convolvulaceae*), 31 July 2008, Jamjan Meeboon (BBH 23716).

Hosts – *Apadanthera sagittifolia*, *Benincasa cerifera*, *B. hispida*, *Bryoania* sp., *Bryonopsis laciniata*, *Citrullus lanatus*, *C. vulgaris*, *Citrullus* sp., *Coccinia cordifolia*, *C. indica*, *Ctenolepsis cerasiformis*, *Ctenolepsis* sp., *Cucumis anguria*, *C. callosus*, *C. maxima*, *C. melo*, *C. sativa*, *Cucurbita foetidissima*, *C. maxima*, *C. moschata*, *C. pepo*, *C. perennis*, *C. sativus*, *Lagenaria leucantha*, *L. siceraria*, *L. vulgaris*, *Luffa acutangula*, *L. aegyptiaca*, *L. amara*, *L. cylindrica*, *L. vulgaris*, *Melothria pendula*, *Momordica charantia*, *M. cochinchinensis*, *M. cordifolia*, *M. dioica*, *M. foetida*, *M. schimperiana*, *Sechium edule*, *Sicana odorifera*, *Telfaria pedata*, *Trichosamthes anguina*, *T. japonica* (*Cucurbitaceae*) (Crous & Braun 2003).

Distribution – Worldwide, where the host plants are cultivated or growing, including American Samoa, Argentina, Austria, Bangladesh, Barbados, Belize, Bolivia, Brazil, Brunei, Bulgaria, Cambodia, Canada, Chile, China, Cook Island, Costa Rica, Cuba, Czech Republic, Denmark, Dominican Republic, El Salvador, Ethiopia, Fiji, French Polynesia, Gabon, Georgia, Germany, Ghana, Great Britain, Greece, Guam, Hong Kong, India, Indonesia, Iran, Iraq, Ireland, Israel, Italy, Jamaica, Japan, Kenya, Korea, Laos,

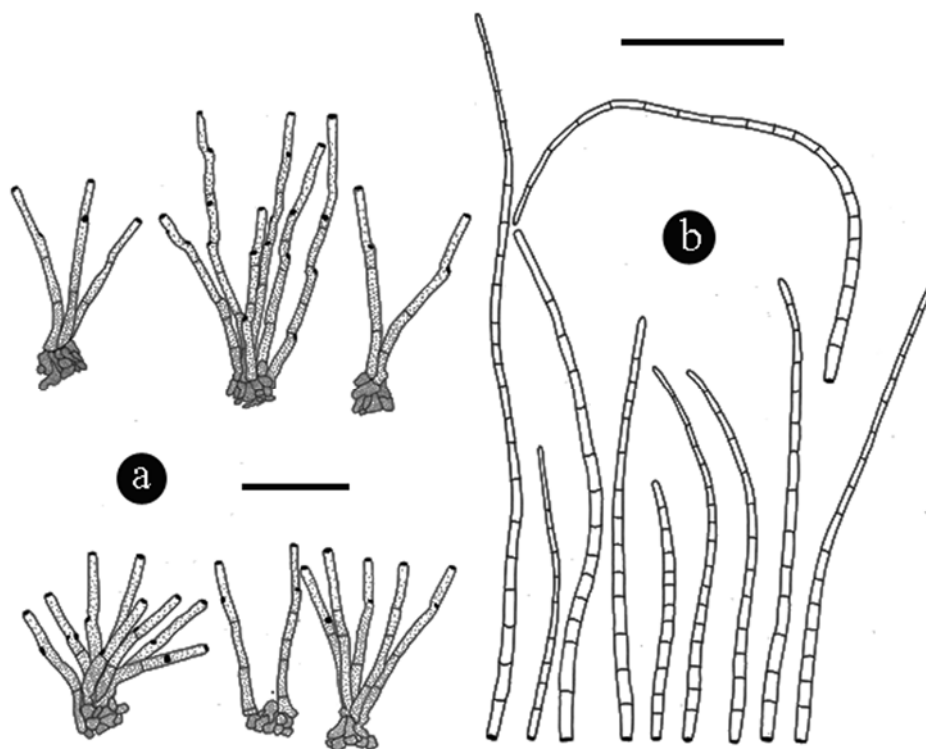


Fig. 36 – Line drawings of *Cercospora citrullina* on *Ipomoea nil*. **a.** Conidiophores and stromata. **b.** Conidia. Bars = 50 μm . (Meeboon 2009).

Malawi, Malaysia, Mauritius, Mexico, Morocco, Myanmar, Nepal, Netherlands, New Caledonia, New Zealand, Nicaragua, Nigeria, Norway, Pakistan, Panama, Papua New Guinea, Peru, Philippines, Pitcairn Island, Poland, Puerto Rico, Romania, Russia, Samoa, Saudi Arabia, Solomon Islands, Somalia, South Africa, Sri Lanka, Sweden, Switzerland, Sudan, Taiwan, Tanzania, Thailand, Togo, Tonga, Trinidad and Tobago, Uganda, Ukraine, UK, USA, Vanuatu, Venezuela, Virgin Islands, Zambia, Zimbabwe (Crous & Braun 2003).

Notes – *Ipomoea nil* is reported here as a new host of *C. citrullina*. Crous & Braun (2003) assigned this species to *C. apii* s. lat.

Literature – Chupp (1954, p. 185), Ellis (1976, p. 255).

Cercospora ipomoeae G. Winter, Hedwigia 26: 34 (1887).

= *Cercospora dichondrae* Katsuki, Ann. Phytopathol. Soc. Japan 20: 72 (1955).

(= *C. apii* s. lat.) Fig. 37

Leaf spots 15–30 mm diam., amphigenous, circular or subcircular, at first pale

greenish to ochraceous, later brown to dark brown, finally with greyish brown centre, surrounded by a dark margin. *Caespituli* amphigenous. *Stromata* 24–40 μm diam., intra-epidermal, well-developed, subglobose, brown to blackish brown. *Conidiophores* 13.5–134 \times 3–5 μm , in loose to dense fascicles, 2–3-septate, numerous, arising from stromata, simple, straight, erect to decumbent, smooth, pale yellow to pale brown, sometimes branched, subcylindrical, geniculate to sinuous. *Conidiogenous cells* integrated, terminal, holoblastic, monoblastic or polyblastic, sympodially proliferating. *Conidiogenous loci* 2–3 μm diam., conspicuous, thickened and darkened. *Conidia* 44.5–143 \times 3–3.5 μm , solitary, narrowly obclavate to subacicular, straight, hyaline, 6–15-septate, smooth, base obconically truncate, with subacute apex, hila 2–2.5 μm diam., thickened and darkened.

Specimens examined – THAILAND, Chiang Rai Province, A. Wiang Pa Pao, on leaves of *Ipomoea aquatica* Forssk. and *I. nil* (L.) Roth (*Convolvulaceae*), 9 March 2005, Jamjan Meeboon (CMU 28220 and CMU 28221); Chiang Mai Province, A. Pa Pae, Bahn

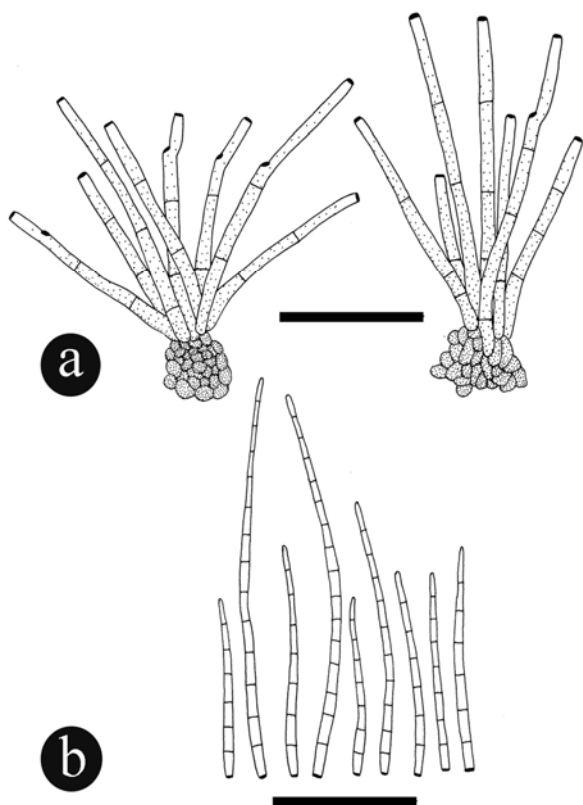


Fig. 37 – Line drawings of *Cercospora ipomoeae* on *Ipomoea obscura*. **a.** Conidiophores and stromata. **b.** Conidia. Bars = 50 μm . (Meeboon 2009).

Phadeng, Mushroom Research Centre, on leaves of *Argyreia henryi* Craib (*Convolvulaceae*), 10 November 2006, Ikumitsu Araki (CMU 27911); Chiang Mai Province, Chiang Mai University, Faculty of Agriculture, on leaves of *I. obscura* (L.) Ker Gawl. (*Convolvulaceae*), 21 August 2008, Jamjan Meeboon (BBH 23558).

Hosts – *Argyreia tiliaefolia*, *Convolvulus arvensis*, *Dichondra repens*, *Hewittia bicolor*, *Hewittia* sp., *Ipomoea acuminata*, *I. alba*, *I. aquatica*, *I. armata*, *I. asarifolia*, *I. batats*, *I. biloba*, *I. bonanox*, *I. cairica*, *I. carnea*, *I. clarensis*, *I. coccinea*, *I. cordofana*, *I. cymosa*, *I. eriocarpa*, *I. fistulosa*, *I. forsteri*, *I. hederacea*, *I. hildebrandtii*, *I. indica*, *I. kentrocarpa*, *I. lacumosa*, *I. leari*, *I. longicuspis*, *I. nil*, *I. pandurata*, *I. pes-caprae*, *pestigridis*, *I. purpurea*, *I. quamoclit*, *I. ramonii*, *I. reptans*, *I. septaria*, *I. triloba*, *I. turpethum*, *I. villosa*, *Jacquemontia tammifolia*, *Merremia chrysoides*, *M. Emarginata*, *M. Umbellata*, *Operculina* sp. (*Convolvulaceae*) (Crous & Braun 2003, Meeboon et al. 2007c).

Distribution – Worldwide, including American Samoa, Antigua and Barbuda, Argentina, Australia, Barbados, Brazil, Brunei, China, Cook Islands, Costa Rica, Cuba, Fiji, Guam, Hong Kong, India, Indonesia, Italy, Ivory Coast, Jamaica, Japan, Kenya, Kiribati, Korea, Malaysia, Marshall Islands, Mauritius, Myanmar, New Caledonia, New Zealand, Pakistan, Panama, Papua New Guinea, Puerto Rico, Samoa, Sierra Leone, Solomon Island, Sudan, Venezuela, Taiwan, Tanzania, Thailand, USA, Vanuatu (Crous & Braun 2003, Meeboon et al. 2007c).

Notes – The first report of *C. ipomoeae* on *Argyreia henryi* from Thailand was made by Meeboon et al. (2007c). Crous & Braun (2003) assigned this species to *C. apii* s.lat.

Literature – Chupp (1954, p. 171).

Cercospora operculinae Mendoza, Phiipp. J. Sci. 75: 174 (1941).

= *Cercospora operculinicola* Kamal, in herb. (IMI 367133).

(= *C. apii* s. lat.)

Fig. 38

Leaf spots 1–6 mm diam., amphigenous, distinct, circular to subcircular, brown, with dark margin. *Caespituli* amphigenous. *Stromata* 7–55 μm diam., substomatal, small to well-developed, composed of a few globose to subglobose, brown cells. *Conidiophores* 64–127.5 \times 3–5 μm , 2–7 in loose fascicles, 2–8-septate, arising from stromata, straight, unbranched, cylindrical, smooth, brown at the base, paler toward the apex, plainly geniculate. *Conidiogenous cells* integrated, holoblastic, polyblastic, rarely monoblastic, terminal, sympodially proliferating. *Conidiogenous loci* 1–2 μm diam., conspicuous, thickened and darkened. *Conidia* 22.5–96 \times 3–3.5 μm , solitary, acicular, sometimes obclavate, straight, hyaline, 6–9-septate, smooth, truncate at the base, tapering toward a subacute apex, hila 1–2.3 μm diam., conspicuous, thickened and darkened.

Specimen examined – THAILAND, Chiang Mai Province, A. Mae Taeng, on leaves of *Operculina turpethum* (L.) Silva Manso (*Convolvulaceae*), 6 February 2008, Jamjan Meeboon and Iman Hidayat (BBH 23768).

Hosts – *Operculina bufalina*, *O. riedeliana*, *O. turpethum* (*Convolvulaceae*) (Crous & Braun 2003).

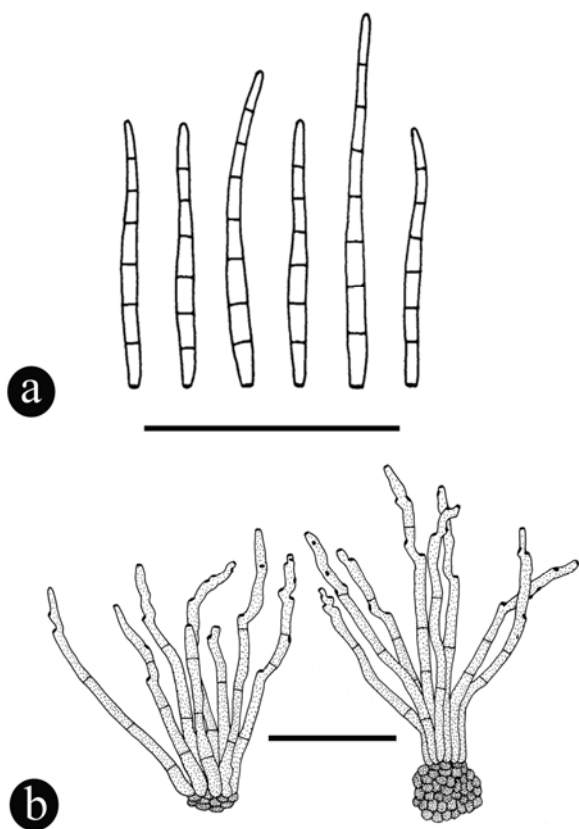


Fig. 38 – Line drawings of *Cercospora operculinae* on *Operculina turpethum*. **a.** Conidia. **b.** Conidiophores and stromata. Bars = 50 μ m. (Meeboon 2009).

Distribution – India, Papua New Guinea and Philippines (Crous & Braun 2003).

Notes – This specimen is the first report of *C. operculinae* from Thailand. Crous & Braun (2003) assigned this species to *C. apii s.lat.*

Literature – Chupp (1954, p. 172).

Cucurbitaceae

Cercospora citrullina Cooke Grevillea 12: 31 (1883).

= *Cercospora cucurbitae* Ellis & Everh., J. Mycol. 4: 3 (1883).

= *Cercospora sechii* J.A. Stev., Puerto Rico Agric. exp. Sta. Rep. 1917–1918: 137 (1919).

= *Cercospora momordicae* McRae, Ann. Cryptog. Exot. 2: 267 (1929).

= *Cercospora trichosanthi* McRae, Ann. Cryptog. Exot. 2: 270 (1929).

= *Cercospora luffae* Hara, Diseases of cultivated plants: 228 (1928).

= *Cercospora chardoniana* Chupp, Monogr. Univ. Puerto Rico, B, 2: 245 (1934).

= *Cercospora momordicae* Mend., Philipp. J. Sci. 75: 173 (1941). (*nom. illeg.*), homonym of *C. momordicae* McRae (1929).

= *Cercospora momordicae* Sawada, Rep. Gov. Agric. Res. Inst. Taiwan 86: 173 (1943), (*nom. inval.*), homonym of *C. momordicae* McRae 1929.

(= *C. apii s. lat.*)

Fig. 39

Leaf spots 5–25 mm diam., amphigenous, irregular, greyish brown, with dark brown margin. *Caespituli* amphigenous. *Stromata* 14–30 μ m diam., substomatal, small to well-developed, composed of a few globose to subglobose, brown to dark brown cells. *Conidiophores* 52–106.5 \times 2.5–5 μ m, 6–11 in loose fascicles, 2–5-septate, arising from stomata, straight, smooth, brown at the base, and paler toward the apex, unbranched, cylindrical, not geniculate. *Conidiogenous cells* integrated, holoblastic, monoblastic, terminal, sympodially proliferating. *Conidiogenous loci* 1.5–2.5 μ m diam., conspicuous, thickened and darkened. *Conidia* 63–296.5 \times 2.5–4.5 μ m, solitary, acicular, straight, hyaline, 8–26-septate, smooth, truncate at the base, tapering toward a subacute apex, hila 1.5–2 μ m diam., conspicuous, thickened and darkened.

Specimens examined – THAILAND, Chiang Rai Province, A. Wiang Pa Pao, on leaves of *Sechium edule* (Jacq.) Sw. (*Cucurbitaceae*), 19 December 2005, Jamjan Meeboon (CMU 28215); the same host, Chiang Mai Province, Faculty of Chiang Mai University, Multiple Cropping Centre, 1 August 2008, Jamjan Meeboon (BBH 23721); same locality, Faculty of Agriculture, on leaves of *Coccinia grandis* (L.) Voigt (*Cucurbitaceae*), 19 January 2005, Jamjan Meeboon (CMU 27903); *ibid*, 12 June 2007, Jamjan Meeboon (BBH 23652); Chiang Rai Province, A. Wiang Pa Pao, T. Wiang Ga Long, Moo 11, Bahn Tung Ruang Tong, on leaves of *Cucumis sativus* L. (*Cucurbitaceae*), 30 July 2007, Jamjan Meeboon (BBH 23623); Chiang Mai Province, Hang Dong, Num Phrae, Farming area, on leaves of *Lagenaria siceraria* (Molina) Standl. (*Cucurbitaceae*), 7 August 2008, Jamjan Meeboon (BBH 23591); Chiang Mai Province, Sansai, Mae Fag, on leaves of

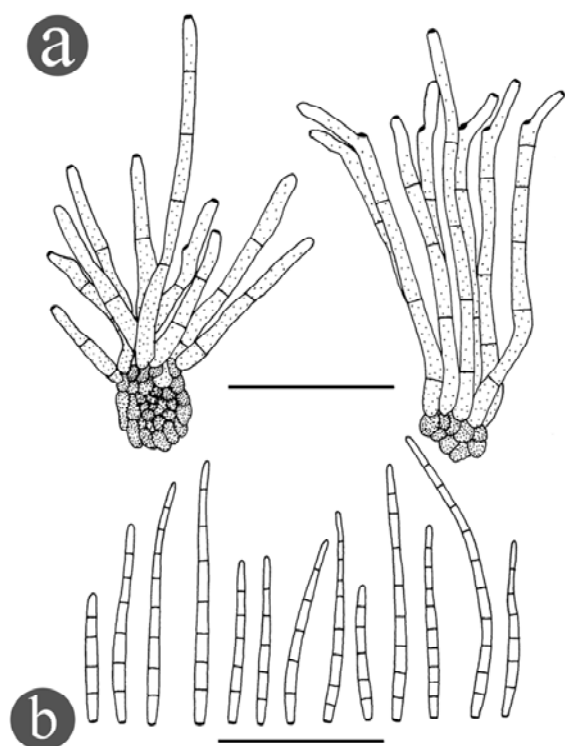


Fig. 39 – Line drawings of *Cercospora citrullina* on *Citrullus vulgaris*. **a.** Conidiophores and stromata. **b.** Conidia. Bars = 50 μ m. (Meeboon 2009).

Momordica charantia L. (*Cucurbitaceae*), 3 August 2008, Jamjan Meeboon (BBH 23754); Chiang Mai Province, Mae Jo University, Farming area, on leaves of *Citrullus vulgaris* Schrad. (*Cucurbitaceae*), 9 August 2008, Jamjan Meeboon (BBH 23703).

Hosts – *Apadhanthera sagittifolia*, *Benincasa cerifera*, *B. hispida*, *Bryoania* sp., *Bryonopsis laciniata*, *Citrullus lanatus*, *C. vulgaris*, *Citrullus* sp., *Coccinia cordifolia*, *C. indica*, *Ctenolepsis cerasiformis*, *Ctenolepsis* sp., *Cucumis anguria*, *C. callosus*, *C. maxima*, *C. melo*, *C. sativa*, *Cucurbita foetidissima*, *C. maxima*, *C. moschata*, *C. pepo*, *C. perennis*, *C. sativus*, *Lagenaria leucantha*, *L. siceraria*, *L. vulgaris*, *Luffa acutangula*, *L. aegyptiaca*, *L. amara*, *L. cylindrica*, *L. vulgaris*, *Melothria pendula*, *Momordica charantia*, *M. cochinchinensis*, *M. cordifolia*, *M. dioica*, *M. foetida*, *M. schimperiana*, *Sechium edule*, *Sicana odorifera*, *Telfaria pedata*, *Trichosamthes anguina*, *T. japonica* (*Cucurbitaceae*) (Crous & Braun 2003).

Distribution – Worldwide, where the host plants are cultivated or growing, including

American Samoa, Argentina, Austria, Bangladesh, Barbados, Belize, Bolivia, Brazil, Brunei, Bulgaria, Cambodia, Canada, Chile, China, Cook Islands, Costa Rica, Cuba, Czech Republic, Denmark, Dominican Republic, El Salvador, Ethiopia, Fiji, French Polynesia, Gabon, Georgia, Germany, Ghana, Great Britain, Greece, Guam, Hong Kong, India, Indonesia, Iran, Iraq, Ireland, Israel, Italy, Jamaica, Japan, Kenya, Korea, Laos, Malawi, Malaysia, Mauritius, Mexico, Morocco, Myanmar, Nepal, Netherlands, New Caledonia, New Zealand, Nicaragua, Nigeria, Norway, Pakistan, Panama, Papua New Guinea, Peru, Philippines, Pitcairn Island, Poland, Puerto Rico, Romania, Russia, Samoa, Saudi Arabia, Solomon Islands, Somalia, South Africa, Sri Lanka, Sweden, Switzerland, Sudan, Taiwan, Tanzania, Thailand, Togo, Tonga, Trinidad and Tobago, Uganda, Ukraine, UK, USA, Vanuatu, Venezuela, Virgin Islands, Zambia, Zimbabwe (Crous & Braun 2003).

Notes – *Sechium edule* is reported here as a new host of *C. citrullina*. *Cercospora citrullina* was previously reported from Thailand by Petcharat & Kanjanamaneesathian (1989), and Meeboon et al. (2007b) on *Coccinia grandis*. Crous & Braun (2003) considered this species as *C. apii* s. lat.

Literature – Chupp (1954, p. 185), Ellis (1976, p. 255).

Cercospora cocciniae Munjal, Lall & Chona, Indian Phytopathol. 12: 86 (1959). Fig. 40

Leaf spots 1–5 mm diam., amphigenous, scattered to confluent, distinct, circular to subcircular, pale to pale brown, greyish brown to greyish white at the center, with distinct, yellowish brown to dark brown margins. *Caespituli* epiphyllous, rarely amphigenous. *Stromata* 18–29.5 μ m diam., small, sometimes rudimentary to poorly developed, composed of a few sub-globular to irregular, brown to dark brown cells. *Conidiophores* 18–108.5 \times 3–5.5 μ m, very variable in length, 4–15 in divergent fascicles, 1–9-septate, arising from stromata through the cuticle, pale olivaceous brown, sometimes paler at the apex, straight to slightly curved, unbranched, strongly geniculate. *Conidiogenous cells* integrated, terminal, holoblastic, mostly polyblastic, sympodially proli-

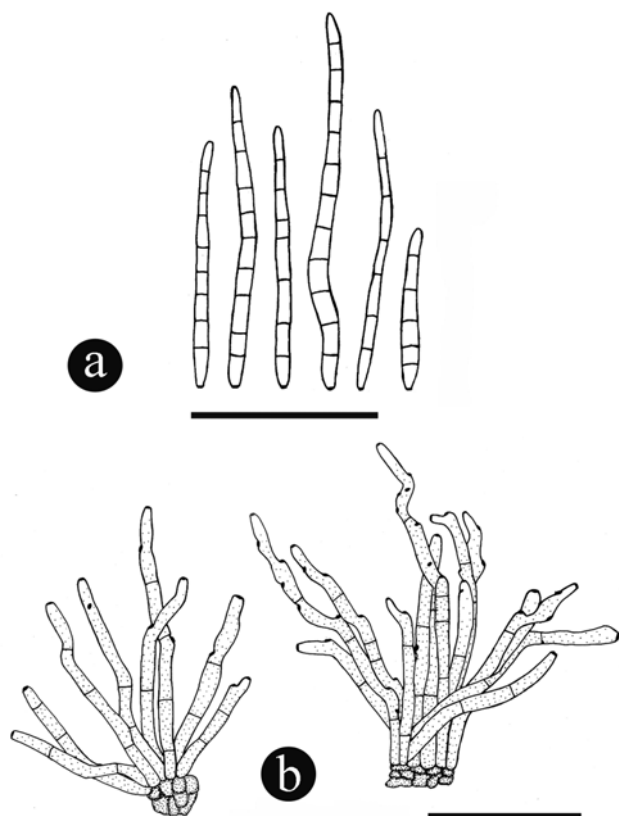


Fig. 40 – Line drawings of *Cercospora cocciniae* on *Coccinia grandis*. **a.** Conidia. **b.** Conidiophores and stromata. Bars = 50 μm . (Meeboon 2009).

ferating. *Conidiogenous loci* 1.5–2.5 μm diam., conspicuous, thickened and darkened. *Conidia* 41–102 \times 2.5–5 μm , solitary, obclavate-cylindric, straight to mildly curved, hyaline, 5–10-septate, very variable in length, smooth obconically truncate at the base, tapering toward a subacute apex, hila 1.5–2.5 μm diam., thickened and darkened.

Specimen examined – THAILAND, Chiang Mai Province, Chiang Mai University, Faculty of Agriculture, on leaves of *Coccinia grandis* (L.) Voigt (*Cucurbitaceae*), 29 February 2008, Jamjan Meeboon (BBH 23564).

Hosts – *Coccinia indica*, *Momordica charantia* (*Cucurbitaceae*) (Crous & Braun 2003), *Coccinia grandis* (Meeboon 2009).

Distribution – Brunei, India, Pakistan, Thailand (Crous & Braun 2003, Meeboon 2009).

Notes – This specimens is typical of *C. cocciniae* is having obclavate conidia. *Cercospora cocciniae* was first reported from Thailand by Meeboon (2009).

Euphorbiaceae

Cercospora acalyphae Peck, Rep. (Annual) New York State Mus. Nat. Hist. 34: 48 (1881).

= *Cercospora acalypharum* Tharp, Mycologia 9: 106 (1917).

≡ *Cercosporina acalypharum* (Tharp) Sacc., Syll. Fung. 25: 902 (1931). Fig. 41

Leaf spots 15–30 mm diam., amphigenous, circular or subcircular, symptoms at first pale greenish to ochraceous, later brown to dark brown, finally with grayish brown at the centre, surrounded by a dark margin. *Caespituli* amphigenous. *Stromata* 25–47 μm diam., intraepidermal, well-developed, composed of globose to subglobose, brown to blackish brown cells. *Conidiophores* 48.5–83.5 \times 4–6 μm , 2–8 in loose fascicles, 1–3-septate, arising from stomata, simple, straight, erect to decumbent, smooth, pale yellow to pale brown, sometimes branched, subcylindrical, slightly geniculate. *Conidiogenous cells* integrated, terminal, holoblastic, mostly monoblastic, sometimes polyblastic, sympodially proliferating. *Conidiogenous loci* 2.5–3.5 μm diam., conspicuous, thickened and darkened. *Conidia* 44–256 \times 1.5–3 μm , solitary, narrowly obclavate to subacicular, straight, hyaline, 4–18-septate, smooth, base obconically truncate, with subacute apex, hila 2–3 μm diam., thickened and darkened.

Specimens examined – THAILAND, Phetchabun Province, Nam Nao National Park, on leaves of *Acalypha wilkesiana* Mull. Arg. (*Euphorbiaceae*), 24 November 2004, Chiharu Nakashima and Jamjan Meeboon (CMU 27898); Chiang Mai Province, A. Mae Jo, Sansai, Farming area, on leaves of *A. wilkesiana*, 31 July 2008, Jamjan Meeboon (BBH 23694).

Hosts – *Acalypha alopecurioides*, *A. australis*, *A. ciliata*, *A. gracilens*, *A. grandis*, *A. hispida*, *A. indica*, *A. marginata*, *A. marvorata*, *A. ostryifolia*, *A. rhomboidea*, *A. virginica*, *A. wilkesiana*, *Acalypha* sp. (*Euphorbiaceae*) (Crous & Braun 2003, Meeboon et al. 2007c).

Distribution – Brazil, China, Cuba, India, Jamaica, Japan, Solomon Islands, Thailand, USA, Venezuela (Crous & Braun 2003, Meeboon et al. 2007c).

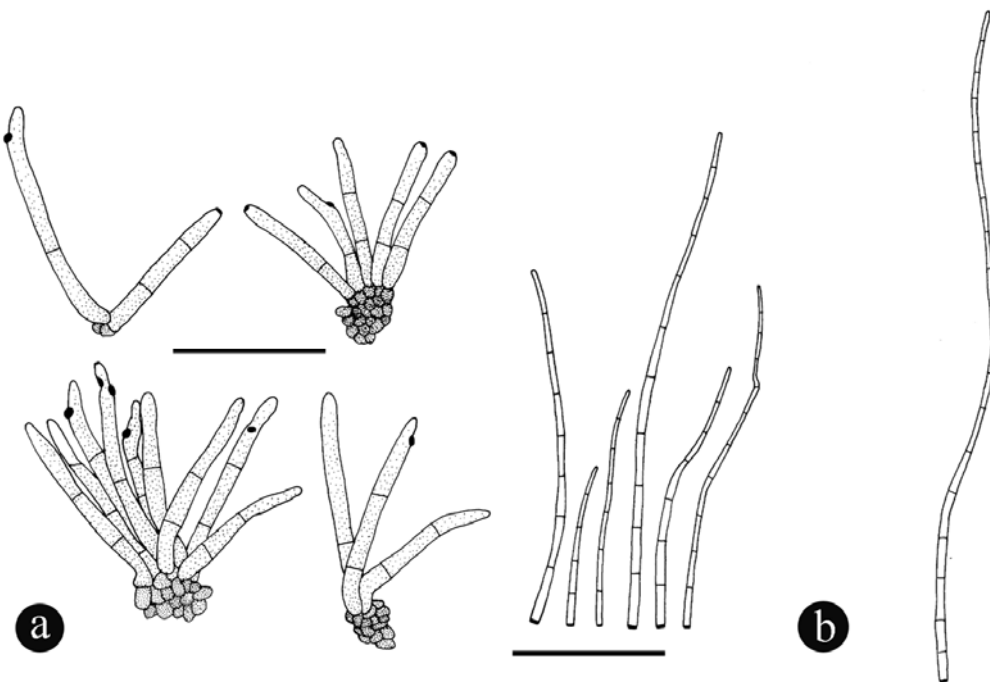


Fig. 41 – Line drawings of *Cercospora acalyphae* on *Acalypha wilkesiana*. **a.** Conidiophores and stromata. **b.** Conidia. Bars = 50 μm . (Meeboon 2009).

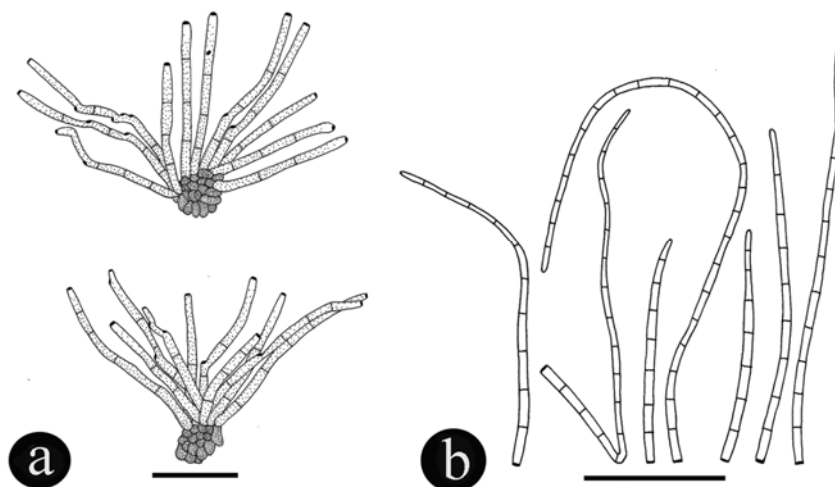


Fig. 42 – Line drawings of *Cercospora codiaeii* on *Codiaeum variegatum*. **a.** Conidiophores and stromata. **b.** Conidia. Bars = 50 μm . (Meeboon 2009)

Notes – Meeboon et al. (2007c) were the first to report this species from Thailand.

Literature – Chupp (1954, p. 200-201).

Cercospora codiaeii Gonz. Frag. & Cif., Boln de la Real Soc. Españ. Hist. Nat., Madrid 26: 199 (1926).

(= *C. apii* s. lat.)

Fig. 42

Leaf spots 2–15 mm diam., amphigenous, subcircular, solitary, pale brown, with reddish

brown margin. *Caespituli* amphigenous. *Stromata* 38–44 μm diam., small, substomatal, composed of a few globose, dark brown cells. *Conidiophores* 56–213 \times 4–5.5 μm , 5–16 in loose fascicles, 4–7-septate, arise through stromata, straight, smooth, brown at the base, paler toward the apex, unbranched, cylindrical, slightly geniculate. *Conidiogenous cells* integrated, holoblastic, polyblastic, sometimes monoblastic, terminal, sympodially proliferating. *Conidiogenous loci* 2–3 μm diam.,

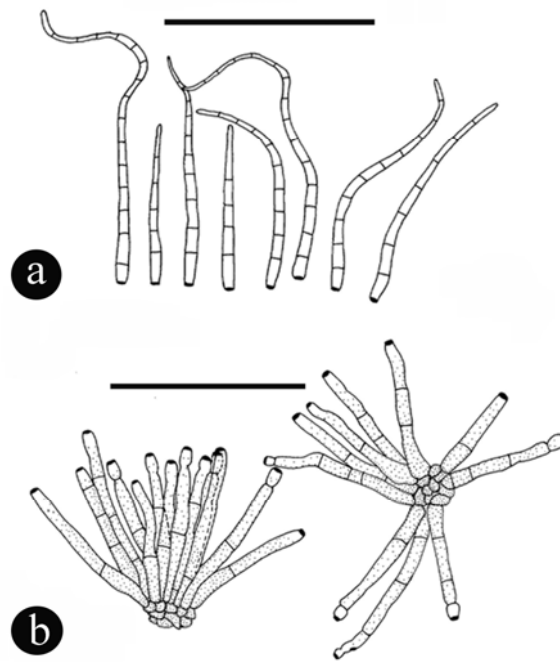


Fig. 43 – Line drawings of *Cercospora phyllanthicola* on *Phyllanthus acidus*. **a.** Conidia. **b.** Conidiophores and stromata. Bars = 50 μm . (Meeboon 2009).

conspicuous, thickened and darkened. *Conidia* 29–160 \times 3–4.5 μm , solitary, acicular, rarely obclavate, straight, hyaline, 3–10-septate, smooth, truncate at the base, with tapering toward a subacute apex, hila 1.5–2 μm diam., conspicuous, thickened and darkened.

Specimen examined – THAILAND, Chiang Mai Province, T. Suthep, A. Muang, Suthep-Pui National Park, Medicinal Plant Garden, on leaves of *Codiaeum variegatum* (L.) A. Juss. (*Euphorbiaceae*), 25 July 2008, Jamjan Meeboon and Iman Hidayat (BBH 23666).

Hosts – *Codiaeum* sp., *Codiaeum variegatum* (*Euphorbiaceae*) (Crous & Braun 2003, Meeboon 2009).

Distribution – Cuba, Dominican Republic, Nigeria, Thailand (Crous & Braun 2003, Meeboon 2009).

Notes – *Cercospora codiae* was first reported from Thailand by Meeboon (2009).

Literature – Chupp (1954, p. 200–215).

Cercospora phyllanthicola S.A. Khan & Kamal, Indian Phytopathol. 15: 296 (1962) [1963].

(= *C. apii* s. lat.)

Fig. 43

Leaf spots 2–5 mm diam., amphigenous,

irregular, brown to dark brown, pale at the center, with dark margin, and limited by vein of the leaf. *Caespituli* amphigenous. *Stromata* 15–32 μm diam., small to well-developed, substomatal to intraepidermal, composed of a few globose to subglobose, dark brown cells. *Conidiophores* 36–66 \times 3–5 μm , 8–13 in loose to dense fascicles, 1–3-septate, arising from stomata, straight to decumbent, smooth, brown at the base, paler toward the apex, cylindrical, sometime constrict at the septate, rough wall, unbranched, geniculate, mostly near the apex. *Conidiogenous cells* integrated, terminal or intercalary, holoblastic, polyblastic, sympodially proliferating. *Conidiogenous loci* 2–3 μm diam., conspicuous, thickened and darkened. *Conidia* 51–133 \times 3–4.5 μm , solitary, obclavate to acicular, straight, slightly curved, hyaline, 5–11-septate, smooth, obconically truncate at the base, tapering toward a subacute apex, hila 1–2.3 μm diam., thickened and darkened.

Specimens examined – THAILAND, Uttradit Province, A. Muang, Sak Yai National Park, on leaves of *Phyllanthus* sp. (*Euphorbiaceae*), 25 November 2004, Chiharu Nakashima and Jamjan Meeboon (CMU 27876); Chiang Rai Province, Wiang Pa Pao, on leaves of *Phyllanthus acidus* (L.) Skeels, 15 February 2008, Jamjan Meeboon (BBH 23670).

Hosts – *Phyllanthus niruri*, *Sauropus androgynus* (*Euphorbiaceae*) (Crous & Braun 2003, Meeboon et al. 2007c).

Distribution – Brunei, India, Malaysia, Myanmar, Pakistan, Singapore, Thailand (Crous & Braun 2003, Meeboon et al. 2007c).

Notes – Three species of *Cercospora* s. str., viz, *C. kirganeliicola* R.K. Srivast., S. Narayan & A.K. Srivast. (*C. apii* s. lat.), *C. phyllanthicola* (*C. apii* s. lat.), and *C. tarii* Deighton have been recorded associated with plant genus *Phyllanthus*. This specimen is very close to *C. phyllanthicola* in having simple conidiophores and acicular conidia. The first report of *C. phyllanthicola* from Thailand was by Meeboon et al. (2007c). Crous & Braun (2003) assigned this species to *C. apii* s. lat.

Fabaceae

Cercospora canescens Ellis & G. Martin, Amer. Naturalist 16: 1003 (1882).

≡ *Cercosporiopsis canescens* (Ellis & G. Martin) Miura, Flora of Manchuria and East Mongolia 3: 529 (1928).

= *Cercospora vignicaulis* Tehon, Mycologia 29: 436 (1937).

(= *C. apii* s. lat.)

Fig. 44

Leaf spots 3–20 mm diam., amphigenous, irregular, brown to dark brown, limited by vein of the leaf. *Caespituli* amphigenous. *Stromata* 26.5–67 µm diam., well-developed, intraepidermal, and composed of globose to subglobose, brown to blackish brown cells. *Conidiophores* 60.5–118 × 3–5 µm, 12–20 in loose to dense fascicles, 1–3-septate, straight to decumbent, cylindrical, smooth, brown at the base, and paler toward the apex, unbranched, geniculate to sinuous. *Conidiogenous cells* 12–35.5 × 3–5 µm, integrated, terminal, holoblastic, polyblastic, sometimes monoblastic, sympodially proliferating. *Conidiogenous loci* 1.5–3 µm diam., conspicuous, thickened and darkened. *Conidia* 56–113.5 × 3–4.5 µm, solitary, narrowly obclavate to subacicular, straight, hyaline, 3–9-septate, smooth, obconically truncate at the base, tapering toward a subacute apex, hila 2–3 µm diam., thickened and darkened.

Specimens examined – THAILAND, Chiang Rai Province, A. Wiang Pa Pao, T. Wiang Ga Long, Moo11, Bahn Tung Ruang

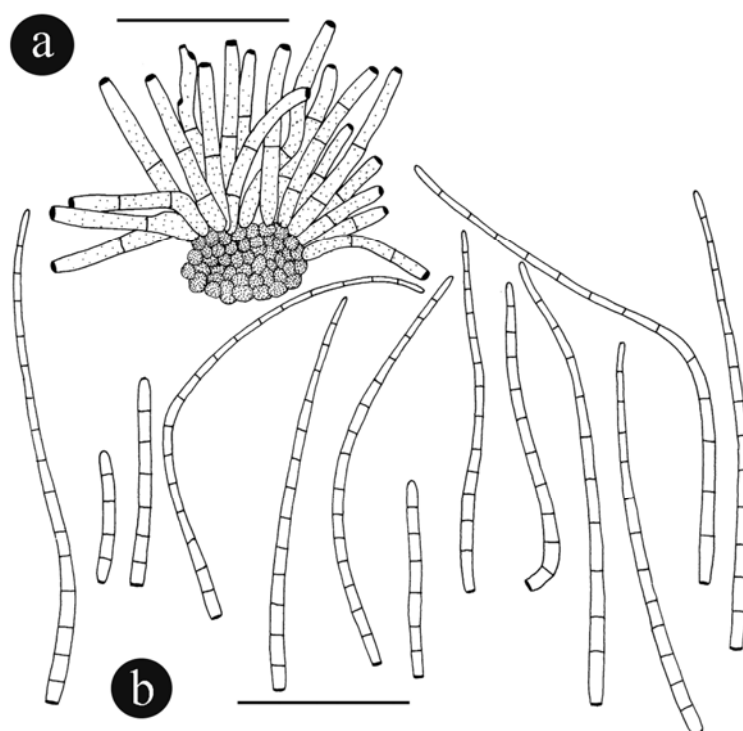


Fig. 44 – Line drawings of *Cercospora canescens* on *Dolichos lablab*. **a.** Conidiophores and stroma. **b.** Conidia. Bars = 50 µm. (Meeboon 2009).

Tong, on leaves of *Vigna radiata* (L.) R. Wilczek, 25 October 2005, Jamjan Meeboon (CMU 27888); the same locality, on leaves of *V. unguiculata* var. *sesquipedalis* (Fabaceae), 18 November 2005, Jamjan Meeboon (CMU 27894); same locality, on leaves of *Lablab purpureus* (L.) Sweet (Fabaceae), 16 July 2007, Jamjan Meeboon (BBH 23624); Chiang Mai Province, San Sai, Mae Fag, 3 August 2008, Jamjan Meeboon (BBH 23749); on leaves of *Psophocarpus tetragonolobus* DC. (Fabaceae), 31 July 2007, Jamjan Meeboon (JM 104); on leaves of *Dolichos lablab* L. (Fabaceae), 25 July 2008, Jamjan Meeboon (BBH 23773); Chiang Mai Province, A. Mae Rim, Nong Hoi Royal Project, on leaves of *V. unguiculata* (L.) Walp. (Fabaceae), 27 September 2007, Jamjan Meeboon and Iman Hidayat (BBH 23678); Chiang Mai Province, Chiang Mai University, Multiple Cropping Centre, on leaves of *V. unguiculata*, 1 August 2008, Jamjan Meeboon (BBH 23722).

Hosts – *Amaranthus* sp., *Celosia argentea* (Amaranthaceae), *Annona odorata*, *A. squarrosa* (Annonaceae), *Rauvolfia serpentina* (Apocynaceae), *Verschaffeltia splendida* (Arecaceae), *Aster novibelgii* (Asteraceae), *Bixa orellana* (Bixaceae), *Raphanus sativus* (Brassicaceae), *Rhynchosia aurea*, *R. minima*, *Ricinus communis* (Euphorbiaceae), *Arachis hagenbeckii*, *A. hypogaea*, *Alysicarpus* sp., *Bauhinia alba*, *B. variegata*, *Cajanus cajan*, *Calopogonium mucunoides*, *Canavalia ensiformis*, *C. gladiata*, *C. maritima*, *Cassia alata*, *C. lathyroides*, *Cassia* sp., *Centrosema acutifolium*, *C. arenarium*, *C. brasilianum*, *C. macrocarpum*, *C. plumieri*, *C. pubescens*, *C. virginianum*, *Clitoria ternatea*, *Codariocalyx gyroides*, *Crotalaria juncea*, *C. mucronata*, *C. mysorensis*, *C. retusa*, *C. spectabilis*, *C. usaramoensis*, *C. verrucosa*, *C. zanzibarica*, *Crotalaria* spp., *Cyamopsis psoralioides*, *Desmodium canum*, *D. gyrans*, *D. gyroides*, *D. incanum*, *D. intortum*, *D. lycioides* subspecies *guerkei*, *D. repandum*, *D. turtuosum*, *D. uncinatum*, *Dolichos biflorus*, *D. daltonii*, *D. lablab*, *D. lignosus*, *D. trilobus*, *D. turtuosum*, *D. uniflorus*, *Erythrina addisoniae*, *E. suberosa*, *E. subumbrans*, *E. variegata*, *Flemingia macrophylla*, *Gliricidia sepium*, *Glycine max*, *G. soja*, *G. ussuriensis*, *G. wightii*, *Heylandia latebrosa*, *Indigofera astragalina*,

Kotschya sp., *Lablab niger*, *L. purpureus*, *Lespedeza* sp., *Lathyrus odoratus*, *Leucaena leucocephala*, *Lotononis bainesii*, *Lupinus* sp., *Macroptilium atropurpureum*, *M. lathyroides*, *M. daltonii*, *M. uniflorum*, *Medicago sativa*, *Mimosa invisa*, *Mucuna pruriens*, *Neonotonia wightii*, *Phaseolus aconitifolius*, *P. angularis*, *P. atropurpureus*, *P. aureus*, *P. calcaratus*, *P. lathyroides*, *P. limensis*, *P. lunatus*, *P. minimus*, *P. panduratus*, *P. radiatus*, *P. trilobus*, *P. vulgaris*, *Pistia stratiotes*, *Pisum sativum*, *Psophocarpus tetragonolobus*, *Psoralea bituminosa*, *P. drupacea*, *Pterocarpus marsupia*, *Pueraria hirsuta*, *P. lobata*, *P. phaseoloides*, *P. trilobam*, *Quercus* sp., *Senna alata*, *S. tora*, *Shutteria involucrata*, *Stylosanthes guianensis*, *S. humilis*, *Vicia unguiculata*, *Vigna angularis*, *V. catjang*, *V. luteola*, *V. marina*, *V. mungo*, *V. parkeri*, *V. radiata*, *V. repens*, *V. reticulata*, *V. sesquipedalis*, *V. sinensis*, *V. umbellata*, *V. vexillata*, *Vitis vinifera*, *Voandzeia subterranea* (Fabaceae), *Coleus* sp., *Ocimum basilicum*, *Plectranthus* sp. (Lamiaceae), *Tetramnus labialis*, *T. uncinatus* (Malphiaceae), *Artocarpus integrifolia* (Moraceae), *Boerhavia erecta*, *Commicarpus* sp. (Nyctaginaceae), *Lycopersicon esculentum*, *Solanum laciniatum* (Solanaceae) (Crous & Braun 2003).

Distribution – Worldwide, wherever the crop is cultivated, including Australia, Bangladesh, Barbados, Brazil, Bolivia, Brunei, Cambodia, China, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, Fiji, Georgia, Ghana, Guyana, Haiti, Hong Kong, India, Indonesia, Iran, Japan, Kenya, Korea, Malawi, Malaysia, Malawi, Mauritius, Myanmar, Nepal, New Caledonia, New Zealand, Nigeria, Pakistan, Panama, Papua New Guinea, Peru, Philippines, Puerto Rico, Russia, Senegal, Sierra Leone, Solomon Islands, Somalia, South Africa, Saint Vincent and the Grenadines, Sudan, Tadjikistan, Taiwan, Tanzania, Trinidad and Tobago, Togo, Uganda, USA, Uzbekistan, Vanuatu, Venezuela, Virgin Islands, Zambia, Zimbabwe (Crous & Braun 2003).

Notes – This species was first reported from Thailand by Sontirat et al. (1980) on *V. radiata*. Crous & Braun (2003) assigned this species to *C. apii* s. lat.

Literature – Chupp (1954, p. 288), Meeboon (2009).

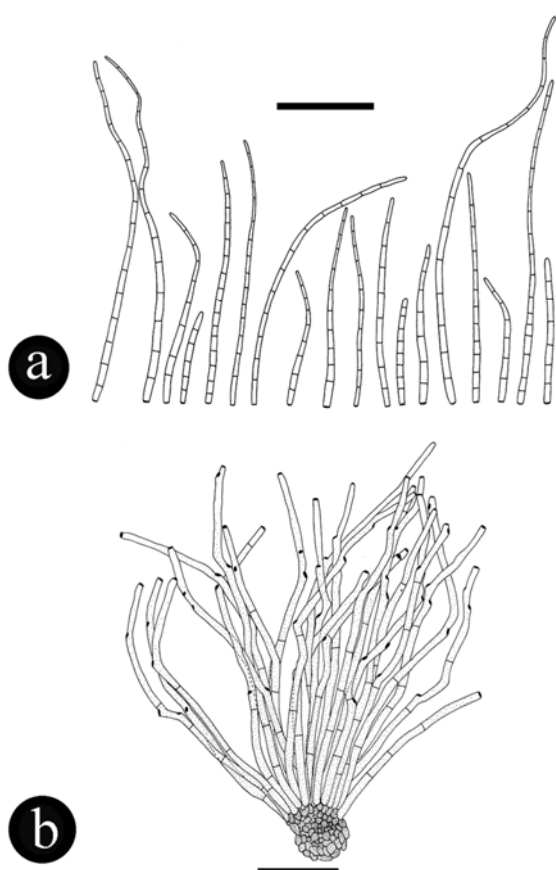


Fig. 45 – Line drawings of *Cercospora crotalariae* on *Crotalaria montana*. **a.** Conidia. **b.** Conidiophores and stroma. Bars: **a** = 40 μm , **b** = 50 μm . (Meeboon 2009).

Cercospora crotalariae Sacc., Syll. Fung. 22: 129 (1913).

= *Cercospora crotalariae-junceae* Sawada, J. Taihoku Soc. Agric. 7: 27 (1942) (*nom. inval.*).

(= *C. apii* s. lat.)

Fig. 45

Leaf spots 1–9 mm diam., amphigenous, scattered to confluent, subcircular to angular, pale brown at the young symptoms, later becoming greyish brown, greyish to pale at the centre, with reddish brown or purplish brown margins. *Caespituli* amphigenous. *Stromata* 25–30.75 μm diam., intraepidermal, small to well-developed, composed of globose to subglobose, brown to blackish brown cells. *Conidiophores* 35–231 \times 3.5–5.5 μm , numerous in dense fascicles, 2–6-septate, arising from stromata, simple, straight, unbranched, erect to decumbent, smooth, pale yellow to pale brown, subcylindrical, geniculate to sinuous. *Conidiogenous cells* integrated, termi-

nal, holoblastic, mostly polyblastic, sympodially proliferating. *Conidiogenous loci* 2.5–3.5 μm diam., conspicuous, thickened, and darkened. *Conidia* 39–206 \times 2–4 μm , solitary, narrowly obclavate to subacicular, straight, hyaline, 5–17-septate, smooth, base obconically truncate, with subacute apex, hila 2.5–3.5 μm diam., thickened and darkened.

Specimen examined – THAILAND, Chiang Mai Province, Mae Jo University, Farming area, on leaves of *Crotalaria montana* Heyne ex Roth (*Fabaceae*), 9 August 2008, Jamjan Meeboon (BBH 23708).

Hosts – *Crotalaria incana*, *C. juncea*, *C. montana*, *C. mucronata*, *C. retusa*, *C. sericeum*, *C. spectabilis*, *C. striata*, *C. stricta*, *C. Usaramoensis*, *Crotalaria* sp. (*Fabaceae*) (Crous & Braun 2003, Meeboon 2009).

Distribution – Bangladesh, China, Cuba, Ethiopia, India, Indonesia, Pakistan, Papua New Guinea, Puerto Rico, Sri Lanka, Taiwan, Thailand, Venezuela (Crous & Braun 2003, Meeboon 2009).

Notes – *Cercospora crotalariae* was first recorded from Thailand by Meeboon (2009). Crous & Braun (2003) assigned this species as *C. apii* s. lat.

Cercospora kikuchii T. Matsumoto & Tomoy., Ann. Phytopathol. Soc. Japan 1: 1 (1925).

≡ *Cercospora kikuchii* T. Matsumoto & Tomoy., *l.c.*: 10.

≡ *Cercospora kikuchii* (T. Matsumoto & Tomoy.) M.W. Gardner, Proc. Indian Acad. Sci. 36: 12 (1927) (*comb. superfl.*).

(= *C. apii* s. lat.)

Fig. 46

Leaf spots 1–9 mm diam., amphigenous, scattered to confluent, subcircular to angular, initially appearing pale brown, later becoming tan to dingy grey, greyish white at the centre, with reddish brown or purplish brown margins. *Caespituli* hypophyllous. *Stromata* 26–39 μm diam., intraepidermal, well-developed, composed of globose to subglobose, brown to blackish brown cells. *Conidiophores* 76–129 \times 3.5–5 μm , 9 to numerous in dense and divergent fascicles, 2–4-septate, arising from stromata, simple, straight, erect to decumbent, smooth, pale yellow to pale brown, sometimes branched, subcylindrical, geniculate to sinuous. *Conidiogenous cells* integrated, terminal, holo-

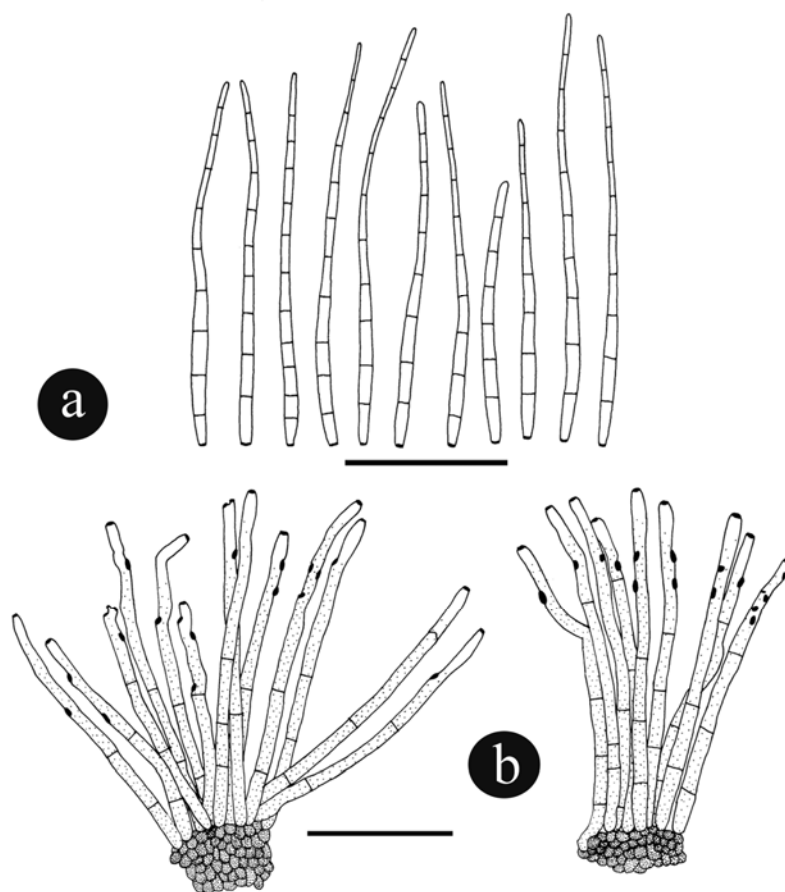


Fig. 46 Line drawings of *Cercospora kikuchii* on *Glycine max*. **a.** Conidia. **b.** Conidiophores and stromata. Bars = 50 μm . (Meeboon 2009).

blastic, monoblastic or polyblastic, sympodially proliferating. *Conidiogenous loci* 2–3 μm diam., conspicuous, thickened and darkened. *Conidia* 80–132 \times 3–3.5 μm , solitary, narrowly obclavate to subacicular, straight, hyaline, 6–11-septate, smooth, base obconically truncate, with subacute apex, hila 2–2.5 μm diam., thickened and darkened.

Specimens examined – THAILAND, Chiang Mai Province, Chiang Mai University, on leaves of *Glycine max* Merr. (*Fabaceae*), 21 November 2004, Jamjan Meeboon (CMU 27878); Chiang Mai Province, Mae Jo University, Farming area, on same host, 9 August 2008, Jamjan Meeboon (BBH 23707).

Hosts – *Cassia obtusifolia*, *Cyamopsis tetragonoloba*, *Dolichos biflorus*, *Glycine hispida*, *G. max*, *G. soja*, *G. tabacina*, *G. ussuriensis*, *Phaseolus aureus*, *P. lunatus*, *P. mungo*, *Senna* sp., *Vigna prainiana* (*Fabaceae*) (Crous & Braun 2003).

Distribution – Worldwide where the host is cultivated, including Argentina, Bangladesh, Bolivia, Brazil, Brunei, Burkina Faso,

Cameroon, Canada, China, Colombia, Cuba, Egypt, Ethiopia, Fiji, France, Gabon, Ghana, Guinea, India, Indonesia, Iran, Jamaica, Japan, Korea, Liberia, Malaysia, Mexico, Mozambique, Nepal, New Caledonia, Nigeria, Pakistan, Panama, Papua New Guinea, Peru, Puerto Rico, Russia, Sierra Leone, Somalia, South Africa, Sri Lanka, Taiwan, Tanzania, Thailand, Togo, Trinidad and Tobago, Uganda, Zambia, Zimbabwe (Crous & Braun 2003).

Note – The first record of this species from Thailand was by Sontirat et al. (1980). Crous & Braun (2003) assigned this species to *C. apii* s.lat.

Literature – Chupp (1954, p. 313).

Hydrangeaceae

Cercospora hydrangeae Ellis & Everh., J. Elisha Mitch. Sci. Soc. 8: 52 (1892).

= *Cercosporina hydrangeicola* Speg., Anales Mus. Nac. Buenos Aires 20: 426 (1910).

≡ *Cercospora hydrangeicola* (Speg.) Vassiljevsky, in Vassiljevsky & Karakulin,

Fungi imperfecti parasitici 1. Hyphomycetes: 339 (1937).

= *Cercospora hydrangeana* Tharp, Mycologia 9: 110 (1917).

≡ *Cercosporina hydrangeana* (Tharp) Sacc., Syll. Fung. 25: 915 (1931).

= *Cercospora arborscentis* Tehon & E. Daniels, Mycologia 17: 246 (1925).

(= *C. apii* s. lat.) Fig. 47

Leaf spots 3–15 mm diam., amphigenous, irregular, pale olivaceous to light brown, centre greyish brown to greyish white with purplish brown to dark brown margins. *Caespituli* amphigenous. *Stromata* lacking. *Conidiophores* 111–227 × 3.5–5 µm, 3–11 in loose fascicles, 1–3-septate, straight to decumbent, unbranched, smooth, very dark brown at the base, and paler toward the apex, cylindrical, strongly geniculate. *Conidiogenous cells* integrated, holoblastic, polyblastic, sometimes monoblastic when young, sympodially proliferating. *Conidiogenous loci* 2–3 µm diam., conspicuous, thickened and darkened. *Conidia* 113–278 × 2.5–3.5 µm, acicular, hyaline, 13–27-septate, solitary, slightly curved at the apex, base obconically truncate, hila 1.5–2.5 µm diam., conspicuous, thickened and darkened.

Specimens examined – THAILAND, Chiang Mai Province, Suthep-Pui National Park, on leaves of *Hydrangea macrophylla* (Thunb.) Ser. (*Hydrangeaceae*), 21 November 2004, Jamjan Meeboon (CMU 27921); Chiang Mai Province, Sanpatong District, Mae Wang Sub-district, T. Mae Win, Bahn Mae Sapok, Mae Sapok Royal Project, on same host, 8 February 2008, Jamjan Meeboon and Iman Hidayat (BBH 23567).

Hosts – *Hydrangea angustisepala*, *H. arborescens*, *H. hortensis*, *H. macrophylla*, *H. opuloides*, *H. paniculata*, *H. serrata*, *Hydrangea* sp. (*Hydrangeaceae*) (Crous & Braun 2003).

Distribution – Argentina, Borneo, Brazil, Brunei, China, Hong Kong, India, Iran, Japan, Korea, Malawi, Malaysia, Myanmar, Nigeria, Philippines, Puerto Rico, Romania, Russia (Asian part), Sabah, Sierra Leone, Singapore, Taiwan, Thailand, USA, Virgin Islands, Zimbabwe (Crous & Braun 2003).

Notes – The first record of this species from Thailand was by Petcharat &

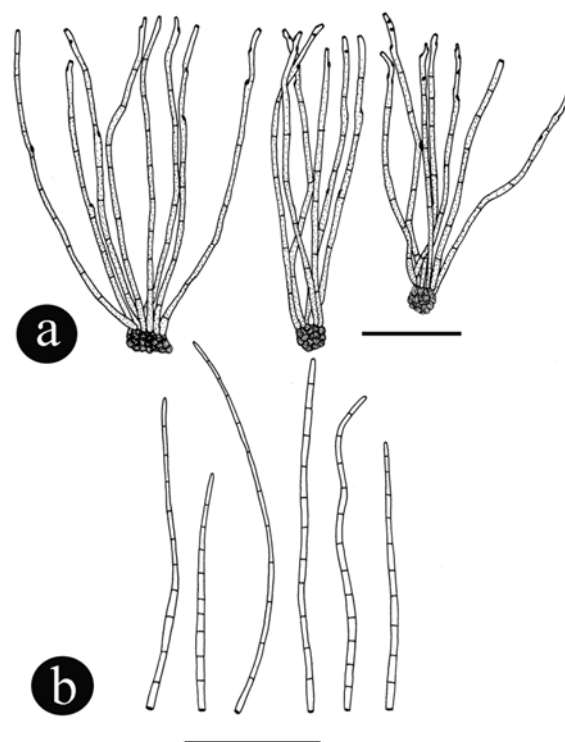


Fig. 47 – Line drawings of *Cercospora hydrangeae* on *Hydrangea macrophylla*. **a.** Conidiophores and stromata. **b.** Conidia. Bars = 50 µm. (Meeboon 2009).

Kanjanamaneesathian (1989), but they did not give any detailed morphological description and illustration for this fungus. Braun (2000) assigned this species to *C. apii* s. lat.

Literature – Chupp (1954, p. 517).

Lamiaceae

Cercospora kabatiana Allesch. ex Lindau, Rabenh. Krypt.- Fl. ed. 2, 9: 130 (1910).

≡ *Cercospora kabatiana* (Allesch. ex Lindau) Moesch, Magyar Biol. Kutatóint. Munkái 3: 115 (1930). Fig.48

Leaf spots 15–30 mm diam., amphigenous, circular or subcircular, at first pale greenish to ochraceous, later become dull brown, finally with pale to greyish white at the centre, surrounded by a dark margin. *Caespituli* amphigenous. *Stromata* lacking. *Conidiophores* 78–185 × 3–5 µm, numerous in loose fascicles, 2–5-septate, arising from stromata, simple, straight, erect to decumbent, smooth, pale yellow to pale brown, rarely branched, subcylindrical, geniculate. *Conidiogenous cells*

integrated, terminal, holoblastic, polyblastic, sympodially proliferating. *Conidiogenous loci* 2.5–3 µm diam., conspicuous, thickened and darkened. *Conidia* 95–144 × 2.5–4 µm, solitary, narrowly obclavate to subacicular, straight, hyaline, 7–12-septate, smooth, base truncate, with subacute apex, hila 2–2.5 µm diam., thickened and darkened.

Specimen examined – THAILAND, Chiang Mai Province, Chiang Mai University, on leaves of *Solenostemon scutellarioides* (L.) Codd (*Lamiaceae*), 1 August 2008, Jamjan Meeboon (BBH 23583).

Hosts – *Lamium amplexicaule*, *L. galeobdolon*, *L. maculatum*, *L. montanum*, *L. nepetaefolia*, *Leonotis* sp., *Solenostemon scutellarioides* (*Lamiaceae*) (Crous & Braun 2003, Meeboon 2009).

Distribution – Armenia, Austria, Czech Republic, Lesotho, USA, Thailand (Crous & Braun 2003, Meeboon 2009).

Notes – This specimen is a typical of *C. apii* s. lat. by having slight or lacking stromata, long conidiophores, and hyaline and long acicular conidia, with truncate base. *Cercospora kabatiana* was assigned to *C. apii* s. lat. by Crous & Braun (2003). This species was first reported from Thailand by Meeboon (2009).

Literature – Chupp (1954, p. 266).

Cercospora physostegiae Jenkins, *Phytopathology* 35: 329 (1945) Fig. 49

Leaf spots 1–8 mm diam., amphigenous, solitary, sometimes clustered to form larger spots, circular to subcircular, sometimes irregular, greyish brown, with dark brown margin, limited by leaf veins. *Caespituli* amphigenous. *Stromata* 14–30 µm diam., small to well-developed, substomatal, composed of a few globose to subglobose, brown-walled cells. *Conidiophores* 20–70 × 3–6 µm, 6–14 in loose fascicles, 1–3-septate, arising through stromata, straight, smooth, brown at the base, and paler toward the apex, unbranched, cylindrical, often not geniculate, very rarely geniculate. *Conidiogenous cells* integrated, terminal, holoblastic, mostly monoblastic, sympodially proliferating. *Conidiogenous loci* 2–3 µm diam., conspicuous, thickened, and darkened. *Conidia* 20–129 × 2–4 µm, solitary, obclavate-filiform

to acicular, straight, hyaline, 12–19-septate, smooth, truncate at the base, tapering toward a subacute apex, hila 1.5–2 µm diam., conspicuous, thickened, and darkened.

Specimen examined – THAILAND, Chiang Mai Province, Royal Flora, on leaves of *Clerodendrum paniculatum* L. (*Lamiaceae*), 13 February 2008, Jamjan Meeboon and Iman Hidayat (BBH 23579).

Hosts – *Clerodendrum paniculatum*, *Physostegia virginiana* (*Lamiaceae*) (Chupp 1954, Meeboon 2009).

Distribution – Thailand, USA (Meeboon 2009, Chupp 1954).

Notes – Four species of *Cercospora* s. str. non *C. apii* s. lat. have been reported from the plant family *Lamiaceae*, viz, *C. isanthi* Ellis & Kellerm., *C. physostegiae*, *C. scorodoniae* Unamuno, and *C. teucarii* Ellis & Kellerm. All these species are characterized by relatively short conidiophores and amphigenous caespituli (Chupp 1954). This specimen is similar to *C. physostegiae* due to the conidiophores often not geniculate and obclavate conidia with an obconically truncate base. The other three species are characterized by acicular conidia and geniculate conidiophores. *Cercospora physostegiae* was firstly reported from Thailand by Meeboon (2009).

Literature – Chupp (1954, p. 270–271).

Cercospora volkameriae Speg., *Revista del Museo de La Plata* 15: 47 (1908).

(= *C. apii* s. lat.)

Fig. 50

Leaf spots 2–5 mm diam., amphigenous, circular or subcircular, limited by vein, often greyish at the centre, brown with a dark reddish margin. *Caespituli* epiphyllous. *Stromata* 12–32 µm diam., intraepidermal, small to well-developed, composed of globose to subglobose, brown to blackish brown cells. *Conidiophores* 36–127.5 × 2.5–4 µm, 8–10 in loose and divergent fascicles, 2–4-septate, arising from stromata, erect to decumbent, smooth, pale yellow to pale brown, straight, rarely branched, subcylindrical, geniculate to sinuous. *Conidiogenous cells* integrated, terminal to intercalary, holoblastic, polyblastic, sympodially proliferating. *Conidiogenous loci* 2.5–3 µm diam., conspicuous, thickened and darkened. *Conidia* 40–87 × 2–3 µm, solitary, narrowly obclavate

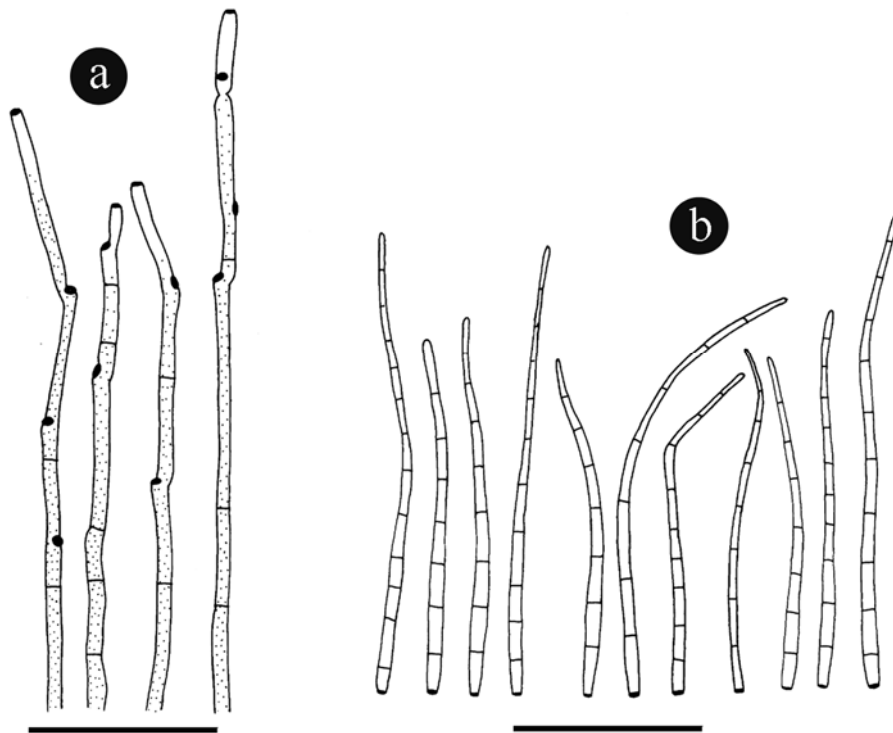


Fig. 48 – Line drawings of *Cercospora kabatiana* on *Solenostemon scutellarioides*. **a.** Apical part of conidiophores. **b.** Conidia. Bars = 50 μ m. (Meeboon 2009).

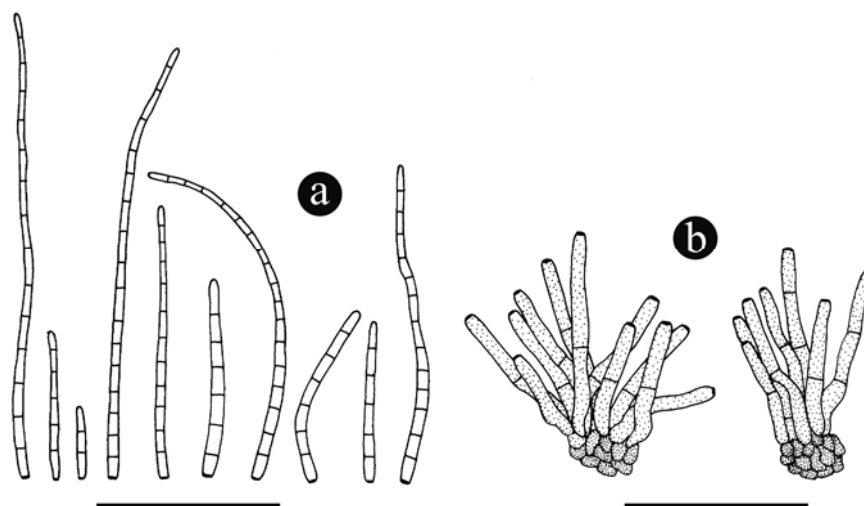


Fig. 49 – Line drawings of *Cercospora physostegiae* on *Clerodendrum paniculatum*. **a.** Conidia. **b.** Conidiophores and stromata. Bars: **a, b** = 50 μ m. (Meeboon 2009).

to subacicular, 3–10-septate, straight, hyaline, smooth, base obconically truncate, with subacute apex, hila 2–2.5 μ m diam., thickened and darkened.

Specimen examined – THAILAND, Chiang Mai Province, Royal Flora, on leaves

of *Clerodendrum fragrans* Willd. (*Lamiaceae*), 27 July 2008, Jamjan Meeboon (BBH 23763).

Hosts – *Clerodendrum cordifolium*, *C. fragrans*, *C. indicum*, *C. infortunatum*, *C. paniculatum*, *C. scandens*, *C. schweinfurthii*, *C. siphonatus*, *C. speciosissimum*, *C. speciosum*,

C. splendens, *C. thomsonae*, *C. trichotomum*, *C. volubile*, *Gmelina arborea* (*Lamiaceae*) (Crous & Braun 2003, Meeboon et al. 2007c).

Distribution – Barbados, Brazil, Brunei, Cuba, Ghana, Guinea, India, Indonesia, Jamaica, Korea, Malawi, Malaysia, Nepal, Nigeria, Sierra Leone, Singapore, Sudan, Taiwan, Tanzania, Thailand, Togo (Crous & Braun 2003, Meeboon et al. 2007c).

Notes – The morphological characteristics of this specimen are close to *C. volkameriae*. The first report of *C. volkameriae* from Thailand was by Meeboon et al. (2007c). Crous & Braun (2003) considered this species as *C. apii* s.lat.

Literature – Chupp (1954, p. 597).

Malvaceae

Cercospora althaeina Sacc. *Michelia* 1: 269 (1878).

= *Cercospora kellermanii* Bubák, *J. Mycol.* 9: 3 (1903).

= *Cercospora ramularia* Siemaszko, *Izv. Kavkazsk. Muz.* 12: 28 (1919) and *Arch. Nauk Biol. Towarz. Nauk. Warszawsk.* 1: 49 (1923).

≡ *Cercosporina ramularia* (Siemaszko) Sacc., *Syll. Fung.* 25: 910 (1931).

= *Cercospora althaeina* var. *praecincta* Davis, *Trans. Wisconsin. Acad. Sci.* 18: 260 (1915).

≡ *Cercospora praecincta* (Davis) Chupp, *Monograph of Cercospora*: 376 (1954).

= *Cercospora althaeina* var. *althaeae-officinalis* Sävul. & Sandu, *Hedwigia* 73: 127 (1933).

= *Cercospora althaeicola* J.M. Yen & S.K. Sun, *Cryptog. Mycol.* 4: 189 (1983).

Fig. 51

Leaf spots 1–5 mm diam., amphigenous, dark to yellowish, only leaf decoloration. *Caespituli* amphigenous. *Stromata* 12–36 µm diam., substomatal, small, composed of a few globose to subglobose, brown to blackish brown

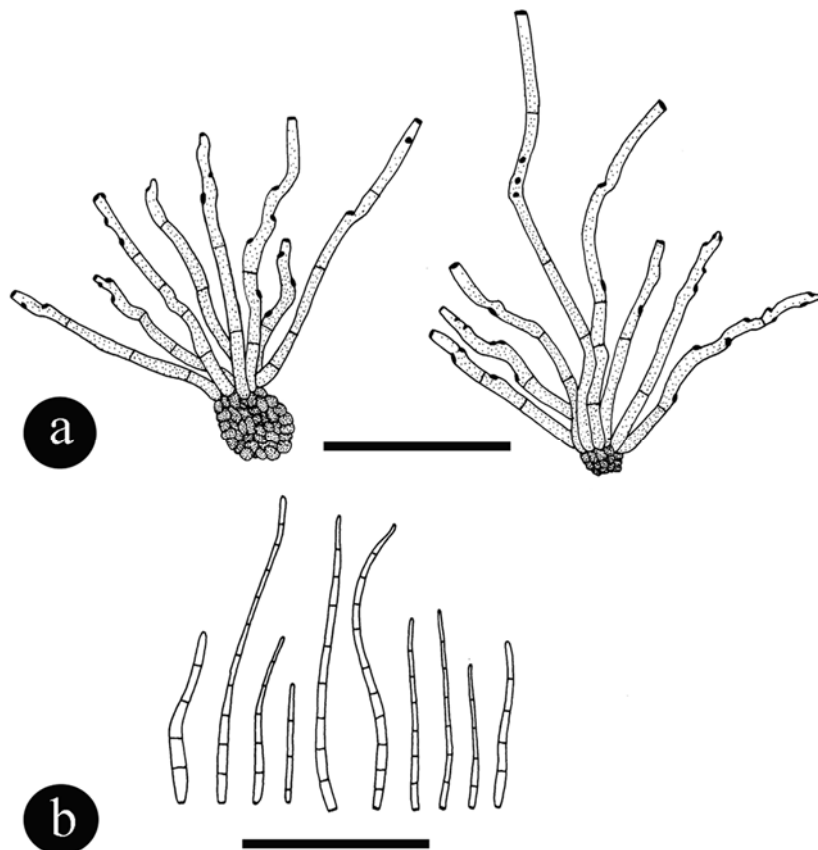


Fig. 50 – Line drawings of *Cercospora volkameriae* on *Clerodendrum fragrans*. **a.** Conidiophores and stromata. **b.** Conidia. Bars = 50 µm. (Meeboon 2009).

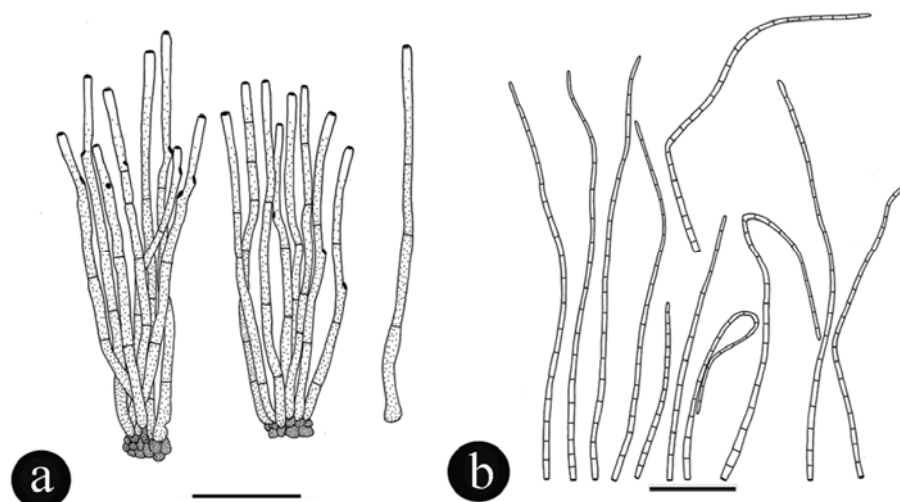


Fig. 51 – Line drawings of *Cercospora althaeina* on *Alcea rosea*. **a.** Conidiophores and stromata. **b.** Conidia. Bars = 50 μm . (Meeboon 2009).

cells. *Conidiophores* 41–186 \times 3–5 μm , up to 8 in dense fascicles, 3–7-septate, arising from stomata, straight, sometime slightly constricted at the septate, smooth, brown at the base, paler toward the apex, cylindrical, unbranched, not geniculate. *Conidiogenous cells* integrated, holoblastic, often monoblastic, sometimes polyblastic and sympodially proliferating. *Conidiogenous loci* 2–3 μm diam., conspicuous, thickened and darkened. *Conidia* 57–316 \times 2–4 μm , solitary, acicular, straight, hyaline, 14–25-septate, smooth, truncate at the base, tapering toward a subacute apex, hila 2–2.5 μm diam., conspicuous, thickened and darkened.

Specimen examined – THAILAND, Chiang Rai Province, Mae Fah Luang, a. Mae Jan, Doi Tung Development, on leaves of *Alcea rosea* L. (*Malvaceae*), 16 August 2008, Jamjan Meeboon (BBH 23585).

Hosts – *Abutilon avicennae*, *A. incanum*, *A. theophrastii*, *Alcea flavovirens*, *A. froloviana*, *A. kusariensis*, *A. litwinowii*, *A. nudiflora*, *A. pallida*, *A. rosea*, *A. rugosa*, *A. tabrisiana*, *Alcea* sp., *Althaea ficifolia*, *A. hirsuta*, *A. officinalis*, *A. rosea*, *Callirhoë involucreta*, *C. triangulata*, *Gossypium hirsutum*, *Hibiscus trionum*, *Hibiscus* sp., *Kydia calycina*, *Kydia* sp., *Lavatera thuringiaca*, *Malva neglecta*, *M. pusilla*, *M. rotundifolia*, *Malva* sp., *Modiola caroliniana*, *Napaea dioica* (*Malvaceae*) (Crous & Braun, 2003).

Distribution – Worldwide, Argentina, Armenia, Australia, Azerbaijan, Bangladesh, Brazil, Bulgaria, Canada, China, Cuba, Georgia, Germany, Guatemala, India, Iran, Italy, Jamaica, Japan, Kazakhstan, Kenya, Kirghizia, Korea, Lithuania, Malawi, Malaysia, Mauritius, Moldova, Myanmar, New Zealand, Pakistan, Romania, Russia (European part), Tadjikistan, Taiwan, Thailand, Ukraine, USA, Zambia, Zimbabwe (Crous & Braun 2003, Meeboon 2009).

Notes – *Cercospora althaeina* was first reported from Thailand by Meeboon (2009).

Literature – Chupp (1954, p. 369, 376).

Moraceae

Cercospora ficina Tharp, *Mycologia* 9: 109 (1917).

\equiv *Cercospora ficina* (Tharp) Sacc., *Syll. Fung.* 25: 911 (1931). Fig. 52

Leaf spots 15–30 mm diam., amphigenous, circular or subcircular, at first pale greenish to ochraceous, later brown to dark brown, finally with greyish brown centre, surrounded by a dark margin or brown halo. Caespituli hypophyllous. *Stromata* 17–38 μm diam., intraepidermal, well-developed, subglobose, brown to blackish brown. *Conidiophores* 42–229 \times 3–6 μm , numerous, in loose to

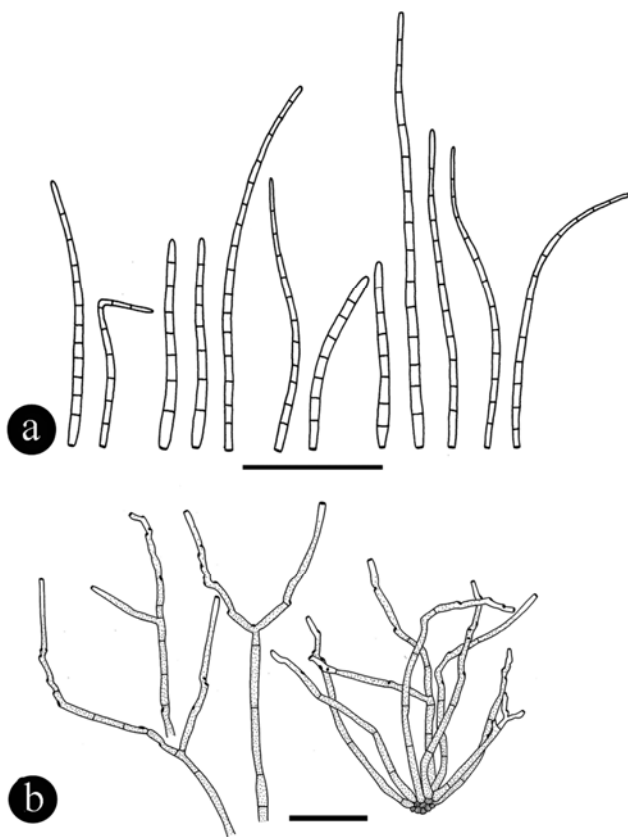


Fig. 52 – Line drawings of *Cercospora ficina* on *Ficus religiosa*. **a.** Conidia. **b.** Conidiophores and stroma. Bars = 50 μm . (Meeboon 2009).

densely fascicules, arising from stomata, branched, subcylindrical, 2–9-septate, geniculate to sinuous, erect to decumbent, smooth, pale yellow to pale brown. *Conidiogenous cells* integrated, terminal, monoblastic to polyblastic, sympodially proliferating. *Conidiogenous loci* 2–2.5 μm diam, conspicuous, thickened and darkened. *Conidia* 42.5–161 \times 2–4.5 μm , solitary, narrowly obclavate to subacicular, straight, hyaline, 7–14-septate, smooth, apex subacute, base obconically truncate, hilum 1.5–2.5 μm diam., thickened and darkened.

Specimen examined – THAILAND, Chiang Mai Province, Chiang Mai University, Faculty of Agriculture, on leaves of *Ficus religiosa* L. (*Moraceae*), 18 August 2008, Jamjan Meeboon (BBH 23557).

Hosts – *Ficus carica*, *F. hispida*, *F. religiosa*, *F. uliginosa*, *F. urceolaria*, *Streblus asper* (*Moraceae*) (Crous & Braun 2003).

Distribution – India, Indonesia, Nigeria, Pakistan, Sudan, Uganda, USA (Crous & Braun 2003).

Notes – The first report of *C. ficina* from Thailand was by Meeboon (2009).

Cercospora elasticae A. Zimm., Bull. Inst. Bot. Buitenzorg 10: 17 (1901).

(= *C. apii* s. lat.)

Fig. 53

Leaf spots 5–8 mm diam., distinct, amphigenous, scattered, circular or subcircular to angular, sometimes forming large symptoms, up to 30 mm diam., greyish brown, with dark margins. *Caespituli* epiphyllous. *Stromata* 18–24 μm diam., intraepidermal, small, composed of globose to subglobose, brown to blackish brown cells. *Conidiophores* 63–139 \times 3–4 μm , 5–8 in loose and divergent fascicules, 2–4-septate, arising from stromata, erect to decumbent, smooth, pale yellow to pale brown, unbranched, subcylindrical, geniculate to sinuous. *Conidiogenous cells* integrated, terminal, holoblastic, monoblastic to polyblastic, sympodially proliferating. *Conidiogenous loci* 2–3 μm diam., conspicuous, thickened and darkened. *Conidia* 120–160 \times 3 μm , solitary, acicular, 8–13-septate, hyaline, smooth, truncate at the base, with acute to subacute apex, hila 2–2.5 μm diam., thickened and darkened.

Specimen examined – THAILAND, Chiang Mai Province, Pang Da Royal project, on leaves of *Ficus carica* L. (*Moraceae*), 5 August 2008, Jamjan Meeboon (BBH 23728).

Hosts – *Ficus carica*, *F. elastica* (*Moraceae*) (Crous & Braun 2003).

Distribution – India, Indonesia, USA, Venezuela (Crous & Braun 2003).

Notes – The first report of *C. elasticae* from Thailand was by Meeboon (2009).

Literature – Chupp (1954, p. 395).

Nyctaginaceae

Cercospora neobougainvilleae Meeboon, Hidayat & C. Nakash., Sydowia 60: 254 (2008).
Fig. 54)

Leaf spots 2–8 mm diam., amphigenous, orbicular, center pale brown, with dark brown margin. *Caespituli* epiphyllous. *Stromata* 11.5–71.5 μm diam., intraepidermal, well-developed, composed of globose to subglobose, dark brown cells. *Conidiophores* 13.5–165 \times 1–9 μm , 4–20 in loose to dense fascicules, 1–3-

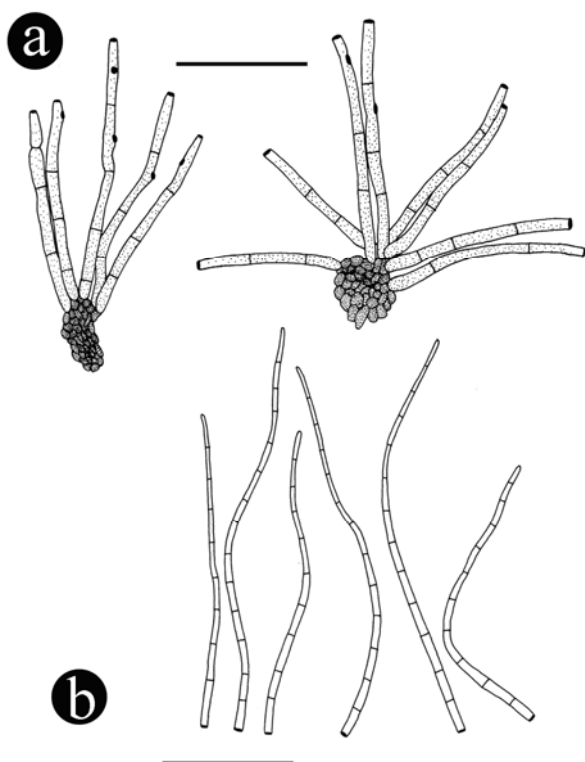


Fig. 53 – Line drawings of *Cercospora elasticae* on *Ficus carica*. **a.** Conidiophores and stromata. **b.** Conidia. Bars = 50 μ m. (Meeboon 2009).

septate, arising from stromata, narrower toward the apex, unbranched, geniculate 1–2 times near the apex, thin-walled to slightly thickened, smooth, brown at the base, paler towards the apex. *Conidiogenous cells* 2–30 \times 1–9, integrated, terminal, sympodial proliferation. *Conidiogenous loci* 1–3 μ m diam., conspicuous, thickened and darkened. *Conidia* 4–112 \times 4–8 μ m, solitary, obclavate, straight to mildly curve, truncate to obconically truncate at base, acute to subobtuse at the apex, 4–5-septate, hyaline, thin-walled, smooth, hila 1–4 μ m diam., thickened and darkened.

Specimens examined – THAILAND, Chiang Mai Province, Chiang Mai University, on leaves of *Bougainvillea spectabilis* Willd. (*Nyctaginaceae*), 30 November 2005, Jamjan Meeboon (CMU 27930: **Holotype**); Chiang Mai Province, A. Muang, RAMA IX Garden, on leaves of *B. spectabilis*, 26 August 2008, Jamjan Meeboon (BBH 23759).

Hosts – *Bougainvillea spectabilis* (*Nyctaginaceae*) (Meeboon et al. 2008).

Distribution – Thailand (type locality) (Meeboon et al. 2008).

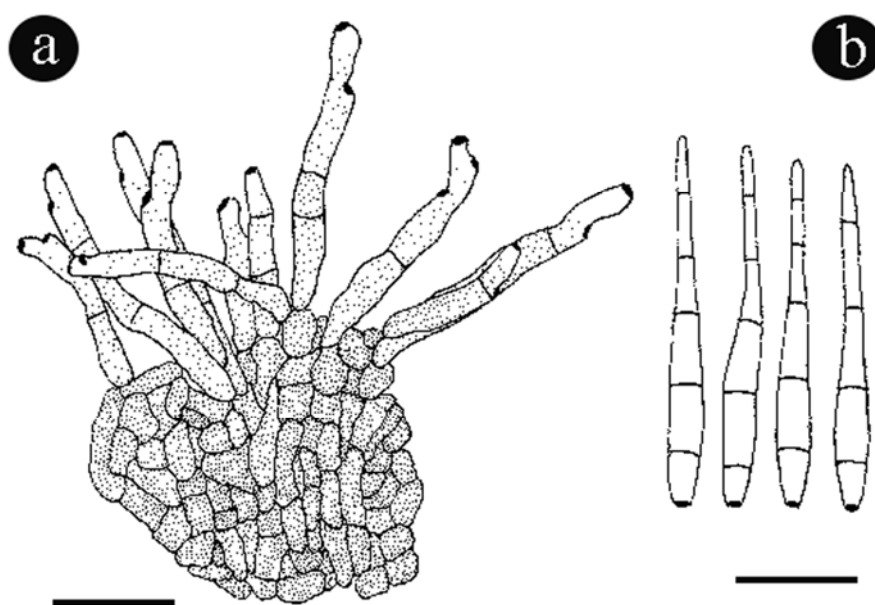


Fig. 54 – Line drawings of *Cercospora neobougainvilleae* on *Bougainvillea spectabilis* (from holotype). **a.** Conidiophores and stroma. **b.** Conidia. Bars = 20 μ m. (Meeboon et al. 2008).

Notes – Four species of *Cercospora* are hitherto known associated with *Nyctaginaceae*, viz, *Cercospora canescens* Ellis & G. Martin,

C. furfurella Speg., *C. mirabilis* Tharp & *C. salpianthi* Chupp & A.S. Mull. (Crous & Braun 2003). Two species, *C. canescens* and

C. salpianthi belong to the species complex *C. apii* s. lat. (Crous & Braun 2003). *Cercospora neobougainvilleae* differs from the plurivorous *C. apii* s. lat. by having obclavate conidia and well-developed stromata (11.5–71.5 µm diam.).

Cercospora neobougainvilleae differs from *C. furfurella* in appearance of leaf spots, stromata and septation characteristics. The symptoms of *C. neobougainvilleae* are pale at the center with dark brown margin, but *C. furfurella* symptoms are almost lacking or dark purple to almost black with grey center. The stromata of *C. neobougainvilleae* is well-developed but *C. furfurella* stromata are small or sometimes lacking. The conidia septation in *C. neobougainvilleae* are distinct with 3–6-septa, but *C. furfurella* is characterized by 4–5-indistinct septa. Moreover, the conidia sizes of *C. neobougainvilleae* are different (4–112 × 4–8 µm vs 30–120 × 2–4.5 µm for *C. furfurella*).

Cercospora mirabilis Tharp, described from *Mirabilis jalapa*, is characterized by having amphigenous caespituli, small or lacking stromata, short branches conidiophores, and acicular conidia with indistinct septation (Chupp 1954). *Cercospora neobougainvilleae* differs from *C. mirabilis* by having epiphyllous caespituli, well-developed stromata, unbranched conidiophores, and obclavate conidia with distinct septation.

Orchidaceae

Cercospora habenariicola Meeboon, Hidayat & C. Nakash., Mycotaxon 99: 118 (2007).

(Fig. 55)

Leaf spots 15–30 mm diam., amphigenous, circular or subcircular, at first pale greenish to ochraceous, later brown to dark brown, finally with greyish brown centre, surrounded by a dark margin or brown halo. *Caespituli* amphigenous, ochre yellow, velvety. *Stromata* 25–75 µm diam., intraepidermal, well-developed, subglobose, brown to blackish brown. *Conidiophores* 50–285 × 7.3–7.5 µm, occasionally up to 952 µm long, loose to dense fascicules, 2–9-septate, numerous, simple, straight, erect to decumbent, smooth, pale yellow to pale brown, rarely branched, subcylindrical, geniculate to sinuous. *Conidiogenous cells* integrated, terminal, sympodially proliferating. *Conidiogenous loci* 2.4–3.6 µm diam., conspicuous, thickened and darkened. *Conidia* 75–110 × 4.9–5 µm, solitary, narrowly obclavate to subacicular, straight, hyaline, 6–10-septate, smooth, apex subacute, base obconically truncate, hila 1.2–2.9 µm diam., thickened and darkened.

Specimen examined – THAILAND, Chiang Mai Province, Queen Sirikit Botanic Garden, on leaves of *Habenaria susannae* (L.) R. Br. (*Orchidaceae*), 14 July 2006, Jamjan Meeboon (CMUMH 155: **Holotype**).

Hosts – *Habenaria susannae* (*Orchidaceae*) (Meeboon et al. 2007a).

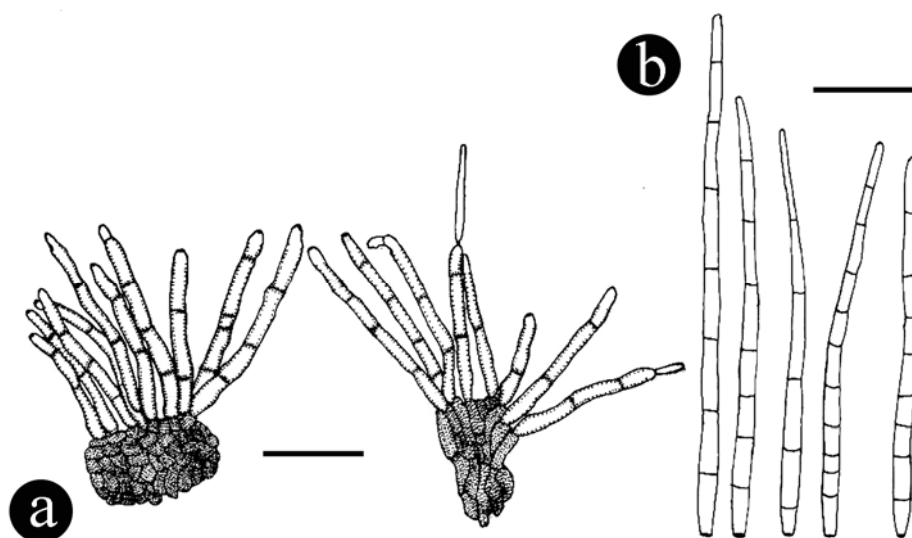


Fig. 55 – Line drawings of *Cercospora habenariicola* on *Habenaria susannae* (from holotype). **a.** Conidiophores and stromata. **b.** Conidia. Bars: **a, b** = 40 µm. (Meeboon et al. 2007a).

Distribution – Thailand (type locality) (Meeboon et al. 2007a).

Notes – This species belongs to *Cercospora s. str.* because of pigmented conidiophores, thickened and darkened conidiogenous loci, and hyaline scolecoïd conidia (Crous & Braun 2003). It is easily distinguishable from the plurivorous *C. apii s. lat.* by having well-developed stromata and obclavate conidia with an obconically truncate base (Crous & Braun 2003).

On orchids numerous species of *Cercospora s. lat.* are known, including *C. cyripedii* Ellis & Dearn., *C. dendrobii* H.C. Burnett, *C. odontoglossii* Prill. & Delacr. and *C. peristeriae* H.C. Burnett, which have been excluded and reallocated to the genus *Pseudocercospora* Speg. (Crous & Braun 2003). *Cercospora angraeci* Feuilleaub. & Roum., described from orchids, is an insufficiently known species of unclear generic affinity (Crous & Braun 2003), but based on the original description *C. habenariicola* differs from *C. an-graeci* in having much longer, occasionally branched conidiophores (Chupp 1954). *Cercospora cephalantherae* Ondřej & Závřel, a genuine species of *Cercospora s. str.*, is characterized by having very short, narrow conidiophores (10–25 × 3.5 µm) and relatively short, narrow conidia (40–100 × 2–3.5 µm). *Cercospora habenariicola* is morphologically close to *C. epipactidis* C. Massal. However, the latter species has consistently unbranched, small conidiophores (10–45 × 4–6 µm), and short, narrow conidia (30–130 × 3.5–5 µm) (Chupp 1954). *Cercospora eulophiae* M.S. Patil is another cercosporoid fungus on an orchid (*Eulophia* sp.), but this species was described having straight to flexuous, smaller conidiophores and pigmented conidia (75–250 × 3.2–4 µm).

Oxalidaceae

Cercospora oxalidis (A.S. Mull. & Chupp) U. Braun & Crous, CBS Biodiversity Series 1: 300 (2003).

≡ *Cercospora oxalidis* A.S. Mull. & Chupp, Arq. Inst. Biol. Veget. Rio de Janeiro 1: 218 (1935) (*nom. inval.*) Fig. 56.

Leaf spots 1–5 mm in diam., amphigenous, scattered to confluent, distinct, circular to subcircular, pale brown to tan, centre greyish brown to greyish white, dark brown margin. *Caespituli* amphigenous. *Stromata* 14–41 µm in diam., small, brown to dark brown, irregular, composed of a few brown hyphal cells. *Conidiophores* 14–122 × 2.5–4.5 µm, loose fascicles, 1–4-septate, emerging through the cuticle, or sometimes from stromata, straight to slightly curved, pale olivaceous brown or sometimes paler towards the apex, geniculate. *Conidiogenous cells* integrated, terminal or intercalary, holoblastic, polyblastic, sympodially proliferating. *Conidiogenous loci* 2.5–3.5 µm diam., conspicuous, thickened and darkened. *Conidia* 57–91 × 1–2.4 µm, solitary, acicular, straight to mildly curved, hyaline, 5–10-septate, smooth, obconically truncate at the base, tapering toward a subacute apex, hila ± 1 µm diam., thickened and darkened.

Specimen examined – THAILAND, Chiang Mai province, Mae Jam District, Mae Hae Royal Project Area, on leaves of *Oxalis debilis* Kunth var. *corymbosa* (DC.) Lourteig (*Oxalidaceae*), 12 February 2008, Jamjan Meeboon and Iman Hidayat (BBH 23595).

Hosts – *Oxalis* sp., *Oxalis debilis* Kunth var. *corymbosa* (*Oxalidaceae*) (Crous & Braun 2003, Meeboon 2009).

Distribution – Brazil, Thailand and USA (Crous & Braun 2003, Meeboon 2009).

Notes – The first report of *C. oxalidis* from Thailand was by Meeboon (2009).

Polypodiaceae

Cercospora platycerii Chupp, Monograph of *Cercospora*: 456 (1954). Fig 57

Leaf spots 5–30 mm diam., amphigenous, subcircular to irregular, grey to pale brown, with dark brown margin, numerous and scattered through the leaf surface. *Caespituli* amphigenous. *Stromata* 16–58 µm diam., small to well-developed, substomatal and composed of a few, globose to subglobose, brown to blackish brown cells. *Conidiophores* 61–200 × 3–5.5 µm, densely fasciculate, 3–10-septate, straight to decumbent, smooth, brown at the

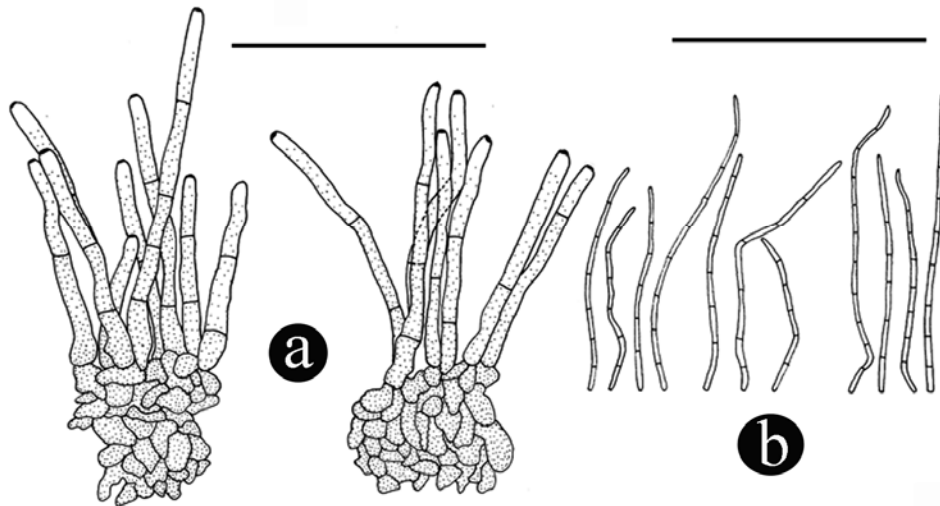


Fig. 56 – Line drawings of *Cercospora oxalidis* on *Oxalis debilis*. **a.** Conidiophores and stromata. **b.** Conidia. Bars = 50 μ m. (Meeboon 2009).

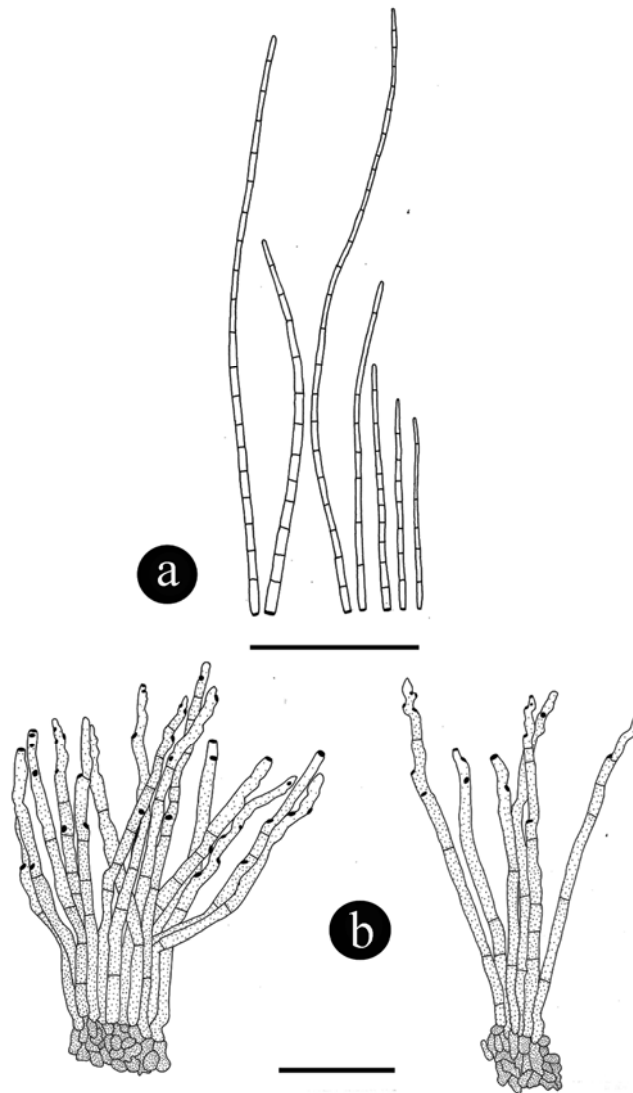


Fig. 57 – Line drawings of *Cercospora platycerii* on *Platycerium wallichii*. **a.** Conidia. **b.** Conidiophores and stromata. Bars = 50 μ m. (Meeboon 2009).

base, paler toward the apex, unbranched, cylindrical, geniculate, sinuous at the apex. *Conidiogenous cells* integrated, terminal, holoblastic, polyblastic, sympodially proliferating. *Conidiogenous loci* 2–3 μm diam., conspicuous, thickened and darkened. *Conidia* 25–280 \times 1–3 μm , solitary, obclavate to acicular, straight, hyaline, 5–24-septate, smooth, truncate at the base, tapering toward a subacute apex, hila 0.5–2 μm diam., conspicuous, thickened and darkened.

Specimens examined – THAILAND, Doi Sa Ket, Chiang Mai Province, on leaves of *P. bifurcatum* (Cav.) C. Chr., 5 July 2006, Jamjan Meeboon (CMU 27904); Chiang Mai Province, T. Sansai, on leaves of *P. wallichii* Hook. (*Polypodiaceae*), 12 September 2007, Parin Noiruang (BBH 23741); Chiang Mai Province, Pang Da Royal Project, on leaves of *P. wallichii*, 5 August 2008, Jamjan Meeboon (BBH 23733).

Hosts – *Platyserium bifurcatum*, *Platyserium* sp. (*Polypodiaceae*) (Crous & Braun, 2003, Meeboon et al. 2007b,c).

Distribution – Thailand, USA (Crous & Braun 2003, Meeboon et al. 2007b,c).

Notes – The first record of *C. platyzerii* from Thailand was by Meeboon et al. (2007b, c) on *P. wallichii* and *P. bifurcatum*.

Pteridaceae

Cercospora cyclosori Goh & W.H. Hsieh, Trans. Mycol. Soc. R.O.C. 4: 26 (1989).

\equiv *Cercospora cyclosori* Sarbajna & Chattopadh., J. Mycopathol. Res. 28: 14 (1990) (*nom. illeg.*), homonym of *C. cyclosori* Goh & W.H. Hsieh (1989).

(= *C. apii* s. lat.)

Fig 58

Leaf spots 2–8 mm diam., amphigenous, irregular, white to pale at the center, with brown margin, sometimes limited by vein. *Caespituli* amphigenous. *Stromata* 23–55 μm diam., substomatal, small to well-developed, composed of a few subglobose, brown-walled cells. *Conidiophores* 111–190 \times 3–5 μm , 9–17 in loose fascicles, 5–7-septate, arising through stromata, straight, smooth, brown at the base, paler toward the apex, unbranched, cylindrical, not geniculate. *Conidiogenous cells* integrated, holoblastic, monoblastic, terminal, sympodially proliferating. *Conidiogenous loci* 2–3 μm diam.,

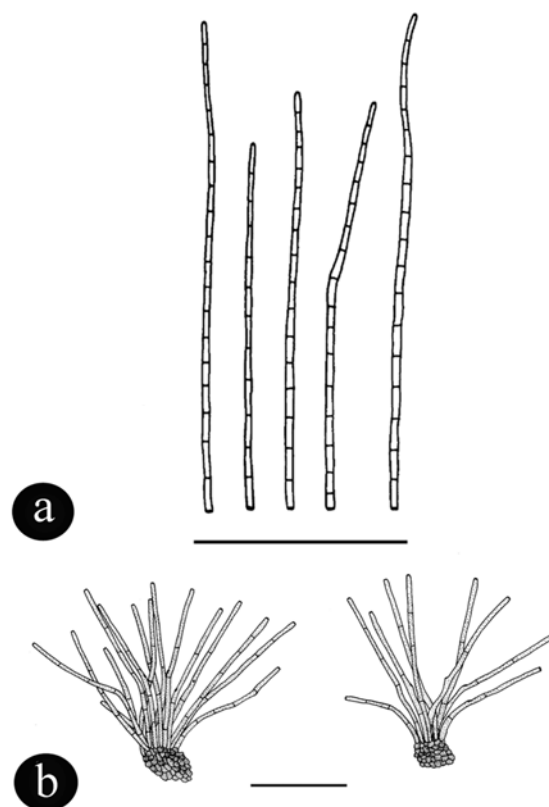


Fig. 58 – Line drawings of *Cercospora cyclosori* on *Pteris biaurita*. **a.** Conidia. **b.** Conidiophores and stromata. Bars = 50 μm . (Meeboon 2009).

conspicuous, thickened and darkened. *Conidia* 179–283 \times 2.5–3.5 μm , solitary, acicular, straight, hyaline, 14–25-septate, smooth, truncate at the base, tapering toward a subacute apex, hila 1.5–2 μm diam., conspicuous, thickened and darkened.

Specimen examined – THAILAND, Chiang Mai Province, Mae Jam District, Mae-Hae Royal Project Area, on leaves of *Pteris biaurita* L. (*Pteridaceae*), 12 February 2008, Jamjan Meeboon and Iman Hidayat (BBH 23617).

Hosts – *Cyclosorus acuminatus*, *Cyclosorus* sp. (*Thelypteridaceae*) (Crous & Braun 2003), *Pteris biaurita* L. (*Pteridaceae*) (Meeboon 2009).

Distribution – India, Taiwan, Thailand (Crous & Braun 2003, Meeboon 2009).

Notes – This specimen is close to *C. cyclosori* in having dark brown symptoms, amphigenous caespituli, conidiophores in divergent fascicles and long acicular conidia with truncate base (Hsieh & Goh 1990). Crous & Braun (2003) assigned this species to

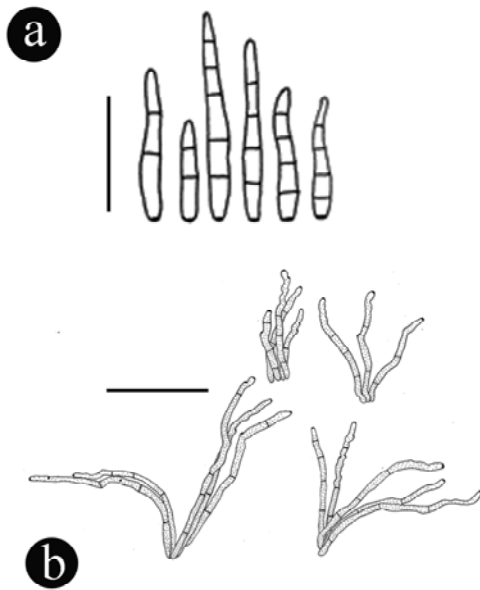


Fig. 59 – Line drawings of *Cercospora scharifii* on *Rosa hybrida*. **a.** Conidia. **b.** Conidiophores. Bars: **a** = 25 μm , **b** = 50 μm . (Meeboon 2009).

C. apii s. lat. This species was first reported from Thailand by Meeboon (2009).

Literature – Hsieh & Goh (1990, p. 327–329).

Rosaceae

Cercospora scharifii Petr., Sydowia 10: 14 (1957) [1956]. Fig. 59

Leaf spots 3–8 mm diam., amphigenous, circular to subcircular, brown, with dark brown to blackish margin. *Caespituli* amphigenous. *Stromata* lacking. *Conidiophores* 30.5–141 \times 3–5 μm , 4–9 in loose fascicles, 1–6-septate, arising from stomata, straight to decumbent, unbranched, cylindrical, smooth, brown at the base, paler toward the apex, geniculate, mostly near the apex. *Conidiogenous cells* integrated, terminal or intercalary, sympodially proliferating. *Conidiogenous loci* 1.5–2.5 μm diam., conspicuous, thickened and darkened. *Conidia* 25–38.5 \times 3.5 μm , solitary, obclavate, straight, hyaline, 4–5-septate, smooth, obconically truncate at the base, tapering toward a subacute apex, hila 1.5–2 μm diam., thickened and darkened.

Specimen examined – THAILAND, Chiang Mai Province, Mae Jam District, Mae

Hae Royal Project Area, on leaves of *Rosa hybrida* E.H. L. Krause (*Rosaceae*), 12 February 2008, Jamjan Meeboon and Iman Hidayat (BBH 23671).

Hosts – *Rosa* sp., *Rosa hybrida* (*Rosaceae*) (Crous & Braun 2003, Meeboon 2009).

Distribution – Iran, Thailand (Crous & Braun 2003, Meeboon 2009).

Notes – *Cercospora scharifii* was first reported from Thailand by Meeboon (2009).

Rubiaceae

Cercospora coffeicola Berk. & M.A. Curtis, Grevillea 9: 99 (1881).

= *Cercospora coffeae* Zimm., Ber. Land-Forstw. Deutch-Oatafr. 2: 35 (1904).

= *Cercospora herrerana* Farneti, Atti Ist. Bot. Univ. Pavia, Ser. 2, 9: 37 (1911). Fig. 60

Leaf spots 5–8 mm diam., amphigenous, circular to subcircular, brown to dark brown, pale at the center, with dark margin. *Caespituli* amphigenous. *Stromata* 16.5–31 μm diam., substomatal to intraepidermal, small, composed of a few globose and brown-walled cells. *Conidiophores* 20–140 \times 2.5–5 μm , 9–23 in loose to dense fascicles, divergent, 2–7-septate, arising from stomata, straight, mostly near the apex, smooth, brown at the base, paler toward the apex, unbranched, cylindrical, geniculate. *Conidiogenous cells* integrated, holoblastic, polyblastic, sometimes monoblastic, terminal or intercalary, sympodially proliferating. *Conidiogenous loci* 2–2.5 μm diam., conspicuous, thickened and darkened. *Conidia* 35–178 \times 3–4 μm , solitary, obclavate, straight, slightly curved, hyaline, 4–21-septate, smooth, obconically truncate at the base, tapering toward a subacute apex, hila 2–2.3 μm diam., thickened and darkened.

Specimen examined – THAILAND, Chiang Mai Province, Mae Jam District, Mae Hae Royal Project Area, on leaves of *Coffea arabica* L. (*Rubiaceae*), 12 February 2008, Jamjan Meeboon and Iman Hidayat (BBH 23600).

Hosts – *Coffea arabica*, *C. canephora*, *C. excelsa*, *C. laurina*, *C. liberica*, *C. robusta*, *C. stenophylla*, *Coffea* spp. (*Rubiaceae*) (Crous & Braun 2003).

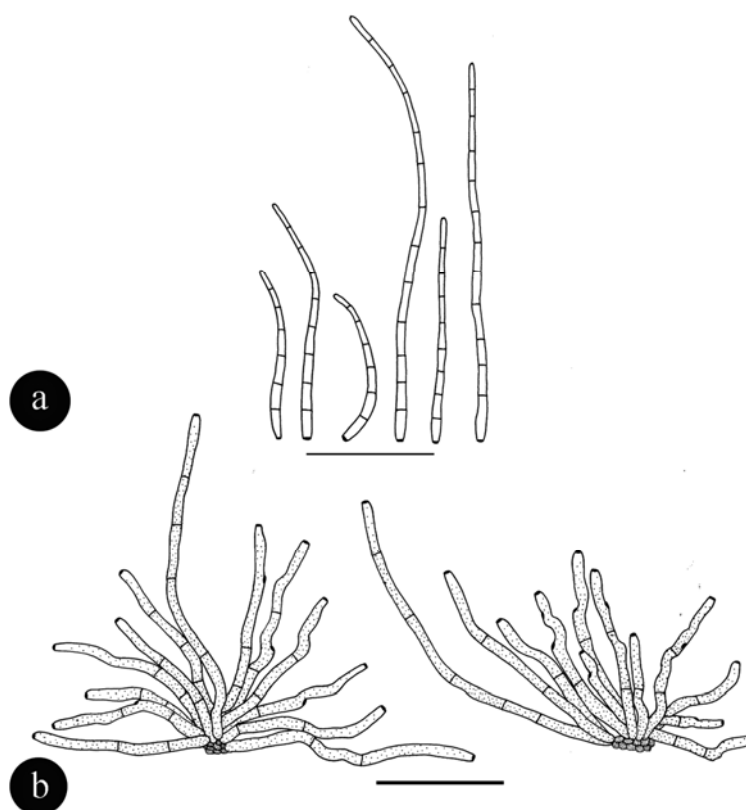


Fig. 60 – Line drawings of *Cercospora coffeicola* on *Coffea arabica*. **a.** Conidia. **b.** Conidiophores and stromata. Bars = 50 μm . (Meeboon 2009).

Distribution – Widely distributed, including American Samoa, Angola, Australia, Brazil, Brunei, Cambodia, China, Colombia, Congo, Costa Rica, Cuba, Dominican Republic, El Salvador, Ethiopia, Fiji, French Guiana, French Polynesia, Guiana, French Polynesia, Gabon, Ghana, Guadeloupe, Guatemala, Guyana, Haiti, India, Indonesia, Ivory Coast, Jamaica, Japan, Kenya, Laos, Madagascar, Malawi, Martinique, Mauritius, Micronesia, Mosambique, Myanmar, Nepal, New Caledonia, Nigeria, Panama, Papua New Guinea, Peru, Philippines, Puerto Rico, Samoa, Sierra Leone, Somalia, South Africa, Sudan, Suriname, Taiwan, Tanzania, Thailand, Togo, Trinidad and Tobago, Uganda, USA, Vanuatu, Venezuela, Yemen, Zimbabwe (Crous & Braun 2003).

Notes – *Cercospora coffeicola* was first reported from Thailand by Sontirat et al. (1980).

Literature – Chupp (1954, p. 493-494).

Saururaceae

Cercospora houttuyniicola Goh & W.H. Hsieh, Bot. Bull. Acad. Sin. Taipei 30: 118 (1989).

(= *C. apii* s. lat.)

Fig. 61

Leaf spots 5–25 mm diam., amphigenous, clustered, irregular, dark brown to blackish, with dark reddish margins. *Caespituli* amphigenous. *Stromata* 13–43 μm diam., substomatal, small to well-developed, and composed of 5–6, globose to subglobose, brown to blackish brown cells. *Conidiophores* 47.5–176 \times 3–4.5 μm , 5–11 in loose fascicles, 1–3-septate, arising through stomata, straight, cylindrical, smooth, brown at the base, paler toward the apex, unbranched, mostly not geniculate, sometimes slightly geniculate. *Conidiogenous cells* integrated, terminal, holoblastic, monoblastic, sympodially proliferating. *Conidiogenous loci* 2–3.5 μm diam., conspicuous, thickened and darkened. *Conidia* 27–99 \times 2–5 μm , solitary, acicular, straight to curve at the apex, hyaline, 7–12-septate, smooth, obconically truncate at the base, tapering toward a acute apex, hila 2–3 μm diam., thickened and darkened.

Specimens examined – THAILAND, Chiang Mai Province, Chiang Mai University, on leaves of *Houttuynia cordata* Thunb. (*Saururaceae*), 6 December 2006, Ikumitsu Araki (CMU 27907); *ibid* 19 July 2007, Jamjan Meeboon and Iman Hidayat (BBH 23737).

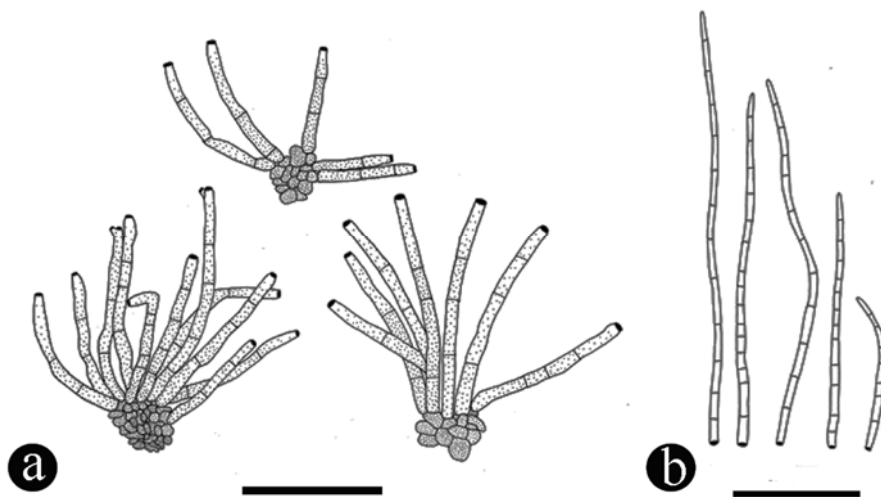


Fig. 61 – Line drawings of *Cercospora houttuyniicola* on *Houttuynia cordata*. **a.** Conidiophores and stromata. **b.** Conidia. Bars = 50 μ m. (Meeboon 2009).

Hosts – *Houttuynia cordata* (*Saururaceae*) (Goh & Hsieh 1989, Meeboon et al. 2007c).

Distribution – Taiwan, Thailand (Goh & Hsieh 1989, Meeboon et al. 2007c).

Notes – The first report of *C. houttuyniicola* from Thailand was carried out by Meeboon et al. (2007c).

Solanaceae

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

≡ *Cercosporina physalidis* (Ellis) Miura, South Manch. Railway Co. Agric. Rept. 27: 525 (1928).

= *Cercospora solanicola* G.F. Atk., *J. Elisha Mitchell Sci. Soc.* 8: 53 (1892).

= *Cercospora nicotianae* Ellis & Everh., *Proc. Acad. Sci. Philadelphia* 45: 170 (1893).

= *Cercospora phyalidicola* Ellis & Barthol., *Erythea* 4: 28 (1896).

= *Cercospora physalidicola* Speg., *Anales Mus. Nac. Buenos Aires* 3: 342 (1899). (*nom. illeg.*).

= *Cercospora raciborskii* Sacc. & Syd., *Syll. Fung.* 16: 1070 (1902).

= *Cercosporina physalidicola* Speg., *Anales Mus. Nac. Hist. Nat. Buenos Aires* 20: 426 (1910).

= *Cercosporina daturicola* Speg., *Anales Mus. Nac. Hist. Nat. Buenos Aires* 20: 425 (1910).

≡ *Cercospora daturicola* (Speg.) Vassiljevsky, *Fungi imperfecti parasitici* 1. *Hyphomycetes*: 247 (1937).

≡ *Cercospora daturicola* (Speg.) W.W. Ray, *Mycologia* 36: 175 (1944).

= *Cercospora capsici* Heald & W.A. Wolf, *Mycologia* 3: 15 (1911).

= *Cercospora abchasica* Siemaszko, *Izv. Severo-Kavkazsk. Muz.* 12: 26 (1919).

= *Cercospora melongenae* Welles, *Phytopathology* 12: 63 (1922).

= *Cercospora atropae* Kvashn., *Izv. Severo-Kavkazsk. Kraev. Stantsii Zashch. Rast.* 4: 37 (1928).

= *Cercosporina petuniae* Saito, *Trans. Tottori Soc. Agric. Sci.* 3: 271 (1931).

≡ *Cercospora petuniae* (Saito) Chupp & A.S. Mull., *Ceiba* 1: 176 (1950) (*nom. illeg.*).

= *Cercospora petuniae* A.S. Mull. & Chupp, *Arq. Inst. Biol. Veg. Rio de Janeiro* 3: 96 (1936) (*nom. inval.*).

= *Cercospora petuniae* Sandu & Sarea, *Lucr. Sti. Inst. Agron.* 1962: 94 (1962) (*nom. illeg.*).

= *Cercospora petuniae* var. *Brevipedicellata* Chidd., *Indian Phytopathol.* 12: 120 (1960) (*nom. inval.*).

(= *C. apii* s. lat.)

Fig. 62

Leaf spots 2–15 mm diam., amphigenous, irregular, brown to dark brown, pale at the center, with dark margin, limited by leaves vein. *Caespituli* amphigenous. *Stromata* 10.5–19 µm diam., substomatal to intraepidermal, small, composed of few globose to subglobose, brown-walled cells. *Conidiophores* 27.5–54 × 2.5–5.5 µm, 3–8 in loose to dense fascicles, 1–3-septate, straight to decumbent, smooth, brown at the base, paler toward the apex, unbranched, cylindrical, strongly geniculate. *Conidiogenous cells* integrated, terminal, holoblastic, polyblastic, sympodially proliferating. *Conidiogenous loci* 1.5–2.5 µm diam., conspicuous, thickened and darkened. *Conidia* 46.5–160 × 2–4 µm, solitary, obclavate to acicular, straight, slightly curved, hyaline, 7–15-septate, smooth, obconically truncate at the base, tapering toward a subacute apex, hila 1–2.3 µm diam., thickened and darkened.

Specimens examined – THAILAND, Phetchabun Province, Num Nao National Park, on leaves of *Capsicum frutescens* L.

(*Solanaceae*), 24 November 2004, Chiharu Nakashima and Jamjan Meeboon (CMU 27965); the same host, Chiang Mai Province, A. Sarapee, 28 November 2006, Jamjan Meeboon (CMU 28065); Chiang Mai Province, Doi Suthep-Pui National Park, on leaves of *C. annuum* L., 2 October 2005, Jamjan Meeboon (CMU 27938); Chiang Rai Province, Wiang Pa Pao, on leaves of *C. annuum* var. *acuminatum* Fingerh (*Solanaceae*), 2 February 2008, Jamjan Meeboon (BBH 23602); Chiang Mai Province, A. Mae Taeng, on leaves of *Nicotiana tabacum* L. (*Solanaceae*), 6 February 2008, Jamjan Meeboon (BBH 23668); Chiang Mai Province, San Sai, Mae Fag, on leaves of *C. annuum*, 3 August 2008, Jamjan Meeboon (BBH 23750); Chiang Mai Province, Chiang Mai University, Multiple Cropping Centre, on leaves of *Solanum nigrum* L. (*Solanaceae*), 1 August 2008, Jamjan Meeboon (BBH 23612); Chiang Mai Province, Suthep-Pui National Park, on leaves of *S. verbascifolium* L., 25 July 2008, Jamjan Meeboon (BBH 23769).

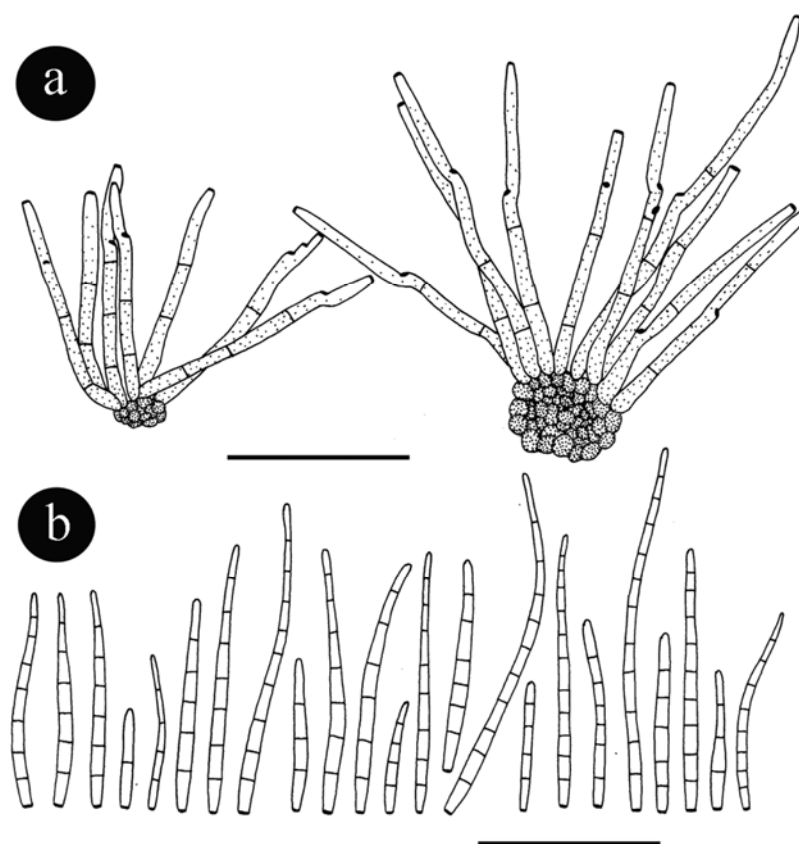


Fig. 62 – Line drawings of *Cercospora physalidis* on *Solanum nigrum*. **a.** Conidiophores and stromata. **b.** Conidia. Bars = 50 µm. (Meeboon 2009).

Hosts – *Atropa bella-donna*, *Capsicum annuum*, *C. baccatum*, *C. frutescens*, *C. grossum*, *Datura alba*, *D. arborea*, *D. fastuosa*, *D. metel*, *D. stramonium*, *D. suaveolens*, *Hyoscyamus agrestis*, *H. niger*, *Lycopersicon esculentum*, *Nicandra physalodes*, *Nicotiana repanda*, *N. rustica*, *N. tabacum*, *Petunia axillaris*, *P. hybrida*, *P. variabilis*, *P. violacea*, *Petunia* sp., *Physalis alkekengi*, *P. angulata*, *P. franchetii*, *P. heterophylla*, *P. hybrida*, *P. lanceolata*, *P. lobata*, *P. longifolia*, *P. minima*, *P. mollis*, *P. parviflora*, *P. pubescens*, *P. subglabrata*, *P. variabilis*, *P. violacea*, *P. virginica*, *P. viscosa*, *Physalis* sp., *Quincula lobata*, *Solanum aculeatum*, *S. aethiopicum*, *S. incanum*, *S. laciniatum*, *S. luteum*, *S. melongena*, *S. nigrum*, *S. torvum*, *S. tuberosum*, *S. xanthocarpum* (*Solanaceae*) (Crous & Braun 2003).

Distribution – Worldwide where the host is cultivated, including including Afghanistan, American Samoa, Argentina, Armenia, Australia, Bangladesh, Barbados, Bhutan, Bolivia, Brazil, Brunei, Bulgaria, Cambodia, China, Colombia, Congo, Cuba, Cyprus, Dominican Republic, Egypt, El Salvador, Ethiopia, Fiji, French Antilles, Gabon, Gambia, Georgia, Germany Ghana, Guam, Guatemala, Guinea, Guyana, Haiti, Hong Kong, India, Indonesia, Iraq, Jamaica, Japan, Jordan, Kenya, Korea, Laos, Libya, Malawi, Malaysia, Mauritius, Mexico, Micronesia, Morocco, Myanmar, Nepal, New Caledonia, Nigeria, New Zealand, Pakistan, Palau, Panama, Papua New Guinea, Philippines, Puerto Rico, Romania, Russia (European part), Samoa, Seychelles, Sierra Leone, Singapore, Solomon Islands, Somalia, South Africa, Spain, Sri Lanka, Sudan, Suriname, Swaziland, Taiwan, Tanzania, Thailand, Tonga, Trinidad and Tobago, Uganda, Ukraine, USA, Vanuatu, Venezuela, Virgin Islands, Wallis and Futuna Islands, Yemen, Zambia, Zimbabwe (Crous & Braun 2003).

Notes – The first record of this species from Thailand was by Sontirat et al. (1980) as '*C. capsici* Heald & F.A. Wolf'. Crous & Braun (2003) considered this species as *C. apii* s.lat. bird chili (*Capsicum frutescens*) is an important crop in Thailand, and its leaf spot disease caused by *C. capsici* is recognized as an important disease. *Solanum verbascifolium*

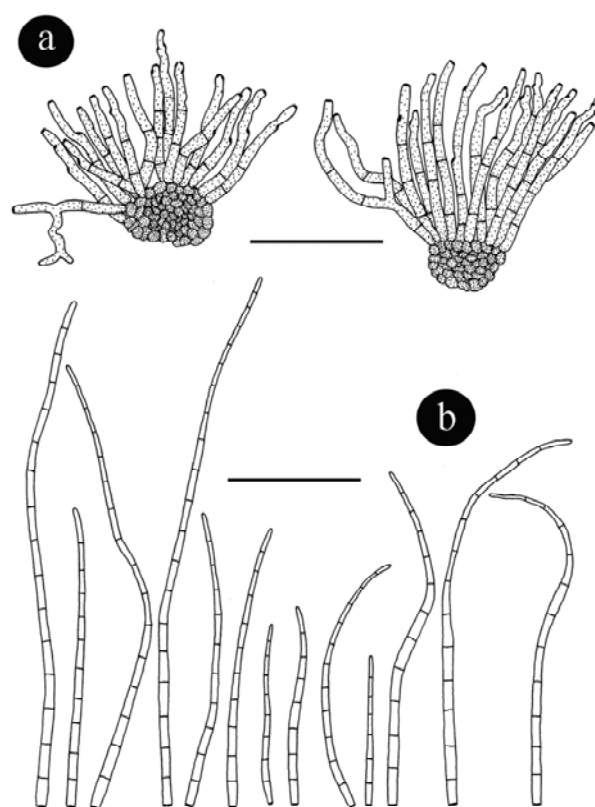


Fig. 63 – Line drawings of *Cercospora puyana* on *Solanum indicum*. **a.** Conidiophores and stromata. **b.** Conidia. Bars = 50 μ m. (Meeboon 2009).

was reported as a new host of this pathogen by Meeboon (2009).

Cercospora puyana Sydow, Ann. Mycol. 37: 431 (1939). Fig. 63

Leaf spots 1–9 mm diam., amphigenous, scattered to confluent, subcircular to angular, initially appearing pale brown, later becoming greyish at the centre, with reddish brown or purplish brown margins. *Caespituli* amphigenous, chiefly hypophyllous. *Stromata* 24–40.5 μ m diam., intraepidermal, well-developed, composed of globose to subglobose, brown to blackish brown cells. *Conidiophores* 39.5–127 \times 3–4 μ m, numerous in dense fascicles, slightly divergent, 1–3-septate, straight, erect to decumbent, smooth, pale yellow to pale brown, branched, subcylindrical, geniculate to sinuous. *Conidiogenous cells* integrated, terminal, holoblastic, polyblastic, sympodially proliferating. *Conidiogenous loci* 2–3 μ m diam., conspicuous, thickened and darkened. *Conidia* 64–165 \times 2–5 μ m, solitary, long obclavate to subacicular, 6–19-septate, straight, hyaline, smooth, base

obconically truncate, with subacute apex, hila 2.5–3 2–3 μm diam., thickened and darkened.

Specimen examined – THAILAND, Chiang Mai Province, Chiang Mai University, Multiple Cropping Centre, on leaves of *Solanum indicum* L. (*Solanaceae*), 1 August 2008, Jamjan Meeboon (JM 108).

Hosts – *Solanum indicum*, *S. trachycypum* (*Solanaceae*) (Meeboon 2009, Chupp 1954).

Distribution – Ecuador, Thailand (Chupp 1954, Meeboon 2009).

Notes – This species is distinct from the plurivorous *C. apii* s. lat. in having well-developed stromata, branched conidiophores and being obconically truncate at the base of conidia (Chupp 1954). Ten species of *Cercospora* (non *C. apii* s. lat.) have been recorded on plant genus *Solanum*, viz, *C. lanugiflori* Chupp & A.S. Mull., *C. nigri* var. *microspora* L.N. Bhardwaj & Y.S. Paul, *C. puyana*, *C. sciadophila* (Speg.) Chupp, *C. solanacea* Sacc. & Berl., *C. solani* Thüm., *C. solanigena* Bhartiya, R. Dubey & S.K. Singh, *C. solani-nigri* Chidd., *C. solani-tuberosi* Thirum. and *C. venezuelae* var. *indica* Govindu & Thirum. (Crous & Braun 2003). This specimen is close to *C. puyana* in having amphigenous caespituli, branched conidiophores and long obclavate conidia with an obconically truncate base. This species was first reported from Thailand by Meeboon (2008).

Literature – Chupp (1954, p. 548).

Cercospora solanacea Sacc. & Berl., Atti Reale Ist. Veneto Sci. Lett. Arti VI, 3: 721 (1885). Fig. 64

Leaf spots 15–30 mm diam., amphigenous, angular, at first pale greenish to ochraceous, later brown to dark brown, finally with grayish brown centre, surrounded by a dark margin. *Caespituli* epiphyllous. *Stromata* 19–24 μm diam., intraepidermal, small to well-developed, composed of globose to subglobose, brown to blackish brown cells. *Conidiophores* 27–79.5 \times 2–4.5 μm , 5–7 in dense fascicles, 1–3-septate, arising from stomata, simple, straight, erect to decumbent, smooth, pale yellow to pale brown, unbranched, subcylindrical, not geniculate. *Conidiogenous cells*

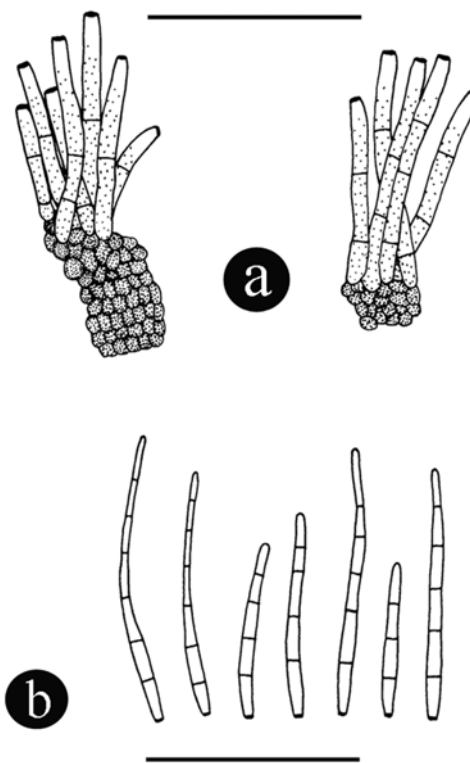


Fig. 64 – Line drawings of *Cercospora solanacea* on *Solanum torvum*. **a.** Conidiophores and stromata. **b.** Conidia. Bars = 50 μm . (Meeboon 2009).

integrated, terminal, holoblastic, mostly monoblastic. *Conidiogenous loci* 2–3 μm diam., conspicuous, thickened and darkened. *Conidia* 30–71.5 \times 3–3.5 μm , solitary, narrowly obclavate, 3–6-septate, straight, hyaline, smooth, base obconically truncate, with subacute apex, hila 2–2.5 2–3 μm diam., thickened and darkened.

Specimen examined – THAILAND, Chiang Mai Province, Chiang Mai University, Multiple Cropping Centre, on leaves of *Solanum torvum* Sw. (*Solanaceae*), 1 August 2008, Jamjan Meeboon (BBH 23719).

Hosts – *Solanum melongena*, *S. Nigrum*, *S. Torvum*, *S. verbascifolium* (*Solanaceae*) (Crous & Braun 2003, Meeboon 2009).

Distribution – Australia, China, India, Taiwan, Thailand, Venezuela (Crous & Braun 2003, Meeboon 2009).

Notes – This specimen is close to *C. lanugiflori* and *C. solanacea* based on epiphyllous caespituli, relatively short and not geniculate conidiophores, and narrowly obcla-

vate and short conidia with a few septate (Chupp 1954). However, the status of *C. lanugiflori* is unclear (Crous & Braun 2003), therefore, this specimen is assigned to *C. solanacea*. *Cercospora solanacea* was first reported from Thailand by Meeboon (2009).

Literature – Chupp (1954, p. 549–550).

Verbenaceae

Cercospora tectonae F. Stevens (*tectoniae*), Bernice P. Bishop Mus. Bull. 19: 155 (1925). (= *C. apii* s. lat.) Fig. 65

Leaf spots 2–14 mm in diam., angular to suborbicular, limited by leaf veins, confluent, brown to greyish brown or white at the centre, with a dark margin. *Caespituli* amphigenous, chiefly epiphyllous. *Stromata* 8–41 µm diam., small to well-developed, composed of a few globose to subglobose, brown to dark brown cells. *Conidiophores* 33.5–76 × 3–5 µm, in loose fascicles, 1–5-septate, straight to decumbent, light brown to medium brown, paler towards the apex, geniculate at the apex. *Conidiogenous cells* integrated, terminal, holoblastic, polyblastic, sympodially proliferating. *Conidiogenous loci* 2–3 µm diam., conspicuous, thickened and darkened. *Conidia* 31–96.5 × 2–3 µm, hyaline, acicular to obclavate-cylindric, 4–13-septate, straight to curved, truncate or obconically truncate at the base, with subacute

apex, hila 2–2.5 µm diam., thickened and darkened.

Specimen examined – THAILAND, Chiang Mai Province, Chiang Mai University, Multiple Cropping Centre, on leaves of *Tectona grandis* L.f. (*Verbenaceae*), 1 December 2005, Jamjan Meeboon (CMU 27928).

Hosts – *Tectona grandis* (*Verbenaceae*) (Crous & Braun 2003, Meeboon et al. 2007c).

Distribution – China, Indonesia, Taiwan, Thailand, Trinidad and Tobago, USA (Crous & Braun 2003, Meeboon et al. 2007c).

Notes – Crous & Braun (2003) assigned this species to *C. apii* s. lat. The first report of *C. tectonae* from Thailand was by Meeboon et al. (2007c).

Literature – Chupp (1954, p. 595)

Zingiberaceae

Cercospora alpiniicola S.Q. Chen & P.K. Chi (*alpinicola*), Journal of South China Agricultural University 11: 57 (1990b); also in Chi, Fungal Diseases of Cultivated Medicinal Plants in Guangdong Province: 33 (1994).

Fig. 66

Leaf spots 2–13 mm diam., amphigenous, distinct, circular to irregular, pale olivaceous brown at the center, sometimes discoloration forming surrounding the margin. *Caespituli* amphigenous. *Stromata* 12.5–19 µm diam.,

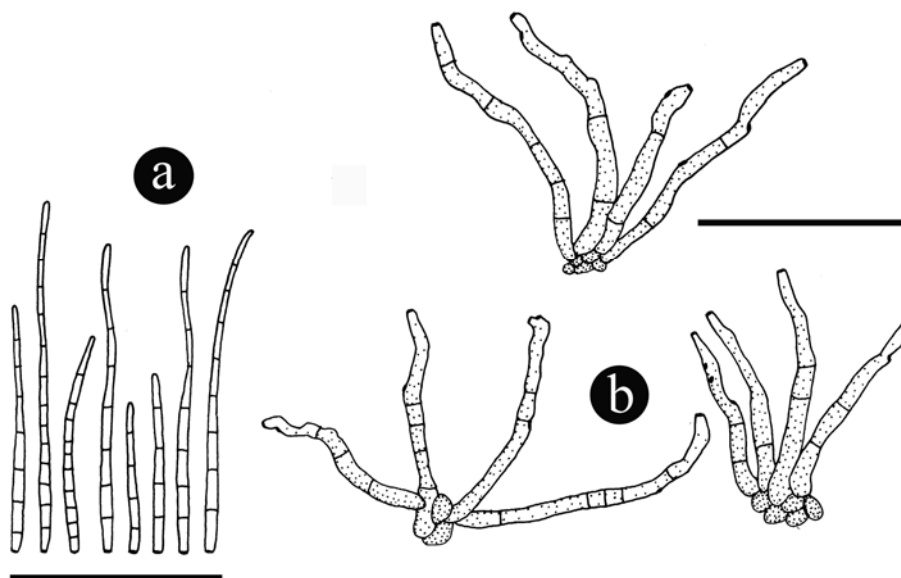


Fig. 65 – Line drawings of *Cercospora tectonae* on *Tectona grandis*. **a.** Conidia. **b.** Conidiophores and stromata. Bars = 50 µm. (Meeboon 2009).

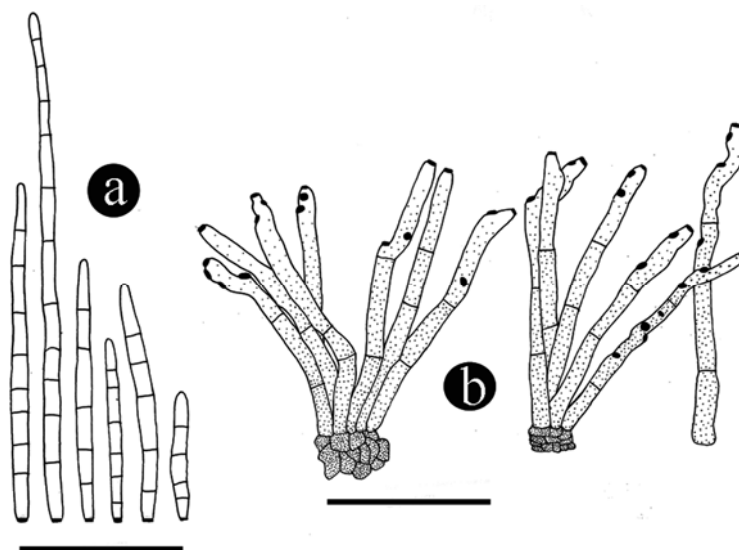


Fig. 66 – Line drawings of *Cercospora alpiniicola* on *Alpinia purpurata*. **a.** Conidia. **b.** Conidiophores and stromata. Bars = 50 μm . (Meeboon 2009).

small, substomatal to intraepidermal, composed of a few globose to subglobose, brown-walled cells. *Conidiophores* 48.5–100 \times 4.5–6.5 μm , 3–8 in loose to dense fascicles, 1–3-septate, arising from stromata, straight, smooth, brown at the base, paler toward the apex, unbranched, cylindrical, strongly geniculate. *Conidiogenous cells* integrated, holoblastic, terminal, polyblastic, sometimes monoblastic, sympodially proliferating. *Conidiogenous loci* 1.3–2.8 μm diam., conspicuous, thickened and darkened. *Conidia* 39.5–162 \times 3.5–5.5 μm , solitary, obclavate to acicular, straight, slightly curved, hyaline, 4–11-septate, smooth, obconically truncate at the base, tapering toward a subacute apex, hila 2–2.5 μm diam., thickened and darkened.

Specimen examined – THAILAND, Chiang Mai Province, Sanpatong District, Mae Wang Sub-district, Tambol Mae Win, Bahn Mae Sapok, Mae Sapok Royal Project, on leaves of *Alpinia purpurata* K. Schum, (*Zingiberaceae*), 8 February 2008, Jamjan Meeboon and Iman Hidayat (BBH 23684).

Hosts – *Alpinia oxyphylla*, *A. purpurata* (*Zingiberaceae*) (Chen & Chi 1990b, Meeboon 2009).

Distribution – China, Thailand (Chen & Chi 1990b, Meeboon 2009).

Notes – The first report of *C. alpiniicola* from Thailand was by Meeboon (2009).

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