

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

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### 한국산 *Cercospora* 및 관련 속의 분류학적 연구 (IV)

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**ABSTRACT:** This paper is a fourth contribution towards taxonomic studies on *Cercospora* and allied genera, and contains ten species of Korean cercosporoid fungi; viz. *Cercospora capsici*, *C. cardaminae*, *C. nasturtii*, *Phacellium episphaerium*, *Pseudocercospora chengtzensis*, *P. diospyri-morrisianae*, *Pseudocercospora capsellae*, *Ramularia armoraciae*, *R. lamii* var. *lamii*, and *R. pratensis* var. *pratensis*. Morphological characteristics of taxonomic value are described and drawn for these species to contribute towards a mycological monograph of Korean cercosporoid fungi.

**KEYWORDS:** *Cercospora*, *Phacellium*, *Pseudocercospora*, *Pseudocercospora*, *Ramularia*, Monograph

In previous contributions of this series (Kim and Shin, 1998a, 1998b, 1998c), 30 cercosporoid fungi from Korea including 12 species belonging to *Cercospora*, 1 to *Cercospora*, 1 to *Distocercospora*, 2 to *Mycovellosiella*, 3 to *Passalora*, 1 to *Phaeoisariopsis*, 7 to *Pseudocercospora* and 3 to *Ramularia* have been reported. In the present paper, based on Korean specimens, 10 cercosporoid fungi, 3 species belonging to *Cercospora*, 1 to *Phacellium*, 2 to *Pseudocercospora*, 1 to *Pseudocercospora* and 3 to *Ramularia* are described and illustrated. The specimens examined are preserved at the mycological herbarium (SMK) at the Department of Agricultural Biology, Korea University, Seoul, Korea.

### Descriptions

1. *Cercospora capsici* Heald & F.A. Wolf (Fig. 1)  
Mycologia 3: 15 (1911)

Leaf spots scattered, distinct, circular to sub-circular, 2~10 mm diam., at first appearing greenish brown, then becoming brown to yellowish brown concentric lesions, center whitish gray surrounded by raised blackish brown border line; on the lower surface brown to yellowish brown with or without reddish brown margin. **Caespituli** amphigenous, later appearing as grayish brown due to abundant fungal fructification. **Mycelium** internal, hyphae septate, branched. **Stromata** lacking to rudimentary, composed of a few swollen brown hyphal cells. **Conidiophores** 3~15 in a divergent fascicle, emerging through stomata or erumpent through the cuticle, olivaceous to brown, paler upwards, 0~6-septate, straight to slightly curved, sometimes mildly sinuous, 1~3 times geniculate, not branched, 28~120×3.0~5.5(~6.5) μm, conidial scars large and conspicuous, apical or on shoulders caused by geniculation. **Conidia** solitary, acicular to filiform, straight to mildly curved, hyaline, 2~12-

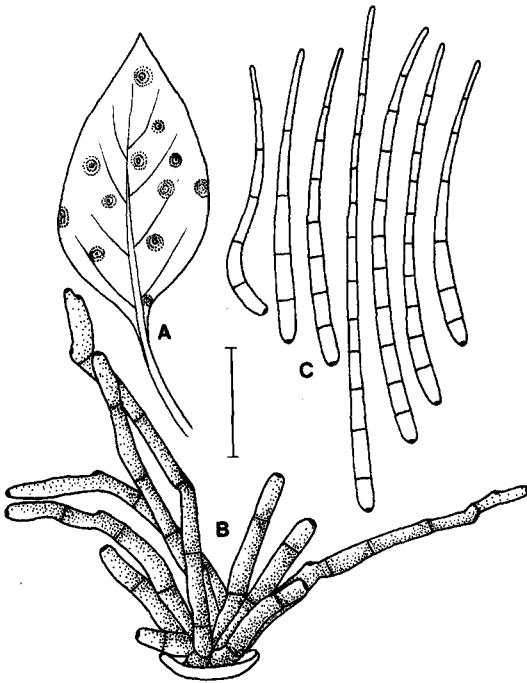


Fig. 1. *Cercospora capsici*: A, Leaf spots on the upper leaf surface of *Capsicum annuum* (0.5 $\times$ ); B, Conidiophores; C, Conidia. Bar= 30  $\mu$ m.

septate, usually non-constricted at the septa, subacute at the apex, obconically truncate at the base, 64~180 $\times$ 4.0~5.5  $\mu$ m; hilum conspicuously thickened, darkened, and non-protuberant.

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

**Specimens examined:** SMK 12287 (25 X 1992, Kangnung), 14183 (25 IX 1997, Yangku), 14244 (27 IX 1997 Chunchon), 14263 (27 IX 1997, Chunchon), 14876 (21 VIII 1998, Hongchon), 15436 (9 X 1998, Chunchon).

**Distribution:** Cuba, Haiti, Mexico, Puerto Rico, USA, Venezuela, Virgin Islands, Spain, Bangladesh, Brunei, Burma, China, India, Japan, Korea, Nepal, Philippines, Singapore, Ghana, Malawi, Sudan, Tanzania, Uganda and Zaire.

**Notes:** Chung *et al.* (1977), Sung *et al.* (1984) and Shin and Braun (1993) listed this fungus

from Korea. Cho *et al.* (1997) added a brief morphological report based on a Korean material. Katsuki (1965) described this fungus on the same host species from Japan with cylindrical to cylindro-obclavate, and olivaceous conidia. Kirk (1982) described conidial scars are only on small shoulders caused by geniculation. These differences are, however, only of little taxonomic importance, since these features are variable.

## 2. *Cercospora cardaminae* Losa España (Fig. 2)

Anal. Jard. Bot. Madrid 6 (Part 1): 453 (1946)

**Leaf spots** scattered to confluent, distinct, circular to angular, vein-limited, 1~10 mm diam., first pale olivaceous brown without definite margin, later center appearing grayish brown with dark brown border line. **Caespituli** amphigenous, mostly hypophyllous. **Mycelium** internal, hyphae septate, branched. **Stromata** lacking to rudimentary. **Conidiophores** 4~10 in a loose fascicle, emerging through stomata and erumpent through the cuticle, olivaceous brown throughout, straight to slightly curved, 2~5 times slightly geniculate, not branched, 2~4-septate, 32~112 $\times$ 4.0~5.5  $\mu$ m, conidial scars large and conspicuous, apical or on shoulders caused by geniculation. **Conidia** solitary, filiform to obclavate-cylindric, hyaline, straight to mildly curved, 3~10-septate, obtuse to subobtuse at the apex, truncate to subtruncate at the base, non-constricted at the septa, 30~120 $\times$ 4.0~5.5  $\mu$ m; hilum conspicuously thickened, darkened, and non-protuberant.

**Habitat:** On living leaves of *Cardamine amaraeformis* Nakai (Cruciferae).

**Specimens examined:** SMK 13142 (2 X 1994 Yangku), 14873 (21 VIII 1998, Hongchon).

**Distribution:** Poland, Spain, China and Korea.

**Notes:** Shin and Braun (1996) listed this fungus for the first time from Korea. A

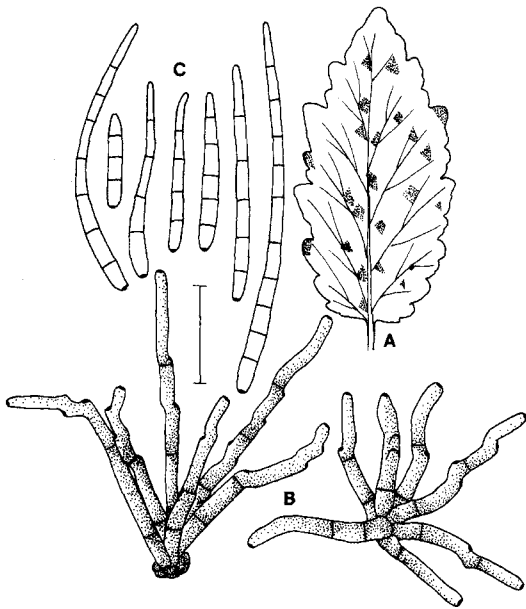


Fig. 2. *Cercospora cardaminae*: A, Leaf spots on the lower leaf surface of *Cardamine amaraeformis* (0.5 $\times$ ); B, Conidiophores; C, Conidia. Bar=30  $\mu$ m.

Chinese collection (Guo, 1997) has rather longer (30~170  $\mu$ m) conidiophores and acicular, somewhat narrower (3.0~4.0  $\mu$ m) conidia, but these differences are due to the variability of this species. This Korean material agrees well with Chupp's description (1954), although caespituli are mostly hypophyllous.

### 3. *Cercospora nasturtii* Pass. (Fig. 3)

Hedwigia 16: 124 (1877)

**Leaf spots** scattered, often confluent, distinct or indistinct, circular to irregular, 2~9 mm in diam., at first only water-soaked or with slight discoloration, later becoming pale tan to dingy gray with broad yellowish green margin, finally center changing grayish brown, thin, papery and dropping out, leaving a ragged hole. **Caespituli** amphigenous. **Mycelium** internal, hyphae septate, branched. **Stromata** rudimentary or slightly developed, composed of a few brown hyphal cells. **Coni-**

**diophores** 3~10 in a divergent fascicle, uniformly olivaceous brown throughout or paler upwards, 3~6-septate, straight to mildly geniculate, occasionally 1~2 times abruptly geniculate, not branched, 40~140 $\times$ 3.5~5.5  $\mu$ m, conidial scars large and conspicuous, apical or on shoulders caused by geniculation. **Conidia** solitary, acicular to filiform, but shorter ones obclavato-cylindric, straight to mildly curved, hyaline, 3~15-septate, usually non-constricted at the septa, subacute to subobtuse at the apex, subtruncate to truncate at the base, 30~152 $\times$ 3.0~4.5  $\mu$ m; hilum conspicuously thickened, darkened, and slightly protuberant.

**Habitat:** On living leaves of *Arabis pendula* L. and *A. glabra* (L.) Bernh. (Cruciferae).

**Specimens examined:** On *Arabis pendula*, SMK 12486 (1 VIII 1993, Jongsun); On *A. glabra*, SMK 13540 (16 VI 1995, Kangnung).

**Distribution:** Cuba, USA, Italy, Angola, China, Japan, Korea and Taiwan.

**Notes:** Shin and Braun (1996) recorded this fungus for the first time from Korea. Chupp (1954) described that caespituli of *C. nas-*

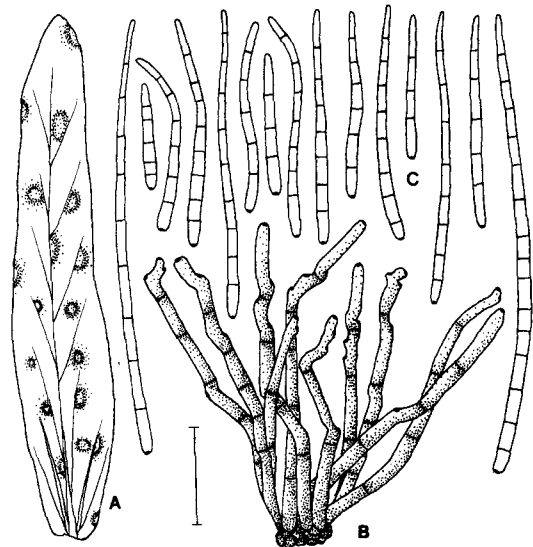


Fig. 3. *Cercospora nasturtii*: A, Leaf spots on the upper leaf surface of *Arabis glabra* (0.5 $\times$ ); B, Conidiophores; C, Conidia. Bar=30  $\mu$ m.

*turtii* on *Nasturtium* spp. are chiefly epiphyllous. He pointed out that the differences among *C. nasturtii*, *C. barbareae* and *C. beteroae* were not very marked, indicating that an alternative taxonomic treatment may ultimately be desirable. Katsuki (1965) described *Cercospora nasturtii* on *Rorippa nasturtium-aquaticum* from Japan with comparatively narrower (2–3  $\mu\text{m}$ ) conidiophores, and olivaceous brown conidia. And caespituli are amphigenous but mostly epiphyllous. These characters are, however, generally variable and only of little taxonomic value. Therefore, Japanese collections agree well with our fungus.

4. *Phacellium episphaerium* (Desm.) U. Braun (Fig. 4)

Nova Hedwigia 50: 509 (1990)

$\equiv$  *Isaria episphaeria* Desm., Ann. Sci. Nat., 2 Sér., 19: 370 (1843)

$\equiv$  *Isariopsis episphaeria* (Desm.) v. Höhn., Sber. Akad. Wiss. Wien, Math.-Nat. Kl., Abt. I, 125: 117 (1916)

$\equiv$  *Ramularia episphaeria* (Desm.) Gunnerb., Sv. Bot. Tidskr. 61: 129 (1967)

$\equiv$  *Stysanus pusillus* Fuckel, Jahrb. Nass. Ver. Naturk. 23/24: 101 (1870)

$\equiv$  *Graphiothecium pusillum* (Fuckel) Sacc., Syll. Fung. IV: 625 (1886)

$\equiv$  *Stysanus pallescens* Fuckel, Jahrb. Nass. Ver. Naturk. 23/24: 102 (1870)

$\equiv$  *Harpographium pallescens* (Fuckel) Magnus, Hedwigia 44: 373 (1905)

$\equiv$  *Graphium pallescens* (Fuckel) Magnus, Hedwigia 44: 375 (1905)

$\equiv$  *Ramularia stellariae* Rabenh., Fungi eur. exs., Ed. nov., Cent. XV, No. 1466 (1871)

$\equiv$  *Ovularia stellariae* (Rabenh.) Sacc., Syll. Fung. X: 542 (1892)

$\equiv$  *Isariopsis stellariae* Trail, Trans. Cryptog. Scot. 1889: 49 (1889)

**Leaf spots** on the upper surface tan to yellowish white, indistinct, circular to subcircular,

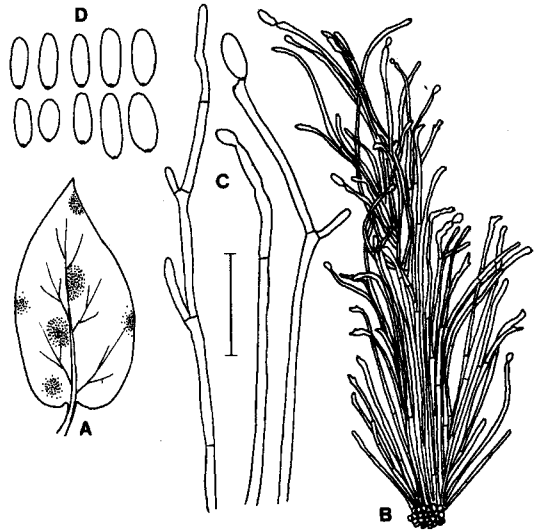


Fig. 4. *Phacellium episphaerium*: A, Leaf spots on the lower leaf surface of *Stellaria aquatica* (0.5 $\times$ ), B, Conidiophores; C, Upper portion of conidiophores; D, Conidia. Bar=30  $\mu\text{m}$  (but 75  $\mu\text{m}$  for B).

usually one large spot per leaf, 3–10 mm diam., without definite margin; on the lower surface, first indistinct, pale greenish discoloration, later yellowish gray with or without definite border line. **Caespituli** hypophyllous, effuse, velvety, appearing as flucose white patches like symptoms of downy mildews. **Mycelium** internal, hyphae septate, branched. **Stromata** medium to large, subglobose, 15–30  $\mu\text{m}$  diam., moderately to well-developed, composed of some swollen brown hyphal cells in the substomatal cavity. **Conidiophores** ca. 20–40 in a dense synnematos fascicle, hyaline throughout, 2–6-septate, 0–3 times branched, substraight to mildly sinuous, usually not geniculate, but occasionally once geniculate, up to 370  $\mu\text{m}$  in length, 2.5–4.0  $\mu\text{m}$  in width, conidial scars small but conspicuously darkened on the apex. **Conidia** solitary, sometimes in short chains, ellipsoidal, hyaline, aseptate, obtuse to broadly rounded at the apex, rounded or obconically pointed at the base, 6–24 $\times$ 4.5–7.0  $\mu\text{m}$ ; hilum very small but conspicuously thickened, darkened,

and non-protuberant.

**Habitat:** On living leaves of *Stellaria aquatica* Scop. and *S. media* Villars (Caryophyllaceae).

**Specimens examined:** On *Stellaria aquatica*, SMK 11568 (23 XI 1991, Kangnung), 11579 (12 V 1992, Kangnung), 11707 (19 VI 1992, Kangnung), 12313 (28 X 1992, Kangnung), 13184 (18 X 1994, Kangnung), 13302 (1 XI 1994, Samchok); On *S. media*, SMK 11452 (5 XI 1991, Kangnung).

**Distribution:** Canada, USA, Europe, Central Asia, China, Japan, Korea, Russia, Uzbekistan and Morocco.

**Notes:** Shin and Braun (1993) listed this fungus for the first time from Korea. In this Korean material, the synnemata are at first hyaline, later yellowish to pale brown at the basal portion. Our collection agrees well with Braun's description, although Braun (1998) depicted *Phacellium episphaerium* as having rather short (90~370  $\mu\text{m}$ ) conidiophores and rough conidia. These features are, however, generally variable, and usually of little taxonomic importance in this species of *Phacellium*.

##### 5. *Pseudocercospora chengtzensis* (Tai) Deighton (Fig. 5)

Mycol. Papers 140: 141 (1976)

$\equiv$  *Cercospora chengtzensis* Tai, Lloydia 11: 40 (1948)

**Leaf spots** scattered to confluent, indistinct, circular to irregular, 1~5 mm diam.; on the upper surface indistinct, invisible or appearing pale yellowish discolored; on the lower surface sooty olivaceous brown to dirty yellowish gray. **Caespituli** hypophyllous, effuse in circular patches, velvety, later appearing as sooty patches. **Mycelium** internal, hyphae septate, branched. **Stromata** fairly large, prominent, well-developed, globular, 15~30  $\mu\text{m}$  diam., composed of swollen brown hyphal cells. **Conidiophores** ca. 15~40 in a dense fascicle

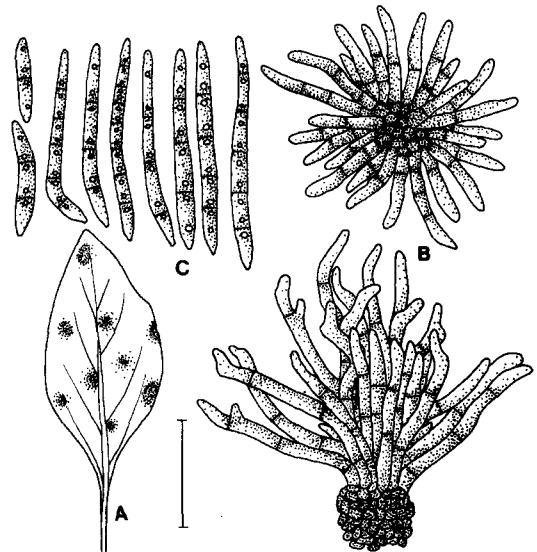


Fig. 5. *Pseudocercospora chengtzensis*: A, Leaf spots on the lower leaf surface of *Lycium chinense* (0.5 $\times$ ); B, Conidiophores; C, Conidia. Bar=30  $\mu\text{m}$ .

through stomatal opening, olivaceous brown or brown throughout, darker than conidia in colour, 1~4-septate, branched, substraight to curved or flexuous, geniculate, 20~96 $\times$ 3.0~4.5  $\mu\text{m}$ , conidial scars inconspicuous. **Conidia** solitary, filiform to obclavato-cylindric, straight to mildly curved, olivaceous brown, guttulate, 1~13-septate, usually non-constricted at the septa, but some spores slightly constricted at the apex, obconically truncate at the base, very variable in length, 15~85 $\times$ 3.0~5.5  $\mu\text{m}$ ; hilum inconspicuous.

**Habitat:** On living leaves of *Lycium chinense* Mill. (Solanaceae).

**Specimens examined:** SMK 13024 (14 IX 1994, Taejon), 13335 (5 XI 1994, Suwon), 15405 (5 X 1998, Suwon).

**Distribution:** China, Japan, Korea and Taiwan.

**Notes:** Shin (1995) first recorded this fungus from Korea and made a brief morphological description. *Cercospora chengtzensis* ( $\equiv$  *Pseudocercospora chengtzensis*) described by Katsuki (1965) based on Japanese ma-

terial possesses very short conidiophores (22~45  $\mu\text{m}$ ). The measurements of conidiophores are, however, usually of little taxonomic importance, since these structures are very variable. In Taiwanese collections reported by Hsieh and Goh (1990) in their monograph, external mycelium is sometimes well-developed. In all Korean collections, secondary mycelium could not be observed, but the formation of external hyphae is often variable in *Pseudocercospora*.

6. *Pseudocercospora diospyri-morrisianae* Goh & W.H. Hsieh (Fig. 6)

Trans. Mycol. Soc. R.O.C. 2(2): 90 (1987)

= *Cercospora diospyri-morrisianae* Sawada, Taiwan Agric. Res. Inst. Rept. 85: 103 (1943) (nomen non rite publicatum, sine descriptione latina)

**Leaf spots** scattered, sometimes confluent, circular to angular, vein-limited, first appearing invisible or as indistinct discoloration without definite margin, later reddish brown with a blackish brown, finally forming olivaceous angular patch on the lower surface. **Caespituli** hypophyllous, appearing as pale fuliginous patches. **Primary mycelium** internal, hyphae septate, branched. **Secondary mycelium** superficial hyphae septate, branched, creeping on the epidermis, connecting to stomatal stomata, forming lateral conidiophores. **Stromata** lacking to rudimentary, composed of a few swollen brown hyphal cells. **Conidiophores** 4~10 in a loose fascicle, emerging through stomata as lateral branches from external hyphae, olivaceous brown, 0~3-septate, usually not branched, but sometimes branched, substraight to mildly curved, rarely geniculate, 15~56  $\times$  2.5~3.5  $\mu\text{m}$ , narrower in the upper portion, rounded to obconic at the apex, conidial scars inconspicuous. **Conidia** solitary, filiform to subcylindric, shorter ones obclavate, substraight to curved, pale olivaceous

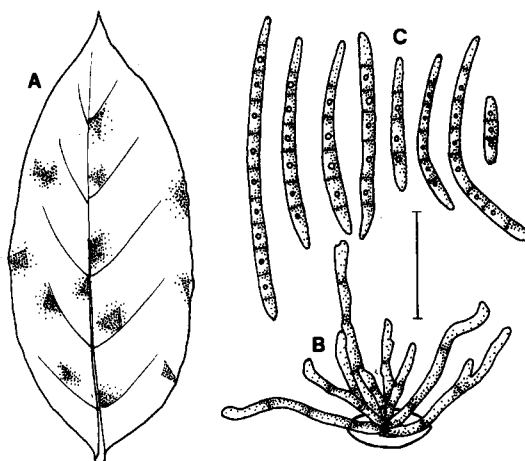


Fig. 6. *Pseudocercospora diospyri-morrisianae*: A, Leaf spots on the lower leaf surface of *Diospyros lotus* (0.5 $\times$ ); B, Conidiophores; C, Conidia. Bar=30  $\mu\text{m}$ .

brown, guttulate, 2~11-septate, non-constricted or slightly constricted at the septa, subacute to subobtuse at the apex, obconically truncate at the base, variable in length, 15~84  $\times$  3.0~4.5  $\mu\text{m}$ ; hilum inconspicuous.

**Habitat:** On living leaves of *Diospyros lotus* L. (Ebenaceae).

**Specimens examined:** SMK 11042 (9 IX 1991, Kangnung), 11214 (3 X 1991, Kangnung), 12585 (1 IX 1993, Kangnung), 13280 (30 X 1994, Kangnung).

**Distribution:** China, Japan, Korea and Taiwan.

**Notes:** Shin and Braun (1993) first listed this fungus from Korea, and Shin (1995) provided a brief morphological description based on Korean material. Several *Pseudocercospora* species have been recorded from *Diospyros* L. in China (Guo and Hsieh, 1995) and Taiwan (Hsieh and Goh, 1990). *P. diospyri-morrisianae* Goh & W.H. Hsieh is close to *P. diospyri-erianthae* Goh & W.H. Hsieh but differs in having smaller conidiophore fascicles and narrower conidiophores. *P. diospyri-morrisianae* Goh & W.H. Hsieh is distinguished from *P. diospyri-lycioides* Crous & U. Braun by superficial mycelium with secondary conidiophores.

diophores. *P. kaki* Goh & W.H. Hsieh possess very large stroma with numerous conidiophores and broader conidia (3.0~5.0  $\mu$ m). Therefore, the Korean collection agrees well with *P. diospyri-morrisianae* described by Goh and Hsieh (1990).

7. *Pseudocercospora capsellae* (Ellis & Everh.)

Deighton (Fig. 7)

Mycol. Papers 133: 42 (1973)

= *Cylindrosporium capsellae* Ellis & Everh., J. Mycol. 3: 130 (1887)

= *Cercoseptoria capsellae* (Ellis & Everh.) H. C. Greene, Trans. Wis. Acad. Sci. Art. Lett. 47: 127 (1959)

= *Cercoseptoria capsellae* (Ellis & Everh.) v. Arx, Proc. Kon. Nederl. Akad. Wet. C, 86: 35 (1983)

= *Cylindrosporium brassicae* Fautrey & Roum., Rev. Mycol. 13: 61 (1891)

= *Cercospora brassicae* (Fautrey & Roum.) Höhn., Anns Mycol. 22: 193 (1924)

= *Cercospora brassicae* (Fautrey & Roum.) Chupp, in Weiss *et al.*, Agric. Handb. U.S. Dept. Agric. 165: 99/100 (1960), comb. inval.! (nomen non rite publicatum, sine descriptione latina)

= *Ovularia brassicae* Bres. & Allesch., in Allesch., Ber. Bot. Ver. Landshut 12: 94 (1892) and in Allesch. and Schnabl, F. Bavar. 195 (1892)

= *Cercospora albomaculans* Ellis & Everh., Proc. Acad. Phil. 1894: 378 (1894)

= *Cercospora albomaculans* (Ellis & Everh.) Sacc., Syll. Fung. 11: 606 (1895)

= *Ramularia rapae* Pim, J. Bot. Lond. 35: 58 (1897)

= *Cercospora rapistri* Hollós, Anns Hist.-Nat. Mus. Hung. 6: 536 (1908)

= *Cercospora brassicae* Jaap., F. sel. exs. 846 (1916) nom. nud!

= *Cylindrosporium neslina* Bubák, Anns Mycol. 14: 346 (1916)

= *Cercospora raphanistri* Baudyš & Pich.,

Acta Soc. Sci. Nat. moravosiles 1(5): 305 (1924)

= *Cercospora nesliana* Baudyš & Pich., Acta Soc. Sci. Nat. moravosiles 1(5): 306 (1924)

= *Ramularia chorisporae* Lobik, Bolez. Rast. 17: 190 (1928)

= *Cercospora nesliae* Dearn. & Bisby, in Bisby *et al.*, The Fungi of Manitoba: 125 (1929)

= *Cercospora isatidis* Mel'nik, Nov. Sist. niz. Rast. 8: 201 (1971)

= *Cercospora conringiae* Annaliev, Nov. Sist. niz. Rast. 9: 195 (1972)

= *Cercospora goldbachiae* Annaliev, Nov. Sist. niz. Rast. 9: 196 (1972)

= *Cercospora litvinoviae* Annaliev, Nov. Sist. niz. Rast. 9: 200 (1972)

= *Cercospora malcolmiae* Annaliev, Nov. Sist. niz. Rast. 9: 202 (1972)

= *Cercospora cardariae* Vasjagina, in Švarcman *et al.*, Fl. Spor. Rast. Kazakhstana, T. VIII, I. Monilial'nye: 487/488, Alma-Ata (1973)

= *Ramularia camelinae* Osipjan, Mikofl. Arm. SSR, T. III, Gifalnye griby: 559, Erevan (1975)

= *Cercospora babajaniae* Osipjan, Mikofl. Arm. SSR, T. III, Gifalnye griby: 558, Erevan (1975)

= *Cercospora crambes* Annaliev, Nov. Sist. niz. Rast. 18: 57 (1981)

= *Ramularia thelypodii* F.E. & E.S. Clements, Cryptog. Form. Colorad. 504, nom. nud.!

= *Cercospora euclidii* Golovin, Tr. sredneaz. gos. Univ., N.S., 14, Biol. Nauki, 5: 23 (1950)

Teleomorph: *Mycosphaerella capsellae* Inman & Sivanesan, in Inman *et al.*, Mycol. Res. 95: 1339 (1991)

**Leaf spots** scattered, often confluent, sub-circular to irregular, 2~10 mm diam., or up

to 20 mm, first grayish to gray, later turning brownish gray to grayish white, usually with narrow greenish brown margin. **Caespituli** amphigenous, but mostly hypophyllous. **Mycelium** internal, hyphae septate, branched. **Stromata** rudimentary to small, slightly to moderately developed, composed of swollen hyphal cells. **Conidiophores** solitary or 2~8 in a loose fascicle, emerging through stomata, hyaline, aseptate or uniseptate, not branched, straight to slightly sinuous, usually not geniculate, but rarely geniculate in the upper portion,  $16\sim40\times3.0\sim4.0\ \mu\text{m}$ , conidial scars inconspicuous. **Conidia** solitary, filiform or subcylindric to slightly obclavate, straight to substraight, hyaline, 0~7-septate, non-constricted at the septa, obtuse to subobtuse at the apex, obconically truncate at the base,  $16\sim78\times2.0\sim3.5\ \mu\text{m}$ ; hilum inconspicuous.

**Habitat:** On living leaves of *Brassica campestris* subsp. *napus* var. *nippo-oleifera* Makino, *B. campestris* subsp. *napus* var. *pekinensis* Makino, and *Capsella bursa-pastoris* (L.) Medicus (Cruciferae).

**Specimens examined:** On *B. campestris* subsp. *napus* var. *nippo-oleifera*, SMK 11566 (23 XI 1991, Kangnung), 12225 (20 X 1992, Kangnung), 13285 (31 X 1994, Kangnung), 13400 (12 XI 1994, Tonghae); On *B. campestris* subsp. *napus* var. *pekinensis*, SMK 11536 (17 XI 1991, Kangnung), 12096 (9 X 1992, Kangnung), 12120 (10 X 1992, Kangnung), 12211 (20 X 1992, Kangnung), 13406 (12 XI 1994, Tonghae); On *C. bursa-pastoris*, SMK 12399 (19 V 1993, Kangnung).

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

**Notes:** Nakata and Takimoto (1928), Park (1958, 1967), Shin and Braun (1993) and Cho *et al.* (1997) listed the present fungus from Korea. Shin and Kim (1997) added a brief morphological description based on *Capsella*

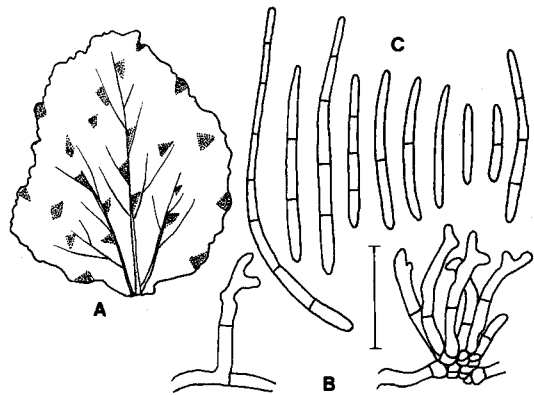


Fig. 7. *Pseudocercospora capsellae*: A, Leaf spots on the lower leaf surface of *Brassica campestris* subsp. *napus* var. *nippo-oleifera* (0.3 $\times$ ); B, Conidiophores; C, Conidia. Bar=30  $\mu\text{m}$ .

*bursa-pastoris* from Korea. Deighton (1973) mentioned numerous synonyms of *P. capsellae* including *Cercospora conringiae*, *C. goldbachiae*, *C. litvinoviae* and *C. malcomiae*. *Ramularia chorisporae* is added as a synonym of *P. capsellae* by Braun (1990). *R. chorisporae* forms the conidiophores ( $10\sim25\times2.0\sim3.5\ \mu\text{m}$ ) singly or in loose groups, the conidia ( $30\sim75\times2.0\sim4.0\ \mu\text{m}$ ) are solitary, subcylindric, obscurely 1~3-septate, and conidial scars are inconspicuous. Braun (1991) investigated various original samples of *Ovularia brassicae*. *Pseudocercospora pastinacae* is morphologically close to our collection, but *P. pastinacae* differs from latter species in having solitary only or loosely aggregated conidiophores and well-developed stromata. In Korean collections, conidiophores and conidia of this fungus on *B. campestris* subsp. *napus* var. *pekinensis* are usually somewhat longer and wider. Based on the original description of *Cercospora eulidii* (conidiophores short, up to 8.7  $\mu\text{m}$  long, almost colourless; conidia solitary, cylindrical, hyaline, 1~6-septate), Braun (1998) reduced this species as a synonym of *P. capsellae*.

#### 8. *Ramularia amoraciae* Fuckel (Fig. 8)



- Jahrb. Nass. Ver. Naturk. 23/24: 361 (1870)  
 = *Ovularia armoraciae* (Fuckel) Masee, Brit. Fung.-Fl. 3: 321 London, New York (1893)  
 = *Cylindrospora armoraciae* (Fuckel) J. Schroet., in Chon, Krypt.-Fl. Schles., Plize II: 485 (1897)  
 = *Entylomella armoraciae* (Fuckel) Cif., Anns Mycol. 26: 17 (1928)  
 = *Oidium fusisporioides* f. *armoraciae* Fuckel, F. rhen., Fasc. II, No. 133 (1863), nom. nud.!  
 = *Ramularia matronalis* Sacc., Michelia 2: 153 (1880)  
 = *Ramularia cochleaiae* Cook, Grevillea 11: 155 (1883)  
 = *Ovularia covhleariae* (Cook) Masee, Brit. Fung.-Fl. 3: 322, London, New York (1893)  
 = *Ramularia barbarae* Peck, Ann. Rep. N.Y. State Mus. Nat. Hist. 40: 63 (1887)  
 = *Ramularia buniadis* Veatergr., Jahreskat. Wiener Tauschanstalt 1897: 4 (1897)  
 = *Ramularia barbarae* House, Bull. N.Y. State Mus 219/220: 61 (1920)  
 = *Ramularia buniadis* Moesz, Bot. Közlem. 23: 120 (1926)  
 = *Ramularia hesperidis* Săvul. & Sandu, Mem. Sect. Sci. Acad. Roum., Ser. 3, 15: 477 (1940)  
 = *Ramularia brassicae* Vasjagina, in Švarcman *et al.*, Fl. Spor. Rast. Kazakhstana 8, Fungi imperfecti (Deuderomycetes), 1. Moniliales: 380 (1973)  
 = *Didymaria nasturtii* Pospelov, in N. P. Golovina, Nov. Sist. niz. Rast. 1964: 211 (1964)  
 = *Ramularia cchleariae* f. *barbarae* P. Syd., Mycoth. marth. 3286, nom. nud.!

Leaf spots scattered, circular to irregular, distinct, 2~5 mm diam., tan to light brown, with greenish margin; on the lower surface indistinct, center appearing grayish brown with or without narrow greenish brown border line. **Caespituli** hypophyllous. **Mycelium** intern-

al, hyphae septate, branched. **Stromata** small, well-developed, composed of swollen hyphal cells in the substomatal cavity. **Conidiophores** 2~5 in a divergent fascicle, hyaline throughout, 0~1-septate, usually not branched or rarely branched, substraight to mildly sinuous, not geniculate, 20~60×2.5~3.5 μm, occasionally wider in the upper portion, conidial scars minute, slightly conspicuous at the apex. **Conidia** solitary, rarely in short chains, cylindric to ellipsoidal, hyaline, 0~1-septate, ends subobtuse to somewhat attenuated, occasionally obconically tapered, 10~28×2.5~4.0 μm in aseptate ones, but 18~38 μm long in uniseptate ones; hilum slightly thickened, darkened, and non-protuberant.

**Habitat:** On living leaves of *Barbarea orthoceras* Ledeb. (Cruciferae).

**Specimens examined:** SMK 12401 (19 V 1993, Kangnung), 12423 (26 VI 1993, Pyongchang), 12437 (2 VII 1993, Kangnung), 12770 (20 V 1994, Kangnung), 12780 (22 V 1994, Pyongchang), 12806 (1 VI 1994, Kangnung), 14506 (10 V 1998, Kangnung).

**Distribution:** Canada, USA, Austria, Poland, Sweden, Kenya and Korea.

**Notes:** Shin and Braun (1996) listed this fungus for the first time from Korea as a

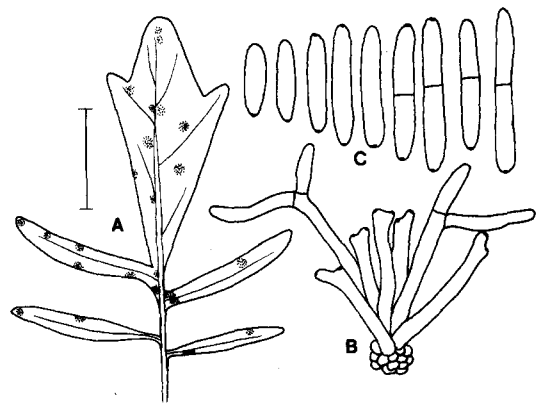


Fig. 8. *Ramularia armoraciae*: A, Leaf spots on the lower leaf surface of *Barbarea orthoceras* (0.5×); B, Conidiophores; C, Conidia. Bar=20 μm.

casual agent of leaf disease on *Barbarea orthoceras*. Braun (1998) described this species with wider conidiophores (2~6  $\mu\text{m}$ ) in dense fascicles, and ellipsoid-ovoid to subcylindric fusiform conidia. However, the measurements of conidiophores and shapes of conidia are usually of little taxonomic value, since these structures are very variable in this fungus. The Korean collection agrees well with description of *R. armoraciae* (Braun, 1998). In the Korean collection, the apex of conidiophores is denticle-like. *R. cardamines* is very similar to our specimen, but differs in having filiform, frequently branched conidiophores, poorly developed stromata.

9. *Ramularia lammii* var. *lammii* Fuckel (Fig. 9) Jahrb. Nass. Ver. Naturk. 23/24: 361 (1870)  
 = *Ovularia lammii* (Fuckel) Sacc., Syll. Fung. IV: 144 (1886)  
 = *Ramularia leonuri* Sorokin, Tr. Obšč. Estestv. pri Kazank. Univ. 2: 30 (1872) (Fig. 9)  
 = *Ramularia sorokinii* Sacc. & Syd., in Sacc., Syll. Fung. XIV: 1065 (1899)  
 = *Fusarium stachydis* Pass., in Thüm., Mycoth. Univ. 1565 (1880) and Flora 64: 298 (1881)  
 = *Ramularia stachydis* (Pass.) C. Massal., Atti. Acc. d'Agric. Art. Comm. Verona, 3 Ser., 45: 113 (1889)  
 = *Cylindrospora stachydis* (Pass.) J. Schroet., in Cohn, Krypt.-Fl. Schles., Pilze II: 491, Breslau (1897)  
 = *Ramularia menthae* Sacc., Fungi Ital. del., Tab. 991 (1881) and Michelia 2: 549 (1882), non *Ramularia menthicola* Sacc., Syll. Fung. IV: 213 (1886)  
 = *Ramularia leonuri* Sacc. & Penz., Michelia 2: 638 (1882)  
 = *Ramularia lamiicola* C. Massal., Bot. Centralbl. XLII: 386 (1890)  
 = *Ramulria brunellae* Briard & Hariot, Rev. Mycol. 13:17 (1891), non *Ramularia brunel-*

- lae* Ellis & Everh. (1889)  
 = *Ramularia stachydis-alpinae* Allesch., Ber. Bot. Ver. Landshut 12: 104 (1892)  
 = *Ramularia exilis* Syd. & P. Syd., Anns Mycol. 3: 186 (1905)  
 = *Ramularia lycopi* Hollós, Ann. Mus. Nat. Hung. 5: 467 (1907)  
 = *Ramularia variata* Davis, Trans. Wis. Acad. Sci. Art. Lett. 19(2): 688 (1919)  
 = *Ramularia salviae* Bondartsev, Mat. mikol. Obsled. Ross. 5: 8 (1922)  
 = *Ramularia salviae* Hollós, Math. Term. Közlem. Mag. Tud. Akad. 35: 51 (1926)  
 = *Ramularia salviicola* Lobik, Bolez. Rast. 17: 192 (1928), non *Ramularia salviicola* Tharp (1917)  
 = *Ramularia stachydis-germanicae* Moesz, Ann. Mus. Nat. Hung. 33: 122 (1940)  
 = *Ramularia anatolica* Bremer & Petr., Sydowia 1: 258 (1947)  
 = *Ramularia agastaches* Sawada, Bull. Govt. For. Exp. Stat., Tokyo 105: 85 (1958)  
 = *Ramularia stachydis-palustris* Pospelov, in Golovina, Dokl. Akad. Nauk Uzbek. SSR 2: 54 (1960)  
 = *Ramularia stachyopsidis* Vasjagina, in Švarcman *et al.*, Fl. Spor. Rast. Kazakhstana, 8: Fungi imperfecti (Deuteromycetes), 1. Moniliales: 425 (1973)

Leaf spots scattered, indistinct; on the upper surface yellowish green, indistinct, usually not visible; on the lower surface yellowish green without definite margin. **Caespituli** hypophyllous, appearing as floccose white fungal patches like symptoms of downy mildews. **Mycelium** internal, hyphae septate, branched. **Stromata** large, globular, 25~50  $\mu\text{m}$ , well-developed, composed of swollen hyphal cells from substomatal cavity. **Conidiophores** ca. 10~40 in a dense semisynnematus fascicle, hyaline throughout, usually 0~1-septate, rarely 2-septate not branched, straight to mildly sinuous, usually not geniculate, but

sometimes once geniculate in the apical portion,  $24\text{--}56 \times 2.5\text{--}3.5 \mu\text{m}$ , conidial scars minute, slightly conspicuous, apical or on the small shoulders caused by geniculation. **Conidia** solitary, sometimes in short (2-3) chains, cylindrical to ellipsoidal, hyaline, aseptate or uniseptate, ends obtuse, occasionally obconically attenuated,  $14\text{--}38 \times 3.5\text{--}5.5 \mu\text{m}$ ; hilum minute, but slightly thickened, darkened, and non-protuberant.

**Habitat:** On living leaves of *Leonurus sibiricus* L. (Labiatae).

**Specimens examined:** SMK 11445 (2 XI 1991, Chunchon), 11957 (12 IX 1992, Yangku), 13375 (9 XI 1994, Kangnung), 14617 (7 VI 1998, Yangku), 14830 (19 VIII 1098, Chunchon), 15013 (4 IX 1998, Seoul).

**Distribution:** USA, Europe, China, Central Asia, Japan, Korea and Taiwan.

**Notes:** Shin and Braun (1993) first listed this fungus as *R. leonuri* from Korea, and Shin (1995) added a brief morphological description based on a Korean collection. After Braun (1998) investigated *Ramularia* collections on numerous host plants belonging to the Lamiaceae, he reduced *R. leonuri* to syno-

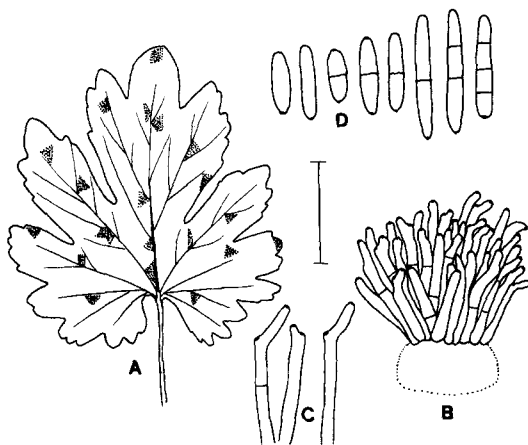
nymy with *R. lamii* var. *lamii*. However, *R. lamii* var. *lamii*, somewhat differs from our collection, in having usually smooth to verruculose conidia with obconically truncate ends. But the differences are within the variability of this species and other important taxonomic characters agree well with Braun's description (1998).

**10. *Ramularia pratensis* var. *pratensis* U. Braun (Fig. 10)**

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= *Ovularia rumicis* A.G. Eliasson, Bih. k. Sv. Vet.-Akad., Handl. 22, Afd. 3, 12: 18 (1897)  
 = *Ramularia rumicis-crispi* Sawada, Bull. Govt. Agric. Exp. Stat. Formosa 85: 89 (1943)  
 = *Ramularia oxyriae-digynae* Gjaerum, Norw. J. Bot. 18(2): 110 (1971)

**Leaf spots** scattered, often confluent, circular to subcircular, distinct, 2-10 mm diam., center grayish brown to reddish brown, with dark reddish brown margin; on the lower surface indistinct discoloration, grayish brown with or without brown border line. **Caespituli** hypophyllous, emerging through stomata and erumpent through the cuticle. **Mycelium** internal, hyphae septate, branched, occasionally with superficial secondary mycelium connected to the substomatal cavity. **Stromata** medium, well-developed, subglobular, 15-30  $\mu\text{m}$ , composed of swollen hyphal cells. **Conidiophores** 2-15 in a divergent fascicle, hyaline throughout, straight or substraight to slightly curved, 0-1-septate, not branched, usually not geniculate, but occasionally once geniculate,  $16\text{--}48 \times 2.0\text{--}4.5 \mu\text{m}$ , conidial scars very small but conspicuous, apical or on small shoulders caused by geniculation. **Conidia** solitary, sometimes in short (1-2) chains, cylindrical, straight, hyaline, aseptate to uniseptate, ends subobtuse to pointed, occasion-



**Fig. 9. *Ramularia lamii* var. *lamii*:** A, Leaf spots on the lower leaf surface of *Leonurus sibiricus* (0.5 $\times$ ); B, Conidiophores; C, Upper portion of conidiophores; D, Conidia. Bar=30  $\mu\text{m}$ .

ally obconically attenuated, 12~45×2.5~4.0 μm; hilum minute but very slightly thickened, darkened, and non-protruberant.

**Habitat:** On living leaves of *Rumex acetosa* L. and *R. crispus* L. (Polygonaceae).

**Specimens examined:** On *R. acetosa*, SMK 12858 (8 VI 1994, Kangnung), 13287 (31 X 1994, Kangnung); On *R. crispus*, SMK 12422 (26 VI 1993, Pyongchang), 12915 (26 VI 1994, Jongsun), 12998 (13 IX 1994, Chonju), 13364 (8 XI 1994, Kangnung), 13409 (12 XI 1994, Tonghae), 14808 (19 VIII 1998, Chunchon).

**Distribution:** USA, Germany, Hungary, Italy, Portugal, Scotland, Sweden, United Kingdom, Sweden and Korea.

**Notes:** Shin and Braun (1996) listed this fungus for the first time from Korea. Braun (1998) described this fungus: the leaf spots are somewhat zonate; stromata are not well-developed; conidia are sometimes rough. However, these characters are greatly variable and our collection agrees well with Braun's description. *R. pratensis* var. *angustiformis* from *Rumex acetosella* is close to our fungus, but differs in having very narrow (1.5~2.0 μm) conidia and very small stromata. Therefore, Braun (1998) placed some collections on *R. acetosella* in a separate variety. *R. pseudodecipiens* described by Braun (1992) from *R. venosus* is distinguished by oblong or cylindrical, 1~3-septate conidia, and *R. decipiens* is characterized by wider (5~7 μm) conidia. Braun (1998) mentioned that collections on *Oxyria* and *Rheum* are morphologically indistinguishable from *R. pratensis* on *Rumex*. *R. rumicis* on *R. obtusifolius* somewhat differs in having large leaf spots (10~20 mm diam.) and only a few one-celled conidia.

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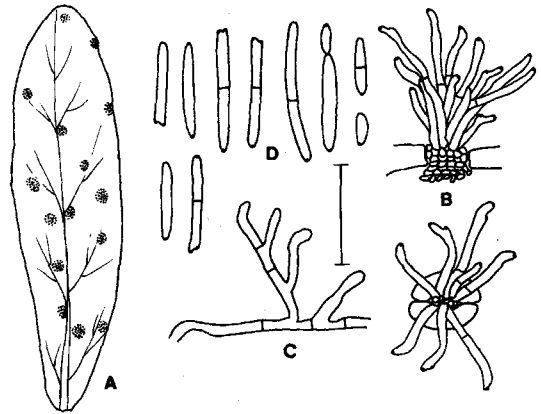


Fig. 10. *Ramularia pratensis* var. *pratensis*: A, Leaf spots on the lower leaf surface of *Rumex crispus* (0.3×); B, Conidiophores; C, Branched conidiophores borne on the external mycelium; D, Conidia. Bar=30 μm.

Martin-Luther Universität, Germany, and Prof. Dr. P. W. Crous, University of Stellenbosch, South Africa, kindly reviewed the manuscript.

#### 적 요

본 연구는 1990년부터 국내에서 채집하여 고려대학교 농생물학과 진균표본보관소(SMK)에 보존하고 있는 *Cercospora* 및 관련 속의 진균을 대상으로 분류학적 연구를 실시한 결과의 네 번째 보고이다. 이번에는 *Cercospora* 3종, *Phacellium* 1종 *Pseudocercospora* 2종, *Pseudocercospora* 1종 및 *Ramularia* 3종에 대한 균학적 특징을 기재, 묘사하였다. 고추에서 *Cercospora capsici*, 꽃황새냉이에서 *C. cardaminae*, 느러진장대와 장대나물에서 *C. nasturtii*, 쇠별꽃과 별꽃에서 *Phacellium episphaerium*, 구기자나무에서 *Pseudocercospora chengtuenensis*, 고욤나무에서 *P. diospyri-morrisiana*, 배추와 유채 및 냉이에서 *Pseudocercospora capsellae*, 나도냉이에서 *Ramularia armoraciae*, 익모초에서 *R. lamii* var. *lamii*, 수영 및 소리쟁이에서 *R. pratensis* var. *pratensis*를 각각 동정하였다.

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