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 arecacearum*, *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 families, 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 “kerkōk” (tail) and “sporos” (seed), designates the filiform conidia of the fungus (Crous & Braun 2003). The teleomorphic 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 Syllage 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., Cercosporella Sacc., Cercosporidium Earle, Fusidium Bonord., Mycovellosiella Rangel, Passalora Fr., Phaeoisariopsis Ferraris, Phaeoramularia Munkt.-Cvetk., Syistosporium 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 *Stigmina*, and published the new genus *Sirosporium* 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, Scolecostigmina* U. Braun, *Semi-pseudocercospora* 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. apiii 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. apiii 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. apiii s. lat.* (Crous & Braun 2003).


**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 example, *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 (amphi- genous); 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 3b, 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
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 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


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

1. Conidiogenous loci inconspicuous or sub-denticate, 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
3. Conidia hyaline or subhyaline, scolecosporous, acicular, obclavate-cylindrical, filiform, usually pluriseptate. \textit{Cercospora}

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

**Presentation of Results**

\textit{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 \textit{Cercospora}, and the relationship with other related genera within anamorphic taxa of \textit{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 AmpliTag 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 Paracerecospora 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-Willems (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.
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-patrini (Shin & Sameva 2002) (arrows show the location of conidiophores inside conidiomata).

& Fr.) Mont. & Fr. (= 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 multisepate 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 synnematous (Phaeoisariopsis) 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.
**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 $\beta$-tubulin of a *Cercospora lactucae-sativae* Ben$^R$ strain between codon 159 to 264.

<table>
<thead>
<tr>
<th>Fungus</th>
<th>Strain</th>
<th>Type</th>
<th>Alignment</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>C. lactucae-sativae</em></td>
<td>CCR-18</td>
<td>R</td>
<td>AAC TCC GAC GCG ACT TTC TGT ATC GAC AAC GAG</td>
</tr>
<tr>
<td><em>C. beticola</em></td>
<td>C-3</td>
<td>S</td>
<td>AAC TCC GAC GAG ACC TTC TGT ATC GAC AAC GAG</td>
</tr>
<tr>
<td><em>C. beticola</em></td>
<td>AD-762</td>
<td>R</td>
<td>AAC TCC GAC GCG ACC TTC TGT ATC GAC AAC GAG</td>
</tr>
<tr>
<td><em>M. fijiensis</em></td>
<td>020501</td>
<td>S</td>
<td>AAC TCT GAC GAC ACC TTC TGT ATC GAC AAC GAG</td>
</tr>
<tr>
<td><em>M. fijiensis</em></td>
<td>020301</td>
<td>R</td>
<td>AAC TCT GAC GCG ACC TTC TGT ATC GAC AAC GAG</td>
</tr>
<tr>
<td><em>C. kikuchii</em></td>
<td>JC-203</td>
<td>R</td>
<td>AAC TCC GAC GCG ACC TTC TGT ATC GAC AAC GAG</td>
</tr>
</tbody>
</table>

Fig. 11 Sequence alignment for *C. lactucae-sativae* $\beta$-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. Stromata 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, acroleurogenous, simple, obclavate or subulate, colourless or pale, pluriseptate, smooth.

Holotype species – *Cercospora penicil-lata* (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 × 3–6.5 μm, geniculate; on *Andrographis*........................... *C. andrographidica*  
2. Stromata small, 20–24 μm diam.; conidiophores long, 85–209 × 3–4 μm, slightly geniculate near the apex; on *Barleria* ............ *C. barleriicola*

**Adiantaceae**

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

**Amaranthaceae**

1. Caespituli hypohyllous; stromata often lacking, if present, small, up to 8 μm diam.; conidiophores up to 5 in loose fascicles, long, 90.5–192 × 3–4 μm; conidia acicular, 8–316 × 3–4 μm, 10–22-septate; on *Iresine* and *Celosia* ............ *Cercospora canescens*  
2. Caespituli amphigenous ............................. 2

1. Conidiophores up to 13 in moderately dense fascicles, 34–85 × 2.5–5 μm; conidia acicular, 12–67 × 2.5–3.5 μm, 4–7-septate; on *Celosia*........................................... *Cercospora celsiae*

2. Stromata small, 12–26 μm diam.; conidiophores 5–9 in loose and divergent fascicles, 47–125 × 3–5 μm; conidia narrowly obclavate to acicular, 29–168.5 × 2.5–3.5 μm, 2–12-septate; on *Ricinus* ......................  
3. Conidiophores not geniculate or rarely geniculate, 32.5–220 × 3–8 μm; conidia 45–196 × 1.5–3 μm, acicular, 13–19-septate, truncate at the base; on *Cynara*............................. *Cercospora cynarae*  
4. Conidiophores distinctly geniculate........... 7

1. Conidia obclavate, 80–96 × 3.5–4 μm; on *Conyza*.............. *Cercospora nilghirensis*  
2. Conidia narrowly obclavate to subacicular, 60–198 × 2–4 μm; on *Gerbera*....................  
3. Conidia truncate at the base, 23–190 × 2–4 μm, 3–10-septate; on *Chrysanthemum* ........................................... *Cercospora chrysanthemi*  
4. Conidia obconically truncate at the base, 36–182 × 3–6.5 μm, 7–13-septate; on *Lactuca* ... *Cercospora lactucae-sativae*
**Balsaminaceae**

1. Conidiophores 52–129 × 2–3.5 μm, unbranched; conidia obclavate with obconically truncate at the base, 35–73 × 4–5 μm, 3–11-septate; on *Impatiens walleriana* .......... .............................. *Cercospora balsaminiana*

1. Conidiophores 49–112 × 4–6.5 μm, sometimes branched; conidia narrowly obclavate to subacicular with truncate to obconically truncate at the base, 60–120 × 2.5–5 μm, 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 × 3–5 μm; conidia 44.5–143 × 3–3.5 μm, narrowly obclavate to subacicular, 6–15-septate, base obconically truncate; on *Ipomoea* and *Argyreia* ........................................... .............................. *Cercospora ipomoeae*

1. Conidiophores unbranched................................. 2

2. Conidia 80–240 × 3–4 μm, 9–14-septate, acicular to long obclavate, base obconically truncate; on *Ipomoea*........................................... .............................. *Cercospora citrullina*

2. Conidia 22.5–96 × 3–3.5 μm, 6–9-septate, acicular, sometimes obclavate, truncate at the base; on *Operculina* ........................................... .............................. *Cercospora operculinae*

**Cucurbitaceae**

1. Caespituli amphigenous; conidiophores 52–106.5 × 2.5–5 μm, not geniculate; conidia acicular, 63–296.5 × 2.5–4.5 μm, 8–26-septate, truncate at the base; on various genera of *Cucurbitaceae* .............................. .............................. *Cercospora citrullina*

1. Conidiophores sometimes branched, 48.5–83.5 × 4–6 μm, slightly geniculate; conidia 44–256 × 1.5–3 μm, narrowly obclavate to subacicular, 4–18-septate, base obconically truncate; on *Acalypha* ........................................... .............................. *Cercospora acalyphae*

2. Conidiophores 56–213 × 4–5.5 μm, slightly geniculate; conidia 29–160 × 3–4.5 μm, acicular, rarely obclavate, 3–10-septate, truncate at the base; on *Codiaeum* ........................................... .............................. *Cercospora codiaeae*

2. Conidiophores 36–66 × 3–5 μm, sometimes constrict at the septate, rough wall, geniculate, mostly near the apex; conidia 51–133 × 3–4.5 μm, obclavate to acicular, 5–11-septate, obconically truncate at the base; on *Phyllanthu* .............................. *Cercospora phyllanthicola*

**Fabaceae**

1. Caespituli hypophyllous; conidiophores 76–129 × 3.5–5 μm, rarely branched; conidia 80–132 × 3–3.5 μm, narrowly obclavate to subacicular, 6–11-septate; on *Glycine* ........................................... .............................. *Cercospora kikuchii*

1. Conidiophores amphigenous ................................. 2

2. Stromata well-developed, 26.5–67 μm diam.; conidia 56–113.5 × 3–4.5 μm, narrowly obclavate to subacicular, 3–9-septate; on various genera of *Fabaceae* ........................................... .............................. *Cercospora canescens*

2. Caespituli amphigenous; stromata small, 25–30.75 μm diam.; conidia 39–206 × 2–4 μm, 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 × 2.5–4 μm, rarely branched, geniculate to sinuous; conidia 40–87 × 2–3 μm, narrowly obclavate to subacicular, 3–10-septate, base obconically truncate; on *Clerodendrum fragrans*.............. *Cercospora volkameriae*

**Malvaceae**

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

**Moraceae**

1. Caespituli hypophyllous; conidiophores 42-229 × 3–6 μm, branched; conidia 42.5–161 × 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 × 3–4 μm, not branched; conidia 120–160 × 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 *Platycerium*......................... *Cercospora platycerii*

**Pteridaceae**

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

**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 × 2–4.5 μm, not branched, not geniculate; conidia 30–71.5 × 3–3.5 μm, narrowly obclavate, 3–6-septate; on *Solanum torvum*..... *Cercospora solanacea*

1. Caespituli amphigenous............................. 2

2. Conidiophores 27.5–54 × 2.5–5.5 μm, unbranched, strongly geniculate; conidia 46.5–160 × 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 × 3–4 μm, branched, geniculate to sinuous; conidia 64–165 × 2–5 μm, long obclavate to subacicular, 6–19-septate; on *Solanum indicum*......................... *Cercospora puyana*

**Verbenaceae**

A single species, on *Habenaria*......................... *Cercospora habenariicola*
A single species, on Tectona........................... Cercospora tectonae

Zingiberaceae

A single species, on Alpinia............................ Cercospora alpinicola

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

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

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


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


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**Fig. 13** – Line drawings of *Cercospora barleriicola* on *Barleria cristata*. **a.** Conidia. **b.** Stroma and conidiophores. Bars = 25 μm. (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


(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).

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

Notes – *Doryopoteris 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. api s. lat.), *C. adiandigena* U. Braun & Crous, and *C. pteridigena* M.K. Khan, R.K. Verm & Kamal. This specimen is identified as *C. adiandigena* due to short and obclavate conidia (53–60 × 2–3 μm vs 40–90 × (4) 5–8 μm *C. adiantigena*). It is distinct from *C. pteridigena* due to the later species having very long conidio-phores and large conidiogenous loci (4-5 μm diam.). This specimen was first reported from Thailand by (Meeboon 2009).

*amaranthaceae*


(≡ *C. api s. lat.*) (Fig. 15)

Leaf spots – 3–6 mm diam., amphigenous, dark to yellowish. Caespituli hypophyllous. Stromata mostly lacking, if present small, up to 8 μm diam., composed of 4–5 globose to subglobose, brown to dark brown cells. Conidiophores 90.5–192 × 3–4 μm, 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 2.5–3.5 μm diam., conspicuous, thickened and darkened

![Fig. 15](image-url) – 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).


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).


(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-sptulī* amphigenous, chiefly hypophyllous.
Stromata 19–29 µm diam., small, composed of a few globose to subglobose, dark brown cells. Conidiophores 34–85 × 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 × 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.


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. cristata was reported from Thailand by Petcharat & Kanjanamaneeasathian (1989), Sontirat et al. (1980) and Meeboon (2009).

≡ 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., intraepidermal, small, composed of globular to angular, brown to blackish brown cells. Conidiophores 47–125 × 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 × 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).

C. ricinella

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).


Apocynaceae


(= 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 × 3–4.5 µm, 7–12 in loose to dense fascicles, 2–4-septate, often divergent, arising from stromata, simple, erect to decumbent,


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 arecacearum 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 × 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 × 4–5 μm, integrated, terminal, sympodially proliferating. Conidiogenous loci 2.5–3 μm diam., conspicuous, thickened and darkened. Conidia 140–320 × 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 scolecoid conidia. This fungus is distinct from the

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).
plurivorous *C. apii s. lat.* by having well-developed, large stromata, and strongly geniculate, branched conidiophores in deve 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**


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 × 4–5.5μm, 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,
holoblastic, monoblastic or polyblastic, sympodially proliferating. *Conidiogenous loci* 2.5–3 μm diam., conspicuous, thickened and darkened. *Conidia* 43.5–207.5 × 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).


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).


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


(*= *C. apii s. lat.*)
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 × 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 × 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).


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 × 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 × 1.5–3 µm, solitary, acicular, curved, hyaline, 13–19-septate, smooth, truncate at the base, apex acute, hila ± 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).


Notes – This species was first reported from Thailand by Meeboon (2009).
Fig. 22 – Line drawings of *Cercospora cynaraceae* 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).


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

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 × 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 × 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.*


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

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...
subglobose, brown to blackish brown cells. 
Conidiophores 36–163 × 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 × 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).


(= C. apii s. lat.)

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. apiis s. lat.


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


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

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, 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 23572); 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).


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).


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 × 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 × 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).


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

Notes – This specimen is much closer to C. nilghirensis than to C. bidentis Tharp. due to distinct and amphigenous leaf spot, amphigenous caespituli, stromata small to lacking, unbranched and genculation 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).


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, genculate 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).


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).


(= 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 µm. (Meeboon 2009).

**Fig. 29** – Line drawings of *Cercospora zinniicola* on *Zinnia elegans*. **a.** Conidiophores and stromata. **b.** Conidia. 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 × 2–3.5 µm, solitary, narrowly obclavate 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).


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


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

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

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).
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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).


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).


= Cercospora balsaminae Kellerm. & Swingle, fide Chupp (1954).
(= C. apii s. lat.)

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).
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, Samereng District, Pang Da Royal Project, on leaves of *I. balsamina*, 7 February 2008, Jamjan Meeboon (BBH 23616).


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 stromata and the cuticle, light brown, paler towards the apex, straight to slightly curved, unbranched, plainly geniculate near the apex. *Conidiogenous cells* integrated, terminal or intercalary, holoblastic, monoblastic or polyblastic, sympodially proliferating. *Conidiogenous 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 brassicae-juncea Sawada (brassicace-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., substomal to intrapidermal, 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, phylloblastic, sympodially proliferating. Conidiogenous loci 2.5–5 μm diam., conspicuous, thickened and 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).


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 & Kanjanamaneesathanian (1989). *Raphanus sativus* was first reported by Meeboon (2009) as a new host of *C. brassicicola*.


**Caricaceae**


≡ (= *C. apii s. lat*)

*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. *Conidio- phores* 46–202 × 3–5.5 µm, very variable in 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*.

**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).
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).


Convulvulaceae

Cercospora citrullina Cooke Grevillea 12: 31 (1883).

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


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


(= C. apii s. lat.) Fig. 36

Leaf spots 1–5 mm in diam., amphi- genous, 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 (Convulvulaceae), 8 September 2007, Jamjan Meeboon (BBH 23594); Chiang Mai Province, Mae Jo, Sansai, Farming area, on leaves of I. aquatica Forssk. (Convulvulaceae), 31 July 2008, Jamjan Meeboon (BBH 23716).


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, 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. apiis s. lat.


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


(= C. apiis 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., intrapidermal, well-developed, subglobose, brown to blackish brown. Conidiophores 13.5–134 × 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 × 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 (Convulvulaceae), 9 March 2005, Jamjan Meeboon (CMU 28220 and CMU 28221); Chiang Mai Province, A. Pa Pae, Bahn
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 operculinicola* Kamal, in herb. (IMI 367133).

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

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 × 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 × 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 *Opeculina turpethum* (L.) Silva Manso (*Convolvulaceae*), 6 February 2008, Jamjan Meeboon and Iman Hidayat (BB 23768).

Hosts – *Opeculina bufalina*, *O. riedelianna*, *O. turpethum* (*Convolvulaceae*) (Crous & Braun 2003).
Fig. 38 – Line drawings of *Cercospora operculinae* on *Operculina turpethum*. **a.** Conidia. **b.** Conidiophores and stromata. Bars = 50 μm. (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.*


**Cucurbitaceae**

*Cercospora citrullina* Cooke Grevillea 12: 31 (1883).

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


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


(= *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 μm diam., substomatal, small to well-developed, composed of a few globose to subglobose, brown to dark brown cells. *Conidiophores* 52–106.5 × 2.5–5 μm, 6-11 in loose fascicules, 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 μm diam., conspicuous, thickened and darkened. *Conidia* 63–296.5 × 2.5–4.5 μm, solitary, acicular, straight, hyaline, 8-26-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 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 *Cucumis sativus* L. (*Cucurbitaceae*), 30 July 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 *Lagenaria siceraria* (Molina) Standl. (*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*), 30 July 2007, Jamjan Meeboon (BBH 23623); 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 μm. (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).


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 & Kanjanamanee-sathian (1989), and Meeboon et al. (2007b) on Coccinia grandis. Crous & Braun (2003) considered this species as C. api s. lat.


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 μm diam., small, sometimes rudimentary to poorly developed, composed of a few sub-globular to irregular, brown to dark brown cells. Conidiophores 18–108.5 × 3–5.5 μm, 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).

Conidiogenous loci 1.5–2.5 μm diam., conspicuous, thickened and darkened.

Conidia 41–102 × 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.

Specimens 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).  


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

### Euphorbiaceae


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


*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 × 4–6 μm, 2–8 in loose fascicules, 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 × 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).


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.


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

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 × 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.


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

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

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


*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 × 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 × 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. kirganelicola* 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**


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).


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, Tajikistan, 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.*

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-juncea* Sawada, J. Taihoku Soc. Agric. 7: 27 (1942) (nom. inval.).

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

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 × 3.5–5.5 μm, numerous in dense fascicules, 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, terminal, holoblastic, mostly polyblastic, sympodially proliferating. *Conidiogenous loci* 2.5–3.5 μm diam., conspicuous, thickened, and darkened. *Conidia* 39–206 × 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).


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., *l.c.*: 10.


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

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 × 3.5–5 μm, 9 to numerous in dense and divergent fascicules, 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, holoblastic, mostly polyblastic, sympodially proliferating. *Conidiogenous loci* 3.5–5 μm diam., conspicuous, thickened, and darkened. *Conidia* 35–206 × 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).


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


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).


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

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


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 & 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).
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 scutellarioideae* (L.) Codd (*Lamiaceae*), 1 August 2008, Jamjan Meeboon (BBH 23583).


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

Notes – This specimen is a typical of *C. api 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. api 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).


Notes – Four species of *Cercospora s. str.* non *C. api s*. lat. have been reported from the plant family *Lamiaceae*, viz, *C. isanthi* Ellis & Kellerm., *C. physostegiae*, *C. scorodoniae* Unamuno, and *C. teucr ii* 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).


(= *C. api 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 stomata, 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 μm. (Meeboon 2009).

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

to subacicular, 3–10-septate, straight, hyaline, smooth, base obconically truncate, with subacute apex, hila 2–2.5 μm 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. schwarzwurthii*, *C. siphonatus*, *C. speciosissimum*, *C. speciosum*, *C. speciosum*,

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. apiis s.lat.

Literature – Chupp (1954, p. 597).

Malvaceae


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


≡ Cercospora althaeina var. althaeae-officinalis Sául. & Sandu, Hedwigia 73: 127 (1933).


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).
cells. Conidiophores 41–186 × 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 × 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).


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), Tadzhikistan, 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).


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, subgbose, brown to blackish brown. Conidiophores 42–229 × 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 × 2–4.5 μm, solitary, narrow obclavate to subcircular, 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, Pang Da Royal project, on leaves of Ficus carica L. (Moraceae), 18 August 2008, Jamjan Meeboon (BBH 23557).

Hosts – Ficus carica, F. hispida, F. religiosa, F. uliginusa, F. urceolaria, Strybelius 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).


(= C. apii s. lat.)

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 × 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 × 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).


Nyctaginaceae


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 × 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 μm. (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 × 1–9, integrated, terminal, sympodial proliferation. *Conidiogenous loci* 1–3 μm diam., conspicuous, thickened and darkened. *Conidia* 4–112 × 4–8 μm, 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 μm 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 μm. (Meeboon et al. 2008).

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


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 scolecoid conidia (Crous & Braun 2003). It is easily distinguishable from the plurivorous *C. apiisp. lat.* because of pigmented conidiophores, thickened and darkened conidiogenous loci, and hyaline scolecoid conidia (Crous & Braun 2003). It is easily distinguishable from the plurivorous *C. apiisp. 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 *Cercospora cypripedii* Ellis & Deam., *Cercospora dendrobii* H.C. Burnett, *Cercospora odontoglossii* Prill. & Delacr. and *Cercospora peristeriae* H.C. Burnett, which have been excluded and reallocated to the genus *Pseudocercospora* Speg. (Crous & Braun 2003).

*Cercospora angraecii* 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-graecii* in having much longer, occasionally branched conidiophores (Chupp 1954).

*Cercospora cephalantherae* Ondřej & Zavřel, 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**


Leaf spots 1–5 mm in diam., amphiogenous, 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 fascicules, 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).


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).  


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 μm. (Meeboon 2009).

Fig. 57 – Line drawings of Cercospora platyceri on Platycerium wallichii. a. Conidia. b. Conidiophores and stromata. Bars = 50 μm. (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 × 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).


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

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

Pteridaceae


(= C. apiī 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 × 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., conspicuous, thickened and darkened. Conidia 179–283 × 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. 58 – Line drawings of Cercospora cyclosori on Pteris biaurita. a. Conidia. b. Conidiophores and stromata. Bars = 50 μm. (Meeboon 2009).
C. apii s. lat. This species was first reported from Thailand by Meeboon (2009).


Rosaceae

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

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 × 3–5 μm, 4–9 in loose fascicules, 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, holoblastic, polyblastic, sometimes monoblastic, terminal or intercalary, sympodially proliferating. Conidiogenous loci 2–2.5 μm diam., conspicuous, thickened and darkened. Conidia 25–38.5 × 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).

Rubieae


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 × 2.5–5 μm, 9–23 in loose to dense fascicules, 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 × 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. (Rubieae), 12 February 2008, Jamjan Meeboon and Iman Hidayat (BBH 23600).

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, n 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).


*Saururaceae*


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

*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 × 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 × 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 μm. (Meeboon 2009).


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 phylandicola* Ellis & Barthol., Erythea 4: 28 (1896).


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

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


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


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


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

≡ *C. apii s. lat.*
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).

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


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 μm diam., intraepidermal, well-developed, composed of globose to subglobose, brown to blackish brown cells. *Conidiophores* 39.5–127 × 3–4 μm, 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 μm diam., conspicuous, thickened and darkened. *Conidia* 64–165 × 2–5 μm, solitary, long obclavate to subacicular, 6–19-septate, straight, hyaline, smooth, base
obconically truncate, with subacute apex, hila 2.5–3 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).


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. microsporae 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).


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 × 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 integrated, terminal, holoblastic, mostly monoblastic. Conidiogenous loci 2–3 μm diam., conspicuous, thickened and darkened. Conidia 30–71.5 × 3–3.5 μm, solitary, narrowly obclavate, 3–6-septate, straight, hyaline, 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 Solanum torvum Sw. (Solanaceae), 1 August 2008, Jamjan Meeboon (BBH 23719).


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 obclavate conidia.
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**


(*C. apii s.lat.*)

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, holo–blastic, 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**


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).](image-url)
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 × 4.5–6.5 μm, 3–8 in loose to dense fascicules, 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 × 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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