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Taxonomic Studies on *Cercospora* and Allied Genera in Korea (I)

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한국산 *Cercospora* 및 관련 속의 분류학적 연구 (I)

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ABSTRACT: The mycoflora of Korea, especially the cercosporoid taxa, have been poorly studied in the past. For this reason, a systematic revision of these taxa has been initiated, with the eventual aim of producing a monograph of the Korean cercosporoid taxa. The present study circumscribes ten species; viz., *Cercospora althaeina, C. arachidicola, C. armoraciae, C. carotae, C. ipomoeae, Mycovellosiella ferruginea, Passalora miurae, Pseudocercospora araliae, P. cannabina* and *P. vitis*. Distinguishing morphological characteristics are described and illustrated for each species.

KEYWORDS: ***Cercospora, Mycovellosiella, Passalora, Pseudocercospora*, Monograph**

The genus *Cercospora* Speg. is a typical genus of hyphomycetes, known to have teleomorphs in *Mycosphaerella* Johanson. Saccardo (1886) introduced a first comprehensive, but very artificial classification for asexual fungi, mainly based on shape, septation and pigmentation of conidia. The Saccardoan system has strongly influenced hyphomycete taxonomy for almost 100 years.

First attempts to reclassify conidial fungi based on features of the conidiogenesis date back to Hughes (1953). Kendrick (1971) summarized the results of a conference of leading hyphomycetologists dealing with attempts to introduce a clear, concise terminological system of the conidium ontogeny that became standard for the years to come. Minter *et al.* (1982, 1983a, 1983b) carried out optical and electron microscopical studies on developmental types of the conidiogenesis in conidial fungi and demonstrated a continuum of developmental process. They published a new teminological approach which has been adopted by Hawksworth *et al.* (1995). Hennebert & Sutton (1994) discussed the terminology of the structures of conidiogenous cells and features of the conidiogenesis and introduced some attentions.

Cercospora and allied genera are, as far as known, anamorphs of the ascomycetous genus *Mycosphaerella*. They usually cause conspicuous spots that either stay relatively small and separate or may enlarge and coalesce, resulting in conspicuous necrotic spots on leaves, pedicels, flowers, fruits, bracts and seeds (Agrios, 1997). Most species of *Cercospora* and allied genera occur on a wide range of ferns and a great number of economically important cereals, grasses, vegetables, forest trees, ornamental plants and are important plant pathogens. There are also certain species that coexist with the rust fungi, either as hyperparasites, i.e. *Cercospora acori* J.M. Yen parasitizing the uredospores of *Uromyces aparganii* Clint. & Peck or mersely associated, such as *Pseudocercospora anthoclei-*

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stae (J.M. Yen & Gilles) Deighton with *Puçciniosira mitrogynae* Dietel: Syd. & P. Syd. Since Fresenius (1863) introduced the genus *Cercospora*, based on the type species *Cercospora apii* Fresen., which has coloured conidiophores and hyaline, acicular conidia, numerous species of *Cercospora* and allied genera including *Passalora*-like fungi have been described by many mycologists and phytopathologists (Saccardo, 1880, 1886; Lindau, 1907; Ferraris, 1910; Katsuki, 1965).

Some genera were segregated from *Cercospora* to *Cercosporina* and *Pseudocercospora* by Spegazzini (1910). He established *Cercosporina* as a new generic name for reception of those species with hyaline conidia and proposed the generic name *Pseudocercospora* to accommodate *Septonema vitis* Lév. Solheim (1930) and Solheim & Stevens (1931) published the first attempt to divide *Cercospora* sensu lato into several smaller morphological genera. They introduced various sections, based on the presence or absence of superficial mycelium, stromata, branching of the conidiophores, as well as the conidial shape. Later, they reclassified the genus *Cercospora* by adding the features of conidial scars and subdivided the genus into various genera. From these species, they transferred those exhibiting conidial catenulation into a new genus *Raghildiana*.

In 1954, Chupp described 1419 species in his treatment, "*A Monograph of the Fungus Genus Cercospora*". However, he did not accept names other than those in *Cercospora* and *Cercosporina*. Although several mycologists had attempted to split *Cercospora*, he thought there existed many intermediate species which did not allow such a reclassification.

Deighton (1967a, 1967b, 1971, 1973, 1974, 1976, 1979, 1983, 1987), Pons & Sutton (1988) and Braun (1988a, 1988b, 1989, 1990) concluded that the generic conception of *Cercospora* adopted by Chupp (1954) was too wide, and that it could safely be redefined and the genus split into various additional genera to provide a better workable system. Generic separations were established on diverse criteria including ontogeny, pigmentation, and ornamentation of conidia, conidiophores and conidiomata. Deighton (1967a, 1967b, 1971, 1973, 1974, 1976, 1979, 1983, 1987) discussed the development of taxonomic concepts over the more than 100 years of its history and addressed problems concerning generic differentiation in the modern context. He placed considerable emphasis on the presence or absence of thickening in the scars left on the conidiogenous cells after conidial secession. Two distinct taxonomic categories were recognized by Deighton (1976), one in which old conidial scars on conidiogenous cells are thickened to a greater or lesser degree and the other where scars are not thicker than anywhere else on the conidiogenous cell wall. The hilum at the base of conidium is thickened or unthickened in correspondence with the scars left on the conidiogenous cell. In contrast to many genera with thickened scars such as *Camptomeris, Cercospora, Cercosporella, Cercosporidium, Fusicladium, Mycovellosiella, Passalora, Phaeoisariopsis, Phaeoramularia, Ramularia, Sirosporium, Stenella*, etc., the group with unthickened scars includes only *Cercoseptoria, Denticularia, Isariopsis, Mycocentrospora, Pseudocercospora, Pseudocercosporella, Stigma*, etc.

Pons & Sutton (1988) described *Distocercospora* for *Cercospora*-like hyphomycetes with distoseptate scolecospores. Braun (1993a, 1993b, 1993c, 1993d) separated *Pseudocercospora*-like species with percurrent proliferating conidiogenous cells and *Mycosphaerella* teleomorphs from *Stigmina*, and created the new genus *Cercostigmina*. Although Deighton (1967b) separated *Passalora* and *Cercospori-*

dium on account of the presence or absence of a substomatal stroma, Braun (1995a, 1995b) redefined *Cercospora, Passalora* and *Phaeoisariopsis*. He discussed the status of these genera and pointed out 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 substromatal cavities should not be used for generic differentiations within *Cercospora* and allied genera. Sutton (1994) and Braun (1995b, 1996) added some species to *Prathigada* and defined it more precisely. Braun (in Braun & Melnik, 1997) introduced the new genus *Pseudophaeoramularia* for cercosporoid fungi intemediate between *Pseudocercospora* and *Phaeoramularia*.

Mycologists and phytopathologists of Asia or some regions payed attention to the fundamental taxonomic studies and taxonomical changes of the cercosporoid complex. In 1960, Yamamoto & Maeda already enumerated 229 species of the genus under the title of "*Cercospora* species in Japan". Several of these species, however, did not occur in Japan. This study subsequently led to that of Katsuki (1965), who reported 226 species of *Cercospora* from Japan. In Taiwan, Hsieh & Goh (1990) contributed in taxonomic studies of 346 cercosporoid fungi by printing a monograph "*Cercospora* and Similar Fungi from Taiwan". Guo & Hsieh (1995) compiled only the genus *Pseudocercospora* from China, and added numerous unpublished collections deposited in herbaria of this country. Furthermore, Braun & Melnik (1997) compiled a taxonomic and nomenclatural reference list of these fungi in Russia and adjacent countries.

The cercosporoid fungi of Korea are insufficiently known. There have been no comprehensive studies on this group of fungi in Korea. Some phytopathologists intermittently reported 70 species of the Korean cercosporoids through several phytopathological papers (Nakata & Takimoto, 1928; Park, 1958, 1961, 1967). Nakata & Takimoto (1928) reported about 30 species of Korean species belonging to the genera *Cercospora, Cercosporella* and *Cercosporidium* with brief descriptions. Unfortunately, however, their collections were not preserved. Recently, Shin & Braun (1993, 1996) conducted further taxonomic studies of this group of fungi and listed 80 species including 6 new species, 4 new combinations and 1 new variety. The present contribution is the first of series of papers aimed at producing a monograph of the Korean cercosporoid fungi.

Materials and Methods

The specimens studied in this paper and the next series of contribution have been collected by H. D. Shin in various locations of Korea since 1990 and maintained at the mycological herbarium (SMK) at the Department of Agricultural Biology, Korea University. A small piece of the infected tissue from each specimen was mounted in water or lactic acid for examining conidiomata, conidiophores and conidia. Measurements of conidia and other fungal structures were made from 30~50 replicates for each fungus under 400× magnification with the aid of an eyepiece micrometer. Drawing of fungal structures of taxonomic value was prepared under 1000× magnification.

In some cases, microscopic observations were made with the fresh material at the day of collection or during the next day by keeping specimens in polyethylene bags at room temperature. When a dried specimen was needed for additional observation, the herbarium specimen was rehydrated in lactic acid and examined. For resuming the shrunken structures of these fungi, a small piece of the leaf tissue was soaked in a drop of lactic

acid. All of these were carried out on a slide glass, heating it carefully for a few seconds above a small flame. Shortly after cooling it enough to handle, the fungus was carefully scraped away from the leaf tissue with a razor blade and mounted in a drop of lactic acid for light microscopy (Shin, 1990). The mycological characteristics of conidia and conidiophores, viz., shape, size, color, number of septa, scar, stromata, etc. were described and illustrated with the aid of a drawing tube (Olympus DA).

Each specimen was pressed between clean paper sheets and carefully dried for preservation. Herbarium packets were labeled with the host and fungal species, date, collection site and some additional notes.

Descriptions

1. *Cercospora althaeina* Sacc. (Fig. 1)
Michelia 1: 269 (1878)
= *Cercospora kellermanii* Bubák, J. Mycol. 9: 3 (1903)
= *Cercospora ramularia* Siemaszko, Bull. Mus. Caucase. 12: 28 (1919)
= *Cercospora althaeina* var. *althaea-officinalis* Săvul. & Sandu, Hedwigia 73: 127, 128 (1933)
= *Cercospora althaeicola* J.M. Yen & S.K. Sun, Cryptog. Mycol. 4: 189 (1983)
= *Cercospora althaeigena* J.M Yen & S.K. Sun, Cryptog. Mycol. 4: 191 (1983)

Leaf spots on the upper surface scattered to confluent, distinct, angular to irregular, small to large, 1~7 mm diam., olivaceous brown, sometimes grayish brown with dark brown margin, center becoming pale gray with black dots, later turning white; on the lower surface obscure or slightly discoloured. **Caespituli** amphigenous, but mostly epiphyllous. **Mycelium** internal, hyphae septate, branched. **Stromata** moderately developed, composed of

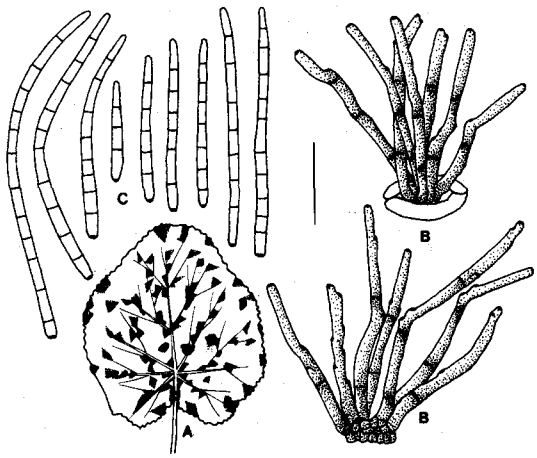

Fig. 1. *Cercospora althaeina*: A, Leaf spots on the upper leaf surface of *Althaea rosea* (0.3×); B, Conidiophores; C, Conidia. Bar=30 μm.

a few brown swollen hyphal cells, emerging through stomata or erumpent through the cuticle. **Conidiophores** 6~12(~20) in a divergent fascicle, pale olivaceous brown at the base and paler upwards, 0~3-septate, substraight to mildly sinuous, 0~2 times mildly geniculate in the upper portion, not branched, 32~90 (~140)×4.0~6.5 μm, conically narrowed at the apex, conidial scars small but conspicuous on the apex and on shoulders caused by geniculation. **Conidia** solitary, filiform, sometimes obclavato-cylindric, straight or mildly curved, hyaline to subhyaline, 1~10(~15)-septate, non-constricted at the septa, obtuse at the apex, subtruncate or obconically truncate at the base, very variable in length, (20~)40~138×3.3~5.0 μm; hilum conspicuously thickened, darkened, and protuberant.

Habitat: On living leaves of *Althaea rosea* Cav. (Malvaceae).

Specimens examined: SMK 10653 (31 X 1990, Kangnung), 10814 (2 VII 1991, Kangnung), 11047 (14 IX 1991, Kangnung), 11166 (1 X 1991, Kangnung), 11170 (1 X 1991, Kangnung), 11379 (23 X 1991, Kangnung), 11477 (6 XI 1991, Kangnung), 11480 (12 XI 1991, Kangnung), 13037 (21 IX 1994, Pyongchang), 13265 (29 X 1994, Chunchon), 13337 (5 XI

1994, Suwon), 13450 (5 XI 1994, Kangnung), 13453 (7 XI 1994, Kangnung), 13733 (30 X 1996, Suwon), 14436 (17 X 1997, Suwon).

Distribution: Nearly throughout the world wherever the plant is cultivated, including China, Japan, Korea and Taiwan.

Notes: Park (1967) and Shin & Braun (1993) listed this leaf spot fungus on *A. rosea* from Korea. According to Yen & Sun (1983), *Cercospora althaeigena* on *A. rosea* is different from this fungus in having coloured obclavate or obclavato-cylindric to cylindric conidia. They also recorded *Cercospora althaeicola* on *A. rosea*, which differs from the present species in its indistinct leaf spots and cylindric conidia. However, subhyaline and obclavato-cylindric conidia have also been observed in the present Korean collections, and indistinct leaf spots are present on the lower surface in these specimens. The conidial shape and pigmentation is very variable in *C. althaeina*. Hence, *C. althaeigena* and *C. althaeicola* are reduced to synonymy with this species.

2. *Cercospora arachidicola* Hori (Fig. 2)

Nishigahara Agric. Expt. Stat. Tokyo Ann. Rept. p. 26 (1917)

= *Cercospora arachidis* var. *macrospora* Maffei, Riv. Pat. Veget. 12: 7 (1922)

Teleomorph: *Mycosphaerella arachidis* Deighton, Trans. Brit. Mycol. Soc. 50: 328 (1967)

Leaf spots scattered, rarely confluent, distinct, circular or subcircular to irregular, small to fairly large, 1~12 mm diam., dark to blackish brown, on the upper surface surrounded by a yellow halo. **Caespituli** amphigenous, but mostly epiphyllous. **Mycelium** internal, hyphae septate, branched. **Stromata** slightly to moderately developed. **Conidiophores** 5~10(~16) in a fascicle, pale olivaceous brown at the base and paler upwards, 0~2-septate, straight or 1~2 times mildly geniculate in the upper portion, not branched, (24~)30~72(~96)×3.5~6.5 μm, conically narrowed at the apex, conidial scars small but conspicuous on the apex and on shoulders caused by geniculation. **Conidia** solitary, filiform or narrowly obclavate to obclavato-cylindric, straight to slightly curved, subhyaline to pale olivaceous due to dense cytoplasm and minute oil drops, 3~10(~13)-septate, non-constricted at the septa, subobtuse or broadly rounded at the apex, truncate or obconically truncate at the base, 30~120×4.0~5.5 μm; hilum conspicuously thickened, darkened, and non-protuberant.

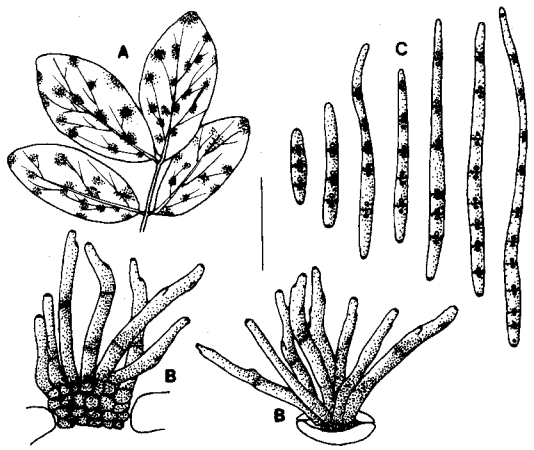

Fig. 2. *Cercospora arachidicola*: A, Leaf spots on the upper leaf surface of *Arachis hypogaea* (0.4×); B, Fascicle of conidiophores; C, Conidia. Bar=30 μm.

Habitat: On living leaves of *Arachis hypogaea* L. (Leguminosae).

Specimens examined: SMK 12579 (29 VIII 1993, Yangku), 12970 (5 IX 1994, Chunchon), 13003 (13 IX 1994, Chonju).

Distribution: Nearly throughout the world wherever the crop is cultivated, including China, Japan, Korea and Taiwan.

Notes: Park (1961) first recorded this fungus from Korea, and Shin & Braun (1996) included it in a paper dealing with Korean cercosporoid fungi. The less dense fascicle, the mildly geniculate conidiophores and the

truncate or obconically truncate bases of the conidia separate it from other cercosporoid species on hosts of this family, especially from *C. personata* (Berk. & Curt.) Ellis & Everh. which has cylindric conidia, 5~7 μm wide. This species grows often together with *C. personata* on the same leaves. Microscopically it is very different from the latter.

3. *Cercospora armoraciae* Sacc. (Fig. 3)
Nuovo Giorn. Bot. Ital. 8: 188 (1876)

Leaf spots scattered, often confluent, distinct, circular to irregular, without definite margin, at first pale tan to dingy gray with narrow brown margin, later dirty gray due to abundant production of conidiophores and conidia. **Caespituli** amphigenous. **Mycelium** internal, hyphae septate, branched. **Stromata** poorly developed, composed of a few swollen hyphal cells. **Conidiophores** 3~9 in a divergent fascicle, uniformly olivaceous brown throughout or paler upwards, 4~6-septate, straight to 1~2 times mildly geniculate in the upper portion, not branched, 50~124×4.0~6.5 μm, conidial scars small but conspicuous. **Conidia** solitary, filiform to somewhat acicular, substraight to slightly curved, hyaline to subhyaline, 4~13-septate, non-constricted at the septa, obtuse to subobtuse at the apex, subtruncate at the base, 60~153×3.5~5.0 μm; hilum conspicuously thickened, darkened, and protuberant.

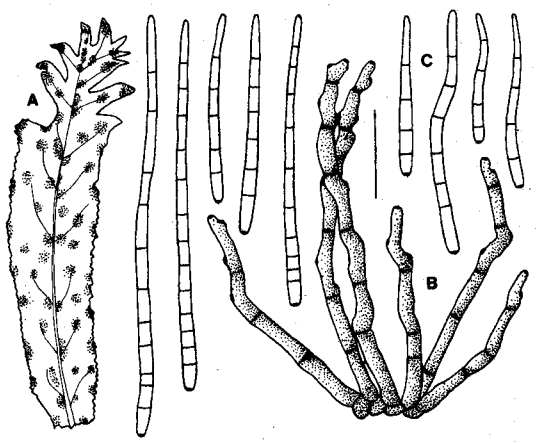

Fig. 3. *Cercospora armoraciae*: A, Leaf spots on the lower leaf surface of *Armoracia lapathifolia* (0.2×); B, Conidiophores; C, Conidia. Bar=30 μm.

Habitat: On living leaves of *Armoracia lapathifolia* Gilib. (Cruciferae).

Specimens examined: SMK 10938 (29 VII 1991, Suwon), 12555 (20 VIII 1993, Suwon), 12977 (12 IX 1994, Suwon), 13334 (5 XI 1994, Suwon).

Distribution: Canada, USA, England, Italy, Sweden, Korea, Philippines, Australia, New Zealand and Africa.

Notes: Shin & Braun (1993) first listed this fungus from Korea, and Shin (1995b) provided a brief description based on Korean material. The conidiophores and conidia of the Korean collections are generally longer than those described by Chupp (1954) on *Armoracia rusticana*. The conidiophores and conidia are very variable, and the conidiophores are formed in relatively loose fascicles. The length of conidiophores and conidia is, however, generally variable in species of *Cercospora* s. str.

4. *Cercospora carotae* (Pass.) Kazn. & Siemazko (Fig. 4)
Zbl. Bakt. 2, 78: 115 (1929)
≡ *Cercospora carotae* (Pass.) Solheim, Biol. Monogr. 12: 43 (1929)
≡ *Cercospora apii* var. *carotae* Pass., Atti Real. Accad. Lincei, Roma., Ser. 4, 6: 469 (1889)

Leaf spots scattered or often confluent, subcircular to elliptic or angular to irregular when coalescing, 2~8 mm diam., grayish to blackish brown; also on petioles causing oblong to elliptic gray lesion. **Caespituli** amphigenous, fluccose-velutinose, grayish. **Mycelium** internal, hyphae septate, branched.

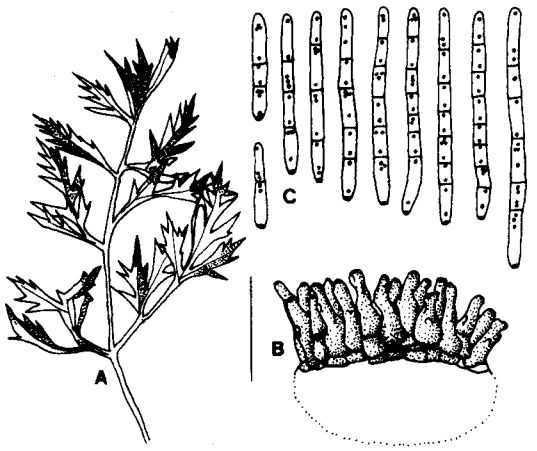

Fig. 4. *Cercospora carotae*: A, Leaf spots on the lower leaf surface of *Daucus carota* var. *sativa* (0.4×); B, Conidiophores; C, Conidia. Bar=30 μm.

Stromata well-developed, slightly erumpent, globular. **Conidiophores** densely fasciculate, pale olivaceous brown at the base, but paler upwards, 0~1-septate at the base, 0~2 times slightly geniculate in the apical portion, usually bulbous at the base, not branched, 15~40×2.8~4.5 μm, up to 7 μm at the base, conidial scars small and conspicuous. **Conidia** solitary, filiform to cylindric, straight to very slightly curved, hyaline to subhyaline due to minute oil drops, 1~7(~9)-septate, usually non-constricted at the septa but very slightly constricted in shorter conidia, obtuse at the apex, short-obconic to rounded at the base, 34~108×3.5~6.0 μm; hilum conspicuously thickened, darkened, and slightly protuberant.

Habitat: On living leaves and petioles of *Daucus carota* var. *sativa* Hoffm. (Umbelliferae).

Specimen examined: SMK 13042 (22 IX 1994, Kangnung).

Distribution: Nearly throughout the world wherever the crop is cultivated, including Japan, China, Korea and Taiwan.

Notes: Park (1967) and Shin & Braun (1996) listed this fungus from Korea, based on Korean material. Hsieh & Goh (1990) described Taiwanese collection (not seen!) from carrot as *Pseudocercosporella daucicola* by its short and narrow conidiophores (5~20×2~3 μm) and unthickened conidial scars. However, *P. daucicola* may be synonymous with this species.

5. *Cercospora ipomoeae* G. Winter (Fig. 5)
Hedwigia 26: 34 (1887)
= *Cercospora viridula* Ellis & Everh., J. Mycol. 5: 70 (1889)
= *Cercospora alabamensis* G.F. Atk., J. Elisha Mitchell Sci. Soc. 8: 51 (1892)
= *Cercospora stuckertiana* Syd. & P. Syd., Mem. Herb. Boissier 8(4): 2 (1900)
= *Cercospora ipomoeae-illustriae* Chidd., Ind. Phytopath. 12: 114 (1959)
= *Cercospora ipomoeae-pes-caprae* J.M. Yen & Lim, Bull. Soc. Mycol. Fr. 86(3): 747 (1970)

Leaf spots scattered or confluent, distinct, circular, often zonate, small to fairly large, 1~8 mm diam., center pale tan to dingy gray, with dark or purplish brown margin, sometimes surrounded by a narrow dark brown margin, later grayish brown due to abundant fructification of the fungus. **Caespituli** amphigenous, but abundantly hypophyllous. **Mycelium** internal, hyphae septate, branched. **Stromata** rudimentary to slightly developed, composed of several brown hyphal cells. **Conidiophores** 4~12 in a divergent fascicle, usually pale olivaceous brown throughout or sometimes paler towards the apex, 0~2(~3)-septate, 1~3 times slightly geniculate in the apical portion, not branched, 35~216×3.5~6.0 μm, conidial scars large and conspicuous, apical and at small shoulders caused by geniculation. **Conidia** solitary, acicular, occasionally obclavate, straight to mildly curved, gradually narrowed towards the tip, hyaline, 2~22-septate, non-constricted at the septa, su-

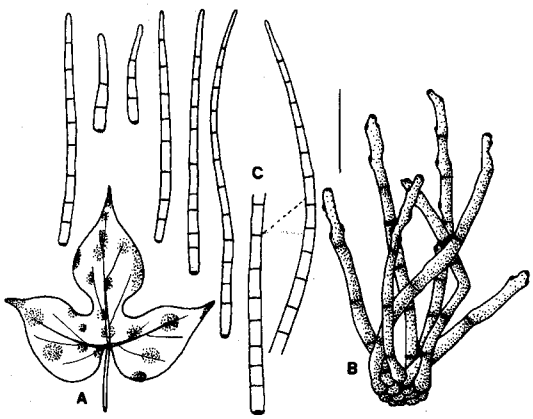

Fig. 5. *Cercospora ipomoeae*: A, Leaf spots on the lower leaf surface of *Pharbitis nil* (0.3×); B, Fascicle of conidiophores; C, Conidia. Bar=30 μm.

bacute at the apex, truncate at the base, very variable in length, 28~224×3.0~4.5 μm; hilum conspicuously thickened, darkened, and protuberant.

Habitat: On living leaves of *Pharbitis nil* Chois. (Convolvulaceae).

Specimens examined: SMK 11940 (10 IX 1992, Chunchon), 14409 (12 X 1997, Dongduchon), 14411 (22 X 1997, Dongduchon), 14805 (19 VIII 1998, Chunchon).

Distribution: Nearly throughout the world wherever the plant is growing, including China, Japan, Korea and Taiwan.

Notes: Shin & Braun (1993) first listed this species from Korea. Shin (1995) provided a brief description based on Korean materal. Hsieh & Goh (1990) described *Cercospora ipomoeae* from Taiwan on *Ipomoea accminata* and *I. aquatica* with comparatively short conidiophores (15~150 μm) and narrow conidia (2~4 μm). *C. ipomoeae-pes-caprae* J.M. Yen & Lim (1970) agrees in general with our Korean collection, but the conidiophores (20~40 μm) and conidia (44~115 μm) are shorter. Although the conidiophores (34~136, rarely up to 173 μm) and conida (20~125 μm) are shorter, *C. ipomoeae-illustriae* Chidd. (1959) from India is in accordance with our Korean material. The conidiophores (35~216 μm long) and conidia (28~224 μm long) in *C. ipomoeae* are, however, extremely variable. Therefore, *C. ipomoeae-pescaprae* and *C. ipomoeae-illustriae* may be reduced to synonymy with this species.

6. *Mycovellosiella ferruginea* (Fuckel) Deighton (Fig. 6)

Mycol. Papers 144: 14 (1979)

≡ *Cercospora ferruginea* Fuckel, in Fresenius, Beitr. Mykol. 3: 93 (1863)

= *Cercospora olivacea* Otth, Mitt. Naturf. Ges. Bern. 1868: 65 (1869)

= *Helminthosporium absinthii* Peck, Ann. Rep. N.Y. State Mus. 30: 54 (1878)

≡ *Cercospora absinthii* (Peck) Sacc., Syll. Fung. 4: 444 (1886)

= *Cercosporidium artemisiae* Sawada, Taiwan Agric. Res. Inst. Rept. 86: 164 (1943) (nomen non rite publicatum, sine descriptione latina)

Leaf spots on the lower surface scattered to confluent, subcircular to irregular, effuse, 2~10 mm diam., without definite margin, dingy to dark brown or even blackish; on the upper surface at first inconspicuous, later appearing as indefinite yellowish discolorations. **Caespituli** almost entirely hypophyllous, but rarely also epiphyllous, velutinous, effuse, blackish brown. **Primary mycelium** internal, hyphae septate, branched. **Secondary mycelium** external, secondary hyphae septate, branched, emerging from substomatal stromata, creeping on the host surface or entangled with leaf hairs. **Stromata** rudimentary or very slightly developed, composed of a few brown hyphal cells. **Conidiophores** 2~10(~13) in a loose fascicle, arising from stomata, brown to olivaceous brown at the base, paler upwards, 6~11-septate, straight to mildly sinuous, sometimes branched above the middle or at the base, usually wider in the upper

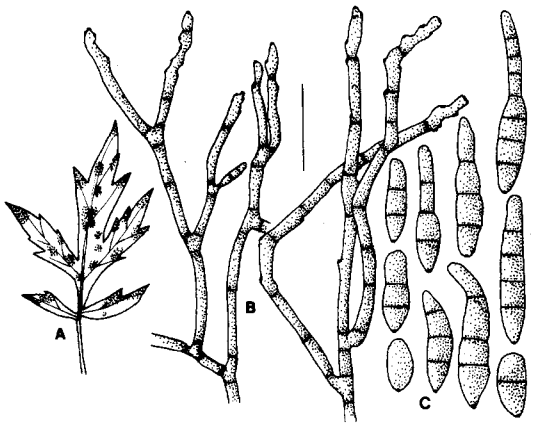

Fig. 6. *Mycovellosiella ferruginea*: A, Leaf spots on the lower leaf surface of *Artemisia argyi* (0.4×); B, Branched conidiophores borne on external mycelium; C, Conidia. Bar=30 μm.

portion, 4.0~5.5 μm wide, up to 500 μm long, conidial scars small but conspicuous, apical. **Conidia** solitary, obclavate to nearly ellipsoid-ovoid or turbinate, straight to slightly curved, pale olivaceous brown, 0~5(~7)-septate, usually non-constricted, sometimes moderately constricted at some septa, obtuse to rounded at the apex, obconically attenuated to rounded at the base, variable in length, 16~70× 6.5~10.5 μm; hilum conspicuously thickened, darkened, and protuberant.

Habitat: On living leaves of *Artemisia* spp. (Compositae).

Specimens examined: On *Artemisia argyi* Lév. & Vent., SMK 13145 (2 X 1994, Yangku), 14308 (27 IX 1997, Chunchon); On *A. feddei* Lév. & Vent., SMK 13144 (2 X 1994, Yangku); On *A. kodzumii* Nakai, SMK 14161 (14 IX 1997, Chunchon).

Distribution: Canada, USA, Europe, Burma, China, India, Korea and Taiwan.

Notes: Shin (1995b) reported this fungus from Korea on *Artemisia argryi* and *A. feddei* and added a brief description. The conidiophores mostly arise terminally and as lateral branches of secondary hyphae, but sometimes they emerge in small or even distinct fascicles directly through stomata. Chupp (1954) distinguished *C. ferruginea* (syn. *M. ferruginea*) from *C. olivacea* by the presence of stromata, but this feature is variable and of little taxonomic importance. Superficial secondary mycelium is not always well-developed.

7. *Passalora miurae* (Syd. & P. Syd.) U. Braun & H.D. Shin (Fig. 7)

Mycotaxon 49: 354 (1993)

≡ *Cercospora miurae* Syd. & P. Syd., Annls Mycol. 11: 117 (1913)

≡ *Cercosporidium miurae* (Syd. & P. Syd.) X.J. Liu & Y.L. Guo, Acta Mycol. Sinica 1(2): 98 (1982)

Leaf spots on the lower surface scattered to confluent, distinct, at first without definite margin or clearly vein-limited, later covering the whole leaf surface, 3~10 mm diam., dingy to dark brown; on the upper surface appearing as indefinite yellowish discolorations. **Caespituli** hypophyllous, effuse, velvety, blackish brown due to abundant fungal fructification. **Mycelium** internal, hyphae septate, branched. **Stromata** slightly developed, composed of a few swollen brown hyphal cells forming aggregations. **Conidiophores** 3~21 in a divergent fascicle, arising through stomata, brown to olivaceous brown at the base, paler upwards, 1~8(~12)-septate, substraight, 1~3 times geniculate in the upper portion, usually not branched, but sometimes once branched below the middle, 44~110(~154)× 3.2~5.0 μm, sometimes apically swollen, up to 8 μm, conidial scars conspicuous, and apically concentrated. **Conidia** solitary, obclavate, slightly to mildly curved at the middle part, uniformly olivaceous brown to dark brown, 1~3(~4)-septate, non-constricted, sometimes very slightly constricted at some septa, obtuse to rounded at the apex, long obconic at the base, 12~43×5.5~9.0 μm; hilum slightly thickened,

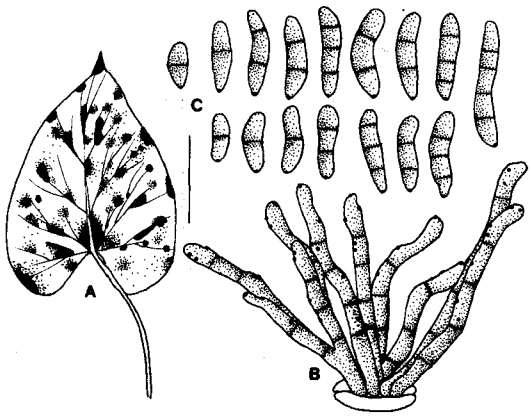

Fig. 7. *Passalora miurae*: A, Leaf spots on the lower leaf surface of *Metaplexis japonica* (0.4×); B, Conidiophores; C, Conidia. Bar= 30 μm.

darkened, and slightly protuberant.

Habitat: On living leaves of *Metaplexis japonica* (Thunb.) Makino (Asclepiadaceae).

Specimens examined: SMK 10433 (22 IX 1990, Kangnung), 10453 (24, IX 1990, Kangnung), 10488 (2 X 1990, Chunchon), 10927 (26 VII 1991, Kangnung), 11948 (10 IX 1992, Chunchon), 12654 (3 IX 1993, Chunchon), 13126 (2 X 1994, Yangku), 13276 (29 X 1994, Chunchon).

Distribution: China, Japan, Korea and Russia.

Notes: Shin & Braun (1993) first listed this fungus from Korea, and Shin (1995a) added a brief description based on Korean material. The short and broad conidia with few (usually 1~3) septa are one of the important features of this species. In most collections examined, the conidia usually did not exceed 45 μm in length. Based on slightly thickened conidial scars and obclavate, pigmented only 1~3(~4)-septate conidia, Shin & Braun (1993) placed this species in *Passalora*.

8. *Pseudocercospora araliae* (Henn.) Deighton (Fig. 8)

Mycol. Papers 140: 19 (1976)

≡ *Cercospora araliae* Henn., Bot. Jahrb. 31: 742 (1902)

≡ *Cercosporiopsis araliae* (Henn.) Miura, Flora of Manchuria and East Mongolia. Part III (Cryptogams, Fungi). p. 533 (1928)

Leaf spots on the upper surface, at first indistinct, subcircular to irregular, ca. 2~10 mm diam., without definite margin, later pale yellowish to brown. **Caespituli** hypophyllous, effuse, vein-limited, velutinous, forming dark brown patches. **Mycelium** internal, hyphae septate, branched. **Stromata** rudimentary or slightly developed, substomatal, composed of a few brown swollen hyphal cells. **Conidiophores** 3~8(~11) in a loose fascicle, olivaceous brown throughout or paler upwards, darker than conidia, 3~5(~6)-septate, branched at the base or at the middle, substraight to mildly sinuous, not geniculate, 58~190× 3.5~5.5 μm, conidial scars inconspicuous. **Conidia** solitary, obclavato-cylindric or clavato-turbinate, straight to mildly curved or sometimes slightly sigmoid, pale olivaceous brown, usually guttulate in constricted spores, 3~7 (~8)-septate, some septa inconspicuous by some oil drops or vacuoles, usually non-constricted, but some spores constricted at the septa, obtuse at the apex, obconically truncate at the base, 35~93×4.0~5.5 μm; hilum unthickened, not darkened.

Habitat: On living leaves of *Aralia elata* Seem. (Araliaceae).

Specimens examined: SMK 13084 (28 IX 1994, Kangnung), 13174 (18 X 1994, Kangnung), 14342 (4 X 1997, Pochun).

Distribution: China, Japan, Korea and Taiwan.

Notes: Shin (1995b) recorded this fungus from Korea on *Aralia elata* and added a brief description. The conidial septa are often not very conspicuous, caused by numerous vacuoles and minute oil drops. Based on Chinese material, Guo & Hsieh (1995) described well-developed external mycelium. In all Korean collections, secondary mycelium could not be observed, but the formation of external hy-

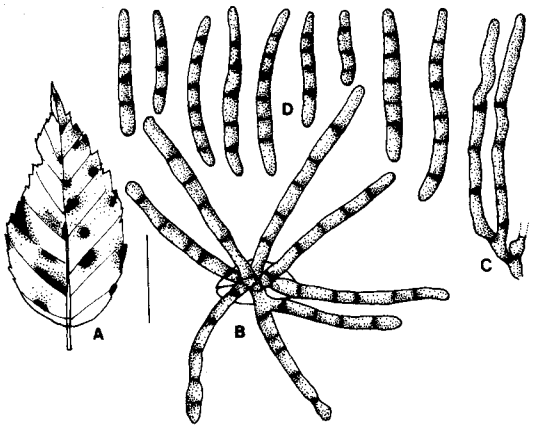

Fig. 8. *Pseudocercospora araliae*: A, Leaf spots on lower leaf surface of *Aralia elata* (0.3×); B, Conidiophores; C, Upper portion of branched conidiophores; D, Conidia. Bar= 30 μm.

phae is often variable in *Pseudocercospora*.

9. *Pseudocercospora cannabina* (Wakef.) Deighton (Fig. 9)

Mycol. Papers 140: 141 (1976)

≡ *Cercospora cannabina* Wakef., Kew Bull. 1917: 314 (1917)

= *Cercospora cannabis* Hara & Fukui, Dis. Cult. Plant. p. 594 (1925)

= *Cercospora hosodai* Fukui, J. Plant Prot. (Japan) 12: 448 (1925)

Leaf spots on the upper surface, at first inconspicuous to slightly discoloured, but later pale yellowish, irregular to subcircular, 1~6 mm diam., without definite margin. **Caespituli** hypophyllous, effuse, vein-limited, dark brown patches, velutinous. **Mycelium** internal, hyphae septate, branched. **Stromata** rudimentary or poorly developed, forming substomatal hyphal aggregations. **Conidiophores** 1~5(~8) in a loose fascicle, olivaceous brown or brown throughout, darker than conidia or concoloured, 3~9-septate, 0~3 times branched near the middle, substraight to slightly sinuous, not geniculate, 40~150×3.5~5.0 μm, conspicuously narrowed at the apex,

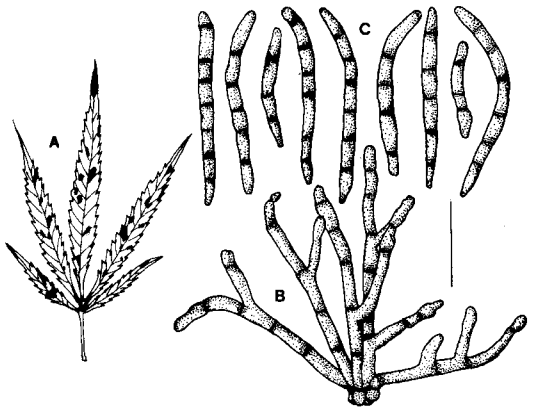

Fig. 9. *Pseudocercospora cannabina*: A, Leaf spots on the upper leaf surface of *Cannabis sativa* (0.3×); B, Conidiophores; C, Conidia. Bar=30 μm.

conidial scars inconspicuous. **Conidia** solitary, filiform to obclavato-cylindric, straight to curved, very pale olivaceous brown, vacuolate, 3~7-septate, usually not constricted at the septa, but in some conidia slightly constricted at the septa, broadly rounded at the apex, obconically truncate to truncate at the base, 35~90×3.5~5.5 μm; hilum unthickened, and not darkened.

Habitat: On living leaves of *Cannabis sativa* L. (Moraceae).

Specimens examined: SMK 12982 (12 IX 1994, Suwon).

Distribution: USA, USSR, Cambodia, China, India, Japan, Korea, Pakistan and Uganda.

Notes: Nakata & Takimoto (1928) and Park (1967) reported this fungus from Korea as *Cercosporina cannabis* and *Cercospora cannabis*, respectively. The present Korean specimen somewhat differs from Chinese collections described by Guo & Hsieh (1995) on *Cannabis sativa* in having rather long conidiophores (40~150 μm) and non-constricted conidia (only occasionally constricted), but the length of conidiophores and the shape of conidia are only of little taxonomic value.

10. *Pseudocercospora vitis* (Lév.) Speg. (Fig. 10)

Ann. Mus. Nac. Hist. Nat. B. Aires 20: 438 (1910)

≡ *Septonema vitis* Lév., Ann. Sci. Nat. Bot., Ser. III. 9: 261 (1848)

≡ *Cladosporium vitis* (Lév.) Sacc., Mycol. Venet. No. 284 (1875)

≡ *Cercospora vitis* (Lév.) Sacc., Nuovo Giorn. Bot. Ital. 8: 188 (1875)

≡ *Helminthosporium vitis* (Lév.) Pirotta, Rev. Mycol. 11: 185 (1889)

≡ *Phaeoisariopsis vitis* (Lév.) Sawada, Rep. Dept. Agric. Govt. Res. Inst. Formosa 2: 164 (1922)

≡ *Cercosporiopsis vitis* (Lév.) Miura, Flora of Manchuria and East Mongolia. III (Cryptogams, Fungi). p. 527 (1928)

= *Cladosporium viticolum* Ces., Flora 38: 206 (1854)

≡ *Cercospora viticola* (Ces.) Sacc., Syll. Fung. 4: 485 (1886)

= *Cladosporium ampelinum* Pass., Erb. Critt. Ital., Ser. 2, n. 595 (1872)

= *Graphium clavisporum* Berk. & Cooke, Grevillea 3: 100 (1874)

≡ *Isariopsis clavispora* (Berk. & Cooke) Sacc., Syll. Fung. 4: 631 (1886)

= *Cercospora vitis* (Lév.) Sacc. var. *rupestris* Cif., Annls Mycol. 20: 45 (1922)

Teleomorph: *Mycosphaerella personata* Higgins, Am. J. Bot. 16: 287 (1929)

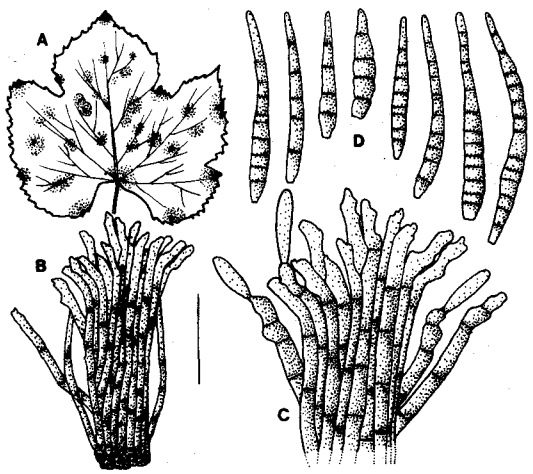

Fig. 10. *Pseudocercospora vitis*: A, Leaf spots on the upper leaf surface of *Vitis vinifera* (0.1×); B, Coremioid fascicle of conidiophores; C, Upper portion of conidiophores showing the apices; D, Conidia. Bar=30 μm (but 60 μm for B).

Leaf spots scattered, subcircular to irregular, 1~10 mm diam., sometimes confluent, at first with dark or grayish brown to purplish brown center, later reddish brown with indefinitely purplish margin, then turning to almost black, finally center becoming grayish white, gray, pale brown, the margin surrounded by a pale brown to dark brown border line. **Caespituli** amphigenous, but mostly hypophyllous. **Mycelium** internal, hyphae septate, branched. **Stromata** well-developed, globular, pale brown to moderately dark brown. **Conidiophores** ca. 6~40 in a densely packed coremioid fascicle, synnematous, pale olivaceous to dark brown, 4~8-septate, not branched, substraight to mildly sinuous, or somewhat geniculate at the apex, (90~)120~300×3.0~5.5 μm, sometimes up to 500 μm long, conidial scars inconspicuous, sometimes denticle-like. **Conidia** solitary, obclavate to obclavato-cylindric, straight to mildly curved, varying from rather pale olivaceous to dark brown, 4~11(~14)-septate, non-constricted to constricted at the septa, smooth or often wrinkled-rough, broadly rounded at the apex, obconically truncate at the base, 45~90×5.0~9.0 μm; hilum unthickened, and not darkened.

Habitat: On living leaves *Vitis amurensis* Rupr. and *Vitis vinifera* L. (Vitaceae).

Specimens examined: On *Vitis amurensis*, SMK 10988 (31 VIII 1991, Kangnung), 11939 (10 IX 1992, Chunchon), 12992 (13 IX 1994, Taejon), 14062 (26 VIII 1997, Kangnung), 14175 (15 IX 1997, Chunchon); On *Vitis vinifera*, SMK 12270 (23 X 1992, Kangnung), 12980 (12 IX 1994, Suwon), 13205 (25 X 1994, Kangnung), 13694 (29 IX 1996, Kangnung) 13726 (10 X 1996, Kangnung), 14193 (15 IX

1997, Yangku).

Distribution: Nearly throughout the world wherever the host plants are cultivated or growing, including China, Japan, Korea and Taiwan.

Notes: Nakata & Takimoto (1928), Park (1958, 1967), Shin & Braun (1993) listed the present fungus from Korea as a causal agent of leaf spots on *Vitis vinifera*, and Shin (1997) provided it with a brief description based on Korean collection from *V. amurensis*. The conidial scars are sometimes denticle-like, situated on small shoulders caused by sympodial proliferation. The conidia vary from pale olivaceous to rather deep brown (slender ones are pale but stouter ones are darker in colour).

Acknowledgements

This study was partly supported by the Korea Science & Engineering Foundation (Grant No. 941-0600-043-2). Dr. Uwe Braun, Martin-Luther Universität, Germany, and Prof. Dr. P. W. Crous, University of Stellenbosch, South Africa, kindly reviewed the manuscript.

적 요

지금까지 국내에서는 *Cercospora* 및 관련 속의 진균을 여러 식물병리학자들이 산발적으로 보고하였으나, 이들에 대한 분류학적 연구가 체계적으로 이루어지지 못한 실정이다. 본 연구는 지금까지 보고된 한국산 *Cercospora* 및 관련 속의 진균을 최근의 분류체계에 따라 재검토하고 monograph를 작성하기 위하여 실시하였다. 각 시료는 1990년부터 국내에서 채집하여 고려대학교 농생물학과 진균표본보관소(SMK)에 보존하고 있다. 이번 보고에서는 *Cercospora* 5종, *Mycovellosiella* 1종, *Passalora* 1종 및 *Pseudocercospora* 3종에 대한 균학적 특징을 기재, 묘사하였다.

접시꽃에서 *Cercospora althaeina*, 땅콩에서 *C. arachidicola*, 겨자무에서 *C. armoraciae*, 당근에서 *C. carotae*, 나팔꽃에서 *C. ipomoeae*, 빵쑥과 황해쑥 및 율무쑥에서 *Mycovellosiella ferruginea*, 박주가리에서 *Passalora miurae*, 두릅나무에서 *Pseudocercospora araliae*, 삼에서 *P. cannabina*, 그리고 왕머루와 포도에서 *P. vitis*를 각각 동정하였다.

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