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# All that glitters is not *Ramularia*

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**Abstract:** *Ramularia* is a species-rich genus that harbours plant pathogens responsible for yield losses to many important crops, including barley, sugar beet and strawberry. Species of *Ramularia* are hyphomycetes with hyaline conidiophores and conidia with distinct, thickened, darkened, refractive conidiogenous loci and conidial hila, and *Mycosphaerella* sexual morphs. Because of its simple morphology and general lack of DNA data in public databases, several allied genera are frequently confused with *Ramularia*. In order to improve the delimitation of *Ramularia* from allied genera and the circumscription of species within the genus *Ramularia*, a polyphasic approach based on multilocus DNA sequences, morphological and cultural data were used in this study. A total of 420 isolates belonging to *Ramularia* and allied genera were targeted for the amplification and sequencing of six partial genes. Although *Ramularia* and *Ramulariopsis* proved to be monophyletic, *Cercosporella* and *Pseudocercosporella* were polyphyletic. *Phacellium* isolates clustered within the *Ramularia* clade and the genus is thus tentatively reduced to synonymy under *Ramularia*. *Cercosporella* and *Pseudocercosporella* isolates that were not congeneric with the ex-type strains of the type species of those genera were assigned to existing genera or to the newly introduced genera *Teratoramularia* and *Xenoramularia*, respectively. *Teratoramularia* is a genus with ramularia-like morphology belonging to the *Teratosphaeriaceae*, and *Xenoramularia* was introduced to accommodate hyphomycetous species closely related to *Zymoseptoria*. The genera *Apseudocercosporella*, *Epicoleosporium*, *Filiella*, *Fusidiella*, *Neopseudocercosporella*, and *Mycosphaerelloides* were also newly introduced to accommodate species non-congeneric with their purported types. A total of nine new combinations and 24 new species were introduced in this study.

**Key words:** Barcoding, Cercosporoid, Multilocus phylogeny, *Mycosphaerella*, Plant pathogen.

**Taxonomic novelties: New genera:** *Apseudocercosporella* Videira & Crous, *Epicoleosporium* Videira & Crous, *Filiella* Videira & Crous, *Fusoidiella* Videira & Crous, *Mycosphaerelloides* Videira & Crous, *Neopseudocercosporella* Videira & Crous, *Teratoramularia* Videira, H.D. Shin & Crous, *Xenoramularia* Videira, H.D. Shin & Crous; **New combinations:** *Filiella pastinacae* (P. Karst.) Videira & Crous, *Fusoidiella depressa* (Berk. & Broome) Videira & Crous, *Mycosphaerelloides madeirae* (Crous & Denman) Videira & Crous, *Neopseudocercosporella brassicae* (Chevall.) Videira & Crous, *Neopseudocercosporella capsellae* (Ellis & Everh.) Videira & Crous, *Ramularia cerastiicola* (Crous) Videira & Crous, *Ramularia stellariicola* (M.J. Park *et al.*) Videira, H.D. Shin & Crous, *Sphaerulina chaenomelis* (Y. Suto) Videira, U. Braun, H.D. Shin & Crous, *Sphaerulina koreana* (Crous *et al.*) Videira, H.D. Shin & Crous; **New names:** *Ramularia alangiicola* Videira, H.D. Shin & Crous, *Ramularia veronicicola* Videira & Crous; **New species:** *Acrodontium fagicola* Videira & Crous, *Acrodontium luzulae* Videira & Crous, *Acrodontium pigmentosum* Videira & Crous, *Apseudocercosporella trigonotidis* Videira, H.D. Shin & Crous, *Cercosporella catenulata* Videira & Crous, *Epicoleosporium ramularioides* Videira, H.D. Shin & Crous, *Ramularia euonymicola* Videira, H.D. Shin, U. Braun & Crous, *Ramularia gaultheriae* Videira & Crous, *Ramularia geraniicola* Videira & Crous, *Ramularia malicola* Videira & Crous, *Ramularia neodeusta* Videira & Crous, *Ramularia osterici* Videira, H.D. Shin & Crous, *Ramularia rumicicola* Videira, H.D. Shin & Crous, *Ramularia trigonotidis* Videira, H.D. Shin & Crous, *Ramularia weberiana* Videira & Crous, *Ramulariopsis pseudoglycines* Videira, Crous & Braun, *Teratoramularia infinita* Videira & Crous, *Teratoramularia kirschneriana* Videira & Crous, *Teratoramularia persicariae* Videira, H.D. Shin & Crous, *Teratoramularia rumicicola* Videira, H.D. Shin & Crous, *Xenoramularia arxii* Videira & Crous, *Xenoramularia neerlandica* Videira & Crous, *Xenoramularia polygonicola* Videira, H.D. Shin & Crous; **Typifications: Epitypifications:** *Cercosporella gossypii* Speg., *Cylindrosporium heraclei* Oudem., *Fusoma inaequale* Preuss, *Ovularia tovarae* Sawada, *Ramularia acroptili* Bremer, *Ramularia aplospora* Speg., *Ramularia armoraciae* Fuckel, *Ramularia beticola* Fautrey & Lambotte, *Ramularia geranii* Fuckel, *Ramularia lamii* Fuckel var. *lamii*, *Ramularia pusilla* Unger, *Ramularia vallisumbrosae* Cavara, *Ramularia variabilis* Fuckel; **Neotypifications:** *Crocysporium rubellum* Bonord., *Ramularia collo-cygni* B. Sutton & J.M. Waller; **Lectotypification:** *Ramularia kriegeriana* Bres.

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## INTRODUCTION

*Ramularia* (Unger 1833) is a species-rich genus (1 220 names listed in MycoBank, accessed 6 Nov. 2015) that belongs to the family *Mycosphaerellaceae* in the order *Capnodiales*. *Ramularia* species are mostly phytopathogenic and associated with leaf spots, necrosis or chlorosis, but some species can be saprobic or even mycophylic. The genus was monographed by Braun (1995, 1998) who defined *Ramularia* as genus of hyphomycetous species with hyaline conidiophores and conidia with distinct, thickened, darkened and refractive conidiogenous loci and conidial hila. *Ramularia* and allied genera were traditionally described based on the colour (hyaline or pigmented) and the structure of conidiophores (simple or branched), the structure of conidiogenous loci and conidial hila (conspicuous or inconspicuous, by being thickened and darkened or not). Genera with hyaline structures and conspicuous conidial loci include *Cercosporella*, *Hawksworthiana*, *Neoovularia*, *Phacellium*, *Pseudodidymaria*, *Ramularia* and *Ramulariopsis*, while genera with inconspicuous conidial loci include *Monodidymaria*, *Neoramularia* and *Pseudocercosporella*.

Although these morphological characters have been considered important to define these genera, molecular studies have indicated that they are not always phylogenetically informative, and that the generic concepts need to be revised (Crous *et al.* 2001, Verkley *et al.* 2004, Kirschner 2009). The genus *Cercosporella* was usually distinguished from *Ramularia* by having bulging and hyaline conidiogenous loci. However, these characters are minute

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and difficult to observe with light microscopy, resulting in frequent transfers of species between both genera. Based on 28S nrDNA sequence data the type species of *Cercosporella* (*C. virgaureae*) was shown to cluster in a sister clade to *Ramularia s. str.* (Kirschner 2009), and two additional characters were observed: *Cercosporella* has flat conidiogenous loci shaped as a truncated cone and produces cup-shaped appressoria. In contrast, *Ramularia* has conidiogenous loci with a raised rim with a tall central dome and a crater in between (resembling *Cladosporium*, see Bensch *et al.* 2012), and does not form appressoria.

Species of *Ramularia* have *Mycosphaerella* sexual morphs, but only a few lifecycles have been experimentally proven, and some species may be asexual holomorphs (Braun 1995, 1998, Verkley *et al.* 2004, Videira *et al.* 2015b). *Mycosphaerella s. lat.* species have been associated with more than 30 genera, including both hyphomycetes and coelomycetes (*Mycosphaerellaceae*) (Crous 2009). *Mycosphaerella s. str.*, however, was shown to be confined to taxa with *Ramularia* asexual morphs (Verkley *et al.* 2004, Crous *et al.* 2009b, Videira *et al.* 2015b). In agreement with the new rules for naming of pleomorphic fungi in the *International Code of Nomenclature for algae*, *fungi and plants* (ICN; Hawksworth 2011, Hawksworth *et al.* 2011, Wingfield *et al.* 2012, Crous *et al.* 2015), the older name *Ramularia* was selected over that of *Mycosphaerella* (see Videira *et al.* 2015b for more details), and is included in a list of protected generic names (Kirk *et al.* 2013, Wijayawardene *et al.* 2014, Rossman *et al.* 2015).

The genus *Ramularia* includes important plant pathogens such as *R. collo-cygni* and *R. beticola* that cause severe economic losses to barley and sugar beet crops, respectively. Protecting crops from damage by weeds, animal pests and pathogens is a major prerequisite to increase productivity to meet the global increase in demand for food, feed and bioenergy. *Ramularia collo-cygni* is responsible for yield losses of 15–25 % in winter barley in northern European countries and New Zealand (Cromey *et al.* 2004). Yield losses in sugar beet due to plant pathogens and pests are estimated in general to be 26 % with, and more than 80 % without, crop protection (Oerke & Dehne 2004).

As plant pathogens, some cercosporoid species have shown potential as biocontrol agents of weeds, but no commercial application is yet available. *Acroptilon repens* and *Centaurea solstitiales* are both invasive weeds in the eastern USA. The fungi *Cercosporella acroptili* and *Cercosporella centaureicola* cause significant damage to *A. repens* and *C. solstitiales*, respectively (Berner *et al.* 2005). *Crupina vulgaris* is an invasive weed of pastures in the western USA that is susceptible to leaf blight caused by *Ramularia crupinae*. *Myrica faya* is considered an invasive plant in Hawaii but, in its natural habitat, is susceptible to *Ramularia* dieback caused by *Phacellium rufibasis* (= *Ramularia destructiva*) (Gardner & Hodges 1990). The necrotrophic fungus *Ramularia rubella* is also effective against *Rumex obtusifolius*, an invasive plant of pastures, by causing severe defoliation, shoot and root weight loss (Zaller 2004).

Plant pathogenic fungi are known to produce toxic metabolites that contribute to symptom development in the host. Some phytotoxins induce the formation of reactive oxygen molecules in the plant cells such as superoxide, hydrogen peroxide or hydroxyl radicals that induce oxidative processes of membrane fatty acids. The phytopathogenic species *Ramularia rubella* was the first species of this genus observed producing rubellin metabolites (Arnone *et al.* 1986), a photodynamically active anthraquinone derivative (Heiser *et al.* 2003). More recently, also *Ramularia collo-cygni* (Miethbauer *et al.* 2003) and the mycophylic species *R. uredinicola* (Khodaparast & Braun 2005) were documented as producing rubellins, with *R. rosea* also being a candidate for rubellin biosynthesis. Although a few *Ramularia* species use the photodynamically active rubellins as non-host-specific phytotoxins, most of the species in this genus are unable to produce these compounds (Miethbauer *et al.* 2006).

Given the importance of the genus *Ramularia* to agriculture as outlined above, the aims of the present study were: (i) to resolve the phylogenetic placement of *Ramularia* and allied genera within the order *Capnodiales*, and (ii) to apply a polyphasic approach based on multilocus DNA sequence, morphological and cultural data to delimit species within the genus *Ramularia* and allied genera.

## MATERIALS AND METHODS

### Isolates

Isolates included in this study were obtained from the culture collection of the CBS-KNAW Fungal Biodiversity Centre (CBS), Utrecht, the Netherlands, from the working collection of Pedro Crous (CPC), housed at CBS, or were freshly isolated from a range of different plant hosts (Table 1). Single-conidium and ascospore cultures were obtained using the techniques described for species of *Mycosphaerella* and its asexual morphs (Crous *et al.* 1991, Crous 1998). Representative cultures of the new species delineated in this study were deposited in the CBS culture collection.

### DNA extraction, amplification and sequencing

Fungal mycelia of strains (Table 1) were harvested with a sterile scalpel and the genomic DNA isolated using the UltraClean$^{TM}$ Microbial DNA Isolation Kit (MoBio Laboratories, Inc., Solana Beach, CA, USA) following the manufacturers' protocols. The DNA was initially targeted for the amplification and sequencing of 11 partial nuclear genes: 28S nrRNA gene (LSU), internal transcribed spacer regions and intervening 5.8S nrRNA gene (ITS) of the nrDNA operon, actin (*actA*), translation elongation factor 1-α (*tef1*-α), histone H3 (*his3*), glyceraldehyde-3-phosphate dehydrogenase (*gapdh*), RNA polymerase II second largest subunit (*rpb2*), calmodulin (*cmdA*), β-tubulin (*tub2*), chitin-synthase 1 (*chs-1*) and a gene encoding a minichromosome maintenance protein (*mcm7*). The primers employed for PCR amplification of each partial gene region are listed in Table 2, with the respective annealing temperatures used. During the course of this study, new primers were designed to amplify *rpb2*. The primer positions based on GenBank accession KT216537.1 are: Rpb2-F4 34–56, Rpb2-F1 247–266, Rpb2-R1 937–959. A new forward primer was also designed for the amplification of *gapdh* and its position based on GenBank accession KJ504580.1 is: Gapdh-F1 14–32. The PCR amplifications were performed on a GeneAmp® PCR System 9700 (Applied Biosystems, Foster City, CA, USA). The PCR mixtures consisted of 1 µL genomic DNA, 1× NH4 reaction buffer (Bioline, Luckenwalde, Germany), 2 mM $MgCl_2$, 40 µM of each dNTP, 0.2 µM of each primer and 0.5 U *Taq* DNA polymerase (Bioline) in a total volume of 12.5 µL. The PCR mixtures for *his3*, *gapdh*, *rpb2*, *cmdA* and *tub2* contained 2 µL genomic DNA. The general PCR conditions were: initial

**Table 1.** Collection details and GenBank accession numbers of isolates included in this study.[3]

| Species[4] | Culture number[1,2] | Previous name[4] | Host | Country | Collector | LSU | ITS | *actA* | *tef1*-α | *gapdh* | *rpb2* | *his3* | *cmdA* | *tub2* | *chs-1* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Acrodontium crateriforme* | **CBS 144.33**$^{T}$; ATCC 15679; MUCL 15748; MUCL 8978 | | Associated with *Tuberculina maxima* | Netherlands | – | KX286952 | FN666565 | – | – | – | KX288399 | – | – | – | – |
| | CBS 151.58; MUCL 15750 | | Human sputum | Netherlands | – | KX286953 | KX287266 | – | – | – | KX288400 | – | – | – | – |
| | CBS 985.70 | | *Fraxinus excelsior* | UK, Westmorland | J.C. Frankland | KX286954 | KX287267 | – | – | – | KX288401 | – | – | – | – |
| | CBS 840.71 | | Foodstuff | Netherlands | – | KX286955 | KX287268 | – | – | – | KX288402 | – | – | – | – |
| | CBS 842.71 | | *Citrus* sp. | Indonesia, Java | J.H. van Emden | KX286956 | KX287269 | – | – | – | KX288403 | – | – | – | – |
| | CPC 11509 | *P. fraxini* | *Fraxinus rhynchophylla* | South Korea | H.D. Shin | GU214682 | GU214682 | (GU320413) | (GU384425) | – | KX288404 | KX288727 | KX289011 | – | – |
| | CPC 11519 | *Pseudocercosporella* sp. | *Agrimonia pilosa* | South Korea | H.D. Shin | KX286957 | KX287270 | KX287558 | – | KX288123 | KX288405 | KX288728 | KX289012 | – | – |
| | CPC 25894 | | *Ranunculus* sp. | Germany | W. Quaedvlieg | KX286958 | KX287271 | KX287559 | – | KX288124 | KX288406 | KX288729 | – | – | – |
| | CPC 25895 | | *Betula* sp. | Germany | W. Quaedvlieg | KX286959 | KX287272 | KX287560 | – | – | KX288407 | KX288730 | – | – | – |
| | CBS 137975; CPC 22172 | *A. neolitsiae* | *Neolitsea australiensis* | Australia | B.A. Summerell | KJ869184 | KJ869127 | – | – | – | KX288408 | – | – | – | – |
| *A. fagicola* | **CBS 714.79**$^{T}$ | *Acrodontium* sp. | *Fagus sylvatica* | Germany | – | KX286960 | – | – | – | – | KX288409 | – | – | – | – |
| *A. luzulae* | CBS 841.71 | *A. crateriforme* | *Puccinia* sp., on leaf of *Carex* sp. | Netherlands | – | KX286961 | KX287273 | – | – | – | KX288410 | – | – | – | – |
| | **CBS 839.71**$^{T}$ | *A. crateriforme* | *Luzula sylvatica* | UK, England | – | KX286962 | KX287274 | – | – | – | KX288411 | – | – | – | – |
| *A. pigmentosum* | **CBS 111111**$^{T}$ | *A. griseum* | Outdoor air | Finland | S. Haatainen | KX286963 | KX287275 | – | – | – | KX288412 | – | – | – | – |
| *Apseudocercosporella trigonotidis* | CPC 10865 | *Pseudocercosporella* sp. | *Trigonotis peduncularis* | South Korea | H.D. Shin | KX286964 | KX287276 | KX287561 | – | – | KX288413 | – | – | – | – |
| | **CBS 131890**$^{T}$; CPC 10864 | *Pseudocercosporella* sp. | *Trigonotis peduncularis* | South Korea | H.D. Shin | JQ324972 | GU269858 | (JQ325029) | (GU384569) | – | KX288414 | – | – | – | – |
| *Caryophylloseptoria lychnidis* | CBS 109102 | | *Silene pratensis* | Austria | G. Verkley | KF251793 | KF251289 | (KF253598) | (KF253237) | – | KX348048 | – | (KF253952) | (KF252771) | – |
| *Ca. pseudolychnidis* | CBS 128614; KACC 42904; SMKC 22691 | | *Lychnis cognata* | South Korea | – | KF251794 | KF251290 | (KF253599) | (KF253238) | – | KX348049 | – | (KF253953) | (KF252772) | – |
| *Cercospora campi-silii* | CBS 132625; CPC 14585 | | *Impatiens noli-tangere* | South Korea | H.D. Shin | KX286965 | JX143561 | (JX143069) | (JX143315) | – | KX288415 | (JX142577) | (JX142823) | – | – |
| *Cercospora* cf. *chenopodii* | CBS 132677; CPC 15599 | *Ce. chenopodii* | *Chenopodium* sp. | Mexico | M. de Jesús Yáñez-Morales | KX286966 | JX143573 | (JX143083) | (JX143329) | – | KX288416 | (JX142591) | (JX142837) | – | – |

(*continued on next page*)

**Table 1.** (Continued).

| Species[4] | Culture number[1,2] | Previous name[4] | Host | Country | Collector | LSU | ITS | *actA* | *tef1-α* | *gapdh* | *rpb2* | *his3* | *cmdA* | *tub2* | *chs-1* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CPC 12450 | *Pa. dubia* | *Chenopodium ficifolium* | South Korea | H.D. Shin | KX286967 | JX143574 | (JX143084) | (JX143330) | – | KX288417 | (JX142592) | (JX142838) | – | – |
| *Ce. dubia* | CPC 15600 | *Cercosporella* sp. | *Chenopodium* sp. | Mexico | M. de Jesús Yáñez-Morales | KX286968 | KX287277 | – | – | – | KX288418 | – | – | – | – |
| *Ce. sojina* | **CBS 132615**$^{NT}$; CPC 11353 | | *Glycine soja* | South Korea | H.D. Shin | KX286969 | JX143659 | (JX143173) | (JX143419) | – | KX288419 | (JX142681) | (JX142927) | – | – |
| *Ce. sorghi* | CBS 478.92; INIFAT C91/204 | *Ramulispora sorghi* | – | – | – | KX286970 | KX287278 | – | – | – | KX288420 | – | – | – | – |
| *Cercospora* sp. | CBS 220.31 | *Pa. personata* | – | – | – | KX286971 | KX287279 | – | – | – | KX288421 | – | – | – | – |
| *Cercospora* sp. | CPC 11422 | *Pa. sojina* | *Glycine soja* | South Korea | H.D. Shin | KX286972 | KX287280 | – | – | – | KX288422 | – | – | – | – |
| *Cercosporella dolichandrae* | **CBS 138101**$^{T}$; CPC 22948 | | *Dolichandra unguiscati* | South Africa | A. King | KJ869197 | KJ869140 | KX287562 | – | – | KX288423 | – | – | – | – |
| *C. catenulata* | **CBS 355.73**$^{T}$ | *R. deusta* var. *alba* | *Phaseolus vulgaris* | Rwanda | D. Froment | KX286973 | KX287281 | KX287563 | – | – | KX288424 | KX288731 | KX289013 | – | – |
| *C. virgaureae* | CPC 11456 | | *Erigeron annuus* | South Korea | H.D. Shin | KX286974 | – | KX287564 | KX287838 | KX288125 | KX348050 | KX288732 | KX289014 | – | – |
| | CPC 11457 | | *Erigeron annuus* | South Korea | H.D. Shin | KX286975 | KX287282 | KX287565 | KX287839 | KX288126 | KX288425 | KX288733 | KX289015 | – | – |
| | CPC 11460 | | *Erigeron annuus* | South Korea | H.D. Shin | KX286976 | KX287283 | KX287566 | KX287840 | KX288127 | KX288426 | KX288734 | KX289016 | – | – |
| | CPC 11461 | | *Erigeron annuus* | South Korea | H.D. Shin | KX286977 | KX287284 | KX287567 | KX287841 | – | KX288427 | KX288735 | KX289017 | – | – |
| | CPC 10286 | | *Erigeron annuus* | South Korea | H.D. Shin | KX286978 | KX287285 | KX287568 | KX287842 | KX288128 | KX288428 | KX288736 | KX289018 | – | – |
| | CPC 10287 | | *Erigeron annuus* | South Korea | H.D. Shin | KX286979 | KX287286 | KX287569 | KX287843 | KX288129 | KX288429 | KX288737 | KX289019 | – | – |
| | CPC 10288 | | *Erigeron annuus* | South Korea | H.D. Shin | KX286980 | KX287287 | KX287570 | KX287844 | – | KX288430 | KX288738 | – | – | – |
| | CBS 113304 | | *Erigeron annuus* | – | H.D. Shin | KF251805 | GU214658 | (KF253610) | (KF253249) | KX288130 | KX348051 | KX288739 | (KF253964) | – | – |
| | CPC 19492 | *Cercosporella* sp. | *Conyza canadensis* | Brazil | B.S. Vieira | KX286981 | KX287288 | KX287571 | KX287845 | KX288131 | KX288431 | KX288740 | KX289020 | – | – |
| *Cladosporium cladosporioides* | **CBS 112388**$^{NT}$ | | Indoor air | Germany | Ch. Traumann | KX286982 | HM148003 | (HM148490) | (HM148244) | – | KX288432 | – | – | – | – |
| *Epicoleosporium ramularioides* | **CBS 141103**$^{T}$; CPC 10672 | *R. coleosporii* | *Coleosporium phellodendrion* on *Phellodendron amurense* | South Korea | H.D. Shin | GU214688 | GU214688 | – | KX287846 | – | KX288433 | – | – | – | – |
| | CPC 10673 | *R. coleosporii* | *Coleosporium phellodendrion* on *Phellodendron amurense* | South Korea | H.D. Shin | – | KX287289 | – | KX287847 | – | KX288434 | – | – | – | KX289242 |
| *Dissoconium aciculare* | CBS 204.89 | | *Astragalus* sp. | Germany | T. Hijwegen | GU214419 | AY725520 | – | – | – | KX288435 | – | – | – | – |
| *Dothistroma pini* | CBS 121005; CMW 24852 | | *Pinus pallasiana* | Russia | T.S. Bulgakov | KF251659 | KF251155 | (JX902075) | (KF253115) | – | KX348052 | – | (JX901514) | (KF252653) | – |
| | CBS 116486 | | *Pinus nigra* | USA, Michigan | G. Adams | JX901823 | JX901735 | (JX902070) | (JX901621) | – | KX348053 | – | (JX901509) | (JX902192) | – |

**Table 1.** (Continued).

| Species[4] | Culture number[1,2] | Previous name[4] | Host | Country | Collector | LSU | ITS | *actA* | *tef1*-α | *gapdh* | *rpb2* | *his3* | *cmdA* | *tub2* | *chs-1* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *D. septosporum* | CBS 128782;<br>CPC 16798 | | *Pinus mugo* subsp. *rostrata* | Netherlands | W. Quaedvlieg | JX901829 | JX901741 | (JX902076) | (JX901627) | – | KX348054 | – | (JX901515) | (JX902198) | – |
| *Fusoidiella depressa* | CBS 141335;<br>CPC 14915 | *Pa. depressa* | *Angelica gigas* | South Korea | H.D. Shin | KF251813 | KF251309 | – | (KF253256) | – | KX348055 | – | (KF253972) | (KF252788) | – |
| *Filiella pastinacae* | CBS 114116;<br>UPSC 2633 | *P. pastinacae* | *Laserpitium latifolium* | Sweden | K. & L. Holm | KF251832 | KF251328 | (KF253633) | (KF253275) | – | KX348056 | – | (KF253980) | (KF252803) | – |
| *Microcyclosporella mali* | **CBS 126136**$^{T}$;<br>CPC 16184;<br>HJS 300-07 | | *Malus domestica* | Slovenia | J. Frank | GU570547 | GU570535 | KX287572 | (HM177424) | – | KX288436 | – | – | – | – |
| *Microcyclosporella* sp. | CBS 118960;<br>CUD3b | *Pseudocercosporella* sp. | – | USA, Illinois | J. Batzer | KX286985 | KX287290 | KX287573 | KX287848 | KX288132 | KX288437 | KX288741 | – | – | – |
| | CBS 125654;<br>RH7;<br>GA3 3D1b | *Pseudocercosporella* sp. | *Malus* sp. | USA, Georgia | M. Wheeler | FJ031995 | FJ425202 | KX287574 | KX287849 | KX288133 | KX288438 | KX288742 | – | – | – |
| | CBS 119461;<br>RH2.2 | *Pseudocercosporella* sp. | – | USA, Illinois | J. Batzer | KX286986 | KX287291 | KX287575 | KX287850 | KX288134 | KX288439 | KX288743 | KX289021 | – | – |
| | CBS 125653;<br>RH6;<br>MI3 20F1a | *Pseudocercosporella* sp. | *Malus* sp. | USA, Michigan | G. Sundin | FJ031994 | FJ425201 | KX287576 | KX287851 | KX288135 | KX288440 | – | – | – | – |
| | CBS 118969;<br>UMD1a | *Pseudocercosporella* sp. | – | USA, Missouri | J. Batzer | KX286987 | KX287292 | KX287577 | KX287852 | KX288136 | KX288441 | KX288744 | – | – | – |
| | CBS 125651;<br>RH1;<br>OH1 34D2a | *Pseudocercosporella* sp. | *Malus* sp. | USA, Ohio | M. Ellis | FJ031989 | FJ425196 | KX287578 | KX287853 | KX288137 | KX288442 | KX288745 | KX289022 | – | – |
| *Mycosphaerelloides madeirae* | **CBS 112895**$^{T}$;<br>CMW 14458;<br>CPC 3745 | *M. madeirae* | *Eucalyptus globulus* | Portugal | S. Denman | KF902017 | AY725553 | – | (KF903109) | – | KX348057 | KX288746 | (KF902545) | – | – |
| | CBS 115936 | *Ramularia* sp. | – | Netherlands | – | KX286988 | AY853187 | KX287579 | KX287854 | KX288138 | KX288443 | – | KX289023 | – | – |
| | CBS 116066 | *Ramularia* sp. | *Quercus robur* | Netherlands | – | KX286989 | AY853188 | KX287580 | KX287855 | KX288139 | KX288444 | KX288747 | KX289024 | – | – |
| | CBS 116068 | *Ramularia* sp. | *Quercus robur* | Netherlands | – | KX286990 | AY853189 | KX287581 | KX287856 | KX288140 | KX288445 | KX288748 | KX289025 | – | – |
| *Neocercospora ammicola* | **CBS 136450**$^{T}$;<br>CCTU 1186 | *Cercospora* sp. | *Ammi majus* | Iran | M. Arzanlou | KR232405 | KR232407 | (KR232411) | (KR232409) | – | KX288446 | (KR232413) | – | – | – |
| *Neopseudocercosporella brassicicola* | CBS 228.32 | *M. brassicicola* | *Brassica oleraceae* | Denmark | – | KF251808 | KF251304 | (KF253613) | (KF253252) | – | KX348058 | – | (KF253967) | (KF252783) | – |
| | CBS 173.88 | *M. brassicicola* | *Brassica oleracea* | Germany | – | KX286991 | KX287293 | KX287582 | KX287857 | – | KX288447 | – | – | – | – |

(*continued on next page*)

**Table 1.** (Continued).

| Species[4] | Culture number[1,2] | Previous name[4] | Host | Country | Collector | LSU | ITS | *actA* | *tef1*-α | *gapdh* | *rpb2* | *his3* | *cmdA* | *tub2* | *chs-1* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CBS 267.53 | *M. brassicicola* | *Brassica oleraceae* var. *acephala* subvar. *sabelica* | Netherlands | – | KF251809 | KF251305 | (KF253614) | (KF253253) | – | KX348059 | – | (KF253968) | (KF252784) | – |
| *N. capsellae* | CBS 135464; CPC 11677 | *Mycosphaerella* sp. | *Draba nemorosa* var. *hebecarpa* | South Korea | H.D. Shin | KX286992 | DQ303091 | (KF253616) | KX287858 | – | KX288448 | – | (KF253970) | (KF252786) | – |
| | CPC 14774 | *P. capsellae* | *Raphanus sativus* | South Korea | H.D. Shin | KX286993 | KX287294 | KX287583 | KX287859 | KX288141 | KX288449 | – | – | – | – |
| | CBS 131896; CPC 14773 | *P. capsellae* | *Raphanus sativus* | South Korea | H.D. Shin | GU253714 | GU269666 | (GU320372) | (GU384383) | KX288142 | KX288450 | KX288749 | – | – | – |
| | CBS 112032; HJS 601 | *P. capsellae* | *Brassica* sp. | – | – | KF251824 | KF251320 | (KF253627) | (KF253267) | – | KX348060 | – | (KF253975) | (KF252797) | – |
| | CBS 112033; HJS 600 | *P. capsellae* | *Brassica* sp. | – | – | KF251810 | KF251306 | (KF253615) | (KF253254) | – | KX348061 | – | (KF253969) | (KF252785) | – |
| | CPC 12518 | | *Capsella bursa-pastoris* | South Korea | H.D. Shin | KX286994 | KX287295 | KX287584 | KX287860 | – | KX288451 | KX288750 | – | – | – |
| | CPC 12519 | | *Capsella bursa-pastoris* | South Korea | H.D. Shin | KX286995 | KX287296 | KX287585 | KX287861 | – | KX288452 | KX288751 | – | – | – |
| *Pallidocercospora acaciigena* | **CBS 112515**$^{T}$; CPC 3837 | | *Acacia mangium* | Venezuela | M.J. Wingfield | KF902166 | KF901805 | (KF903455) | (KF903125) | – | KX348062 | – | (KF902564) | (KF902828) | – |
| *Pal. crystallina* | CBS 111045; CPC 1179 | | *Eucalyptus grandis* | South Africa | M.J. Wingfield | KF902051 | KF901704 | (KF903424) | (KF903129) | – | KX348063 | – | (KF902568) | (KF902832) | – |
| *Pal. heimii* | CPC 11716 | *M. parkii* | – | Brazil | A.C. Alfenas | KF901937 | KF901612 | (KF903605) | (KF903134) | – | KX348064 | – | (KF902573) | (KF902837) | – |
| *Pal. irregulariramosa* | CBS 111211; CPC 1362 | | *Eucalyptus saligna* | South Africa | M.J. Wingfield | KF902053 | KX287297 | (KF903441) | (KF903139) | – | KX348065 | – | (KF902578) | (KF902842) | – |
| *Pal. konae* | CBS 111028; CPC 2125; JT 526 | | *Leucadendron* cv. Safari Sunset | USA, Hawaii | P.W. Crous | KF902158 | KF901798 | (KF903422) | (KF903140) | – | KX348066 | – | – | (KF902843) | – |
| *Parapenidiella pseudotasmaniensis* | CBS 111681; CPC 1539 | *Mycovellosiella* sp. | – | – | – | KX286996 | KX287298 | – | – | – | KX288453 | – | – | – | – |
| | **CBS 124991**$^{T}$; CPC 12400 | | *Eucalyptus globulus* | Australia | I.W. Smith | KF901844 | KF901522 | (KF903562) | (KF903152) | – | KX348067 | – | (KF902589) | (KF902855) | – |
| *Pp. tasmaniensis* | **CBS 111687**$^{T}$; CMW 14780; CPC 1555 | | *Eucalyptus nitens* | Australia | – | KF901843 | DQ267591 | (KF903451) | (KF903150) | – | KX348068 | – | (KF902587) | (KF902853) | – |
| *Pseudocercospora dingleyae* | CBS 114645 | *P. dingleyae* | *Haloragis erecta* | New Zealand | – | KX286997 | KX287299 | – | – | – | KX288454 | – | – | – | – |
| *Ps. eucalyptorum* | CBS 132015; CPC 11713 | | *Eucalyptus globulus* | Spain | P. Mansilla | KF902096 | KF901743 | (KF903604) | (GU384523) | – | KX348069 | – | (KF902615) | (KF902884) | – |
| | CBS 114866; CPC 11 | | *Eucalyptus nitens* | South Africa | P.W. Crous | KF902067 | KF901720 | (KF903474) | (KF903195) | – | KX348070 | – | (KF902627) | (KF902897) | – |

**Table 1.** (Continued).

| Species[4] | Culture number[1,2] | Previous name[4] | Host | Country | Collector | LSU | ITS | *actA* | *tef1*-α | *gapdh* | *rpb2* | *his3* | *cmdA* | *tub2* | *chs-1* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Ps. flavomarginata* | CBS 124990;<br>CPC 13492 | | *Eucalyptus camaldulensis* | Thailand | W. Himaman | GU253817 | KF251323 | (KF253629) | (KF253270) | – | KX348071 | – | – | (JX902274) | – |
| *Ps. fori* | CBS 113286;<br>CMW 9096 | | *Eucalyptus* sp. | South Africa | J. Roux | KF902068 | KF901721 | (KF903463) | (KF903197) | – | KX348072 | – | (KF902628) | (KF902899) | – |
| *Ps. macadamiae* | **CBS 133432**$^{ET}$;<br>BRIP 55526a | | *Macadamia integrifolia* | Australia, Queensland | O.A. Akinsanmi | KX286998 | KX287300 | – | – | – | KX288455 | – | – | – | – |
| *Ps. metrosideri* | CBS 114294 | *P. metrosideri* | *Metrosideros excelsa* | New Zealand | – | KX286999 | KX287301 | – | – | – | KX288456 | – | – | – | – |
| *Ps. myopori* | CBS 114644 | *Cercospora* sp. | *Myoporum laetum* | New Zealand | – | KX287000 | KX287302 | – | – | – | KX288457 | – | – | – | – |
| *Ps. norchiensis* | **CBS 120738**$^{T}$;<br>CPC 13049 | | *Eucalyptus* sp. | Italy | W. Gams | GU253780 | KF901665 | (KF903531) | (GU384464) | – | KX348073 | – | (KF902633) | (KF902906) | – |
| *Ps. pistacina* | CPC 23118 | Pseudocercospora-like sp. | *Pistacia vera* | Turkey | K. Sarpkaya | KF442674 | KF442647 | – | KF442637 | – | KX348074 | – | – | (KF442733) | – |
| *Ps. robusta* | **CBS 111175**$^{T}$;<br>CMW 5151;<br>CPC 1269 | | *Eucalyptus robur* | Malaysia | M.J. Wingfield | KF902020 | KF442500 | (JX902150) | (JX901694) | – | KX348075 | – | (KF902640) | (KF442463) | – |
| *Pseudocercospora* sp. | CPC 19535 | *Cercosporella* sp. | *Eichhornia azurea* | Brazil | D.J. Soares | KX287001 | KX287303 | – | – | – | KX288458 | – | – | – | – |
| | CBS 113386 | *Mycovellosiella* sp. | *Chromolaena odorata* | Guatemala | M.J. Morris | KX287002 | DQ676532 | – | – | – | KX288459 | (DQ676557) | – | – | – |
| | CPC 19537 | *Cercosporella* sp. | *Eichhornia azurea* | Brazil | D.J. Soares | KX287003 | KX287304 | – | – | – | KX288460 | – | – | – | – |
| | CBS 110780;<br>CPC 204 | *Pseudocercosporella* sp. | *Syzygium cordatum* | South Africa | P.W. Crous | KX287004 | KX287305 | – | – | – | KX288461 | – | – | – | – |
| *Ps. vitis* | CBS 132012;<br>CPC 11595 | | *Vitis vinifera* | South Korea | – | KF902011 | KF901669 | (KF903603) | (GU384541) | – | KX348076 | – | (KF902649) | (KF902927) | – |
| *Pseudocercosporella bakeri* | CBS 119488;<br>Lynfield 1252 | | *Ipomoea indica* | New Zealand | C.F. Hill | KX287005 | KX287306 | KX287586 | KX287862 | – | KX288462 | – | – | – | – |
| | **CBS 125685**$^{ET}$;<br>CPC 17570 | | *Ipomoea aquatica* | Laos | P. Phengsintham | GU570553 | GU570542 | KX287587 | KX287863 | – | KX288463 | KX288752 | – | – | – |
| *Ramichloridium apiculatum* | CBS 400.76;<br>IMI 088021 | | Soil | Pakistan | – | EU041851 | EU041794 | – | – | – | KX348077 | – | – | – | – |
| | **CBS 156.59**$^{T}$;<br>ATCC 13211; | | Forest soil | USA, Georgia | – | EU041848 | EU041791 | – | – | – | – | – | – | – | – |

(*continued on next page*)

**Table 1.** (Continued).

| Species[4] | Culture number[1,2] | Previous name[4] | Host | Country | Collector | LSU | ITS | *actA* | *tef1*-α | *gapdh* | *rpb2* | *his3* | *cmdA* | *tub2* | *chs-1* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | IMI 100716;<br>JCM 6972;<br>MUCL 15753;<br>MUCL 7991;<br>QM 7716 | | | | | | | | | | | | | | |
| *Ramichloridium* sp. | CPC 12310 | *Pseudocercosporella* sp. | *Vicia amurensis* | South Korea | H.D. Shin | GU214687 | GU214687 | – | – | – | KX288464 | – | – | – | – |
| *Ramularia abscondita* | CBS 114727;<br>UPSC 3341 | | *Arctium tomentosum* | Sweden | E. Gunnerbeck | KX287006 | KX287307 | KX287588 | KX287864 | KX288143 | KX288465 | KX288753 | KX289026 | KX289126 | – |
| *R. acris* | CPC 25898 | | *Ranunculus acris* | Netherlands | S.I.R. Videira | KX287007 | KX287308 | KX287589 | KX287865 | KX288144 | KX288466 | KX288754 | – | – | – |
| | CPC 25899 | | *Ranunculus acris* | Netherlands | S.I.R. Videira | KX287008 | KX287309 | KX287590 | KX287866 | KX288145 | KX288467 | KX288755 | – | – | – |
| | CPC 25900 | | ?*Ranunculus* sp. | Netherlands | U. Damm | KX287009 | KX287310 | KX287591 | KX287867 | KX288146 | KX288468 | KX288756 | – | – | – |
| | CBS 109794 | *R. didyma* var. *didyma* | *Ranunculus* sp. | Netherlands | G. Verkley | KX287010 | KX287311 | KX287592 | KX287868 | KX288147 | KX288469 | KX288757 | – | KX289127 | – |
| *R. acroptili* | CPC 18723 | *Ramularia* sp. | *Cynara cardunculus* | USA, California | L. Davenport | KX287011 | KX287312 | KX287593 | KX287869 | KX288148 | KX288470 | KX288758 | – | KX289128 | – |
| | CPC 18724 | *Ramularia* sp. | *Cynara cardunculus* | USA, California | L. Davenport | KX287012 | KX287313 | KX287594 | KX287870 | KX288149 | KX288471 | KX288759 | – | KX289129 | – |
| | **CBS 120252**$^{\text{ET}}$;<br>98-001 | | *Acroptilon repens* | Turkey | R. Sobhian | GU214689 | GU214689 | KX287595 | KX287871 | KX288150 | KX288472 | KX288760 | KX289027 | – | – |
| | CBS 120253;<br>04-011 | *C. centaureicola* | *Centaurea solstitialis* | Greece | D. Berner | EU019257 | EU019257 | KX287596 | KX287872 | KX288151 | KX288473 | KX288761 | KX289028 | KX289130 | – |
| *R. actinidiae* | CPC 11674* | *Ramularia* sp. | *Actinidia polygama* | South Korea | H.D. Shin | KX287013 | KX287314 | – | – | – | – | – | – | – | – |
| | CPC 11675 | *Ramularia* sp. | *Actinidia polygama* | South Korea | H.D. Shin | KX287014 | KX287315 | KX287597 | KX287873 | KX288152 | KX288474 | KX288762 | – | – | – |
| *R. agastaches* | CPC 10819 | *R. lamii* | *Agastache rugosa* | South Korea | H.D. Shin | KX287015 | KX287316 | KX287598 | KX287874 | KX288153 | KX288475 | KX288763 | – | KX289131 | – |
| | CPC 10820 | *R. lamii* | *Agastache rugosa* | South Korea | H.D. Shin | KX287016 | KX287317 | KX287599 | KX287875 | KX288154 | KX288476 | KX288764 | KX289029 | KX289132 | – |
| | CPC 10821 | *R. lamii* | *Agastache rugosa* | South Korea | H.D. Shin | KX287017 | KX287318 | KX287600 | KX287876 | KX288155 | KX288477 | KX288765 | KX289030 | KX289133 | – |
| *R. agrimoniae* | CPC 11450 | *Ramularia* sp. | *Agrimonia pilosa* | South Korea | H.D. Shin | KX287018 | KX287319 | KX287601 | KX287877 | KX288156 | KX288478 | KX288766 | – | KX289134 | – |
| | CPC 11451 | *Ramularia* sp. | *Agrimonia pilosa* | South Korea | H.D. Shin | KX287019 | KX287320 | KX287602 | KX287878 | KX288157 | KX288479 | KX288767 | – | KX289135 | – |
| | CPC 11452 | *Ramularia* sp. | *Agrimonia pilosa* | South Korea | H.D. Shin | KX287020 | KX287321 | KX287603 | KX287879 | KX288158 | KX288480 | KX288768 | – | KX289136 | – |
| | CPC 11651 | | *Agrimonia pilosa* | South Korea | H.D. Shin | KX287021 | KX287322 | KX287604 | KX287880 | KX288159 | KX288481 | KX288769 | – | KX289137 | KX289243 |
| | CPC 11652 | | *Agrimonia pilosa* | South Korea | H.D. Shin | KX287022 | KX287323 | KX287605 | KX287881 | KX288160 | KX288482 | KX288770 | – | KX289138 | – |

**Table 1.** (Continued).

| Species[4] | Culture number[1,2] | Previous name[4] | Host | Country | Collector | LSU | ITS | *actA* | *tef1-α* | *gapdh* | *rpb2* | *his3* | *cmdA* | *tub2* | *chs-1* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CPC 11653 | | *Agrimonia pilosa* | South Korea | H.D. Shin | KJ504743 | KJ504784 | KJ504448 | KJ504699 | KJ504567 | KJ504655 | KJ504611 | – | KJ504481 | – |
| *R. alangiicola* | CPC 10299 | *Ph. alangii* | *Alangium platanifolium* var. *macrophylum* | South Korea | H.D. Shin | KX287023 | KX287324 | – | KX287882 | KX288161 | KX288483 | KX288771 | – | – | – |
| *R. aplospora* | **CBS 545.82**$^{\text{ET}}$ | *Cladosporium* sp. | Mildew on *Alchemilla vulgaris* | Germany | – | KP894110 | EU040238 | KP894325 | KP894435 | KP894545 | KP894656 | KP894767 | KP894878 | KP894965 | – |
| | CBS 109120 | | *Alchemilla vulgaris* | Austria | G. Verkley | KP894108 | KP894217 | KP894323 | KP894433 | KP894543 | KP894654 | KP894765 | KP894876 | – | – |
| | CBS 109121 | | *Alchemilla vulgaris* | Austria | G. Verkley | KX287024 | KX287325 | KX287606 | KX287883 | KX288162 | KX288484 | KX288772 | KX289031 | – | – |
| | CBS 237.73;<br>CCM F-367 | | *Alchemilla xanthochlora* | former Czechoslovakia | – | KX287025 | KX287326 | KX287607 | KX287884 | KX288163 | KX288485 | KX288773 | KX289032 | KX289139 | – |
| | CBS 109013 | | *Alchemilla vulgaris* | Austria | G. Verkley | KX287026 | KX287327 | KP894322 | KX287885 | KX288164 | KX288486 | KX288774 | KX289033 | KX289140 | – |
| | CBS 109014 | | *Alchemilla vulgaris* | Austria | G. Verkley | KP894107 | KP894216 | KP894322 | KP894432 | KP894542 | KP894653 | KP894764 | KP894875 | – | – |
| | CBS 114118;<br>UPSC 2679 | | *Alchemilla vulgaris* | Sweden | E. Gunnerbeck | KP894109 | KP894218 | KP894324 | KP894434 | KP894544 | KP894655 | KP894766 | KP894877 | – | – |
| *R. archangelicae* | CBS 108991 | | *Angelica sylvestris* | Austria | G. Verkley | KX287027 | KX287328 | KX287608 | KX287886 | KX288165 | KX288487 | KX288775 | KX289034 | – | – |
| | CBS 108992 | | *Angelica sylvestris* | Austria | G. Verkley | KX287028 | KX287329 | KX287609 | KX287887 | KX288166 | KX288488 | KX288776 | KX289035 | – | – |
| | CBS 109011 | | *Angelica sylvestris* | Austria | G. Verkley | KX287029 | KX287330 | KX287610 | KX287888 | KX288167 | KX288489 | KX288777 | KX289036 | – | KX289244 |
| | CBS 109012 | | *Angelica sylvestris* | Austria | G. Verkley | KX287030 | KX287331 | KX287611 | KX287889 | KX288168 | KX288490 | KX288778 | KX289037 | – | KX289245 |
| | CBS 288.49 | *M. rubella* | *Angelica sylvestris* | Austria | – | KX287031 | AY490767 | KX287612 | KX287890 | KX288169 | KX288491 | KX288779 | KX289038 | – | – |
| *R. armoraciae* | **CBS 241.90**$^{\text{ET}}$ | | *Armoracia rusticana* | Germany | S. Petzoldt | KX287032 | KX287332 | KX287613 | KX287891 | KX288170 | KX288492 | KX288780 | – | – | – |
| | CBS 253.28 | | *Armoracia rusticana* | Netherlands | – | KX287033 | KX287333 | KX287614 | KX287892 | KX288171 | KX288493 | KX288781 | – | KX289141 | KX289246 |
| *R. asteris* | CBS 131.21;<br>ATCC 44003 | | *Aster tripolium* | Netherlands | – | KX287034 | KX287334 | KX287615 | KX287893 | KX288172 | KX288494 | KX288782 | KX289039 | KX289142 | – |
| *R. bellunensis* | CBS 118417 | | *Argyranthemum frutescens* | New Zealand | – | KX287035 | KX287335 | KX287616 | KX287894 | KX288173 | KX348078 | KX288783 | – | – | – |

(*continued on next page*)

**Table 1.** (Continued).

| Species[4] | Culture number[1,2] | Previous name[4] | Host | Country | Collector | LSU | ITS | *actA* | *tef1*-α | *gapdh* | *rpb2* | *his3* | *cmdA* | *tub2* | *chs-1* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CBS 116.43 | | *Chrysanthemum frutescens* | Netherlands | – | KX287036 | KX287336 | KX287617 | KX287895 | KX288174 | KX288495 | KX288784 | – | – | – |
| *R. beticola* | CPC 30065 | | *Beta vulgaris* | Denmark | A.L. Hansen | KX287037 | KX287337 | KX287618 | KX287896 | KX288175 | KX288496 | KX288785 | KX289040 | – | – |
| | **CBS 141109**$^{ET}$; CPC 30066 | | *Beta vulgaris* | France | A. Champeil | KX287038 | KX287338 | KX287619 | KX287897 | KX288176 | KX288497 | KX288786 | KX289041 | – | – |
| | CPC 30067 | | *Beta vulgaris* | Netherlands | S.I.R. Videira | KX287039 | KX287339 | KX287620 | KX287898 | KX288177 | KX288498 | KX288787 | KX289042 | – | – |
| | CPC 30063 | | *Beta vulgaris* | Netherlands | S.I.R. Videira | KX287040 | KX287340 | KX287621 | KX287899 | KX288178 | KX288499 | KX288788 | KX289043 | – | – |
| | CPC 30064 | | *Beta vulgaris* | Netherlands | – | KX287041 | KX287341 | KX287622 | KX287900 | KX288179 | KX288500 | KX288789 | KX289044 | – | – |
| | CBS 341.29 | *R. betae* | – | Germany | – | KX287042 | KX287342 | KX287623 | KX287901 | KX288180 | KX288501 | KX288790 | KX289045 | – | – |
| | CBS 113540; UPSC 1612 | | *Beta vulgaris* | Sweden | O. Constantinescu | KX287043 | KX287343 | KX287624 | KX287902 | KX288181 | KX288502 | KX288791 | KX289046 | – | – |
| | CBS 151.67 | | *Beta vulgaris* | Switzerland | – | KX287044 | KX287344 | KX287625 | KX287903 | KX288182 | KX288503 | KX288792 | KX289047 | – | – |
| *R. bosniaca* | CBS 123880; V6024.2 | *Ramularia* sp. | *Scabiosa ochroleuca* | Czech Republic | G. Verkley | KX287045 | KX287345 | KX287626 | KX287904 | KX288183 | KX288504 | KX288793 | – | KX289143 | – |
| | CBS 123881; V6024.1 | *Ramularia* sp. | *Scabiosa ochroleuca* | Czech Republic | G. Verkley | KX287046 | KX287346 | KX287627 | KX287905 | KX288184 | KX288505 | KX288794 | – | KX289144 | – |
| *R. buniadis* | CBS 114301; UPSC 2718 | | *Bunias orientalis* | Sweden | E. Gunnerbeck | KX287047 | KX287347 | KX287628 | KX287906 | KX288185 | KX288506 | KX288795 | KX289048 | KX289145 | – |
| *R. calcea* | CBS 101612 | | *Symphytum* sp. | Germany | G. Arnold | KP894111 | KP894219 | KP894326 | KP894436 | KP894546 | KP894657 | KP894768 | KP894879 | KP894966 | – |
| | CBS 101613 | | *Symphytum* sp. | Germany | G. Arnold | KP894112 | KP894220 | KP894327 | KP894437 | KP894547 | KP894658 | KP894769 | – | KP894967 | – |
| | CBS 114442; UPSC 2727 | *R. lactea* | *Viola hirta* | Sweden | E. Gunnerbeck | KP894122 | KP894229 | KP894337 | KP894447 | KP894557 | KP894668 | KP894779 | KP894884 | KP894972 | – |
| *R. carneola* | CBS 108975 | | *Scrophularia nodosa* | Netherlands | G. Verkley | KX287048 | KX287348 | KX287629 | KX287907 | KX288186 | KX288507 | KX288796 | KX289049 | KX289146 | – |
| | CBS 108976 | | *Scrophularia nodosa* | Netherlands | G. Verkley | KX287049 | KX287349 | KX287630 | KX287908 | KX288187 | KX288508 | KX288797 | KX289050 | KX289147 | KX289247 |
| | CBS 108977 | | *Scrophularia nodosa* | Netherlands | G. Verkley | KX287050 | KX287350 | KX287631 | KX287909 | KX288188 | KX288509 | KX288798 | KX289051 | KX289148 | – |
| | CBS 108978 | | *Scrophularia nodosa* | Netherlands | G. Verkley | KX287051 | KX287351 | KX287632 | KX287910 | KX288189 | KX288510 | KX288799 | KX289052 | KX289149 | – |
| | CBS 109847 | | *Scrophularia nodosa* | Netherlands | G. Verkley | KX287052 | KX287352 | KX287633 | KX287911 | KX288190 | KX288511 | KX288800 | KX289053 | KX289150 | – |
| *R. cerastiicola* | **CBS 115913**$^{T}$; CPC 11290 | *M. cerastiicola* | *Cerastium semidecandrum* | Netherlands | A. Aptroot | KF251727 | KF251224 | KX287634 | KF253180 | KX288191 | KX348079 | KX288801 | – | – | – |
| *R. chamaedryos* | CBS 116577; UPSC 2322 | | *Veronica chamaedrys* | Sweden | E. Gunnerbeck | KX287053 | KX287353 | KX287635 | KX287912 | KX288192 | KX288512 | KX288802 | KX289054 | – | – |
| | CBS 113307 | *Ramularia* sp. | *Veronica didyma* | South Korea | H.D. Shin | KX287054 | KX287354 | KX287636 | KX287913 | KX288193 | KX288513 | KX288803 | – | KX289151 | – |

**Table 1.** (Continued).

| Species[4] | Culture number[1,2] | Previous name[4] | Host | Country | Collector | LSU | ITS | *actA* | *tef1*-α | *gapdh* | *rpb2* | *his3* | *cmdA* | *tub2* | *chs-1* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CBS 131773; KACC 42885 | | *Veronica persica* | South Korea | H.D. Shin & M.J. Park | KX287055 | KX287355 | KX287637 | KX287914 | KX288194 | KX288514 | KX288804 | – | KX289152 | – |
| | CBS 118794 | *R. veronicae* | *Veronica persica* | New Zealand | – | KX287056 | KX287356 | KX287638 | KX287915 | KX288195 | KX288515 | KX288805 | KX289055 | – | – |
| | CBS 114731; UPSC 3243 | *R. anagallidis* | *Veronica anagallis-aquatica* | Sweden | E. Gunnerbeck | KX287057 | KX287357 | KX287639 | KX287916 | KX288196 | KX288516 | KX288806 | – | – | – |
| *R. chelidonii* | CPC 12208 | | *Hylomecon vernalis* | South Korea | H.D. Shin | KX287058 | KX287358 | KX287640 | KX287917 | KX288197 | KX288517 | KX288807 | KX289056 | – | – |
| | CPC 12209 | | *Hylomecon vernalis* | South Korea | H.D. Shin | KX287059 | KX287359 | KX287641 | KX287918 | KX288198 | KX288518 | KX288808 | – | – | – |
| | CBS 113317 | *Ramularia* sp. | *Hylomecon vernalis* | South Korea | H.D. Shin | KX287060 | KX287360 | KX287642 | KX287919 | KX288199 | KX288519 | KX288809 | – | – | – |
| *R. coleosporii* | CPC 10653 | *Ramularia* sp. | *Coleosporium eupatorii* on *Eupatorium japonicum* | South Korea | H.D. Shin | KX287061 | KX287361 | – | KX287920 | – | KX288520 | – | – | – | – |
| | CPC 10669 | *Ramularia* sp. | *Coleosporium eupatorii* on *Eupatorium japonicum* | South Korea | H.D. Shin | KX287062 | KX287362 | KX287643 | KX287921 | KX288200 | KX288521 | KX288810 | – | KX289153 | – |
| | CPC 10731 | *Ramularia* sp. | *Coleosporium clematidis-apiifoliae* on *Clematis apiifolia* | South Korea | H.D. Shin | KX287063 | KX287363 | KX287644 | KX287922 | KX288201 | KX288522 | KX288811 | – | KX289154 | – |
| | CPC 10732 | *Ramularia* sp. | *Coleosporium clematidis-apiifoliae* on *Clematis apiifolia* | South Korea | H.D. Shin | KX287064 | KX287364 | KX287645 | KX287923 | KX288202 | KX288523 | KX288812 | – | KX289155 | – |
| | CPC 10733 | *Ramularia* sp. | *Coleosporium clematidis-apiifoliae* on *Clematis apiifolia* | South Korea | H.D. Shin | KX287065 | KX287365 | KX287646 | KX287924 | KX288203 | KX288524 | KX288813 | – | – | – |
| | CPC 10746 | *Ramularia* sp. | *Coleosporium eupatorii* on *Eupatorium lindleyanum* | South Korea | H.D. Shin | KX287066 | KX287366 | KX287647 | KX287925 | KX288204 | KX288525 | KX288814 | – | KX289156 | – |
| | CPC 10747 | *Ramularia* sp. | *Coleosporium eupatorii* on *Eupatorium lindleyanum* | South Korea | H.D. Shin | KX287067 | KX287367 | KX287648 | KX287926 | KX288205 | KX288526 | KX288815 | – | KX289157 | – |
| | CPC 10748 | *Ramularia* sp. | *Coleosporium eupatorii* on *Eupatorium lindleyanum* | South Korea | H.D. Shin | KX287068 | KX287368 | KX287649 | KX287927 | KX288206 | KX288527 | KX288816 | – | KX289158 | – |

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**Table 1.** (Continued).

| Species[4] | Culture number[1,2] | Previous name[4] | Host | Country | Collector | LSU | ITS | *actA* | *tef1*-α | *gapdh* | *rpb2* | *his3* | *cmdA* | *tub2* | *chs-1* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  | CPC 11516 |  | *Coleosporium plectranthi* on *Plectranthus japonicus* | South Korea | H.D. Shin | KX287069 | KX287369 | KX287650 | KX287928 | KX288207 | KX288528 | KX288817 | – | KX289159 | – |
|  | CBS 131753; KACC 42483 |  | *Coleosporium perillae* on *Perilla frutescens* var. *japonica* | South Korea | H.D. Shin & M.J. Park | KX287070 | KX287370 | KX287651 | KX287929 | KX288208 | KX288529 | KX288818 | – | KX289160 | – |
|  | CBS 131754; KACC 43177 |  | *Coleosporium asterum* on *Aster pilosus* | South Korea | H.D. Shin & M.J. Park | KX287071 | KX287371 | KX287652 | KX287930 | KX288209 | KX288530 | KX288819 | – | KX289161 | – |
|  | CBS 131755; KACC 43977 |  | *Coleosporium asterum* on *Aster pilosus* | South Korea | H.D. Shin & M.J. Park | KX287072 | KX287372 | KX287653 | KX287931 | KX288210 | – | KX288820 | – | KX289162 | – |
|  | CBS 131756; KACC 43200 |  | *Coleosporium clematidis-apiifoliae* on *Clematis apiifolia* | South Korea | H.D. Shin & M.J. Park | KX287073 | KX287373 | KX287654 | KX287932 | KX288211 | KX288531 | KX288821 | – | KX289163 | – |
|  | CBS 131757; KACC 43185 |  | *Coleosporium horianum* on *Codonopsis lanceolata* | South Korea | H.D. Shin & M.J. Park | KX287074 | KX287374 | KX287655 | KX287933 | KX288212 | KX288532 | KX288822 | – | – | KX289248 |
|  | CBS 131758; KACC 44854 |  | *Coleosporium cacaliae* on *Syneilesis palmata* | South Korea | H.D. Shin & M.J. Park | KX287075 | KX287375 | KX287656 | KX287934 | KX288213 | KX288533 | KX288823 | – | – | – |
|  | CBS 131759; KACC 44073 |  | *Coleosporium horianum* on *Codonopsis lanceolata* | South Korea | H.D. Shin & M.J. Park | KX287076 | KX287376 | KX287657 | KX287935 | KX288214 | KX288534 | KX288824 | – | – | – |
|  | CBS 131760; KACC 44081 |  | *Coleosporium horianum* on *Codonopsis lanceolata* | South Korea | H.D. Shin & M.J. Park | KX287077 | KX287377 | KX287658 | KX287936 | KX288215 | KX288535 | KX288825 | – | KX289164 | – |
|  | CBS 131761; KACC 44855 |  | *Coleosporium saussureae* on *Saussurea pulchella* | South Korea | H.D. Shin & M.J. Park | KX287078 | KX287378 | KX287659 | KX287937 | KX288216 | KX288536 | KX288826 | – | KX289165 | – |
|  | CBS 131762; KACC 44860 |  | *Coleosporium* sp. on *Solidago serotina* | South Korea | H.D. Shin & M.J. Park | KX287079 | KX287379 | KX287660 | KX287938 | KX288217 | KX288537 | KX288827 | – | KX289166 | – |

**Table 1.** (Continued).

| Species[4] | Culture number[1,2] | Previous name[4] | Host | Country | Collector | LSU | ITS | *actA* | *tef1*-α | *gapdh* | *rpb2* | *his3* | *cmdA* | *tub2* | *chs-1* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CBS 131763; KACC 42484 | | *Coleosporium eupatorii* on *Eupatorium japonicum* | South Korea | H.D. Shin & M.J. Park | KX287080 | KX287380 | KX287661 | KX287939 | KX288218 | KX288538 | KX288828 | KX289057 | KX289167 | KX289249 |
| | CBS 131764; KACC 43182 | | *Coleosporium eupatorii* on *Eupatorium lindleyanum* | South Korea | H.D. Shin & M.J. Park | KX287081 | KX287381 | KX287662 | KX287940 | KX288219 | KX288539 | KX288829 | – | KX289168 | – |
| | CBS 131765; KACC 42635 | | *Coleosporium asterum* on *Aster pilosus* | South Korea | H.D. Shin & M.J. Park | KX287082 | KX287382 | KX287663 | KX287941 | KX288220 | KX288540 | KX288830 | – | KX289169 | – |
| | CBS 131766; KACC 43058 | | *Coleosporium clerodendri* on *Clerodendron trichotomum* | South Korea | H.D. Shin & M.J. Park | KX287083 | KX287383 | KX287664 | KX287942 | KX288221 | KX288541 | KX288831 | – | KX289170 | – |
| | CBS 131767; KACC 44053 | | *Pileolaria shiraiana* on *Rhus trichocarpa* | South Korea | H.D. Shin & M.J. Park | KX287084 | KX287384 | KX287665 | KX287943 | KX288222 | KX288542 | KX288832 | – | KX289171 | – |
| *R. collo-cygni* | **CBS 101180**$^{NT}$ | | *Hordeum vulgare* | Austria | Züchtungsfirma Saatbau Linz | KX287085 | KX287385 | KX287666 | KX287944 | KX288223 | KX288543 | KX288833 | – | KX289172 | – |
| | CBS 101181 | | *Hordeum vulgare* | Germany, Bavaria | E. Sachs | KJ504745 | KJ504786 | KJ504450 | KJ504701 | KJ504569 | KJ504657 | KJ504613 | KJ504513 | KJ504483 | – |
| | CBS 101182 | | *Hordeum vulgare* | Germany, Bavaria | E. Sachs | KX287086 | KX287386 | KX287667 | KX287945 | KX288224 | KX288544 | KX288834 | KX289058 | KX289173 | – |
| | CBS 119442; CPC 12688; V22 | | *Hordeum vulgare* | Norway | S. Salamati | KX287087 | KX287387 | KX287668 | KX287946 | KX288225 | KX288545 | KX288835 | – | – | – |
| | CBS 119441; CPC 12690; V40 | | *Hordeum vulgare* | Norway | S. Salamati | KX287088 | KX287388 | KX287669 | KX287947 | KX288226 | KX288546 | KX288836 | – | – | – |
| | CBS 119440; CPC 12692; V58 | | *Hordeum vulgare* | Norway | S. Salamati | KX287089 | KX287389 | KX287670 | KX287948 | KX288227 | KX288547 | KX288837 | KX289059 | – | – |
| | CBS 119439; CPC 12693; V74 | | *Hordeum vulgare* | Norway | S. Salamati | KX287090 | KX287390 | KX287671 | KX287949 | KX288228 | KX288548 | KX288838 | KX289060 | – | – |
| *R. coryli* | CBS 117800; CPC 12090 | *R. endophylla* | *Corylus avellana* | Netherlands | G. Verkley | KX287091 | KX287391 | KX287672 | KX287950 | KX288229 | KX288549 | KX288839 | KX289061 | – | KX289250 |
| *R. cupulariae* | CBS 235.73 | | *Inula* sp. | former Czechoslovakia | L. Marvanová | KX287092 | KX287392 | KX287673 | KX287951 | KX288230 | KX288550 | KX288840 | – | KX289174 | – |
| *R. cyclaminicola* | CBS 399.51 | | *Cyclamen persicum* | USA | – | KX287093 | KX287393 | KX287674 | KX287952 | KX288231 | KX288551 | KX288841 | – | – | – |
| *R. cynarae* | CPC 18427 | | *Cynara cardunculus* | USA, California | S.T. Koike | KX287094 | KX287394 | KX287675 | KX287953 | KX288232 | KX288552 | KX288842 | – | KX289175 | – |

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**Table 1.** (Continued).

| Species[4] | Culture number[1,2] | Previous name[4] | Host | Country | Collector | LSU | ITS | *actA* | *tef1*-α | *gapdh* | *rpb2* | *his3* | *cmdA* | *tub2* | *chs-1* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CBS 128779; CPC 18725 | | *Carthamus tinctorius* | USA, California | S.T. Koike | KX287095 | HQ728118 | KX287676 | KX287954 | KX288233 | KX288553 | KX288843 | – | KX289176 | – |
| | **CBS 128912**$^{ET}$; CPC 18426 | | *Cynara cardunculus* | USA, California | S.T. Koike | KX287096 | HQ728117 | KX287677 | KX287955 | KX288234 | KX288554 | KX288844 | – | KX289177 | – |
| | CBS 114728; UPSC 3248 | *R. cirsii* | *Cirsium arvense* | Sweden | E. Gunnerbeck | KX287097 | KX287395 | KX287678 | KX287956 | KX288235 | KX288555 | KX288845 | – | KX289178 | – |
| | CPC 25896 | | *Carex acutiformis* | Netherlands | S.I.R. Videira | KX287098 | KX287396 | KX287679 | KX287957 | KX288236 | KX288556 | KX288846 | – | – | – |
| | CPC 25897 | | *Carduus* sp. | Netherlands | S.I.R. Videira | KX287099 | KX287397 | KX287680 | KX287958 | KX288237 | KX288557 | KX288847 | – | KX289179 | – |
| | CBS 114729; UPSC 3338 | *R. cardui* | *Carduus crispus* | Sweden | E. Gunnerbeck | KX287100 | KX287398 | KX287681 | KX287959 | KX288238 | KX288558 | KX288848 | – | KX289180 | – |
| *R. deusta* | CBS 473.50; IMI 099672 | *R. deusta* f. *latifolia* | *Lathyrus latifolius* | Guadeloupe | – | KX287101 | KX287399 | KX287682 | KX287960 | KX288239 | KX288559 | KX288849 | KX289062 | KX289181 | – |
| *R. didyma* var. *didyma* | CBS 114299; UPSC 2746 | *R. didyma* | *Ranunculus repens* | Sweden | E. Gunnerbeck | KX287102 | KX287400 | KX287683 | KX287961 | KX288240 | KX288560 | KX288850 | – | KX289182 | – |
| | CBS 420.67 | *R. didyma* | *Ranunculus repens* | UK, England | – | KX287103 | KX287401 | KX287684 | KX287962 | KX288241 | KX288561 | KX288851 | – | KX289183 | – |
| | CBS 431.67* | *R. didyma* | *Ranunculus repens* | Luxembourg | – | KX287104 | KX287402 | KX287685 | KX287963 | KX288242 | – | KX288852 | – | – | – |
| *R. diervillae* | CPC 16860 | *Ramularia* sp. | *Diervilla lonicera* | Canada | K.A. Seifert | KX287105 | KX287403 | KX287686 | KX287964 | KX288243 | KX288562 | KX288853 | – | KX289184 | – |
| | CPC 16864 | *Ramularia* sp. | *Diervilla lonicera* | Canada | K.A. Seifert | KX287106 | KX287404 | KX287687 | KX287965 | KX288244 | KX288563 | KX288854 | – | KX289185 | – |
| | CPC 16859 | *Ramularia* sp. | *Diervilla lonicera* | Canada | K.A. Seifert | KX287107 | KX287405 | KX287688 | KX287966 | KX288245 | KX288564 | – | – | KX289186 | – |
| | CPC 16863 | *Ramularia* sp. | *Diervilla lonicera* | Canada | K.A. Seifert | KX287108 | KX287406 | KX287689 | KX287967 | KX288246 | KX288565 | KX288855 | – | KX289187 | – |
| *R. digitalis-ambiguae* | CBS 434.67 | *R. variabilis* | *Digitalis purpurea* | Luxembourg | – | KX287109 | KX287407 | KX287690 | KX287968 | KX288247 | KX288566 | KX288856 | KX289063 | – | – |
| | **CBS 297.37**$^{T}$ | *R. variabilis* | *Digitalis* sp. | Netherlands | – | KX287110 | KX287408 | KX287691 | KX287969 | KX288248 | KX288567 | KX288857 | – | – | – |
| *R. endophylla* | CBS 113871 | | *Quercus robur* | Netherlands | G. Verkley | KP894130 | KP894237 | KP894345 | KP894455 | KP894566 | KP894677 | KP894787 | KP894891 | KP894977 | – |
| | **CBS 113265**$^{ET}$ | | *Quercus robur* | Netherlands | G. Verkley | AY490776 | AY490763 | KF903461 | KF253276 | KP894562 | KP894673 | KP207603 | KF253981 | KP894975 | – |
| | CBS 101680 | | *Castanea sativa* | Netherlands | A. Aptroot | KP894126 | KP894233 | KP894341 | KP894451 | KP894561 | KP894672 | KP894783 | KP894887 | KP894974 | – |
| | CBS 115303 | | *Quercus robur* | Netherlands | – | KP894133 | KP894240 | KP894348 | KP894458 | KP894569 | KP894680 | KP894790 | KP894894 | – | – |
| | CBS 113869 | | *Quercus robur* | Netherlands | G. Verkley | KP894128 | KP894235 | KP894343 | KP894453 | KP894564 | KP894675 | KP894785 | KP894889 | – | – |
| | CBS 115302 | | *Quercus robur* | Netherlands | – | KP894132 | KP894239 | KP894347 | KP894457 | KP894568 | KP894679 | KP894789 | KP894893 | KP894978 | – |
| *R. eucalypti* | CBS 120728; CPC 13304 | | *Eucalyptus* sp. | Australia, Queensland | P.W. Crous | KJ504751 | KJ504793 | KJ504457 | KJ504708 | KJ504576 | KJ504664 | KJ504620 | KJ504520 | – | – |
| | CPC 19188 | *Ramularia* sp. | *Phragmites* sp. | Netherlands | P.W. Crous | KJ504756 | KJ504798 | KJ504462 | KJ504713 | KJ504581 | KJ504669 | KJ504625 | KJ504524 | KJ504491 | – |
| | **CBS 120726**$^{T}$; CPC 13043 | | *Corymbia grandifolia* | Italy | W. Gams | KF251834 | KJ504792 | KJ504456 | KJ504707 | KJ504575 | KJ504663 | KJ504619 | KJ504519 | – | KJ504542 |
| *R. euonymicola* | **CBS 113308**$^{T}$ | *Ramularia* sp. | *Euonymus alatus* | South Korea | H.D. Shin | KX287111 | KX287409 | KX287692 | KX287970 | KX288249 | KX288568 | KX288858 | – | KX289188 | – |
| *R. gaultheriae* | **CBS 299.80**$^{T}$ | *Ramularia* sp. | *Gaultheria shallon* | Italy | – | KX287112 | KX287410 | KX287693 | KX287971 | KX288250 | KX288569 | KX288859 | – | – | – |

**Table 1.** (Continued).

| Species[4] | Culture number[1,2] | Previous name[4] | Host | Country | Collector | LSU | ITS | *actA* | *tef1*-α | *gapdh* | *rpb2* | *his3* | *cmdA* | *tub2* | *chs-1* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *R. gei* | CBS 344.49 | | *Geum urbanum* | Netherlands | J.A. von Arx | KX287113 | KX287411 | KX287694 | KX287972 | KX288251 | KX288570 | KX288860 | KX289064 | – | – |
| | CBS 113977; UPSC 2323 | | *Geum* sp. | Sweden | E. Gunnerbeck | KX287114 | KX287412 | KX287695 | KX287973 | KX288252 | KX288571 | KX288861 | KX289065 | KX289189 | – |
| *R. geranii* | CBS 159.24 | | *Geranium pyrenaicum* | France | – | KX287115 | KX287413 | KX287696 | KX287974 | KX288253 | KX288572 | KX288862 | KX289066 | KX289190 | KX289251 |
| | **CBS 160.24**$^{ET}$ | | *Geranium sylvaticum* | France | C. Killian | KX287116 | KX287414 | KX287697 | KX287975 | KX288254 | KX288573 | KX288863 | KX289067 | KX289191 | – |
| *R. geraniicola* | **CPC 25912**$^{T}$ | | *Geranium* sp. | Netherlands | U. Damm | KX287117 | KX287415 | KX287698 | KX287976 | KX288255 | KX288574 | KX288864 | – | – | – |
| *R. glechomatis* | CBS 343.49 | *R. calcea* | *Glechoma hederacea* | Netherlands | – | KX287118 | KX287416 | KX287699 | KX287977 | KX288256 | KX288575 | KX288865 | – | KX289192 | – |
| | CBS 108979 | | *Glechoma hederacea* | Netherlands | G. Verkley | KJ504757 | KJ504799 | KJ504463 | KJ504714 | KJ504582 | KJ504670 | KJ504626 | – | KJ504492 | KJ504543 |
| | CBS 108980 | | *Glechoma hederacea* | Netherlands | G. Verkley | KX287119 | KX287417 | KX287700 | KX287978 | KX288257 | KX288576 | KX288866 | – | KX289193 | – |
| *R. glennii* | **CBS 129441**$^{T}$; det. 11-013M | | Human bronchial alveolar lavage | Netherlands | – | KJ504728 | KJ504769 | KJ504433 | KJ504684 | KJ504552 | KJ504640 | KJ504596 | KJ504500 | – | – |
| | CBS 122989; CPC 15195 | | Human skin | Netherlands | – | KJ504727 | KJ504768 | KJ504432 | KJ504683 | KJ504551 | KJ504639 | KJ504595 | KJ504499 | – | – |
| | CPC 18468 | *R. eucalypti* | Rubber of refrigerator | USA, Athens | A.E. Glenn | KJ504734 | KJ504775 | KJ504439 | KJ504690 | KJ504558 | KJ504646 | KJ504602 | KJ504503 | – | – |
| | CBS 120727; CPC 13046 | | *Corymbia grandifolia* | Italy | W. Gams | KJ504726 | KJ504767 | KJ504431 | KJ504682 | – | KJ504638 | KJ504594 | KJ504498 | KJ504474 | KJ504530 |
| | CPC 16560 | *Ramularia* sp. | *Eucalyptus camaldulensis* | Iraq | A. Saadoon | KJ504731 | KJ504772 | KJ504436 | KJ504687 | KJ504555 | KJ504643 | KJ504599 | KJ504501 | KJ504475 | KJ504532 |
| | CPC 16565 | *Ramularia* sp. | *Eucalyptus camaldulensis* | Iraq | A. Saadoon | KJ504733 | KJ504774 | KJ504438 | KJ504689 | KJ504557 | KJ504645 | KJ504601 | – | KJ504477 | KJ504533 |
| *R. grevilleana* | CBS 259.36 | *M. fragariae* | – | Netherlands | – | KP894114 | KP894222 | KP894329 | KP894439 | KP894549 | KP894660 | KP894771 | – | – | – |
| | CBS 719.84 | *M. fragariae* | *Fragaria* × *ananassa* Tioga | New Zealand | – | KP894116 | EU167605 | KP894331 | KP894441 | KP894551 | KP894662 | KP894773 | KP894881 | – | – |
| | CBS 298.34 | *M. fragariae* | – | Netherlands | – | KP894115 | KP894223 | KP894330 | KP894440 | KP894550 | KP894661 | KP894772 | KP894880 | KP894969 | – |
| | CBS 114732; UPSC 3244 | | *Fragaria ananassa* | Sweden | E. Gunnerbeck | KP894113 | KP894221 | KP894328 | KP894438 | KP894548 | KP894659 | KP894770 | – | KP894968 | – |
| *R. haroldporteri* | CPC 16297 | *Ramularia* sp. | Unidentified bulb plant | South Africa | P.W. Crous | KX287120 | KX287418 | KX287701 | KX287979 | KX288258 | KX288577 | KX288867 | – | – | – |
| | **CBS 137272**$^{T}$; CPC 16296 | | Unidentified bulb plant | South Africa | P.W. Crous | KJ504725 | KJ504766 | KJ504430 | KJ504681 | (KJ504549) | KJ504637 | KJ504593 | KJ504497 | – | – |
| *R. heraclei* | **CBS 108969**$^{ET}$ | | *Heracleum sphondylium* | Netherlands | G. Verkley | KX287121 | KX287419 | KX287702 | KX287980 | KX288259 | KX288578 | – | KX289068 | – | – |

(*continued on next page*)

**Table 1.** (Continued).

| Species[4] | Culture number[1,2] | Previous name[4] | Host | Country | Collector | LSU | ITS | *actA* | *tef1-α* | *gapdh* | *rpb2* | *his3* | *cmdA* | *tub2* | *chs-1* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CBS 108972 | | *Heracleum sphondylium* | Netherlands | G. Verkley | KX287122 | KX287420 | KX287703 | KX287981 | KX288260 | KX288579 | – | KX289069 | – | – |
| | CBS 108987 | | *Heracleum* sp. | Austria | G. Verkley | KX287123 | KX287421 | KX287704 | KX287982 | KX288261 | KX288580 | KX288868 | – | – | KX289252 |
| | CBS 108988 | | *Heracleum* sp. | Austria | G. Verkley | KX287124 | KX287422 | KX287705 | KX287983 | KX288262 | KX288581 | KX288869 | KX289070 | – | – |
| | CPC 11505 | *Ramularia* sp. | *Heracleum moellendorffii* | South Korea | H.D. Shin | KX287125 | KX287423 | KX287706 | KX287984 | KX288263 | KX288582 | KX288870 | KX289071 | – | KX289253 |
| | CPC 11506 | *Ramularia* sp. | *Heracleum moellendorffii* | South Korea | H.D. Shin | KX287126 | KX287424 | KX287707 | KX287985 | KX288264 | KX288583 | KX288871 | KX289072 | – | – |
| | CPC 11507 | *Ramularia* sp. | *Heracleum moellendorffii* | South Korea | H.D. Shin | KX287127 | KX287425 | KX287708 | KX287986 | KX288265 | KX288584 | KX288872 | KX289073 | – | – |
| | CBS 113976;<br>UPSC 2344 | | *Heracleum sphondylium* | Sweden | E. Gunnerbeck | KX287128 | KX287426 | KX287709 | KX287987 | KX288266 | KX288585 | KX288873 | KX289074 | – | – |
| | CBS 194.25 | | *Pastinaca sativa* | – | – | KX287129 | KX287427 | KX287710 | KX287988 | KX288267 | KX288586 | KX288874 | KX289075 | – | – |
| *R. hieracii-umbellati* | CPC 10690 | *R. inaequalis* | *Hieracium umbellatum* | South Korea | H.D. Shin | KX287130 | KX287428 | KX287711 | KX287989 | KX288268 | KX288587 | KX288875 | – | – | – |
| | CPC 10691 | *R. inaequalis* | *Hieracium umbellatum* | South Korea | H.D. Shin | KX287131 | KX287429 | KX287712 | KX287990 | KX288269 | KX288588 | KX288876 | – | – | – |
| | CPC 10692 | *R. inaequalis* | *Hieracium umbellatum* | South Korea | H.D. Shin | KX287132 | KX287430 | KX287713 | KX287991 | KX288270 | KX288589 | KX288877 | – | – | – |
| | CPC 10788 | *R. inaequalis* | *Hieracium umbellatum* | South Korea | H.D. Shin | KX287133 | KX287431 | KX287714 | KX287992 | KX288271 | KX288590 | KX288878 | – | – | – |
| | CPC 10789 | *R. inaequalis* | *Hieracium umbellatum* | South Korea | H.D. Shin | KX287134 | KX287432 | KX287715 | KX287993 | KX288272 | KX288591 | KX288879 | KX289076 | – | – |
| *R. hydrangeae-macrophyllae* | **CBS 122273**$^{T}$;<br>2007/2068 | | *Hydrangea macrophylla* | New Zealand | C.F. Hill | KX287135 | KX287433 | KX287716 | KX287994 | KX288273 | KX288592 | KX288880 | KX289077 | – | – |
| | CPC 25908 | | *Laurus* sp. | Netherlands | W. Quaedvlieg | KX287136 | KX287434 | KX287717 | KX287995 | KX288274 | KX288593 | KX288881 | – | – | – |
| | CBS 118410 | *Ramularia* sp. | *Ligularia clivorum* | New Zealand | – | KX287137 | KX287435 | KX287718 | KX287996 | KX288275 | KX288594 | KX288882 | KX289078 | KX289194 | – |
| | CPC 25905 | | *Carex* sp. | Netherlands | W. Quaedvlieg | KX287138 | KX287436 | KX287719 | KX287997 | KX288276 | KX288595 | KX288883 | – | – | – |
| | CBS 122625;<br>CPC 14811;<br>2007/3485-B | *R. rollandii* | *Iris* × *hollandica* hybrid | New Zealand | C.F. Hill | KX287139 | KX287437 | KX287720 | KX287998 | KX288277 | KX288596 | KX288884 | KX289079 | KX289195 | – |
| | CBS 122272;<br>2007/2973 | *Ramularia* sp. | *Iris* sp. | New Zealand | C.F. Hill | KX287140 | KX287438 | KX287721 | KX287999 | KX288278 | KX288597 | KX288885 | KX289080 | KX289196 | – |
| | CPC 25902 | | *Aesculus hippocastanum* | Netherlands | S.I.R. Videira | KX287141 | KX287439 | KX287722 | KX288000 | KX288279 | KX288598 | KX288886 | KX289081 | – | – |
| | CPC 25906 | | *Carex* sp. | Netherlands | W. Quaedvlieg | KX287142 | KX287440 | KX287723 | KX288001 | KX288280 | KX288599 | KX288887 | – | – | – |
| | CPC 19854 | *Ramularia* sp. | *Feijoa sellowiana* | Italy | G. Polizzi | KX287143 | KX287441 | KX287724 | KX288002 | KX288281 | KX288600 | KX288888 | KX289082 | – | – |
| | CPC 19026 | *Ramularia* sp. | *Phragmites* sp. | Netherlands | P.W. Crous | KX287144 | KX287442 | KX287725 | KX288003 | KX288282 | KX288601 | KX288889 | – | – | – |

**Table 1.** (Continued).

| Species[4] | Culture number[1,2] | Previous name[4] | Host | Country | Collector | LSU | ITS | *actA* | *tef1*-α | *gapdh* | *rpb2* | *his3* | *cmdA* | *tub2* | *chs-1* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CPC 19027 | *Ramularia* sp. | *Phragmites* sp. | Netherlands | P.W. Crous | KX287145 | KX287443 | KX287726 | KX288004 | KX288283 | KX288602 | KX288890 | KX289083 | – | – |
| | CBS 341.49 | *R. archangelicae* | *Angelica sylvestris* | Netherlands | – | KX287146 | KX287444 | KX287727 | KX288005 | KX288284 | KX288603 | KX288891 | KX289084 | KX289197 | – |
| | CPC 25907 | | *Juncus* sp. | Netherlands | U. Damm | KX287147 | KX287445 | KX287728 | KX288006 | KX288285 | KX288604 | KX288892 | – | – | – |
| | CPC 20406 | *Ramularia* sp. | *Eucalyptus caesia* | USA, California | P.W. Crous | KX287148 | KX287446 | KX287729 | KX288007 | KX288286 | KX288605 | KX288893 | – | – | – |
| | CPC 20484 | *Ramularia* sp. | *Iris foetidissima* | Netherlands | – | KX287149 | KX287447 | KX287730 | KX288008 | KX288287 | KX288606 | KX288894 | – | – | – |
| | CPC 25901 | | *Platanus* sp. | Netherlands | S.I.R. Videira | KX287150 | KX287448 | KX287731 | KX288009 | KX288288 | KX288607 | KX288895 | KX289085 | – | KX289254 |
| | CBS 766.84 | *R. deusta* var. *alba* | *Ulex europaeus* | UK, England | – | KX287151 | KX287449 | KX287732 | KX288010 | KX288289 | KX288608 | KX288896 | – | KX289198 | – |
| | CBS 159.82 | *R. sparganii* | *Sparganium ramosum* | Netherlands | W. Gams | KX287152 | KX287450 | KX287733 | KX288011 | KX288290 | KX288609 | KX288897 | KX289086 | KX289199 | – |
| | CPC 19030 | *Ramularia* sp. | *Iris* sp. | UK | P.W. Crous | KX287153 | KX287451 | KX287734 | KX288012 | KX288291 | KX288610 | KX288898 | KX289087 | KX289200 | – |
| | CBS 114117; UPSC 2662 | *R. butomi* | *Filipendula vulgaris* | Sweden | E. Gunnerbeck | KX287154 | KX287452 | KX287735 | KX288013 | KX288292 | KX288611 | KX288899 | KX289088 | KX289201 | – |
| | CPC 25904 | | *Potentilla* sp. | Netherlands | U. Damm | KX287155 | KX287453 | KX287736 | KX288014 | KX288293 | KX288612 | KX288900 | – | – | – |
| | CBS 113614 | *Ramularia* sp. | *Sparganium ramosum* | Netherlands | – | KX287156 | KX287454 | KX287737 | KX288015 | KX288294 | KX288613 | KX288901 | KX289089 | – | – |
| | CPC 25903 | | *Typha* sp. | Netherlands | S.I.R. Videira | KX287157 | KX287455 | KX287738 | KX288016 | KX288295 | KX288614 | KX288902 | KX289090 | KX289202 | – |
| | CBS 118408 | *R. hellebori* | *Helleborus niger* | New Zealand | C.F. Hill | KX287158 | KX287456 | KX287739 | KX288017 | KX288296 | KX288615 | KX288903 | KX289091 | – | – |
| *R. inaequalis* | CPC 15815 | Cercosporoid sp. | *Taraxacum* sp. | Mexico | M. de Jesús Yáñez-Morales | KX287159 | KX287457 | KX287740 | KX288018 | KX288297 | KX288616 | KX288904 | KX289092 | KX289203 | – |
| | CBS 250.96 | *R. inaequalis* | *Taraxacum officinale* | Canada, Nova Scotia | S. Green | KP894117 | KP894224 | KP894332 | KP894442 | KP894552 | KP894663 | KP894774 | KP894882 | KP894970 | – |
| | CPC 15752 | *Ramularia* sp. | *Taraxacum* sp. | Mexico | M. de Jesús Yáñez-Morales | KP894118 | KP894225 | KP894333 | KP894443 | KP894553 | KP894664 | KP894775 | – | – | – |
| | CPC 15753 | *Ramularia* sp. | *Taraxacum* sp. | Mexico | M. de Jesús Yáñez-Morales | KP894119 | KP894226 | KP894334 | KP894444 | KP894554 | KP894665 | KP894776 | KP894883 | KP894971 | – |
| | **CBS 141111**$^{ET}$; CPC 25741 | | *Taraxacum officinale* | Netherlands | U. Damm | KP894120 | KP894227 | KP894335 | KP894445 | KP894555 | KP894666 | KP894777 | – | – | – |
| | CPC 25742; X40 | | *Corylus avellana* | Netherlands | S.I.R. Videira | KP894121 | KP894228 | KP894336 | KP894446 | KP894556 | KP894667 | KP894778 | – | – | – |
| *R. interstitialis* | CBS 120.68 | *R. primulae* | *Primula variabilis* | UK | S.A.J. Tarr | KX287160 | KX287458 | – | – | – | – | – | – | – | – |
| *R. kriegeriana* | CPC 10825 | | *Plantago asiatica* | South Korea | H.D. Shin | KX287161 | KX287459 | KX287741 | KX288019 | KX288298 | KX288617 | KX288905 | – | KX289204 | KX289255 |
| | CPC 10826 | | *Plantago asiatica* | South Korea | H.D. Shin | KX287162 | KX287460 | KX287742 | KX288020 | KX288299 | KX288618 | KX288906 | – | KX289205 | KX289256 |
| | CPC 10827 | | *Plantago asiatica* | South Korea | H.D. Shin | KX287163 | KX287461 | KX287743 | KX288021 | KX288300 | KX288619 | KX288907 | – | KX289206 | KX289257 |
| *R. lamii* var. *lamii* | **CBS 108970**$^{ET}$ | | *Lamium album* | Netherlands | G. Verkley | KX287164 | KX287462 | KX287744 | KX288022 | KX288301 | KX288620 | KX288908 | KX289093 | – | KX289258 |
| | CBS 108971 | | *Lamium album* | Netherlands | G. Verkley | KX287165 | KX287463 | KX287745 | KX288023 | KX288302 | KX288621 | KX288909 | KX289094 | – | – |

(*continued on next page*)

**Table 1.** (Continued).

| Species[4] | Culture number[1,2] | Previous name[4] | Host | Country | Collector | LSU | ITS | *actA* | *tef1*-α | *gapdh* | *rpb2* | *his3* | *cmdA* | *tub2* | *chs-1* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *R. leonuri* | CPC 11312 | *R. lamii* var. *lamii* | *Leonurus sibiricus* | South Korea | H.D. Shin | KF251835 | KF251331 | KF253636 | KF253178 | KX288303 | KX348080 | KX288910 | KF253983 | KF252711 | – |
| | CPC 11313 | *R. lamii* var. *lamii* | *Leonurus sibiricus* | South Korea | H.D. Shin | KX287166 | KX287464 | KX287746 | KX288024 | KX288304 | KX288622 | KX288911 | – | KX289207 | – |
| | CPC 11314 | *R. lamii* var. *lamii* | *Leonurus sibiricus* | South Korea | H.D. Shin | KX287167 | KX287465 | KX287747 | KX288025 | KX288305 | KX288623 | KX288912 | KX289095 | KX289208 | – |
| | CPC 11411 | *R. lamii* var. *lamii* | *Leonurus sibiricus* | South Korea | H.D. Shin | KX287168 | KX287466 | KX287748 | KX288026 | KX288306 | KX288624 | KX288913 | KX289096 | KX289209 | – |
| | CPC 11412 | *R. lamii* var. *lamii* | *Leonurus sibiricus* | South Korea | H.D. Shin | KX287169 | KX287467 | KX287749 | KX288027 | KX288307 | KX288625 | KX288914 | – | KX289210 | – |
| | CPC 11413 | *R. lamii* var. *lamii* | *Leonurus sibiricus* | South Korea | H.D. Shin | KX287170 | KX287468 | KX287750 | KX288028 | KX288308 | KX288626 | KX288915 | – | KX289211 | – |
| | CBS 141112; CPC 14570 | *R. lamii* var. *lamii* | *Leonurus sibiricus* | South Korea | H.D. Shin | KX287171 | KX287469 | KX287751 | KX288029 | KX288309 | KX288627 | KX288916 | – | KX289212 | – |
| | CPC 14571 | *R. lamii* var. *lamii* | *Leonurus sibiricus* | South Korea | H.D. Shin | KX287172 | KX287470 | KX287752 | KX288030 | KX288310 | KX288628 | KX288917 | – | KX289213 | – |
| | CPC 14572 | *R. lamii* var. *lamii* | *Leonurus sibiricus* | South Korea | H.D. Shin | KX287173 | KX287471 | KX287753 | KX288031 | KX288311 | KX288629 | KX288918 | – | KX289214 | – |
| *R. lethalis* | CBS 141113; CPC 25910 | | *Acer pseudoplatanus* | Netherlands | S.I.R. Videira | KX287174 | KX287472 | KX287754 | KX288032 | KX288312 | KX288630 | KX288919 | KX289097 | – | – |
| *R. ligustrina* | CBS 379.52 | | *Ligustrum vulgare* | Italy | – | KX287175 | KX287473 | KX287755 | KX288033 | KX288313 | KX288631 | KX288920 | KX289098 | – | – |
| *R. macrospora* | CBS 109015 | | – | – | – | KX287176 | KX287474 | – | – | – | KX288632 | KX288921 | – | – | – |
| *R. major* | CBS 141114; CPC 12542 | | *Petasites japonicus* | South Korea | H.D. Shin | KX287177 | KX287475 | KX287756 | KX288034 | KX288314 | KX288633 | KX288922 | – | KX289215 | – |
| | CPC 12543 | | *Petasites japonicus* | South Korea | H.D. Shin | KJ504758 | KJ504800 | KJ504464 | KJ504715 | KJ504583 | KJ504671 | KJ504627 | – | KJ504493 | – |
| | CPC 12544 | | *Petasites japonicus* | South Korea | H.D. Shin | KX287178 | KX287476 | KX287757 | KX288035 | KX288315 | KX288634 | KX288923 | – | KX289216 | – |
| *R. mali* | **CBS 129581**$^{T}$ | | Apple in cold storage | Italy | – | KJ504737 | KJ504778 | KJ504442 | KJ504693 | KJ504561 | KJ504649 | KJ504605 | KJ504506 | KJ504478 | KJ504534 |
| *R. malicola* | **CBS 119227**$^{T}$; P5 | *Ramularia* sp. | *Malus* sp. | USA, Missouri | J. Batzer | AY598910 | AY598873 | KX287758 | KX288036 | KX288316 | KX288635 | KX288924 | KX289099 | KX289217 | – |
| *R. miae* | **CBS 120121**$^{T}$; CPC 12736 | | *Wachendorfia thyrsifolia* | South Africa | M.K. & P.W. Crous | DQ885902 | KJ504801 | KJ504465 | KJ504716 | KJ504584 | KJ504672 | KJ504628 | KJ504525 | – | KJ504544 |
| | CPC 21692 | *Ramularia* sp. | *Wachendorfia thyrsifolia* | South Africa | M.J. Wingfield | KX287179 | KX287477 | KX287759 | KX288037 | KX288317 | KX288636 | KX288925 | – | – | – |
| | CPC 19770 | *Teratosphaeria* sp. | *Leonotis leonurus* | South Africa | P.W. Crous | KJ504762 | KJ504805 | KJ504469 | KJ504720 | KJ504588 | KJ504676 | KJ504632 | KJ504528 | – | – |
| | CPC 19835 | *Ramularia* sp. | *Gazania rigens* var. *uniflora* | South Africa | P.W. Crous | KJ504761 | KJ504804 | KJ504468 | KJ504719 | KJ504587 | KJ504675 | KJ504631 | KJ504527 | – | – |
| *R. neodeusta* | CPC 13568 | *R. deusta* var. *alba* | *Lathyrus odoratus* | New Zealand | C.F. Hill | KX287180 | KX287478 | KX287760 | KX288038 | KX288318 | KX288637 | KX288926 | KX289100 | – | – |
| | **CBS 141115**$^{T}$; CPC 13567 | *Ramularia* sp. | *Vicia faba* | New Zealand | C.F. Hill | KX287181 | KX287479 | KX287761 | KX288039 | KX288319 | KX288638 | KX288927 | KX289101 | – | – |
| *R. helminthiae* | CPC 11502 | *R. inaequalis* | *Picris hieracioides* var. *glabrensis* | South Korea | H.D. Shin | KX287182 | KX287480 | KX287762 | KX288040 | KX288320 | KX288639 | KX288928 | KX289102 | – | – |
| | CPC 11504 | *R. inaequalis* | *Picris hieracioides* var. *glabrensis* | South Korea | H.D. Shin | KX287183 | KX287481 | KX287763 | KX288041 | KX288321 | KX288640 | KX288929 | KX289103 | – | – |
| | CBS 118418 | *R. inaequalis* | *Picris echioides* | New Zealand | – | KX287184 | KX287482 | KX287764 | KX288042 | KX288322 | KX288641 | KX288930 | KX289104 | KX289218 | – |

**Table 1.** (Continued).

| Species[4] | Culture number[1,2] | Previous name[4] | Host | Country | Collector | LSU | ITS | *actA* | *tef1*-α | *gapdh* | *rpb2* | *his3* | *cmdA* | *tub2* | *chs-1* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *R. nyssicola* | **CBS 127665**$^{\text{ET}}$; AR 4656; DM 2 | | *Nyssa ogeche* × *sylvatica* hybrid | USA, Maryland | R. Olsen | KJ504724 | KJ504765 | KJ504429 | KJ504680 | KJ504548 | KJ504636 | KJ504592 | KJ504496 | KJ504473 | – |
| | CBS 127664; AR 4629 | *M. nyssicola* | *Nyssa ogeche* × *sylvatica* hybrid | USA, Maryland | R. Olsen | KP894124 | KP894231 | KP894339 | KP894449 | KP894559 | KP894670 | KP894781 | KP894885 | – | – |
| *R. osterici* | **CBS 141116**$^{\text{T}}$**; CPC 10750** | *R. archangelicae* | *Ostericum koreanum* | South Korea | H.D. Shin | KX287185 | KX287483 | KX287765 | KX288043 | KX288323 | KX288642 | KX288931 | KX289105 | – | – |
| | CPC 10751 | *R. archangelicae* | *Ostericum koreanum* | South Korea | H.D. Shin | KX287186 | KX287484 | KX287766 | KX288044 | KX288324 | KX288643 | KX288932 | KX289106 | – | – |
| | CPC 10752 | *R. archangelicae* | *Ostericum koreanum* | South Korea | H.D. Shin | KX287187 | KX287485 | KX287767 | KX288045 | KX288325 | KX288644 | KX288933 | KX289107 | – | – |
| *R. parietariae* | CBS 123730; V6019.1 | | *Parietaria officinalis* | Czech Republic | G. Verkley | KX287188 | KX287486 | KX287768 | KX288046 | KX288326 | KX288645 | KX288934 | KX289108 | – | – |
| | CBS 123731; V6019.2 | | *Parietaria officinalis* | Czech Republic | G. Verkley | KX287189 | KX287487 | KX287769 | KX288047 | KX288327 | KX288646 | KX288935 | KX289109 | – | – |
| *R. phacae-frigidae* | **CBS 234.55**$^{\text{T}}$ | *M. phacae-frigidae* | *Phaca frigida* | Switzerland | E. Müller | KP894125 | KP894232 | KP894340 | KP894450 | KP894560 | KP894671 | KP894782 | KP894886 | – | – |
| *R. plurivora* | **CBS 118743**$^{\text{T}}$; CPC 12207 | | Human bone marrow | Netherlands | – | KJ504739 | KJ504780 | KJ504444 | KJ504695 | KJ504563 | KJ504651 | KJ504607 | KJ504508 | KJ504479 | KJ504536 |
| | CPC 16123 | Cladosporium-like sp. | Melon in storage | Netherlands | J.H. Houbraken | KJ504741 | KJ504782 | KJ504446 | KJ504697 | KJ504565 | KJ504653 | KJ504609 | KJ504510 | – | KJ504538 |
| | CBS 118693; CPC 12206 | | Human skin | Netherlands | – | KJ504738 | KJ504779 | KJ504443 | KJ504694 | KJ504562 | KJ504650 | KJ504606 | KJ504507 | – | – |
| | CPC 16124 | Cladosporium-like sp. | Melon in storage | Netherlands | J.H. Houbraken | KJ504742 | KJ504783 | KJ504447 | KJ504698 | KJ504566 | KJ504654 | KJ504610 | KJ504511 | – | – |
| *R. pratensis* var. *pratensis* | CBS 122105; RoKi 3045 | *R. pratensis* | *Rumex* sp. | Taiwan | R. Kirschner & C.-J. Chen | KX287190 | KX287488 | KX287770 | KX288048 | KX288328 | KX288647 | KX288936 | KX289110 | – | – |
| | CPC 16868 | *Ramularia* sp. | *Verbascum* sp. | Canada | K.A. Seifert | KX287191 | KX287489 | KX287771 | KX288049 | KX288329 | KX288648 | KX288937 | – | – | KX289259 |
| | CPC 19448 | *Ramularia* sp. | *Prunus domestica* | – | – | KX287192 | KX287490 | KX287772 | KX288050 | KX288330 | KX288649 | KX288938 | – | KX289219 | – |
| *R. proteae* | **CBS 112161**$^{\text{T}}$; CPC 3075 | | *Protea longifolia* | Australia, Tasmania | A. Macfadyen | EU707899 | EU707899 | – | – | – | KX288650 | KX288939 | – | – | – |
| *R. pusilla* | **CBS 124973**$^{\text{ET}}$; RoKi 3143 | | *Poa annua* | Germany | R. Kirschner | KP894141 | KP894248 | KP894356 | KP894466 | – | KP894687 | KP894798 | KP894901 | – | – |
| *R. rhabdospora* | CBS 312.92 | | – | Germany | S. Petzoldt | KX287193 | KX287491 | KX287773 | KX288051 | KX288331 | KX288651 | KX288940 | – | KX289220 | – |
| | CBS 118415 | | *Plantago lanceolata* | New Zealand | – | KX287194 | KX287492 | KX287774 | KX288052 | KX288332 | KX288652 | KX288941 | – | – | – |
| *R. rubella* | CPC 15748 | *Ramularia* sp. | *Rumex* sp. | Mexico | M. de Jesús Yáñez-Morales | KX287195 | KX287493 | KX287775 | KX288053 | KX288333 | KX288653 | KX288942 | – | – | – |
| | CPC 15749 | *Ramularia* sp. | *Rumex* sp. | Mexico | M. de Jesús Yáñez-Morales | KX287196 | KX287494 | KX287776 | KX288054 | KX288334 | KX288654 | KX288943 | – | KX289221 | – |
| | CPC 15750 | *Ramularia* sp. | *Rumex* sp. | Mexico | M. de Jesús Yáñez-Morales | KX287197 | KX287495 | KX287777 | KX288055 | KX288335 | KX288655 | KX288944 | – | KX289222 | – |
| | CBS 120161 | | *Rumex obtusifolius* | New Zealand | – | KX287198 | KX287496 | KX287778 | KX288056 | KX288336 | KX288656 | KX288945 | KX289111 | – | – |
| | CBS 114440; UPSC 2857 | | *Rumex longifolius* | Sweden | E. Gunnerbeck | KX287199 | KX287497 | KX287779 | KX288057 | KX288337 | KX288657 | KX288946 | KX289112 | – | KX289260 |

(*continued on next page*)

**Table 1.** (Continued).

| **Species**[4] | **Culture number**[1,2] | **Previous name**[4] | **Host** | **Country** | **Collector** | **LSU** | **ITS** | ***actA*** | ***tef1*-α** | ***gapdh*** | ***rpb2*** | ***his3*** | ***cmdA*** | ***tub2*** | ***chs-1*** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CPC 19471 | *Cercosporella* sp. | *Prunus* sp. | Netherlands | W. Quaedvlieg | KX287200 | KX287498 | KX287780 | KX288058 | KX288338 | KX288658 | KX288947 | KX289113 | – | – |
| | CPC 19472 | *Cercosporella* sp. | *Prunus* sp. | Netherlands | W. Quaedvlieg | KX287201 | KX287499 | KX287781 | KX288059 | KX288339 | KX288659 | KX288948 | – | – | – |
| | CPC 15821 | *Ramularia* sp. | *Rumex* sp. | Mexico | M. de Jesús Yáñez-Morales | KX287202 | KX287500 | KX287782 | KX288060 | KX288340 | KX288660 | KX288949 | KX289114 | KX289223 | – |
| | **CBS 141117**$^{\text{NT}}$; CPC 25911 | | *Rumex* sp. | Netherlands | U. Damm | KX287203 | KX287501 | KX287783 | KX288061 | KX288341 | KX288661 | KX288950 | – | – | – |
| *R. rufibasis* | CBS 114567; UPSC 3339 | *Ph. rufibasis* | *Myrica gale* | Sweden | E. Gunnerbeck | KX287204 | KX287502 | KX287784 | KX288062 | KX288342 | KX288662 | KX288951 | – | KX289224 | – |
| *R. rumicicola* | **CBS 141118**$^{\text{T}}$; CPC 11294 | *R. pratensis* var. *pratensis* | *Rumex crispus* | South Korea | H.D. Shin | KF902111 | KF901756 | KF903599 | KX288063 | KX288343 | KX348081 | KX288952 | – | (KF902946) | – |
| | CPC 11295 | *R. pratensis* var. *pratensis* | *Rumex crispus* | South Korea | H.D. Shin | KX287205 | KX287503 | KX287785 | KX288064 | KX288344 | KX288663 | KX288953 | KX289115 | – | KX289261 |
| | CPC 11296 | *R. pratensis* var. *pratensis* | *Rumex crispus* | South Korea | H.D. Shin | KX287206 | KX287504 | KX287786 | KX288065 | KX288345 | KX288664 | KX288954 | – | – | – |
| *R. rumicis* | CBS 114300; UPSC 2724 | *R. decipiens* | *Rumex aquaticus* | Sweden | E. Gunnerbeck | KJ504746 | KJ504787 | KJ504451 | KJ504702 | KJ504570 | KJ504658 | KJ504614 | KJ504514 | – | KJ504539 |
| *Ramularia* sp. A | CBS 114566; UPSC 3340 | | *Geranium pusillum* | Sweden | E. Gunnerbeck | KX287207 | KX287505 | KX287787 | KX288066 | KX288346 | KX288665 | KX288955 | KX289116 | – | – |
| *Ramularia* sp. B | CBS 114568; UPSC 3246 | *Ramularia* sp. | *Epilobium hirsutum* | Sweden | E. Gunnerbeck | KJ504747 | KJ504788 | KJ504452 | KJ504703 | KJ504571 | KJ504659 | KJ504615 | KJ504515 | – | KJ504540 |
| *Ramularia* sp. C | CBS 299.49 | | *Symphytum officinale* | Netherlands | – | KX287208 | KX287506 | KX287788 | KX288067 | KX288347 | KX288666 | KX288956 | – | – | – |
| *Ramularia* sp. D | CBS 135.23 | *R. lactea* | *Viola odorata* | – | – | KP894123 | KP894230 | KP894338 | KP894448 | KP894558 | KP894669 | KP894780 | – | KP894973 | – |
| *Ramularia* sp. E | CPC 14767 | *Ramularia* sp. | *Hydrangea serrata* | South Korea | H.D. Shin | KX287209 | KX287507 | KX287789 | KX288068 | KX288348 | KX288667 | KX288957 | – | – | – |
| | CPC 14768 | *Ramularia* sp. | *Hydrangea serrata* | South Korea | H.D. Shin | KX287210 | KX287508 | KX287790 | KX288069 | KX288349 | KX288668 | KX288958 | – | – | – |
| | CPC 14769 | *Ramularia* sp. | *Hydrangea serrata* | South Korea | H.D. Shin | KX287211 | KX287509 | KX287791 | KX288070 | KX288350 | KX288669 | KX288959 | – | – | – |
| | CPC 14832 | *Ramularia* sp. | *Hydrangea serrata* | South Korea | H.D. Shin | KX287212 | KX287510 | KX287792 | KX288071 | KX288351 | KX288670 | KX288960 | – | – | – |
| | CPC 14833 | *Ramularia* sp. | *Hydrangea serrata* | South Korea | H.D. Shin | KX287213 | KX287511 | KX287793 | KX288072 | KX288352 | KX288671 | KX288961 | – | – | – |
| | CPC 14834 | *Ramularia* sp. | *Hydrangea serrata* | South Korea | H.D. Shin | KX287214 | KX287512 | KX287794 | KX288073 | KX288353 | KX288672 | KX288962 | – | – | – |
| *R. sphaeroidea* | CBS 112891; CPC 5242 | | *Vicia villosa* subsp. *varia* | USA, California | S.T. Koike | KX287215 | AY352584 | KX287795 | KX288074 | KX288354 | KX288673 | KX288963 | KX289117 | – | – |
| *R. stellariicola* | CPC 11298 | *Cercosporella* sp. | *Stellaria aquatica* | South Korea | H.D. Shin | KX287216 | KX287513 | KX287796 | KX288075 | KX288355 | KX288674 | KX288964 | – | – | – |
| | **CBS 130592**$^{\text{T}}$; CPC 11297; KACC 42363 | *P. stellariicola* | *Stellaria aquatica* | South Korea | H.D. Shin & M.J. Park | GU214693 | GU214693 | KX287797 | KX288076 | KX288356 | KX288675 | KX288965 | KX289118 | – | – |

**Table 1.** (Continued).

| Species[4] | Culture number[1,2] | Previous name[4] | Host | Country | Collector | LSU | ITS | *actA* | *tef1*-α | *gapdh* | *rpb2* | *his3* | *cmdA* | *tub2* | *chs-1* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *R. stellenboschensis* | **CBS 130600**$^{T}$; CPC 18294 | | *Protea* sp., with *Vizella interupta* | South Africa | P.W. Crous | JN712566 | JN712499 | KX287798 | – | KX288357 | KX288676 | KX288966 | – | – | – |
| *R. tovarae* | **CBS 113305**$^{ET}$ | *Ramularia* sp. | *Polygonum filiforme* | South Korea | H.D. Shin | KJ504764 | KJ504807 | KJ504471 | KJ504722 | KJ504590 | KJ504678 | KJ504634 | KJ504529 | KJ504494 | – |
| *R. tricherae* | CBS 108973 | | *Knautia arvensis* | Netherlands | G. Verkley | KP894142 | KP894249 | KP894357 | KP894467 | KP894577 | KP894688 | KP894799 | KP894902 | KP894985 | – |
| | CBS 108974 | | *Knautia arvensis* | Netherlands | G. Verkley | KX287217 | KX287514 | KX287799 | KX288077 | KX288358 | KX288677 | KX288967 | KX289119 | KX289225 | KX289262 |
| | CBS 108994 | | *Knautia arvensis* | Netherlands | G. Verkley | KP894145 | KP894252 | KP894360 | KP894470 | KP894580 | KP894691 | KP894802 | KP894905 | KP894987 | – |
| | CBS 108995 | | *Knautia arvensis* | Netherlands | G. Verkley | KX287218 | KX287515 | KX287800 | KX288078 | KX288359 | KX288678 | KX288968 | KX289120 | KX289226 | – |
| | CBS 108989 | | *Knautia dipsacifolia* | Austria | G. Verkley | KP894143 | KP894250 | KP894358 | KP894468 | KP894578 | KP894689 | KP894800 | KP894903 | KP894986 | – |
| | CBS 108990 | | *Knautia dipsacifolia* | Austria | G. Verkley | KP894144 | KP894251 | KP894359 | KP894469 | KP894579 | KP894690 | KP894801 | KP894904 | – | – |
| | CBS 236.73; CCM F-369 | | *Knautia drymeia* | former Czechoslovakia | – | KP894146 | KP894253 | KP894361 | KP894471 | KP894581 | KP894692 | KP894803 | KP894906 | – | – |
| *R. trigonotidis* | **CBS 141119**$^{T}$; CPC 14764 | *Ramularia* sp. | *Trigonotis nakaii* | South Korea | H.D. Shin | KX287219 | KX287516 | KX287801 | KX288079 | KX288360 | KX288679 | KX288969 | – | – | – |
| | CPC 14765 | *Ramularia* sp. | *Trigonotis nakaii* | South Korea | H.D. Shin | KX287220 | KX287517 | KX287802 | KX288080 | KX288361 | KX288680 | KX288970 | – | – | – |
| | CPC 14766 | *Ramularia* sp. | *Trigonotis nakaii* | South Korea | H.D. Shin | KX287221 | KX287518 | KX287803 | KX288081 | KX288362 | KX288681 | KX288971 | – | – | – |
| *R. trollii* | CBS 109118 | *P. trollii* | *Trollius europaeus* | Austria | G. Verkley | KX287222 | KX287519 | KX287804 | KX288082 | KX288363 | KX288682 | KX288972 | – | KX289227 | – |
| | CBS 109119 | *P. trollii* | *Trollius europaeus* | Austria | G. Verkley | KX287223 | KX287520 | KX287805 | KX288083 | KX288364 | KX288683 | KX288973 | – | – | – |
| *R. unterseheri* | CBS 124846 | *R. endophylla* | *Fagus sylvatica* | Germany | M. Unterseher | KP894160 | KP894267 | KP894375 | KP894485 | KP894595 | KP894706 | KP894817 | KP894920 | KP894999 | – |
| | CBS 124838; li-26.4 | *R. endophylla* | *Fagus sylvatica* | Germany | M. Unterseher | KP894158 | KP894265 | KP894373 | KP894483 | KP894593 | KP894704 | KP894815 | KP894918 | – | – |
| | CBS 130721 | *R. endophylla* | Room inside a castle | Germany | – | KP894164 | KP894271 | KP894379 | KP894489 | KP894599 | KP894710 | KP894821 | KP894924 | – | – |
| | CBS 117879; CPC 11207 | *R. endophylla* | *Acer pseudoplatanus* | Netherlands | G. Verkley | KP894150 | KP894257 | KP894365 | KP894475 | KP894585 | KP894696 | KP894807 | KP894910 | – | – |
| | **CBS 124884**$^{T}$ | *R. endophylla* | *Fagus sylvatica* | Germany | M. Unterseher | KP894163 | KP894270 | KP894378 | KP894488 | KP894598 | KP894709 | KP894820 | KP894923 | KP895002 | – |
| *R. uredinicola* | **CBS 141120**$^{T}$; CPC 11852 | | *Melampsora* sp. on *Salix babylonica* | Iran | S.A. Khodaparast | KX287224 | KX287521 | KX287806 | KX288084 | KX288365 | KX288684 | KX288974 | – | KX289228 | – |
| | CBS 179.68 | *R. uredinis* | *Melampsora* sp. on *Populus* sp. | Italy | – | KX287225 | KX287522 | KX287807 | KX288085 | KX288366 | KX288685 | KX288975 | – | – | – |
| | CPC 12491 | *Ramularia* sp. | *Melampsora* sp. on *Salix* sp. | South Korea | H.D. Shin | KX287226 | KX287523 | KX287808 | KX288086 | KX288367 | KX288686 | KX288976 | – | KX289229 | – |
| | CPC 12492 | *Ramularia* sp. | *Melampsora* sp. on *Salix* sp. | South Korea | H.D. Shin | KX287227 | KX287524 | KX287809 | KX288087 | KX288368 | KX288687 | KX288977 | – | KX289230 | – |
| | CPC 12493 | *Ramularia* sp. | *Melampsora* sp. on *Salix* sp. | South Korea | H.D. Shin | KX287228 | KX287525 | KX287810 | KX288088 | KX288369 | KX288688 | KX288978 | – | KX289231 | – |
| | CPC 11481 | *Ramularia* sp. | *Melampsora* sp. on *Salix* sp. | South Korea | H.D. Shin | KX287229 | KX287526 | KX287811 | KX288089 | KX288370 | KX288689 | KX288979 | – | KX289232 | – |

(*continued on next page*)

**Table 1.** (Continued).

| Species[4] | Culture number[1,2] | Previous name[4] | Host | Country | Collector | LSU | ITS | *actA* | *tef1*-α | *gapdh* | *rpb2* | *his3* | *cmdA* | *tub2* | *chs-1* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CPC 11482 | *Ramularia* sp. | *Melampsora* sp. on *Salix* sp. | South Korea | H.D. Shin | KX287230 | KX287527 | KX287812 | KX288090 | KX288371 | KX288690 | KX288980 | – | KX289233 | – |
| | CBS 131769;<br>KACC 42535 | | *Melampsora* sp. on *Salix gracilistyla* | South Korea | H.D. Shin & M.J. Park | KX287231 | KX287528 | KX287813 | KX288091 | KX288372 | KX288691 | KX288981 | – | KX289234 | – |
| | CBS 131770;<br>KACC 44864 | | *Melampsora* sp. on *Populus alba* × *glandulosa* | South Korea | H.D. Shin & M.J. Park | KX287232 | KX287529 | KX287814 | KX288092 | KX288373 | KX288692 | KX288982 | – | KX289235 | – |
| | CBS 131771;<br>KACC 44215 | | *Melampsora* sp. on *Salix koreensis* | South Korea | H.D. Shin & M.J. Park | KX287233 | KX287530 | KX287815 | KX288093 | KX288374 | KX288693 | KX288983 | – | KX289236 | – |
| | CBS 131772;<br>KACC 44218 | | *Melampsora* sp. on *Salix matsudana* for. tortuosa | South Korea | H.D. Shin & M.J. Park | KX287234 | KX287531 | KX287816 | KX288094 | KX288375 | – | KX288984 | – | KX289237 | – |
| *R. urticae* | CBS 105.26 | *An. pulmonalis* | – | – | – | KP894169 | KP894276 | KP894384 | KP894494 | KP894604 | KP894715 | KP894826 | – | – | – |
| | CBS 113974;<br>UPSC 2359 | | *Urtica dioica* | Sweden | E. Gunnerbeck | KP894168 | KP894275 | KP894383 | KP894493 | KP894603 | KP894714 | KP894825 | KP894926 | KP895005 | – |
| | CBS 162.91 | *Ramulariopsis* sp. | *Urtica dioica* | Germany, Thüringen | G. Arnold | KP894170 | KP894277 | KP894385 | KP894495 | KP894605 | KP894716 | KP894827 | – | KP895006 | – |
| | CPC 14807 | *Ramularia* sp. | *Aconitum pseudo-laeve* var. *erectum* | South Korea | H.D. Shin | KX287235 | KX287532 | KX287817 | KX288095 | KX288376 | KX288694 | KX288985 | – | – | – |
| *R. valerianae* var. *valerianae* | CBS 109122 | | *Valeriana* sp. | Austria | G. Verkley | KX287237 | KX287534 | KX287818 | KX288096 | – | KX288696 | KX288986 | – | – | – |
| | CBS 109123 | | *Valeriana* sp. | Austria | G. Verkley | KX287238 | KX287535 | KX287819 | KX288097 | KX288377 | KX288697 | KX288987 | – | KX289238 | – |
| *R. vallisumbrosae* | CBS 271.38 | | *Narcissus* cv. Victoria | UK, England | – | KX287239 | KX287536 | KX287820 | KX288098 | KX288378 | KX288698 | KX288988 | KX289121 | KX289239 | – |
| | **CBS 272.38**$^{ET}$ | | *Narcissus* cv. Golden Spur | UK, England | – | KX287240 | KX287537 | KX287821 | KX288099 | KX288379 | KX288699 | KX288989 | KX289122 | KX289240 | – |
| *R. variabilis* | CPC 16865 | *Ramularia* sp. | *Verbascum* sp. | Canada | K.A. Seifert | KP894171 | KP894278 | KP894386 | KP894496 | KP894606 | KP894717 | KP894828 | – | KP895007 | – |
| | CPC 16866 | *Ramularia* sp. | *Verbascum* sp. | Canada | K.A. Seifert | KP894172 | KP894279 | KP894387 | KP894497 | KP894607 | KP894718 | KP894829 | – | KP895008 | – |
| | **CBS 141121**$^{ET}$;<br>CPC 25967 | | *Verbascum* sp. | Germany | C. Scheuer | KP894173 | KP894280 | KP894388 | KP894498 | KP894608 | KP894719 | KP894830 | – | – | – |
| *R. veronicicola* | CBS 113981;<br>UPSC 2320 | *Ph. veronicae* | *Veronica spicata* | Sweden | E. Gunnerbeck | KX287241 | KX287538 | KX287822 | KX288100 | KX288380 | KX288700 | KX288990 | – | KX289241 | – |
| *R. vizellae* | **CBS 130601**$^{T}$;<br>CPC 18283 | | *Protea* sp., in association with *Vizella interupta* | South Africa | P.W. Crous | JN712567 | KJ504808 | KJ504472 | KJ504723 | KJ504591 | KJ504679 | KJ504635 | – | KJ504495 | – |
| | CBS 117798;<br>CPC 12088 | *R. endophylla* | *Carpinus betulus* | Netherlands | G. Verkley | KP894182 | KP894289 | KP894397 | KP894507 | KP894617 | KP894728 | KP894839 | – | – | – |

**Table 1.** (Continued).

| Species[4] | Culture number[1,2] | Previous name[4] | Host | Country | Collector | LSU | ITS | *actA* | *tef1*-α | *gapdh* | *rpb2* | *his3* | *cmdA* | *tub2* | *chs-1* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CBS 115981 | *R. endophylla* | *Malus* dead leaf litter | Netherlands | – | KP894176 | KP894283 | KP894391 | KP894501 | KP894611 | KP894722 | KP894833 | KP894928 | KP895010 | – |
| | CBS 115982 | *R. endophylla* | *Malus* dead leaf litter | Netherlands | – | KP894177 | KP894284 | KP894392 | KP894502 | KP894612 | KP894723 | KP894834 | KP894929 | KP895011 | – |
| | CBS 117871; CPC 11194 | *R. endophylla* | *Quercus rubra* | Netherlands | G. Verkley | KP894188 | KP894295 | KP894403 | KP894513 | KP894623 | KP894734 | KP894845 | KP894939 | KP895021 | – |
| | CBS 117872; CPC 11197 | *R. endophylla* | *Amelanchier lamarckii* | Netherlands | G. Verkley | KP894189 | KP894296 | KP894404 | KP894514 | KP894624 | KP894735 | KP894846 | KP894940 | KP895022 | – |
| *R. weberiana* | **CBS 136.23**$^{T}$ | *R. pratensis* | – | – | – | KJ504763 | KJ504806 | KJ504470 | KJ504721 | KJ504589 | KJ504677 | KJ504633 | – | – | KJ504547 |
| *R. weigelae* | CBS 113309 | *Phaeoramularia weigelicola* | *Weigela subsessilis* | South Korea | H.D. Shin | KX287242 | KX287539 | – | KX288101 | – | KX288701 | – | – | – | – |
| *Ramulariopsis gossypii* | **CBS 141099**$^{ET}$; CPC 25909 | | *Gossypium* sp. | Brazil | – | KX287243 | KX287540 | KX287823 | KX288102 | KX288381 | KX288702 | KX288991 | – | – | – |
| *Rp. pseudoglycines* | CPC 20036 | *Rp. gossypii* | *Gossypium barbadense* | Togo | M. Piatek | KX287244 | KX287541 | KX287824 | KX288103 | – | KX288703 | KX288992 | KX289123 | – | – |
| | CPC 18241 | *Rp. gossypii* | *Gossypium* sp. | Brazil | – | KX287245 | KX287542 | KX287825 | KX288104 | – | KX288704 | KX288993 | KX289124 | – | – |
| | **CBS 141100**$^{T}$; CPC 18242 | *Rp. gossypii* | *Gossypium* sp. | Brazil | – | KX287246 | KX287543 | KX287826 | KX288105 | – | KX288705 | KX288994 | – | – | – |
| *Readeriella angustia* | CBS 124998; CPC 13618 | | *Eucalyptus delegatensis* | Australia, Tasmania | B.A. Summerell | KF902113 | KF901758 | (KF903567) | (KF903245) | – | KX348082 | – | (KF902668) | (KF902949) | – |
| *Re. eucalyptigena* | **CBS 124999**$^{T}$; CPC 13026 | | *Eucalyptus dives* | Australia, New South Wales | B.A. Summerell | KF901868 | KF901546 | (KF903568) | (KF903254) | – | KX348083 | – | (KF902676) | (KF902957) | – |
| *Re. menaiensis* | **CBS 125003**$^{T}$; CPC 14447 | | *Eucalyptus oblonga* | Australia, New South Wales | B.A. Summerell | KF901870 | KF901548 | (KF903572) | (KF903256) | – | KX348084 | – | (KF902678) | (KF902959) | – |
| *Re. pseudocallista* | **CBS 125001**$^{T}$; CPC 13599 | | *Eucalyptus prominula* | Australia, New South Wales | B.A. Summerell | KF901861 | KF901539 | (KF903570) | (KF903239) | – | KX348085 | – | (KF902664) | (KF902943) | – |
| *Re. tasmanica* | **CBS 125002**$^{T}$; CPC 13631 | | *Eucalyptus delegatensis* | Australia, Tasmania | B.A. Summerell | KF902116 | KF901761 | (KF903656) | (KF903264) | – | KX348086 | – | (KF902687) | (KF902967) | – |
| *Septoria cerastii* | CBS 132028; CPC 12343 | | *Cerastium holosteoides* var. *hallaisanense* | South Korea | H.D. Shin | GU253869 | KF251366 | (KF253670) | (KF253313) | – | KX348087 | – | (KF254018) | (KF252838) | – |
| *S. dysentericae* | CBS 131892; CPC 12328 | | *Inula britannica* var. *chinensis* | South Korea | H.D. Shin | GU253866 | KF251406 | (KF253710) | (KF253353) | – | KX348088 | – | (KF254058) | (KF252877) | – |
| *S. lamiicola* | CBS 123882; V6020.2 | | *Lamium* sp. | Czech Republic | G. Verkley | KF251951 | KF251447 | (KF253751) | (KF253395) | – | KX348089 | – | (KF254099) | (KF252919) | – |
| *S. leucanthemi* | CBS 353.58; BBA 8504; IMI 091322 | | *Chrysanthemum maximum* | Germany, Hamburg | R. Schneider | KF251962 | KF251458 | (KF253762) | (KF253406) | – | KX348090 | – | (KF254110) | (KF252930) | – |

(*continued on next page*)

**Table 1.** (Continued).

| Species[4] | Culture number[1,2] | Previous name[4] | Host | Country | Collector | LSU | ITS | *actA* | *tef1*-α | *gapdh* | *rpb2* | *his3* | *cmdA* | *tub2* | *chs-1* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *S. lycopersici* | CBS 128654;<br>KACC 42519;<br>SMKC 22002 | | *Lycopersicum esculentum* | South Korea | – | KF251966 | KF251462 | (KF253766) | (KF253410) | – | KX348091 | – | (KF254114) | (KF252934) | – |
| *S. paridis* | CBS 109110 | | *Paris quadrifolia* | Austria | G. Verkley | KF251995 | KF251490 | (KF253794) | (KF253439) | – | KX348092 | – | (KF254143) | (KF252960) | – |
| *Sphaerulina chaenomelis* | CBS 131897;<br>CPC 14795 | *P. chaenomellis* | *Chaenomeles speciosa* | South Korea | H.D. Shin | GU253834 | GU269817 | (GU320520) | (GU384530) | – | KX288706 | – | – | – | – |
| *Sp. berberidis* | CBS 324.52 | *M. berberidis* | *Berberis vulgaris* | Switzerland | E. Müller | KF252106 | KF251601 | (KF253903) | (KF253548) | – | KX348093 | – | (KF254253) | (KF253067) | – |
| *Sp. betulae* | CBS 128597;<br>KACC 43119;<br>SMKC 23059 | | *Betula schmidtii* | South Korea | – | KF252109 | KF251604 | (KF253906) | (KF253551) | – | KX348094 | – | (KF254256) | (KF253070) | – |
| *Sp. gei* | CBS 128632;<br>KACC 44051;<br>SMKC 23686 | | *Geum japonicum* | South Korea | – | KF252120 | KF251615 | (KF253917) | (KF253562) | – | KX348095 | – | (KF254267) | (KF253081) | – |
| *Sp. koreana* | **CBS 135462**$^{T}$;<br>CPC 11414 | *P. koreana* | *Vicia amurensis* | South Korea | H.D. Shin | GU214683 | GU269852 | (GU320556) | (GU384564) | – | KX288707 | – | – | – | – |
| | CBS 131898;<br>CPC 11415 | *Sp. viciae* | *Vicia amurensis* | South Korea | H.D. Shin | KF252144 | KF251639 | (KF253940) | (KF253586) | – | KX348096 | – | (KF254291) | (KF253101) | – |
| *Sphaerulina* sp. | CPC 13566 | | *Haloragis erecta* | New Zealand | C.F. Hill | KX287247 | – | – | – | – | KX288708 | – | – | – | – |
| *Sp. tirolensis* | **CBS 109018**$^{T}$ | | *Rubus idaeus* | Austria | G. Verkley | KF252143 | KF251638 | (KF253939) | (KF253585) | – | KX348097 | – | (KF254290) | (KF253100) | – |
| *Stromatoseptoria castaneicola* | CBS 102322 | | *Castanea sativa* | Netherlands | G. Verkley | KF251774 | KF251271 | – | (KF253219) | – | KX348098 | – | – | (KF252752) | – |
| | CBS 102377 | | *Castanea sativa* | Netherlands | G. Verkley | KF251775 | KF251272 | – | (KF253220) | – | KX348099 | – | – | (KF252753) | – |
| *Teratoramularia infinita* | CBS 120815 | *Cercosporella* sp. | *Thladiantha punctata* | Taiwan | R. Kirschner & C.-J. Chen | KX287248 | KX287544 | KX287827 | KX288106 | KX288382 | KX288709 | KX288995 | – | – | – |
| | **CBS 141104**$^{T}$;<br>CPC 19488 | *Cercosporella* sp. | *Conyza canadensis* | Brazil | – | KX287249 | KX287545 | KX287828 | KX288107 | KX288383 | KX288710 | – | KX289125 | – | – |
| *Tr. persicariae* | CPC 11408 | *Ramularia* sp. | *Persicaria nepalensis* | South Korea | H.D. Shin | KX287250 | KX287546 | KX287829 | KX288108 | KX288384 | KX288711 | KX288996 | – | – | – |
| | CPC 11409 | *Ramularia* sp. | *Persicaria nepalensis* | South Korea | H.D. Shin | KX287251 | KX287547 | KX287830 | KX288109 | KX288385 | KX288712 | KX288997 | – | – | – |
| | **CBS 141105**$^{T}$;<br>CPC 11410 | *Ramularia* sp. | *Persicaria nepalensis* | South Korea | H.D. Shin | KX287252 | KX287548 | KX287831 | KX288110 | KX288386 | KX288713 | KX288998 | – | – | – |
| | CBS 195.27 | *R. anomala* | *Fagopyrum esculentum* | – | – | KX287253 | – | – | KX288111 | KX288387 | KX288714 | KX288999 | – | – | – |
| *Tr. rumicicola* | CPC 14652 | *R. pratensis* var. *pratensis* | *Rumex crispus* | South Korea | H.D. Shin | KX287254 | KX287549 | – | KX288112 | KX288388 | KX288715 | KX289000 | – | – | – |
| | **CBS 141106**$^{T}$;<br>CPC 14653 | *R. pratensis* var. *pratensis* | *Rumex crispus* | South Korea | H.D. Shin | KX287255 | KX287550 | – | KX288113 | KX288389 | KX288716 | KX289001 | – | – | – |

**Table 1.** (Continued).

| Species[4] | Culture number[1,2] | Previous name[4] | Host | Country | Collector | LSU | ITS | *actA* | *tef1*-α | *gapdh* | *rpb2* | *his3* | *cmdA* | *tub2* | *chs-1* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CPC 14654 | *R. pratensis* var. *pratensis* | *Rumex crispus* | South Korea | H.D. Shin | KX287256 | KX287551 | – | KX288114 | KX288390 | KX288717 | KX289002 | – | – | – |
| *Tr. kirschneriana* | **CBS 113093**$^{\mathrm{T}}$; RoKi 1144 | *Ph. paspali* | *Setaria palmifolia* | Taiwan | R. Kirschner & C.-J. Chen | GQ852627 | GU214669 | KX287832 | KX288115 | KX288391 | KX288718 | KX289003 | – | – | – |
| *Teratosphaeria biformis* | **CBS 124578**$^{\mathrm{T}}$; MUCC 693 | | *Eucalyptus globulus* | Australia, Queensland | G. Whyte | KF901887 | KF901564 | (KF903551) | (KF903287) | – | KX348100 | – | (KF902703) | (KF902987) | – |
| *T. cryptica* | CBS 111663; CPC 1558 | | – | – | – | KF901823 | KF901506 | (KF903449) | (KF903300) | – | KX348101 | – | (KF902715) | (KF902999) | – |
| *T. eucalypti* | CPC 12552 | *Phaeophleospora eucalypti* | *Eucalyptus nitens* | Australia | C. Mohammed | KF901900 | KF901576 | (KF903619) | (KF903303) | – | KX348102 | – | (KF902718) | (KF903002) | – |
| *T. gauchensis* | CBS 119465; CMW 17545 | | *Eucalyptus grandis* | Uruguay | M.J. Wingfield | KF902145 | KF901787 | (KF903509) | (KF903312) | – | KX348103 | – | (KF902726) | (KF903010) | – |
| *T. molleriana* | CBS 118359; CMW 11560 | | *Eucalyptus globulus* | Australia, Tasmania | – | KF902120 | KF901764 | (KF903490) | (KF903327) | – | KX348104 | – | (KF902740) | (KF903024) | – |
| *Uwebraunia australiensis* | CBS 120729; CPC 13282 | *U. australiensis* | *Eucalyptus platyphylla* | Australia, Queensland | P.W. Crous | KF442553 | EF394854 | – | (JQ622129) | – | KX348105 | – | – | (KF442475) | – |
| *U. commune* | CPC 12397 | *M. lateralis* | *Eucalyptus globulus* | Australia | I. Smith | KF251740 | KF251237 | – | (KF253190) | – | KX348106 | – | – | (KF252724) | – |
| *U. musae* | **CBS 122453**$^{\mathrm{T}}$; X1021 | | *Musa acuminata* cv. Nendran | India | I. Buddenhagen | JQ739816 | EU514225 | (EU514296) | – | – | KX348107 | (EU514349) | – | – | – |
| | CBS 122454; X1022 | | *Musa acuminata* cv. Grande Naine | Indonesia | I. Buddenhagen | KX287257 | EU514226 | (EU514297) | – | – | KX288719 | (EU514350) | – | – | – |
| *Xenoramularia arxii* | **CBS 342.49**$^{\mathrm{T}}$ | *R. aromatica* | *Acorus calamus* | Netherlands | J.A. von Arx | KX287258 | KX287552 | KX287833 | KX288116 | KX288392 | KX288720 | KX289004 | – | – | – |
| *X. neerlandica* | CBS 113615 | *Pseudocercosporella* sp. | *Sparganium ramosum* | Netherlands | – | KX287259 | KX287553 | KX287834 | KX288117 | KX288393 | KX288721 | KX289005 | – | – | – |
| | **CBS 141101**$^{\mathrm{T}}$; CPC 18377 | *Pseudocercosporella* sp. | *Iris pseudacorus* | Netherlands | P.W. Crous | KX287260 | KX287554 | KX287835 | KX288118 | KX288394 | KX288722 | KX289006 | – | – | – |
| | CPC 18378 | *Pseudocercosporella* sp. | *Iris pseudacorus* | Netherlands | P.W. Crous | KX287261 | – | KX287836 | KX288119 | KX288395 | KX348108 | KX289007 | – | – | – |
| *X. polygonicola* | **CBS 141102**$^{\mathrm{T}}$; CPC 10852 | *Ramularia* sp. | *Polygonum* sp. | South Korea | H.D. Shin | GU214695 | GU214695 | KX287837 | KX288120 | KX288396 | KX288723 | KX289008 | – | – | – |
| | CPC 10853 | *Ramularia* sp. | *Polygonum* sp. | South Korea | H.D. Shin | KX287262 | KX287555 | – | KX288121 | KX288397 | KX288724 | KX289009 | – | – | – |
| | CPC 10854 | *Ramularia* sp. | *Polygonum* sp. | South Korea | H.D. Shin | KX287263 | KX287556 | – | KX288122 | KX288398 | KX288725 | KX289010 | – | – | – |
| *Zymoseptoria brevis* | **CBS 128853**$^{\mathrm{T}}$; CPC 18106; no. 8S | | *Phalaris minor* | Iran | M. Razavi | JQ739833 | JF700867 | (JF701036) | (JQ739777) | – | KX348109 | – | (JF701104) | (JF700968) | – |

(*continued on next page*)

**Table 1.** (Continued).

| Species[4] | Culture number[1,2] | Previous name[4] | Host | Country | Collector | LSU | ITS | *actA* | *tef1*-α | *gapdh* | *rpb2* | *his3* | *cmdA* | *tub2* | *chs-1* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Z. halophila* | **CBS 128854**$^{T}$;<br>CPC 18105;<br>IRAN1483C;<br>GLS1 | | *Hordeum glaucum* | Iran | M. Razavi | KF252150 | KF251645 | (KF253946) | (KF253592) | – | KX348110 | – | (KF254297) | (JF700977) | – |
| *Z. passerinii* | **CBS 120382**$^{ET}$;<br>P 83 | | *Hordeum vulgare* | USA,<br>North Dakota | S. Goodwin | JQ739843 | JF700877 | (JF701046) | (JQ739787) | (KP894652) | KP894763 | (KP894874) | (JF701114) | (JF700978) | – |
| *Z. tritici* | CPC 18116 | *Septoria* sp. | *Avena* sp. | Iran | Amir | KX287264 | JF700884 | (JF701053) | – | – | KX348111 | – | (JF701121) | (JF700985) | – |
| | **CBS 115943**$^{ET}$;<br>IPO 323 | *M. graminicola* | *Triticum aestivum* | Netherlands | R. Daamen | GU214436 | AF181692 | (JF701061) | – | – | KX348112 | – | (JF701129) | (JF700993) | – |
| *Z. verkleyi* | **CBS 133618**$^{T}$ | | *Poa annua* | Netherlands | S.I.R. Videira | KF442686 | KC005781 | – | – | – | KX348113 | – | – | – | – |
| | CBS 136761 | | *Poa annua* | Netherlands | U. Damm | KX287265 | KX287557 | – | – | – | KX288726 | – | – | – | – |

* Strains not included in the phylogenetic analyses for lack of complete dataset. Species identification is based on the available data.

[1] AR: Personal culture collection of Amy Rossman; ATCC: American Type Culture Collection, Virginia, USA; BRIP: Plant Pathology Herbarium, Department of Primary Industries, Queensland, Australia; CBS: CBS-KNAW Fungal Biodiversity Centre, Utrecht, The Netherlands; CCM: Czech Collection of Microorganisms, Masaryk University, Brno, Czech Republic; CMW: Culture Collection of the Forestry and Agricultural Biotechnology Institute (FABI) of the University of Pretoria, Pretoria, South Africa; CPC: Personal culture collection of Pedro Crous, housed at CBS; IMI: International Mycological Institute, CABI-Bioscience, Egham, Bakeham Lane, United Kingdom; INIFAT: Alexander Humboldt Institute for Basic Research in Tropical Agriculture, Ciudad de La Habana, Cuba; JCM: Japan Collection of Microorganism, RIKEN BioResource Center, Japan; JT: Personal number of J.E. Taylor; KACC: Korean Agricultural Culture Collection, National Institute of Agricultural Biotechnology, Rural Development Administration, Suwon, Republic of Korea; MUCL: Université Catholique de Louvain, Louvain-la-Neuve, Belgium; QM: Quartermaster Research and Development Center, U.S. Army, Massachusetts, USA; RoKI: Personal culture collection of Roland Kirschner; UPSC: Uppsala University Culture Collection of Fungi, Botanical Museum University of Uppsala, Uppsala, Sweden.

[2] Status of the strains: (**T**) ex-type, (**ET**) ex-epitype, (**NT**) ex-neotype.

[3] LSU: large subunit (28S) of the nrRNA gene operon; ITS: internal transcribed spacers and intervening 5.8S nrDNA; *actA*: partial actin gene; *tef1-α*: partial translation elongation factor 1-alpha gene; *gapdh*: partial glyceraldehyde-3-phosphate dehydrogenase (GAPDH) gene; *rpb2*: partial RNA polymerase II second largest subunit gene; *his3*: partial histone H3 gene; *cmdA*: partial calmodulin gene; *tub2*: partial beta-tubulin gene; *chs-1*: partial chitin synthase-1 gene; "–" represents missing data.

[4] *A. = Acrodontium*; *An. = Antennaria*; *C. = Cercosporella*; *Ca. = Caryophylloseptoria*; *Ce. = Cercospora*; *D. = Dothistroma*; *N. = Neopseudocercosporella*; *M. = Mycosphaerella*; *P. = Pseudocercosporella*; *Pa. = Passalora*; *Pal. = Pallidocercospora*; *Ph. = Phacellium*; *Pp. = Parapenidiella*; *Ps. = Pseudocercospora*; *R. = Ramularia*; *Re. = Readeriella*; *Rp. = Ramulariopsis*; *S. = Septoria*; *Sp. = Sphaerulina*; *T. = Teratosphaeria; Tr. = Teratoramularia*; *U. = Uwebraunia*; *X. = Xenoramularia*; *Z. = Zymoseptoria*.

**Table 2.** Details of primers used and/or developed in this study for the PCR amplification and sequencing of different loci.

| Locus[1] | Primer Name | Sequence 5′ → 3′ | Annealing temperature (°C) | Orientation | Reference |
|---|---|---|---|---|---|
| *actA* | ACT-2Rd | ARR TCR CGD CCR GCC ATG TC | 55 | Reverse | Groenewald *et al.* (2013) |
| | ACT-512F | ATG TGC AAG GCC GGT TTC GC | 55 | Forward | Carbone & Kohn (1999) |
| | ACT-783R | TAC GAG TCC TTC TGG CCC AT | 55 | Reverse | Carbone & Kohn (1999) |
| *chs-1* | CHS-354R | TGG AAG AAC CAT CTG TGA GAG TTG | 52 | Reverse | Carbone & Kohn (1999) |
| | CHS-79F | TGG GGC AAG GAT GCT TGG AAG AAG | 52 | Forward | Carbone & Kohn (1999) |
| *cmdA* | CAL-228F | GAG TTC AAG GAG GCC TTC TCC C | 58 | Forward | Carbone & Kohn (1999) |
| | CAL-737R | CAT CTT TCT GGC CAT CAT GG | 58 | Reverse | Carbone & Kohn (1999) |
| | Cal2Rd | TGR TCN GCC TCD CGG ATC ATC TC | 58 | Reverse | Groenewald *et al.* (2013) |
| *gapdh* | Gapdh-F1 | ATY GTC TTC CGC AAY GCGT | 56 | Forward | This study |
| | gpd1 | CAA CGG CTT CGG TCG CAT TG | 58 | Forward | Berbee *et al.* (1999) |
| | gpd2 | GCC AAG CAG TTG GTT GTG C | 58 | Reverse | Berbee *et al.* (1999) |
| *his3* | CylH3F | AGG TCC ACT GGT GGC AAG | 52 | Forward | Crous *et al.* (2004b) |
| | CylH3R | AGC TGG ATG TCC TTG GAC TG | 52 | Reverse | Crous *et al.* (2004b) |
| ITS | ITS4 | TCC TCC GCT TAT TGA TAT GC | 52 | Reverse | White *et al.* (1990) |
| | V9G | TTA CGT CCC TGC CCT TTG TA | 52 | Forward | De Hoog & Gerrits van den Ende (1998) |
| LSU | LR5 | TCC TGA GGG AAA CTT CG | 52 | Reverse | Vilgalys & Hester (1990) |
| | LSU1Fd | GRA TCA GGT AGG RAT ACC CG | 52 | Forward | Crous *et al.* (2009c) |
| *mcm7* | Mcm7-1348rev | GAY TTD GCI ACI CCI GGR TCW CCC AT | 56 | Reverse | Schmitt *et al.* (2009) |
| | Mcm7-709for | ACI MGI GTI TCV GAY GTH AAR CC | 56 | Forward | Schmitt *et al.* (2009) |
| *rpb2* | RPB2-5f2 | GGG GWG AYC AGA AGA AGG C | 60 → 58 → 54 | Forward | Sung *et al.* (2007) |
| | RPB2-7cR | CCC ATR GCT TGY TTR CCC AT | 60 → 58 → 54 | Reverse | Liu *et al.* (1999) |
| | Rpb2-F1 | GGTGTCAGTCARGTGYTGAA | 60 → 58 → 54 | Forward | This study |
| | Rpb2-F4 | GAY YTB GCI GGI CCI YTI ATG GC | 60 → 58 → 54 | Forward | This study |
| | RPB2-f5f | GAY GAY MGW GAT CAY TTY GG | 60 → 58 → 54 | Forward | Liu *et al.* (1999) |
| | Rpb2-R1 | TCC TCN GGV GTC ATG ATR ATC AT | 60 → 58 → 54 | Reverse | This study |
| *tef1*-α | EF-2 | GGA RGT ACC AGT SAT CAT GTT | 54 | Reverse | O'Donnell *et al.* (1998) |
| | EF1-728F | CAT CGA GAA GTT CGA GAA GG | 54 | Forward | Carbone & Kohn (1999) |
| | TEF-1R | CTT GAT GAA ATC ACG GTG ACC | 54 | Reverse | Videira *et al.* (2015a) |
| *tub2* | Bt-2a | GGT AAC CAA ATC GGT GCT GCT TTC | 52 | Forward | Glass & Donaldson (1995) |
| | Bt-2b | ACC CTC AGT GTA GTG ACC CTT GGC | 52 | Reverse | Glass & Donaldson (1995) |
| | T1 | AAC ATG CGT GAG ATT GTA AGT | 52 | Forward | O'Donnell & Cigelnik (1997) |
| | β-Sandy-R | GCR CGN GGV ACR TAC TTG TT | 52 | Reverse | Stukenbrock *et al.* (2012) |

[1] *actA*: partial actin gene; *chs-1*: partial chitin synthase-1 gene; *cmdA*: partial calmodulin gene; *gapdh*: partial glyceraldehyde-3-phosphate dehydrogenase gene; *his3*: partial histone H3 gene; ITS: internal transcribed spacer regions and intervening 5.8S nrRNA gene of the nrDNA operon; LSU: partial 28S nrRNA gene; *mcm7*: partial gene encoding a minichromosome maintenance protein gene; *rpb2*: partial RNA polymerase II second largest subunit gene; *tef1-α*: partial translation elongation factor 1-α gene; *tub2*: partial β-tubulin gene.

denaturation (94 °C, 3 min); 35 cycles amplification [denaturation 94 °C, 30 s; locus-specific annealing temperature (Table 2), 30 s; extension 72 °C, 45 s], and final extension (72 °C, 5 min). For *gapdh* and *his3*, 40 amplification cycles were used. To obtain the partial *rpb2*, a touchdown PCR protocol was used: initial denaturation (94 °C, 3 min), 5 amplification cycles (denaturation 94 °C, 45 s; annealing 60 °C, 45 s; extension 72 °C, 2 min), 5 amplification cycles (denaturation 94 °C, 45 s; annealing 58 °C, 45 s; extension 72 °C, 2 min), 30 amplification cycles (denaturation 94 °C, 45 s; annealing 54 °C, 45 s; extension 72 °C, 2 min) and a final extension (72 °C, 8 min). In a few cases that double bands were obtained in the amplification of *gapdh* and *his3*, the band of correct size was purified from the agarose gel using the QIAquick® Gel Extraction Kit (Qiagen) according to the manufacturer's instructions. These purified samples underwent a second round of PCR amplification following the protocol originally used to amplify that fragment. The amplified DNA fragments were sequenced in both directions using the PCR primers and the BigDye® Terminator v. 3.1 Cycle Sequencing Kit (Applied Biosystems Life Technologies, Carlsbad, CA, USA). DNA sequencing amplicons were purified through Sephadex G-50 Superfine columns (Sigma-Aldrich, St. Louis, MO) in MultiScreen HV plates (Millipore, Billerica, MA). Purified sequence reactions were analysed on an Applied Biosystems 3730xl DNA Analyzer (Life Technologies, Carlsbad, CA, USA). The DNA sequences generated were analysed and consensus sequences were computed using the BioNumerics v. 4.61 software package (Applied Maths, St-Martens-Latem, Belgium).

## Phylogenetic analyses

The generated sequences for each gene were aligned with the online version of MAFFT v. 7 (Katoh & Standley 2013). The alignments were manually checked and improved where necessary using MEGA v. 5 (Tamura *et al.* 2011) and were concatenated with Mesquite v. 2.75 (Maddison & Maddison 2011). From the strains listed in Table 1, only those with the complete dataset of genes were used in the subsequent phylogenetic analyses, with the exception of *R. pusilla* (missing *gapdh* sequence) and *R. primulae* (missing *rpb*2 sequence), in which cases they were considered as missing data in the alignments. The phylogenetic methods used in this study included Neighbour-Joining and Parsimony analyses, both performed with PAUP v. 4.0b10 (Swofford 2003), a Maximum-Likelihood analysis performed with RAxML v. 8 (Stamatakis 2014) and a Bayesian analysis performed with MrBayes v. 3.2 (Ronquist *et al.* 2011). The **Neighbour-Joining** analysis using the HKY85 substitution model was applied to each gene partition individually in order to manually check the congruency among the genes (data not shown, trees deposited in TreeBASE S19315). Alignment gaps were treated as missing data and all characters were unordered and of equal weight. Any ties were broken randomly when encountered. For **parsimony** analysis, alignment gaps were treated as fifth character state and all characters were unordered and of unequal weight. Maximum parsimony analysis was performed in PAUP using the heuristic search option with 100 random taxon additions and tree bisection and reconnection (TBR) as the branch-swapping algorithm. Branches of zero length were collapsed and all multiple, equally most parsimonious trees were saved. The robustness of the trees obtained was evaluated by 1 000 bootstrap replications (Hillis & Bull 1993). Other measures calculated included tree length (TL), consistency index (CI), retention index (RI) and rescaled consistency index (RC). MrModeltest v. 2.2 (Nylander 2004) was used to determine the best nucleotide substitution model settings for each data partition in order to perform a model-optimised **Bayesian phylogenetic** reconstruction. The Markov Chain Monte Carlo (MCMC) analysis of four chains started in parallel from a random tree topology, the heat parameter was set at 0.1 and trees were saved every 100 (overview phylogeny) or 1 000 (*Ramularia* species phylogeny) generations until the average standard deviation of split frequencies reached 0.01 (stop value). Burn-in was set to 25 % after which the likelihood values were considered to be stationary. The **Maximum-Likelihood** analysis used the GTRGAMMA model and included 1 000 bootstrap replicates. All resulting trees were printed with Geneious v. 7.0.6 (Kearse *et al.* 2012). All new sequences generated in this study were deposited in NCBI's GenBank nucleotide database (www.ncbi.nlm.nih.gov) and the accession numbers are listed in Table 1. The alignments and respective phylogenetic trees were deposited in TreeBASE S19315 (www.TreeBASE.org).

## Kimura-2-parameter values

To evaluate the ability of each gene for species resolution, inter- and intra-specific distance matrixes were calculated based on each gene's individual alignment using MEGA v. 5 (Tamura *et al.* 2011). Single strain species were excluded from the analyses. The matrixes were generated using the Kimura-2-parameter model, with substitutions including transitions and transversions, using uniform rates among sites and treating gaps as complete deletion. The obtained distance values were sorted into frequency distribution bins using Microsoft Excel 2007. The frequency distribution mean was calculated according to the formula $x = \Sigma(f.b) / \Sigma(f)$, in which the "f" is the frequency and "b" is the bin. The distance between the mean of the inter- and intra-specific distance distributions represents the barcoding gap (Hebert *et al.* 2003).

## Taxonomy

Isolates were cultivated for 7–15 d at 21 °C in a regular day/night regime. Morphological observations of reproductive structures were determined using a Nikon Eclipse 80i compound microscope with differential interference contrast (DIC) illumination. Slides were prepared using the inclined coverslip method (Kawato & Shinobu 1959, revised in Nugent *et al.* 2006) and also transparent adhesive tape (Titan Ultra Clear Tape, Conglom Inc., Toronto, Canada) (Bensch *et al.* 2012). Clear lactic acid was used as mounting medium for microscopic observations of structures *in vivo* while Shear's solution was used for structures from herbarium material. The morphological structure terminology followed those used for *Ramularia* species by Crous *et al.* (2011). The observed isolates were cultivated on synthetic nutrient-poor agar (SNA) for the observation and measurement of conidiogenous structures (recipes according to Crous *et al.* 2009e). The recorded measurements represent the minimum value followed by the 95 % confidence interval of 30 individual measurements and the maximum value, for both length and width. For culture characterisation the isolates were inoculated on 2 % potato dextrose agar (PDA), oatmeal agar (OA) and 2 % malt extract agar (MEA) (recipes according to Crous *et al.* 2009e), and incubated in the dark at 25 °C. After 14 d, the colony diameter was measured and the colony colour described according to the mycological colour charts of Rayner (1970). Nomenclatural novelties and descriptions were deposited in MycoBank (Crous *et al.* 2004a).

## RESULTS

The PCR amplification and sequencing of *actA*, *gapdh*, *his3*, ITS, LSU, *rpb2* and *tef1*-α was successful for most of the isolates included in this study. The amplification of *cmdA* and *tub2* often resulted in multiple bands, despite the attempts of protocol optimisation, and were therefore excluded from the phylogenetic analysis. The amplification of the partial genes *chs-1* and *mcm7* was unsuccessful for most of the strains tested and were therefore not targeted for the complete dataset. The amplification of *gapdh* and *his3* of a few isolates resulted in double bands from which the band with the correct size was subsequently purified from the agarose gel and re-amplified using the same primers to obtain a single band. All the obtained sequences were deposited in GenBank (Table 1). The individual gene trees based on Neighbour-Joining analysis using the HKY85 substitution model (data not shown, available in TreeBASE S19315) showed that: 1) ITS was able to discriminate several clades but some species could not be distinguished; 2) *actA*, *gapdh*, *rpb2* and *tef1*-α each supported the same general species clades and were suitable to use in a multigene analysis, and 3) the *his3* phylogenetic tree was not congruent with the other genes trees and these sequences were therefore not used in the multigene analysis. Based on the *his3* gene, clades were split apart and closely related species based on the other gene trees were positioned far apart (e.g. Fig. 1, clades 19–20, 21, 23–25).

**LSU & *rpb2* phylogeny:** The concatenated alignment of two loci (LSU and *rpb2*) was used to build a phylogeny that resolved the phylogenetic position of *Ramularia* and allied genera known from culture within the *Dissoconiaceae*, *Mycosphaerellaceae* and *Teratosphaeriaceae*. A strain of *Cladosporium cladosporioides* (CBS 112388) was used as outgroup. Based on the results of MrModelTest the **Bayesian** (BA) analysis was performed with the GTR+I+G substitution model, with inverse gamma rates and with dirichlet base frequencies for both genes (LSU and *rpb2*). The alignment contained a total of 625 unique site patterns: 200 (LSU) and 425 (*rpb2*). The analysis generated 9 222 trees from which 6 918 were sampled and 2 304 were discarded (25 % burnin) and the consensus tree is depicted in Fig. 1. The **Maximum-Likelihood** (ML) analysis detected 625 distinct patterns and reached a final ML optimisation likelihood of −31995.929951. The bootstrap support values from the best-scoring tree were mapped on the Bayesian tree as the second value in the tree nodes (Fig. 1; bootstrap values $\geq$ 80 %). The **Parsimony** (PA) analysis generated the maximum of 1 000 equally most parsimonious trees. From the total of 1 367 characters analysed, 745 were constant, 62 were variable and parsimony-uninformative and 560 were parsimony-informative. The robustness of the trees obtained was evaluated by 1 000 bootstrap replications. The bootstrap support values were mapped on the Bayesian tree as the third value in the tree nodes (Fig. 1, bootstrap values $\geq$ 80 %). A parsimony strict consensus tree was calculated from the equally most parsimonious trees and the branches were mapped with a thicker stroke on the Bayesian tree (Fig. 1). The additional parameters calculated were TL = 7149, CI = 0.167, RI = 0.793, RC = 0.132.

The phylogenetic trees generated using the three phylogenetic methods separated the strains into the same genus clades (Fig. 1). Clades I to XXII belong to *Mycosphaerellaceae*, clades XXIII to XXV to *Dissoconiaceae* and clades XXVI to XXX to *Teratosphaeriaceae*. Within these families we observed well-known and highly supported clades (Bayesian posterior probability/Maximum Likelihood bootstrap support/Parsimony bootstrap support) such as *Cercospora* (clade VI, 1/100/100), *Septoria* (clade VII, 1/97/100), *Sphaerulina* (clade VIII, 1/100/100), *Caryophylloseptoria* (clade IX, 1/100/100), *Cercosporella* (clade X, 0.99/86/-), *Ramulariopsis* (clade XI, 1/99/93), *Pseudocercospora* (clade XII, 1/89/94), *Pallidocercospora* (clade XIII, 1/100/100), *Ramularia* (clade XIV, 1/100/100), *Zymoseptoria* (clade XVI, 0.92/−/−), *Dothistroma* (clade XVII, 1/100/99), *Stromatoseptoria* (clade XVIII, 1/100/100), *Pseudocercosporella* (clade XIX, 1/100/100), *Microcyclosporella* (clade XX, 1/98/100), *Uwebraunia* (clade XXIII, 1/100/99), *Ramichloridium* (clade XXV, 1/100/99), *Acrodontium* (clade XXVI, 1/99/100), *Parapenidiella* (clade XXVII, 1/100/100), *Teratosphaeria* (clade XXVIII, 1/100/100) and *Readeriella* (clade XXIX, 1/100/100). In this phylogeny, the genera *Neocercospora* (clade V) and *Dissoconium* (clade XXIV) are represented as single lineages (Fig. 1). Additional distinct clades with high support values were observed and are described as new genera in the Taxonomy section below, namely, *Neopseudocercosporella* (clade I, 1/100/100), *Apseudocercosporella* (clade IV, 1/100/100), *Xenoramularia* (clade XV, 0.57/−), *Mycosphaerelloides* (clade XXI, 1/100/100), *Epicoleosporium* (clade XXII, 1/100/100) and *Teratoramularia* (clade XXX, 1/100/98). The genera *Fusoidiella* (clade II) and *Filiella* (clade III) are represented as single lineages and are described as new genera based on both molecular and morphological differences.

**Multigene phylogeny of *Ramularia s. str.*:** The concatenated alignment of five loci was used to build a phylogeny that revealed the species diversity within the genus *Ramularia* for species known from culture. A strain of *Zymoseptoria halophila* (CBS 128854) was used as outgroup. The final alignment included 300 taxa and contained 2 689 characters (including alignment gaps) divided into five partitions: 664 (*rpb2*), 529 (ITS), 263 (*actA*), 633 (*gapdh*) and 580 (*tef1*-α) characters respectively. The five characters artificially introduced as spacers between partitions were excluded from the phylogenetic analysis (see alignment in TreeBASE S19315). The following characters were also excluded as ambiguously aligned regions: 1 053–1 059 (ITS), 1 391–1 400 (*actA*), 1 545–1 560 and 1 686–1 720 (*gapdh*), 2 255–2 276, 2 369–2 376 and 2 426–2 506 (*tef1*-α). Based on the results of MrModelTest the **Bayesian** analysis was performed with the GTR+I+G substitution model, with inverse gamma rates and with dirichlet base frequencies for *actA*, *gapdh* and *rpb2*. The ITS partition was analysed with a SYM+I+G substitution model with fixed frequencies and with inverse gamma rates while the *tef1*-α partition was analysed with the HKY+I+G substitution model with inverse gamma rates and with dirichlet base frequencies. The alignment contained a total of 1 476 unique site patterns: 374 (*rpb2*), 178 (ITS), 191 (*actA*), 354 (*gapdh*), and 379 (*tef1*-α). The analysis generated 17 232 trees from which 12 924 were sampled and 4 308 were discarded (25 % burnin) and the final tree is depicted in Fig. 2. The **Maximum Likelihood** analysis using the GTRGAMMA model detected 1 415 distinct patterns and reached a final ML optimisation likelihood of -62205.001171. The bootstrap support values from the best-scoring tree were mapped on the Bayesian tree as the second value in the tree nodes (Fig. 2; bootstrap values $\geq$ 80 %). The **parsimony** analysis generated the maximum of 1 000 equally most parsimonious trees. From the 2 499 characters analysed, 1 068 were constant, 182 were variable and parsimony-uninformative and 1 249 were parsimony-informative. The robustness of the trees obtained was evaluated by 1000 bootstrap replications. The bootstrap support values were mapped on the Bayesian tree as the third value in the tree nodes (Fig. 2, bootstrap values $\geq$ 80 %). A consensus parsimony tree was calculated from the equally most parsimonious trees and the branches were mapped with a thicker stroke on the Bayesian tree (Fig. 2). The additional parameters calculated were TL = 14589, CI = 0.213, RI = 0.827 and RC = 0.176.

The phylogenetic trees based on the multigene dataset (Fig. 2) that were generated with BA, ML and PA separated the strains into similar species clades. The phylogeny distributed the species into three main clades, and the position of single species clades varied with each gene and each phylogenetic method. The tree depicted a total of 86 clades, of which 30 are single lineages (clades 4, 6, 11, 12, 14, 18, 22, 25, 26, 33, 34, 36, 37, 39, 43, 44, 48, 51, 62–64, 69, 73, 75, 77, 80, 82–84, 88), 20 clades represent new species (clades 1, 5, 7, 15, 20, 24, 25, 44, 51, 56, 58, 70, 76, 77, 80, 83, 84, 88), and 12 clades contained good candidates for epitypification for existing species (clades 3, 16, 27, 38–40, 48, 50, 52, 67, 78, 79). These are discussed in further detail in the Taxonomy section below.

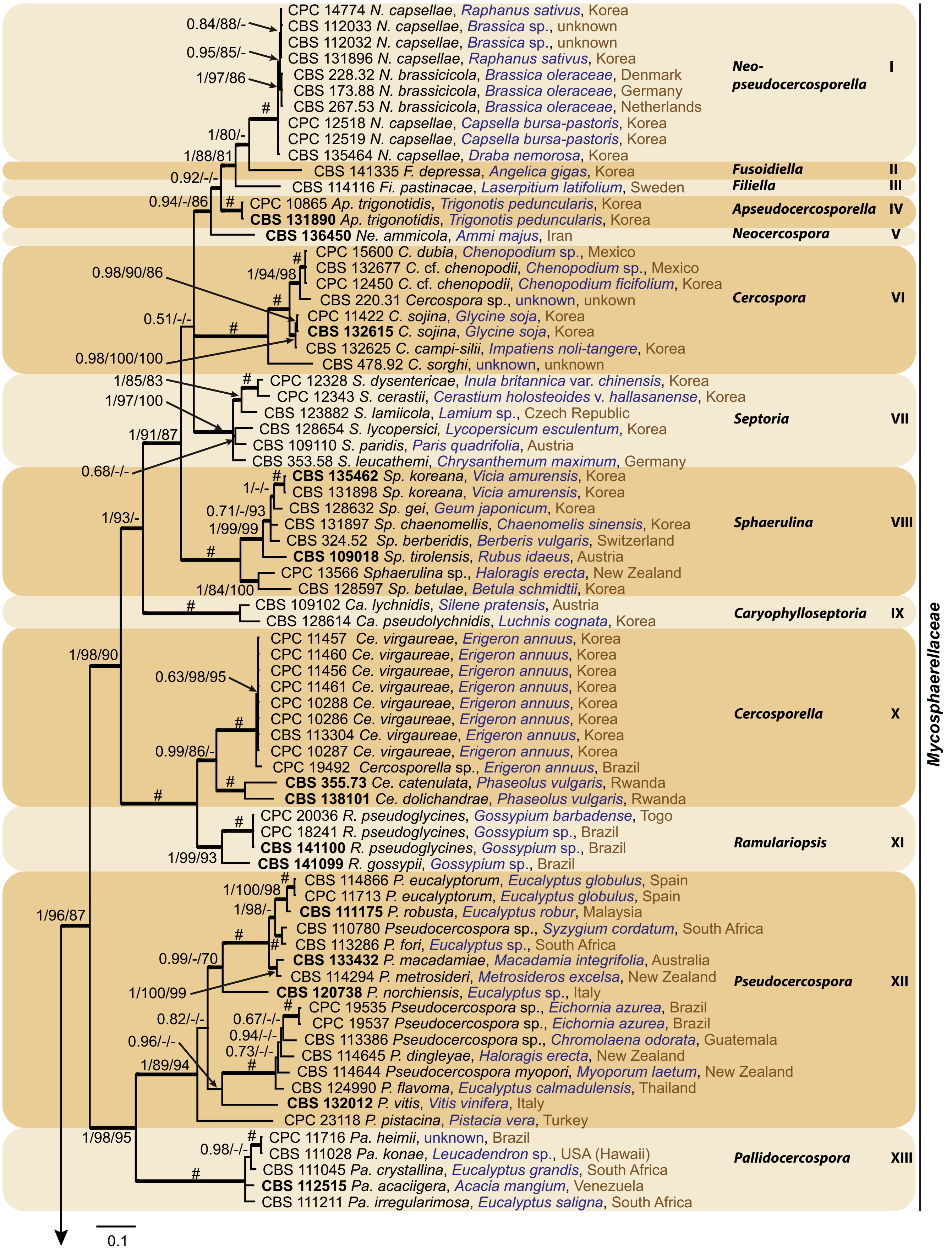

**Fig. 1.** Phylogenetic tree resulting from a Bayesian analysis on the combined alignment of LSU and *rpb2*. Bayesian posterior probabilities (BPP), maximum likelihood bootstrap support values (≥ 80 %; MLBS) and parsimony bootstrap support values (≥ 80 %; PBS) are indicated at the nodes (BPP/MLBS/PBS). Values of BPP/MLBS/PBS equal to 1/100/100 were replaced with a hash (#). The scale bar represents the expected number of changes per site. Branches in a thicker stroke represent the branches present in the strict consensus parsimony tree. Species names are written in black text, host names in green and country of origin in brown. In the species names, in descending order on the tree, the genus is abbreviated as: *N.* = *Neopseudocercosporella*; *F.* = *Fusoidiella*; *Fi.* = *Filiella*; *A.* = *Apseudocercosporella*; *Ne.* = *Neocercospora*; *C.* = *Cercospora*; *S.* = *Septoria*; *Sp.* = *Sphaerulina*; *Ca.* = *Caryophylloseptoria*; *Ce.* = *Cercosporella*; *R.* = *Ramulariopsis*; *P.* = *Pseudocercospora*; *Pa.* = *Pallidocercospora*; *Ra.* = *Ramularia*; *X.* = *Xenoramularia*; *Z.* = *Zymoseptoria*; *D.* = *Dothistroma*; *St.* = *Stromatoseptoria*; *Ps.* = *Pseudocercosporella*; *M.* = *Microcyclosporella*; *My.* = *Mycosphaerelloides*; *E.* = *Epicoleosporium*; *U.* = *Uwebrawnia*; *Di.* = *Dissoconium*; *Ram.* = *Ramichloridium*; *Ac.* = *Acrodontium*; *Par.* = *Parapenidiella*; *T.* = *Teratosphaeria*; *R.* = *Readeriella*; *Te.* = *Teratoramularia*. Genus clades are delimited in coloured blocks, with genus names and clade numbers indicated to the right of the tree together with the family they belong to. Type strains are represented in **bold**. The tree was rooted to *Cladosporium cladosporioides* (CBS 112388).

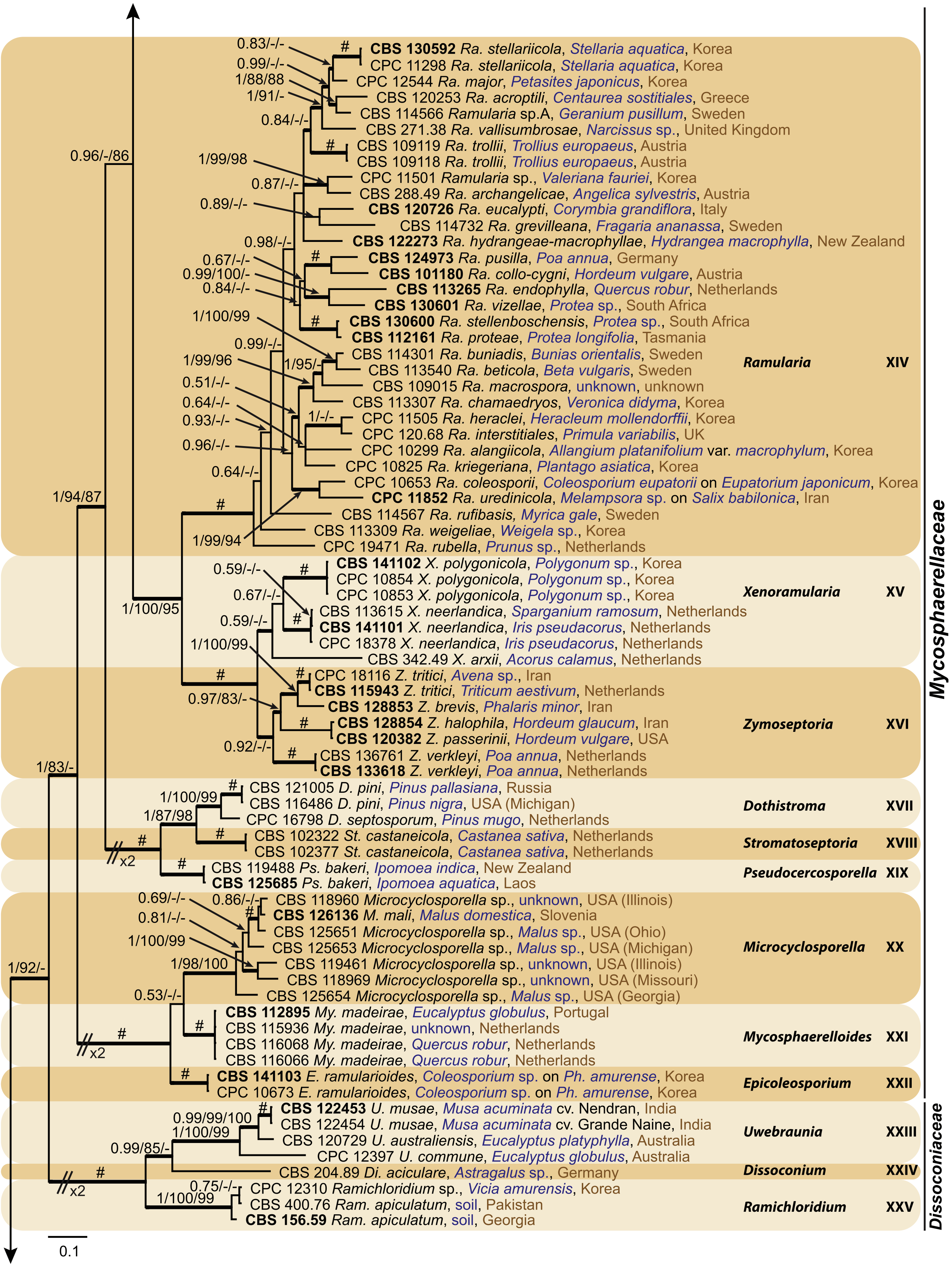

**Fig. 1.** (Continued).

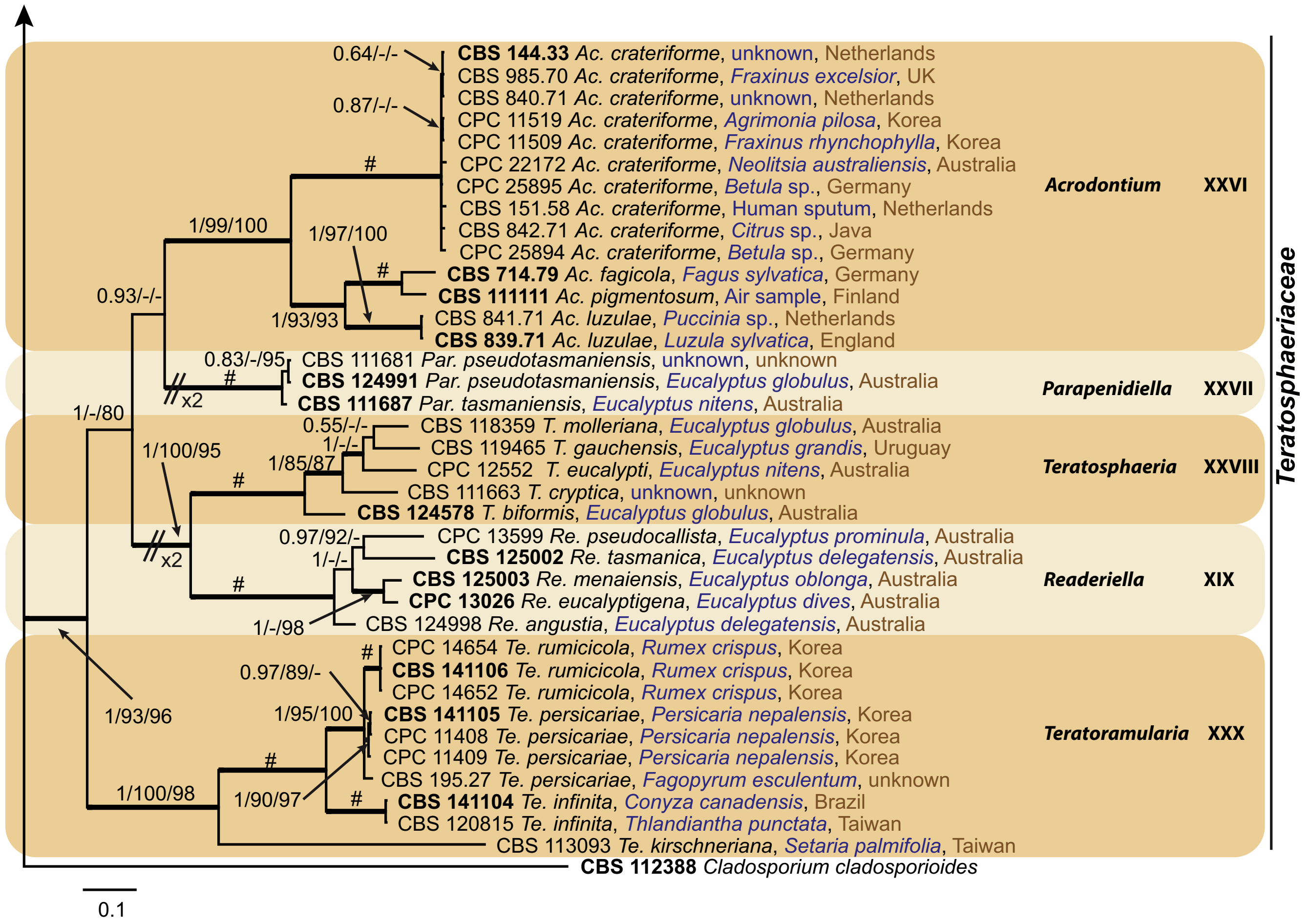

**Fig. 1.** (Continued).

**Kimura-2-parameter values:** The individual loci showed varying degrees of effectiveness in their ability to separate species (Fig. 3). In these datasets, *rpb2* and *gapdh* showed the best barcode gap distances between the inter- and intraspecific distances, followed by *actA*, *tef1*-α and *his3*. The ITS lacked a significant barcode gap, which indicates that this gene performs poorly for species resolution in the genus *Ramularia*. The *gapdh* and *rpb2* also showed the lowest overlap between the intra- and interspecific distances, followed by *tef1*-α, *actA* and ITS, respectively. A good barcode should be easily amplifiable by PCR, have a large barcode gap and a small overlap between intra- and interspecific distances (Schoch *et al.* 2012, Stielow *et al.* 2015). Based on these characteristics, both *rpb2* and *actA* make good secondary barcode loci for *Ramularia* species.

## Taxonomy

In this study we applied the Consolidated Species Concept (Quaedvlieg *et al.* 2014), a polyphasic approach combining the concordance of multiple gene genealogies with morphological and ecological information to improve fungal species delimitation. The genera mapped in Fig. 1 are discussed by clade order followed by a section describing and illustrating the allied genera of *Ramularia* for which only herbarium specimens were available. The species of *Ramularia* resolved in Fig. 2 are discussed in alphabetical order in a third section to which a few important species not known from culture but of phytopathological importance were added.

**Clade I: *Neopseudocercosporella*** Videira & Crous, **gen. nov.** MycoBank MB816820.

*Etymology*: Named after the similarity with *Pseudocercosporella*.

Phytopathogenic, causing leaf spots. *Mycelium* internal, hyaline, septate, branched, stromata almost absent to well-developed. *Ascomata* pseudothecial, mycosphaerelloid, single to aggregated, black, immersed, becoming erumpent, globose, with an apical ostiole; wall of medium brown *textura angularis*. *Asci* aparaphysate, fasciculate, bitunicate, subsessile, obovoid to narrowly ellipsoid. *Ascospores*, straight to fusoid-ellipsoid, hyaline, guttulate, thin-walled, with subobtuse ends, medianly 1-septate. *Conidiophores* solitary or grouped, erumpent through the cuticle or emerging through stomata, hyaline, sometimes faintly pigmented, smooth, simple, straight, slightly curved or geniculate-sinuous, usually aseptate, i.e. reduced to conidiogenous cells, thin-walled, smooth. *Conidiogenous cells* hyaline, subcylindrical to geniculate-sinuous, with inconspicuous conidiogenous loci, unthickened, neither darkened nor refractive, mostly truncate. *Conidia* solitary, hyaline or rarely slightly pigmented, thin-walled, smooth, straight to flexuous, subcylindrical to obclavate, with apex obtuse to subacute and base truncate, sometimes somewhat obconically, one- to multiseptate, hilum not thickened or darkened.

*Type species*: *Neopseudocercosporella capsellae* (Ellis & Everh.) Videira & Crous.

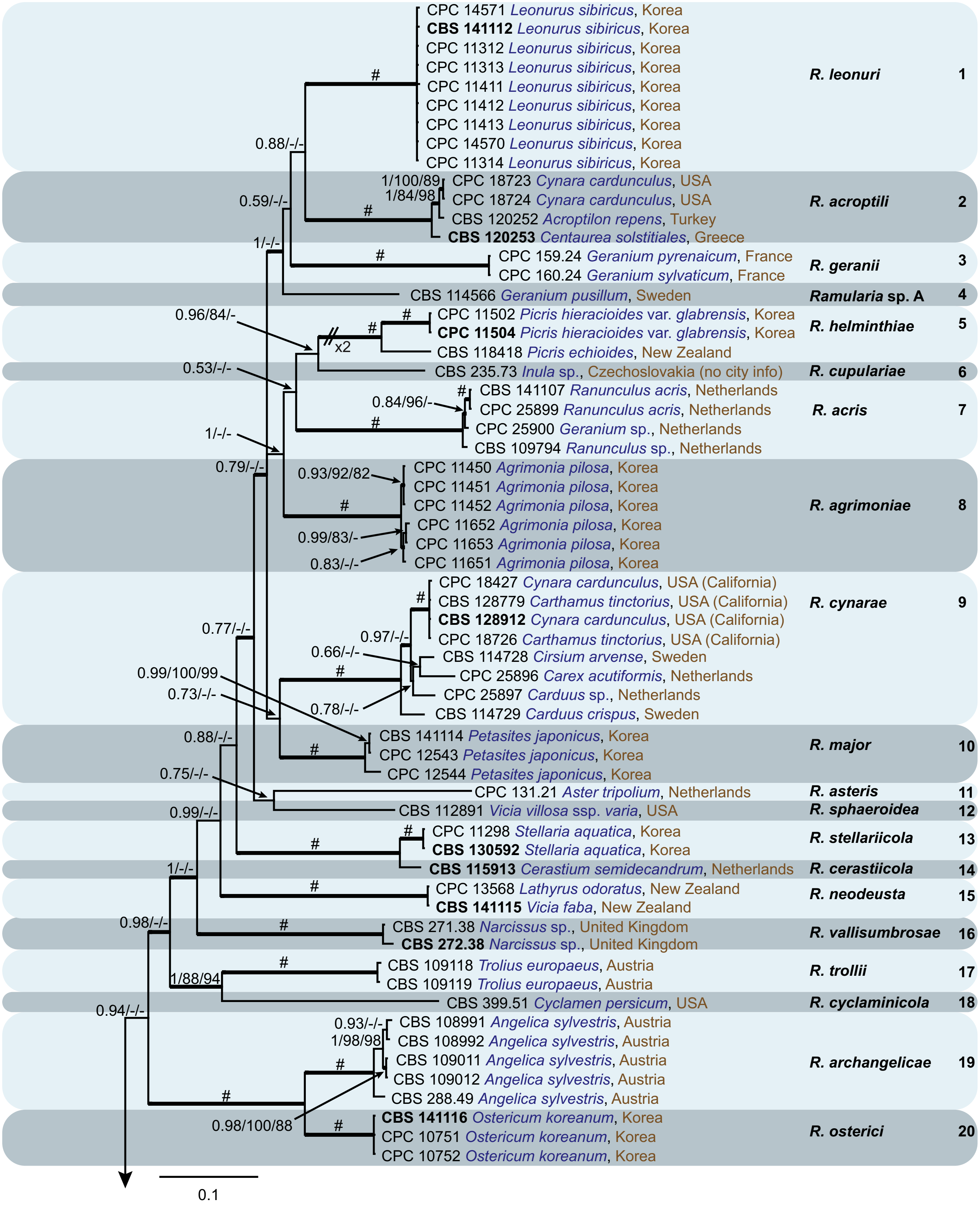

**Fig. 2.** Phylogenetic tree resulting from a Bayesian analysis on the combined alignment of five genes (*rpb2*, ITS, *actA*, *gapdh*, *tef1*-α). Bayesian posterior probabilities (BPP), maximum likelihood bootstrap support values (≥ 80 %; MLBS) and parsimony bootstrap support values (≥ 80 %; PBS) are indicated at the nodes (BPP/MLBS/PBS). Values of BPP/MLBS/PBS equal to 1/100/100 were replaced with a hash (#). The scale bar represents the expected number of changes per site. Branches in a thicker stroke represent the branches present in the strict consensus parsimony tree. Species clades are delimited in coloured blocks, where strain numbers are written in black, host names in blue and country of origin in brown. The current species name and clade number are indicated to the right of the tree. Type strains are represented in **bold**. The tree was rooted to *Zymoseptoria halophila* (CBS 128854).

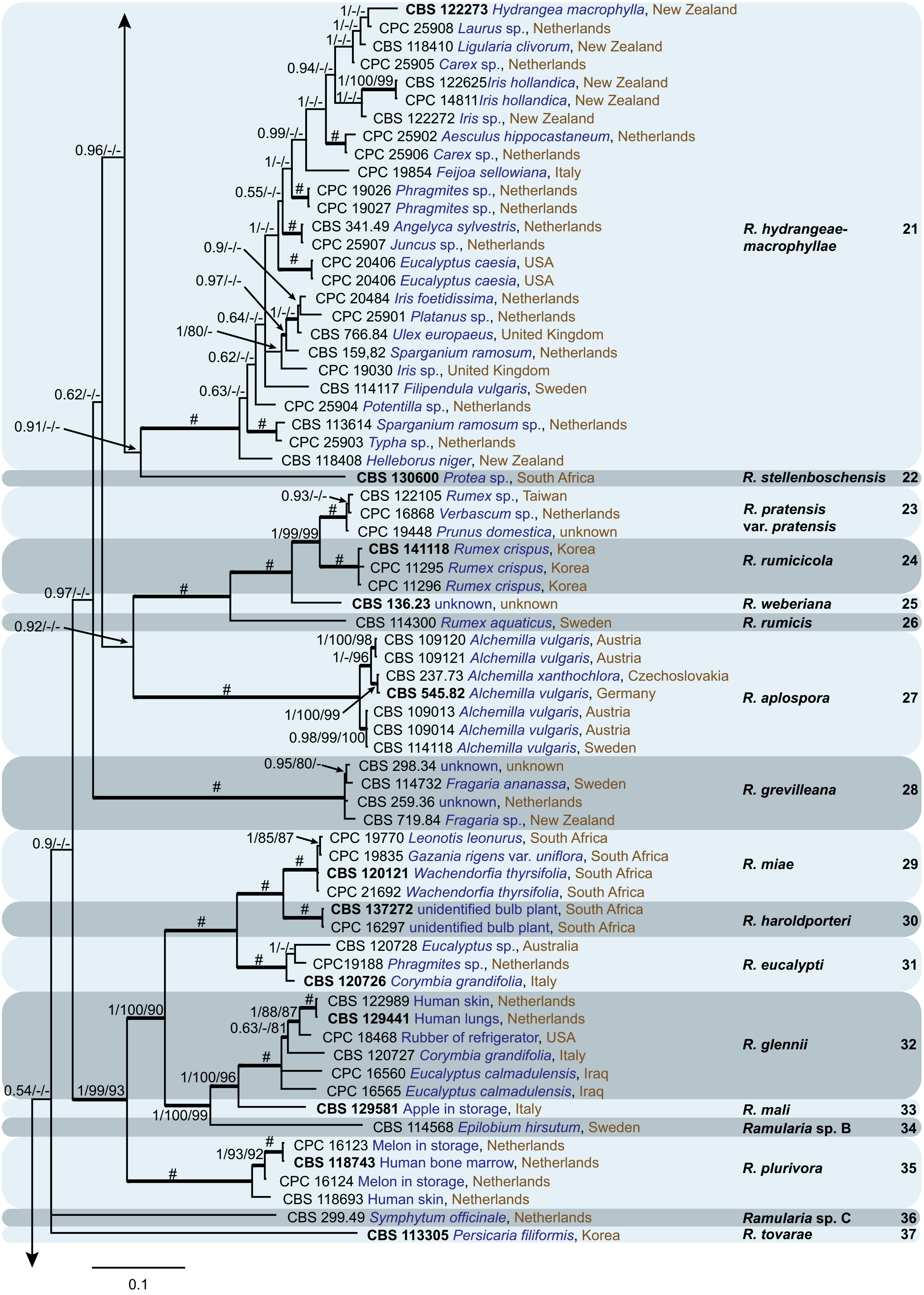

**Fig. 2.** (Continued).

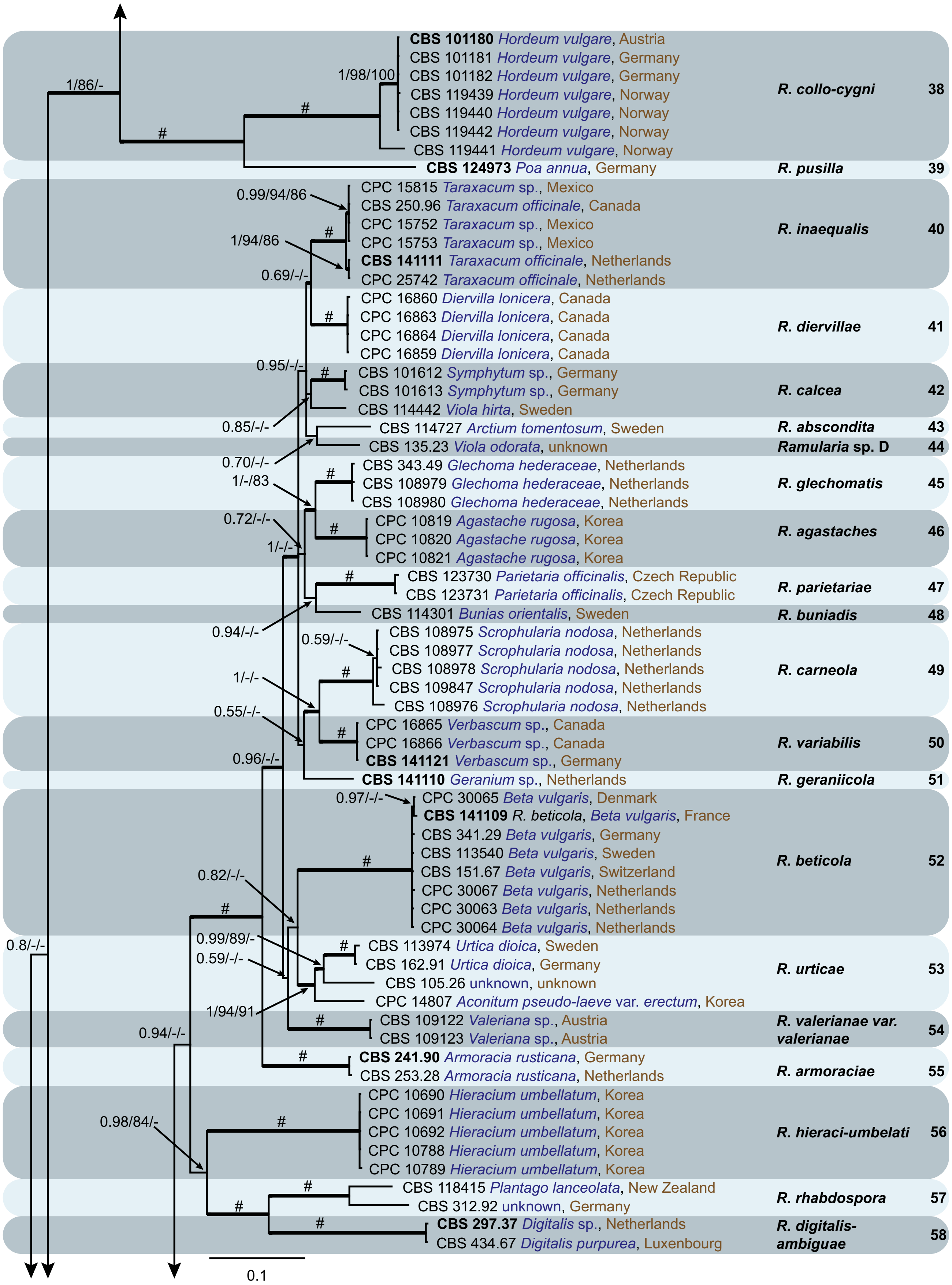

**Fig. 2.** (Continued).

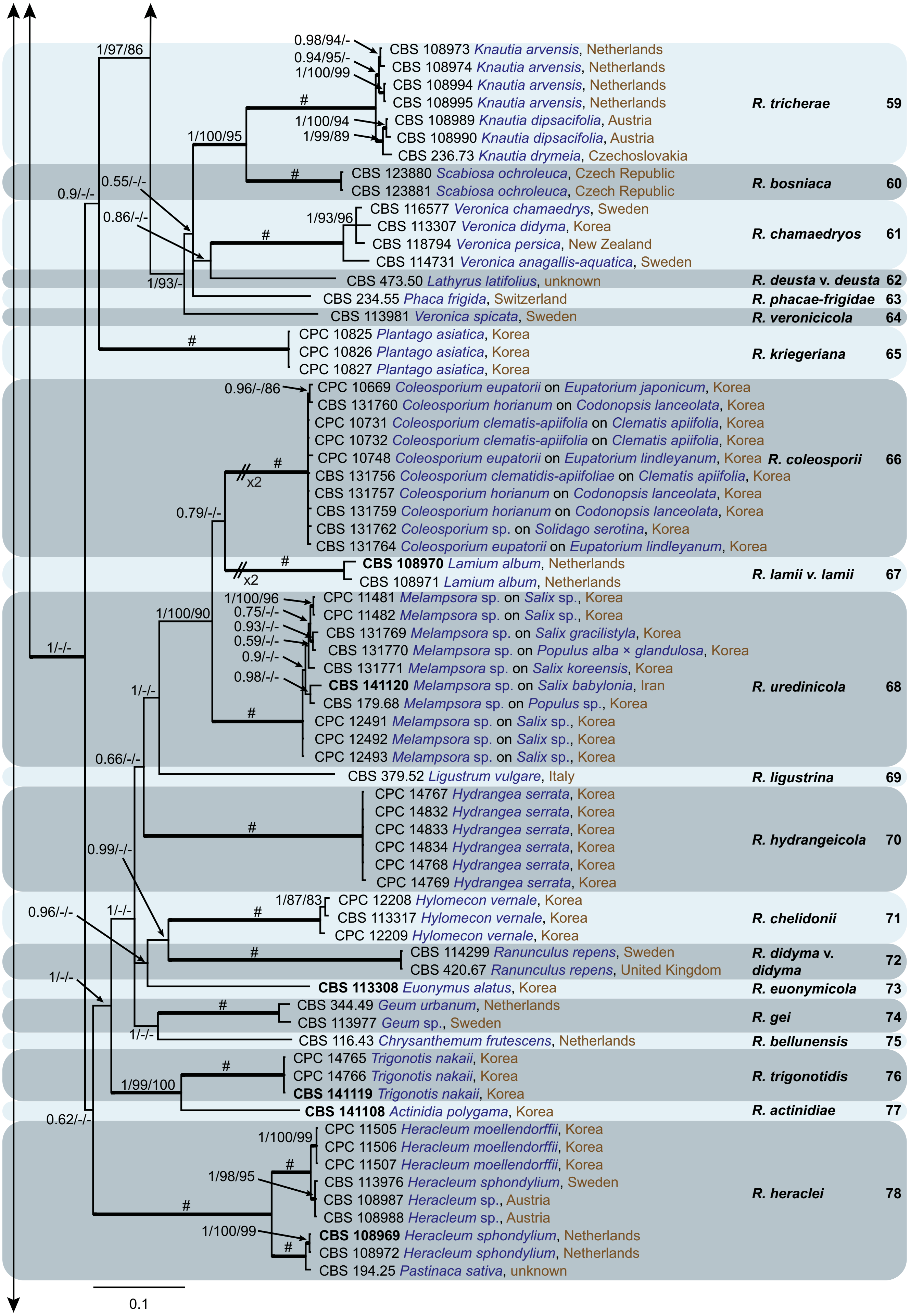

**Fig. 2.** (Continued).

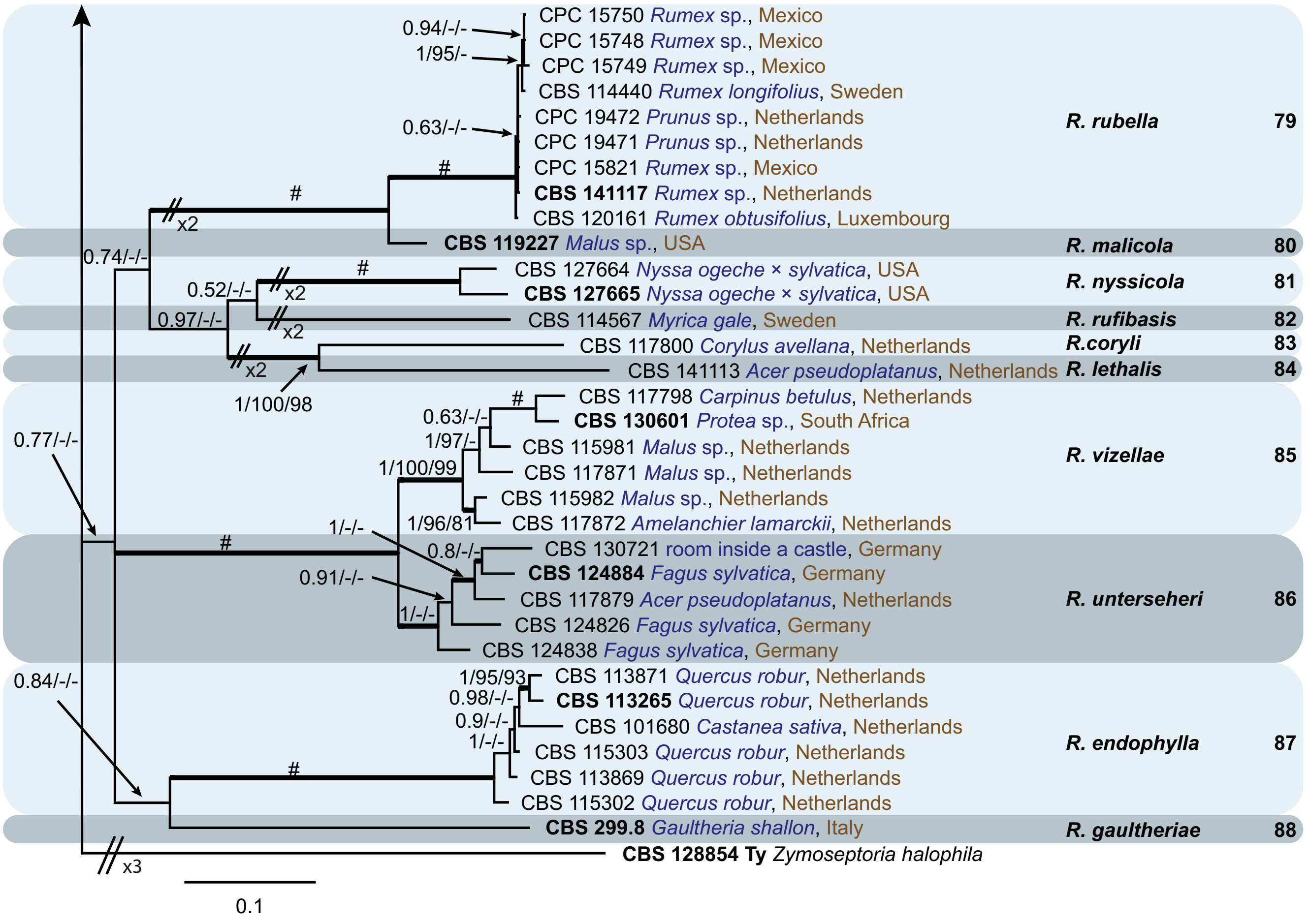

**Fig. 2.** (Continued).

*Notes*: This genus currently accommodates two species, *Neopseudocercosporella capsellae* (syn. *Pseudocercosporella capsellae*/*Mycosphaerella capsellae*) and *Neopseudocercosporella brassicae* (syn. *Mycosphaerella brassicicola*) (Fig. 1, clade I; Fig. 4) which are not congeneric with the type species of *Pseudocercosporella*. Both are considered as important pathogens of *Brassica* species, especially in the *Brassica oleraceae* group that includes broccoli, cauliflower and Brussel sprouts, and have been reported worldwide. *Neopseudocercosporella capsellae* is the causative agent of White Leaf Spot disease while *Neopseudocercosporella brassicae* causes Ringspot disease. In literature, these pathogens are usually distinguished based on their disease symptoms, morphology of their ascospores, and culture characteristics (Inman *et al.* 1991). Both pathogens cause symptoms on leaves, stems and pods. The lesions caused by *N. capsellae* are round to angular and tan to light grey while the lesions caused by *N. brassicae* expand in a pattern of concentric rings with shades of grey. The ascomata, asci and ascospores of *N. capsellae* and *N. brassicae* are very similar in size and shape. The ascospores in both species are 1-septate and not constricted at the septa but the ascospores of *N. brassicae* typically have one cell that is broader than the other while in *N. capsellae* they are of similar size and shape. In culture, *N. capsellae* isolates produced spermogonia and conidia and also secreted a pink pigment into the media, while *N. brassicae* isolates produced no spermogonia, conidia or pigment. The similarity between these two diseases is high and White Leaf Spot disease was previously misdiagnosed as Ringspot in Canada, since both diseases produce slate grey lesions with spermogonia and pseudothecia on stems and pods (Rimmer *et al.* 2007). The character used to distinguish these two species that is most emphasised in literature is their ascospore morphology (Inman *et al.* 1991, Rimmer *et al.* 2007). The production of pigment into the media should be considered a poor character to distinguish these species since it has been observed that, among a large number of isolates of *N. capsellae*, only a small percentage could produce pigment and this ability was highly dependant on the media used (Gunasinghe *et al.* 2016). Although these are economically important fungi, only a few isolates are available in culture collections and mostly of *N. capsellae*. The sequences of five gene regions of strains deposited in the culture collection as *N. capsellae* and *N. brassicae* used in this study showed only 6–8 unique nucleotide differences in a concatenated alignment containing about 3 000 nucleotides. None of these are from ex-type cultures or specimens and only *N. capsellae* ITS and LSU sequences were available on GenBank for comparison. Based on molecular data there is a distinct possibility that these two species might be synonymous but for now we prefer to keep them separate pending the recollection of fresh material. *Neopseudocercosporella capsellae* has a predominantly asexual life cycle and the sexual morph is produced at the end of the season to enable survival. *Neopseudocercosporella brassicae* has no recorded asexual morph other than spermatogonia *in vivo*. Ascomata can be produced all year round and the fungus is homothallic, meaning ascomata can be produced without the need for two complementary mating types (Rimmer *et al.* 2007).

***Neopseudocercosporella brassicae*** (Chevall.) Videira & Crous, **comb. nov.** MycoBank MB817145.

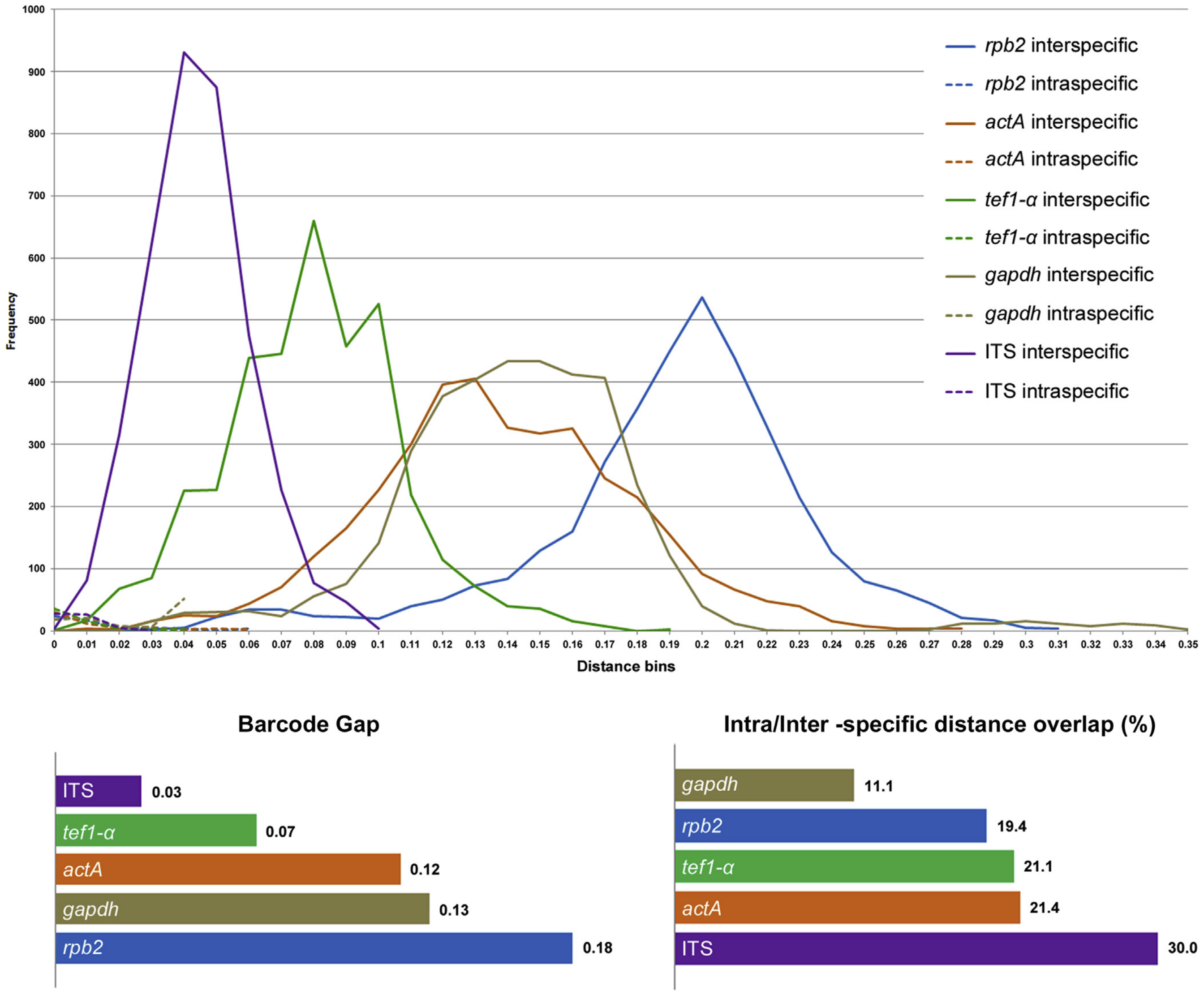

**Fig. 3.** Frequency distribution graph of the Kimura-2-parameter distance test for the five individual gene loci (*actaA*; *gapdh*; ITS; *rpb2*; *tef1-α*). Barcoding gap calculated based on the frequency distributions. Percentage of overlap between the inter- and intra-specific distances based on the frequency distributions.

*Basionym*: *Asteroma brassicae* Chevall., *Fl. gén. env.* (Paris) 1: 449. 1826.

≡ *Asteromella brassicae* (Chevall.) Boerema & Kesteren, Persoonia 3: 18. 1964.

= *Sphaeria brassicicola* Duby, as "*brassicaecola*", Bot. gall., Edn 2 (Paris) 2: 712. 1830.

≡ *Depazea brassicicola* (Duby) Klotzsch, in Klotzsch, Herb. Viv. Mycol.: no. 1142. 1848.

≡ *Mycosphaerella brassicicola* (Duby) Lindau, in Engler & Prantl, Nat. Pflanzenfam. 1(1): 424. 1897.

≡ *Sphaerella brassicicola* (Duby) Ces. & De Not., Comment. Soc. Crittog. Ital. 1(4): 238. 1863.

= *Dothidea brassicae* Desm., Ann. Sci. Nat., Bot., ser. 2 17: 113. 1842.

= *Phyllosticta brassicicola* Grove, J. Roy. Hort. Soc. 40: 76. 1914.

*Specimens examined*: **Denmark**, on *Brassica oleraceae*, date and collector unknown, isol. and dep. by C.A. Jörgensen, Feb. 1932, culture CBS 228.32. **Netherlands**, Berlikum, on *Brassica oleraceae* var. *acephala* subvar. *sabelica*, date and collector unknown, isol. and dep. by F. Quak, Nov. 1953, culture CBS 267.53. **Germany**, Schleswig-Holstein, Marne, on *Brassica oleracea*, date and collector unknown, isol. by W. Zornbach, Aug. 1986, dep. by W. Zornbach, Mar. 1988, culture CBS 173.88.

*Substrate and distribution*: On various *Brassica oleraceae* subspecies and varieties (Brussels sprouts, broccoli, cauliflower and cabbage) and other cruciferous species such as oilseedrape, rutabanga and kale.

*Notes*: Boerema & van Kesteren (1964) addressed the nomenclatural history of *Mycosphaerella brassicicola. Mycosphaerella brassicicola* (1897) is based on *Sphaeria brassicicola* (1830) from *Brassica oleraceae* from France, Germany, Italy and Belgium. It is hereby transferred to the genus *Neopseudocercosporella.* Although the isolates used in this study match this host and localities, they were unfortunately sterile in culture (Fig. 1, clade I). Fresh cultures need to be collected from plants exhibiting typical disease symptoms and included in a molecular phylogeny.

***Neopseudocercosporella capsellae*** (Ellis & Everh.) Videira & Crous, **comb. nov.** MycoBank MB817119. Fig. 4.

*Basionym*: *Cylindrosporium capsellae* Ellis & Everh., J. Mycol. 3(11): 130. 1887.

≡ *Cercoseptoria capsellae* (Ellis & Everh.) H.C. Greene, Trans. Wisconsin Acad. Sci. 47: 127. 1959.

≡ *Pseudocercosporella capsellae* (Ellis & Everh.) Deighton, Mycol. Pap. 133: 42. 1973.

≡ *Cercoseptoria capsellae* (Ellis & Everh.) Arx, Proc. Kon. Ned. Akad. Wetensch. C 86(1): 35. 1983.

= *Mycosphaerella capsellae* A.J. Inman & Sivan., Mycol. Res. 95: 1339. 1991.

For additional synonyms see Braun (1995) or MycoBank.

**Fig. 4.** *Neopseudocercosporella capsellae* (A–D. CPC 14774; E–I. CPC 12518; J–N. CPC 11677). A, E. Leaf spot symptoms on hosts. B–D, F. Conidiogenous cell and conidia from herbarium material. G, H, J, K, L. Conidiogenous cells and conidia from culture. I, M, N. Conidia from culture. Scale bars = 10 µm.

*Description in vivo*: See Braun (1995).

*Specimens examined*: **South Korea**, Hongcheon, on *Capsella bursa-pastoris*, 4 Nov. 2005, H.D. Shin, culture CPC 12519; on *Draba nemorosa*, 30 Oct. 2004, H.D. Shin, culture CBS 135464 = CPC 11677; Inje, on *Trigonotis peduncularis*, 14 Sep. 2003, H.D. Shin, culture CPC 10865; Namyangju, on *Raphanus sativus*, 22 Oct. 2007, H.D. Shin, culture CBS 131896 = CPC 14773. **New Zealand**, Auckland, Mt. Albert, on *Brassica* sp., unknown date and collector, isol. C.F. Hill, Jul. 2005, culture CBS 118412. **Unknown country**, on *Brassica* sp., unknown date and collector, isol. R. Evans, 28 Aug. 2002, cultures CBS 112032, CBS 112033. **USA**, Columbia, Missouri, Boone Co., on *Capsella bursa-pastoris*, May 1887, Galloway 253 (**holotype** NY 883641, **isotype** BPI 399944).

*Substrate and distribution*: Various cruciferous species (*Brassicaceae*), circumglobal (host list and detailed distribution see Braun 1995).

*Notes*: *Pseudocercosporella capsellae* (1973) is based on *Cylindrosporium capsellae* (1887) from *Capsella bursa-pastoris* from the USA (Columbia, Missouri). It is hereby combined in the new genus *Neopseudocercosporella*. *Neopseudocercosporella capsellae* causes White Leaf Spot disease, an important disease of cruciferous species worldwide (Fig. 1, Clade I; Fig. 4). The strains CPC 12518 and CPS 12519 were isolated from this host but originated from South Korea. *Mycosphaerella capsellae* (1991) is described from *Brassica napus* in the UK and linked to *Pseudocercosporella capsellae*. The isolates CBS 112032 and 112033 are listed from the UK but with *Brassica* sp. as host and were deposited by R. Evans who also at approximately the same time deposited IMI 389562, which is listed in the IMI database as being from *Brassica napus*. Based on ITS and partial LSU, an isolate from ATCC (38562 from *Brassica rapa*, USA, California; GenBank JX499036) which is listed in ATCC as *Pseudocercosporella capsellae*, also belongs to this clade. Unfortunately no other sequences were available for this isolate. Fresh cultures need to be collected from plants exhibiting typical disease symptoms and included in a molecular phylogeny.

**Clade II: *Fusoidiella*** Videira & Crous, **gen. nov.** MycoBank MB816818.

*Etymology*: Named after the fusiform-shaped conidia of the type species.

Phytopathogenic, causing small yellow to olivaceous green spots on leaves. *Mycelium* internal. *Conidiophores* aggregated in dense fascicles, arising through stomata, aseptate, i.e. usually reduced to conidiogenous cells, smooth, brown, subcylindrical to clavate, straight to curved due to thickening of the wall on one side, not geniculate, one to multiple conidiogenous loci located laterally or apically, loci conspicuous, thickened and broad, areolate, darkened and refractive. *Conidia* solitary, smooth, light brown, thin-walled, fusiform to obclavate-fusiform, straight to somewhat curved, septate, not constricted at the septa, apex obtuse and base truncate, hilum flattened, thickened, darkened and refractive.

*Type species*: *Fusoidiella depressa* (Berk. & Broome) Videira & Crous.

*Notes*: The morphology of the type species is quite unique and different from the closest phylogenetic species, *Neopseudocercosporella capsellae*. *Fusoidiella depressa* forms a single lineage in the phylogenetic analysis (Fig. 1, clade II).

***Fusoidiella depressa*** (Berk. & Broome) Videira & Crous, **comb. nov.** MycoBank MB817146. Fig. 5.
*Basionym*: *Cladosporium depressum* Berk. & Broome, Ann. Mag. Nat. Hist. 7: 99, t. 5: 8. 1851.
≡ *Passalora depressa* (Berk. & Broome) Sacc., Nuovo Giorn. Bot. Ital. 8(2): 187. 1876.
≡ *Fusicladium depressum* (Berk. & Broome) Roum., Fungi Sel. Gall. Exs.: No. 86. 1879.
≡ *Cercospora depressa* (Berk. & Broome) Vassiljevsky, Fungi imperfecti Parasitici. I. Hyphomycetes: 385. 1937.
≡ *Cercosporidium depressum* (Berk. & Broome) Deighton, Mycol. Pap. 112: 37. 1967.
For additional synonyms see Deighton (1967), Crous & Braun (2003) and MycoBank.

*Specimen examined*: **South Korea**, Bonghwa, on *Angelica gigas*, 18 Oct. 2007, H.D. Shin, KUS-F23064 = CBS H-22632, culture CBS 141335 = CPC 14915.

*Notes*: The specimen studied here (KUS-F23064) was initially identified as *Passalora depressa* and both the symptoms on the host and morphological characters (Fig. 5) are similar to those described from the authentic specimen (herb. K(M) 29181, on *Angelica sylvestris*, Great Britain; Deighton 1967). The conidiophores of the herbarium specimen observed are slightly smaller [(10.5–)20–23(–29) × (3–)4–5(–6) µm] than those described for the type [20–70(–120) × 4–8 µm]. Similarly, the observed conidia were also slightly smaller [(17.5–)32–38(–47) × (4.5–)5–6(–8) µm] than those described for the type [20–78 × 6.5–11 µm]. This species forms a single lineage in the phylogenetic analysis **(**Fig. 1, clade II). Fresh collections of *Passalora depressa* on *Angelica sylvestris* from the UK are required to facilitate an epitypification, and to fix the application of the name.

**Clade III: *Filiella*** Videira & Crous, **gen. nov.** MycoBank MB816823.

*Etymology*: Named after the filiform-shaped conidia of the type species.

Phytopathogenic. Mycelium internal, hyaline, septate, branched, forming well-developed stromata composed of swollen hyphae. *Conidiophores* emerging in dense fascicles from stromata, through the cuticle or through stomata, subcylindrical, straight to flexuous, geniculate-sinuous, aseptate, i.e. usually reduced to conidiogenous cells, rarely 1-septate near the base, hyaline to pale yellow at the base, thin-walled, smooth, with inconspicuous conidiogenous loci, unthickened, neither darkened nor refractive. *Conidia* solitary, acicular, subcylindrical, filiform, narrowly obclavate, hyaline, discretely septate, thin-walled, smooth, apex subacute, base truncate, hila unthickened, not darkened (adapted from Braun 1993).

*Type species*: *Filiella pastinacae* (P. Karst.) Videira & Crous.

*Notes*: This monotypic genus (Fig. 1, Clade III) was established to accommodate *Pseudocercosporella pastinacae*, since it is not congeneric with *Pseudocercosporella s. str.* based on *P. bakeri* (Fig. 1, clade XIX). This species is represented by a single lineage in the phylogenetic analysis (Fig. 1, clade III). It is closely related to *Neopseudocercosporella* and *Fusoidiella*, but can be distinguished by the acicular-filiform conidia instead of the subcylindrical conidia of *N. capsellae*, or pigmented, fusiform conidia of *F. depressa*.

***Filiella pastinacae*** (P. Karst.) Videira & Crous, **comb. nov.** MycoBank MB817147.
*Basionym*: *Cercosporella pastinacae* P. Karst., Hedwigia 23: 63. 1884.
≡ *Ramularia pastinacae* (P. Karst.) Lindr. & Vestergr., Acta Soc. Fauna Fl. Fenn. 22(1): 8. 1902.
≡ *Pseudocercosporella pastinacae* (P. Karst.) U. Braun, Nova Hedwigia 56(3–4): 444. 1993.
= *Phyllosticta umbellatarum* Rabenh., Fungi Eur. Exs., Cent. XII: no. 1262. 1869.
= *Phloeospora laserpitii* Bres., Fungi trident. 2(8–10): 45. 1892.
= *Cylindrosporium septatum* Romell, Syll. Fung. 10: 503. 1892.
For additional synonyms see Braun (1995) and MycoBank.

*Specimens examined*: **Germany**, Dresden, on *Pastinaca sativa*, 1866, Rabenh., Fungi Eur. Exs. 1262 (**neotype**, designated in Braun 1995, HAL). **Sweden**, Uppland, Uppsala Näs, Vreta, on *Laserpitium latifolium*, 2 Jun. 1988, K. & L. Holm, culture CBS 114116.

*Substrate and distribution*: On *Angelica*, *Apium*, *Archangelica*, *Astrantia*, *Eremodaucus*, *Heracleum*, *Laserpitium*, *Libanotis*, *Pastinaca*, and other hosts (*Apiaceae*); Caucasus, Central Asia, Europe, N. America and S. Africa (see Braun 1995).

*Notes*: *Cercosporella pastinacae* was transferred to *Pseudocercosporella* by Braun (1993). It was originally described on *Pastinaca sativa* from Finland. The type material was not preserved and a neotype specimen on *Pastinaca sativa* from Germany was selected (Braun 1995; neotype in HAL). This species is known for causing cercosporoid leaf blight of parsnip that is characterised by the formation of yellow-brown spots on leaves and petioles that later become necrotic and lead to plant defoliation. *Filiella pastinacae* (= *P. pastinacae*) is often found in mixed infections with *R. heraclei* (= *R. pastinacae-sativa*) and they have been often confused. *Filiela pastinacae* also infects celery, and *Angelica* species and seeds contaminated with this pathogen must be discarded. The disease has been reported from Europe and Central Asia (Braun 1995) and is susceptible to various fungicides (Davis & Raid 2002). This species is represented by a single lineage in the phylogenetic analyses (Fig. 1, clade III).

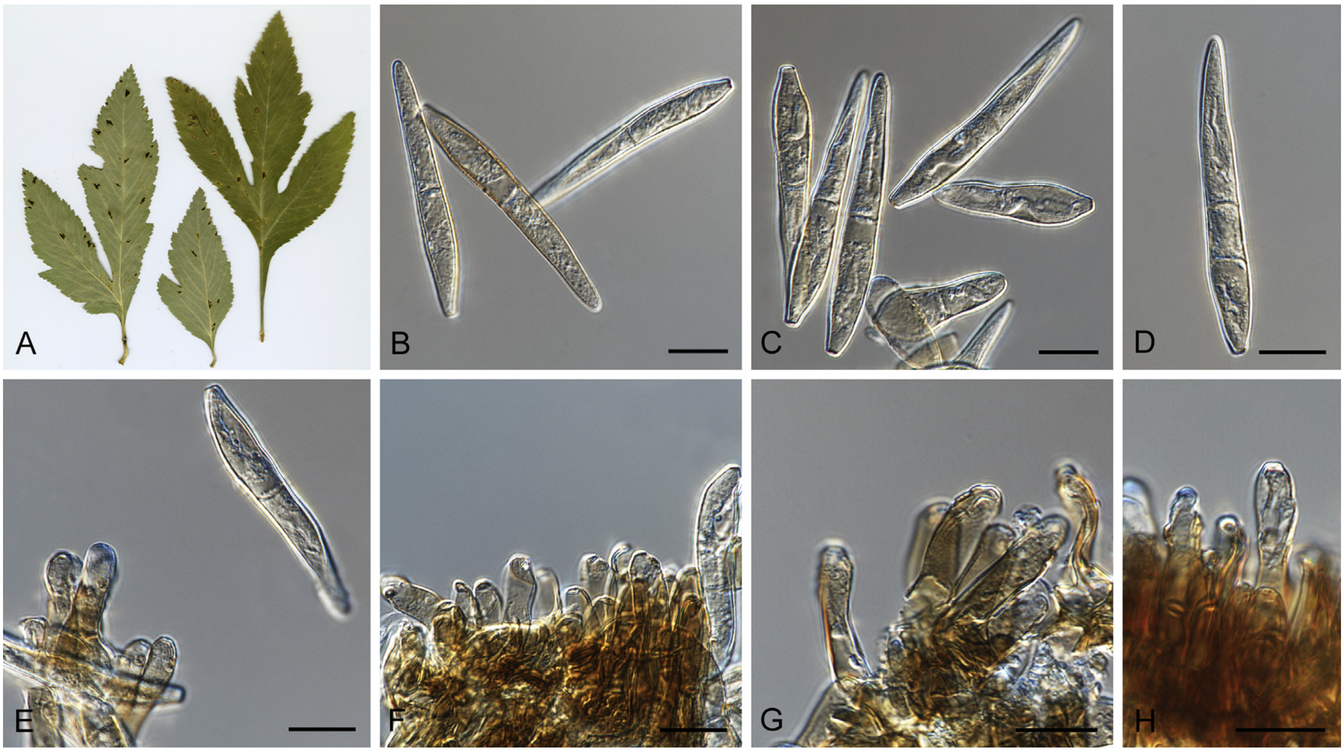

**Fig. 5.** *Fusoidiella depressa* (CBS 141335). A–H. Observations from herbarium material. A. Leaf spot symptoms on the host. B–D. Conidia. E. Conidia and conidiophores. F–H. Conidiophores. Scale bars = 10 µm.

**Clade IV: *Apseudocercosporella*** Videira & Crous, **gen. nov.** MycoBank MB816816.

*Etymology*: Named after the similarity with the genus *Pseudocercosporella*.

Phytopathogenic. *Mycelium* composed of hyaline, septate, branched, thin-walled, smooth hyphae. *Conidiophores* arising from hyphae, simple, and occasionally branched, straight and subcylindrical to flexuous, geniculate-sinuous, septate or aseptate, hyaline, thin-walled, smooth. *Conidiogenous cells* integrated, terminal or conidiophores often reduced to conidiogenous cells, subcylindrical to geniculate-sinuous, conidiogenous loci slightly thickened and darkened. *Conidia* formed singly, filiform, or subcylindrical, hyaline, thin-walled, smooth, septate or aseptate, base more or less truncate, hilum slightly thickened and darkened.

*Type species*: *Apseudocercosporella trigonotidis* Videira, H.D. Shin & Crous.

*Notes*: This monotypic genus (Fig. 1, Clade IV) was established to accommodate a pseudocercosporella-like species, since it is not congeneric with *Pseudocercosporella s. str.* based on *P. bakeri* (Fig. 1, clade XIX). This genus clade is highly supported in the phylogenetic analysis (Fig. 1, clade IV, 1/100/100). It is closely related to *Filiella* and *Neopseudocercosporella*, but can be distinguished by the conidial hila and conidiogenous loci that are slightly thickened and darkened instead of inconspicuous.

***Apseudocercosporella trigonotidis*** Videira, H.D. Shin & Crous, **sp. nov.** MycoBank MB816845. Fig. 6.

*Etymology*: Named after the host on which it was observed, *Trigonotis*.

*Mycelium* composed of hyaline, septate, branched, hyphae, 1–2 µm diam. *Conidiophores* arising from hyphae, simple, occasionally branched, straight and subcylindrical to flexuous, geniculate-sinuous, (5.5–)11–16(–32) × 1–1.5 µm, aseptate to 1(–2)-septate, hyaline, thin-walled, smooth. *Conidiogenous cells* integrated, terminal or conidiophores often reduced to conidiogenous cells, subcylindrical to geniculate-sinuous, (4–)6.5–8(–13) × 1–2 µm; conidiogenous loci slightly thickened and darkened, 1–2 µm diam. *Conidia* formed singly, filiform, or subcylindrical, (11–)19–22(–30) × 1 µm, hyaline, thin-walled, smooth, aseptate or 1–4-septate, apex obtuse, base more or less truncate, 1 µm diam, hilum slightly thickened and darkened.

*Culture characteristics*: On MEA, 32 mm diam, surface low convex, smooth, white with a greyish tinge, with margins undulate, colony reverse ochraceous; on OA, 20 mm diam, surface flat, white, sparse aerial mycelium in the colony centre, fluffy, with margins crenate, colony reverse buff; on PDA, 29 mm diam, surface low convex, white, sparse aerial mycelium in the colony centre, fluffy, with margins entire, colony reverse buff.

*Specimen examined*: **South Korea**, Jeju, on *Trigonotis peduncularis*, 12 Nov. 2003, H.D. Shin (**holotype** KUS-F20054, isotype CBS H-22515, culture ex-type CBS 131890 = CPC 10864); *idem*. CPC 10865.

*Notes*: *Apseudocercosporella* is the first cercosporoid species isolated from *Trigonotis*. It differs from the closest species in the phylogenetic tree (Fig. 1) by the slightly darkened conidiogenous loci and hila (Fig. 6). The clade is highly supported by BA and ML phylogenetic analysis (Fig. 1, clade IV, 1/100/100).

**Clade V: *Neocercospora*** M. Bakhshi *et al.*, Phytotaxa 213: 28. 2015.

*Note*: See Bakshi *et al.* (2015a).

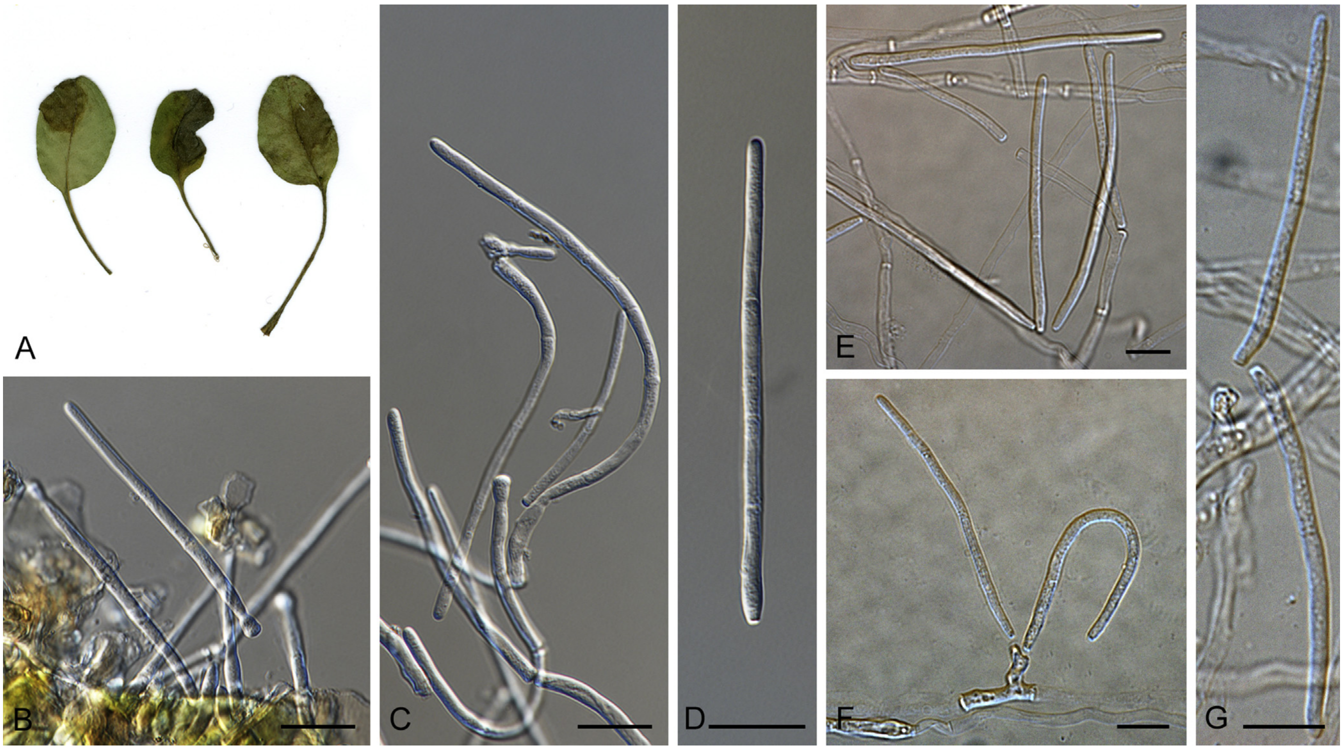

**Fig. 6.** *Apseudocercosporella trigonotidis* (CPC 10865). A–D. Observations from herbarium material. E–G. Structures formed in culture. A. Leaf spot symptoms on the host. B, C, E–G. Conidiophores, conidiogenous cells and conidia. D. Conidium. Scale bars = 10 µm.

**Clade VI: *Cercospora*** Fresen. ex Fuckel, Fungi Rhen. Exs., Fasc. II: no. 117, 1863.

*Note*: See Groenewald *et al.* (2013), Bakshi *et al.* (2015b) and Braun *et al.* (2015).

**Clade VII: *Septoria*** Sacc., Syll. Fung. 3: 474. 1884.

*Note*: See Verkley *et al.* (2013) and Quaedvlieg *et al.* (2013).

**Clade VIII: *Sphaerulina*** Sacc., Michelia 1(4): 399. 1878.

*Note*: See Quaedvlieg *et al.* (2013).

***Sphaerulina chaenomelis*** (Y. Suto) Videira, U. Braun, H.D. Shin & Crous, **comb. nov.** MycoBank MB817148.
*Basionym*: *Cercosporella chaenomelis* Y. Suto, Mycoscience 40: 513. 1999.

≡ *Pseudocercosporella chaenomelis* (Y. Suto) C. Nakash. *et al.*, Stud. Mycol. 75: 70. 2013.

*Specimens examined*: **Japan**, Mie Pref., Tsu, on leaves of *Chaenomeles sinensis*, 29 Oct. 2011, C. Nakashima (**epitype** TFM: FPH-8101, culture ex-epitype CBS 132131 = MUCC 1510). **South Korea**, Kimhae, on *Chaenomeles speciosa*, 14 Nov. 2007, H.D. Shin, CBS H-20844 = KUS-F23225, culture CBS 131897 = CPC 14795.

*Notes*: *Chaenomeles sinensis* is a deciduous tree native to China that is planted as ornamental in Japan. It is susceptible to a leaf spot disease commonly called frosty mildew caused by *Cercosporella chaenomelis* (Horie & Kobayashi 1982). Disease symptoms include large coalescing leaf spots, the development of white tufts of conidiophores on the lower surfaces, and tree defoliation. This species has been linked to the sexual morph *Mycosphaerella chaenomelis* (Suto 1999) that forms ascomata on fallen overwintered leaves providing inoculum for new infections. Crous *et al.* (2013) considered that the fungus would be better placed in *Pseudocercosporella* due to the hyaline conidia with unthickened conidial hila and proposed a new combination in that genus. Based on DNA sequence data from the ITS and *actA* gene regions, strains from Japan and South Korea are identical (Crous *et al.* 2013, unpubl. data). *Pseudocercosporella chaenomelis* is morphologically comparable only with *Pseudocercosporella gei*, known on *Geum* spp. in North America and the Far East of Russia (Braun 1995). In this study, based on LSU and *rpb2*, this species falls in the *Sphaerulina* clade (Fig. 1, clade VIII), and a new combination is therefore proposed. In the genus *Sphaerulina*, there is also *Sphaerulina gei*, on *Geum japonicum* from South Korea, and one could speculate that *Pseudocercosporella gei* may be a synonym of the latter, but no molecular data are presently available for this species, which could of course also be a different fungus.

***Sphaerulina koreana*** (Crous *et al.*) Videira, H.D. Shin & Crous, **comb. nov.** MycoBank MB817149.
*Basionym*: *Pseudocercosporella koreana* Crous *et al.*, Stud. Mycol. 75: 71. 2013 (2012).

= *Sphaerulina viciae* Quaedvl. *et al.*, Stud. Mycol. 75: 348. 2013.

*Specimen examined*: **South Korea**, Hoengseong, on *Vicia amurensis*, 4 Aug. 2004, H.D. Shin (**holotype** CBS H-20845, isotypes HAL 1850 F, KUS-F20554, culture ex-type CBS 135462 = CPC 11414; CPC 11415).

*Notes*: This isolate was described as a new species in two different papers in the same journal volume (Studies in Mycology 75). The name *Pseudocercosporella koreana* (Crous *et al.* 2013) was published online earlier than the name *Sphaerulina viciae* (Quaedvlieg *et al.* 2013). Therefore, the name *Pseudocercosporella koreana* is retained as basionym with *Sphaerulina viciae* as later synonym.

**Clade IX: *Caryophylloseptoria*** Verkley *et al.*, Stud. Mycol. 75: 233. 2013.

*Note*: See Verkley *et al.* (2013) and Quaedvlieg *et al.* (2013).

**Clade X: *Cercosporella*** Sacc., Michelia 2(6): 20. 1880.

Phytopathogenic, mostly causing leaf spots. *Hyphae* restricted to intercellular spaces and forming cup- or bowl-shaped appresoria, 7–17 µm diam that attach to walls of mesophyll cells. *Conidiophores* emerging through stomata or erumpent through the cuticle, straight, subcylindrical to geniculate-sinuous, hyaline, sometimes lightly pigmented near the base, more or less thin-walled and smooth. *Conidiogenous cells* integrated, terminal, polyblastic, sympodial, mostly conspicuously geniculate, conidiogenous loci conspicuous, hyaline but refractive, thickened and raised in the shape of a truncated cone (ultrastructure). *Conidia* formed singly, hyaline, subcylindrical to obclavate, sometimes fusiform, 1- to multi-septate, usually thin-walled and smooth, apex obtuse, base often rounded to truncate or obconically truncate, hilum thickened, not darkened but refractive. Description adapted from Braun (1995) and Kirschner (2009).

*Type species*: *Cercosporella virgaureae* (Thüm.) Allesch. [= *Cercosporella cana* (Sacc.) Sacc. (designated by Deighton 1973)].

*Notes*: *Cercosporella* species are phytopathogenic and mostly cause leaf spots. The genus was first described by Saccardo (1880) on *Solidago virgaurea*, Austria, and was later redescribed by Deighton (1973). Species with consistently internal mycelium *in vivo* are allocated to *Cercosporella* subgen. *Cercosporella* (type species *C. virgaureae*) and species with superficial mycelium *in vivo* to *Cercosporella* subgen. *Pseudovellosiella* (type species *C. crataevae*) (Braun 1995). Morphologically, *Cercosporella* differs from *Ramularia* by producing cup-shaped appressoria and by having flat conidial loci in the shape of a truncated cone (Kirschner 2009). Conidiogenous loci of *Ramularia* spp. have a raised rim with a central dome that is cladosporium-like and does not produce appressoria. A representative of the type species of the genus, *C. virgaureae*, was recently recollected but unfortunately not deposited in a culture collection (Kirschner 2009). A LSU sequence retrieved from the *Cercosporella* strain clustered in a sister clade to *Ramularia* (Kirschner 2009, this study). The LSU sequence of this isolate (GenBank EU710894) is 100 % identical to the LSU sequence of the South Korean isolates used in this study (Fig. 1, clade X). The recently described species *C. dolichandrae* belongs to *Cercosporella* as currently circumscribed (Crous *et al.* 2014). A first report of the leaf spot disease caused by *Cercosporella pfaffiae* on Brazilian Ginseng was published, with the closest match on LSU data (GenBank JQ990330) being *Cercosporella virgaureae* (CBS 113304; GenBank GU214658) (Machado *et al.* 2012), but due to the lack of an *rpb2* sequence it was not included in the phylogeny created in this study. There are a total of 50 species described in the genus *Cercosporella* (Braun 1995, Seifert *et al.* 2011) but very few are available as cultures, and many are not congeneric with *Cercosporella s. str.* (e.g. Fig. 1, clades XII, XIV, XXX). A particularly important species cited in literature is *Cercosporella rubi* (G. Winter) Plakidas (≡ *Fusisporium rubi* G. Winter), the causal agent of the Blackberry rosette disease, a major disease of blackberries in the Southeastern USA. It infects the axillary buds and induces them to germinate as leafy bunches called rosettes. The disease causes reduced yield, poor quality fruit and in severe cases, cane death (Ellis & Converse 1991). Braun (1995) re-examined type material of this species and described and discussed this fungus under "Excluded, doubtful and insufficiently known species". Unfortunately no cultures of this species were available for study.

***Cercosporella catenulata*** Videira & Crous, **sp. nov.** MycoBank MB816846. Fig. 7.

*Etymology*: Named after the unusual production of short conidial chains.

*Mycelium* composed of hyaline, septate, branched hyphae, 1–2 µm diam. *Conidiophores* arising from hyphae, simple or branched, straight and subcylindrical to flexuous or geniculate-sinuous, (8.5–)37–50(–77) × (1–)1.5–2 µm, 2–6-septate, hyaline, thin-walled, smooth. *Conidiogenous cells* integrated, terminal or lateral, subcylindrical to geniculate-sinuous, (4–)8.5–10.5(–15) × (1–)1.5(–2) µm, with a single to multiple conidiogenous loci, conspicuous, thickened but not darkened. *Conidia* hyaline, smooth, formed singly or in very short chains, aseptate but rarely 1-septate, with *hila* thickened but not darkened, 1 µm diam. *Ramoconidia* fusoid, (5–)9–11(–15) × 2–2.5(–3) µm, with two apical hila. *Intercalary conidia* fusoid, (7–)9.5–11(–14) × 2–2.5(–3) µm, in branched chains of up to two conidia. *Terminal conidia* fusoid to obovoid, (3.5–)6–7.5(–12) × 2–2.5(–3) µm.

*Culture characteristics*: On MEA, 5 mm diam, surface raised, erumpent aerial mycelium, buff, with margins undulate, colony reverse hazel; on OA, 5 mm diam, surface low convex, erumpent aerial mycelium, buff, with margins crenate, feathery, colony reverse hazel; on PDA, 11 mm diam, surface convex, erumpent aerial mycelium, rosy buff, with margins entire and with sparse mycelium, colony reverse honey in the centre and buff at the margin.

*Specimen examined*: **Rwanda**, Rubona, on leaves of *Phaseolus vulgaris*, 10 Jan. 1973, D. Froment (**holotype** CBS H-17715, culture ex-type CBS 355.73).

*Substrate and distribution*: Only known from the type host and location.

*Notes*: *Cercosporella catenulata* is an unusual member of the genus, since it produces catenate conidia (Fig. 7). This species is represented by a single lineage in the phylogenetic analysis (Fig. 1, clade X).

***Cercosporella virgaureae*** (Thüm.) Allesch., Hedwigia 34: 286. 1895. Fig. 8.
*Basionym*: *Ramularia virgaureae* Thüm., Fungi Austr. Exs., Cent. 11: no. 1072. 1874.

≡ *Ovularia virgaureae* (Thüm.) Sacc., Syll. Fung. 4: 142. 1886.
≡ *Cylindrosporium virgaureae* (Thüm.) J. Schröt., Krypt.-Fl. Schlesien 3–2(10): 489. 1897.
≡ *Cercospora virgaureae* (Thüm.) Oudem., Ned. Kruidk. Arch. 2: 315. 1901.

For additional synonyms see Braun (1995) or MycoBank.

**Fig. 7.** *Cercosporella catenulata* (CBS 355.73). A–H. Structures observed in culture. A, B, D, E, H. Conidiophores, conidiogenous cells and conidia. C, F. Conidia. G. Conidiophore. Scale bars = 10 μm.

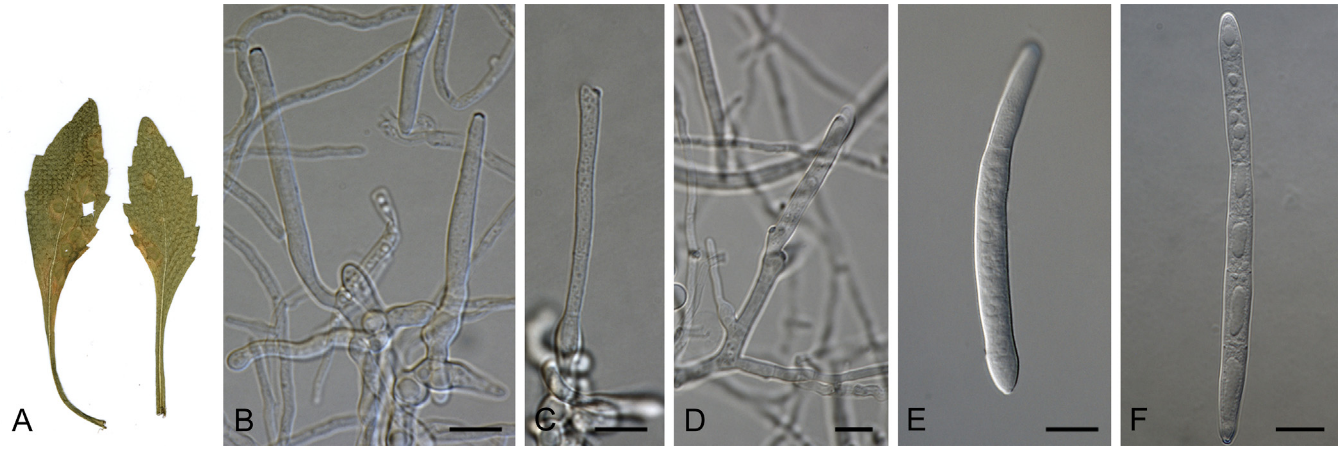

**Fig. 8.** *Cercosporella virgaureae* (CPC 11461). A. Leaf spot symptoms on the host in herbarium material. B–F. Structures observed in culture. B–D. Conidiophores and conidiogenous cells. E, F. Conidia. Scale bars = 10 μm.

*Description in vivo*: See Braun (1995).

*Specimens examined*: **Austria**, Krems, on *Solidago virgaurea*, 1871 [Thüm., Fungi Austr. Exs. 1072] (**lectotype** K). **Brazil**, Guimarania, Minas Gerais, on *Conyza canadensis*, unknown date, B.S. Vieira, culture CPC 19492. **South Korea**, Jinju, on *Erigeron annuus*, 1 Jul. 2004, H.D. Shin, cultures CPC 11456, CPC 11457, CPC 11460, CPC 11461; Namyangju, on *Erigeron annuus*, 9 Oct. 2002, H.D. Shin, cultures CPC 10286–10288; Chuncheon, on *Erigeron annuus*, 21 May 2003, H.D. Shin, culture CBS 113304.

*Notes*: *Cercosporella virgaureae* has a nearly circumglobal distribution and has been isolated from several hosts in the *Asteraceae* (Braun 1995), although it was originally described on *Solidago virgaurea*, Austria. Deighton (1973) reduced numerous *Cercosporella* species to synonymy with *C. virgaureae*. Kirschner (2009) collected representative strains of the type species of *Ramularia* (*R. pusilla*) and *Cercosporella* (*C. virgaureae*) and compared them based on LSU sequences, light microscopy and scanning electron microscopy, confirming them to represent two separate genera. The phylogenetic analysis in this study also supports the separation of *Cercosporella* (Fig. 1, clade X) from *Ramularia* (Fig. 1, clade XIV).

**Clade XI: *Ramulariopsis*** Speg., Anales Mus. Nac. Hist. Nat. Buenos Aires 20(13): 421 [ser. 3, 13]. 1910. Fig. 9.

Phytopathogenic on vascular plants and usually forming leaf spots. *Mycelium* internal. *Conidiophores* fasciculate, arising through stomata or erumpent, hyaline, septate, thin-walled, smooth, simple or often branched. *Conidiogenous cells* integrated, terminal, intercalary as well as pleurogenous (as short nodulose protuberances or subcylindrical branchlets), polyblastic, sympodial, with thickened and darkened conidiogenous loci. *Conidia* catenate, in simple as well as branched chains, ellipsoid-ovoid, subcylindrical-fusiform, 0–1- to multi-euseptate, thin-walled, hyaline, with thickened and darkened hila; conidial secession schizolytic. Description adapted from Braun (1998).

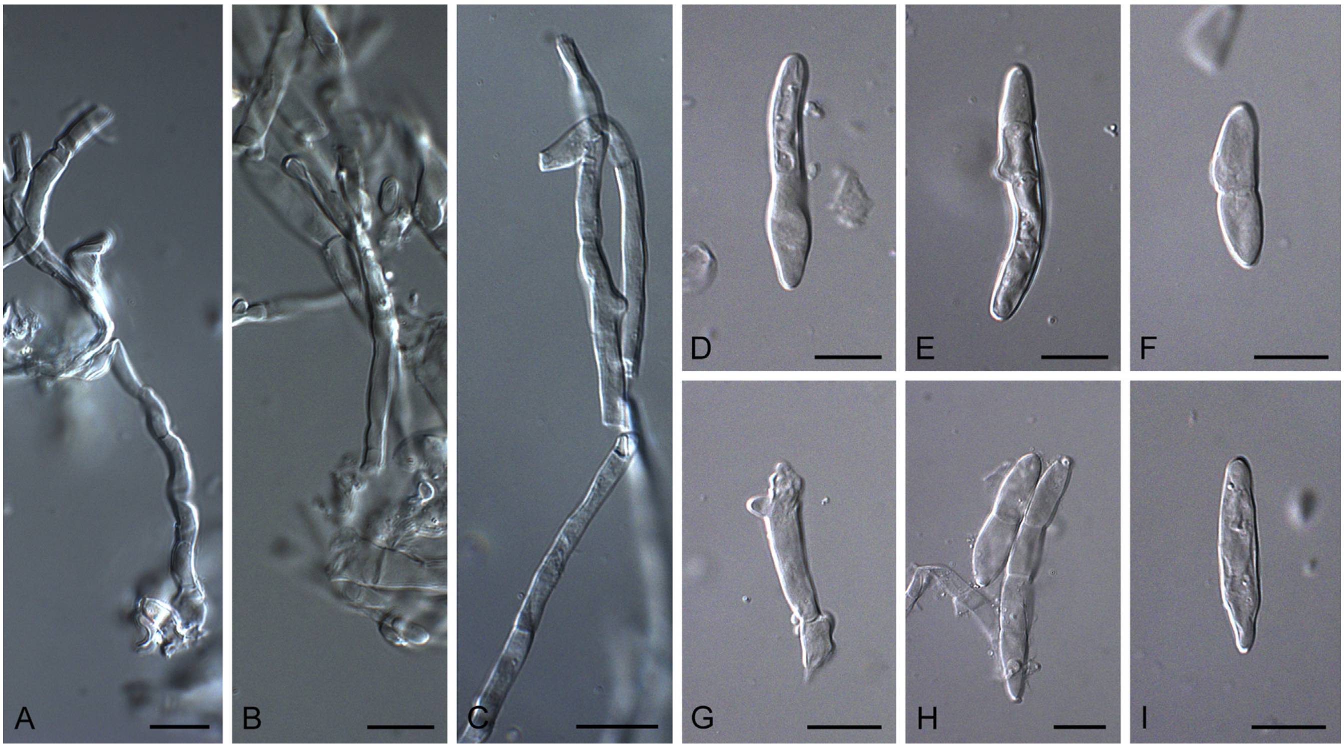

**Fig. 9.** *Ramulariopsis cnidoscoli* (LPS herbarium N°12.850, type specimen). A–C. Conidiophores. D–F, H, I, Conidia. G. Conidiogenous cell. Scale bars = 10 µm.

*Type species*: *Ramulariopsis cnidoscoli* Speg.

*Specimen examined*: **Argentina**, Salta, Orán, on *Cnidoscolus vitifolius* var. *cnicodendron* (= *C. cnicodendron*), Apr. 1905, C. Spegazzini (**lectotype**, designated by Deighton 1972, LPS 12.850) (Fig. 9).

*Notes*: *Ramulariopsis* species have frequently branched conidiophores with integrated, terminal, intercalary and pleurogenous conidiogenous cells with thickened and darkened conidiogenous loci. The conidia are catenate in simple or branched chains. *Ramularia* is very similar to the present genus, but differs in having simple conidiophores with consistently terminal conidiogenous cells. *Ramulariopsis* was described by Spegazzini (1910) and emended by Deighton (1972). The type species, *R. cnidoscoli*, was collected on *Cnidoscolus vitifolius* in Argentina, and is only known from herbarium material (Fig. 9). This genus currently accommodates four species (Seifert *et al.* 2011) that are phytopathogenic, and usually cause leaf spots (Braun 1998). The most widespread and economically important species is *R. gossypii*, known to be the causal agent of areolate mildew of cotton.

***Ramulariopsis gossypii*** (Speg.) U. Braun, Nova Hedwigia 56: 432. 1993. Fig. 10.

*Basionym*: *Cercosporella gossypii* Speg., Anales Soc. Ci. Argent. 22(4): 208. 1886.

≡ *Ramularia gossypii* (Speg.) Cif., Quad. Lab. Crittog. Ist. Bot. Univ. Pavia 19: 124. 1962.

≡ *Septocylindrium gossypii* (Speg.) Subram., Hyphomycetes (New Delhi): 309. 1971.

= *Ramularia areola* G.F. Atk., Bot. Gaz. 15: 168. 1890.

= *Mycosphaerella areola* Ehrlich & F.A. Wolf, Phytopathology 22: 238. 1932.

*Description in vivo*: See Braun (1998: 314).

*Mycelium* composed of hyaline, septate, branched hyphae, 1–3 µm diam. *Conidiophores* hyaline, thin-walled, smooth, erect, subcylindrical to geniculate-sinuous, simple or sometimes branching from the base to the apex, septate, (18–)27–35(–46) × (1.5–)2–3 µm. *Conidiogenous cells* hyaline, smooth, integrated, terminal or pleurogenous, formed as short lateral branchlets, subcylindrical to geniculate-sinuous, (15–)17–19(–20) × (2–)2.5–3 µm, with conidiogenous loci slightly thickened and darkened. *Ramoconidia* hyaline, thin-walled, smooth, subcylindrical-fusiform, 0–3-septate, (12–)16–19(–23) × (1.5–)2–3(–4) µm. *Intercalary conidia* hyaline, smooth, fusiform, 0–3-septate, (7.5–)11.5–13(–17) × (1.5–)2–3 µm. *Terminal conidia* hyaline, smooth, catenate, 0–1-septate, fusiform, obovoid, (3–)9–11(–16) × (1–)2–3(–4) µm, hila slightly thickened and darkened.

*Culture characteristics*: On MEA, 8 mm diam, surface raised, lumpy, hairy, iron-grey and olivaceous grey, with margins crenate, convex, colony reverse iron-grey and olivaceous grey; on OA, 8 mm diam, surface irregular, patches with pale olivaceous grey erumpent mycelium and others naked and iron-grey, with margins undulate, with sparse mycelium and hazel, colony reverse olivaceous grey; on PDA, 8 mm diam, surface raised, lumpy, hairy in the centre with iron-grey and pale olivaceous grey patches, with margins crenate and convex, colony reverse olivaceous grey.

*Specimens examined*: **Brazil**, Paraguari, on *Gossypium* sp., May 1883, Balansa 3856 (**lectotype,** designated in Braun (1998), LPS). **Brazil**, on *Gossypium* sp., Oct. 2000, collector unknown (**epitype designated here** CBS H-22535, MBT204824, culture ex-epitype CBS 141099 = CPC 25909).

*Notes*: *Ramulariopsis gossypii* is the causal agent of a major disease of cotton known as cotton areolate mildew. In countries like Madagascar and India, yield losses due to the disease can reach up to 60 % of the crop (Kirkpatrick & Rothrock 2001). In Brazil it was considered a minor disease but the expansion of the cultivated area on cotton and the introduction of susceptible varieties increased the disease incidence and yield losses now reach 30 % of crop production (Lima *et al.* 2010). *Ramulariopsis*

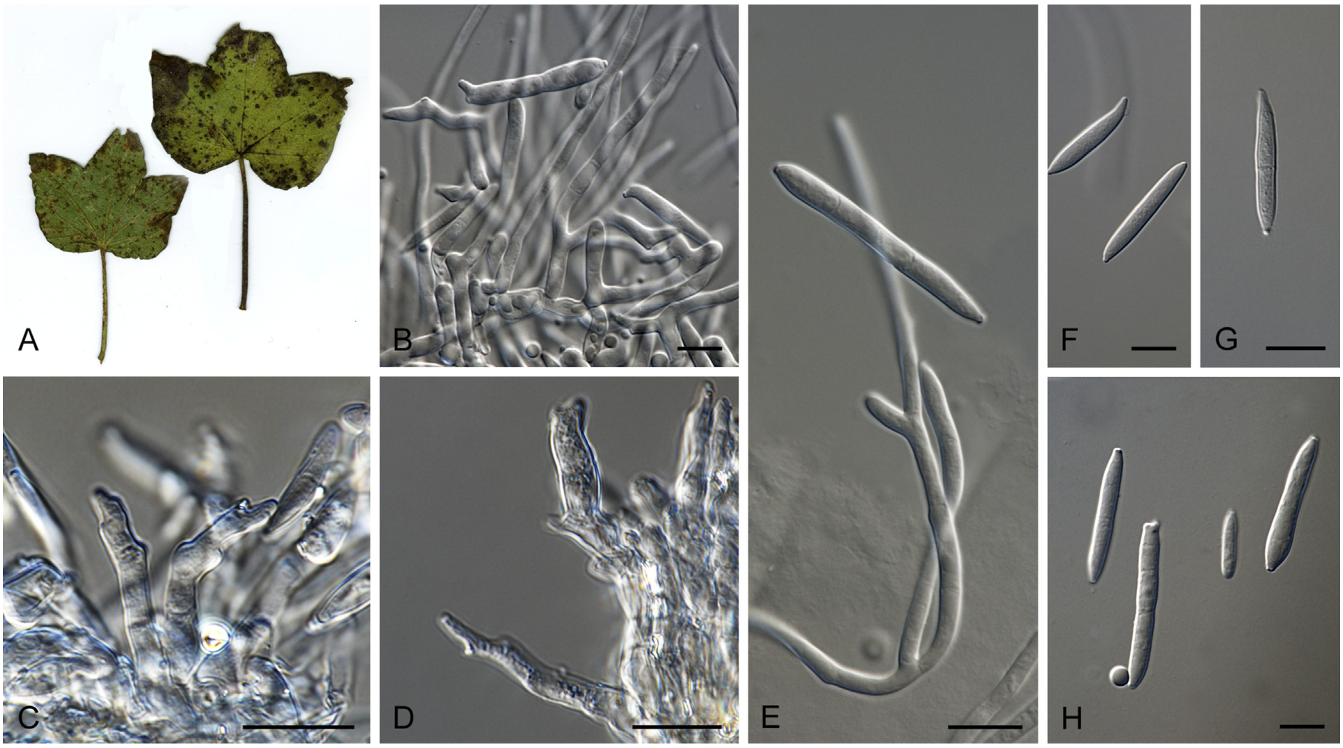

**Fig. 10.** *Ramulariopsis gossypii* (CBS 141099). A, C, D. Observations from herbarium material. B, E–H. Structures formed in culture. A. Leaf spot symptoms on the host. B, E. Conidiophores and conidia. C, D. Conidiophores. F–H. Conidia. Scale bars = 10 µm.

*gossypii* was originally described on *Gossypium* sp. from Brazil (lectotype in LPS) but the species has a worldwide distribution wherever cotton is cultivated (Braun 1998). Therefore, strain CPC 25909, which is from the same host and country and conforms to the morphological description of this species (Fig. 10), is herewith designated as epitype. This species is represented by a single lineage in the phylogenetic analysis (Fig. 1, clade XI).

***Ramulariopsis pseudoglycines*** Videira, Crous & Braun, **sp. nov.** MycoBank MB816926. Fig. 11.

*Etymology*: Named after its morphological similarity to the species *Ramulariopsis glycines*.

*Mycelium* composed of hyaline, septate, branched, hyphae, 1.5–3 µm diam. *Conidiophores* hyaline, thin-walled, smooth, erect, subcylindrical to geniculate-sinuous, simple or sometimes branching from the base to the apex, septate, (67–)121–175(–226) × 2 µm. *Conidiogenous cells* hyaline, smooth, terminal or formed as short lateral branchlets, subcylindrical to geniculate-sinuous, sometimes integrated in the mycelium, pleurogenous, (14–)21–25(–33) × (1.5–)2(–3) µm, with conidiogenous loci slightly thickened and darkened. *Ramoconidia* hyaline, smooth, 0–3-septate, (9–)14–17(–21) × (2–)2.5–3 µm. *Intercalary conidia* hyaline, smooth, fusiform, 0–2-septate, (7–)12–15(–23) × (1.5–)2–3(–3.5) µm. *Terminal conidia* hyaline, smooth, catenate, aseptate, fusiform to obovoid, (4.5–)6.5–8(–12) × (2–)2.5–3 µm; hila slightly thickened and darkened.

*Culture characteristics*: On MEA, 10 mm diam, surface raised, lumpy, smooth, pale olivaceous grey with whitish areas, with margins undulate and fimbriate, colony reverse iron-grey; on OA, 10 mm diam, surface low convex, smooth, smoke grey in the centre and a pale olivaceous margin, with margins entire, colony reverse iron-grey; on PDA, 10 mm diam, surface low convex, lumpy, olivaceous grey with pale olivaceous grey patches, with margins undulate, colony reverse olivaceous grey.

*Specimens examined*: **Brazil**, on *Gossypium* sp., 2000, unknown collector (**holotype** CBS H-22546, culture ex-type CBS 141100 = CPC 18242); *idem*. CPC 18241. **Togo**, Kara region, on *Gossypium barbadense*, 31 Oct. 2011, M. Piatek, culture CPC 20036.

*Notes*: These strains were initially identified as *R. gossypii* but observations of the conidiogenous structures in culture and in the herbarium specimen revealed this species to have very long conidiophores, rather similar to *Ramulariopsis glycines* but much longer (Fig. 11). *Ramulariopsis glycines*, however, was originally described from *Glycine javanica*, Zambia, and has not been previously reported on *Gossypium* from Brazil (Braun 1998). This species clade is highly supported by the phylogenetic analysis (Fig. 1, clade XI, 1/100/100).

**Clade XII: *Pseudocercospora*** Speg., Anales Mus. Nac. Buenos Aires, Ser. 3, 20: 437. 1910.

*Notes*: *Pseudocercospora* was established by Spegazzini (1910) to accommodate species that produce pigmented conidiophores and conidia with neither thickened nor darkened conidiogenous loci and conidial hila (Braun 1995, Crous *et al*. 2013). The genus was based on the type species *P. vitis*, a foliar pathogen of grapevines, but also includes species that are endophytes or saprobes. The generic circumscription of *Pseudocercospora* has been emended in recent years due to the publication of DNA sequence data of various gene regions (Crous *et al*. 2000, 2001, 2013). Based on these studies the genera *Cercostigmina*, *Phaeoisariopsis* and *Pseudophaeoramularia* have been reduced to synonymy under *Pseudocercospora* and the name *Pseudocercospora* was conserved over *Stigmina*, which represented an older generic name (Braun & Crous 2006).

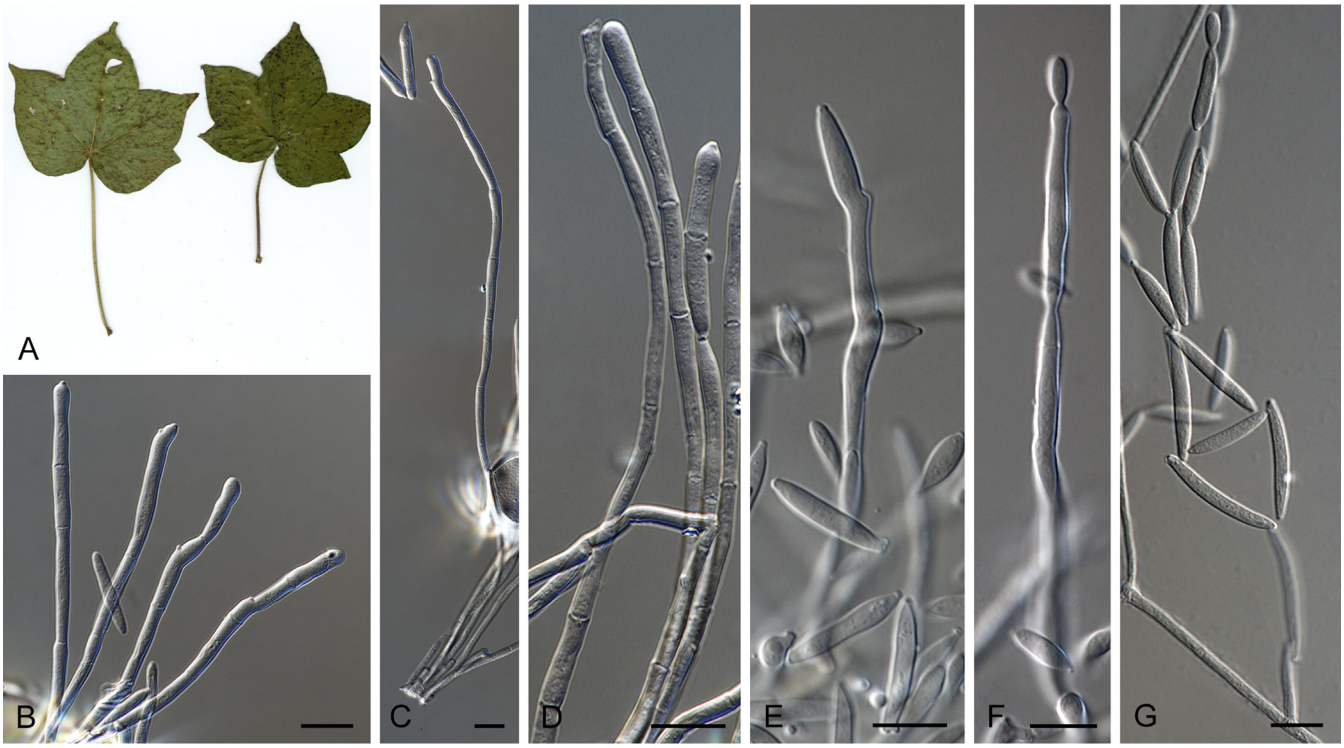

**Fig. 11.** *Ramulariopsis pseudoglycines* (CBS 141100). A–D. Observations from herbarium material. E–G. Structures formed in culture. A. Leaf spot symptoms on the host. B–G. Conidiophores, conidiogenous cells and conidia. Scale bars = 10 µm.

**Clade XIII: *Pallidocercospora*** Crous, Stud. Mycol. 75: 73. 2013.

*Note*: See Crous *et al.* (2013).

**Clade XIV: *Ramularia*** Unger, Exanth. Pflanzen (Wien): 169. 1833. emend. U. Braun (nom. cons.).

= *Didymaria* Corda, Icon. fung. (Prague) 5: 9. 1842.
≡ *Septocylindrium* Bonord. ex Sacc., Michelia 2: 15. 1880.
= *Acrotheca* Fuckel, Jahrb. Vereins Naturk. Herzogth. Nassau 15: 43. 1860.
= *Phacellium* Bonord., in Rabenh., Fungi Eur. Exs., Edn. 2, ser. 2: no. 288. 1860.
= *Ovularia* Sacc., Michelia 2: 17. 1880.
= *Ophiocladium* Cav., Z. Pflanzenkrankh. 3: 26. 1893.
= *Pseudovularia* Speg., Anales Mus. Nac. Buenos Aires, Ser. 3, 20: 418. 1910.

For additional synonyms see Braun (1998).

Mostly phytopathogenic (leaf spots, chlorosis or necrosis), sometimes saprobic or mycophylic. *Conidiophores* individual or synnematous, sometimes forming small to sporodochial caespituli, emerging through stomata or through the cuticle, straight, subcylindrical to geniculate-sinuous, continuous or septate, hyaline or in some species with a faintly reddish tinge, occasionally branched, thin-walled, usually smooth but rarely rough. *Conidiogenous cells* integrated, terminal, polyblastic, sympodially elongating, straight to geniculate-sinuous, conidiogenous loci conspicuously thickened, darkened and refractive, coronate (cladosporoid). *Conidia* consistently solitary or in simple or branched chains, solitary conidia 0–1-septate, catenate conidia aseptate to multiseptate (mostly 1–4 eusepta), hyaline, in a few species with a faintly reddish tinge, usually ellipsoid-ovoid, cylindrical-fusiform, rarely filiform, occasionally constricted at the septa, thin-walled, smooth to verruculose-echinulate, hila distinct, slightly to conspicuously thickened, darkened, refractive; conidial secession schizolytic.

*Type species*: *Ramularia pusilla* Unger.

*Notes*: The genus *Ramularia* was described by Unger (1833) to include two species *R. pusilla* and *R. didyma*, of which *R. pusilla* on *Poa nemoralis*, Austria, was later designated as lectotype (Unger 1836). The confused taxonomic history of *Ramularia* has been addressed by several authors (Hughes 1949, Braun 1988, Sutton & Waller 1988), and the genus was monographed by Braun (1995, 1998). *Ramularia* species are usually described as hyphomycetes with hyaline conidiophores and conidia with distinct, thickened, darkened and refractive conidial loci and hila. Braun (1998) divided the genus *Ramularia* in two morphologically circumscribed subgenera, one with conidia consistently solitary (*Ramularia* subgen. *Ramularia*) and another with catenate conidia (*Ramularia* subgen. *Septocylindrium*, type species *R. septata*). Within *Ramularia* subgen. *Ramularia*, two sections were established, one with conidiogenous cells straight to geniculous-sinuous (Sect. *Ramularia*, type *Ramularia pusilla*) and one with conidiogenous cells strongly curved like a swan's neck (Sect. *Ophiocladium*, type species *R. collo-cygni*).

*Ramularia* species are phytopathogenic and mostly cause leaf spots but they can also be endophytic, saprophytic and mycophylic. There are about 325 species accepted in this genus (Braun 1998, or MycoBank) of which only six have thus far been experimentally linked to a *Mycosphaerella* sexual morph (Videira *et al.* 2015b). Currently *Ramularia* is accepted as being a host-specific genus of phytopathogenic fungi (Braun 1998), although some exceptions are known (e.g. *R. vizellae*, Videira *et al.* 2015b).

*Phacellium* was described by Bonorden (1861) and currently includes 27 species (Braun 1998, Seifert *et al.* 2011 or MycoBank). The type species, *Ph. alborosellum* (Fig. 12) was described from *Cerastium holosteoides* in France and is

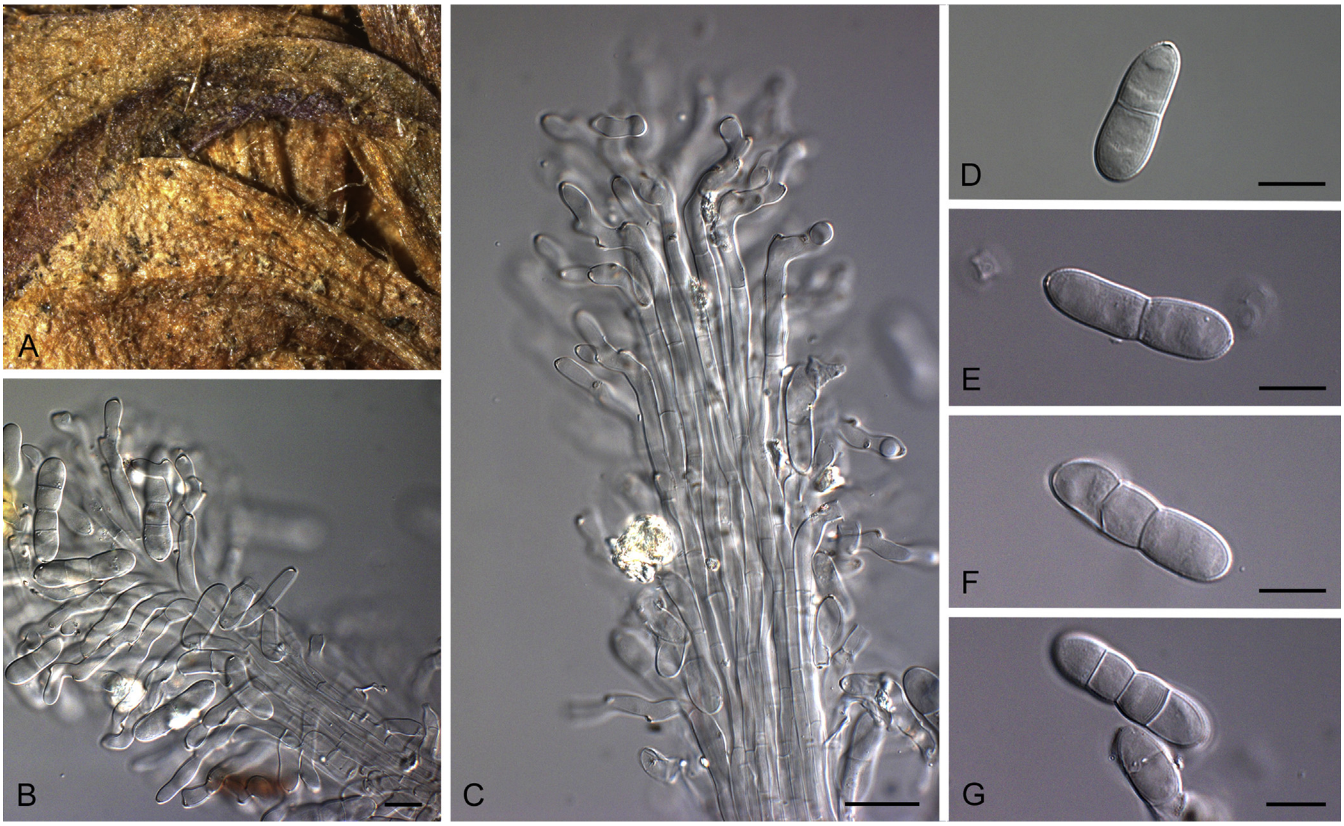

**Fig. 12.** *Phacellium alborosellum* (PC herbarium PC0084649, type specimen). A. Disease symptom on host leaf. B, C. Synnematous conidiophores, conidiogenous cells and conidia. D–G. Single and multiseptate conidia. Scale bars = 10 µm.

characterised by forming synnematous conidiomata that can be hyaline or slightly pigmented. The *Phacellium* strains in this study cluster within *Ramularia* (Fig. 1, clade XIV; Fig. 2, clade 64, clade 82) and a new *Ramularia* species that forms synnemata is described (Fig. 2, clade 76). These results support the hypothesis that, as in *Pseudocercospora*, synnematous conidiophores is a feature that is unreliable at generic level. Therefore, the genus *Phacellium* is tentatively synonymised with *Ramularia* until the exact phylogenetic position of its type species becomes known.

**Clade XV: *Xenoramularia*** Videira, H.D. Shin & Crous, **gen. nov.** MycoBank MB816822.

*Etymology*: Named after its morphological similarity to the genus *Ramularia*, composed of xeno- (xenos, Greek for strange) and the latter genus name.

Phytopathogenic, causing leaf spots. *Mycelium* composed of hyaline, septate, branched hyphae. *Conidiophores* hyaline to pigmented, solitary, simple, straight or slightly curved, often reduced to conidiogenous cells, thin-walled, smooth. *Conidiogenous cells* hyaline, integrated in the mycelium or terminal in the conidiophores, subcylindrical to geniculate-sinuous, with one or multiple thickened but not darkened conidiogenous loci. *Conidia* hyaline, thin-walled, smooth, formed singly or catenate, aseptate or 1-septate, subcylindrical, apex obtuse to subacute, base truncate; hila thickened but not darkened.

*Type species*: *Xenoramularia polygonicola* Videira, H.D. Shin & Crous.

*Notes*: The genus *Xenoramularia* (Fig. 1, clade XV, 0.59/–/–) is very close to *Zymoseptoria* (Fig. 1, clade XVI, 0.92/–/–) and their individual support by the phylogeny is low but they are maintained apart due to morphological differences. Morphologically *Xenoramularia* is similar to *Ramularia* but can be distinguished by the following set of characters: it tends to have reduced conidiophores that are mostly solitary (always solitary in culture, rarely with weakly developed fascicles on host tissue), hyaline, but at times somewhat pigmented, and conidial hila and conidiogenous loci that are thickened, but not darkened and refractive as in *Ramularia*.

***Xenoramularia arxii*** Videira & Crous, **sp. nov.** MycoBank MB816927. Fig. 13.

*Etymology*: Named after Josef Adolf von Arx, who collected this species.

*Mycelium* consisting of hyaline, septate, branched hyphae, 1–3 µm diam. *Conidiophores* reduced to conidiogenous cells. *Conidiogenous cells* integrated in the mycelium, hyaline, thin-walled, smooth, subcylindrical, (4–)8–10(–14) × 1.5–2 µm, with single or multiple conidiogenous loci that are thickened but not darkened. *Conidia* formed singly, aseptate or 1-septate, hyaline, thin-walled, smooth, subcylindrical, with a rounded apex and an acute base, (5–)9–12(–21) × (1.5–)2(–3) µm; hila thickened but not darkened.

*Culture characteristics*: On MEA, 47 mm diam, surface raised, smooth mycelium, white with buff tinge with margins entire and feathery, colony reverse iron grey in the centre and ochreous towards the margin; on OA, 45 mm diam, surface flat, feathery white mycelium in the centre becoming sparse and hazel towards the margin, margin undulate, almost naked, colony reverse hazel; on PDA, 50 mm diam, surface low convex, centre

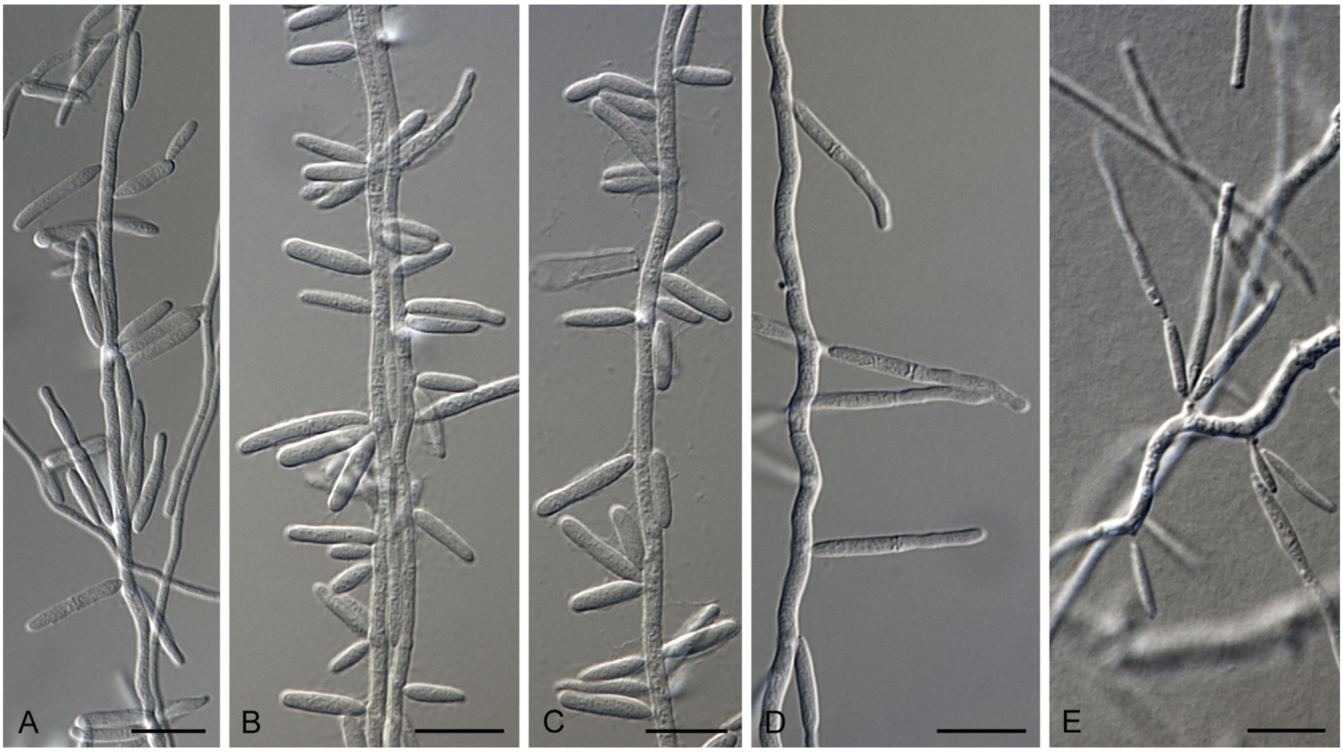

**Fig. 13.** *Xenoramularia arxii* (CBS 342.49). A–E. Conidiogenous cells and conidia formed in culture. Scale bars = 10 µm.

white turning pale olivaceous grey and erumpent towards the margin, with margin olivaceous grey and sparse mycelium, colony reverse olivaceous black in the centre and olivaceous towards the buff margin.

*Specimen examined*: **Netherlands**, Utrecht Prov., Baarn, Eemufer, on leaf spot of *Acorus calamus*, 5 Sep. 1949, J.A. von Arx (**holotype** CBS H-4925, culture ex-type CBS 342.49).

*Notes*: *Xenoramularia arxii* (Fig. 13) forms a basal single lineage to other taxa in the genus (Fig. 1, clade XV), but is retained in *Xenoramularia* as it is morphologically similar. For a morphological comparison see notes under *X. polygonicola*.

***Xenoramularia neerlandica*** Videira & Crous, **sp. nov.** MycoBank MB816928. Fig. 14.

*Etymology*: Named after the country from where it was collected, the Netherlands.

*Mycelium* consisting of hyaline, septate, branched, hyphae, 0.5–1 µm diam. *Conidiophores* reduced to conidiogenous cells. *Conidiogenous cells* integrated in the mycelium, hyaline, thin-walled, smooth, subcylindrical, (8–)11–13.5(–16) × (1–)1.5(–2) µm, with single or multiple conidiogenous loci that are thickened but not darkened. *Conidia* formed singly or catenate and ramoconidia scarce. *Ramoconidia* hyaline, thin-walled, smooth, aseptate or 1-septate, subcylindrical to fusiform, (9–)13.5–18(–23) × (0.5–)1(–1.5) µm. *Intercalary conidia* hyaline, smooth, aseptate or 1-septate, subcylindrical to fusiform, (7–)10–12(–19) × (0.5–)1 µm. *Terminal conidia* hyaline, smooth, aseptate or 1-septate, subcylindrical to fusiform, (3–)11–17(–32) × (0.5–)1(–2) µm; hila thickened but not darkened.

*Culture characteristics*: On MEA, 20 mm diam, surface raised, smooth, white with pale grey and olivaceous grey tinge, margins undulate, colony reverse olivaceous grey; on OA, 22 mm diam, surface with fluffy mycelium pale grey and olivaceous grey, margins undulate and with sparse aerial mycelium, reverse iron-grey; on PDA, 18 mm diam, surface flat, smooth aerial mycelium, centre white turning pale olivaceous grey towards the margin, margin undulate with sparse mycelium, reverse olivaceous grey.

*Specimens examined*: **Netherlands**, Utrecht Prov., Breukelen, on *Sparganium ramosum*, Sep. 2003, W. Gams, culture CBS 113615; Utrecht, De Uithof, on *Iris pseudacorus*, 26 Jun. 2006, P.W. Crous (**holotype** CBS H-22540, culture ex-type CBS 141101 = CPC 18377); *idem*. CPC 18378.

*Notes*: *Xenoramularia neerlandica* (Fig. 14) is highly supported in the phylogenetic analysis (Fig. 1, clade XV, 1/100/100). For morphological comparison with the other species in this genus see notes under *X. polygonicola*.

***Xenoramularia polygonicola*** Videira, H.D. Shin & Crous, **sp. nov.** MycoBank MB 816929. Fig. 15.

*Etymology*: Named after the host genus from which it was described, *Polygonum.*

*Mycelium* consisting of hyaline, septate, branched, hyphae, 0.5–1 µm diam. *Conidiophores* hyaline, thin-walled, smooth, solitary, simple, sometimes branched, straight to slightly curved, sometimes reduced to conidiogenous cells, (13.5–)23–29(–42) × (0.5–)1 µm. *Conidiogenous cells* integrated in the mycelium, lateral or terminal in the conidiophores, subcylindrical to geniculate-sinuous, (6.5–)9–11(–17) × (0.5–)1 µm, with conidiogenous loci thickened but not darkened. *Conidia* formed singly or catenate, but no ramoconidia were observed. *Intercalary conidia* hyaline, smooth, subcylindrical, aseptate or 1-septate, (6–)8.5–11(–16) × (0.5–)1 µm. *Terminal conidia* hyaline, smooth, formed singly or catenate, aseptate or 1-septate,

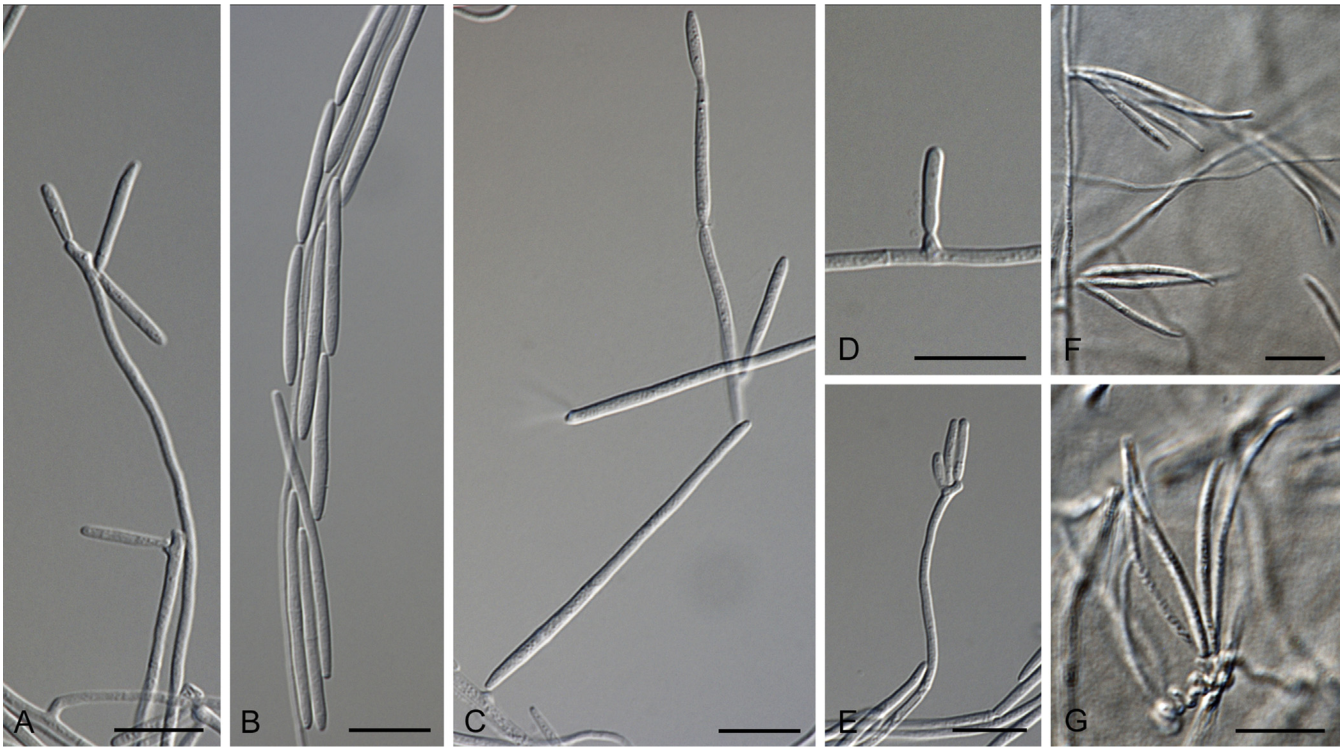

**Fig. 14.** *Xenoramularia neerlandica* (CBS 113615). A–G. Structures formed in culture. A, C–G. Conidiogenous cells and conidia. B. Conidia. Scale bars = 10 µm.

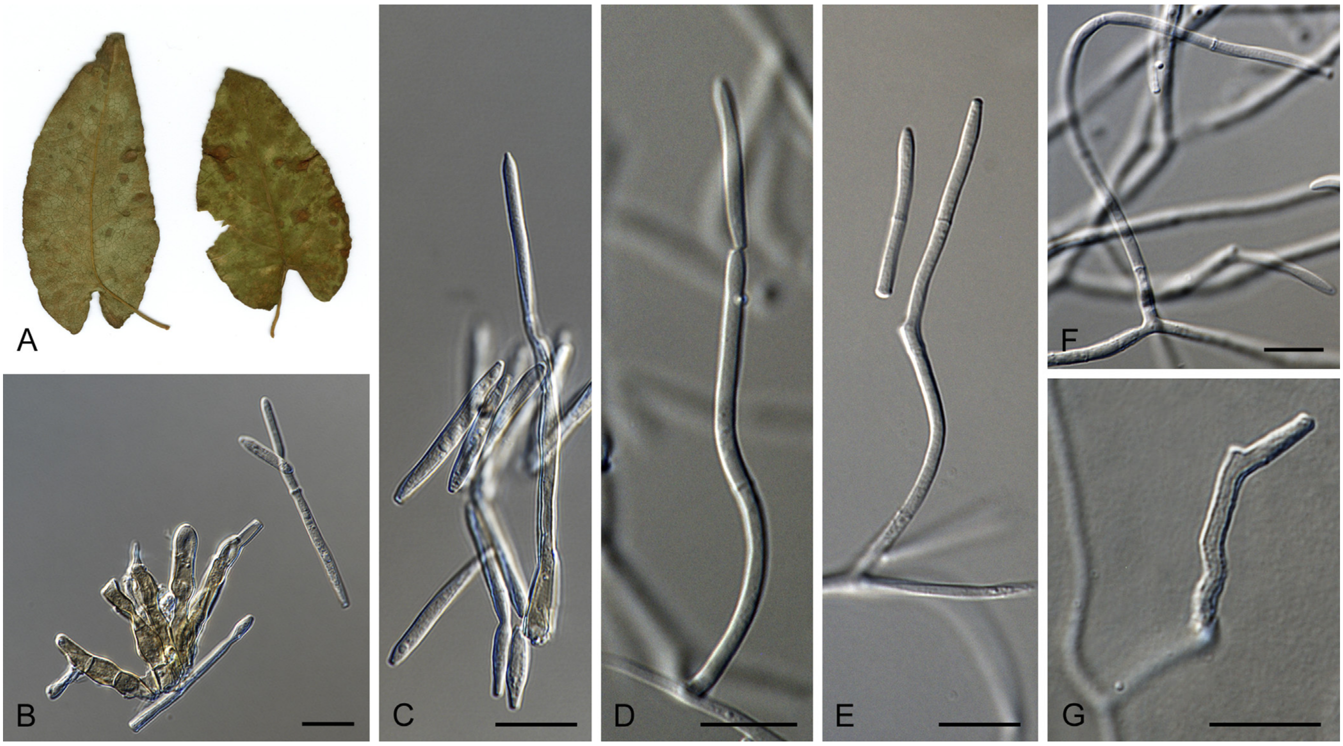

**Fig. 15.** *Xenoramularia polygonicola* (CBS 141102). A–C. Observations from herbarium material. D–G. Structures formed in culture. A. Leaf spot symptoms on host. B–F. Conidiophores, conidiogenous cells and conidia. G. Conidiophore. Scale bars = 10 µm.

subcylindrical, apex obtuse to subacute, base truncate, (4–)6.5–8(–11) × (0.5–)1 µm; hila thickened but not darkened.

*Culture characteristics*: On MEA, 8 mm diam, surface raised, lumpy, smooth mycelium, pale olivaceous grey, with margins undulate, buff, convex, colony reverse iron grey; on OA, 8 mm diam, surface flat, smooth mycelium, pale olivaceous grey, with margins entire, with sparse aerial mycelium, colony reverse olivaceous grey; on PDA, 10 mm diam, surface low convex, smooth, grey olivaceous, radially striated and cutting into the agar, with margins undulate, convex and buff, colony reverse olivaceous grey.

*Specimens examined*: **South Korea**, Pyeongchang, on *Polygonum* sp., 20 Sep. 2003, H.D. Shin (**holotype** KUS-F19688, isotype CBS H-22541, culture ex-type CBS 141102 = CPC 10852); *idem*. CPC 10853, CPC 10854.

*Notes*: The species *X. polygonicola* is highly supported in the phylogenetic analysis (Fig. 1, clade XV, 1/100/100).

*Xenoramularia polygonicola* (Fig. 15) forms conidiophores while *X. arxii* (Fig. 13) and *X. neerlandica* (Fig. 14) have conidiophores reduced to conidiogenous cells. *Xenoramularia polygonicola* and *X. arxii* do not produce ramoconidia and in *X. neerlandica* they were rarely observed. *Xenoramularia polygonicola* and *X. neerlandica* produce both single and catenate conidia while *X. arxii* produces only single, wider conidia.

**Clade XVI: *Zymoseptoria*** Quaedvl. & Crous, Persoonia 26: 64. 2011.

*Note*: See Quaedvlieg *et al.* (2011) and Stukenbrock *et al.* (2012).

**Clade XVII: *Dothistroma*** Hulbary, Bull. Illinois Nat. Hist. Surv. 21: 235. 1941.

*Note*: See Barnes *et al.* (2004).

**Clade XVIII: *Stromatoseptoria*** Quaedvl., Verkley & Crous, Stud. Mycol. 75: 353. 2013.

*Note*: See Quaedvlieg *et al.* (2013).

**Clade XIX: *Pseudocercosporella*** Deighton, Mycol. Pap. 133: 38. 1973.

*Colonies in vivo*. *Mycelium* consisting of hyaline to pale brown, septate and smooth hyphae. *Conidiophores* solitary to fasciculate, emerging through stomata or through the cuticle, arising from inner hyphae or from stromata, sometimes arising from superficial hyphae or forming subglobose sporodochia, aseptate or septate, straight and subcylindrical to geniculate-sinuous, rarely branched, mostly hyaline but occasionally faintly pigmented, thin-walled, mostly more or less smooth. *Conidiogenous cells* integrated, terminal or conidiophores reduced to conidiogenous cells, mono- to polyblastic, sympodial; conidiogenous loci inconspicuous, unthickened and hyaline. *Conidia* formed singly, subcylindrical, filiform to obclavate, 1- multi-euseptate, hyaline, thin-walled, mostly smooth, apex obtuse to subacute, base subtruncate, hilum unthickened, not darkened nor refractive. Adapted from Frank *et al.* (2010).

*Type species*: *Pseudocercosporella bakeri* (Syd. & P. Syd.) Deighton (= *Pseudocercosporella ipomoeae* Deighton).

*Notes*: *Pseudocercosporella* was described by Deighton (1973), and is characterised by solitary conidia, rarely in chains, with unthickened, inconspicuous conidial loci (Braun 1995). Braun (1990) confined *Pseudocercosporella* to species with solitary conidia and the species with catenate conidia were transferred to *Thedgonia*. However, the conidial ontogeny in *Thedgonia* is thallic (i.e. conidia form in disarticulating chains) while the species in question had polyblastic conidiogenesis and conidia in acropetal chains (Crous *et al.* 2009a). Braun (1995) placed these species back in *Pseudocercosporella* under a different subgenus: *Pseudocercosporella* subgen. *Pseudocercocatenella* (type: *Pseudocercosporella dioscoriae*). Braun (1995) also established another subgenus based on morphology to include species with superficial secondary mycelium and solitary conidiophores: *Pseudocercosporella* subgen. *Cercovellosiella* (type: *Pseudocercosporella crataegi*). The type species *Pseudocercosporella bakeri* (= *P. ipomoea*) has recently been epitypified (on *Ipomoeae* sp., Philippines, ex-epitype culture CBS 125685; Frank *et al.* 2010) and forms a single species clade (Fig. 1, clade XIX) that clusters close to *Dothistroma* (Fig. 1, clade XVII) and *Stromatoseptoria* (Fig. 1, clade XVIII). The pseudocercosporella-like morphology is polyphyletic (see Frank *et al.* 2010, Crous *et al.* 2011, 2012), and new taxonomically useful morphological features will need to be found to delineate all the genera presently accommodated in other clades.

**Clade XX: *Microcyclosporella*** J. Frank *et al.*, Persoonia 24: 101. 2010.

*Mycelium* consisting of pale brown, smooth to finely verruculose, branched, septate hyphae, sometimes covered in a mucoid layer. *Conidiophores* mostly reduced to conidiogenous cells. *Conidiogenous cells* integrated in hyphae, cylindrical to doliiform, pale brown to hyaline if occurring in yeast-like sectors of colonies, thin-walled, smooth, mono- or polyblastic, proliferating sympodially; conidiogenous loci lateral, inconspicuous, truncate, unthickened, not darkened. *Conidia* hyaline, thin-walled, smooth, subcylindrical to narrowly obclavate or narrowly fusoid with acutely rounded apex and obconically truncate base, guttulate, 0–6 transversely septate; microcyclic conidiation common. Adapted from Frank *et al.* (2010).

*Type species*: *Microcyclosporella mali* J. Frank, Schroers & Crous.

*Specimens examined*: **Slovenia**, Senozeti, Dolsko, on fruit surface *Malus domestica*, 7 Aug. 2007, J. Frank (**holotype** CBS H-20413, culture ex-type 300-07 = CBS 126136 = CPC 16184). **USA**, Georgia, Ellijay, on *Malus* sp., 29 Aug. 2005, M. Wheeler, culture CBS 125654; Illinois, Chester, on unknown host, Sep. 2000, J. Batzer, culture CBS 119461; Illinois Rockford, Illinois, on unknown host, Sep. 2000, J. Batzer, culture CBS 118960; Michigan, Fennville, on *Malus* sp., 1 Sep. 2005, G. Sundin, culture CBS 125653; Missouri, New Franklin, on unknown host, Sep. 2000, J. Batzer, culture CBS 118969; Ohio, Wooster on *Malus* sp., 5 Sep. 2005, M. Ellis, culture CBS 125651.

*Notes*: *Microcyclosporella* was described by Frank *et al.* (2010) to accommodate species with hyaline conidiophores and long scolecosporous conidia with inconspicuous conidiogenous loci and unthickened, non-pigmented hila, resembling *Pseudocercosporella*, but also displaying microcyclic conidiation. More work needs to be done in this genus since the variation observed in the phylogeny (Fig. 1, clade XX) indicates that more than one species may be present.

**Clade XXI: *Mycosphaerelloides*** Videira & Crous, **gen. nov.** MycoBank MB816819.

*Etymology*: Named after the morphological similarity to the genus *Mycosphaerella*.

*Ascomata* pseudothecial, single, black, immersed, becoming erumpent, globose, apical ostiole, wall with medium brown *textura angularis*. *Asci* aparaphysate, fasciculate, bitunicate, subsessile, obovoid to narrowly ellipsoid. *Ascospores*, straight to fusoid-ellipsoid, hyaline, guttulate, thin-walled, with subobtuse ends, medianly 1-septate, widest in the middle of the apical cell. *Ascospore germination* from both ends, with germ tubes parallel to the long axis of the spore. *Mycelium* consisting of smooth, branched, septate, pale to medium brown hyphae.

*Conidiomata* fasciculate, medium brown. *Conidiophores* arising from mycelium or from the upper cells of a brown stroma, pale to medium brown, smooth, unbranched or branched, subcylindrical, straight to variously curved. *Conidiogenous cells* terminal or lateral, solitary, pale brown, smooth, proliferating sympodially or percurrently; conidiogenous loci inconspicuous. *Conidia* smooth, subcylindrical, multiseptate; hila neither thickened nor darkened-refractive. Adapted from Crous *et al.* (2004b).

*Type species*: *Mycosphaerelloides madeirae* (Crous & Denman) Videira & Crous.

*Notes*: The strains in this genus represent a mycosphaerella-like species lacking a ramularia-like asexual morph, and also not being congeneric with *Ramularia* based on *R. pusilla* (Fig. 1, clade XIV). This monotypic genus is highly supported by the phylogenetic analysis (Fig. 1, clade XXI, 1/100/100).

***Mycosphaerelloides madeirae*** (Crous & Denman) Videira & Crous, **comb. nov.** MycoBank MB817150.

*Basionym*: *Mycosphaerella madeirae* Crous & Denman, Stud. Mycol. 50: 204. 2004.

*Specimens examined*: **Portugal**, Madeira, Party Farm, on leaves of *Eucalyptus globulus*, Apr. 2000, S. Denman (**holotype** CBS H-9898, culture ex-type CBS 112895 = CPC 3745); *idem*. CBS 112301 = CPC 3747. **Netherlands**, Utrecht, Soest, endophytic on green leaves of *Quercus robur*, 2002, G. Verkley, cultures CBS 115936, CBS 116068, CBS 116066.

*Notes*: *Mycosphaerelloides madeirae* was isolated from *Eucalyptus globulus* collected in Madeira (Portugal), and is very similar to *M. heimioides* (Crous 1998), but can be distinguished by its ascospore germination pattern as well as its cultural characteristics.

**Clade XXII: *Epicoleosporium*** Videira & Crous, **gen. nov.** MycoBank MB816817.

*Etymology:* Named after the host its type species was isolated from, *Coleosporium*.

Colonies growing on uredinia of *Coleosporium*, mycophylic. *Mycelium* superficial, consisting of hyaline, septate, thin-walled, smooth hyphae. *Conidiophores* hyaline, loose, straight, subcylindrical, unbranched, septate, thin-walled, smooth. *Conidiogenous cells* hyaline, terminal in the conidiophore, cylindrical-oblong, proliferation sympodial, with conspicuous conidiogenous loci, thickened, darkened and refractive. *Conidia* hyaline, smooth, solitary or in short chains, cylindrical-oblong, clavate, obovate, aseptate, thin-walled, smooth, with hila thickened, darkened and refractive.

*Type species: Epicoleosporium ramularioides* Videira, H.D. Shin & Crous.

*Notes*: This monotypic genus is highly supported by the phylogenetic analysis (Fig. 1, clade XXII, 1/100/100) and represents a mycophylic species that is ramularia-like in its morphology but is not congeneric with *Ramularia* based on *R. pusilla* (Fig. 1, clade XIV).

***Epicoleosporium ramularioides*** Videira, H.D. Shin & Crous, **sp. nov.** MycoBank MB816847. Fig. 16.

*Etymology:* Named after its morphological similarity with the genus *Ramularia.*

Colonies on uredinia of *Coleosporium*, mycophylic, whitish. *Mycelium* superficial, consisting of hyaline, septate, thin-walled, smooth hyphae, 1.5–2 μm diam. *Conidiophores* hyaline, loose, erect, straight, subcylindrical, unbranched, (37–)65–83(–129) × 2–3 μm, septate, thin-walled, smooth. *Conidiogenous cells* hyaline, integrated, terminal on the conidiophore, cylindrical-oblong, (9–)11–13(–15) × 1.5–2(–2.5) μm, conidiogenous loci thickened, darkened and refractive, 1 μm diam. *Conidia* hyaline, thin-walled, smooth, solitary or in short chains, cylindrical-oblong, clavate, obovate, aseptate, (6–)10–13(–21) × (2.5–)3–4(–5) μm, apex obtuse, base obtuse to slightly elongated, with hila thickened, darkened and refractive, 1 μm diam.

*Specimens examined*: **South Korea**, Pyeongchang, on *Coleosporium phellodendri* on leaves of *Phellodendron amurense*, 4 Sep. 2003, H.D. Shin (**holotype** KUS-F19603, isotype CBS H-22542, culture ex-type CBS 141103 = CPC 10672); *idem*. CPC 10673.

*Notes*: *Epicoleosporium ramularioides* is morphologically ramularia-like (Fig. 16) and represents another addition to the list of known mycophylic cercosporoid species. It differs from *R. coleosporii* that produces conidiophores occasionally branched, longer and wider [(20–)30–200(–270) × 3–6 μm]. In addition, the conidia of *R. coleospori* are catenate, ellipsoid-ovoid, smooth to rough, longer and wider [8–35(–45) × 3–8 μm] and 0–1(–3)-septate (Braun 1998). The development of the conidial structures of *E. ramularioides* in culture is unusual (Fig. 16).

**Clade XXIII: *Uwebraunia*** Crous & M.J. Wingf., Mycologia 88: 446. 1996.

*Note*: See Crous and Wingfield (1996) and Li *et al.* (2012).

**Clade XXIV: *Dissoconium*** de Hoog *et al.*, Proc. Kon. Ned. Akad. Wetensch. C 86(2): 198. 1983.

*Note*: See Crous *et al.* (1999), Jakson *et al.* (2004) and Li *et al.* (2012).

**Clade XXV: *Ramichloridium*** Stahel ex de Hoog, Stud. Mycol. 15: 59. 1977.

*Note*: See Arzanlou *et al.* (2007).

**Clade XXVI: *Acrodontium*** de Hoog, Stud. Mycol. 1: 23. 1972.

Saprobic or mycophylic. *Mycelium* consisting of subhyaline, brownish or olivaceous, smooth, thin-walled, septate hyphae. *Conidiophores* when present arising from hyphae, erect or procumbent, sometimes thick-walled and dark brown at the base, paler brown towards the apex, branched verticillately or dichotomously. *Conidiogenous cells* integrated, terminal in conidiophores and often forming whorls or conidiophores reduced to conidiogenous cells, arising from hyphae, basal part flask-

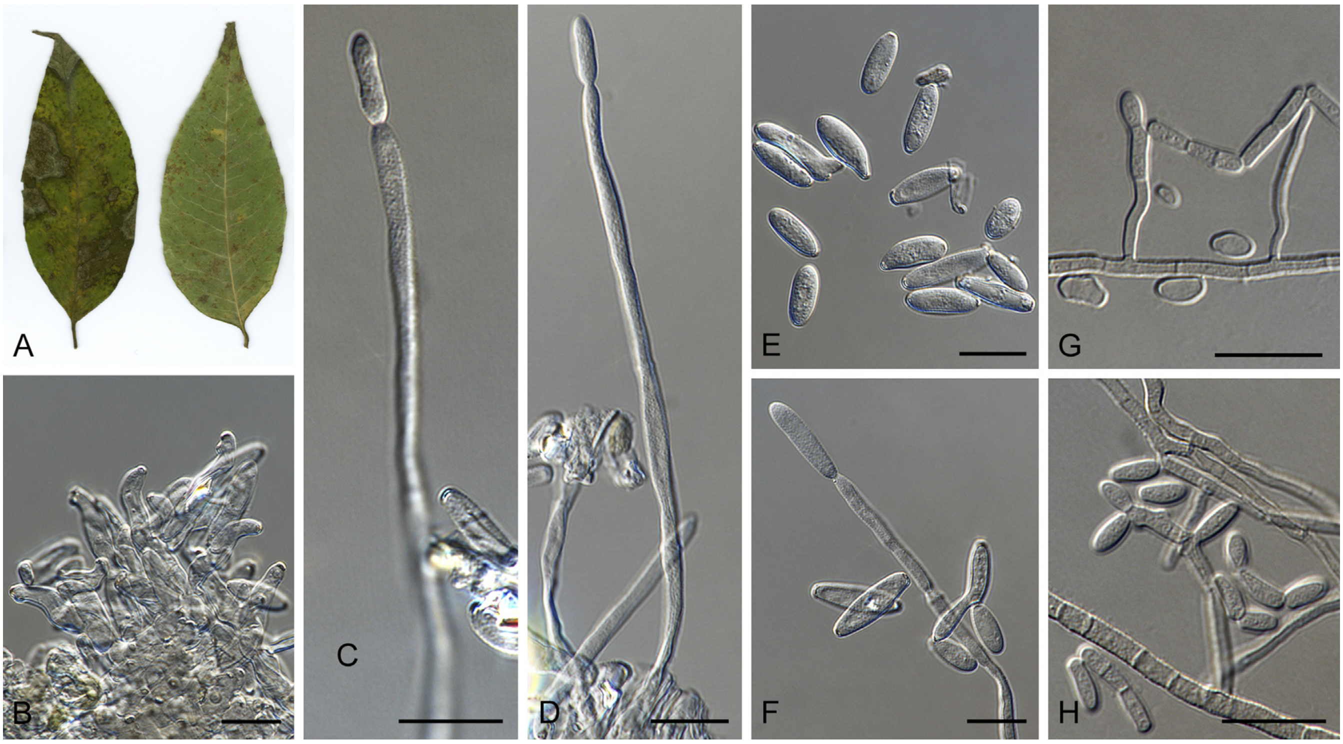

**Fig. 16.** *Epicoleosporium ramularioides* (CBS 141103). A–F. Observations from herbarium material. G, H. Structures formed in culture. A. Leaf spot symptoms on host. B. Conidiophores. C, D, F–H. Conidiophore and conidia. E. Conidia. Scale bars = 10 µm.

shaped or elongate, tapering towards the tip forming a sympodial denticulate rachis, straight to flexuous. *Conidia* formed singly, hyaline or pigmented, smooth, subglobose to fusiform, with an apiculate base. Adapted from De Hoog (1972).

*Type species*: *Acrodontium crateriforme* (J.F.H. Beyma) de Hoog.

*Notes*: The genus *Acrodontium* was introduced by De Hoog (1972), and currently accommodates 10 species varying in lifestyle from saprobic to mycophylic (Seifert *et al.* 2011). *Acrodontium* species have conidiogenous cells that bear conidia on a sympodially proliferating rachis, straight or slightly flexuous, bearing alternating denticles at regular intervals (De Hoog 1972). According to the present study, the type species of the genus, *A. crateriforme* (CBS 144.33), belongs to the *Teratosphaeriaceae* (Fig. 1, clade XXVI, 1/100/100). The LSU sequences of isolates belonging to *A. antarcticum*, *A. abietis*, *A. griseum*, *A. hydnicola*, *A. salmoneum*, *A. simplex* and *A. virelum* currently housed in the CBS collection (data not shown) place them in different orders (e.g. *Sordariomycetes* and *Leotiomycetes*) and will not be treated here.

***Acrodontium crateriforme*** (J.F.H. Beyma) de Hoog, Stud. Mycol. 1: 26. 1972. Fig. 17.
*Basionym*: *Chloridium crateriforme* J.F.H. Beyma, Zentralbl. Bakteriol., 2 Abt., 89: 241. 1933.

≡ *Tritirachium crateriforme* (J.F.H. Beyma) Matsush., Icon. microfung. Matsush. lect.: 160. 1975.
= *Acrodontium neolitseae* Crous & Summerell, Persoonia 32: 209. 2014.

Description *in vitro*: See De Hoog (1972: 26)

*Specimens examined*: **Australia**, Nightcap National Park, on *Neolitsea australiensis*, 9 Mar. 2013, B. Summerell, culture CBS 137975 = CPC 22172. **Germany**, Hesse, Schlangenbad, on leaves of *Betula* sp., 2012, W. Quaedvlieg, culture CPC 25895; on leaves of *Ranunculus* sp., 2012, W. Quaedvlieg, culture CPC 25894. **Java**, Tjibodas Hortus Botanicus, on leaf of *Citrus* sp., 1969, J.H. van Emden, culture CBS 842.71. **South Korea**, Hoengseong, on *Agrimonia pilosa*, 21 Ago. 2004, H.D. Shin, culture CPC 11519; Hongcheon, on *Fraxinus chinensis* subsp. *rhynchophylla* (≡ *F. rhynchophylla*), 11 Aug. 2004, H.D. Shin, culture CPC 11509. **Netherlands**, on foodstuff, unknown collector and date, isol. M. van Schothorst, dep. RIV, Bilthoven, Oct. 1971, culture CBS 840.71; Baarn, isolated from sputum, unknown collector and date, isol. G.A. de Vries, dep. Jul. 1958, culture CBS 151.58; Baarn, associated with *Tuberculina maxima*, unknown collector and date, isol. H.A. Diddens, dep. F.H. van Beyma, Jun. 1933 (culture ex-type CBS 144.33 = ATCC 15679 = MUCL 15748 = MUCL 8978). **UK**, Westmorland, Meathop Wood, on living leaflet of *Fraxinus excelsior*, unknown date, J.C. Frankland, culture CBS 985.70.

*Notes*: The recently described species *A. neolitseae* (CPC 22172) is 100 % identical to *A. crateriforme* on LSU but differs on 3 nucleotides on ITS and 7 nucleotides on *rpb2*. The morphological description of *A. neolitseae* also fits with *A. crateriforme* (Fig. 17) since this taxon can sometimes have slightly pigmented conidiophores and conidia. At the time *A. neolitsiae* was described, the ITS BLAST resulted in a 99 % similarity to a strain identified as *Pseudocercosporella fraxini* (GenBank GU214682; CPC 11509) and *Acrodontium crateriforme* (GenBank FN666566), which we show here to represent the same species (Fig. 1, clade XXVI). Since the strain CPC 11509 was not used in a morphological study before two scenarios are possible, namely that the fungus isolated from the specimen was the wrong one or that the culture was contaminated previous to storage and is no longer *P. fraxini* but *A. crateriforme*. The phylogenetic analysis strongly supports this species clade (Fig. 1, clade XXVI, 1/100/100).

***Acrodontium fagicola*** Videira & Crous, **sp. nov.** MycoBank MB817151. Fig. 18.

*Etymology*: Named after the host genus *Fagus*, from which it was collected.

**Fig. 17.** *Acrodontium crateriforme* (CBS 144.33). A–E. Structures formed in culture. A–D. Conidiophores, conidiogenous cells and conidia. E. Conidia. Scale bars = 10 µm.

*Mycelium* hyaline, consisting of septate, branched, smooth, 1–1.5 µm diam hyphae. *Conidiophores* reduced to conidiogenous cells. *Conidiogenous cells* hyaline, thin-walled, smooth, subulate to slightly ampulliform, sometimes with a transverse septum, straight to flexuous, proliferating sympodially and forming a rachis in the upper part, (16.5–)31–38(–61) × (1–)1.5–2 µm, with multiple conidiogenous loci slightly thickened but not darkened. *Conidia* hyaline, thin-walled, smooth, solitary, ellipsoid with obtuse apex, (2–)2.5–3 × 1.5–2 µm; hilum slightly thickened but not darkened.

*Culture characteristics*: On MEA, 10 mm diam, surface raised, smooth, with erumpent aerial mycelium, olivaceous, margins undulate, reverse sepia; on OA, 11 mm diam, surface raised, smooth, with erumpent aerial mycelium, olivaceous and sepia, margins undulate, reverse umber; on PDA, 10 mm diam, surface flat, smooth, with erumpent aerial mycelium, olivaceous and sepia, margins entire, reverse sepia.

*Specimen examined*: **Germany**, on *Fagus sylvatica*, isol. G. Arnold, Oct. 1978, dep. G. Arnold, Dec. 1979 (**holotype** CBS H-8534, culture ex-type CBS 714.79).

*Note*: This species is represented by a single lineage in the phylogenetic analysis (Fig. 1, clade XXVI) and differs from *A. crateriforme* by having longer conidiogenous cells and smaller conidia (Fig. 18).

***Acrodontium luzulae*** Videira & Crous, **sp. nov.** MycoBank MB816844. Fig. 19.

*Etymology*: Named after the host genus *Luzula*, from which the ex-type strain was collected.

*Mycelium* consisting of hyaline, septate, branched, smooth, 1–2 µm diam hyphae. *Conidiophores* reduced to conidiogenous cells. *Conidiogenous cells* hyaline, thin-walled, smooth, elongate ampulliform, straight to flexuous, proliferating sympodially and forming a rachis in the upper part, (23–)44–56(–98) × (1.5–)2(–3) µm, with multiple conidiogenous loci slightly thickened but not darkened. *Conidia* hyaline, thin-walled, smooth, solitary, ellipsoid with obtuse apex, (2.5–)3–4(–5) × (1–)2(–2.5) µm, hilum slightly thickened but not darkened.

*Culture characteristics*: On MEA, 10 mm diam, surface flat, smooth, with sparse erumpent aerial mycelium, buff, margins entire, reverse umber; on OA, 10 mm diam, surface flat, smooth, greyish sepia, margins undulate, reverse fawn; on PDA, 10 mm diam, surface flat, smooth, with sparse erumpent aerial mycelium, buff, margins entire, reverse sepia.

*Specimens examined*: **England**, Devon, East Lyn River, on dead leaf of *Luzula sylvatica*, unknown collector and date, isol. W. Gams, Sep. 1971, dep. Nov. 1971, (**holotype** CBS H-8529, culture ex-type CBS 839.71). **Netherlands**, Beerze, near Campina, on leaf of *Carex* sp., unknown collector and date, isol. W. Gams, Apr. 1968, dep. Nov. 1971, culture CBS 841.71.

*Notes*: Although initially identified as *A. crateriforme*, these strains are not conspecific with the type species, and the phylogenetic analysis strongly supports this clade (Fig. 1, clade XXVI, 1/97/100). Morphologically it differs from *A. pigmentosum* by having longer conidiogenous cells and conidia (Fig. 19).

***Acrodontium pigmentosum*** Videira & Crous, **sp. nov.** MycoBank MB817152. Fig. 20.

*Etymology*: Named after its pigmented mycelium.

*Mycelium* consisting of hyaline to slightly olivaceous, septate, branched, thin-walled, smooth hyphae, 0.8–1.5 µm diam. *Conidiophores* reduced to conidiogenous cells. *Conidiogenous cells* hyaline, thin-walled, smooth, subulate, sometimes with a transverse septum, arising from the mycelium or from a subtending cell in groups of two, straight to flexuous, proliferating sympodially and forming a rachis in the upper part, (9.5–)15.5–19(–31) × (1–)1.5–2 µm, with multiple conidiogenous loci slightly thickened but not darkened. *Conidia* hyaline, thin-walled, smooth, solitary, subglobose to broadly ellipsoidal, 2–3 × 1–2 µm, hilum slightly thickened but not darkened.

*Culture characteristics*: On MEA, 8 mm diam, surface raised, smooth, with erumpent aerial mycelium, smoke-grey, margins

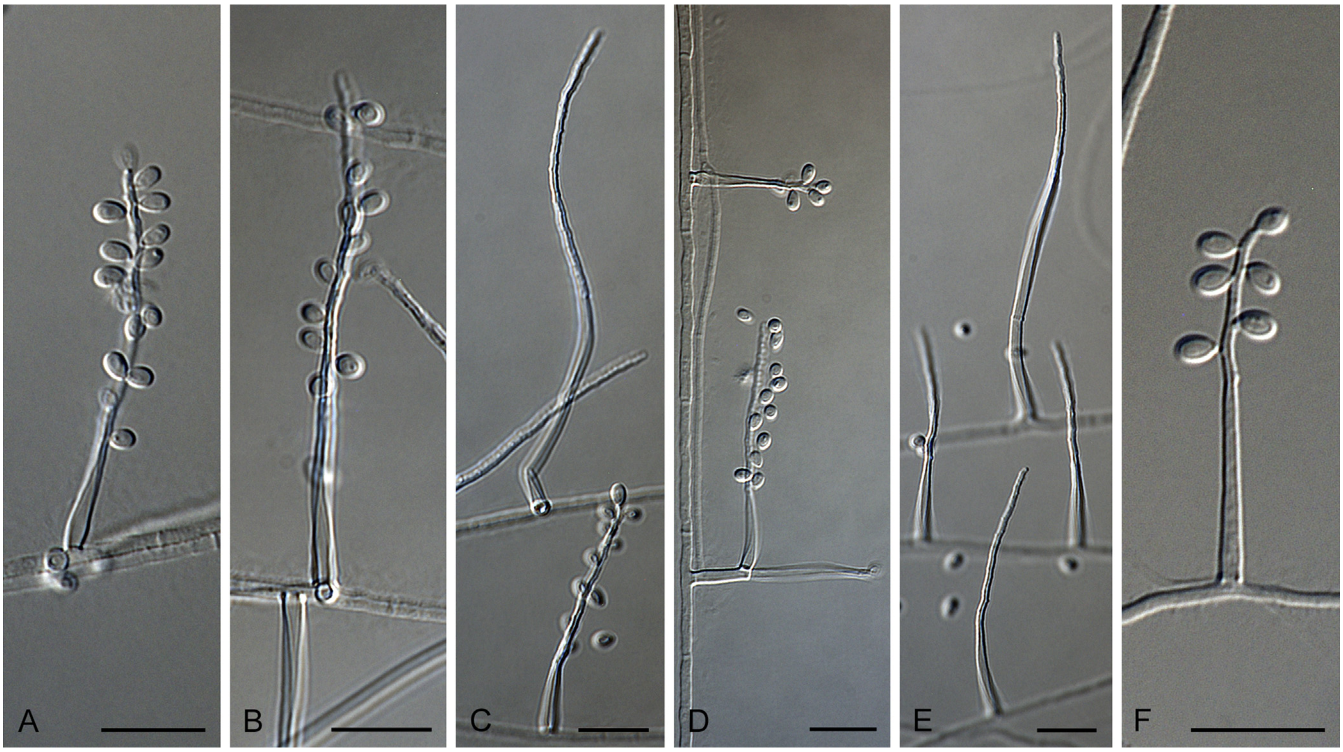

**Fig. 18.** *Acrodontium fagicola* (CBS 714.79). A–F. Conidiophores, conidiogenous cells and conidia formed in culture. Scale bars = 10 µm.

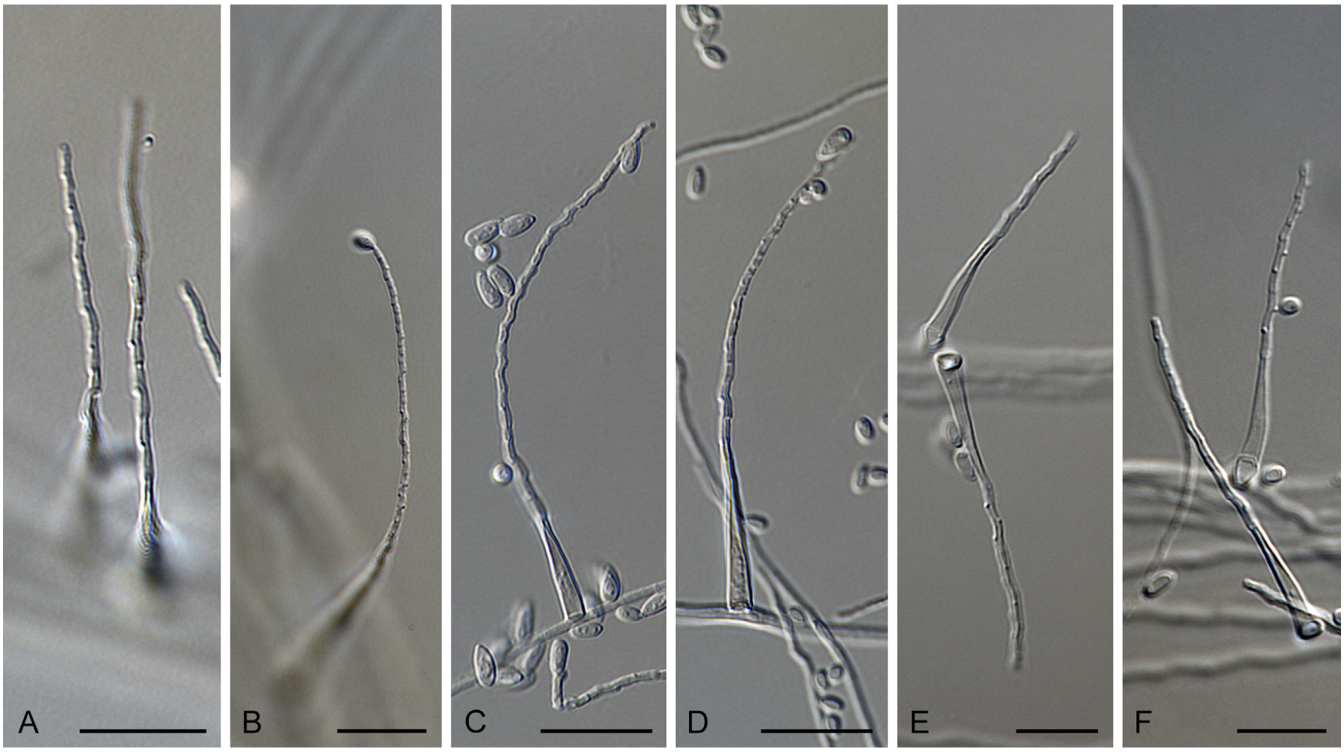

**Fig. 19.** *Acrodontium luzulae* (CBS 839.71). A–F. Structures formed in culture. A. Conidiogenous loci in the rachis. B–F. Conidiophores, conidiogenous cells and conidia. Scale bars = 10 µm.

entire, reverse iron grey; on OA, 11 mm diam, surface raised, smooth, with erumpent aerial mycelium, greyish sepia, margins undulate, reverse fuscous black; on PDA, 10 mm diam, surface flat, smooth, with erumpent aerial mycelium, olivaceous and greyish sepia, margins entire, reverse olivaceous black.

*Specimen examined*: **Finland**, from outdoor air, unknown date, S. Haatainen (**holotype** CBS H-22637, culture ex-type CBS 111111).

*Notes*: Initially identified as *A. griseum*, the micro- and macro-morphology of *A. pigmentosum* differs significantly from *A. griseum* by not forming markedly differentiated conidiophores with a thick stalk, smooth and thick-walled, bearing multiple brown conidiogenous cells in side branches and also by not forming olivaceous conidia (De Hoog 1972). This species is represented by a single lineage in the phylogenetic analysis (Fig. 1, clade XXVI) and differs from the closest species, *A. fagicola* by having wider conidiogenous cells, larger

**Fig. 20.** *Acrodontium pigmentosum* (CBS 111111). A–G. Conidiophores, conidiogenous cells and conidia formed in culture. Scale bars = 10 µm.

conidiophores and pigmented mycelium (Fig. 20), as well as 47 nucleotides in *rpb2*, and 5 in LSU.

**Clade XXVII:** ***Parapenidiella*** Crous & Summerell, Persoonia 29: 185. 2012.

*Note*: See Crous *et al.* (2012).

**Clade XXVIII:** ***Teratosphaeria*** Syd. & P. Syd., Ann. Mycol. 10: 39. 1912.

*Note*: See Crous *et al.* (2009c) and Quaedvlieg *et al.* (2014).

**Clade XXIX:** ***Readeriella*** Syd. & P. Syd., Ann. Mycol. 6: 484. 1908.

*Note*: See Crous *et al.* (2009c).

**Clade XXX:** ***Teratoramularia*** Videira, H.D. Shin & Crous, **gen. nov.** MycoBank MB816821.

*Etymology*: composed of *Terato*- from *Teratosphaeriaceae* and *Ramularia*.

*Mycelium* consisting of smooth, branched, septate, hyaline hyphae, or swollen pale to brown hyphae. *Conidiophores* at times synnematal, but mostly reduced to conidiogenous cells or consisting of one supporting cell and conidiogenous cell. *Conidiogenous cells* hyaline, thin-walled, smooth, terminal or lateral, subcylindrical, straight, proliferating sympodially; conidiogenous loci conspicuous, thickened and darkened. *Conidia* are catenate, forming ramoconidia, intercalary conidia and terminal conidia. *Conidia (type I)* hyaline, thin-walled, smooth, subcylindrical, long, aseptate to 1-septate, with conspicuous hila, thickened and darkened. *Conidia (type II)*, sometimes formed, brown, multiseptate, constricted at the septa, with thickened and darkened hila, germinating to form pigmented mycelium.

*Type species*: *Teratoramularia persicariae* Videira, H.D. Shin & Crous.

*Notes*: This is the first time that the ramularia-like morphology is observed outside the *Mycosphaerellaceae*. Like in *Ramularia*, species of *Teratoramularia* produce catenate, hyaline conidia with conspicuous hila, but differ by having conidiophores mostly reduced to conidiogenous cells, and by producing very long intercalary conidia and ramoconidia that usually appear immediately next to the conidiogenous cell. In addition, on OA, sometimes pigmented mycelium as well as conidia are observed, that are brown, multiseptate and constricted at their septa. The pigmented conidia were not observed in association with the hosts in the herbarium material. The phylogenetic analysis strongly supports this genus clade (Fig. 1, clade XXX, 1/100/98).

***Teratoramularia infinita*** Videira & Crous, **sp. nov.** MycoBank MB817153. Fig. 21.

*Etymology*: The epithet "*infinita*" indicates its ability to infect a wide host range.

*Mycelium* consisting of hyaline, septate, branched, thin-walled, smooth, 1–1.5 µm diam hyphae. *Conidiophores* reduced to conidiogenous cells. *Conidiogenous cells* hyaline, thin-walled, smooth, integrated in hyphae, cylindrical-oblong, (6.5–)11.5–14(–19) × 1–1.5(–2) µm, with 1 thickened and darkened apical locus, 1 µm diam. *Conidia* are catenate, forming ramoconidia, intercalary conidia and terminal conidia. *Conidia (type I)* hyaline, thin-walled, smooth, aseptate, *hila* thickened and darkened, 1 µm diam; *ramoconidia* subcylindrical to fusiform, (4.5–)8.5–11(–17) × (1–)1.5–2 µm, with two apical hila; *intercalary conidia*, subcylindrical to fusiform, sometimes curved, (5–)

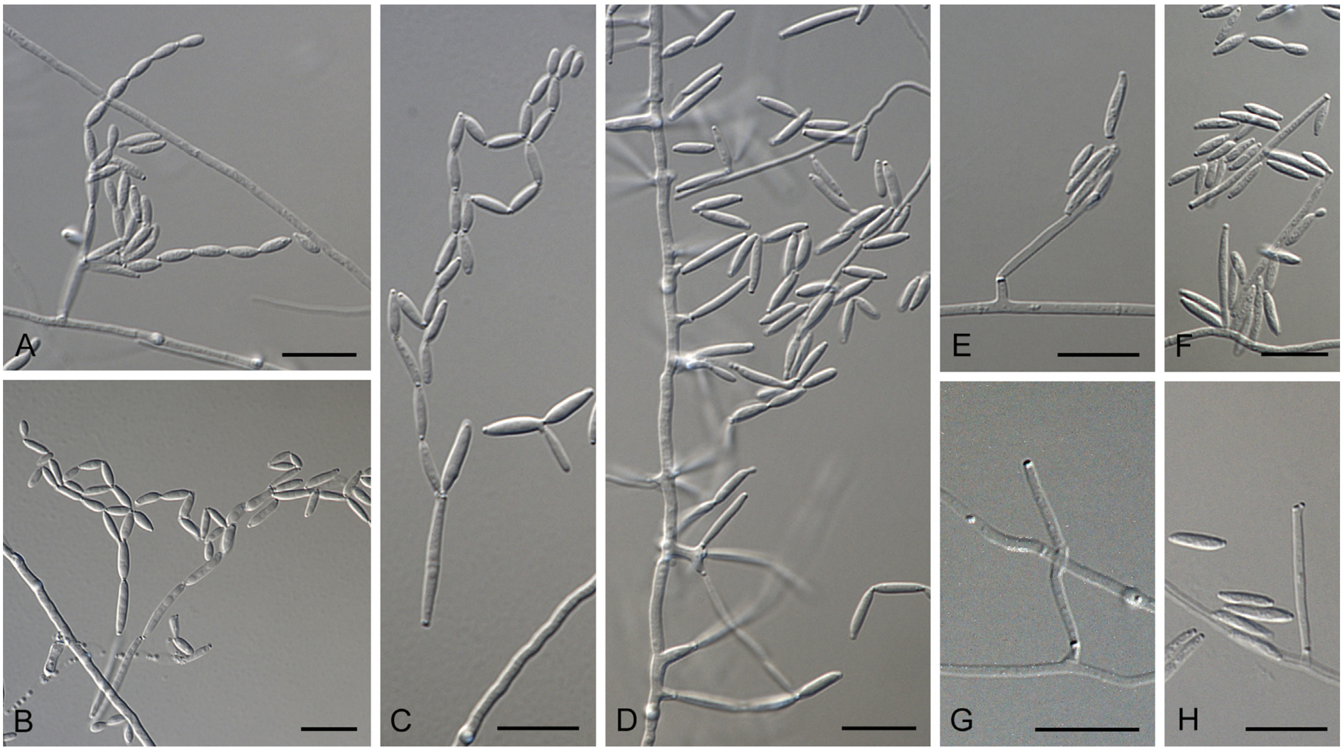

**Fig. 21.** *Teratoramularia infinita* (CBS 120815). A–H. Conidiophores, conidiogenous cells and conidia observed in culture. Scale bars = 10 µm.

10–14.5(–25.5) × (1–)1.5–2 µm, in chains of up to 11 conidia; *terminal conidia* obovoid, (3–)4(–6) × (1–)1.5–2 µm. *Conidia (type II)* not observed.

*Culture characteristics*: On MEA, 18 mm diam, surface raised, folded, smooth, pale grey, with margins crenate, convex, underneath olivaceous grey; on OA, 14 mm diam, surface flat, smooth, pale olivaceous grey, with margins undulate, with sparse olivaceous grey mycelium, reverse iron-grey; on PDA, 15 mm diam, surface, smooth, pale olivaceous grey, with margins crenate, reverse olivaceous grey.

*Specimens examined*: **Brazil**, on *Conyza canadensis*, 2000, unknown collector (**holotype** CBS H-22536, culture ex-type CBS 141104 = CPC 19488). **Taiwan**, Chiayi, Meishan, Taixingcun, on living leaves of *Thladiantha punctata*, unknown date, R. Kirschner & C.-J. Chen, culture CBS 120815.

*Notes*: The two strains in this clade have been isolated from two very distinct hosts, *Conyza canadensis* (*Asteraceae*) and *Thladiantha punctata* (*Cucurbitaceae*), and from two very distinct locations, Brazil and Taiwan, respectively. Nevertheless, they are identical on five genes suggesting this species has a wide host range and distribution. The phylogeny supports their separation from the closest neighbour, *T. rumicicola* (Fig. 1, clade XXX, 1/100/100) from which it also differs morphologically by producing longer conidiogenous cells, shorter and slightly narrower ramoconidia and terminal conidia (Fig. 21).

***Teratoramularia persicariae*** Videira, H.D. Shin & Crous, **sp. nov.** MycoBank MB817154. Fig. 22.

*Etymology*: Named after the host genus *Persicaria*, from which the ex-type strain of this taxon was collected.

*Mycelium* consisting of hyaline, septate, branched, thin-walled, smooth, 1–2 µm diam hyphae, but on OA also brown, pigmented hyphae are formed. *Conidiophores* reduced to conidiogenous cells. *Conidiogenous cells* hyaline, thin-walled, smooth, integrated in hyphae, cylindrical-oblong, (4.5–)9–11(–15) × (1–)1.5(–2) µm, with one thickened and darkened conidiogenous locus, 1 µm diam. *Conidia* are catenate, forming ramoconidia, intercalary conidia and terminal conidia. *Conidia (type 1)* hyaline, thin-walled, smooth, aseptate, with *hila* thickened and darkened, 1 µm diam; *ramoconidia* subcylindrical to fusiform, (9.5–)17–20(–30) × (1.5–)2(–2.5) µm, with 2 apical hila; *intercalary conidia* subcylindrical to fusiform, sometimes curved, (8.5–)14–18(–30) × (1–)1.5–2(–2.5) µm, in chains of up to eight conidia; *terminal conidia* hyaline, smooth, aseptate, subcylindrical, (3–)7–8(–10) × (1.5–)2(–3) µm. *Conidia (type II)* not observed.

*Culture characteristics*: On MEA, 15 mm diam, surface smooth, raised, lumpy, olivaceous grey with buff and white patches, with margins crenate and convex, reverse iron-grey with ochreous patches; on OA, 10 mm diam, surface concave, smooth, pale olivaceous grey, with margins raised, undulate, with sparse aerial mycelium, reverse olivaceous grey; on PDA, 13 mm diam, surface smooth, lumpy, irregular, iron-grey with pale vinaceous patches, margins undulate, reverse rosy buff and olivaceous grey.

*Specimens examined*: **South Korea**, Hongcheon, on *Persicaria nepalensis*, 29 Jul. 2004, H.D. Shin (**holotype** KUS-F20536, isotype CBS H-22537, culture ex-type CBS 141105 = CPC 11410); *idem*. CPC 11408, CPC 11409. **Unknown country**, on leaf spot of *Fagopyrum esculentum*, isol. and dep. M.W. Gardner, Jul. 1927, culture CBS 195.27.

*Notes*: The host species, *Persicaria nepalensis*, is distributed worldwide but a broader sampling is required to show whether the fungal species follows this distribution. The phylogenetic analysis supports the separation of *Teratoramularia persicariae* from *T. rumicicola* (Fig. 1, clade XXX, 0.99/95) and,

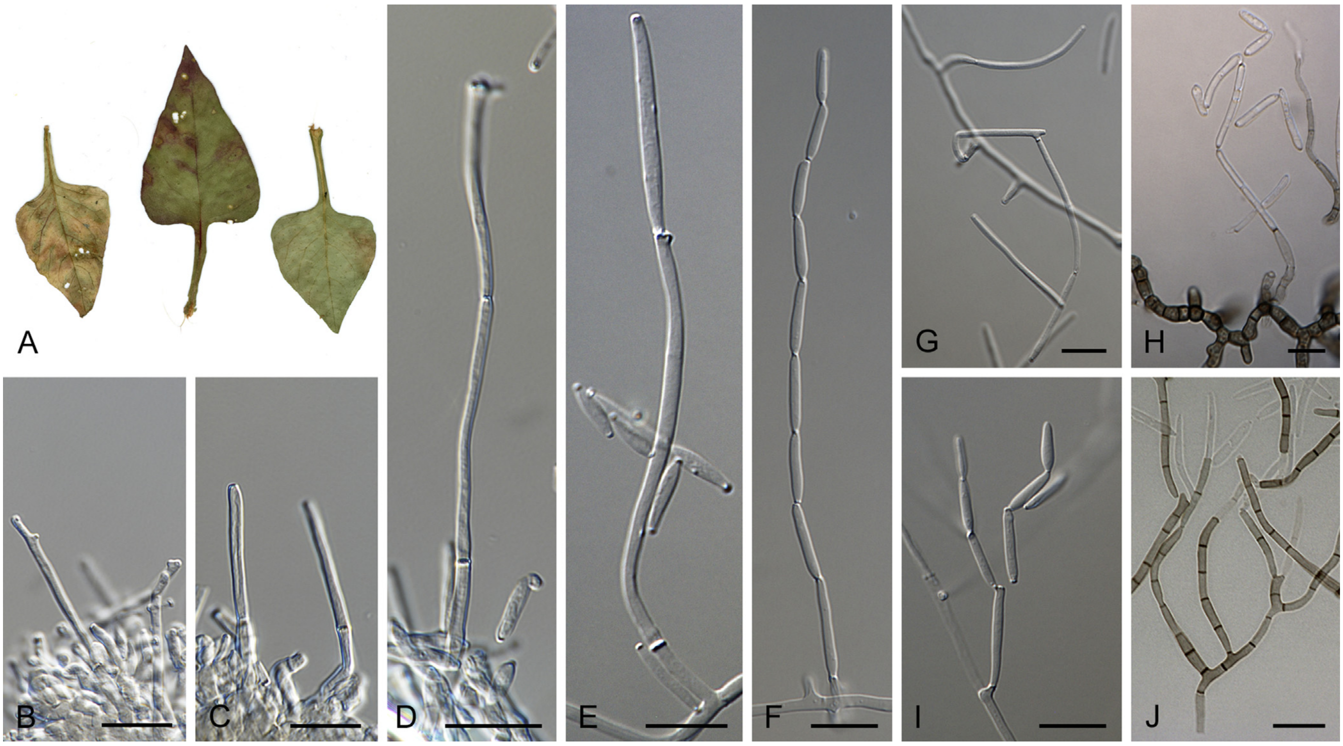

**Fig. 22.** *Teratoramularia persicariae* (CBS 141105). A–D. Observations from herbarium material. E–J. Structures formed in culture. A. Leaf spot symptoms on the host. B, C. Conidiophores and conidiogenous cells. D–H. Conidiophores, conidiogenous cells and conidia. H, J. Pigmented conidiogenous structures developed on OA culture medium. Scale bars = 10 µm.

morphologically, *T. persicariae* (Fig. 22) produces longer conidia than *T. rumicicola*.

***Teratoramularia rumicicola*** Videira, H.D. Shin & Crous, **sp. nov.** MycoBank MB817155. Fig. 23.

*Etymology*: Named after the host genus *Rumex*, from which it was collected.

*Mycelium* consisting of hyaline, septate, branched, thin-walled, smooth, 1–2 µm diam hyphae. *Conidiophores* reduced to conidiogenous cells. *Conidiogenous cells* hyaline, thin-walled, smooth, integrated in hyphae, cylindrical-oblong, (5–)10–12.5(–16.5) × (1–)1.5(–2) µm, with 1 thickened and darkened apical locus, 1 µm diam. *Conidia* are catenate, forming ramoconidia, intercalary conidia and terminal conidia. *Conidia (type I)* hyaline, thin-walled, smooth, catenate, aseptate or occasionally 1-septate, with *hila* conspicuous, thickened and darkened, 1 µm diam; *ramoconidia* subcylindrical to fusiform, (8.5–)12–15(–23) × (1.5–)2(–2.5) µm, with 2 apical hila; *intercalary conidia* subcylindrical, sometimes slightly curved, (6.5–)10–13(–20) × (1.5–)2(–2.5) µm, in chains of up to five conidia; *terminal conidia* subcylindrical to obovoid, (3–)5.5–6(–8) × (1.5–)2(–3) µm. *Conidia (type II)* brown, smooth, catenate, 1-4-septate, constricted at the septa, (5–)11.5–14.5(–18.5) × (2–)2.5–3 µm, with *hila* thickened and darkened.

*Culture characteristics*: On MEA, 20 mm diam, surface raised, strongly folded, smooth, white with greyish tinge in the centre, with margins crenate, convex, olivaceous grey, reverse iron-grey; on OA, 15 mm diam, surface flat, smooth, pale olivaceous grey, with margins undulate, with sparse olivaceous grey mycelium, reverse iron-grey; on PDA, 16 mm diam, surface with smooth and folded portions, pale olivaceous grey, with margins crenate and smoke grey, reverse olivaceous grey.

*Specimens examined*: **South Korea**, Jecheon, on *Rumex crispus*, 19 Oct. 2007, H.D. Shin (**holotype** KUS-F23080, isotype CBS H-22538, culture ex-type CBS 141106 = CPC 14653); *idem*. CPC 14652, CPC 14654.

*Notes*: A total of seven *Ramularia* species have been described from *Rumex* worldwide (Braun 1998) and two of these species form filiform, long conidia, i.e. *R. pseudodecipiens* and *R. pratensis*. *Ramularia pseudodecipiens* is only known from the type collection in the USA (Wyoming), has larger conidia [(10–)25–45(–55) × 2–5 µm] that are consistently septate and, although sometimes constricted at the septa, they are always hyaline. *Ramularia pratensis* has a worldwide distribution and produces conidia of approximately the same size, (6–)8–25(–35) × (1.5–)2–4(–5) µm, but they are never constricted at the septa or pigmented. In addition, the conidiophores in *T. rumicicola* (Fig. 23) were consistently reduced to conidiogenous cells while both *R. pseudodecipiens* and *R. pratensis* produce long conidiophores. The phylogenetic analysis supports this species clade (Fig. 1, clade XXX, 1/100/100).

***Teratoramularia kirschneriana*** Videira & Crous, **sp. nov.** MycoBank MB817156. Fig. 24.

*Etymology*: Named after the mycologist Roland Kirschner, who has contributed greatly to our knowledge of cercosporoid fungi.

*Mycelium* consisting of hyaline, septate, branched, thin-walled, smooth, 0.5–1.5 µm diam hyphae. *Conidiophores* reduced to conidiogenous cells. *Conidiogenous cells* hyaline, smooth, integrated in hyphae, cylindrical-oblong, (13.5–)14–15(–16) × 1(–1.5) µm, with 1 thickened and darkened

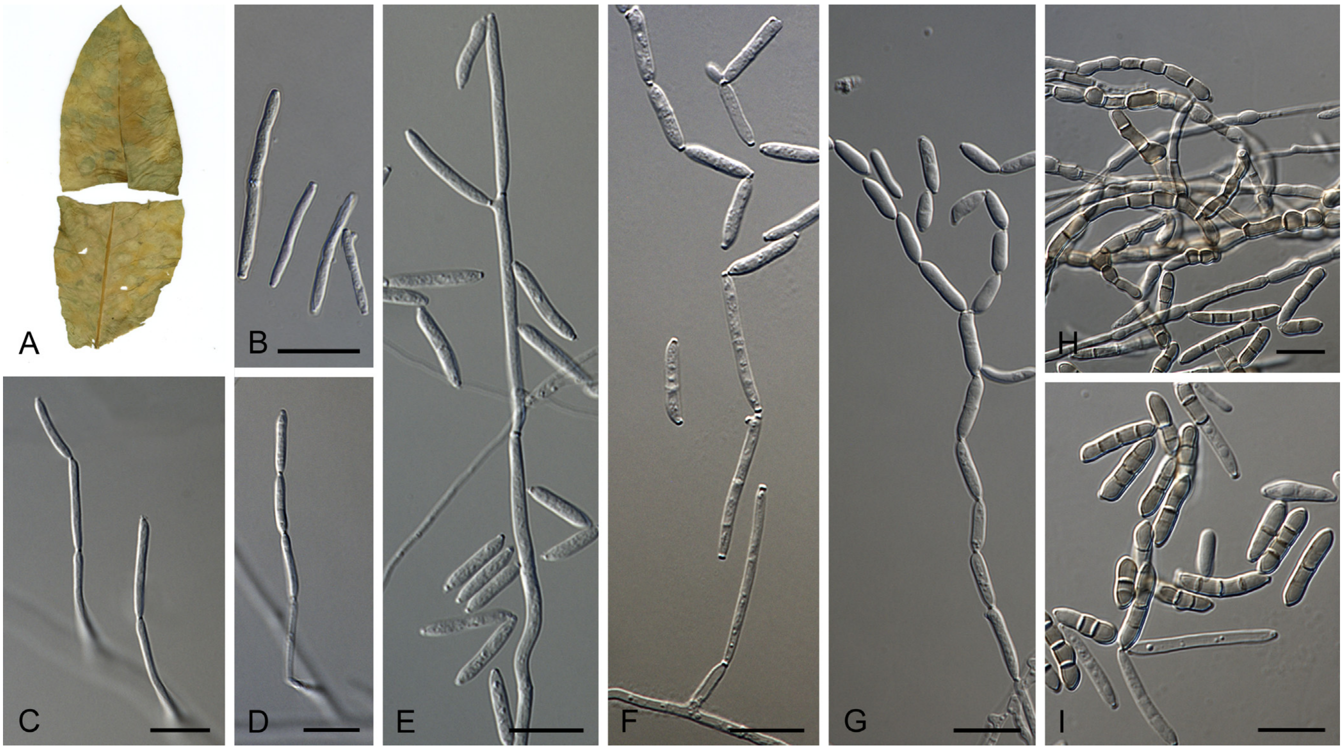

**Fig. 23.** *Teratoramularia rumicicola* (CBS 141106). A–B. Observations from herbarium material. C–I. Structures formed in culture. B. Conidia. C–G. Conidiophores, conidiogenous cells and conidia. H, I. Pigmented conidiogenous structures and conidia formed on OA culture medium. Scale bars = 10 µm.

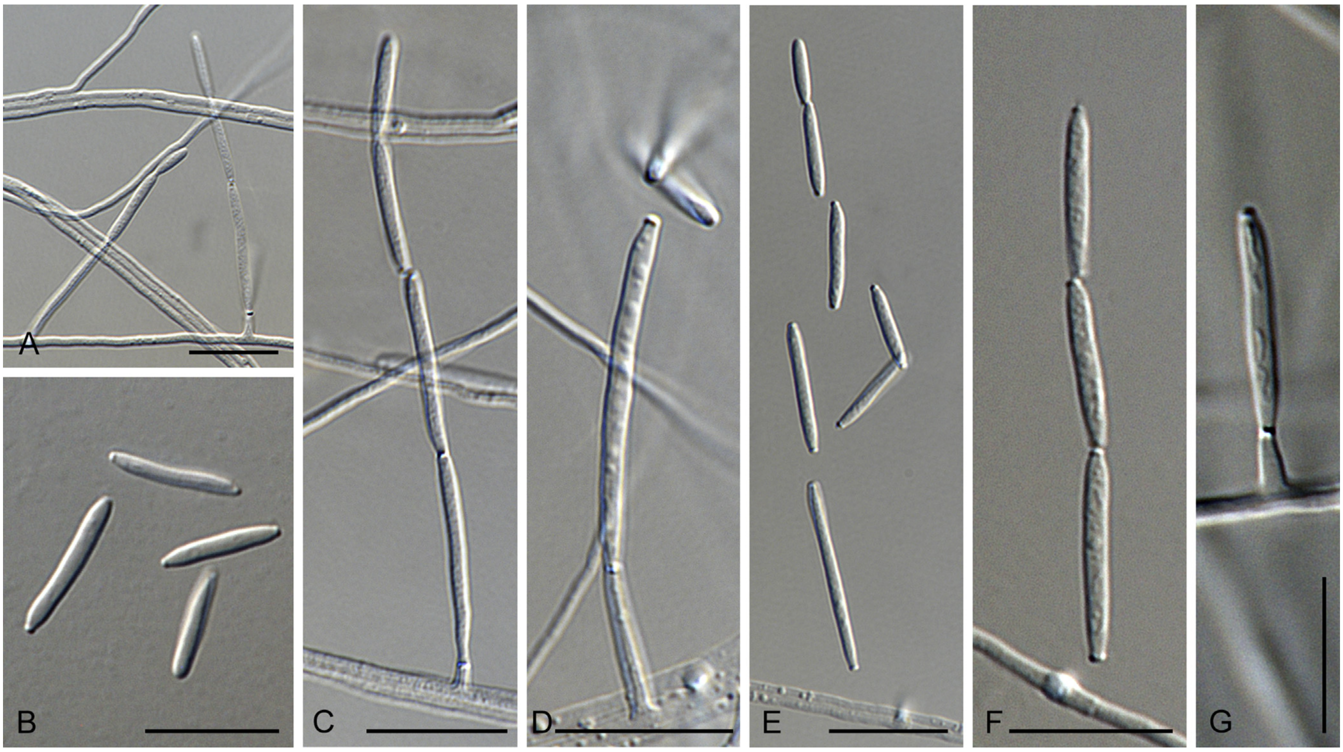

**Fig. 24.** *Teratoramularia kirschneriana* (CBS 113093). A–G. Structures formed in culture. A, C–G. Conidiogenous cells and conidia. B. Conidia. Scale bars = 10 µm.

apical locus, 1 µm diam. *Conidia* are catenate, forming ramoconidia, intercalary conidia and terminal conidia. *Conidia (type I)* hyaline, thin-walled, smooth, aseptate, *hila* thickened and darkened, 1 µm diam.; *ramoconidia* subcylindrical to fusiform, (7–)8.5–10(–15) × (1–)1.5–2 µm, with two apical hila; *intercalary conidia*, fusiform, (6–)8–10(–17) × (1–)1.5–2 µm, in chains of up to five conidia; *terminal conidia*, fusiform to obovoid, (3.5–)5–6(–7) × (1–)1.5–2 µm. *Conidia (type II)* not observed.

*Culture characteristics*: On MEA, 16 mm diam, surface folded, smooth, pale grey, with margins crenate, convex, colony reverse iron-grey; on OA, 15 mm diam, surface flat, smooth, pale grey, with margins undulate, colony reverse iron-grey; on PDA, 13 mm diam, surface smooth, pale grey, with margins crenate, colony reverse iron-grey.

*Specimen examined*: **Taiwan**, Tahsuehshan, on leaves of *Setaria palmifolia*, 13 Apr. 2002, R. Kirschner & C.-J. Chen (**holotype** TNM No. F0016568, isotype CBS H-22539, culture ex-type CBS 113093).

*Notes*: The strain representing this species was originally identified as *Phacellium paspali*. The characteristic *Phacellium* synnemata are sometimes also formed in culture. This species is represented by a single basal lineage in the *Teratoramularia* clade in the phylogenetic analysis (Fig. 1, clade XXX). Morphologically (Fig. 24), it is nearly impossible to distinguish it from the closest sister species *T. infinita*.

## *Genera allied to Ramularia lacking cultures*

***Hawksworthiana*** U. Braun, Int. J. Mycol. Lichenol. 3: 276. 1988. Fig. 25.

Lichenicolous, forming gall-like deformations. *Mycelium* consisting of hyaline, septate, sparsely branched, thin-walled hyphae. *Conidiophores* reduced to the conidiogenous cells, erumpent, usually ampulliform but sometimes subcylindrical, aseptate, hyaline, thin-walled, mono- or polyblastic, sympodial, conidiogenous loci conspicuous, thickened and darkened. *Conidia* formed singly, acrogenous, oblong-clavate to subcylindrical, hyaline, thin-walled, smooth, aseptate or 1-septate, hilum conspicuous, thickened and darkened.

*Type species*: *Hawksworthiana peltigericola* (D. Hawksw.) U. Braun.

*Specimens examined*: **Luxembourg**, on lichen *Peltigera rufescens*, 7 May 2008, P. Diederich. **Scotland**, Isle of Mull, Killiemore, on *Peltigera polydactyla*, 16 Jun. 1979, Clark (**holotype** K(M) IMI 239715a).

*Notes*: *Hawksworthiana* is monotypic and was described based on *H. peltigericola* on a specimen of *Peltigera polydactyla* from the Isle of Mull in Scotland. It forms gall-like deformations on lichens of the genus *Peltigera*, and has been reported from Europe and North America. *Hawksworthiana* differs from *Ramularia* by its lichenicolous habit and morphological characters such as the wide ampulliform conidiogenous cells, the conidiogenous loci and hila are not refractive, the absence of stroma-like structures and the symptoms caused on the host (Fig. 25). All attempts to culture this fungus from fresh collections have thus far proven unsuccessful.

***Monodidymaria*** U. Braun, Nova Hedwigia 58: 195. 1994. Fig. 26.

Phytopathogenic, causing leaf spots. *Mycelium* consisting of hyaline, septate, branched, thin-walled hyphae; stromata absent or small. *Conidiophores* macronematous, solitary or in fascicles, arising from internal hyphae or hyphal aggregations, emerging through stomata or erumpent through the cuticle, filiform and straight or flexuous to sinuous, but not geniculate, usually aseptate, thin-walled, hyaline and smooth, sometimes reduced to conidiogenous cells. *Conidiogenous cells* integrated, terminal, monophialidic. *Conidia* formed singly, ellipsoid-ovoid, obovoid, subcylindrical, fusoid or subclavate, aseptate or 1(−3)-septate, hyaline, thin-walled, smooth to rough, base rounded to truncate.

*Type species*: *Monodidymaria canadensis* (Ellis & Everh.) U. Braun.

*Specimens examined*: **Canada**, Ontario, London, on *Carex conoidea*, Aug. 1890, Dearness (**lectotype** NY 01293230, **syntypes** NY 01293231, 01293232 and 01293233).

*Notes*: While *Ramularia* has polyblastic, sympodial and cicatrised conidiogenous cells, *Monodidymaria* has monophialidic conidiogenous cells (Fig. 26). This character excludes *Monodidymaria* from the *Cercosporella*/*Ramularia* complex, but due to their common taxonomical history, they are still studied together. *Monodidymaria* is in fact morphologically more similar to *Cephalosporiopsis*, but the latter genus comprises saprophytic soil hyphomycetes and its taxonomic status is not yet certain (Braun 1998). As a consequence, the genus is maintained until more data is available to clarify its taxonomic position (Braun 1998). Five species are known to belong in this genus and were isolated from several hosts (*Chenopodium*, *Equisetum*, *Scirpus* and *Vitex*) from Asia, Europe, North and South America (Braun 1998, Seifert *et al.* 2011).

***Neoovularia*** U. Braun, Nova Hedwigia 54: 473. 1992. Fig. 27.

Phytopathogenic, causing leaf spots. *Caespituli* amphigenous, whitish to pink or ochraceous. *Mycelium* consisting of hyaline to faintly pigmented, septate, branched, thin-walled hyphae forming well-developed stromata. *Conidiophores* arising from stromata, emerging through stomata or erumpent through the cuticle, often forming sporodochia, subcylindrical, subclavate, simple, thin-walled, smooth, hyaline or lightly pigmented, continuous or septate. *Conidiogenous cells* integrated, terminal, straight to moderately geniculate-sinuous, polyblastic and sympodial, conidiogenous loci numerous, conspicuous, bulging, papilla-like, but not thickened and darkened, at most slightly refractive. *Conidia* formed singly, subglobose, obovoid, ellipsoid, aseptate, hyaline to faintly pigmented, thin-walled, smooth to verruculose; basal hilum not thickened or darkened; conidial secession schizolytic. Adapted from Braun (1998).

*Type species*: *Neoovularia nomuriana* (Sacc.) U. Braun.

*Specimens examined*: **Hungary**, Sükösd, on leaves of *Astragalus cicer*, Sep. 1913, leg. F. Greinich, det. G. Moesz., Flora Hungarica exsiccata 106, cent. II, Fungi 16, M-0177904. **Japan**, Mino Prov., Kawanye-mura, on *Astragalus sinicus*, May 1912, leg. K. Hara, com. P. Sydow, Kabát et Bubák: Fungi Imperfecti exsiccati 835, M-0177907; Kikotaru, on *Astragalus sinicus*, 1903, Nomura (**holotype** PAD). **Russia**, Ufa, Jabalakly, on leaves of *Astragali cicer*, 29 Jun. 1910, leg. Serebrianikow, Tranzschel et Serebrianikow Mycotheca Rossica 195, M-0177906, M-0177905.

*Notes*: *Neoovularia* species are characterised by having unthickened but bulging and refractive conidiogenous loci, and by producing single, subglobose conidia with unthickened but refractive hila (Fig. 27). There are six species described in this genus that are phytopathogenic and cause distinct lesions on leaves and stems (Braun 1998). They have been observed from hosts belonging to four different families (*Asteraceae*, *Fabaceae*, *Lamiaceae* and *Malvaceae*) and located in Europe, Asia, Caucasus and N. America.

***Neoramularia*** U. Braun, Nova Hedwigia 53: 291. 1991. Fig. 28.

Phytopathogenic, causing leaf spots. *Mycelium* consisting of hyaline or subhyaline, septate, branched, thin-walled hyphae forming stromata or not. *Conidiophores* macronematous, usually in large fascicles, sometimes forming sporodochial and

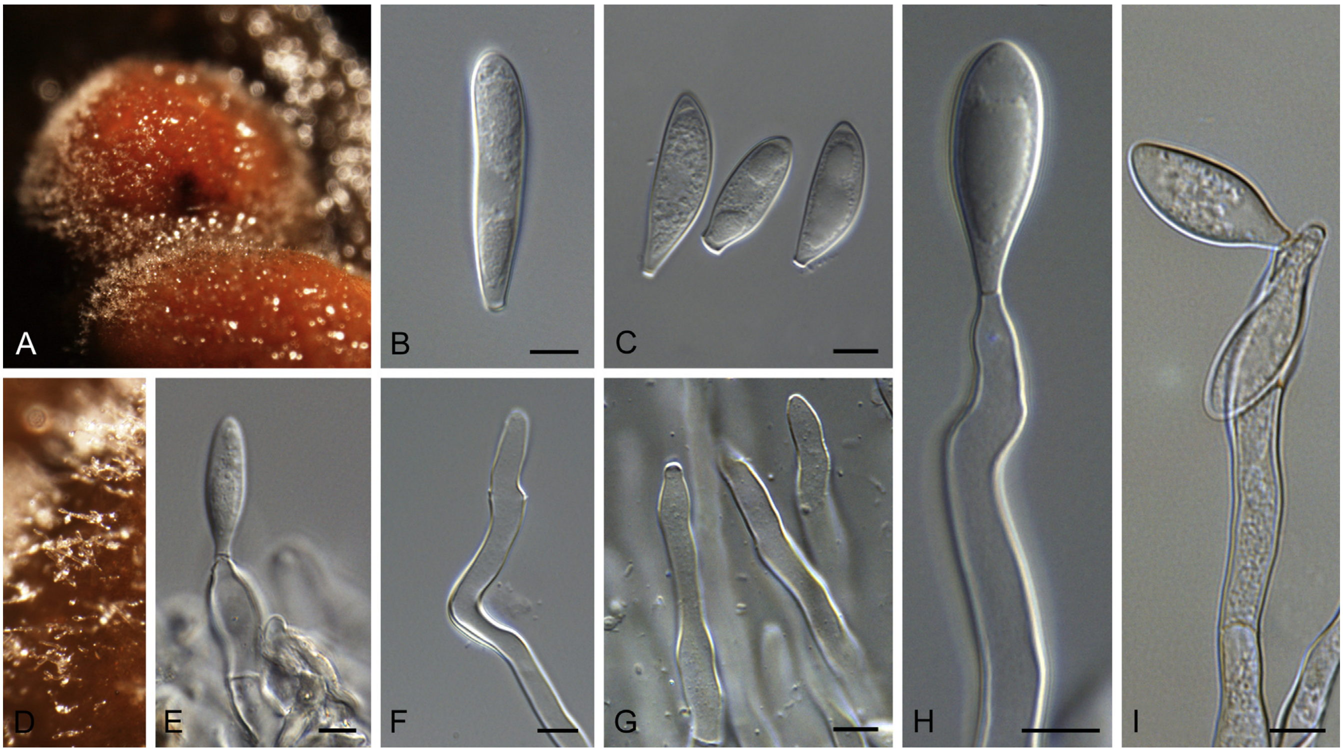

**Fig. 25.** *Hawksworthiana peltigericola* (herbarium Paul Diederich). A–I. Observations from herbarium material. A, D. Conidiogenous structures developing on the host. B, C. Conidia. E, H, I. Conidiophores and conidia. F, G. Conidiophores. Scale bars = 10 µm.

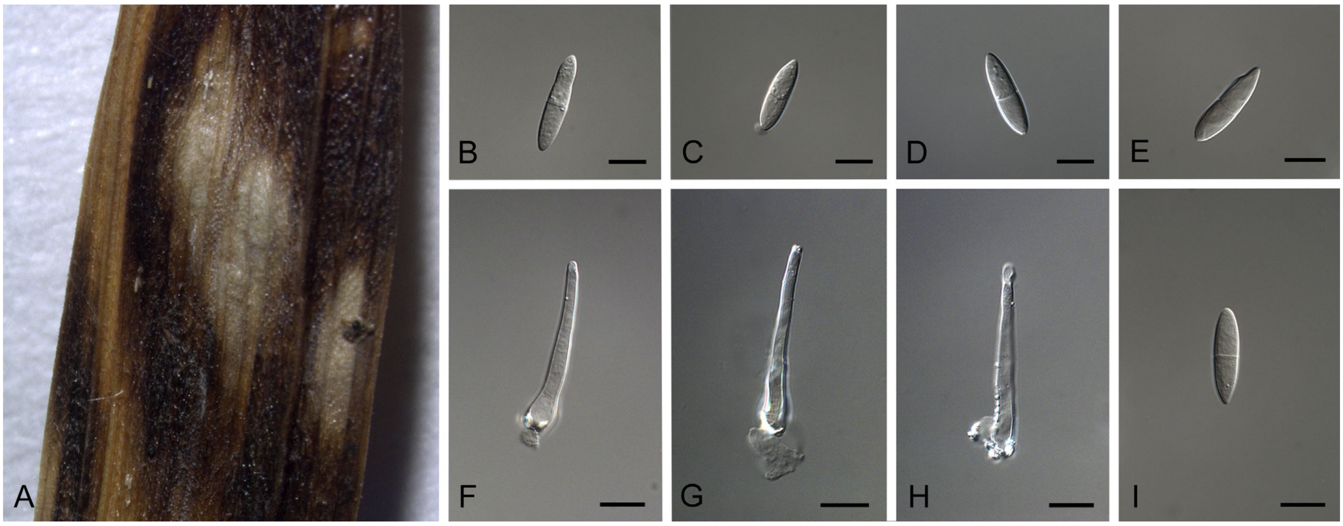

**Fig. 26.** *Monodidymaria canadensis* (NY herbarium, 01293230, lectotype specimen). A. Leaf spot lesion on the host. B–E, I. Conidia. F–H. Conidiophores. Scale bars = 10 µm.

basistromatic conidiomata, emerging through stomata or erumpent through the cuticle, straight, subcylindrical to geniculate-sinuous, simple, hyaline or faintly pigmented, continuous or septate, thin-walled, smooth or occasionally rough. *Conidiogenous cells* integrated, terminal, polyblastic, percurrent and sympodial, conidiogenous loci inconspicuous, not thickened or darkened. *Conidia* solitary or catenate, ellipsoid-ovoid, subcylindrical or fusoid, hyaline or slightly pigmented, aseptate to 3-septate, thin-walled, smooth or almost so, hila unthickened and hyaline, conidial secession schizolytic.

*Type species*: *Neoramularia eurotiae* (Gamalizk.) U. Braun [= *N. kochiae* (Woron.) U. Braun].

*Specimen examined*: **Russia,** Central Tien-Shan, 5 Jun. 1958, Gamalitzkaja (**holotype** of *Ramularia eurotiae* LE 41968).

*Notes*: The genus *Neoramularia* was introduced by Braun (1991) to include species with inconspicuous, unthickened, hyaline conidiogenous loci and hila. The circumscription of *Neoramularia* was later modified to include species forming catenate conidia such as *Neoramularia esfandiarii* (Braun 1992). Ten species are currently known in this genus and have been isolated from different hosts in Asia, Europe and North America (Braun 1998, Seifert *et al.* 2011). The type species is known from *Kochia* sp., Azerbaijan, and a photoplate based on the holotype of *R. eurotia*, a synonym of *Neoramularia kochiae* is presented (Fig. 28).

***Pseudodidymaria*** U. Braun, Cryptog. Bot. 4: 110. 1993. Fig. 29.

Phytopathogenic, causing leaf spots. *Mycelium* consisting of hyaline or faintly pigmented, septate, thin-walled and branched

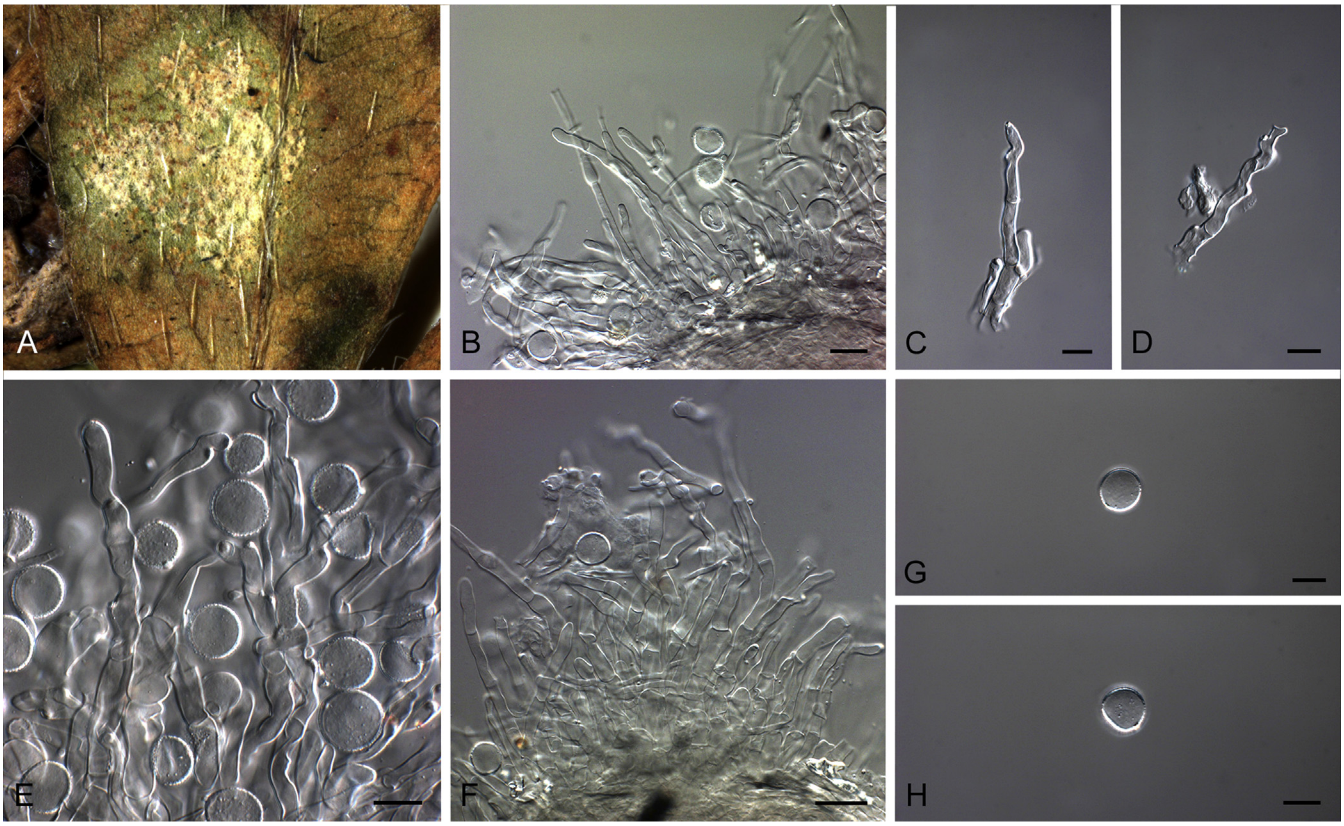

**Fig. 27.** *Neovularia nomuriana* (M-0177907). A. Leaf spot lesion on the host. B, E, F. Conidiophores and conidia. C, D. Conidiogenous cells. G, H. Conidia. Scale bars = 10 µm.

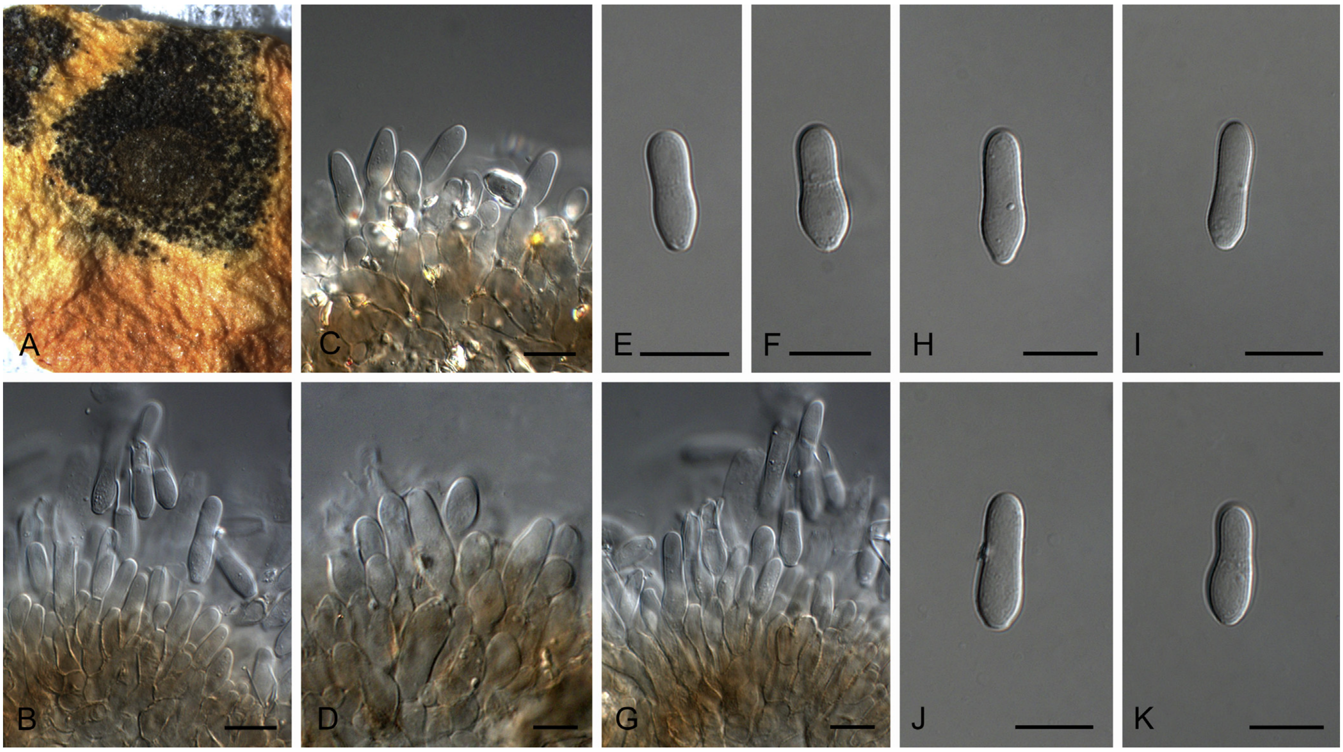

**Fig. 28.** *Neoramularia eurotiae* (No. 41968, LE herbarium, holotype of *Ramularia eurotiae*). A–K. Observations from herbarium material. A. Leaf spot symptoms on the host. B–D, G. Conidiogenous cells and conidia. E, F, H–K. Conidia. Scale bars = 10 µm.

hyphae, forming well developed stromata. *Conidiomata* basistromatic and sporodochial. *Conidiophores* arranged in palisade-like fascicles, subcylindrical, subclavate, straight to flexuous, sinuous, rarely septate, hyaline to faintly pigmented, thin-walled, smooth, sometimes reduced to conidiogenous cells. *Conidiogenous cells* integrated, terminal, polyblastic, sympodial, conidiogenous loci bulging, unthickened or with a thickened rim, not darkened but refractive. *Conidia* formed singly, ellipsoid-obovoid, subclavate, aseptate to 2-septate, base rounded to broadly truncate, hyaline to faintly pigmented, thin-walled, smooth to verruculose, hilum unthickened, not darkened but refractive, conidial secession schizolytic.

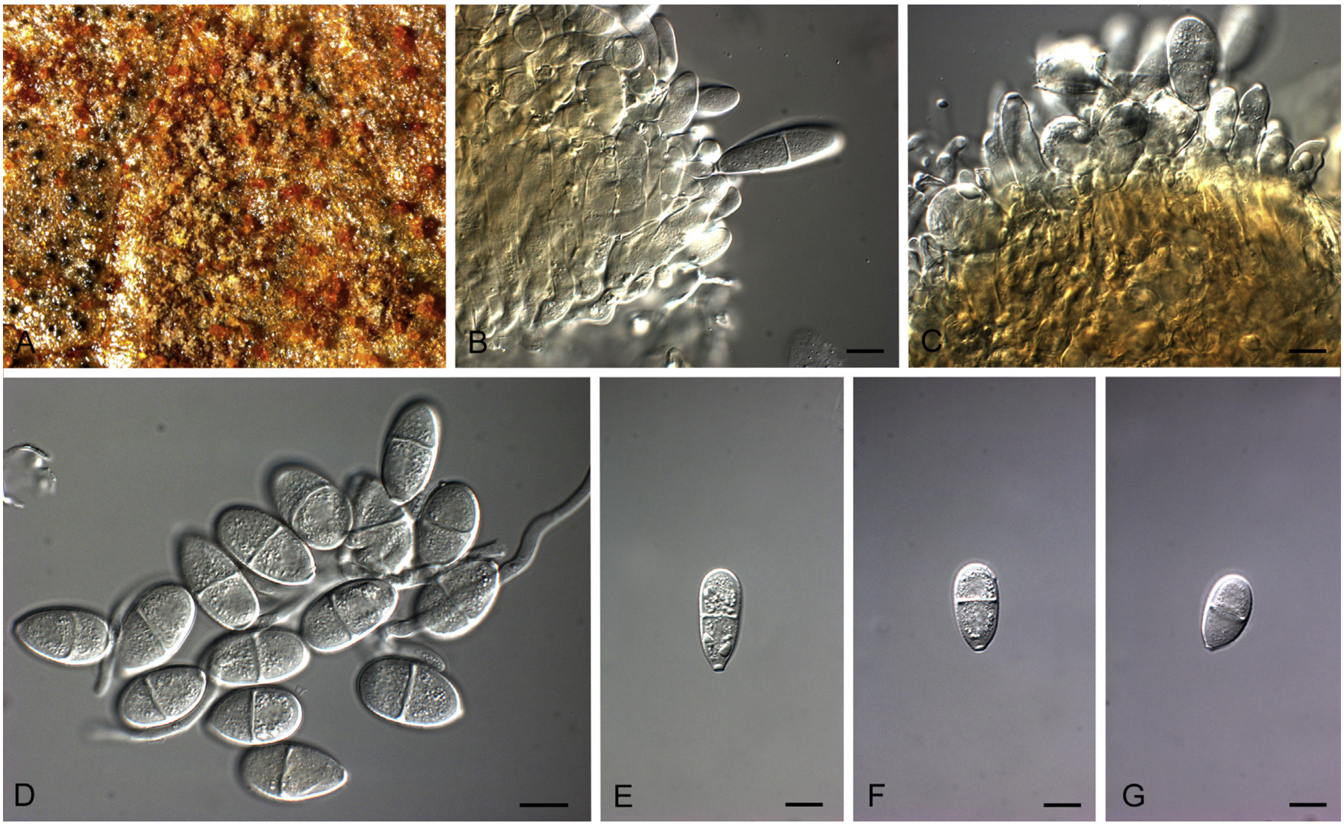

**Fig. 29.** *Pseudodidymaria wyethiae* (NY herbarium 01087025, lectotype specimen). A. Leaf spot lesion on the host. B, C. Conidiogenous cells and conidia. D–G. Conidia. Scale bars = 10 µm.

*Type species*: *Pseudodidymaria wyethiae* (Ellis & Everh.) U. Braun.

*Specimens examined*: **USA**, California, Santa Rosa, on leaves of *Wyethia glabra*, 25 May 1894, WC Blasdale (**lectotype** NY 01087025, **isolectotypes** NY 01087026, 01087027, 01087028).

*Notes*: *Pseudodydimaria* was established to accommodate *Didymaria wyethiae*, since it did not fit comfortably with the description of *Ramularia*, *Pseudocercosporidium* or *Neoovularia*. *Pseudocercosporidium* differs by having very long, branched conidiophores, formed singly or loosely grouped. *Neoovularia* differs by having aseptate, subglobose to ovoid conidia with narrow, darkened, refractive hila. Two species are currently known to belong to this genus, *P. wyethiae* (Fig. 29) and *P. clematidis*, reported from North America (Braun 1998).

***Tretovularia*** Deighton, Trans. Brit. Mycol. Soc. 82: 743. 1984. Fig. 30.

Phytopathogenic, causing leaf spots. *Mycelium* consisting of hyaline, septate, branched, thin-walled hyphae; stromata absent or small. *Conidiophores* macronematous, growing singly or in fascicles, arising from internal hyphae or stromata, emerging through stomata, subcylindrical to sinuous, fertile part usually strongly geniculate-sinuous, hyaline, continuous or sometimes septate, thin-walled, smooth. *Conidiogenous cells* integrated, terminal, sometimes becoming intercalary, polytretic, indeterminate, proliferation sympodial, conidiogenous loci are minute pores located in small shoulders that are later covered by a colourless cap. *Conidia* solitary, subglobose, broad ellipsoid-ovoid, pyriform, aseptate, hyaline, base rounded or with a small protrusion.

*Type species*: *Tretovularia villiana* (Magnus) Deighton.

*Specimen examined*: **Germany**, Unterfranken, Hassfurt near Nürnberg, on *Vicia cassubica*, Sep. 1898, A. Vill [Allesch. & Schn., Fungi bavar. 691], ex-herb. P. Magnus acc.1918 (**holotype** HBG).

*Notes*: This monotypic genus was established to accommodate *Ovularia villiana* (Fig. 30), a phytopathogenic species that forms polytretic conidiogenous cells with sympodial proliferation, a characteristic very different from *Ramularia* and other similar genera.

## *Ramularia sensu stricto*

***Ramularia abscondita*** (Fautrey & F. Lamb.) U. Braun, Int. J. Mycol. Lichenol. 3: 280. 1988. Fig. 31.
*Basionym*: *Ovularia abscondita* Fautrey & F. Lamb., Rev. Mycol. (Toulouse) 18: 144. 1896.

= *Ramularia filaris* f. *lappae* Sacc., Syll. Fung. 4: 210. 1886.
= *Ramularia filaris* var. *lappae* Bres., Hedwigia 36: 200. 1896.
≡ *Ramularia lappae* (Bres.) Ferraris, Fl. Ital. Crypt., Fungi 1(6): 837. 1913.

*Mycelium* consisting of hyaline, septate, branched, smooth, 1–2 µm diam hyphae. *Conidiophores* hyaline, thin-walled, smooth, erect, septate, cylindrical-oblong, straight to geniculate-sinuous, unbranched, (10–)15.5–20.5(–44.5) × (1.5–)2 µm, or reduced to conidiogenous cells. *Conidiogenous cells* integrated in the mycelium or terminal on the conidiophore, cylindrical-oblong to geniculate-sinuous, (7–)11–14(–22.5) × (1–)1.5–2(–3) µm, with multiple conidiogenous loci almost flat to protuberant, thickened, darkened and refractive. *Conidia* hyaline, thin-walled, smooth to slightly verruculose, catenate, with *hila* thickened, darkened and refractive. *Ramoconidia* cylindrical-oblong, clavate,

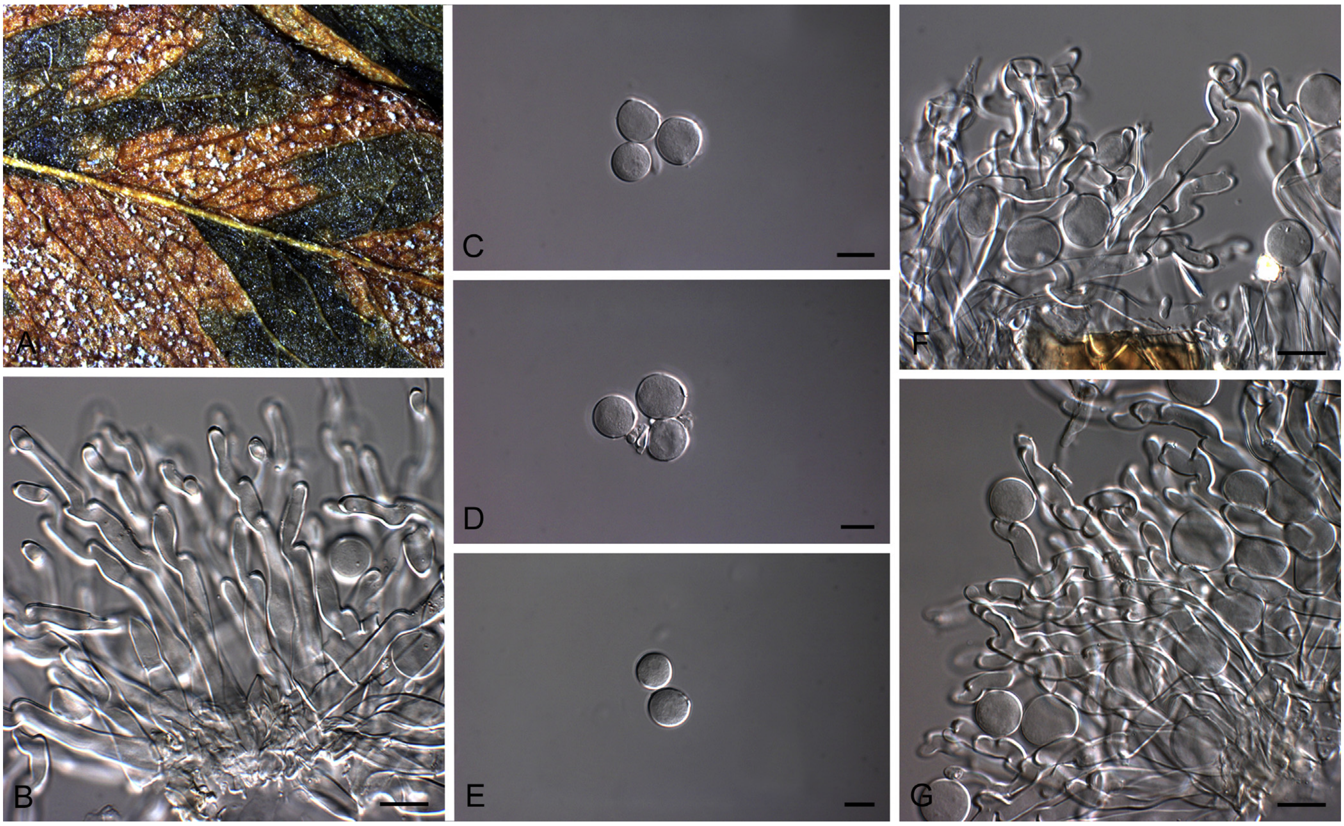

**Fig. 30.** *Tretovularia viliana* (holotype, HBG). A. Leaf spot lesion on the host. B, F, G. Conidiogenous cells and conidia. C–E. Conidia. Scale bars = 10 µm.

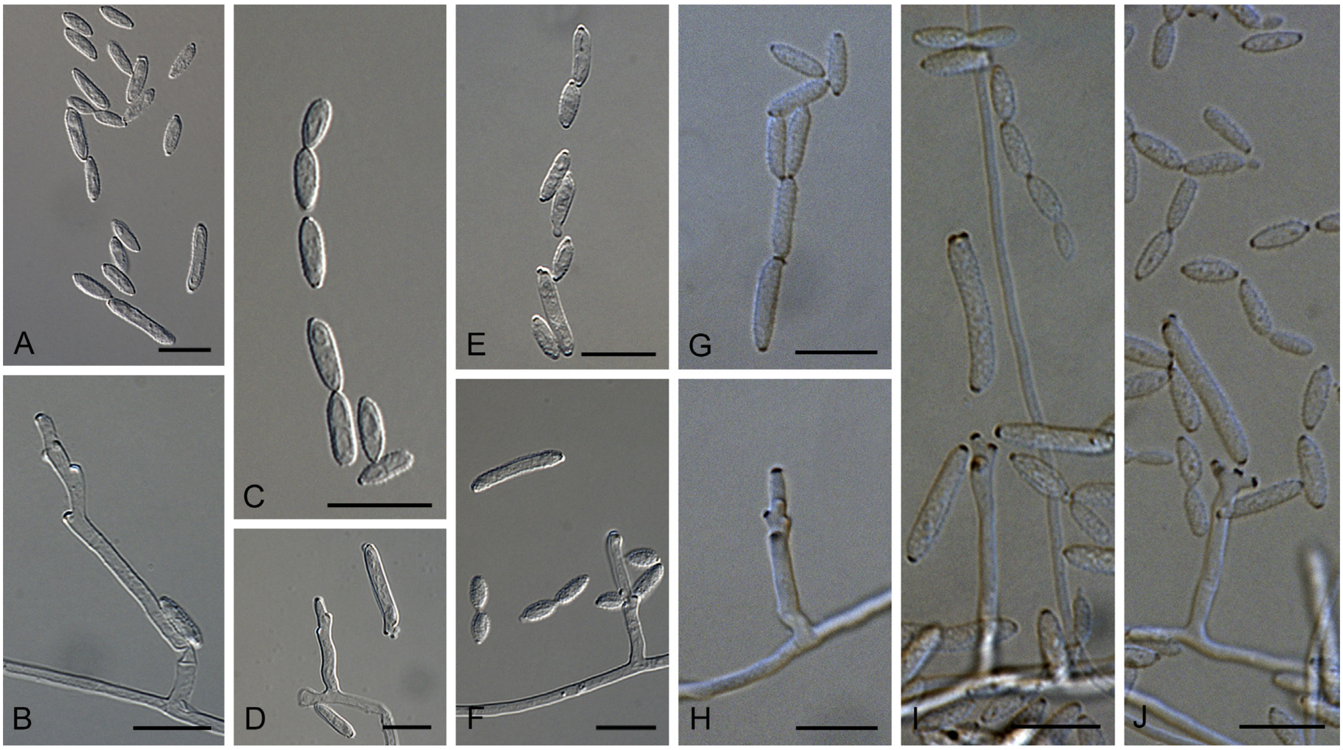

**Fig. 31.** *Ramularia abscondita* (CBS 114727). A–J. Structures formed in culture. A, C, E, G. Conidia. B, D, F, I, J. Conidiophores, conidiogenous cells and conidia. H. Conidiophore. Scale bars = 10 µm.

sometimes curved, oval, (5.5–)8–9.5(–15) × 2–2.5(–3) µm, aseptate, with 2–3 apical hila. *Intercalary conidia* cylindrical-oblong, oval, ellipsoid, aseptate, (4.5–)6.5–7(–10) × 2(–2.5) µm, in branched chains of up to five conidia. *Terminal conidia* obovoid, aseptate, (4–)5(–6) × (1.5–)2–2.5 µm (on SNA, CBS 114727).

*Culture characteristics*: On MEA, 8 mm diam, surface raised, fluffy aerial mycelium, dirty white, with margins undulate, colony reverse ochreous; on OA, 8 mm diam, surface raised, folded, fluffy aerial mycelium, white, margins undulate, colony reverse buff; on PDA, 8 mm diam, surface raised, folded, fluffy aerial mycelium pale grey, with margins undulate, colony reverse buff.

*Description in vivo*: See Braun (1998: 84).

*Specimens examined*: **France**, Viserny, Côte-d'Or, on *Arctium lappa*, 1896, Fautrey [Roum., Fungi Sel. Gall. Exs. 7245] (**lectotype**, designated in Braun 1998, PC). **Sweden**, Uppland, Dalby, on leaves of *Arctium tomentosum*, 20 Sep. 1990, E. Gunnerbeck, culture CBS 114727.

*Substrate and distribution*: On *Arctium* spp. (*Asteraceae*); Caucasus, Central Asia, Europe.

*Notes*: *Ramularia abscondita* was originally described on *Arctium lappa* from France (lectotype in PC). It has a wide geographical distribution but has only been isolated from hosts belonging to the genus *Arctium* (*Asteraceae*), a plants genus commonly known as thistle burdock. Burdock root was used as bittering agent of beer before the introduction of hop and is very much used in Asian cuisine. *Ramularia abscondita* has been reported on *Arctium tomentosum* from Sweden (Braun 1998). The morphological description of this strain (Fig. 31) differs from the one in literature (Braun 1998) based on collections *in vivo* by having longer conidiophores and narrower conidiophores and conidia. These differences may be related to the fungus growing in culture and not being associated with its host. This strain forms a single lineage in the phylogenetic analysis (Fig. 2, clade 43) but will be tentatively considered as a good representative of this species until material from the type host and location is collected and cultured.

***Ramularia acris*** Lindr., Acta Soc. Fauna Fl. Fenn. 22(1): 14. 1902.

= *Septocylindrium ranunculi* Peck, Rep. (Annual) New York State Mus. Nat. Hist. 34: 46. 1881.

= *Ramularia aequivoca* f. *ranunculi-acris* C. Massal., Atti Mem. Accad. Agric. Sci. Art. Verona: 156. 1902.

= *Ramularia aequivoca* var. *andrei* M. Morelet, Bull. Soc. Sci. Nat. Archéol. Toulon Var: 9. 1967.

*Description in vivo*: See Braun (1998: 234).

*Specimens examined*: **Netherlands**, Gelderland Prov., Wageningen, on living leaves of *Ranunculus acris*, Aug. 2012, S.I.R. Videira, cultures CBS 141107 = CPC 25899 and CPC 25898; Utrecht Prov., Utrecht, Rhijnauwen, on living leaves of ?*Ranunculus* sp., May 2013, U. Damm, culture CPC 25900; Zeeland Prov., Borsele, Vladijk near Nisse, on *Ranunculus* sp., 27 Aug. 2001, G. Verkley, culture CBS 109794.

*Substrate and distribution*: On *Ranunculus* (*Ranunculaceae*); Asia, Europe and N. America.

*Notes*: The strains in this clade were previously identified as *R. didyma.* Authentic strains of *R. didyma* cluster in clade 72 (Fig. 2) and, besides *R. didyma*, *R. acris* is also common on *Ranunculus acris*. Since the strains were sterile in culture and no herbarium specimens were preserved, the morphological characters could not be compared with the description available in literature. The strains in this clade cluster in a highly supported clade (Fig. 2, clade 7, 1/100/100) and are tentatively treated as *R. acris*.

***Ramularia acroptili*** Bremer, Sydowia 2: 315. 1984.

≡ *Cercosporella acroptili* (Bremer) U. Braun, Nova Hedwigia 56: 439. 1993.

= *Cercosporella centaureicola* D. Berner *et al.*, Mycologia 97: 1122. 2006.

*Description in vivo*: See Braun (1995: 72).

*Specimens examined*: **Greece**, Macedonia region, Kozani, on leaves of *Centaurea solstitialis*, 28 Apr. 2004, D. Berner, culture CBS 120253 = BPI 844247. **Turkey**, Ankara, on *Acroptilon repens*, 14 Jul 1947, Bremer [Reliquiae Petrakianae 363] (**lectotype** W, No. 11177); near Isparta, on *Acroptilon repens*, 1 Sep. 1997, R. Sobhian (**epitype designated here** BPI 745883, MBT130827, culture ex-epitype CBS 120252). **USA**, California, on *Cynara cardunculus*, Oct. 2010, L. Davenport, cultures CPC 18723, CPC 18724.

*Substrate and distribution*: On *Acroptilon repens, Centaurea solstitiales* and *Cynara cardunculus* (*Asteraceae*); Central Asia, Europe and N. America.

*Notes*: Russian knapweed (*Acroptilon repens*) and yellow starthistle (*Centaurea solstitialis*) are invasive weeds in the western USA. Berner *et al.* (2005) studied two potential biological control agents for these weeds namely *Cercosporella acroptili* for *A. repens*, and a morphologically similar *Cercosporella* sp. on *Centaurea solstitialis*. The culture of *Cercosporella acroptili* (CBS 120252) from the same host and country as the type (*Acroptilon repens*, Turkey) was compared with the herbarium type material and found to be identical. Both *Cercosporella acroptili* (CBS 120252) and *Cercosporella* sp. (CBS 120253) were morphologically cryptic, the infection symptoms were phenotypically similar and the ITS sequences were 99 % similar with only 3 base pairs difference. Pathogenicity tests showed they were only pathogenic to their respective hosts, growth studies showed some culture morphology differences, and that they were vegetatively incompatible (Berner *et al.* 2006). At the time, the combination of these minor differences in morphology, pathogenicity, growth and genetics (ITS sequences) between *C. acroptili* and *Cercosporella* sp. were found sufficient to describe the new species as *Cercosporella centaureicola* (CBS 120253). However, previous studies have shown that a strain isolated from one host that was not able to colonise the other host did not necessarily mean they were different species; they can be the same species with different physiological specialisations to the host in which case a *forma specialis* is usually proposed (Macedo *et al.* 2013). In this study, the strains CBS 120252 and CBS 120253 show minimal nucleotide differences for the six genes amplified: 0 (LSU), 5 (ITS), 3 (*rpb2*), 2 (*actA*), 2 (*gapdh*) and 5 (*tef1*-α). We propose that this is the same species and synonymise *Cercosporella centaureicola* and *C. acroptili* under *R. acroptili*, since this is the older name. These strains fall in the *Ramularia* clade (Fig. 1, clade XIV, 1/100) and cluster in a highly supported clade based on BA, ML and PA phylogenetic analysis (Fig. 2, clade 2, 1/100).

***Ramularia actinidiae*** Ablak., Bot. Mater. Otd. Sporov. Rast. Bot. Inst. Komarova Akad. Nauk S.S.S.R. 13: 244. 1960. Fig. 32.

*Mycelium* consisting of hyaline, septate, branched, smooth, 1–2 µm diam hyphae. *Conidiophores* reduced to conidiogenous cells. *Conidiogenous cells* hyaline, thin-walled, smooth, intermediate in the mycelium, cylindrical-oblong, (6–)11.5–15(–20) × (1.5–)2(–3) µm, with one *conidiogenous locus*, almost flat to protuberant, thickened, darkened and refractive. *Conidia* hyaline, thin-walled, smooth, catenate, with *hila* thickened, darkened and refractive. *Ramoconidia* subcylindrical, fusoid, (15–)18–20(–28) × (1.5–)2–3 µm, 0–1-septate, with two apical hila. *Intercalary conidia* subcylindrical, fusoid, 0–1-septate, slightly narrower at the septa, (11–)17–20(–27) × 2–3 µm, in branched chains of up to four conidia. *Terminal conidia* subcylindrical, obovoid, aseptate, (7–)10–12.5(–20) × (1.5–)2(–3) µm (on SNA).

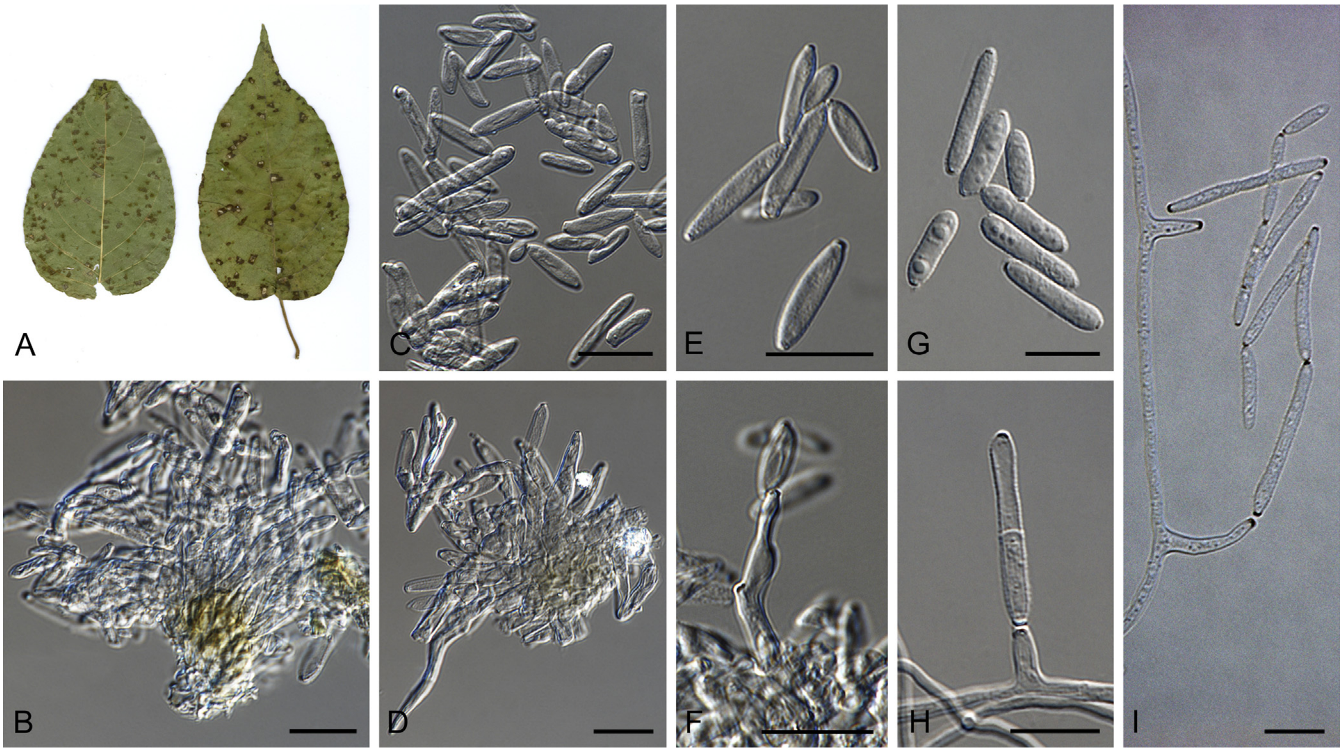

**Fig. 32.** *Ramularia actinidiae* (CBS 141108). A–F. Observations from herbarium material. G–I. Structures formed in culture. A. Leaf spot lesion on the host. B, D, F, H, I. Conidiophores and conidia. C, E, G. Conidia. Scale bars = 10 µm.

*Culture characteristics*: On MEA, 17 mm diam, surface convex, pale olivaceous grey, smooth flat mycelium, radially striated close to the margin, margins white and lobate, colony reverse olivaceous grey with a buff margin and radially striated; on OA, 15 mm diam, surface flat, short and uniform aerial mycelium, livid vinaceous in the centre and smoke-grey towards margin, with margins olivaceous grey, undulate and with scarce aerial mycelium, colony reverse iron-grey; on PDA, 18 mm diam, surface low convex, short and uniform aerial mycelium, pale olivaceous grey, with margins undulate, feathery, white, colony reverse iron-grey.

*Description in vivo*: See Braun (1998: 46).

*Specimen examined*: **South Korea**, Yangpyeong, on *Actinidia polygama*, 24 Oct. 2004, H.D. Shin, KUS-F20880, CBS H-22543, cultures CBS 141108 = CPC 11675, and CPC 11674.

*Substrate and distribution*: On *Actinidia polygama*; Russia and South Korea.

*Notes*: The description of *R. actinidiae* available in literature includes greyish caespituli, conidiophores, hyaline, simple, 20–40 µm long, conidia cylindrical, aseptate, 10.5–17 × 3 µm. The specimen observed has short conidiophores (12–)19–23(–35) × (1.5)–2–2.5(–3) µm and conidial dimensions matching the ones in culture (5–)10–12(–21) × (1.5–)2(–3) µm. *Ramularia actinidiae* was originally described on *Actinidia polygama* from Russia. Braun (1998) commented on this species being insufficiently known, and that the type material was not available for study. The strain used in this study is from a different location to that of *R. actinidiae* but the description of the morphology is quite similar (Fig. 32). It forms a single lineage supported by the Bayesian multigene analysis (Fig. 2, clade 77) and is tentatively maintained as *Ramularia actinidiae* until fresh material from the same location and host as the type has been recollected (*Actinidia polygama*, Russia).

***Ramularia agastaches*** Sawada, Bull. Gov. Forest Exp. Sta., Meguro 105: 85. 1958. Fig. 33.

*Mycelium* consisting of hyaline, septate, branched, smooth, 1–2 µm diam hyphae. *Conidiophores* reduced to conidiogenous cells. *Conidiogenous cells* hyaline, thin-walled, smooth, terminal or intermediate in the mycelium, cylindrical-oblong, (8.5–)11–13(–16) × 1.5–2(–2.5) µm, with one or two conidiogenous loci, thickened, darkened and refractive. *Conidia* hyaline, thin-walled, smooth, catenate, with hila thickened, darkened and refractive. *Ramoconidia* subcylindrical, clavate, ovoid, (11–)15–18(–27) × (2.5–)3–3.5(–4) µm, 0–1-septate, with two apical hila. *Intercalary conidia* subcylindrical, 0–1-septate, (11–)13.5–15.5(–21) × 3(–4) µm, in branched chains of up to six conidia. *Terminal conidia* subcylindrical, obovoid, aseptate, (4–)8–10(–13) × (2–)3(–4) µm (on SNA).

*Culture characteristics*: On MEA, 12 mm diam, surface raised, strongly folded, pale olivaceous grey, smooth, with margins crenate, reverse olivaceous grey; on OA, 10 mm diam, surface convex, pale olivaceous grey, fluffy aerial mycelium, with margins undulate, reverse olivaceous grey; on PDA, 10 mm diam, surface raised, pale olivaceous grey with white patches, fluffy aerial mycelium, with margins undulate, reverse rosy buff with olivaceous grey patches.

*Specimen examined*: **South Korea**, Hoengseong, on *Agastache rugosa*, 10 Oct. 2003, H.D. Shin, KUS-F19865, cultures CPC 10819–10821.

*Substrate and distribution*: On *Agastache rugosa*, East Asia (Japan, South Korea).

*Notes*: *Ramularia agastaches* was originally described on *Agastache rugosa* from Japan and was synonymised with *R. lamii* var. *lamii* by Braun (1998) who was not able to examine the type specimen. The strains in this clade were previously

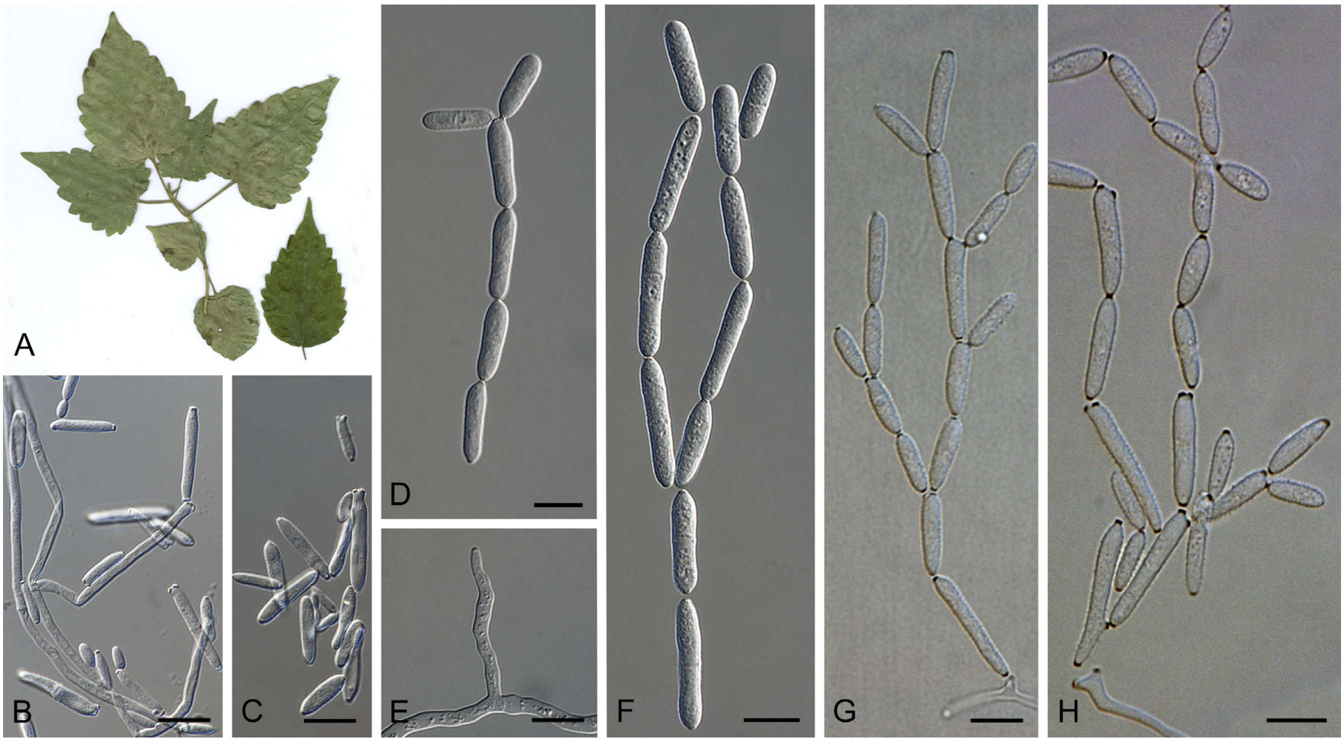

**Fig. 33.** *Ramularia agastaches* (CPC 10820). A–C. Observations from herbarium material. D–H. Structures formed in culture. A. Leaf spot symptoms on the host. B, G, H. Conidiophores, conidiogenous cells and conidia. C, D, F. Conidia. E. Conidiophore. Scale bars = 10 µm.

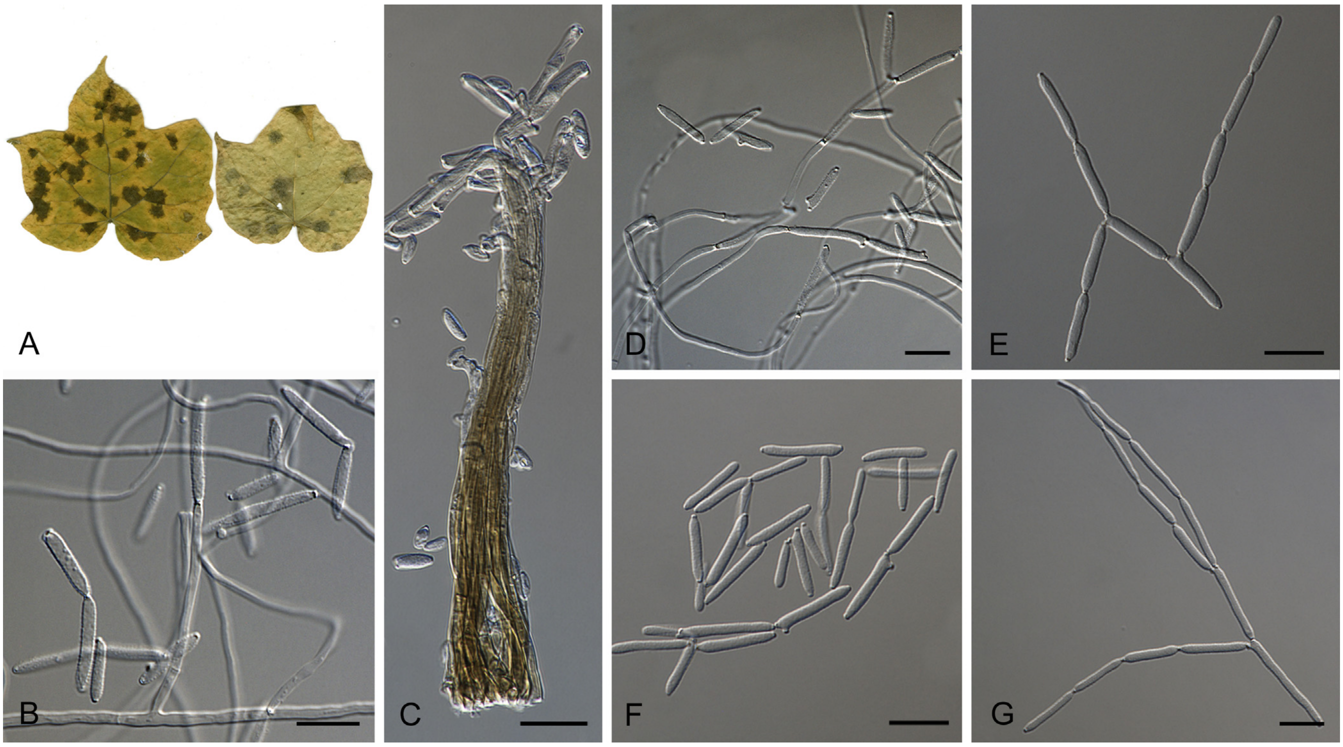

**Fig. 34.** *Ramularia alangiicola* (CPC 10299). A, C. Observations from herbarium material. B, D–G. Structures formed in culture. A. Leaf spot symptoms on the host. B, C, D. Conidiophores and conidia. E–G. Conidia. Scale bars = 10 µm.

identified as *R. lamii*, which is now restricted to species in clade 67 (Fig. 2). The strains in this clade form a highly supported clade by all three methods of phylogenetic analysis (Fig. 2, clade 46, 1/100/100). Morphologically (Fig. 33) the description does not match that of *R. lamii* available in literature (Braun 1998).

***Ramularia agrimoniae*** Sacc., Malpighia 10: 277. 1896.

*Leaf spots* almost absent to subcircular, pale to brownish occasionally with reddish border. *Mycelium* consisting of hyaline, branched, smooth, septate hyphae, sometimes forming small stromata internally. *Conidiophores* in loose fascicles arising from stromata, through stomata, or solitary arising from secondary hyphae, straight, subcylindrical to geniculate-sinuous, simple, 4–30 × 1.5–4 µm, 0–1(–2)-septate, hyaline, thin-walled, smooth; *conidiogenous loci* slightly thickened and darkened. *Conidia* formed in chains, occasionally branched, ellipsoid-ovoid, fusiform, subcylindrical, 6–19.5 × 1.5–3.5(–5) µm, 0–1-septate, hyaline, thin-walled, smooth to faintly rough, ends obtuse to subacute; *hila* minute, slightly thickened and darkened. Adapted from Braun (1998).

*Specimens examined*: **South Korea**, Hoengseong, on *Agrimonia pilosa*, 4 Aug. 2004, H.D. Shin, KUS-F20540, cultures CPC 11450–11452, CPC 11651–11653. **Russia**, Siberia, Paseka, on *Agrimonia* sp., 19 Jun., herb. Saccardo (**holotype** PAD).

*Substrate and distribution*: On *Agrimonia* spp. (*Rosaceae*), Asia, Caucasus, Europe.

*Note*: *Ramularia agrimoniae* was originally described on *Agrimonia* sp. from Siberia, Russia. Despite the reported distribution of this species across Europe and Asia, the available strains in this study all originate from South Korea (Fig. 2, clade 8, 1/100/100).

***Ramularia alangiicola*** Videira, H.D. Shin & Crous, **nom. nov.** MycoBank MB817157. Fig. 34.

*Basionym*: *Phacellium alangii* H.D. Shin & J.D. Kim, Mycotaxon 81: 341. 2002, non *Ramularia alangii* Hasija, 1962.

*Mycelium* consisting of hyaline, septate, branched, smooth, 1–2 µm diam hyphae. *Conidiophores* hyaline, thin-walled, smooth, erect, septate, cylindrical-oblong, straight, unbranched, (11–)24.5–35.5(–67) × (1.5–)2(–3) µm, or reduced to conidiogenous cells. *Conidiogenous cells* integrated in the mycelium or terminal on the conidiophore, cylindrical-oblong, (6–)11–15.5(–27) × (1.5–)2(–3) µm, with 1–2 conidiogenous loci almost flat to protuberant, thickened, darkened and refractive. *Conidia* hyaline, thin-walled, smooth to slightly verruculose, catenate, aseptate, with hila thickened, darkened and refractive. *Ramoconidia* cylindrical-oblong to clavate, (10–)12.5–14(–19) × (1.5–)2(–2.5) µm, with 2–3 apical hila. *Intercalary conidia* cylindrical-oblong, (8.5–)11–12(–16) × (1.5–)2(–2.5) µm, in branched chains of up to five conidia. *Terminal conidia* obovoid, (6–)8.5–9.5(–11.5) × (1.5–)2 µm.

*Specimens examined*: **South Korea**, Chuncheon, on leaves of *Alangium platanifolium* var. *macrophyllum*, 11 Oct. 2002, H.D. Shin, KUS-F19227, culture CPC 10299; Chuncheon, on living leaves of *Alangium platanifolium* var. *macrophyllum*, 29 Sep. 2000, H.D. Shin (**holotype** KUS-F17673, **isotyp**e HAL 1656 F).

*Substrate and distribution*: Only known from the type collection.

*Notes*: *Phacellium alangii* was originally described on *Alangium platanifolium* var. *macrophyllum* from South Korea (holotype in KUS). *In vivo*, this species produced long and septate conidiophores grouped in synnemata (90–340 × 20–50 µm) and conidia solitary or in short chains (5–42 × 2–5 µm) (Shin & Kim 2002). At the time it was described (Shin & Kim 2002), it was compared with *Ramularia alangii* but found different since the later has short and aseptate conidiophores (10–35 × 3–6.5 µm) and longer and wider catenate conidia (20–45 × 3–4.5 µm). *Ramularia alangii* was only known from the type location (on *Alangium salviifolium* [= *A. lamarckii*] from India) and this fact, together with the morphological differences, supported *Phacellium alangii* as a new species. In the herbarium specimen from which isolate CPC 10299 was derived, we observed that the conidiophores grow in synnemata that are hyaline to pale brown (Fig. 34, C). In culture, the synnemata were not observed, the conidiophores and conidia were shorter and narrower than the ones described in the original publication (Shin & Kim 2002). Since the species formed a distinct single lineage in the *Ramularia* clade (Fig. 1, clade XIV) and the production of synnemata is no longer considered a reliable character to separate *Ramularia* from *Phacelium*, a new combination is proposed. Because the epithet “*alangii*” is already occupied in *Ramularia* for a different species, the new epithet “*alangiicola*” is introduced.

***Ramularia aplospora*** Speg., Dec. Mycol. Ital. no. 105. 1879. Fig. 35.

≡ *Ovularia aplospora* (Speg.) Magnus, Hedwigia 44: 17. 1904.
= *Ramularia schroeteri* J.G. Kühn, Hedwigia 20: 147. 1881.
≡ *Ovularia schroeteri* (J.G. Kühn) Sacc., Syll. Fung. 4: 140. 1886.

*Mycelium* consisting of hyaline, septate, branched, smooth, 1–2 µm diam hyphae. *Conidiophores* hyaline, thin-walled, smooth, erect, 1–3(–5)-septate, cylindrical-oblong, straight and apically geniculate-sinuous, unbranched (22–)40–60(–135) × (1–)2(–3) µm. *Conidiogenous cells* terminal in conidiophores, cylindrical-oblong to sinuous, narrower at the top, (10.5–)19–24(–40) × (1–)1.5–2(–2.5) µm, with multiple conidiogenous loci almost flat to protuberant in a terminal and lateral position, thickened, darkened, refractive. *Conidia* hyaline, thin-walled, smooth to slightly verruculose, catenate, with hila thickened, darkened and refractive. *Ramoconidia* ellipsoidal to oval, (8.5–)10–11(–13) × (3.5–)5–6(–7) µm, aseptate, with 2 apical hila. *Intercalary conidia* ellipsoidal to oval, 0–1-septate, (8–)10–11(–14) × (4–)5–5.5(–7) µm, in branched chains of up to five conidia. *Terminal conidia* ellipsoidal to obovoid, aseptate, (5.5–)7.5–8.5(–11) × (3.5–)4.5–5.5(–6.5) µm.

*Culture characteristics*: On MEA, 20 mm diam, surface low convex, smooth, greenish grey, producing small droplets of hyaline exudate on top of the mycelium, radially striated with margins undulate and concave, colony reverse olivaceous grey, broken radially; on OA, 16 mm diam, surface low convex, smooth, pale olivaceous grey producing small droplets of hyaline exudate on top of the mycelium, with margins with an entire edge and with sparse buff mycelium, with a discolouration halo in the media around the colony margins, colony reverse buff and olivaceous grey; on PDA, 18 mm diam, surface low convex, smooth, grey olivaceous, margins feathery with an entire edge, colony reverse olivaceous grey.

*Description in vivo*: See Braun (1998: 242).

*Specimens examined*: **Austria**, Tirol, Ober Inntal, Samnaum Gruppe, Lazidalm near Serfaus, on leaf spot from *Alchemilla vulgaris*, 8 Aug. 2000, G. Verkley, cultures CBS 109120, CBS 109121; Ötztal, Hoch-Sölden, on leaf spot from *Alchemilla vulgaris*, 25 Jul. 2000, G. Verkley, cultures CBS 109013, CBS 109014. **Former Czechoslovakia**, on *Alchemilla xanthochlora*, unknown collector and date, isol. L. Marvanová, Nov. 1972, dep. L. Marvanová, Jan. 1973, culture CBS 237.73. **Germany**, Gössweinstein, Ober-Franken, on *Alchemilla vulgaris*, unknown collector and date, isol. T. Hijwegen, 3 Aug. 1982, dep. T. Hijwegen, Oct. 1982 (**epitype, designated here,** CBS H-1743, MBT204828, culture ex-epitype CBS 545.82). **Italy**, on *Alchemilla vulgaris* L., Speg., Decad. Mycol. Ital. 105 (**lectotype** designated in Braun 1998, PAD). **Sweden**, Uppland, Haga, Årtopet, on *Alchemilla vulgaris*, 14 Aug. 1988, E. Gunnerbeck, culture CBS 114118.

*Substrate and distribution:* On *Alchemilla* and *Aphanes* (*Rosaceae*); Asia, Caucasus, Europe.

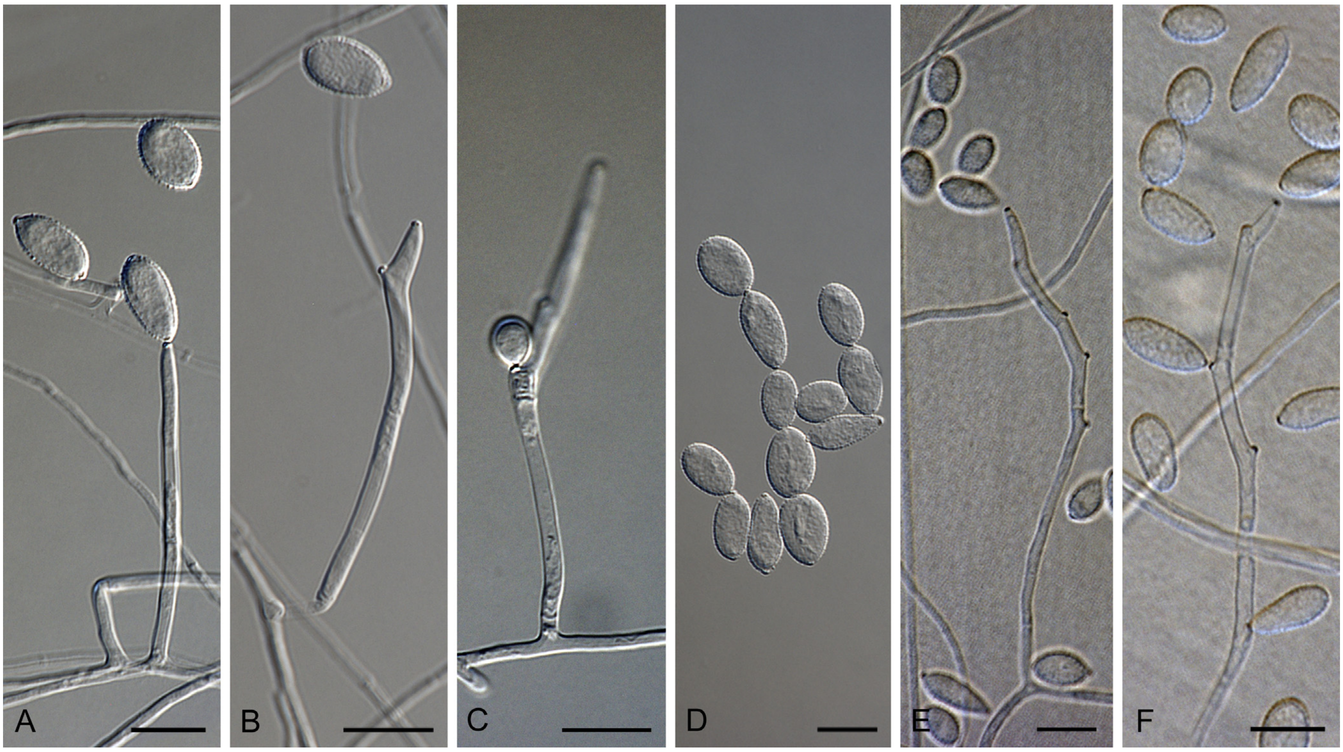

**Fig. 35.** *Ramularia aplospora* (CBS 545.82). A–F. Structures formed in culture. A–C, E, F. Conidiophores, conidiogenous cells and conidia. D. Conidia. Scale bars = 10 µm.

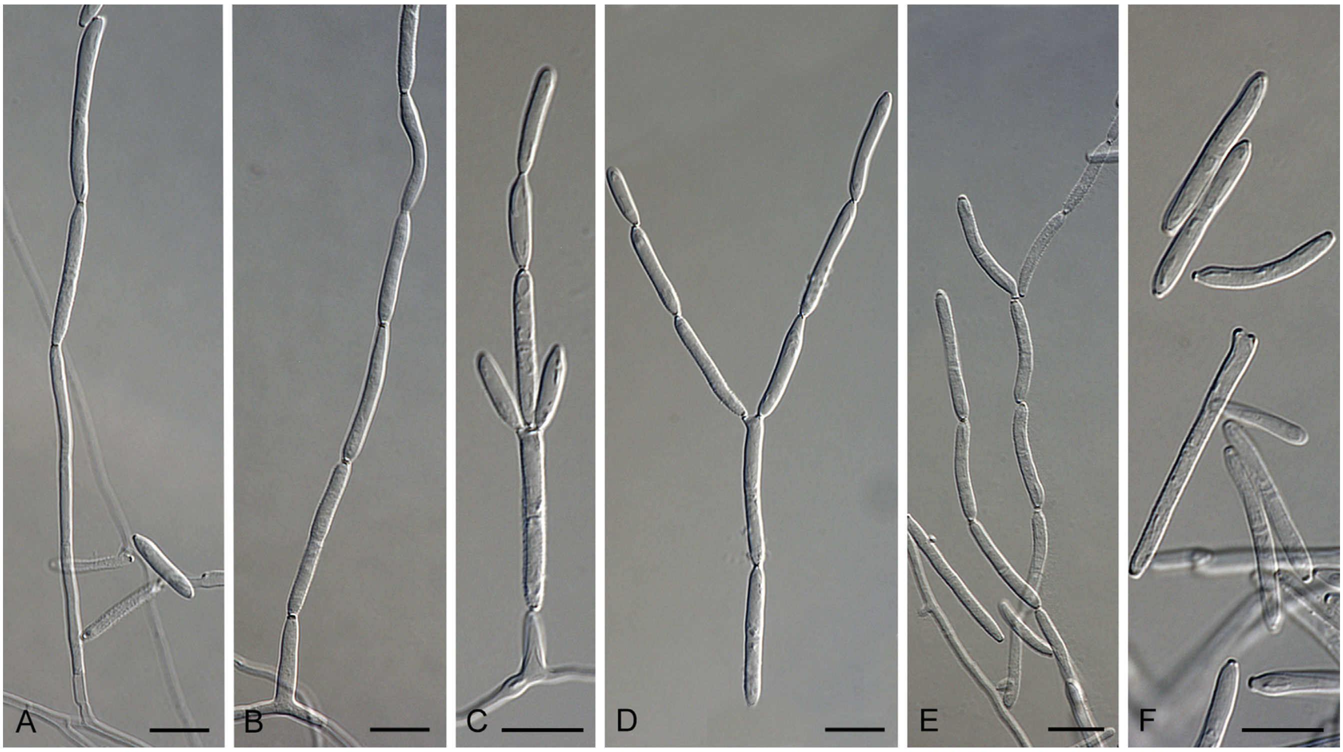

**Fig. 36.** *Ramularia archangelicae* (CBS 108991). A–F. Structures formed in culture. A–C. Conidiophores, conidiogenous cells and conidia. D, F. Conidia. E. Conidiogenous cell and conidia. Scale bars = 10 µm.

*Notes*: In literature, *R. aplospora* is linked to the sexual morph named *Mycosphaerella alchemillicola* (Vassiljevsky 1925, Braun 1998), but experimental proof is still lacking (Videira *et al.* 2015b). The strain CBS 545.82 has previously been indicated as the type strain of the latter (Crous *et al.* 2007) but this was not formally proposed. Therefore, and since the morphological characteristics are in agreement with the original description (Fig. 35), we formally designate CBS 545.82 as the ex-epitype strain of *R. aplospora*. This species formed a highly supported clade (Fig. 2, clade 27, 1/100/100). *Ramularia aplospora* is the only species in this genus known from the host *Alchemilla* (*Rosaceae*). *Alchemilla* plants are herbaceous perennials commonly known as “lady's mantle” and highly appreciated in gardens for their flowers and foliage (Hawke 2004).

**Ramularia archangelicae** Lindr., Acta Soc. Fauna Fl. Fenn. 23: 22. 1902. Fig. 36.

= *Ramularia angelicae* Höhn., Hedwigia 42: 178. 1903.
= *Cylindrosporium vaccarianum* Sacc., Nuovo Giorn. Bot. Ital., N.S., 24: 41. 1917.
= *Ramularia grantii* Dearn., Mycologia 21: 326. 1929.
= *Septocylindrium angelicae* Katsuki, Kyushu Agric. Res. 6: 42. 1953.

*Mycelium* consisting of hyaline, septate, branched, smooth, 0.5–2 µm diam hyphae. *Conidiophores* hyaline, thin-walled, smooth, erect, septate, straight, cylindrical-oblong, unbranched, (11.5–)26.5–36(–46.5) × 1.5–2(–2.5) µm or reduced to conidiogenous cells. *Conidiogenous cells* integrated in mycelium or terminal in conidiophores, cylindrical-oblong, (5.5–)9.5–12(–16) × (1–)1.5–2 µm, with 1–2 apical conidiogenous loci, almost flat to short cylindrical thickened, darkened, refractive. *Conidia* hyaline, thin-walled, smooth, with hila thickened, darkened and refractive. *Ramoconidia* subcylindrical to clavate, (15–)22–25(–35) × (1.5–)2–2.5(–3) µm, 0–3-septate, with 2–3 apical hila. *Intercalary conidia* aseptate or 0–1(–2)-septate, subcylindrical, sometimes curved, (14–)18–22(–37) × (1.5–)2(–2.5) µm, in branched chains of up to seven conidia. *Terminal conidia* aseptate, subcylindrical to obovoid, (6–)10–12(–16) × 1.5–2(–2.5) µm, *hila* thickened, darkened, refractive.

*Culture characteristics*: On MEA, 13 mm diam, surface raised, folded, smooth, light smoke grey with pale vinaceous tinge with margins undulate, convex, feathery, colony reverse brick and with dark vinaceous patches; on OA, 16 mm diam, surface low convex, fluffy aerial mycelium, dirty white to smoke-grey, with margins crenate, producing a brick coloured pigment imbued in the agar forming a 13 mm band surrounding the colony, colony reverse dark vinaceous centre; on PDA, 16 mm diam, surface flat, smooth, pale smoke-grey with pale vinaceous tinge, forming tiny droplets of pale vinaceous exudate, with margins undulate, colony reverse pale vinaceous centre turning lighter shade towards the margin. Strains CBS 108992 and CBS 288.49 did not produce any pigment.

*Description in vivo*: See Braun (1998: 55).

*Specimens examined*: **Austria**, Ötztal, Ötz near Habichen, on leaf spot of *Angelica sylvestris*, 24 Jul. 2000, G. Verkley, cultures CBS 108991, CBS 108992, CBS 109011, CBS 109012; on stem of *Angelica sylvestris*, unknown collector and date, isol. and dep. J.A. von Arx, Jun. 1949, culture CBS 288.49. **Sweden**, Lapponia Lulensis, Sarvestjakko, on *Angelica archangelica*, 12 Aug. 1900 [Vestergr., Micromyc. Rar. Sel. Praec. Scand. 549] (**neotype**, designated in Braun 1998, B).

*Substrate and distribution*: On *Angelica* (*Apiaceae*); Asia, Europe, North America.

*Notes*: This species was described from *Argelica archangelica* collected in Sweden (neotype at B). The representative strains of this species cluster in a clade highly supported by BA and ML phylogenetic analyses (Fig. 2, clade 19, 1/100/100). Morphologically, the structures observed in culture (Fig. 36) are slightly narrower than those described in literature based on material *in vivo* (Braun 1998) but similar in all other characters. The strain CBS 288.49 was initially identified as *Mycosphaerella rubella*, and the type of this species was isolated from *Angelica sylvestris* from Germany. However, there is no evidence in literature of a link between these sexual and asexual names, and further studies are necessary to evaluate whether these species are conspecific.

**Ramularia armoraciae** Fuckel, Jahrb. Nassauischen Vereins Naturk. 23–24: 361 “1869” (1870) emend. U. Braun (1998). Fig. 37.

≡ *Ovularia armoraciae* (Fuckel) Massee, Brit. Fung.-Fl. 3: 321: 1893.
≡ *Cylindrospora armoraciae* (Fuckel) J. Schröt., in Cohn, Krypt.-Fl. Schlesien, 3.2(4): 485: 1897.
≡ *Entylomella armoraciae* (Fuckel) Cif., Ann. Mycol. 26: 17. 1928.
= *Ramularia matronalis* Sacc., Michelia 2(6): 123. 1880.
= *Ramularia cochleariae* Cooke, Grevillea 11(60): 155. 1883.
= *Ramularia hesperidis* Săvul. & Sandu, Mem. Sect. Şti. Acad. Română, Ser. 3, 15: 477. 1940.

For additional synonyms see Braun (1998).

*Mycelium* consisting of hyaline, septate, branched, smooth, 1.5–3 µm diam hyphae. *Conidiophores* hyaline, thin-walled, smooth, erect, septate, straight, cylindrical-oblong, geniculate-sinuous, unbranched, (12–)20–29(–41) × (1.5–)2(–3) µm or reduced to conidiogenous cells. *Conidiogenous cells* integrated in mycelium or terminal in conidiophores, cylindrical-oblong, geniculate-sinuous, (2–)12–17(–30) × (1–)1.5–2.0(–3) µm, with one to multiple apical conidiogenous loci, almost flat or slightly protuberant, thickened, darkened and refractive. *Conidia* hyaline, thin-walled, smooth, catenate, aseptate, with hila thickened, darkened and refractive. *Ramoconidia* subcylindrical to clavate, (10.5–)13–14.5(–18.5) × (2.5–)3(–4) µm, with two apical hila. *Intercalary conidia* fusoid, ovoid, ellipsoid, (8–)10.5–12(–16) × (2.5–)3–3.5(–4) µm, in branched chains of up to ten conidia. *Terminal conidia* obovoid, (5–)7–8(–10) × (2–)3–3.5(–4) µm (on SNA).

*Culture characteristics*: On MEA, 13 mm diam, surface irregular, raised, smooth, white, with margins crenate feathery and olivaceous green, colony reverse olivaceous green; on OA, 14 mm diam, surface flat, smooth, with sparse aerial mycelium, white with olivaceous green patches, with margin irregular, with sparse aerial mycelium, colony reverse iron-grey; on PDA, 13 mm diam, surface flat, smooth, white with pale olivaceous grey patches, margins undulate, colony reverse olivaceous grey.

*Description in vivo*: See Braun (1998: 120).

*Specimens examined*: **Germany**, on *Armoracia rusticana* [Fuckel, Fungi Rhen. Exs. 133; **lectotype**, designated in Braun (1998), HAL]; on *Armoracia rusticana*, S. Petzoldt, unknown date (**epitype designated here,** CBS H-22518, MBT204829, culture ex-epitype CBS 241.90). **Netherlands**, on *Armoracia rusticana*, unknown collector and date, isol. and dep. A.L. Houwink, Nov. 1928, culture CBS 253.28.

*Substrate and distribution*: On various crucifers (*Brassicaceae*); Asia, Caucasus, Europe, Africa (Kenya), N. America.

*Notes*: *Ramularia armoraciae* was first described on *Armoracia rusticana* from Germany (lectotype in HAL). Strain CBS 241.90 originates from the same country and was isolated from the same host as the holotype, and is therefore chosen as ex-epitype (Fig. 37). Phylogenetically, this species is highly supported by the BA and ML analysis (Fig. 2, clade 55).

**Ramularia asteris** (W. Phillips & Plowr.) Bubák, in Kabát & Bubák, Fungi Imperf. Exs., Fasc. 8, no. 388. 1906.
*Basionym*: *Fusidium asteris* W. Phillips & Plowr., Grevillea 6: 23. 1877.

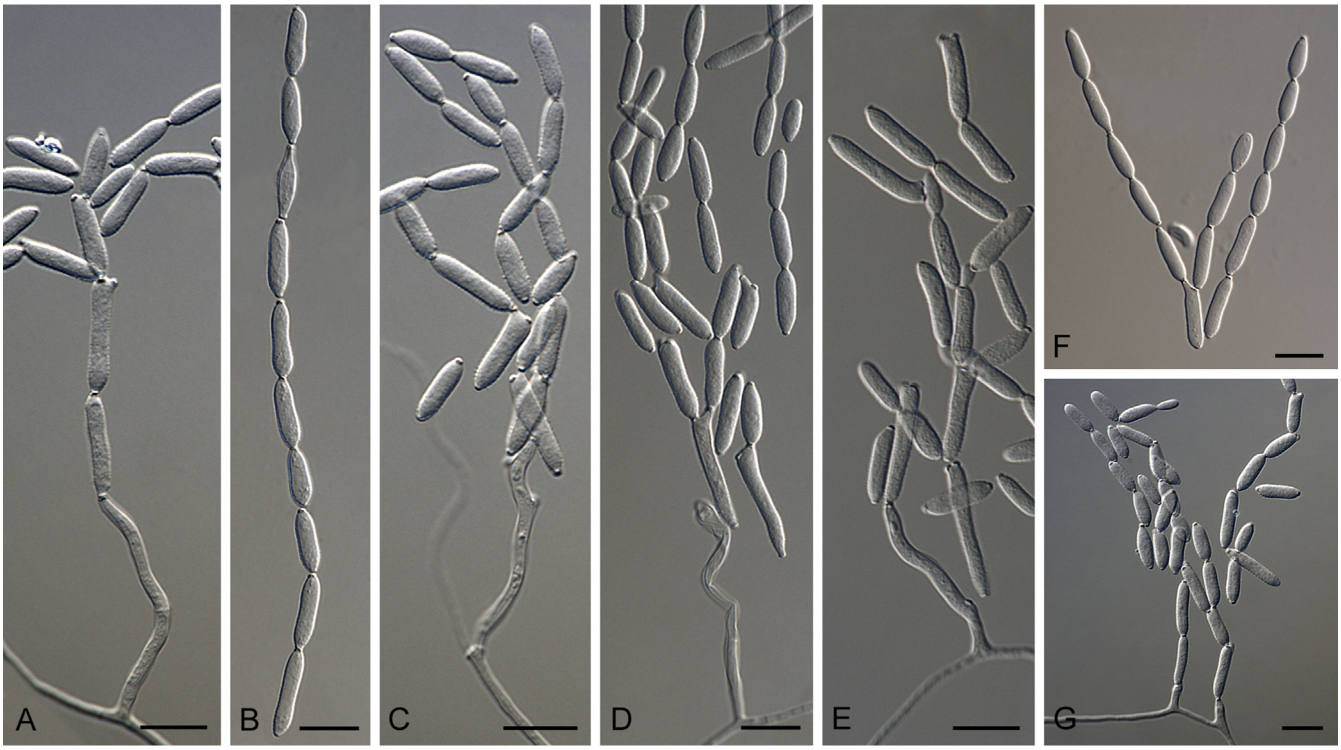

**Fig. 37.** *Ramularia armoraciae* (CBS 241.90). A–G. Structures formed in culture. A, C–E, G. Conidiophores, conidiogenous cells and conidia. B, F. Conidia. Scale bars = 10 µm.

= *Ramularia rudbeckiae* Peck, Rep. (Annual) New York State Mus. Nat. Hist. 34: 47. 1881.
= *R. macrospora* var. *asteris* Trel., Preliminary list of the parasitic fungi of Winsconsin: 13. 1884.
= *Ramularia asteris-tripolii* Jaap, Verh. Bot. Vereins Prov. Brandenburg 50: 48. 1908.
= *R. serotina* var. *stomaticola* U. Braun, Nova Hedwigia 58: 199. 1994.

For additional synonyms see Braun (1998) or MycoBank.

*Description in vivo*: See Braun (1998: 259).

*Specimens examined*: **Netherlands**, on *Aster tripolium*, unknown collector and date, isol. v.d. Molen, dep. Oct. 1921, culture CBS 131.21. **UK**, Kings Lynn, on *Aster tripolium*, 10/5, Plowright (**holotype** K).

*Substrate and distribution*: On *Aster*, *Galatella*, *Grindelia*, *Heteropappus*, *Rudbeckia*, *Solidago* (*Asteraceae*); Asia, Europe, N. America.

*Notes*: *Ramularia asteris* was first observed on *Aster tripolium* from England (holotype in K). There are specimens of *Ramularia asteris* with narrow conidia (3–5 µm) that are referred to as *R. asteris* var. *asteris*, and broader conidia (5–7 µm) that are usually referred to as *R. asteris* var. *latispora* (Braun 1998). Only one isolate was available in this study (CBS 131.21) and it forms a single lineage (Fig. 2, clade 11). The culture was unfortunately sterile and no morphological observations could be made.

***Ramularia bellunensis*** Speg., Michelia 1(5): 475. 1879.

*Description in vivo*: See Braun (1998: 95).

*Specimens examined*: **Italy**, Belluno, on *Tanacetum parthenium*, Oct. 1878, Spegazzini [**lectotype**, designated in Braun (1998), PAD]. **Netherlands**, on *Argyranthemum frutescens* (≡ *Chrysanthemum frutescens*), unknown collector and date, isol. H.C. Koning, dep. Dutch Plant Protection Services, Jan. 1943, culture CBS 116.43. **New Zealand**, Auckland, Grey Lynn, on *A. frutescens*, unknown collector and date, isol. C.F. Hill, Jun. 2005, dep. C.F. Hill, culture CBS 118417.

*Substrate and distribution*: On *Argyranthemum*, *Chrysanthemum*, *Leucanthemum*, *Tanacetum* (*Asteraceae*); Africa, Asia, Caucasus, Europe.

*Notes*: *Ramularia bellunensis* was described in 1879 from *Tanacetum parthenium*, from Italy [lectotype, designated in Braun (1998), in PAD]. This species is represented in a single lineage (Fig. 2, clade 75). This is a new report for the Netherlands and New Zealand, as well as a first report on the host *Argyranthemum frutescens* (Braun 1998). Although strain CBS 118417 is not in the phylogenetic trees, it is identical to CBS 116.43, except on one nucleotide in *gapdh* and one nucleotide in *tef1*-α. It was not included because at the time the trees were prepared we did not possess all the gene sequences. No ex-type strain of this species is available, and collections on *Tanacetum* from Italy are required to resolve its identity.

***Ramularia beticola*** Fautrey & Lambotte, Rev. Mycol. (Toulouse) 19: 54. 1897. Fig. 38.
= *Ramularia betae* Rostr., Bot. Tidskr. 22: 272. 1898 (1899).

*Mycelium* consisting of hyaline, septate, branched, smooth, 1–2 µm diam hyphae. *Conidiophores* hyaline, thin-walled, smooth, erect, 1–2(–4)-septate, straight to sinuous, cylindrical-oblong, unbranched (19.5–)43–58(–83) × 2–2.5(–3) µm or reduced to conidiogenous cells. *Conidiogenous cells* integrated in mycelium or terminal in conidiophores, cylindrical-oblong and narrower at the top, (7–)16.5–20(–30) × 2–2.5(–3) µm, with 1–4 apical conidiogenous loci, almost flat or protuberant, thickened, darkened and refractive. *Conidia* hyaline, thin-walled, smooth to slightly verruculose, catenate, with hila thickened, darkened and refractive. *Ramoconidia* subcylindrical to clavate, (8–)12–14.5(–22) × 3–4 µm, 0–1-septate, with two apical hila. *Intercalary conidia* subcylindrical, sometimes curved, ovoid, 0–1-septate, (8.5–)10.5–12.5(–20) × (2.5–)3(–4) µm, in branched

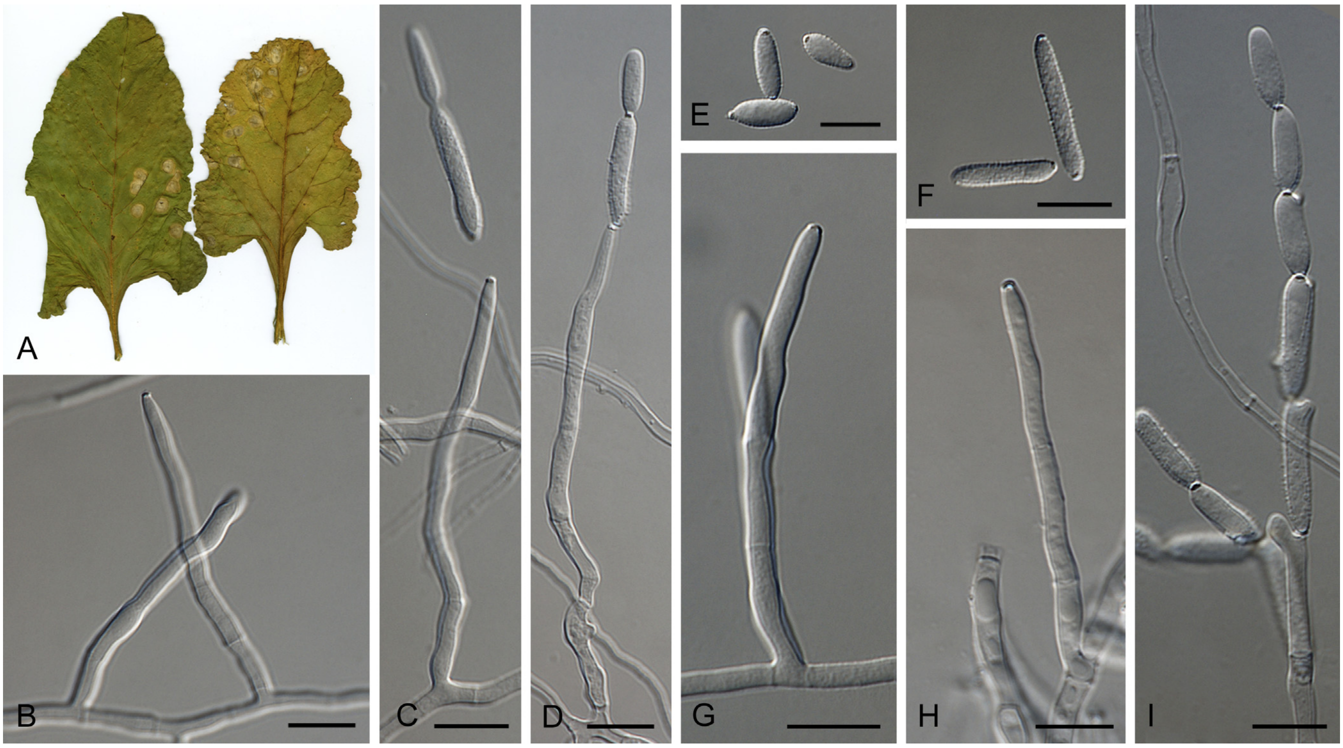

**Fig. 38.** *Ramularia beticola* (CBS 141109). A. Observations from herbarium material. B–H. Structures formed in culture. A. Leaf spot symptoms on the host. B, G, H. Conidiophores and conidiogenous cells. C, D, I. Conidiophores, conidiogenous cells and conidia. E, F. Conidia. Scale bars = 10 µm.

chains of up to eight conidia. *Terminal conidia* subcylindrical to obovoid, aseptate, (3.5–)6.5–8(–11) × (2–)3(–5) µm (on SNA).

*Culture characteristics*: On MEA, 13 mm diam, surface irregular, raised, smooth, white, with margins crenate feathery and olivaceous green, colony reverse olivaceous green; on OA, 14 mm diam, surface flat, smooth, with sparse aerial mycelium white with olivaceous green patches, with margin irregular, with sparse aerial mycelium, colony reverse iron-grey; on PDA, 13 mm diam, surface flat, smooth, with white to pale olivaceous grey patches, margins undulate, colony reverse olivaceous grey.

*Description in vivo*: See Braun (1998: 136).

*Specimens examined*: **Denmark**, Holeby, on leaf spot on *Beta vulgaris*, 2011, A.L. Hansen, culture CPC 30065; Jungshoved, on leaf spot on *Beta vulgaris*, 2011, A.L. Hansen, culture CPC 30653. **France**, Dumont, on *Beta vulgaris* L., 1896, Fautrey [Roum., Fungi Sel. Exs. 7261; **lectotype**, designated in Braun (1998), PC]; Fresney-l'Évêque, on leaf spot on *Beta vulgaris*, 2011, A. Champeil, **epitype designated here** CBS H-22519, MBT204830, culture CBS 141109 = CPC 30066). **Germany**, Bonn, on unknown host, unknown collector and date, isol. and dep. H.A. Diddens, Jan. 1929, culture CBS 341.29. **Netherlands**, Groningen, leaf spot on *Beta vulgaris*, 2011, S.I.R. Videira, culture CPC 30067; Steenbergen, leaf spot on *Beta vulgaris*, 2011, S.I.R. Videira, cultures CPC 30063, CPC 30064. **Switzerland**, Nyon, on *Beta vulgaris*, unknown collector and date, isol. B. Lieberherr, dep. R. Corbaz, Feb. 1967, culture CBS 151.67.

*Substrate and distribution*: On *Beta* (*Chenopodiaceae*); Asia, Europe, North America.

*Notes*: *Ramularia beticola* (Fig. 38) is the causal organism of Ramularia leaf spot disease in sugar beet, table beet and fodder beet. The fungus forms pale brown leaf spots and affected leaves turn yellow, become necrotic and die. The impact of Ramularia leaf spot disease can vary significantly from season to season. Conditions of high humidity, moderate temperature (17–20 °C), high plant density and sulphur deficiency usually increase disease intensity and damage. It has been reported from North America (Oregon, Washington, California and Colorado), Europe (Ireland, UK, the Scandinavian countries, Belgium, France, Germany) and Russia (Harveson *et al.* 2009). Worldwide, yield losses in sugar beet due to plant pathogens and pests are estimated in general to be 26 % with, and more than 80 % without crop protection (Oerke & Dehne 2004). In the Netherlands, in spite of crop protection measures, the yield losses due to pests and diseases for top growers were 37.1 and 16.7 % on sandy and clay soils respectively (Hanse *et al.* 2011). When treatments are applied timely, programmes of disease control in Denmark increased sugar yield by 10 %. Thus far, *R. beticola* has not shown signs of developing resistance to either strobilurin or triazol fungicides, but it remains important to apply fungicides efficiently by following monitoring programmes and respecting the recommended thresholds (www.FRAC.info) (Thach *et al.* 2013). *Ramularia beticola* was described on *Beta vulgaris* from France in 1896. The strains used in this study clustered together in a single and highly supported clade (Fig. 2, clade 52, 1/100/100).

***Ramularia bosniaca*** Bubák, Österr. Bot. Z. 53: 49. 1903. Fig. 39.

= *Ramularia scabiosae* Rostr. ex Lind, Danish Fungi: 511. 1913.
= *Ramularia scabiosae* Jaap, Ann. Mycol. 15: 122. 1917.

*Mycelium* consisting of hyaline, septate, branched, smooth, 1–3 µm diam hyphae. *Conidiophores* hyaline, thin-walled, smooth, erect, 1–2(–4)-septate, straight to geniculate-sinuous, cylindrical-oblong, unbranched, (20–)41–60(–119) × 2–2.5(–3) µm or reduced to conidiogenous cells. *Conidiogenous cells* integrated in mycelium or terminal in conidiophores, cylindrical-oblong and narrower at the top, geniculate-sinuous, (14–)19–23(–35) × 2–2.5(–3) µm, with 1–4 apical conidiogenous loci, almost flat or protuberant,

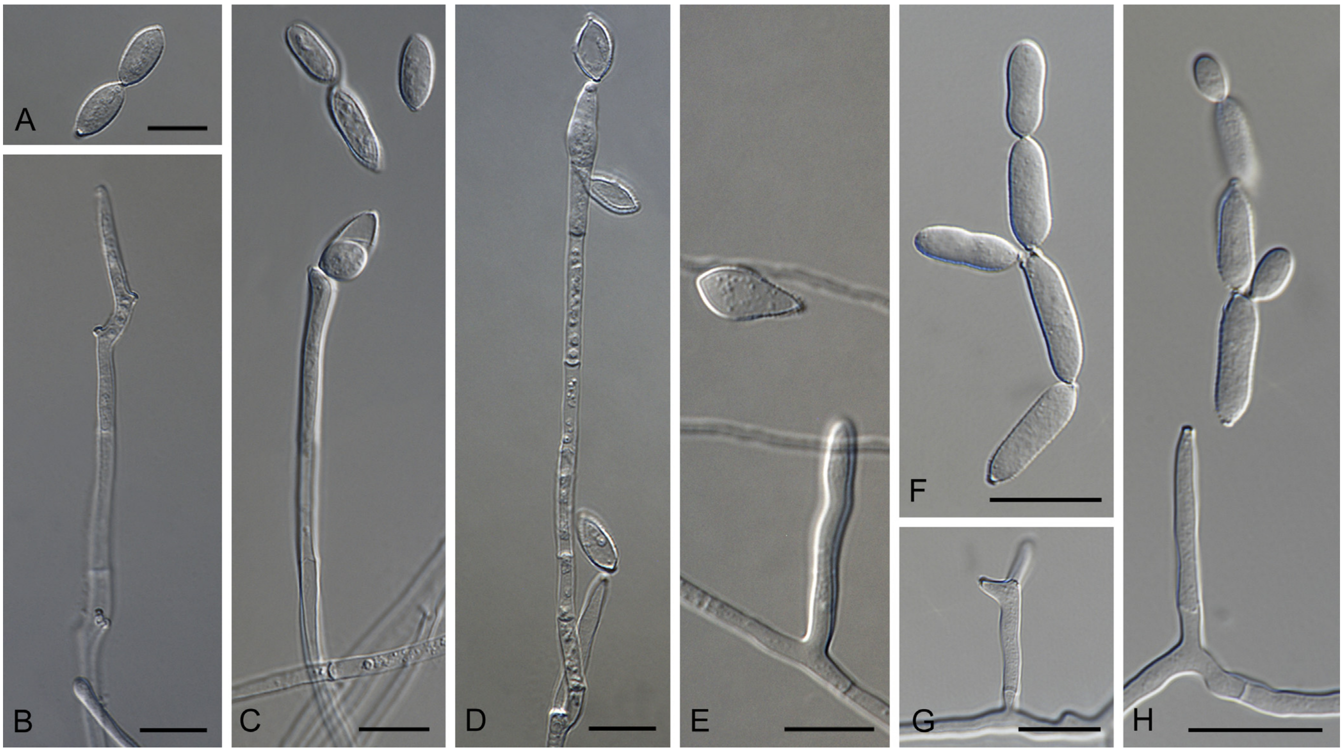

**Fig. 39.** *Ramularia bosniaca* (CBS 123880). A–H. Structures formed in culture. A, F. Conidia. B, G. Conidiophores. C, D, E, H. Conidiophores and conidia. Scale bars = 10 µm.

thickened, darkened and refractive. *Conidia* hyaline, thin-walled, smooth, solitary or catenate, aseptate, with hila thickened, darkened and refractive. *Ramoconidia* subcylindrical to ovoid, (7.5–)10–11(–14) × (3–)4–4.5(–5) µm, with two apical hila. *Intercalary conidia* ovoid, 0–1-septate, (8–)9.5–10.5(–13) × (3–)4–5(–7) µm, in branched chains of up to four conidia. *Terminal conidia* obovoid, (5–)7–8(–10) × (2.5–)4(–5) µm (on SNA).

*Culture characteristics*: On MEA, 13 mm diam, surface irregular, raised, smooth, white, with margins crenate, feathery and olivaceous green, colony reverse olivaceous green; on OA, 14 mm diam, surface flat, smooth, with sparse aerial mycelium white with olivaceous green patches, with margin irregular, with sparse aerial mycelium, colony reverse iron-grey; on PDA, 13 mm diam, surface flat, smooth, with white with pale olivaceous grey patches, margins undulate, colony reverse olivaceous grey.

*Description in vivo*: See Braun (1998: 143).

*Specimen examined*: **Czech Republic**, Moravia, Pavlov, forest around the ruin, leaf spot on *Scabiosa ochroleuca*, 18 Nov. 2008, G. Verkley, cultures CBS 123880, CBS 123881.

*Substrate and distribution*: On *Scabiosa* (*Dipsacaceae*); Central Asia, Caucasus, Europe.

*Notes*: *Ramularia bosniaca* was originally described on the host *Scabiosa columbaria* in Bosnia (holotype BPI 416442 [the neotype designated in Braun (1998), BPI 416443, is obsolete since holotype material has been traced in BPI]) and is the only species of *Ramularia* known to infect *Scabiosa* (Braun 1998). *Ramularia bosniaca* has been reported from several European countries but this is the first time it is reported from the Czech Republic. The description of these collections fit that of *R. bosniaca* (Braun 1998), except that conidia were shorter than 28 µm (Fig. 39). Additional collections from Montenegro may well reveal the strains from the Czech Republic to represent a new species. The phylogenetic analysis provides good support to this species clade (Fig. 2, clade 60, 1/100/100).

***Ramularia buniadis*** Vestergr., Jahreskat. Wiener Kryptog. Tauschanst.: 4. 1897.

*Specimens examined*: **Sweden**, Uppsala, Skottsbacke, X. 1897 [Vestergr., Micromyc. Rar. Sel. Praec. Scad. 73; **lectotype**, designated in Braun (1998), S-F57272]. **Sweden**, Uppland, Haga, Årtopet, on *Bunias orientalis*, 16 Sep. 1988, E. Gunnerbeck, culture CBS 114301 = UPSC 2718.

*Substrate and distribution*: On *Bunias orientalis* (*Brassicaceae*); Caucasus, Europe.

*Notes*: This species was described on *Bunias orientalis* collected in Sweden (lectotype in S). *Ramularia buniadis* (among other names) was synonymised with *R. armoraciae*, but since *R. armoraciae* clusters in clade 55 (Fig. 2), the name *R. buniadis* is again resurrected for this isolate (Fig. 2, clade 48). Although this isolate could be considered a good representative for epitypification, it is sterile in culture and no herbarium material of the CBS isolate was preserved.

***Ramularia calcea*** Ces., in Rabenhorst, Klotzschii Herb. Viv. Mycol., Ed. 1, Cent. 17: no. 1681, Dresden 1852, emend. U. Braun (1998). Fig. 40.

= *Hormodendrum farinosum* Bonord., Bot. Zeitung 19: 196. 1861.
= *Ovularia symphyti-cordati* Săvul. & Sandu, Hedwigia 73: 107. 1933.
= *Ramularia trachystemonis* Siemaszko, Mat. Mikol. Fitopatol. Ross., I, 3: 39. 1915.
= *Ramularia noneae* Lobik, Bolez. Rast. 17: 190. 1928.

For additional synonyms see Braun (1998).

*Mycelium* consisting of hyaline, septate, branched, smooth, 0.5–1.5 µm diam hyphae. *Conidiophores* reduced to conidiogenous cells. *Conidiogenous cells* hyaline, thin-walled, smooth, intermediate in the mycelium, cylindrical-oblong, (5.5–)10.5–13(–17) × 1–1.5(–2) µm, with one or two conidiogenous loci, almost flat to protuberant, thickened, darkened and refractive, 1 µm diam. *Conidia* hyaline, thin-walled, smooth, catenate, with hila thickened, darkened and refractive. *Ramoconidia* cylindrical-oblong to oval, (7–)9.5–12(–23) × (1.5–)2(–2.5) µm, 0–1-septate, with 2–4 apical hila. *Intercalary conidia* cylindrical-oblong, ellipsoid or fusoid, aseptate, (4.5–)7–8(–11) × (1.5–)2(–2.5) µm, in branched chains of up to seven conidia. *Terminal conidia* obovoid, aseptate, (3–)4–4.5(–6) × (1–)1.5–2 µm (on SNA, CBS 101613).

*Culture characteristics*: On MEA, 17 mm diam, surface raised, folded, erumpent aerial mycelium, vinaceous-buff, with margins lobate, convex, feathery, colony reverse brown-vinaceous and fawn margin; on OA, 15 mm diam, surface raised, folded, erumpent aerial mycelium, vinaceous-buff, with margins undulate, rosy-vinaceous and no aerial mycelium, colony surrounded by a 0.5 cm discoloured halo, colony reverse vinaceous; on PDA, 14 mm diam, surface greyish lilac, erumpent, convex, with margins pale vinaceous, undulate, colony surrounded by pale vinaceous pigment diffusing into the media, colony reverse vinaceous.

*Description in vivo*: See Braun (1998: 112).

*Specimens examined*: **Germany**, Thüringen, Weimar, brown leaf spot on *Symphytum* sp., 1999, G. Arnold, cultures CBS 101612, CBS 101613. **Italy**, Vercellis, 1851, Cesatis [Rabenh., Klotzschii Herb. Viv. Mycol. 1681; **lectotype**, designated in Braun (1998), HAL]. **Sweden**, Uppland, Vassunda, on *Viola hirta*, 11 Sep. 1988, E. Gunnerbeck, culture CBS 114442.

*Substrate and distribution*: On *Nonea*, *Symphytum*, and *Trachystemon* spp. (*Boraginaceae*); Asia, Caucasus, Europe.

*Notes*: *Ramularia calcea* is a species with a wide distribution within Europe that was originally described on *Symphytum officinale* from Italy. Morphologically, the strains in this clade have conidiophores reduced to conidiogenous cells and narrower conidia (Fig. 40) than the *in vivo* description of *R. calcea* found in literature (Braun 1998), in which the conidiophores are small and sometimes deeply forked [10–80 × (2–)3–6(–7) µm], and conidia are wider [(5–)8–24(–26.5) × (2.5–)3–7(–8) µm]. Unfortunately, the herbarium specimen from which the culture was retrieved was not preserved which made it impossible to assess the morphological characters of this species on host tissue. The clade formed by these two strains is highly supported by the phylogenetic analysis (Fig. 2, clade 42). Strain CBS 299.49 (Fig. 2, clade 36) is also under the name *R. calcea* in the CBS database, but since this is sterile it will be treated as *Ramularia* sp. C. Therefore, the correct phylogenetic placement of this species remains unresolved until material from the type host and location is recollected. *Ramularia calcea* has been reported on *Symphytum officinale* in both Germany and the Netherlands, among other countries. The morphological characteristics of CBS 114442 are identical to CBS 102612 and 102613, therefore, until more collections become available, these strains will be treated as *R. calcea* here.

***Ramularia carneola*** (Sacc.) Nannf., in Lundell & Nannf., Fungi Exs. Suec., Fasc. XXXIX–LX, Sched.: 25. 1950.

*Basionym*: *Ovularia carneola* Sacc., Fungi ital. Del., Tab. 975. 1881.

= *Ovularia duplex* Sacc., Fungi ital. Del., Tab. 876. 1881.
= *Ramularia scrophulariae* Fautery & Roum., Revue Mycol. (Toulouse): 81. 1891.
= *R. nicolai* Bubák, Sitzungsber. Königl. Böhm. Ges. Wiss. Prag: 19. 1903.
= *R. borghettiana* C. Massal., Malpighia 25: 14. 1912.
= *R. nodosa* Tho, Novosti Sist. Nizsh. Rast. 9: 204. 1972.

*Description in vivo*: See Braun (1998: 264).

*Specimens examined*: **France**, Rouen, on *Scrophularia nodosa*, Letendre, herb. Saccardo (**holotype** PAD). **Netherlands**, Utrecht Prov., Baarn, de Hooge Vuursche, leaf spot on *Scrophularia nodosa*, 22 Jun. 2000, G. Verkley, cultures CBS 108975–108978; Goedereede, Kwade Hoek nature reserve parking, leaf spot on *Scrophularia nodosa*, 13 Sep. 2001, G. Verkley, culture CBS 109847.

*Substrate and distribution*: On *Scrophularia* (*Scrophulariaceae*); Asia, Caucasus, Armenia, Europe, N. America.

*Notes*: *Ramularia carneola* is a pathogen of *Scrophularia* spp. that are commonly known as figworts. It was first described on *Scrophularia nodosa* from France (holotype in PAD). Although *R. carneola* has a broad geographical distribution, this is the first record for the Netherlands. The strains of this species cluster together in a clade highly supported by the BA and ML phylogenetic analyses (Fig. 2, clade 49, 1/100).

***Ramularia cerastiicola*** (Crous) Videira & Crous, **comb. nov.** MycoBank MB816933.

*Basionym*: *Mycosphaerella cerastiicola* Crous, IMA Fungus 2: 55. 2011.

*Specimen examined*: **Netherlands**, Flevoland, on *Cerastium semidecandrum*, 2 May 2004, A. Aptroot (**holotype** CBS H-20549, culture ex-type CBS 115913 = CPC 11290).

*Notes*: When this species was initially described, both the ITS and LSU sequences placed it within the genus *Ramularia* but the cryptic nature of the asexual morph, with its septoria- to pseudocercosporella-like morphology, baffled the researchers (Crous *et al.* 2011). Based on all three phylogenetic analyses performed on the five-gene alignment, this species forms a single lineage (Fig. 2, clade 14) closely related to *Ramularia stellariicola*.

***Ramularia chamaedryos*** (Lindr.) Gunnerb., Svensk Bot. Tidskr. 61: 135. 1967. Fig. 41.

*Basionym*: *Ovularia chamaedryos* Lindr., Acta Soc. Fauna Fl. Fenn. 23: 7. 1902.

= ?*Ramularia veronicae* Fuckel, Jahrb. Nassauischen Vereins Naturk. 23–24: 361. 1869. (1870)
  ≡ *Ovularia veronicae* (Fuckel) Sacc., Fungi ital. Del., t. 974. 1881.
= ?*Ramularia beccabungae* Fautrey, Revue Mycol. (Toulouse) 14: 10. 1892.

*Mycelium* consisting of hyaline, septate, branched, smooth, 1–2 µm diam hyphae. *Conidiophores* hyaline, thin-walled, smooth, erect, septate, straight, cylindrical-oblong, unbranched, (24.5–)60–92(–230) × 1.5–2(–3) µm or reduced to conidiogenous cells. *Conidiogenous cells* integrated in mycelium or terminal in conidiophores, cylindrical-oblong, geniculate-sinuous,

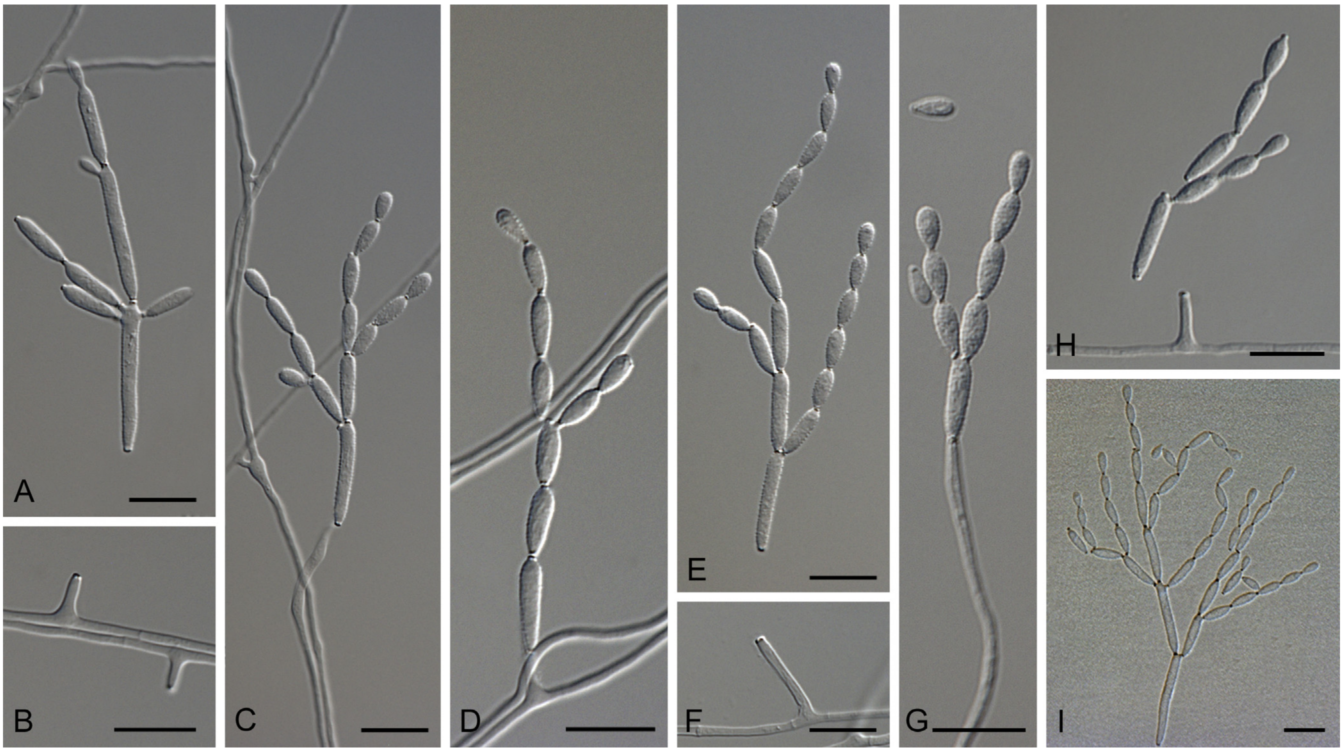

**Fig. 40.** *Ramularia calcea* (CBS 101613). A–I. Structures formed in culture. A, E, I. Conidia. B, F. Conidiophore reduced to conidiogenous cell. C, D, G, H. Conidiophore and conidia. Leaf spot symptoms on the host. Scale bars = 10 µm.

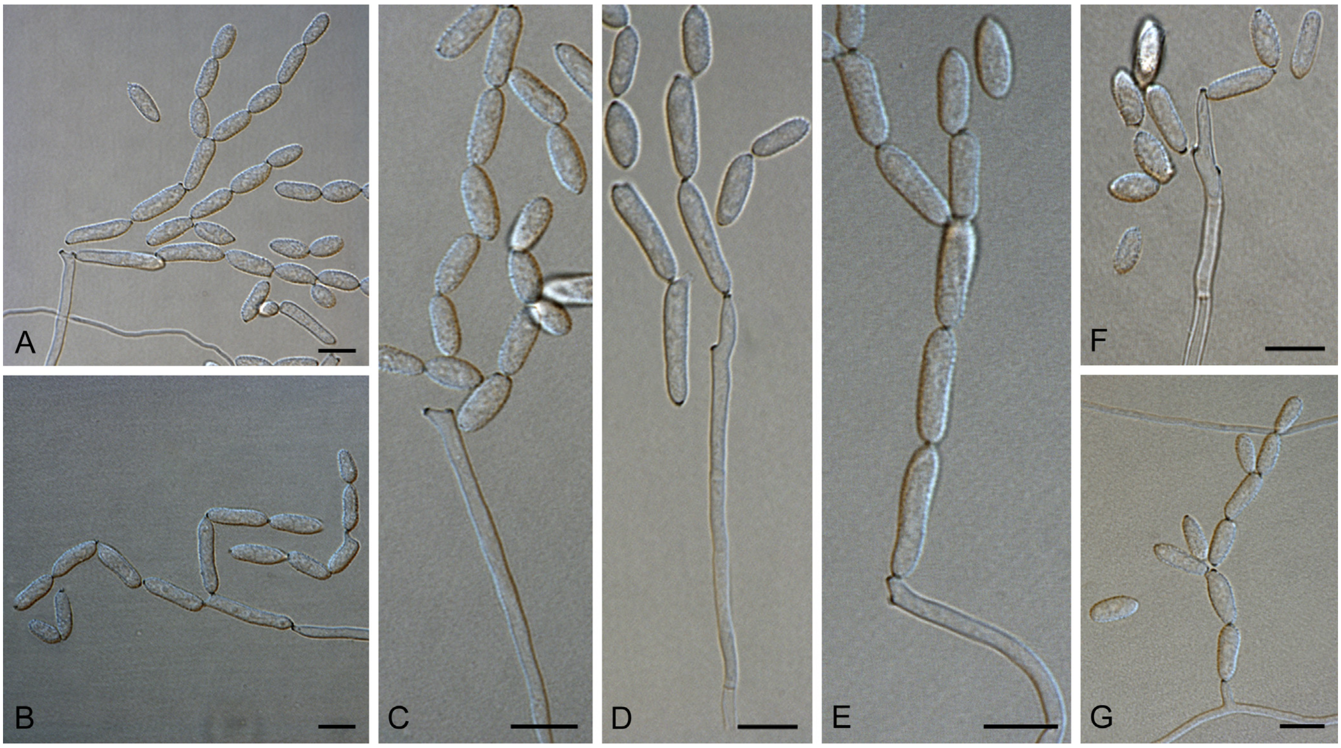

**Fig. 41.** *Ramularia chamaedryos* (CBS 116577). A–G. Conidiophores, conidiogenous cells and conidia formed in culture. Scale bars = 10 µm.

(14–)20–26(–44) × 2–3 µm, with 1–4 apical conidiogenous loci, almost flat or protuberant, thickened, darkened and refractive. *Conidia* hyaline, thin-walled, smooth, aseptate, catenate, with hila thickened, darkened and refractive. *Ramoconidia* subcylindrical, clavate, ovoid, (9.5–)15–19(–31.5) × (3–)3.5–4(–5) µm, with two apical hila. *Intercalary conidia* subcylindrical, fusoid, ovoid, (9–)11–13(–22) × (3–)3.5–4(–4.5) µm, in branched chains of up to five conidia. *Terminal conidia* obovoid, (6.5–)8–9(–11) × (3.5–)4(–5) µm (on SNA, CBS 116577).

*Culture characteristics*: On MEA, 8 mm diam, surface smooth, smoke-grey, with margins undulate, feathery and olivaceous grey, colony reverse olivaceous grey; on OA, 10 mm diam. Surface smooth, with fuffy aerial mycelium, light grey with olivaceous green patches, with margin irregular, with sparse aerial mycelium, colony reverse iron-grey; on PDA, 9 mm diam, surface smooth, buff to smoke-grey, margins crenate, colony reverse olivaceous.

*Description in vivo*: See Braun (1998: 258).

*Specimens examined*: **Latvia**, Vidzeme, on *Veronica chamaedrys*, 1936, Smarods [neotype, designated in Braun (1998), JE]. **Sweden**, Uppland, Uppsala Näs parish, Vängelstra, on *Veronica chamaedrys*, 29 Sep. 1986, E. Gunnerbeck, culture CBS 116577. **New Zealand**, Auckland, St. Johns, on *Veronica persica*, unknown collector and date, isol. C.F. Hill, Oct. 2005, dep. C.F. Hill, culture CBS 118794. **South Korea**, Samcheok, on *Veronica didyma*, 8 May 2003, H.D. Shin, KUS-F19441, culture CBS 113307; Taean, on *Veronica persica*, 17 Apr. 2007, H.D. Shin & M.J. Park, KUS-F22542, culture CBS 131773 = KACC 42885. **Sweden**, Uppland, Knivsta, on *Veronica anagallis-aquatica*, 22 Sep. 1989, E. Gunnerbeck, culture CBS 114731.

*Substrate and distribution*: On *Veronica* (*Scrophulariaceae*); Europe, Korea, New Zealand.

*Notes*: The description of CBS 116577 fits the morphology of *R. chamaedryos*. *Ramularia veronicae* and *R. beccabungae* are similar, but differ *in vivo* in having septate conidia. *Ramularia chamaedryos* is only known from *Veronica chamaedryos* (*Scrophulariaceae*) and was originally described from Finland [type not preserved, neotype designated in Braun (1998), in JE]. *Ramularia veronicae* is known from several *Veronica* spp. worldwide with the exception of Australia and Antartica. *Ramularia beccabungae* has been described from several *Veronica* spp. in Europe and Asia. Some *Ramularia* species have been shown to be plurivorous while others can be seen as host specific. Phylogeny based on five partial gene sequences places sequences retrieved from *Ramularia* on *Veronica chamaedrys* (as ?*R. chamaedryos*), *V. persica* (as ?*R. veronicae*, but not the type host) and *V. anagallis-aquatica* (as ?*R. beccabungae*) in the same clade (Fig. 2, clade 61, 1/100/100), suggesting that a single species is involved. However, this assumption is still vague and unproven since the description of the sporulation *in vitro* is only based on a culture of *R. chamaedryos* on *Veronica chamaedrys* (Fig. 41). Sporulating cultures of *R. veronicae* and *R. beccabungae* based on isolations from the type hosts are necessary for comparison and to evaluate and explain possible differences in the conidial septation between *in vivo* and *in vitro* material. Therefore, a final taxonomic conclusion is not yet possible.

***Ramularia chelidonii*** (Jacz.) Karak., Fungi Imperfecti Parasitici. I. Hyphomycetes: 123. 1937.
*Basionym*: *Didymaria chelidonii* Jacz., Fungi Ross. Exs. 349. 1899.

= *Ramularia hylomeconis* Naumov, Bull. Trimestriel Soc. Mycol. France 30: 80. 1914.

*Description in vivo*: See Braun (1998: 197).

*Specimens examined*: **Russia**, Far East, Amur, near Radde Station, on *Hylomecon japonica* (≡ *Chelidonium japonicum*), 28 May/9 Jun. 1895, Komarov [Jacz. et al., Fungi Ross. Exs. 349; **lectotype**, designated in Braun (1998), LE 40741]. **South Korea**, Hongcheon, on *Hylomecon vernalis*, 6 Jun. 2005, H.D. Shin, KUS-F21198, cultures CPC 12208, CPC 12209; Yangpyeong, on *Hylomecon vernalis*, 4 Jun. 2003, H.D. Shin, KUS-F19550, culture CBS 113317.

*Substrate and distribution*: On *Chelidonium* and *Hylomecon* (*Papaveraceae*); Asia, Caucasus, Europe (Ukraine).

*Notes*: *Ramularia chelidonii* was originally described on *Chelidonium japonicum* from Russia (lectotype in LE). The strains of *R. chelidonii* used in this study cluster in a highly supported clade (Fig. 2, clade 71, 1/100/100). This is the first report of this species from South Korea and on *Hylomecon*.

***Ramularia coleosporii*** Sacc., Michelia 2(6): 170. 1880.

≡ *Cylindrosporium coleosporii* (Sacc.) J. Schröt., Krypt.-Fl. Schlesien, Pilze, 3.2(4): 493. 1897.
= *Ramularia clerodendri* Sawada, Rep. Dept. Agric. Gov. Res. Inst. Formosa 87: 71. 1944, nom. inval.
= *R. fagarae* Sawada, Rep. Dept. Agric. Gov. Res. Inst. Formosa 87: 72. 1944, nom. inval.

*Description in vivo*: See Braun (1998: 39).

*Specimens examined*: **France**, Lyon, on *Coleosporium melampyri* on *Melampyrum nemorosum*, Sep. 1879, Therry [Thüm., Mycoth. Univ. 1566; **lectotype**, designated in Braun (1998), HAL]. **South Korea**, Hongcheon, on *Coleosporium horianum* on *Codonopsis lanceolata*, 9 Oct. 2007, H.D. Shin & M.J. Park, culture CBS 131757 = KACC 43185; same location, date and collectors, on *Coleosporium eupatorii* on *Eupatorium lindleyanum*, culture CBS 131764 = KACC 43182; Incheon, on *Coleosporium* sp. on *Solidago gigantea*, 24 Sep. 2009, H.D. Shin & M.J. Park, culture CBS 131762 = KACC 44860; Inje, on *Coleosporium asterum* on *Aster pilosus*, 3 Oct. 2008, H.D. Shin & M.J. Park, culture CBS 131755 = KACC 43977; Jinju, on *Coleosporium horianum* on *Codonopsis lanceolata*, 13 Oct. 2008, H.D. Shin & M.J. Park, culture CBS 131759 = KACC 44073; Jecheon, on *Coleosporium clematidis-apiifoliae* on *Clematis apiifolia*, 19 Oct. 2007, H.D. Shin & M.J. Park, culture CBS 131756 = KACC 43200; Namyangju, on *Coleosporium perillae* on *Perilla frutescens* var. *japonica*, 21 Aug. 2006, H.D. Shin & M.J. Park, culture CBS 131753 = KACC 42483; Pocheon, on *Coleosporium asterum* on *Aster pilosus*, 22 Sep. 2006, H.D. Shin & M.J. Park, culture CBS 131765 = KACC 42635; Pocheon, on *Coleosporium eupatorii* on *Eupatorium japonicum*, 2 Sep. 2003, H.D. Shin, culture CPC 10669; Pocheon, on *Coleosporium eupatorii* on *Eupatorium japonicum*, 20 Aug. 2006, H.D. Shin & M.J. Park, culture CBS 131763 = KACC 42484; Pocheon, on *Aster ageratoides*, 23 Oct. 2002, H.D. Shin, culture CPC 10085; Pyeongchang, on *Coleosporium clematidis-apiifoliae* on *Clematis apiifolia*, 20 Sep. 2003, H.D. Shin, cultures CPC 10731–10733; Pyeongchang, on *Pileolaria shiraiana* on *Rhus trichocarpa*, 22 Sep. 2008, H.D. Shin & M.J. Park, culture CBS 131767 = KACC 44053; Pyeongchang, on *Coleosporium eupatorii* on *Eupatorium lindleyanum*, 20 Sep. 2003, H.D. Shin, cultures CPC 10746–10748; Pyeongchang, on *Coleosporium cacaliae* on *Syneilesis palmata*, 14 Sep. 2009, H.D. Shin & M.J. Park, culture CBS 131758 = KACC 44854; same location, date and collectors, on *Coleosporium saussureae* on *Saussurea pulchella*, culture CBS 131761 = KACC 44855; Seoul, on *Coleosporium clerodendri* on *Clerodendron trichotomum*, 2 Sep. 2007, H.D. Shin & M.J. Park, culture CBS 131766 = KACC 43058; Suwon, on *Coleosporium asterum* on *Aster pilosus*, 1 Oct. 2007, H.D. Shin & M.J. Park, culture CBS 131754 = KACC 43177; Ulleung, on *Coleosporium horianum* on *Codonopsis lanceolata*, 21 Oct. 2008, H.D. Shin & M.J. Park, culture CBS 131760 = KACC 44081; Pocheon, on *Coleosporium eupatorii* on *Eupatorium japonicum*, 2 Sep. 2003, H.D. Shin, culture CPC 10653; Pyeongchang, on *Coleosporium phellodendri* on *Phellodendron amurense*, 4 Sep. 2003, H.D. Shin, cultures CPC 10672, CPC 10673; Hoengseong, on *Coleosporium plectranthi* on *Plectranthus japonicus*, 21 Aug. 2004, H.D. Shin, culture CPC 11516.

*Substrate and distribution*: Mycophylic on *Chrysomyxa*, *Coleosporium* (*Coleosporiaceae*, *Pucciniales*), *Pileolaria* (*Pileolariaceae, Pucciniales*); Asia, Europe, N. America (USA), West Indies (Puerto Rico).

*Notes*: Only six species of *Ramularia* have been classified as mycophylic (*R. butomi*, *R. coleosporii*, *R. cylindriopsis*, *R. dichosciadii*, *R. uredinearum*, and *R. uredines*). Ķirulis (1942) stated that *R. coleosporii* does not parasitise *Coleosporium* directly but that it is confined to the weakened tissue around the sori and that it is unrelated to other foliicolous species on the same hosts. Braun (1998) hypothesised that *R. coleosporii* could be a separate species or a collective species composed of various races since on some hosts there are morphologically similar phytopathogenic species and in other hosts this species was morphologically distinguishable from other phytopathogenic species. *Ramularia coleosporii* was originally described parasitising *Coleosporium melampyri* on *Melampyrum nemorosum* from France (lectotype in HAL). All the strains of *R. coleosporii* used in this study cluster together in the same clade (Fig. 2, clade 66, 1/100/100) and are clearly separated from the other *Ramularia* spp., supporting the hypothesis that this is indeed a unique species. They were, however, all collected from South Korea, and a few isolates from other countries should be analysed to determine if it is a global species. It was the first time that this species was observed in association with the host *Pileoaria shiraiana*. To determine if *R. coleosporii* is truly mycophylic more studies need to be done to understand the biology and ecology of this species.

***Ramularia collo-cygni*** B. Sutton & J.M. Waller, Trans. Brit. Mycol. Soc. 90: 57. 1988.

≡ *Ophiocladium hordei* Cav., Z. Pflanzenkr. 3: 26. 1893.
≡ *Ovularia hordei* (Cav.) R. Sprague, Mycologia 38: 63. 1946.
≡ *Ramularia hordeicola* U. Braun, Int. J. Mycol. Lichenol. 3 (2–3): 281. 1988.

For additional synonyms see Braun (1998) or MycoBank.

*Description in vivo*: See Braun (1998: 202).

*Specimens examined*: **Austria**, Reichersberg am Inn, on *Hordeum vulgare*, unknown date, Züchtungsfirma Saatbau Linz (**neotype designated here**: CBS H-22641, MBT371836, culture ex-neotype CBS 101180). **Germany**, Bavaria, Aspachhof, Uffenheim, on *Hordeum vulgare*, 1998, E. Sachs, CBS H-17711, cultures CBS 101181, CBS 101182. **Norway**, Central Norway, on *Hordeum vulgare*, unknown date, S. Salamati, cultures CBS 119439 = CPC 12693, CBS 119440 = CPC 12692, CBS 119441 = CPC 12690, CBS 119442 = CPC 12688.

*Substrate and distribution*: On *Bromus*, *Festuca*, *Glyceria*, *Leucopoa*, *Lolium*, *Phalaris*, and *Triticale* (*Poaceae*) and *Cannabis* (*Cannabaceae*); Europe, N. America (Canada, Mexico, USA), S. America (Chile, Colombia), Asia (Japan, Russia), Australia and New Zealand.

*Notes*: *Ramularia collo-cygni* was originally isolated from the host *Hordeum vulgare* collected in Italy, but the type specimen is presumed missing (Braun 1998). The strains used in this study cluster together in a highly supported clade (Fig. 2, clade 38, 1/100/100) and a strain isolated from the same host that was collected in Austria is designated as neotype. *Ramularia collo-cygni* is the causal agent of Ramularia leaf spot disease on barley, a disease that has been known for more than 100 years but of which the importance has only been recognised in the last 30 years. The disease has been reported worldwide and on various cereals and grasses. On barley, the symptoms appear late in the season as reddish brown necrotic spots that lead to premature leaf senescence and subsequent grain yield loss. Environmental conditions such as temperature and humidity are key factors in activating the production of rubellin, a non-host specific toxin, by the fungus. The development of molecular diagnostic tools has improved the detection of the pathogen in plant tissue and seeds before symptom development. Vertical transmission of the fungus in barley has been confirmed (Havis *et al.* 2015) and further evidence points to the existence of an endophytic life-style that shifts towards necrotrophy depending on plant health. Population studies using simple-sequence repeat markers and sequence analyses of housekeeping genes revealed a high genetic diversity in *R. collo-cygni* isolates (Piotrowska 2014, Havis *et al.* 2015). A high level of genotypic diversity is usually indicative of sexual recombination, but the sexual morph of *R. collo-cygni* is yet to be identified. Control of the disease can be accomplished by timely fungicide application between the Zadoks growth stages (ZGS) 30 and ZGS 49, well before the symptoms develop that usually happens at stage ZGS 70. *Ramularia collo-cygni* has lost sensitivity to strobilurin-based fungicides due to the development of the G143A point mutation in the cytochrome b gene, which is now prevalent in most populations. The introduction of a new generation of SDHI fungicide has brought some leverage in disease control, but the rapid evolutionary potential displayed by this fungus suggests it can adapt to new control strategies quickly. Despite all the research performed so far several questions still need to be addressed to fully understand the biology of this species in order to develop appropriate control measures (Havis *et al.* 2015). *Ramularia collo-cygni* also causes Tan Leaf Spot on turfgrass. Turfgrasses are used to control water and wind erosion of soil, and are used as ornamental plants and as ground cover of playing fields in many sports. The disease has been reported from Australia, Japan, New Zealand and North America (Smiley *et al.* 1983).

***Ramularia coryli*** Chevassut, in Braun, Monograph *Cercosporella*, *Ramularia* Allied Genera (Phytopath. Hyphom.) 2: 140. 1998.

*Description in vivo*: See Braun (1998: 140).

*Specimen examined*: **Netherlands**, Utrecht, Rhijnauwen, on dead leaves of *Corylus avellana*, G. Verkley, 25 Apr. 2005, culture CBS 117800 = CPC 12090.

*Substrate and distribution*: On *Corylus avellana*; Europe (France, Netherlands).

*Notes*: *Ramularia coryli* was originally described on *Coryllus avellana* from France, and is currently the only *Ramularia* species known to infect this host (Braun 1998). The strain used in this study forms a single lineage (Fig. 2, clade 83), and is positioned on a very long branch, which supports this species as unique. Unfortunately, this strain proved to be sterile, and thus we could not compare it morphologically. This clade is for now maintained as representative of *R. coryli* until fresh material is collected and more information becomes available.

***Ramularia cupulariae*** Pass., Hedwigia 15: 107. 1876.

= *Ovularia inulae* Sacc., Fungi ital., Tab. 971. 1881.
  ≡ *Ramularia inulae* (Sacc.) Höhn., in Kab. & Bub., Fungi Imperf. Exs. no. 389. 1906.
= *Ovularia inulae* f. *major* Brunaud, Actes Soc. Linn. Bordeaux 1890: 46. 1890.
= *Ramularia inulae-britannicae* Allesch., in Jaap, Abh. Bot. Ver. Prov. Brandenb. 47: 98. 1905.
= *R. codonocephali* Annaliev, Novosti Sist. Nizsh. Rast. 15: 74. 1978.

*Description in vivo*: See Braun (1998: 81).

*Specimens examined*: **Former Czechoslovakia**, on *Inula* sp., unknown date, L. Marvanová, culture CBS 235.73. **Italy**, Vigheffio near Parma, Oct. 1874, Passerini [Rahenh., Fungi Eur. Exs. 2065; **lectotype**, designated in Braun (1998), HAL].

*Substrate and distribution*: On *Carpesium*, *Codonocephalum*, *Inula*, and *Pulicaria* (*Asteraceae*); Asia, Caucasus, Europe.

*Notes*: Two varieties are known for this species, *R. cupulariae* var. *cupulariae* (lectotype on *Inula viscosa*, Italy, in HAL) and

*R. cupulariae* var. *britannicae* (holotype on *Inula britannica*, Germany, in HBG). Specimens of var. *britannicae* have very long and filiform conidiophores (20–100 × 2.5–5 µm) when compared to var. *cupulariae* (5–30 × 2–5 µm). This species has been reported from four different host genera within the family *Asteraceae* (*Carpesium*, *Codonocephalum*, *Inula* and *Pulicaria*) from Asia, Caucasus and Europe. The strain used in this study forms a single lineage (Fig. 2, clade 6).

***Ramularia cyclaminicola*** Trel., Trans. Illinois Acad. Sci. 9: 145. 1916.

= *Cladosporium cyclaminis* Massey & Tilford, Phytopathology 22(1): 19. 1932.

*Description in vivo*: See Braun (1998: 226).

*Specimen examined*: **USA**, on stunted *Cyclamen persicum*, unknown collector and date, isolated and deposited by K.F. Baker, 1951, culture CBS 399.51; Illinois, Urbana, University, north greenhouse, 14 Jan. 1914, Trelease (**holotype** ILL 14246).

*Substrate and distribution*: On *Cyclamen* (*Primulaceae*); N. America.

*Notes*: *Ramularia cyclaminicola* causes both a leaf spot disease and a stunt or wilt through systemic invasion of vascular tissue in *Cyclamen persicum*. Cyclamen plants, grown for their flowers, were imported into America from Germany and the Netherlands. No disease was reported from these countries and it is likely that *R. cyclaminicola* is native to North America, perhaps infecting other members of the *Primulaceae* (Baker *et al.* 1950). The disease may be confused with a physiological problem or with Fusarium wilt or Phialophora wilt, and was more common in the first half of the 20th century than it is today (Daughtrey *et al.* 1995). *Ramularia cyclaminicola* was originally described on *Cyclamen persicum* from Illinois, USA (holotype in ILL). In the present study, *Ramularia cyclaminicola* is represented by a single lineage (Fig. 2, clade 18). Strain CBS 399.51 was isolated by Baker and deposited at CBS in 1951, which means this is likely an authentic strain of this species.

***Ramularia cynarae*** Sacc., Michelia 1: 536. 1879.

= *R. cardui* P. Karst, Meddeland. Soc. Fauna Fl. Fenn. 14: 109. 1888.
= *R. cirsii* Allesch., Ber. Bayr. Bot. Ges. 2: 18. 1892.
= *R. jurineae* Hollós, Ann. Hist.-Nat. Mus. Natl. Hung. 5: 467. 1907.
= *R. carthami* Zaprom., Bolez. Rast. 15(3): 142. 1926, and Mater. Mikofl. Sredn. Azii I: 32. 1926.

For additional synonyms see Braun (1998) or MycoBank.

*Description in vivo*: See Braun (1998: 101).

*Specimens examined*: **France**, Saintes, Brunaud, herb. Saccardo (**holotype** PAD). **Netherlands**, Gelderland Prov., Hoge Veluwe Nat. Park, on *Carduus* sp., 2012, S.I.R. Videira culture CPC 25897; Nijmegen, on *Carex acutiformis*, Jul. 2012, S.I.R. Videira, culture CPC 25896. **Sweden**, Uppland, Haga, Årtopet, on *Cirsium arvense*, 4 Oct. 1989, E. Gunnerbeck, culture CBS 114728; Uppland, Dalby, on leaves of *Carduus crispus*, 29 Aug. 1989, E. Gunnerbeck, culture CBS 114729. **USA**, California, Monterey County, Castrovill, on leaves of *Cynara cardunculus*, 10 Aug. 2010, S.T. Koike (**epitype** CBS H-20514, culture ex-epitype CBS 128912 = CPC 18426); *idem*. CPC 18427; California Santa Clara County, Morgan Hill, on leaves of *Carthamus tinctorius*, 19 Oct. 2010, S.T. Koike, cultures CBS 128779 = CPC 18725, CPC 18726.

*Substrate and distribution*: On *Carduus*, *Carthamus*, *Cirsium*, *Cousinia*, *Cynara*, *Echinops*, *Jurinea*, *Onopordum*, *Saussurea*, and *Silybum* (*Asteraceae*); worldwide.

*Notes*: *Ramularia cynarae* was originally described on *Cynara scolymus* from France (holotype in PAD), but the species has a wide host range within the *Asteraceae* (Braun 1998). This species was epitypified by Koike *et al.* (2011), who reported the pathogen *R. cynarae* as the causal agent of leaf spot symptoms on *Carthamus tinctorius* (spineless safflower) in California, USA. Spineless safflower is grown as commercial cut flower crops in coastal California. The isolates collected from both *Cynara* and *Carthamus* were identical in morphology and ITS sequences (GenBank HQ728117, HQ728118). This supports the hypothesis that *R. cynarae* has a broad host range on *Asteraceae* hosts instead of being a species complex. *Ramularia carthami* was previously reported from agronomic safflower grown for oil production in Northern California (Hostert *et al.* 2006). The ITS sequence of this isolate (DQ466083) is 100 % similar to the ITS sequence of the *R. cynarae* ex-epitype culture (CBS 128912), indicating that these are likely the same species. In this study, strains of *R. cynarae* clustered in a highly supported clade (Fig. 2, clade 9, 1/100/100). Some internal variation was observed and the transition from concordance to conflict determined the phylogenetic limit of this species (Taylor *et al.* 2000). This intraspecific variation may be the reason that this species is able to colonise a broad host range or indicate that it is undergoing sexual reproduction, as can be observed with *R. vizellae* (Videira *et al.* 2015b).

***Ramularia deusta*** (Fuckel) Karak. var. ***deusta***, Fungi Imperfecti Parasitici. I. Hyphomycetes: 116. 1937.
*Basionym*: *Scolicotrichum deustum* Fuckel, Jahrb. Nassauischen Vereins Naturk. 23–24: 357. 1870

*Description in vivo*: See Braun (1998: 156).

*Specimens examined*: **Germany**, near Eberbach, on *Lathyrus linifolius* [Fuckel, Fungi Rhen. Exs. 2206; **lectotype**, designated in Braun (1998), HAL]. **Guadeloupe**, on *Lathyrus latifolius*, unknown collector and date, dep. K.F. Baker & W.C. Snyder, Oct. 1950, culture CBS 473.50.

*Host and distribution*: On *Lathyrus* (*Fabaceae*); Asia, Europe, N. and S. America, New Zealand.

*Notes*: *Ramularia deusta* is distributed worldwide in temperate and subtropical climates on nine species of *Lathyrus*, including the cultivated sweet pea (*L. odoratus*) and perennial pea (*L. latifolius*). The first pathological study was conducted in England on sweet pea (Dowson 1924), and since then it has been reported from several countries around the world. The economical impact of this disease was considered minor on this crop (Baker *et al.* 1950). Two physiological forms were recognised by Baker *et al.* (1950) from collections in California, *R. deusta* f. *odorati* as pathogenic on the host *Lathyrus odoratus*, and *R. deusta* f. *latifolii* as pathogenic on the host *L. latifolius*. Braun (1998) divided *Ramularia deusta* into three varieties. *Ramularia deusta* var. *alba* (on *Lathyrus odoratus*, Denmark, holotype in B) has whitish caespituli while *R. deusta* var. *deusta* (on *Lathyrus linifolius*, Germany, lectotype in HAL) has yellowish ochraceous or pink to reddish caespituli. *Ramularia deusta* var. *lathyri-maritimi* (on *Lathyrus maritimus*, Sweden, holotype in BPI) has longer and mostly septate conidia (15–30 × 2.5–5 µm), while *R. deusta* var. *deusta* has shorter and mostly aseptate conidia, (5–) 8–20(–23) × 2.5–5 µm. Although *R. deusta* f. *odorati* was synonymised under *R. deusta* var. *alba* (Braun 1998), *R. deusta* f.

*latifolii* does not appear as synonym of any of the other varieties and should, therefore, be considered as a synonym of *R. deusta* var. *deusta*. The strain used in this study (CBS 473,50; Fig. 2, clade 62) was previously identified as *R. deusta* f. *latifolii* and was deposited by Baker and Snyder in 1950, which makes it an authentic strain and a reliable representative of the species *Ramularia deusta* var. *deusta* until fresh material from the same location and host as the type material is recollected.

***Ramularia didyma*** Unger var. ***didyma***, Exanth. Pfl.: 169. 1833.

≡ *Didymaria ungeri* Corda, Icon. fung. (Prague) 1: 32. 1837.
≡ *D. didyma* (Unger) Pond, Amer. Naturalist 23: 163. 1889.
= *Fusisporium aequivocum* Ces., Bot. Zeitung (Berlin) 15: 43. 1857.
≡ *Ramularia aequivoca* (Ces.) Sacc., Fungi ital. Del., Tab.: 994. 1881.
= *Ramularia ovularioides* H.C. Greene, Trans. Wisconsin Acad. Sci. 38: 246. 1946 (1947).

For additional synonyms see Braun (1998).

*Description in vivo*: See Braun (1998: 239).

*Specimens examined*: **Luxembourg**, Kantenbach, on leaf spot on *Ranunculus repens*, unknown collector and date, isol. L. Marvanová, 25 Sep. 1967, dep. L. Marvanová, Oct. 1967, culture CBS 431.67. **Sweden**, Uppland, Haga par., Årtopet, on *Ranunculus repens*, 23 Oct. 1988, E. Gunnerbeck, culture CBS 114299 = UPSC 2746. **UK**, South West England, Exeter, on leaf spot from *Ranunculus repens*, unknown collector and date, isol. S.A.J. Tarr, 30 Apr. 1967, dep. S.A.J. Tarr, Sep. 1967, culture CBS 420.67.

*Substrate and distribution*: On *Anemone* and *Ranunculus* (*Ranunculaceae*); Asia, Caucasus, Europe, N. and S. America, New Zealand.

*Notes*: There are three varieties of this species, namely *R. didyma* var. *didyma* [neotype on *Ranunculus nemorosus*, Switzerland, designated in von Arx (1983), in ZT], *R. didyma* var. *exigua* (holotype on *Ranunculus uncinatus*, USA, Oregon, WSP) and *R. didyma* var. *pulsatillae* [neotype on *Pulsatilla pratensis*, Denmark, designated in Braun (1998), in C]. While *R. didyma* var. *didyma* conidiophores emerge through stromata and form catenate conidia, *R. didyma* var. *exigua* exhibits conidiophores erumpent through the cuticle, and *R. didyma* var. *pulsatillae* frequently forms solitary conidia. *Ramularia didyma* var. *didyma* has a wider distribution than the other two varieties (Braun 1998). *Ramularia didyma* was identified as the causal agent of leaf spotting symptoms on Persian buttercups (*Ranunculus asiaticus*) in USA, California. These are colourful, cool-season perennials or annuals grown for the flowers and bulbs. Introduction of this pathogen into commercial production fields could cause significant economic loss (Blomquist & Warfield 2011). The ITS sequence (GenBank HQ442297) generated at that time is 100 % similar to the ITS sequence of the strains in this clade. Based on phylogenetic analyses in this study, this species forms a highly supported clade (Fig. 2, clade 72, 1/100/100). The morphology could not be observed since the cultures were sterile and no herbarium materials corresponding to the strains were preserved. This clade is tentatively maintained as a representative of this species until fresh material from the type host and location is recollected.

***Ramularia diervillae*** Peck, Rep. (Annual) New York State Mus. Nat. Hist. 38: 99. 1885. Fig. 42.

= *Ramularia umbrosa* Davis, Trans. Brit. Mycol. Soc. 19: 714. 1919.

*Mycelium* consisting of hyaline, septate, branched, smooth, 1–2 µm diam hyphae. *Conidiophores* hyaline, thin-walled, smooth, erect, 1–2-septate, cylindrical-oblong, straight to sinuous, unbranched, (10–)26.5–35(–54) × (1–)1.5–2(–3) µm, or reduced to conidiogenous cells, terminal on conidiophores or intermediate in the mycelium, cylindrical-oblong, narrower at the top, (5.5–)14.5–19(–29) × 1.5–2(–3) µm, with one or two conidiogenous loci almost flat to protuberant; *conidiogenous loci* thickened, darkened and refractive. *Conidia* hyaline, thin-walled, smooth, catenate, with hila thickened, darkened and refractive. *Ramoconidia* cylindrical-oblong, sometimes sinuous or curved, (9.5–)14–17(–26.5) × (1.5–)2–2.5(–3) µm, 0–1-septate, with 2 apical hila. *Intercalary conidia* cylindrical-oblong, fusoid, sometimes curved, aseptate, (8–)11–13(–19.5) × (1.5–)2(–3) µm, in branched chains of up to seven conidia. *Terminal conidia* cylindrical-oblong to obovoid, aseptate, (5–)7–8(–11) × (1.5–)2(–2.5) µm. Sporulating on SNA.

*Culture characteristics*: On MEA, 11 mm diam, surface raised, folded, with sparse aerial mycelium, smooth, rosy buff, with margins crenate and convex, colony reverse cinnamon with olivaceous grey patches; on OA, 9 mm diam, surface smooth, low convex, white with pale olivaceous grey tinge, with margins undulate, colony reverse fawn; on PDA, 10 mm diam, surface low convex, pale olivaceous grey, smooth, producing tiny transparent exudate droplets, with margins lobate, colony reverse olivaceous grey with a buff margin.

*Description in vivo*: See Braun (1998: 130).

*Specimens examined*: **Canada**, Quebec, La Peche, Lac Bernard, on *Diervilla lonicera*, 5 Jul. 2009, K.A. Seifert, cultures CPC 16859, CPC 16860, CPC 16863, CPC 16864. **USA**, New York, Adirondack Mt., on *Diervilla lonicera*, Peck (**holotype** NYS).

*Substrate and distribution*: On *Diervilla* (*Caprifoliaceae*); N. America (Canada, USA).

*Notes*: *Ramularia diervilla* was originally described on *Diervilla lonicera* from New York, USA (holotype in NYS), and is the only species of *Ramularia* known to infect this host. Although it has been previously reported from North America, this is the first report from Canada. This species formed a highly supported clade (Fig. 2, clade 41, 1/100/100). Braun (1998) reported that when associated with its host, *R. diervilla* produces simple, straight to geniculate-sinuous conidiophores, 5–25 × 1.5–3.5 µm, and catenate, cylindrical-fusiform conidia, 5–25(–30) × 1.5–4 µm. The conidiophores described in culture are longer and the conidia are slightly narrower than what is described *in vivo* (Fig. 42). In the herbarium specimen corresponding to the isolate CPC 16859, the conidiophores are shorter than in culture [(25–)28–30(–33) × (1.5–)2(–3) µm] but more similar to the description provided by Braun (1998), while the conidial dimensions [(4–)8–9(–12) × (1.5–)2(–3) µm] are smaller than in culture, but still narrower than in Braun (1998). The cultures and specimens represented in this clade are considered here as representative material of the species until collections from the type location are examined.

***Ramularia digitalis-ambiguae*** Arx, Sydowia 3: 93. 1949.

= *Mycosphaerella digitalis-ambiguae* Arx, Sydowia 3: 92. 1949.
= *Asteromella digitalis-ambiguae* Arx, Sydowia 3: 94. 1949.

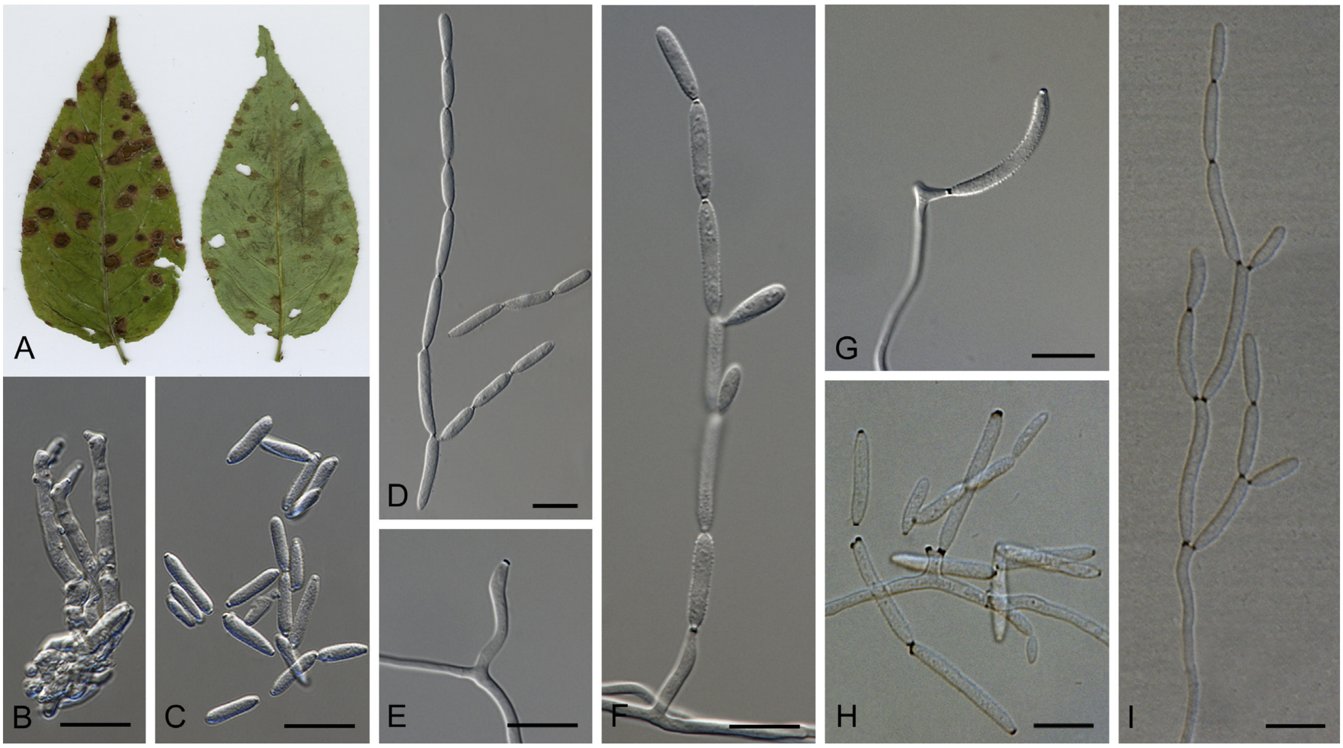

**Fig. 42.** *Ramularia diervillae* (CPC 16859). A–C. Observations from herbarium material. D–I. Structures formed in culture. A. Leaf spot symptoms on the host. B, E. Conidiophores. C, D. Conidia. F–I. Conidiophores and conidia. Scale bars = 10 µm.

*Specimens examined*: **Luxembourg**, Kantenbach, on leaf spot on *Digitalis purpurea*, unknown collector and date, isol. L. Marvanová, 25 Sep. 1967, dep. L. Marvanová, Oct. 1967, culture CBS 434.67. **Netherlands**, on *Digitalis* sp., unknown collector and date, isol. F. Hespe, dep. Jul. 1937, culture ex-type CBS 297.37.

*Notes*: Although these isolates were originally identified as *R. variabilis*, the latter species clusters in clade 50 (Fig. 2; 1/100/100), in contrast to the *Digitalis* isolates (Fig. 2, clade 58, 1/100/100), which clearly represents a different species. Since collections of *Ramularia* on *Digitalis* and *Verbascum* spp. are *in vivo* morphologically barely distinguishable, Braun (1998) assigned them to a single species, *R. variabilis*, and reduced *Mycosphaerella digitalis-ambiguae* and *Ramularia digitalis-ambiguae* to synonym under *R. variabilis*. Although not yet phylogenetically proven, *R. digitalis-ambiguae* is available for the *Digitalis Ramularia* and can at least tentatively be used for this taxon until sporulating cultures retrieved from *Ramularia* lesions on *Digitalis ambigua* and *D. purpurea* are available for comparison. The connection of *Mycosphaerella digitalis-ambiguae* and the two syn-asexual morphs, *Ramularia digitalis-ambiguae* and *Asteromella digitalis-ambiguae*, has only been observed *in vivo* (von Arx 1949), but not yet verified *in vitro* or by means of molecular methods. Aptroot (2006) referred to the strong morphological similarity between *M. digitalis-ambiguae* and the saprobic *M. subradians* (Fr. : Fr.) J. Schröt. *Mycosphaerella digitalis* (Ferraris) Tomilin (≡ *Sphaerella digitalis* Ferraris; Ferraris 1902: 451, and plate X, fig. II), on dry stems of *Digitalis lutea*, described from North Italy, is quite distinct from *M. digitalis-ambiguae*, differing in having much larger asci, 60 × 20–21 µm, and longer, wider ascospores, 18–10 × 5–6 µm without constrictions at the septa (*vs.* asci 32–42 × 7–9 µm, ascospores 11–15 × 3.5–4.5 µm, constricted at the septa in *M. digitalis-ambiguae*).

***Ramularia endophylla*** Verkley & U. Braun, Mycol. Res. 108: 1276. 2004.

= *Sphaeria punctiformis* Pers., Ann. Bot. (Usteri) 11: 26. 1794, non *Ramularia punctiformis* Sacc., 1904.
≡ *Mycosphaerella punctiformis* (Pers.) Starbäck, Bih. Kongl. Svenska Vetensk.-Akad. Handl., Afd. 3, 15(no. 9): 163. 1889.

For additional synonyms see Verkley *et al.* (2004).

*Specimens examined*: **Netherlands**, Utrecht Prov., Baarn, Groeneveld, on dead leaves of *Castanea sativa*, 23 Feb. 1999, A. Aptroot, culture CBS 101680; De Stompert, Soest, on fallen leaves of *Quercus robur*, G. Verkley, culture CBS 113871; same location, on dead fallen leaves of *Quercus robur*, Apr. 2003, G. Verkley (**holotype** CBS H-7949, culture ex-epitype CBS 113265, previously *Mycosphaerella punctiformis*); same location, on green leaf (endophytic) of *Quercus robur*, unknown collector and date, isol. G. Verkley, Aug. 2002, CBS 115302, CBS 115303; same location, on living leaves (endophytic) of *Quercus robur*, G. Verkley, CBS 113869.

*Substrate and distribution*: On *Quercus* and *Castanea* (*Fagaceae*); Europe (Belgium, Netherlands), Asia (South Korea).

*Notes*: See Verkley *et al.* (2004) and Videira *et al.* (2015b). The phylogenetic analyses provide high support for this species clade (Fig. 2, clade 87, 1/100/100). The host range and distribution of this species is insufficiently known and only those of existing strains were considered above.

***Ramularia eucalypti*** Crous, Fungal Diversity 26: 174. 2007.

*Specimens examined*: **Australia**, Queensland, Cairns, Kuranda, Karoomba River Walk, on leaves of *Eucalyptus* sp., 19 Aug. 2006, P.W. Crous, culture CBS 120728 = CPC 13304. **Italy**, Norcia, on *Corymbia grandifolia*, 10 May 2006, W. Gams (**holotype** CBS H-19832, ex-type culture CBS 120726 = CPC 13043). **Netherlands**, Gelderland, Wageningen, *Phragmites* sp., 19 Feb. 2011, P.W. Crous, culture CPC 19188.

*Substrate and distribution*: On *Carex* (*Cyperaceae*), *Corymbia and Eucalyptus* (*Myrtaceae*), *Geranium* (*Geraniaceae*), *Malus* (*Rosaceae*), *Phragmites* (*Poaceae*), and *Pinus* spp. (*Pinaceae*); Australia and Europe.

*Notes*: See Crous *et al.* (2007), Videira *et al.* (2015a). The phylogenetic analyses provide high support for this species clade (Fig. 2, clade 31, 1/100/100).

***Ramularia euonymicola*** Videira, H.D. Shin, U. Braun & Crous, **sp. nov.** MycoBank MB816848. Fig. 43.

*Etymology:* Named after the host genus from which it was isolated, *Euonymus* (inhabitant of *Euonymus*).

*In planta: Leaf spots* subcircular to irregular, white to ochraceous. *Caespituli* emerging through stomata, hyaline to buff. *Conidiophores* hyaline, thin-walled, slightly verruculose, erect, fasciculate, septate, cylindrical-oblong, straight to sinuous, unbranched, (31–)48.5–56(–73) × (2.5–)3–3.5(–4.5) µm. *Conidiogenous cells* hyaline, slightly verruculose, terminal or intermediate in the conidiophore, cylindrical-oblong or geniculate-sinuous, (8–)13–16(–27) × 2–3(–4.5) µm, with one or two conidiogenous loci almost flat to protuberant; *conidiogenous loci* thickened, darkened and refractive. *Conidia* hyaline, thin-walled, slightly verruculose, solitary or in short chains, rarely branched, cylindrical-oblong to obovate, (1–)3–4-septate, (20.5–)30–35.5(–51) × (3–)3.5–4(–5) µm with hila thickened, darkened and refractive.

*Specimen examined*: **South Korea**, Hongcheon, on *Euonymus alatus*, 16 May 2003, H.D. Shin, (**holotype** KUS-F19467, isotypes HAL 1869 F and CBS H-22520, culture ex-type CBS 113308).

*Substrate and distribution*: On *Euonymus alatus* (*Celastraceae*); Asia (South Korea).

*Notes*: Presently only *Ramularia celastri* has been described from *Euonymus alatus* (USA). It was described as having simple and straight to geniculate-sinuous conidiophores measuring 10–40(–60) × 1.5–4.5(–5.5) µm, and catenate conidia that are fusiform to subcylindrical, 0–2(–3)-septate, 8–35 × 2–4.5 µm (Braun 1998). *Ramularia euonymicola* was collected in South Korea and differs from *R. celastri* by producing slightly longer conidiophores and much longer conidia that are often 3–4-septate (Fig. 43). This species is represented by a single lineage in the phylogenetic analyses (Fig. 2, clade 73).

***Ramularia gaultheriae*** Videira & Crous, **sp. nov.** MycoBank MB817158. Fig. 44.

*Etymology:* Named after the host genus from which it was isolated, *Gaultheria*.

*Mycelium* hyaline, septate, branched. Conidiophores and conidiogenous cells scarce and insufficient for complete description. *Conidia* hyaline, smooth to slightly verruculose, catenate, consistently aseptate, ellipsoid-ovoid, subcylindrical, obovoid (4–)5.5–6.5(–11) × (1.5–)2–2.5(–3.5) µm.

Sterile in culture/*in vitro*. *Ramularia gaultheriae* (Fig. 2, clade 88), differs from its closest phylogenetic neighbour, *R. endophylla* (Fig. 2, clade 87), by unique allelles in five loci based on alignments of the separate loci deposited in TreeBASE as Study S19315: *rpb2* positions 3(C), 15(C), 24(G), 33(C), 48(T), 69(C), 78(C), 87(T), 96(T), 99(C), 102(A), 108(G), 138(T), 157(T), 195(C), 196(C), 198(C), 204(C), 219(T), 234(C), 240(A), 249(C), 252(T), 261(A), 291(T), 297(G), 318(A), 324(T), 330(A), 333(C), 336(A), 339(A), 342(T), 345(C), 346(C), 366(C), 369(T), 372(A), 393(A), 402(T), 409(C), 420(C), 429(T), 453(A), 468(C), 471(T), 472(T), 474(C), 475(G), 477(T), 480(C), 483(C), 487(G), 495(C), 498(C), 500(A), 504(A), 511(A), 516(A), 522(T), 525(A), 531(T), 537(A), 541(T), 543(A), 549(C), 552(C), 555(C), 558(T), 559(A), 564(C), 570(G), 573(G), 577(A), 578(A), 583(C), 585(A), 606(C), 607(T), 613(G), 614(G), 627(C), 630(A), 639(T), 642(C), 645(A), 654(A); ITS positions 33(T), 45(A), 46(G), 48(A), 49(A), 50(T), 76(G), 81(A), 421(C), 422(T), 423(T), 425(A), 427(T), 428 insertion (C), 429(A), 430(A), 431(T), 465(A), 466(A), 478(A), 479(A), 480(A); *actA* positions 31(T), 34(C), 47(G), 49(C), 50(T), 62(C), 63(T), 68(C), 69(T), 71(C), 72(G), 73(G), 82(G), 83(C), 87(C), 88(A), 95(G), 98(T), 101(A), 104(G), 105(C), 107(T), 115(C), 118(A), 138(C), 165(T), 166(A), 168(T), 175(T), 177(T), 178(C), 179(A), 180(T), 182(T), 185(A), 186(C), 187 insertion (T), 209(A), 210(C), 212(G), 214(G), 218(C), 220(A), 245(A); *gapdh* positions 17(C), 18(T), 19(C), 21(T), 54–58 insertion (ATGTG), 59(G), 61(T), 64(G), 65(A), 93(T), 94(G), 99(T), 101(G), 107(A), 108(C), 109(A), 111(A), 119(A), 120(C), 121(A), 122(G), 124(A), 156(C), 158(C), 161(T), 207(C), 208(A), 209(G), 210(C), 212(T), 257(C), 259(T), 263(A), 269(G), 271(A), 272(T), 282(C), 284(T), 287(A), 288(C), 289(C), 290(T), 297(C), 298(A), 301(G), 303(C), 304(C), 308(C), 309(A), 310 insertion (A), 311(T), 312(C), 313(C), 353(T), 389(C), 404(C), 405(A), 411(G), 442(A), 449(A), 461(T), 521(C), 557(C), 566(C), 569(C), 575(T), 587(C), 593(T), 617(T); *tef1*-α positions 15(C), 16(T), 22(G), 23(C), 24(T), 25–26 insertion (CC), 59(T), 69(C), 72(G), 78(C), 95(C), 96(A), 107(G), 183(T), 196(C), 205(C), 223(T), 225(A), 233(T), 243(T), 275(C), 277(A), 284(T), 286(T), 294(G), 296(C), 303–304 insertion (GC), 305(G), 313(A), 315(G), 316(T), 399(C), 401(G), 402(C), 404(G), 405(A), 408(A), 410(G), 412(T), 413 insertion (T), 423(A), 424(A), 425(A), 427(T), 429(T), 430(G), 431(C), 444(C).

*Specimen examined*: **Italy**, on healthy leaf of *Gaultheria shallon*, unknown collector and date, isol. and dep. O. Petrini, May 1980, (**holotype** CBS H-17765, ex-type culture CBS 299.80).

*Substrate and distribution*: On *Gaultheria shallon* (*Ericaceae*); Europe (Italy).

*Notes*: The strain used in this study forms a single lineage (Fig. 2, clade 88), basal to *R. endophylla*, and is positioned on a very long branch, which supports this species as unique. No *Ramularia* species is currently known from *Gaultheria*. Unfortunately, the culture was sterile and the herbarium material is an old dried culture on which some conidiophores and conidiogenous cells could be observed but were not sufficient to warrant a full description. (Fig. 44), so the molecular differences based on the sequence data are also provided.

***Ramularia gei*** (A.G. Eliasson) Lindr., Acta Soc. Fauna Fl. Fenn. 23: 26. 1902.
*Basionym*: *Ovularia gei* A.G. Eliasson, Bih. Kongl. Svenska Vetensk.-Akad. Handl. 22(12): 19. 1897.
≡ *Ramularia gei* (A.G. Eliasson) Höhn., Ann. Mycol. 2: 57. 1904, homonym!
≡ *Ramularia gei* (Fuckel) Lindau, in Rabenh., Krypt.-Fl., 2. Aufl., 1 Bd., Pilze IX. Abt., Fungi Imperfecti, Hyphomycetes: 766. 1920, homonym!
≡ *Pseudocercospora gei* (Fuckel) Y.-L. Guo & X.-J. Liu, Acta Mycol. Sin.: 344. 1986.
= *Acrotheca gei* Fuckel, Jahrb. Nassauischen Vereins Naturk. 15: 43. 1860.
For additional synonyms see Braun (1998).

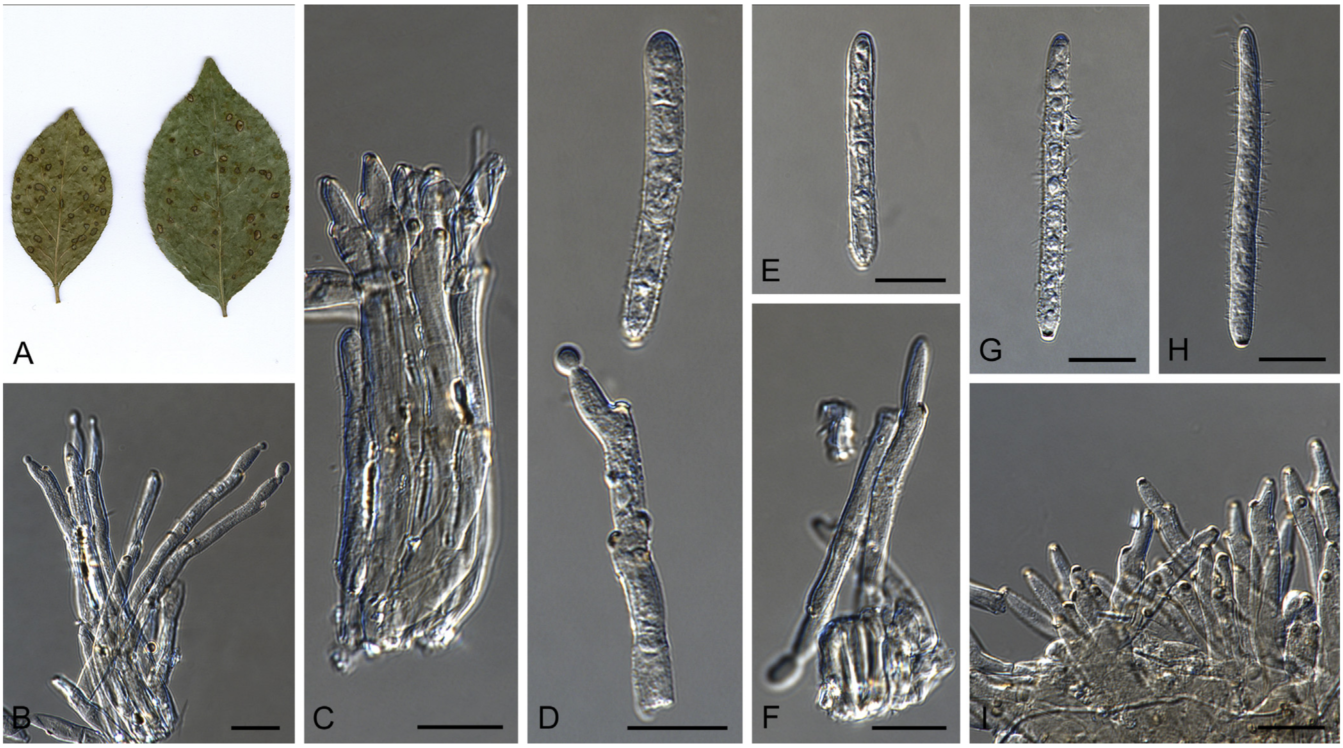

**Fig. 43.** *Ramularia euonymicola* (CBS 113308). A–I. Observations from herbarium material. A. Leaf spot symptoms on the host. B, C, F, I. Conidiophores and conidiogenous cells. D. Conidiogenous cell and conidia. E, G, H. Conidia. Scale bars = 10 µm.

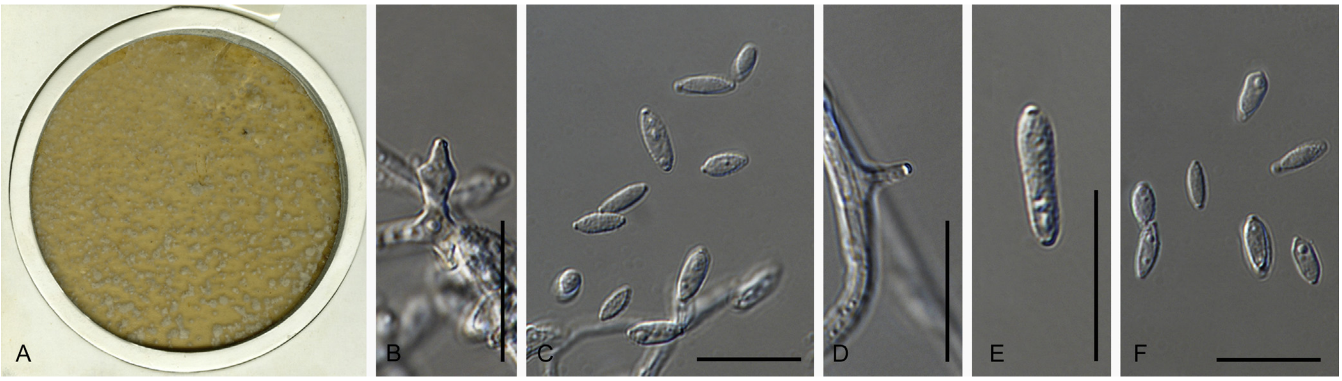

**Fig. 44.** *Ramularia gaultheriae* (CBS 299.80). A–F. Observations from herbarium material. B, D. Conidiophore reduced to conidiogenous cell. C, E, F. Conidia. Scale bars = 10 µm.

*Description in vivo*: See Braun (1998: 246).

*Specimens examined*: **Netherlands**, Baarn, Loenen, Overholland, on *Geum urbanum*, 12 Apr. 1969, J.A. von Arx, CBS H-4927, culture CBS 344.49. **Sweden**, Uppland, Danmark par., Bergsbrunna, on *Geum* sp., 25 Sep. 1986, E. Gunnerbeck, culture CBS 113977; near Uppsala, on *Geum urbanum*, 4 Sep. 1895, Eliasson (**holotype** S-F-58091).

*Substrate and distribution*: On *Geum* (*Rosaceae*); Asia, Caucasus, Europe, Iceland, N. America.

*Notes*: *Ramularia gei* was originally described on *Geum urbanum* from Sweden (holotype in S). The similarities between *Acrotheca gei* and *Ramularia gei* were discussed by Hughes (1953) and those between *R. gei* and *R. submodesta* were pointed out by von Höhnel (1904). The strains included here form a highly supported clade (Fig. 2, clade 74, 1/100/100), but were sterile in culture and the herbarium specimen is depauperate.

***Ramularia geranii*** Fuckel, Jahrb. Nassauischen Vereins Naturk. 23–24: 361. 1870. Fig. 45.

= *Fusidium geranii* Westend., Bull. Acad. Belg. 18: 413. 1851.

≡ *Cylindrospora geranii* (Westend.) J. Schröt., Krypt.-Fl. Schlesien 3.2(4): 486. 1897.

For additional synonyms see Braun (1998) or MycoBank.

*Mycelium* consisting of hyaline, septate, branched, smooth, 1.5–3 µm diam hyphae. *Conidiophores* hyaline, thin-walled, erect, septate, straight to geniculate-sinuous, cylindrical-oblong, unbranched, (65–)82–100(–150) × 2–2.5(–3) µm or reduced to conidiogenous cells, hyaline, smooth, integrated in mycelium or terminal in conidiophores, cylindrical-oblong, (14.5–)19–22(–28) × 2–3 µm, with one apical *conidiogenous locus*,

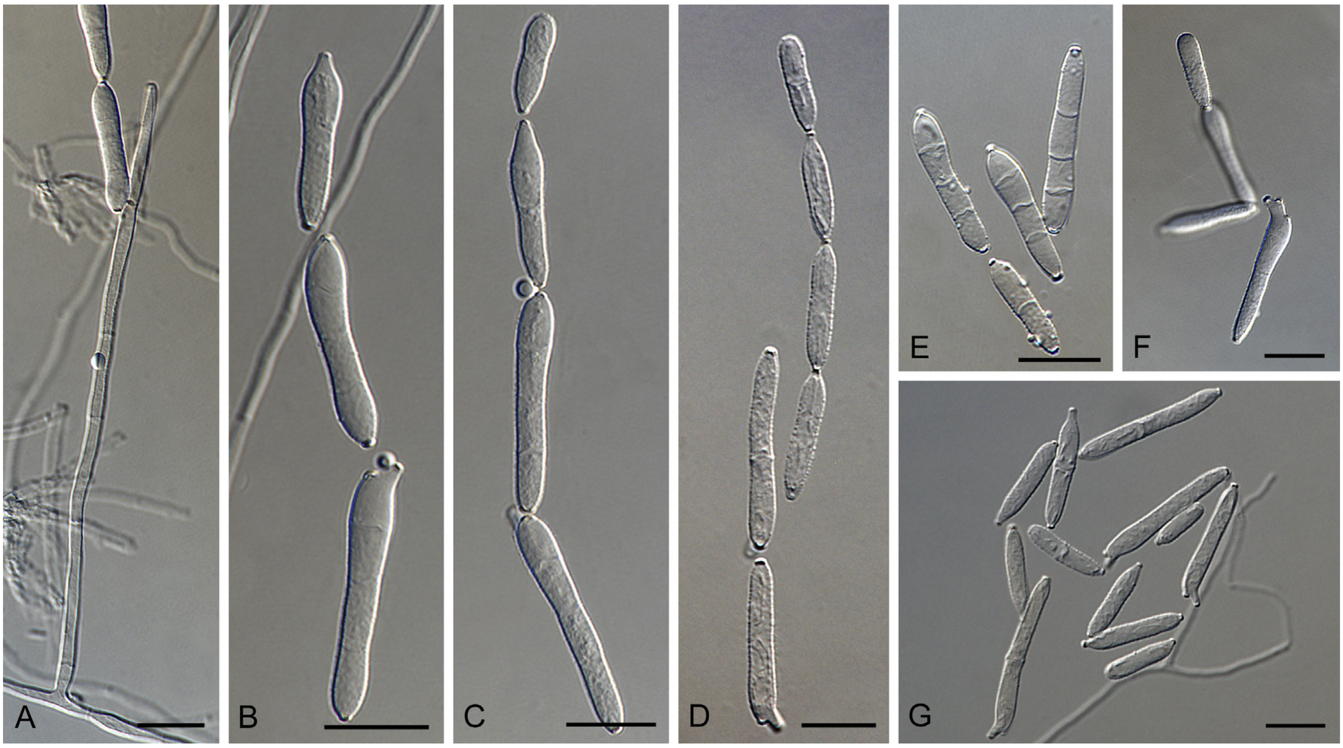

**Fig. 45.** *Ramularia geranii* (CBS 160.24). A–G. Structures formed in culture. A. Conidiophore, conidiogenous cell and conidia. B–G. Conidia. Scale bars = 10 µm.

thickened and darkened. *Conidia* hyaline, thin-walled, smooth, with hila thickened and darkened. *Ramoconidia* subcylindrical to clavate, 1–4-septate, (23–)28–30(–35) × (3–)4–4.5(–5) µm, with 2–3 conidiogenous apical hila. *Intercalary conidia*, 0–3-septate, subcylindrical to clavate, straight or slightly curved, narrower at the centre and broader at the apices, (17–)22–25(–30) × (2.5–)3.5–4(–5) µm, in chains of up to five conidia. *Terminal conidia* 0–1-septate, obovoid, clavate, phalangoid, (11–)15.5–18(–25) × (3–)4(–5) µm.

*Culture characteristics*: On MEA, 11 mm diam, surface rosy vinaceous to pale vinaceous grey, strongly folded, raised with margins crenate, colony reverse cinamon with iron grey patches. On OA, 10 mm diam, surface rosy buff, flat, sparse aerial mycelium with margins undulate and sparse aerial mycelium, colony reverse rosy buff with brown vinaceous patches. On PDA, 11 mm diam, surface folded, rosy buff to pale olivaceous grey, raised, with margins undulate, concave, colony reverse olivaceous.

*Description in vivo*: See Braun (1998: 164).

*Specimens examined*: **France**, on *Geranium pyrenaicum*, collector and date unknown, isol. and dep. C. Killian, Jun. 1924, culture CBS 159.24; on *Geranium sylvaticum*, unknown date, C. Killian (**epitype designated here** CBS H-17726, MBT371838, culture ex-epitype CBS 160.24). **Poland**, on *Geranium pusillum* [Schneider, Herb. Schles. Pilze 898; **neotype**, designated in Braun (1998), HAL].

*Substrate and distribution*: On *Erodium* and *Geranium* (*Geraniaceae*); Asia, Caucasus, Europe, N. America.

*Notes*: Two varieties are known for *Ramularia geranii*, *R. geranii* var. *geranii* (on *Geranium pusillum*, Poland, neotype in HAL) and *R. geranii* var. *erodii* (on *Erodium cicutarium*, Germany, neotype in B). The latter differs from the first by having long slender conidia with up to four septa. They are distributed in the northern hemisphere and *R. gerani* var. *gerani* has also been reported from *Erodium*. The strains representing *Ramularia geranii* in this study clustered separately with CBS 259.24 and CBS 160.20 forming one clade (Fig. 2, clade 3) and CBS 114566 forming a single lineage on a long branch (Fig. 2, clade 4). The strains CBS 159.24 and CBS 160.24 produce very large conidia fitting with the original description and were isolated from the same host genus, but from a different species and country. Strain CBS 114566 was isolated from the same host as the type but from a different European country. Unfortunately it was sterile and morphological comparison with the original description was not possible. Strains CBS 159.24 and CBS 160.24 (Fig. 2, in clade 3, 1/100/100; Fig. 45) are considered good representatives of *R. geranii* both morphologically and phylogenetically, and CBS 160.24 is therefore chosen as ex-epitype. The strain CBS 114566 appears as *R. geranii* in the CBS database but it is not conspecific with the species in this clade and will be treated as a *Ramularia* sp. A for the time being.

***Ramularia geraniicola*** Videira & Crous, **sp. nov.** MycoBank MB816849. Fig. 46.

*Etymology*: Named after the host genus, *Geranium*, from which it was collected.

*Mycelium* consisting of hyaline, septate, branched, smooth, 1–2.5 µm diam hyphae. *Conidiophores* hyaline, thin-walled, smooth, emerging from hyphae or dark hyphal spherical aggregates, erect, 1–2(–4)-septate, straight to sinuous, cylindrical-oblong, unbranched (22.5–)35.5–44(–66.5) × (1.5–)2–3(–4) µm or reduced to conidiogenous cells. *Conidiogenous cells*, integrated, cylindrical-oblong and narrower at the top, geniculate-sinuous, (12–)18–22(–33) × 2–2.5(–3) µm, with 1–4 apical conidiogenous loci, almost flat or protuberant;

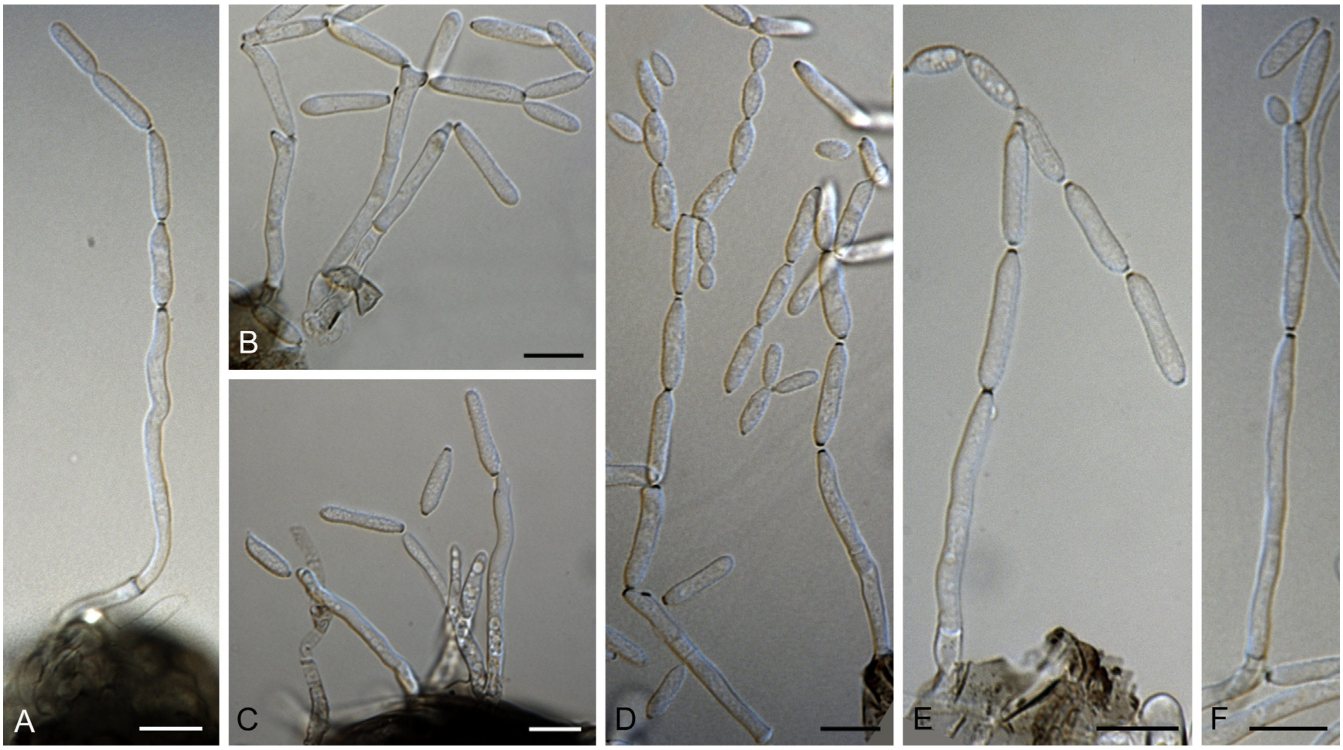

**Fig. 46.** *Ramularia geraniicola* (CBS 141110). A–F. Conidiophores, conidiogenous cells and conidia formed in culture. Scale bars = 10 µm.

*conidiogenous loci* thickened, darkened and refractive. *Conidia* hyaline, thin-walled, smooth, catenate, with hila thickened, darkened and refractive. *Ramoconidia* subcylindrical to clavate, (10–)13.5–16(–22.5) × (2–)3(–4) µm, 0–1-septate, with two apical hila. *Intercalary conidia* subcylindrical, fusoid, 0–1-septate, (8.5–)12.5–14.5(–21.5) × (2.5–)3(–4) µm, in branched chains of up to eight conidia. *Terminal conidia* subcylindrical to obovoid, aseptate, (3–)6.5–8.5(–13) × (2–)2.5–3(–3.5) µm (on SNA).

*Culture characteristics*: On MEA, 15 mm diam, raised, folded, smooth, radially striated, olivaceous grey, with margins pale olivaceous grey and lobate, colony reverse olivaceous grey; on OA, 13 mm diam, flat, sparse aerial mycelium, smooth, olivaceous grey with some tufts pale olivaceous grey, with margins with sparse aerial mycelium and entire edge, colony reverse olivaceous grey; on PDA, 16 mm diam, flat, olivaceous grey, fluffy aerial mycelium, pale olivaceous grey, with margins undulate, colony reverse olivaceous grey and buff margin.

*Specimen examined*: **Netherlands**, Utrecht, Rhijnauwen, on *Geranium* sp., May 2013, U. Damm (**holotype** CBS H-22521, culture ex-type CBS 141110 = CPC 25912).

*Substrate and distribution*: On *Geranium* sp. (*Geraniaceae*); Europe (Netherlands).

*Notes*: Two *Ramularia* species (*R. geranii* var. *geranii*, *R. pseudogeranii*) and two ramularia-like species (*Phacellium geranii* and *Pseudocercosporella magnusiana*) have thus far been described from *Geranium* (Braun 1998). *Ramularia geranii* var. *geranii* produces conidia that are smooth to verruculose, ellipsoid-ovoid to fusiform, 0–3-septate and 10–40(–55) × (2–)2.5–6(–7) µm. *Ramularia pseudogeranii* produces solitary obovoid conidia, 14–25 × 6–12 µm. The synnematous *Phacellium geranii* produces catenate conidia, ellipsoid-ovoid to fusoid, 12–28 × 4–7 µm. *Pseudocercosporella magnusiana* produces solitary conidia, subcylindrical-filiform to acicular (30–)40–100(–120) µm, 2–8-septate, with hyaline, unthickened hilum. The morphological characters of *R. geraniicola* (Fig. 46) are also distinct from the closest species, *R. variabilis* that produces shorter conidiophores and narrower fusiform to obovoid conidia (Fig. 2, clade 50). *Ramularia geraniicola* has unique morphological characters and forms a single lineage in the phylogenetic analysis (Fig. 2, clade 51).

***Ramularia glechomatis*** U. Braun, Nova Hedwigia 56: 426. 1993. Fig. 47.

= *Fusisporium calceum* Desm., Ann. Sci. Nat., Bot., 2 Sér., 17: 95. 1842.
≡ *Cylindrospora calcea* (Desm.) J. Schröt., in Cohn, Krypt.-Fl. Schles. 3.2(4): 491. 1897.

For additional synonyms see Braun (1998) or MycoBank.

*Mycelium* consisting of hyaline, septate, branched, smooth, 1–2 µm diam hyphae. *Conidiophores* hyaline, smooth, thin-walled, erect, septate, cylindrical-oblong, straight to sinuous, unbranched (15–)28–36(–61) × (1.5–)2 µm, or reduced to conidiogenous cells, terminal in conidiophores or intermediate in the mycelium, cylindrical-oblong to geniculate-sinuous, (4–)11–13(–18) × 1.5– 2(–3) µm, with up to three protuberant conidiogenous loci; *conidiogenious loci* thickened, darkened and refractive. *Conidia* hyaline, thin-walled, slightly verruculose, catenate, with hila thickened, darkened and refractive. *Ramoconidia* cylindrical-oblong, (8–)11–13(–17) × 2(–3) µm, 0–1-septate, with two apical hila. *Intercalary conidia* cylindrical-oblong, fusoid, aseptate, (6.5–)8.5–10(–14) × 2(–3) µm, in branched chains of up to seven conidia. *Terminal conidia* cylindrical-oblong to obovoid, aseptate, (3–)5–6.5(–9) × (1–)2(–3) µm (on SNA).

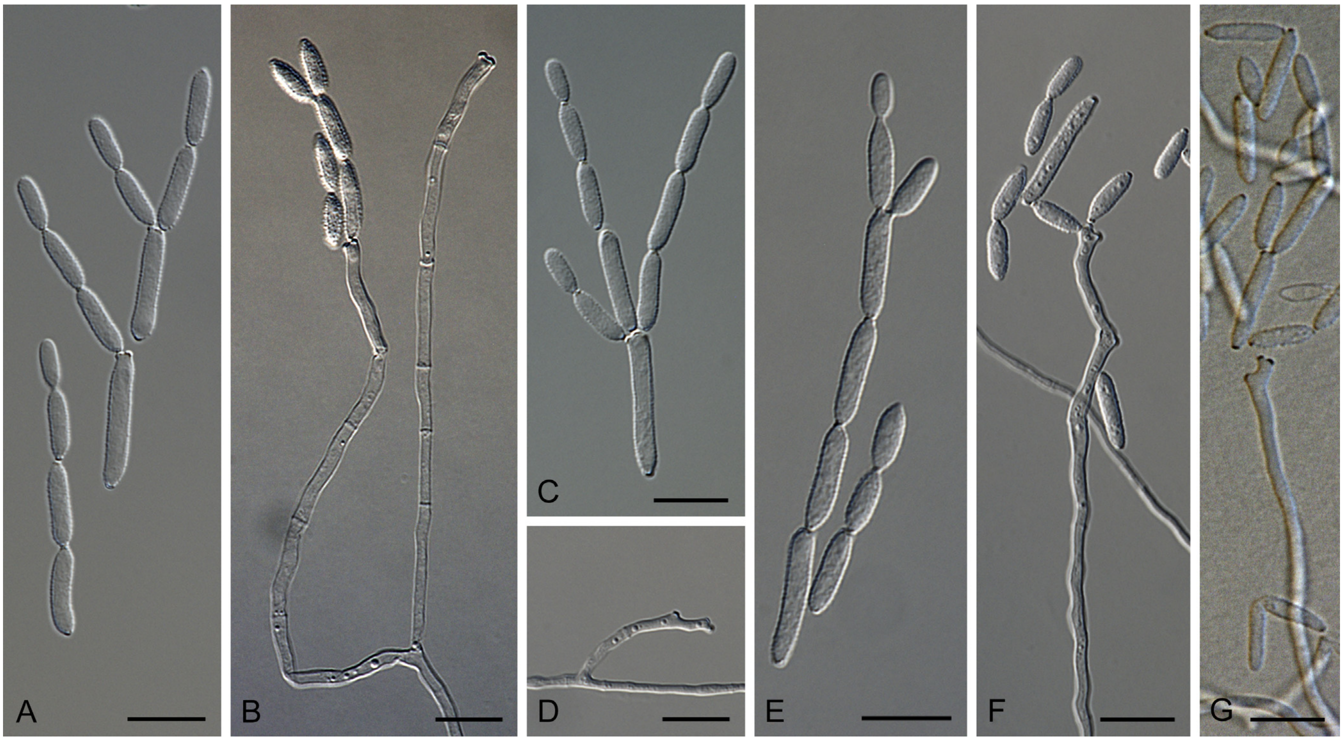

**Fig. 47.** *Ramularia glechomatis* (CBS 108980). A–G. Structures formed in culture. A, C, E. Conidia. B, F, G. Conidiophores, conidiogenous cells and conidia. D. Conidiophore. Scale bars = 10 µm.

*Culture characteristics*: On MEA, 10 mm diam, surface raised, smooth, white with a greyish tinge, with margins lobate, colony reverse iron-grey; on OA, 12 mm diam, surface flat, smooth, pale grey, with margins entire, colony reverse iron-grey; on PDA, 11 mm diam, surface flat, smooth, white with greyish patches, with margins entire, colony reverse iron-grey.

*Description in vivo*: See Braun (1998: 180).

*Specimens examined*: **Germany**, Brandenburg, Nedlitz near Potsdam, on *Glechoma hederacea*, 7 Sep. 1919 [Sydow, Mycoth. Germ. 1757] (**holotype** JE). **Netherlands**, Utrecht Prov., Baarn, de Hooge Vuursche, on leaf spot on *G. hederacea*, 22 Jun. 2000, G. Verkley, cultures CBS 108979, CBS 108980; Utrecht Prov., Nieuwersluis, Overholland, on leaf spot on *Glechoma hederacea*, unknown collector and date, isol. and dep. J.A. von Arx, Nov. 1949, culture CBS 343.49.

*Substrate and distribution*: On *Glechoma hederacea* (*Lamiaceae*); Asia, Caucasus, Europe.

*Notes*: *Ramularia glechomatis* was originally described on *Glechoma hederaceae* from Germany (holotype in JE) but it has been reported on this host from almost all countries in Europe including the Netherlands (Braun 1998). The strains used in this study cluster in a highly supported clade (Fig. 2, clade 45, 1/100/100). Morphologically, they are similar to the description available in literature (Braun 1998) except for producing narrower conidia, but our observations are based on cultures on SNA (Fig. 47).

***Ramularia glennii*** Videira & Crous, Persoonia 34: 55. 2015.

*Specimens examined*: **Iraq**, Al-Kora, Basrah, on leaves of *Eucalyptus camaldulensis*, 1 Mar. 2009, A. Saadoon, cultures CPC 16560, CPC 16565. **Italy**, Viterbo, on leaves of *Corymbia grandifolia*, 1 Apr. 2006, W. Gams, culture CBS 120727 = CPC 13047. **Netherlands**, on human bronchial alveolar lavage, Rotterdam, Maasstad Ziekenhuis (Clara), on human bronchial alveolar lavage, 2011, unknown collector, dep. A. van Duin (**holotype** CBS H-21617, ex-type culture CBS 129441); Rotterdam Maasstad Ziekenhuis (Clara), on human skin tissue, 29 April 2008, unknown collector, dep. H. Naaktgeboren, culture CBS 122989. **USA**, Athens, on rubber of refrigerator, Sep. 2010, A. Glenn, culture CPC 18468.

*Substrate and distribution*: On *Corymbia grandifolia* and *Eucalyptus camaldulensis* (*Myrtaceae*), human and environmental samples; Western Asia (Iraq), Europe, USA.

*Notes*: See Videira *et al.* (2015a). The phylogenetic analyses provide good support for this species clade (Fig. 2, clade 32, 1/100/96).

***Ramularia grevilleana*** (Oudem.) Jørst., Meld. Stat. Plantepatol. Inst. 1: 17. 1945, emend. U. Braun, A monograph of *Cercosporella*, *Ramularia* and allied genera (Phytopathogenic Hyphomycetes) 2: 68. 1998.
*Basionym*: *Cylindrosporium grevilleanum* Oudem., Arch. Néerl. Sci. Exact. Nat. 8: 392. 1873.

= *Cylindrosporium* sp., in Tul. & C. Tul., Select. fung. carpol. 2: 288. 1863.
= *Mycosphaerella fragariae* (Tul. & C. Tul.) Lindau, in Engler & Prantl, Nat. Pflanzenfam., ed.1, Sphaeriales, 1(1): 424. 1897.
= *Ramularia tulasnei* Sacc., Michelia 1: 536. 1879, nom. superfl.!
= *Ramularia fragariae* Peck, Annual Rep. (Annual) New York State Mus. Nat. Hist. 32: 43. 1879.
= *R. modesta* Sacc., Fungi ital. Del., Tab. 999. 1881.

For additional synonyms see Braun (1998) or MycoBank.

*Description in vivo*: See Braun (1998: 248).

*Specimens examined*: **Netherlands**, unknown host, date and collector, isol. Moll, dep. Oct. 1934, cultures CBS 298.34; unknown host, date and collector, isol. van Egmond, dep. Aug. 1936, CBS 259.36; Heemstede, on *Fragaria vesca*, Jul. 1872, Oudemans [**lectotype**, designated by Braun & Pennycook (2003), L 371868]. **New Zealand**, Auckland, on *Fragaria* sp., unknown date and collector, isol. and dep. W.F. Hartill, Dec. 1983, culture CBS 719.84. **Sweden**, Uppland, Alsike, on *Fragaria ananassa*, 4 Oct. 1989, E. Gunnerbeck, culture CBS 114732.

*Substrate and distribution*: On *Duchesnea*, *Fragaria*, *Horkelia*, *Potentilla*, and *Waldsteinia* (*Rosaceae*); almost circumglobal.

*Notes*: The valid publication of *Cylindrosporium grevilleanum*, the basionym of *Ramularia grevilleana*, dates back to Oudemans (1873). A detailed discussion of the complicated nomenclature of this species and its lectotypification has been published by Braun & Pennycook (2003). The phylogenetic analyses provide high support for this species clade (Fig. 2, clade 28, 1/100/100). *Ramularia grevilleana* causes Ramularia leaf spot disease of strawberry and other hosts of the *Rosaceae*. The most conspicuous symptoms are leaf lesions but symptoms can also develop on fruits, calyxes, fruit trusses, petioles and stolons. It occurs worldwide on cultivated varieties as well as wild strawberry species. In earlier years, the economic impact of the disease was so great that Ramularia leaf spot was considered the most important strawberry disease. With increased emphasis on the development and use of resistant cultivars, Ramularia leaf spot disease, although still an important foliar disease is now of less concern (Maas 1984). The link between the sexual morph *Mycosphaerella fragariae* and the asexual morph *R. grevilleana* has been experimentally proven (Dudley 1889).

***Ramularia haroldporteri*** Videira & Crous, Persoonia 34: 58. 2015.

*Specimen examined*: **South Africa**, unidentified bulb plant, 14 Jan. 2009, P.W. Crous (**holotype** CBS H-21616, ex-type cultures CBS 137272 = CPC 16296, CPC16297).

*Substrate and distribution*: Thus far only known from South Africa.

*Notes*: See Videira *et al.* (2015a). The phylogenetic analyses provide high support for this species clade (Fig. 2, clade 30, 1/100/100).

***Ramularia helminthiae*** Bremer & Petr., Sydowia 1: 259. 1947. Fig. 48

= *Ramularia helminthiae* T.M. Achundov, Novosti Sist. Nizsh. Rast. 20: 59. 1983, nom. illeg.

*Mycelium* consisting of hyaline, septate, branched, smooth, 1–3 µm diam hyphae. *Conidiophores* hyaline, thin-walled, smooth, erect, 1–3-septate, straight to flexuous, cylindrical-oblong, unbranched (19–)41–53(–82) × (1.5–)2–2.5(–3) µm or reduced to conidiogenous cells. *Conidiogenous cells* integrated in mycelium or terminal on conidiophores, cylindrical-oblong, (15–)21.5–25.5(–36) × 2.0–2.5(–3) µm, with 1–2 apical conidiogenous loci almost flat to short cylindrical, thickened, darkened, refractive. *Conidia* hyaline, thin-walled, smooth to slightly verruculose, with hila thickened, darkened and refractive. *Ramoconidia* subcylindrical to clavate, (14–)21–27(–44) × (2.5–)3–3.5(–4) µm, 0–3-septate, with 2–3 apical hila. *Intercalary conidia* hyaline, smooth, 0–3-septate, subcylindrical with apices rounded and broader, (14–)19–25(–50) × (2.5–)3–4(–4.5) µm, in branched chains of up to four conidia. *Terminal conidia* aseptate, subcylindrical to obovoid, (5.5–)13–16.5(–25.5) × (2–)3–3.5(–4.5) µm.

*Culture characteristics*: On MEA, 15 mm diam, surface raised, folded, smooth mycelium, smoke-grey with olivaceous tinge, with small buff droplets, with margins lobate, convex, feathery, colony reverse olivaceous grey and ochraceous patches; on OA, 15 mm diam, surface low convex, smooth mycelium, white, with margins buff, naked, undulate, colony reverse rosy-buff; on PDA, 20 mm diam, surface low convex, smooth mycelium, white with greyish tinge with margins undulate, feathery, colony reverse rosy-buff and iron-grey patches.

*Specimens examined*: **Azerbaijan**, Talysh, district Massalli, Kyzylagadzh, on *Helminthotheca echioides* (≡ *Picris echioides*), 2 Jun. 1974, T.M. Achundov (**isotype** of *R. helminthiae* T.M. Achundov LE 41974). **South Korea**, Hongcheon, on *Picris hieracioides* var. *glabrescens*, 9 Jul. 2004, H.D. Shin, KUS-F20442, culture CPC 11502, CPC 11504. **New Zealand**, Auckland, Mt. Albert, on *H. echioides*, unknown collector and date, isol. C.F. Hill, Jul. 2005, det. C.F. Hill, culture CBS 118418. **Turkey**, Adana, Terliksiz, on *H. echioides*, 8 Jun. 1943, G. Karel [**lectotype** of *R. helminthiae* Bremer & Petr., designated in Braun (1998), W 15449].

*Notes*: These strains were initially identified as *R. inaequalis*, but this species clusters in clade 40 (Fig. 2). Several names have been synonymised with *R. inaequalis* that refer to species isolated from different hosts and locations. These need to be recollected and re-examined since it appears that *R. inaequalis* is a species complex. *Helminthotheca echioides* is of Mediterranean origin, but now with a widespread, almost cosmopolitan neophytic distribution. The descriptions of both species named *R. helminthiae* are from the neophytic area of the host, but the origin of the species concerned is probably Mediterranean as well. A sporulating culture based on material collected on *H. echioides* in Turkey or adjacent countries should serve as epitype for this species, but is not yet available. Therefore, the name *R. helminthiae* is only tentatively used for the present strains until appropriate cultures will be available. *Ramularia helminthiae* (Fig. 48) is supported as distinct from other included species by the phylogenetic analyses (Fig. 2, clade 5, 1/100/100). The strain CBS 118418 did not sporulate in culture.

***Ramularia heraclei*** (Oudem.) Sacc., Fungi ital. Del., Tab. 1008. 1881, emend. U. Braun, A monograph of *Cercosporella*, *Ramularia* and allied genera (Phytopathogenic Hyphomycetes) 2: 68. 1998. Fig. 49.

*Basionym*: *Cylindrosporium heraclei* Oudem., Arch. Néerl. Sci. Exact. Nat. 8: 383. 1873.

= *Ramularia cicutae* P. Karst., Hedwigia 23: 7. 1884.
= *R. levistici* Oudem., Ned. Kruidk. Arch., 2 ser., IV: 540. 1886.
= *R. pastinacae* Bubák, Sitzungsber. Königl. Böhm. Ges. Wiss., Math.-nat. Kl., 1903: 19. 1903.
= *R. coriandri* Moesz & Smarods, Magyar Bot. Lapok 1/12: 37. 1930.

For additional synonymies see Braun (1998).

*Description in vivo*: See Braun (1998: 58).

*Specimens examined*: **Austria**, Ötztal, Ötz near Habichen, on leaf spot of *Heracleum* sp., 24 Jul. 2000, G. Verkley, cultures CBS 108987, CBS 108988. **Netherlands**, Bloemendaal, on *Heracleum sphondylium*, Aug. 1871, Oudemans [**lectotype**, designated in Braun (1998), in L]; Limburg Prov., Gerendal, on leaf spot of *Heracleum sphondylium*, 28 Jun. 2000, G. Verkley (**epitype designated here** CBS H-22638, MBT371839, culture ex-epitype CBS 108969); *idem*. CBS 108972. **South Korea**, Yangpyeong, on *Heracleum moellendorffii*, 24 Jun. 2004, H.D. Shin, cultures CPC 11505–11507. **Sweden**, Uppland, Danemora par., Andersby, on *Heracleum sphondylium*, 31 Aug. 1987, E. Gunnerbeck, culture CBS 113976 = UPSC 2344. **Unknown country**, on *Pastinaca sativa*, unknown collector and date, isol. and dep. J.E.V. Smith, Apr. 1923, culture CBS 194.25.

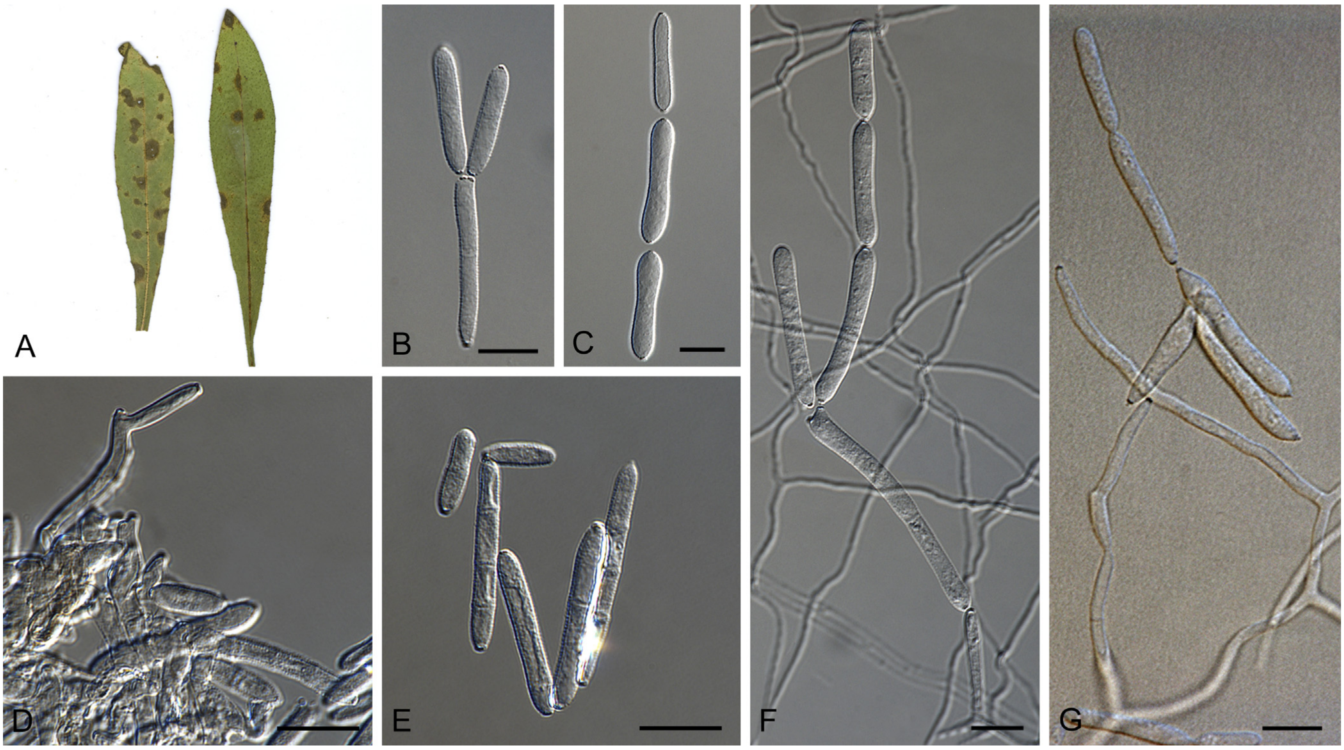

**Fig. 48.** *Ramularia helminthiae* (CPC 11504). A, D, E. Observations from herbarium material. B, C, F, G. Structures formed in culture. A. Leaf spots on the host. D, F, G. Conidiophores and conidia. B, C, E. Conidia. Scale bars = 10 µm.

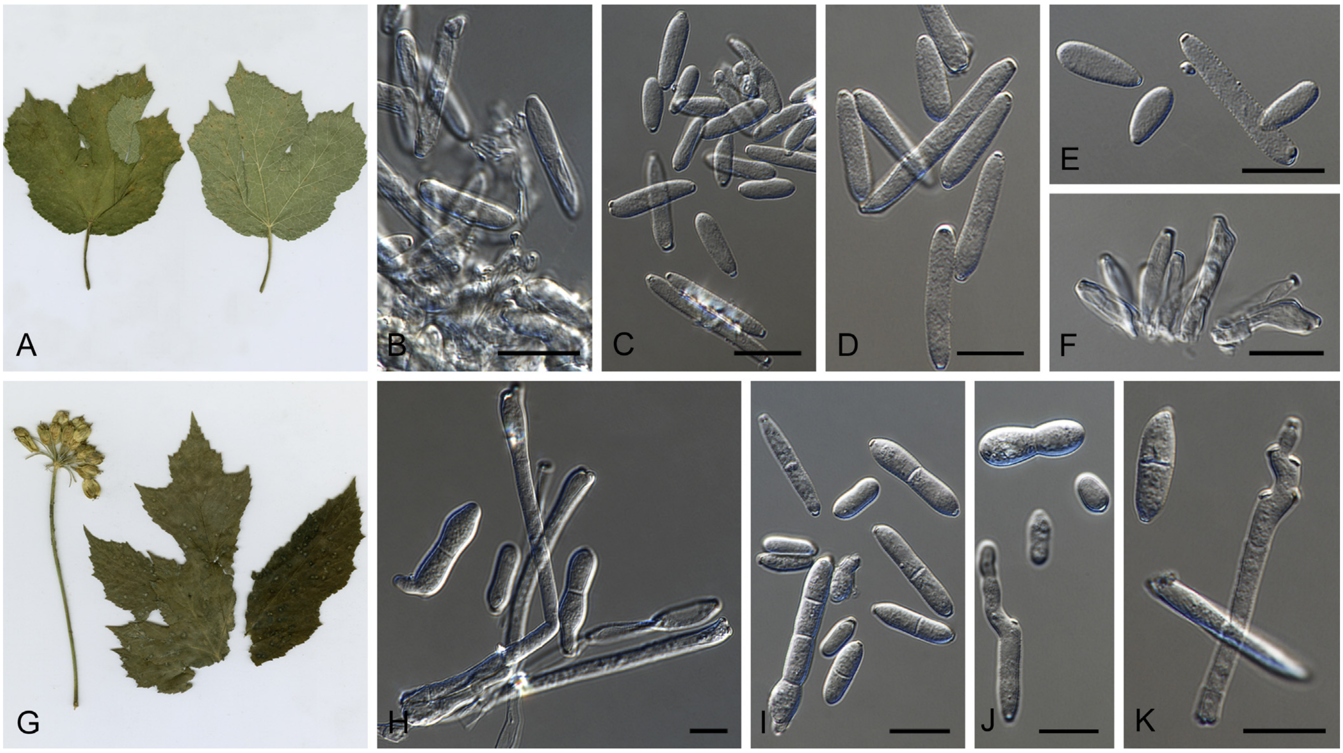

**Fig. 49.** *Ramularia heraclei* (CBS 108972, CBS 108988). A–K. Observations from herbarium material A–F. CBS 108972. G–K. CBS 108988. A, G. Leaf spot symptoms on the host. B, H. Conidiophores, conidiogenous cells and conidia. F, K. Conidiogenous cells. C–E, I–J. Conidia. Scale bars = 10 µm.

*Substrate and distribution*: On *Apium*, *Cicuta*, *Conium*, *Coriandrum*, *Hansenia*, *Heracleum*, *Levisticum*, *Malabaila*, and *Pastinaca* (*Apiaceae*); Asia, Africa, Caucasus, Europe, New Zealand, N. America and West Indies.

*Notes*: *Ramularia heraclei* was originally described on *Heracleum sphondylium* from the Netherlands (lectotype in L). Strains of *Ramularia heraclei* used in this study formed two sister clades that are both highly supported in the multigene phylogeny (Fig. 2, clade 78, 1/100/100). In literature (Braun 1998), the description of this species is quite broad including conidiophores in fascicles or forming crustose-like layers, erect and simple, cylindrical to geniculate-sinuous and variable in length, 5–80(–110) × 2–6 µm and conidia which are catenate, 0–3-septate, smooth to verruculose, (8–)10–35(–45) × 2–6 µm. The herbarium material corresponding to strain CBS 108972 has short conidiophores, (5–)12–17(–20) × 2–3 µm and conidia which are catenate, verruculose, 0–1-septate, (6–)11–14(–25) × (2–)3(–6) µm. The herbarium material corresponding to the strain CBS 108988 has longer conidiophores, (29–)49–59(–82) × 2–3 µm and longer conidia, catenate, smooth to slightly verruculose, (0–)1–3-septate and (6.5–)15.5–20(–36) × (2.5–)3.5–4(–6) µm. They both fit the morphological description in literature and strain CBS 108969, which was collected from the Netherlands and isolated from *Heracleum sphondylium*, the same location and host as the type species, and is herewith designated as epitype (Fig. 49). The morphology of *Ramularia* collections from hosts of *Apiaceae* that are preserved in herbaria are difficult to distinguish and several names were synonymised with *R. heraclei* (Braun 1998). The variation in morphology and the phylogeny indicate that this may be a species complex that needs further study and comparison with collections from other apiaceous hosts.

***Ramularia hieracii-umbellati*** A.G. Eliasson, Svensk. Bot. Tidskr. 9: 412. 1915. Fig. 50.

*In planta*: *Leaf spots* rectangular, following the leaf nerves, yellowish to brown. *Caespituli* emerging through stomata, hyaline to buff. *Conidiophores* hyaline, thin-walled, smooth, erect, septate, cylindrical-oblong, straight to geniculate-sinuous, rarely branched, (14–)27–32(–41.5) × (2–)3(–4) µm. *Conidiogenous cells* terminal or intermediate in the conidiophore, cylindrical-oblong or geniculate-sinuous, (7–)10–13(–22) × (2–)3(–4) µm, with multiple *conidiogenous loci* almost flat to protuberant, thickened, darkened and refractive. *Conidia* hyaline, thin-walled, smooth, solitary or in short chains unbranched, cylindrical-oblong to obovate, (0–)1–2-septate, (8–)15–20(–25) × (2–)2.5–3 µm with hila thickened, darkened and refractive.

*Culture characteristics*: On MEA, 13 mm diam, surface raised, olivaceous grey fluffy aerial mycelium, droplets of iron-grey, margins undulate, convex, feathery, colony reverse undulate, convex, feathery, iron-grey; on OA, 15 mm diam, surface low convex, smooth, pale olivaceous grey, with margins with entire edge, colony reverse olivaceous grey; on PDA, 14 mm diam, surface raised, greenish grey, with olivaceous grey droplets exudate, radially striated, with margins lobate, convex, feathery, colony reverse iron-grey.

*Specimens examined*: **South Korea**, Pocheon, on *Hieracium umbellatum*, 2 Sep. 2003, H.D. Shin, KUS-F19596, cultures CPC 10690–10692; Pyeongchang, on *Hieracium umbellatum*, 4 Sep. 2003, H.D. Shin, KUS-F19601, cultures CPC 10788, CPC 10789; **Sweden**, Smolandiae, Lofthammer, on *Hieracium umbellatum*, 12 Jul. 1912, A.G. Eliasson (**holotype** UPS).

*Substrate and distribution*: On *Hieracium umbellatum* (*Asteraceae*); Asia (South Korea), Europe (Sweden).

*Notes*: Previously identified as *Ramularia inaequalis* these strains in fact represent a separate species (Fig. 50), since they do not cluster together with the type of *R. inaequalis* (Fig. 2, clade 40). The morphology agrees well with *R. hieracii-umbellati* described on *Hieracium umbellatum* from Sweden. Cultures and sequences based on collections from Sweden are not available for comparison, but since the Korean material might belong to this species, we prefer to apply the latter name, at least tentatively. *Hieracium umbellatum* is a widespread circumpolar species. Strains of *R. hieracii-umbellati* form a highly supported clade (Fig. 2, clade 56, 1/100/100). *Ramularia hieracii-umbellati* formed a sister clade to *R. rhabdospora*, but the latter produces wider conidiophores [10–50(–115) × 2–8 µm] and larger catenate conidia [(10–)15–40(–50) × 3–7 µm], echinulate, ellipsoid-ovoid to cylindrical, and 0–3(–4)-septate (Braun 1998).

***Ramularia hydrangeae-macrophyllae*** U. Braun & C.F. Hill, Australas. Mycol. 27: 53. 2008. Fig. 51.

*In planta: Leaf spots* variable, from angular-irregular speckles to large brown leaf blotches. *Mycelium* internal and external but lacking stromata. *Conidiophores* arising from internal hyphae, emerging through stomata or from superficial hyphae, straight, simple, thin-walled, smooth, subcylindrical to moderately geniculous-sinuous, 4–35 × 1.5–3.5 µm, 0–1-septate, or reduced to conidiogenous cells, 4–20 µm long; *conidiogenous loci* conspicuous, thickened and darkened. *Conidia* catenate, sometimes in branched chains, ellipsoid-ovoid to fusiform-subcylindrical, 4–18 × 1.5–2.5 µm, 0–1-septate, hyaline, thin-walled, smooth to verruculose, hila thickened and darkened. Description adapted from Braun & Hill (2008). *Ascomata* pseudothecial, single, brown, immersed, becoming erumpent, globose, apical ostiole. *Asci* aparaphysate, fasciculate, bitunicate, subsessile, obovoid to narrowly ellipsoid. *Ascospores*, straight to fusoid-ellipsoid, hyaline, thin-walled, with subobtuse ends, medianly 1-septate, symmetrical or with one side slightly larger than the other, sometimes slightly constricted at the septa, (4.5–)5–6(–7.5) × (1–)1.5–2(–2.5) µm.

*Specimens examined*: **Italy**, Grancarlo, on *Feijoa sellowiana*, unknown date, G. Polizzi, culture CPC 19854. **Netherlands**, Flevoland Prov., Lelystad, Hollandse Hout, on *Platanus* sp., Apr. 2012, S.I.R. Videira, culture CPC 25901; same prov., Kortenhoefse Plassen, on a dead leaf of *Sparganium ramosum*, Jan. 1982, W. Gams, culture CBS 159.82; Utrecht prov., Bilthoven, on *Phragmites* sp., 6 Jan. 2011, P.W. Crous, cultures CPC 19026, CPC 19027; Breukelen, on *Sparganium ramosum*, unknown collector and date, isol. W. Gams, Sep. 2003, culture CBS 113614; Houten, on *Typha* sp., Jul. 2012, S.I.R. Videira, cultures CPC 25903; Nieuwersluis, Overholland, from leaf spot on *Angelica sylvestris*, unknown collector and date, dep. Nov. 1949, culture CBS 341.49; Utrecht, Botanical Garden, on *Aesculus hippocastanum*, Apr. 2012, S.I.R. Videira, cultures CPC 25902; Utrecht, Botanical Garden, on *Iris foetidissima*, collector and date unknown, culture CPC 20484; Utrecht, on *Juncus* sp., May 2013 U. Damm, culture CPC 25907; Utrecht, on *Potentilla* sp., Oct. 2012, U. Damm, cultures CPC 25904; Utrecht, on *Laurus* sp., May 2013, W. Quaedvlieg, culture CPC 25908; Veenendaal, on *Carex* sp., May 2013, W. Quaedvlieg, cultures CPC 25905, CPC 25906; **New Zealand**, Auckland, Grey Lynn, on *Helleborus niger*, 1 May 2005, C.F. Hill, culture CBS 118408; Mt. Albert, Rurangi Road, on the underside of the leaf of *Hydrangea macrophylla*, 2 Jul. 2007, C.F. Hill (**holotype** HAL 2103 F, culture ex-type CBS 122273); Grafton, Park Road, The Auckland Domain, on dead leaves of *Iris* ×*hollandica* hybrid, 28 Oct. 2007, C.F. Hill, culture CBS 122625 = CPC 14811; Grey Lynn, Great North Road, Western Springs, on leaf lesion from *Iris* sp., 23 Sep. 2007, C.F. Hill, culture CBS 122272; Grey Lynn, on *Ligularia clivorum*, unknown collector and date, isol. C.F. Hill, 13 Jun. 2005, dep. C.F. Hill, culture CBS 118410. **Sweden**, Uppland, Dalby par., Jerusalem, on *Filipendula vulgaris*, 12 Jul. 1988, E. Gunnerbeck, culture CBS 114117. **UK**, England, Basingstoke, Upton Grey, Weston Road, on *Iris* sp., 25 Dec. 2010, P.W. Crous, culture CPC 19030; Exeter, endophyte on *Ulex europaeus*, unknown collector and date, isol. and dep. J. Fisher, Nov. 1984, culture CBS 766.84. **USA**, California, Walnut Creek, Ruth Bancroft Botanical Garden, on *Eucalyptus caesia*, 20 Mar. 2012, P.W. Crous, culture CPC 20406.

*Substrate and distribution*: *Aesculus* (*Sapindaceae*), *Angelica* (*Apiaceae*), *Carex* (*Cyperaceae*), *Eucalyptus*, *Feijoa* (*Myrtaceae*), *Filipendula*, *Potentilla* (*Rosaceae*), *Helleborus*

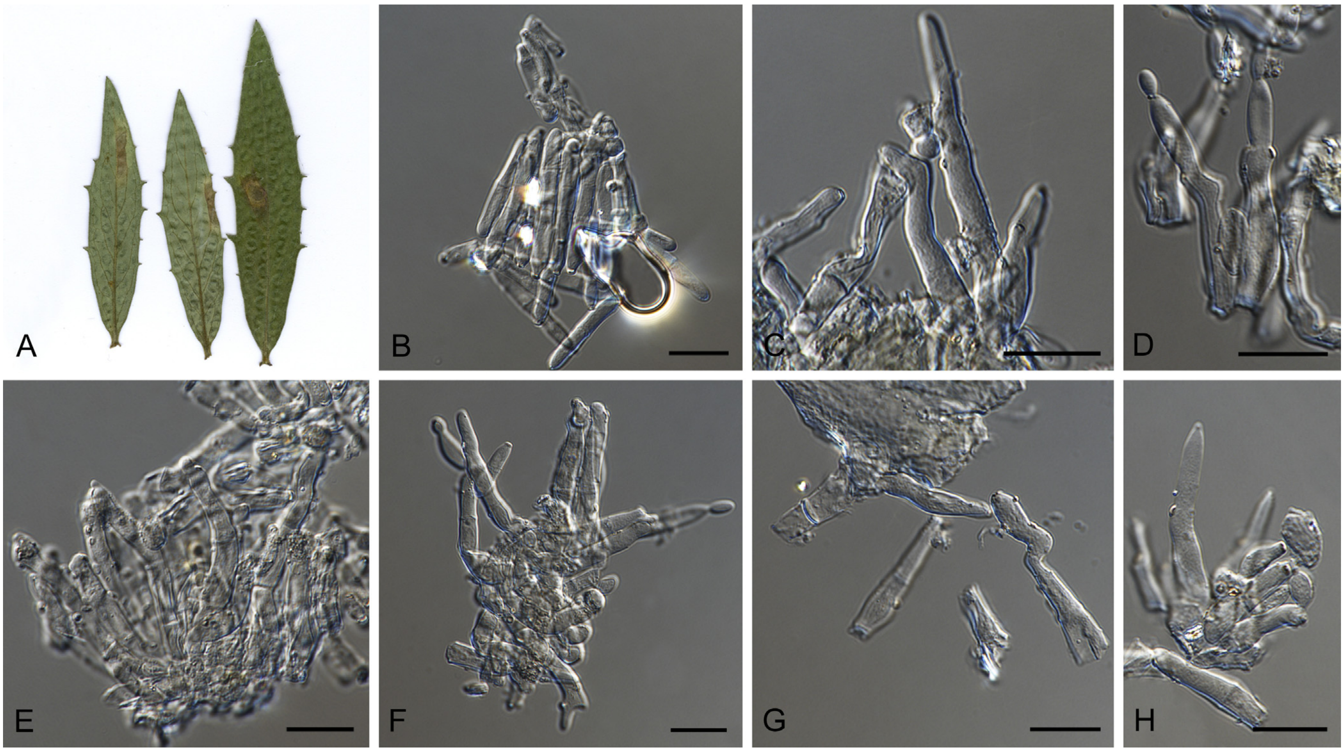

**Fig. 50.** *Ramularia hieracii-umbelati* (CPC 10690). A–H. Observations from herbarium material. A. Leaf spot symptoms on the host. B. Conidia. C–H. Conidiophores and conidiogenous cells. Scale bars = 10 µm.

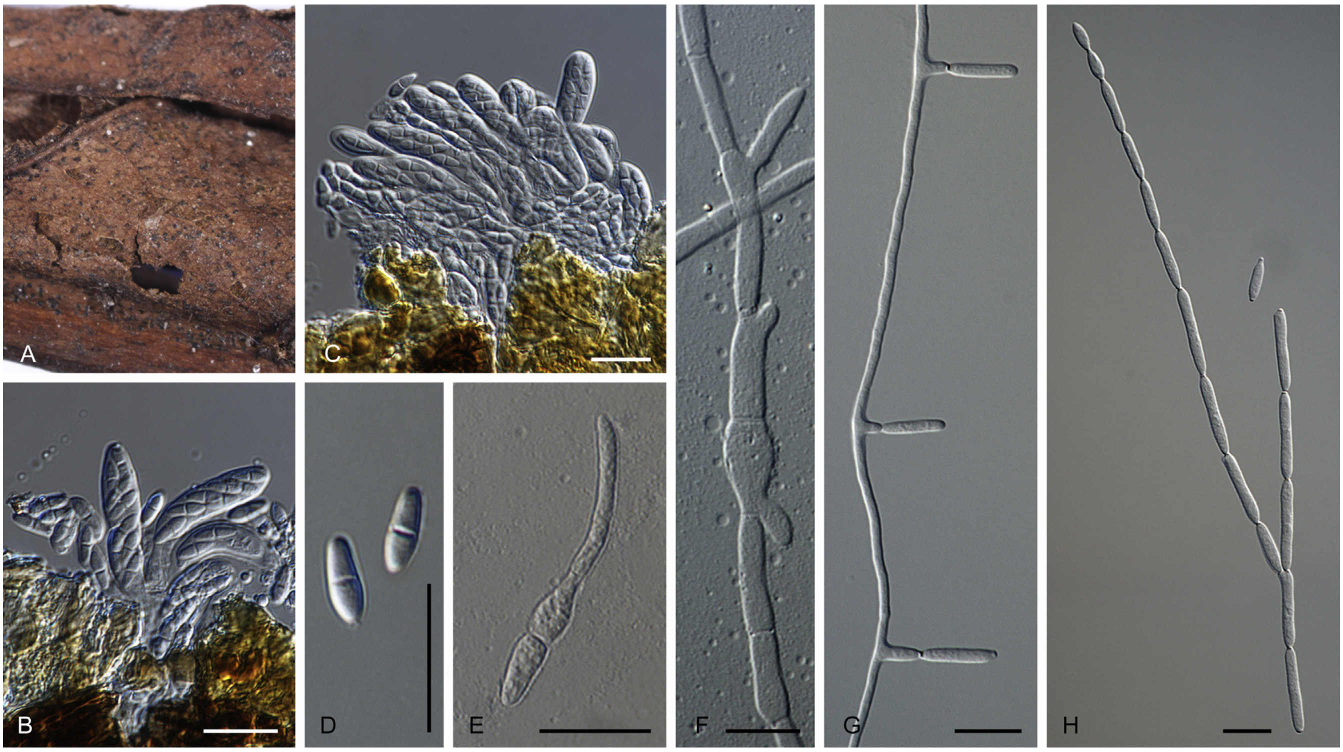

**Fig. 51.** *Ramularia hydrangeae-macrophyllae* (CPC 25902). A–D. Observations from herbarium material. E–H. Structures formed in culture. A. Leaf spot symptoms on the host. B, C. Asci and ascospores. D. Ascospores. E, F. Germinating ascospores. G, H. Conidia. Scale bars = 10 µm.

(*Ranunculaceae*), *Hydrangea* (*Hydrangeaceae*), *Iris* (*Iridaceae*), *Laurus* (*Lauraceae*), *Ligularia* (*Asteraceae*), *Phragmites* (*Poaceae*), *Platanus* (*Platanaceae*), *Sparganium*, *Typha* (*Typhaceae*), and *Ulex* spp. (*Fabaceae*); Europe, N. America, New Zealand.

*Notes*: The species epithet of *Ramularia hydrangeae-macrophyllae* reflects the name of the host on which it was first observed, *Hydrangea macrophylla*, from New Zealand (holotype in HAL). Within this clade the phylogenetic structure was not resolved consistently in all gene trees (data not shown; Fig. 2, clade 21) and, in accordance with the Genealogical Concordance Phylogenetic Species Recognition (GCPSR) concept, the transition from concordance to conflict determined the limit of these species (Taylor *et al.* 2000). *Ramularia sparganii* was described from *Sparganium emersum* from Sweden (holotype in

C) and has not been reported from the Netherlands (Braun 1998). The species produces conidiophores that are subcylindrical to geniculate-sinuous, 5–40(–60) × 1–3 µm, catenate conidia, smooth, ellipsoid-fusoid, 0–1-septate, 8–30(–33) × 1.5–3 µm and with minute hila. The strain CBS 159.82 was possibly misidentified based on the host but was sterile in culture and morphological characters were not observed. *Ramularia hellebori* was described from *Helleborus foetidus* from Germany (lectotype in HAL), and was firstly reported from New Zealand on *Helleborus orientalis* (Braun & Hill 2002) and later on *Helleborus niger* (CBS 118408) (Braun *et al.* 2006), but no ex-type culture was designated. This species description includes conidiophores that are subcylindrical to geniculate sinuous, 10–45 × 1.5–5 µm, conidia catenate, ellipsoid-ovoid to fusiform, verruculose, 0–1-septate, 6–20(–30) × 2–4 µm and minute hila. *Ramularia rollandii* was described from *Iris pseudacorus* from France (lectotype in PC) and the species was reported from New Zealand on an *Iris* × *hollandica* hybrid (CBS 122625) (Braun & Hill 2008), but no ex-type culture is known. This species produces conidiophores that are cylindrical to geniculate-sinuous, apically minutely subdenticulate, 5–15(–20) × 2–3 µm, conidia solitary or in short chains, smooth to faintly verruculose, filiform to acicular, 15–40(–60) × 1–2 µm, 1–4-septate, with minute hila. *Ramularia butomi* is mycophylic and was originally described overgrowing ascomycetous stromata on dead leaves of *Butomus umbellatus* in Sweden (lectotype in B), but the strain CBS 114117 is not documented as hyperparasite in the database. This species produces conidiophores that are simple, subcylindrical to geniculate-sinuous, 8–60 × 1–4 µm, conidia catenate, narrowly ellipsoid-ovoid to subcylindrical-fusiform, (5–) 8–16(–24) × (1.5–)2–3(–4) µm, 0–1(–2)-septate, verruculose and with minute hila. *Ramularia deusta* var. *alba* is not reported from *Ulex* and the representative clade for this species has been designated in this study (Fig. 2, clade 62). All the species mentioned above have in common that the conidia are catenate and slightly verruculose to verruculose, with minute hila, but size and septation vary among them. It is necessary to collect fresh material from the type location and host for further observations. The only ex-type culture present in this clade is that of *Ramularia hydrangeae-macrophyllae* (CBS 122273) (Braun & Hill 2008), and in accordance with the GCPST concept, we accept that name for this clade. This species, now with a broad host range and wide geographical distribution, forms a highly supported clade (Fig. 2, clade 21, 1/100/100). Similar intraspecific variation, wide host range and geographical distribution have been observed before for *Ramularia vizellae* (Videira *et al.* 2015b; Fig. 2, clade 85). Strains CPC 25901 and CPC 25902 were isolated using the method developed for single ascospore isolation for *Mycosphaerella* (Crous *et al.* 1991, Crous 1998), which means this species has a sexual morph (Fig. 51).

***Ramularia hydrangeicola*** J.H. Park & H.D. Shin, Mycotaxon 131: 97. 2016

*Specimens examined*: **South Korea**, Yangpyeong, on *Hydrangea serrata*, 18 Oct. 2007, H.D. Shin, **holotype** KUS-F23039, ex-type culture KACC43597; *idem*. cultures CPC 14767–14769; Jeju, on *Hydrangea serrata*, 2 Nov., H.D. Shin, KUS-F23141, cultures CPC 14832–14834.

*Substrate and distribution*: Only known from South Korea.

*Notes*: This species has been recently described (Park & Shin 2016) and is only known from South Korea. Until now, only two *Ramularia* species were known to infect *Hydrangea* hosts, *R. hydrangeae* Y.L. Guo & U. Braun (on *Hydrangea bretschneideri*, China, holotype in HMAS) and *Ramularia hydrangeae-macrophyllae* U. Braun & C.F. Hill (on *Hydrangea-macrophylla*, New Zealand, holotype in HAL). The isolates of *Ramularia hydrangeicola* cluster in a highly supported clade (Fig. 2, clade 70, 1/100/100) and are not conspecific with *R. hydrangeae-macrophyllae* (Fig. 2, clade 21).

***Ramularia inaequalis*** (Preuss) U. Braun, Monogr. *Cercosporella*, *Ramularia Allied Genera (Phytopath. Hyphom.)* 2: 68. 1998. Fig. 52.

*Basionym*: *Fusoma inaequale* Preuss, Linnaea 26: 706. 1855. 1853.

= *Ramularia lineola* Peck, Rep. (Annual) New York State Mus. Nat. Hist. 32: 43. 1879.

= *R. traxaci* P. Karst., Hedwigia 23: 7. 1884.

For additional synonyms see Braun (1998).

*Mycelium* consisting of hyaline, septate, branched, smooth, 1–2 µm diam hyphae. *Conidiophores* hyaline, thin-walled, smooth, erect, 1–2-septate, cylindrical-oblong, straight to sinuous, unbranched (25–)40–50(–70) × (1.5–) 2–2.5(–3) µm, or reduced to conidiogenous cells. *Conidiogenous cells* terminal on conidiophores or intermediate in the mycelium, cylindrical-oblong, (7.5–)16.5–20(–28) × (1.5–) 2(–2.5) µm, with one conidiogenous locus almost flat to protuberant, thickened, darkened and refractive. *Conidia* catenate, hyaline, thin-walled, smooth with hila thickened, darkened and refractive. *Ramoconidia* cylindrical-oblong, sometimes with the apices broader than the centre, (14.5–)18–20.5(–27) × (1.5–) 2–2.5(–3) µm, 0–1(–3)-septate, with two apical hila. *Intercalary conidia* cylindrical-oblong, fusoid or clavate, 0–1-septate, slightly narrower at the septa, (10.5–) 14–16.5(–26.5) × (1.5–)2(–2.5) µm, in branched chains of up to five conidia. *Terminal conidia* cylindrical-oblong to obovoid, aseptate, (5.5–)10.5–13(–19) × (1–)1.5–2(–3) µm.

*Culture characteristics*: On MEA, 25 mm diam, surface with convex centre, smooth, with rosy-buff centre turning buff and white towards the raised margin, undulate and feathery, colony reverse olivaceous grey in the centre and ochreous margin; on OA, 25 mm diam, surface flat, smooth, white with a greyish tinge, with margins undulate, naked, buff, colony reverse olivaceous grey centre and cinnamon towards the margin; on PDA, 22 mm diam, surface flat, short and uniform aerial mycelium, pale olivaceous grey, margins naked, entire, buff, colony reverse olivaceous grey centre and buff margin.

*Specimens examined*: **Austria**, Krems, on *Taraxacum officinale*, 1870 **[**Thüm, Fungi Austr. Exs. 888; **neotype**, designated in Braun (1998), in HAL]. **Canada**, Nova Scotia, Truro, on *Taraxacum officinale*, unknown date, S. Green, culture CBS 250.96. **Mexico**, Montecillo, on *Taraxacum* sp., 1 Oct. 2008, M. de Jesús Yáñez-Morales, culture CPC 15815; Montecillo, on *Taraxacum* sp., 22 Sep. 2008, M. de Jesús Yáñez-Morales, cultures CPC 15752, CPC 15753. **Netherlands**, Utrecht, Rhijnauwen, on *Taraxacum officinale*, May 2013, U. Damm, (**epitype designated here**: CBS H-22544, MBT204826, culture ex-epitype CBS 141111 = CPC 25741); *idem*. CPC 25742.

*Substrate and distribution*: On *Andryala*, *Cichorium*, *Crepis*, *Hedypnois*, *Hieracium*, *Hyoseris*, *Hypochoeris*, ?*Lactuca*,

**Fig. 52.** *Ramularia inaequalis* (CPC 15752). A–G. Structures formed in culture. A, B, D, F, G. Conidiophores and conidia. C, E. Conidia. Scale bars = 10 µm.

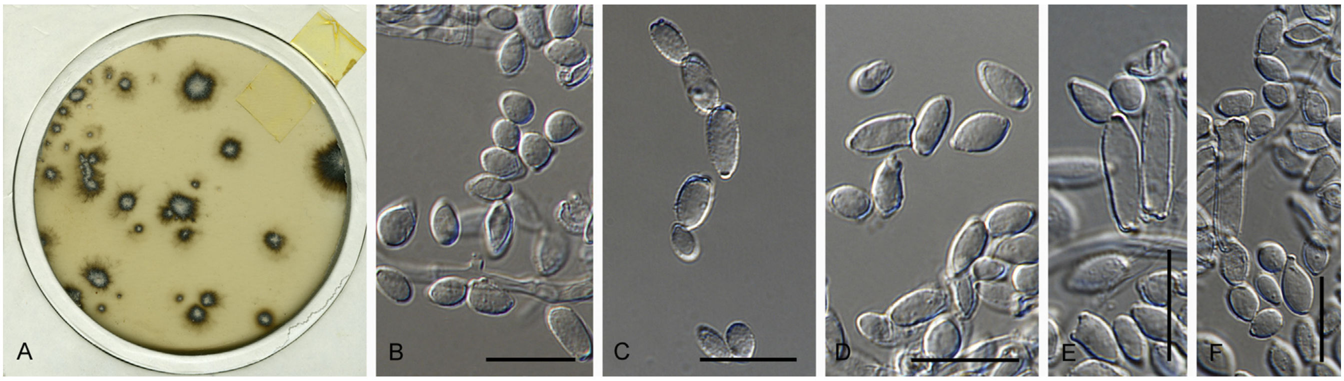

**Fig. 53.** *Ramularia interstitialis* (CBS 120.68). A–F. Observations from herbarium material. B–F. Conidia. Scale bars = 10 µm.

*Leontodon*, *Picris*, *Reichardia*, *Rhagadiolus*, *Scorzonera*, *Sonchus*, *Taraxacum*, and *Tolpis* (*Asteraceae*); circumglobal.

*Notes*: Braun (1998) synonymised several names with *R. inaequalis* since the specimens available on numerous hosts belonging to the *Asteraceae* were morphologically very uniform. *Ramularia inaequalis* was originally described on *Taraxacum officinale* from Austria (neotype in HAL) but it is a commonly reported species worldwide and in a wide range of hosts. The strains originally identified as *R. inaequalis* used in this study fell in three different clades (Fig. 2, clades 5, 40 and 56). Only in clade 40 (Fig. 2) are strains collected from Europe that were suitable for epitypification (Fig. 52); the other strains are tentatively considered as *R. hieracii-umbellati* (Fig. 2, clade 56) and as *R. helminthiae* (Fig. 2, clade 5). The clade representing *R. inaequalis* is highly supported (Fig. 2, clade 40, 1/100/100). *Ramularia inaequalis* has a very wide host range and distribution.

***Ramularia interstitialis*** (Berk. & Broome) Gunnerb. & Constant., Thunbergia 15: 50. 1991. Fig. 53.

*Basionym*: *Peronospora interstitialis* Berk. & Broome, Ann. Mag. Nat. Hist. 15: 34. 1875.

≡ *Ovularia interstitialis* (Berk. & Broome) Massee, British Fungus-Flora 3: 322. 1893.

= *Ramularia primulana* P. Karst., Hedwigia 23 (1): 7. 1884.

= *Ovularia corcellensis* Sacc. & Berl., Atti Ist. Veneto Sci. Lett. Arti 3: 731. 1885.

*Mycelium* hyaline, septate, branched. *Conidiophores* and *conidiogenous cells* scarce and insufficient for complete description. *Conidia* hyaline, smooth to slightly verruculose, catenate, branching chains, consistently aseptate, ellipsoid-ovoid, occasionally subcylindrical, obovoid (3.5–)6–8(–20) × (2.5–)3.5–4(–5) µm.

*Description in vivo*: See Braun (1998: 225).

*Specimen examined*: **UK**, Southwestern England, Exeter, on *Primula vulgaris* × *vernalis*, S.A.J. Tarr, CBS H-17746, culture CBS 120.68.

*Substrate and distribution*: On *Primula* (*Primulaceae*); Europe.

*Notes*: Two species have been described from hosts of the genus *Primula*, *Ramularia primulae* and *R. interstitialis*, that have a broad distribution in Europe. *Ramularia primulae* produces catenate conidia, (8–)10–35(–40) × 3–6 µm, that are 0–2(–3)-septate. *Ramularia interstitialis* produces very distinctive conidiophores, erect or decumbent to repent, long and strongly geniculate-sinuous, the conidia are produced singly, occasionally in short chains, are aseptate and (6–)8–16(–21) × (4–)5–8(–10)µm. In the observed specimen (Fig. 53), the conidiogenous structures observed were too scarce for a proper analysis and the conidia were slightly narrower than in the description of *R. interstitialis* found in literature (Braun 1998). However, the name is tentatively used for this isolate pending the collection of fresh material since *in vitro* measurement can vary when compared to *in vivo*. The strain used in this study originated from the UK and falls in the *Ramularia* clade (Fig. 1, clade XIV), but was not used in the multigene phylogeny because it was not possible to amplify the partial genes of *gapdh* and *rpb2*.

***Ramularia kriegeriana*** Bres., Hedwigia 39: 328. 1900.

= *Ramularia plantaginis* Ellis & G. Martin, Amer. Naturalist 16: 1003. 1882, nom. illeg., non *R. plantaginis* Peck, 1880.

*Specimens examined*: **Germany**, Saxony, Königstein, Pfaffendorf, on *Plantago major*, 17 Jul. 1895 [Krieger, Fungi Saxon Exs. 1630; **lectotype** of *R. kriegeriana*, designated in Braun (1998), in JE]. **South Korea**, Hoengseong, on *Plantago asiatica*, 10 Oct. 2003, H.D. Shin, KUS-F19845, culture CPC 10825–10827. **USA**, Kentucky, Lexington, on *Plantago major*, Jul. 1882, Kellerman s.n.; **type** of *R. plantaginis* Ellis & G. Martin, in BPI 418612.

*Substrate and distribution*: On *Plantago* spp. (*Plantaginaceae*); Asia, Europe, N. America.

*Notes*: Braun (1998) used the name *Ramularia plantaginis* Ellis & G. Martin for *Ramularia* on *Plantago major* and other species characterised by verruculose conidia. This was based on the wrong assumption that *R. plantaginis* Peck was also published in 1882, which is, however, not correct since the latter name was published in 1880, which makes *R. plantaginis* Ellis & G. Martin an illegitimate homonym. Thus, *R. kriegeriana* is the oldest valid name for this fungus. This species has previously been reported from South Korea on *Plantago asiatica*, and is known from several *Plantago* species in Asia, Europe and N. America, including *P. asiatica* from China (Braun 1998). The strains in this study cluster together in a highly supported clade (Fig. 2, clade 65, 1/100/100) although a collection from Germany is required to fix the application of this name. *Plantago asiatica* is phylogenetically close to *P. major*, the principal host of *Ramularia kriegeriana*. The two species belong in *Plantago* subgen. *Plantago*, in contrast to *P. lanceolata*, the principal host of *R. rhabdospora*, which belongs in subgen. *Psyllium* (Rønsted *et al.* 2002).

***Ramularia lamii*** Fuckel var. ***lamii***, Jahrb. Nassauischen Vereins Naturk. 23–24: 361. 1870. Fig. 54.

≡ *Ovularia lamii* (Fuckel) Sacc., Syll. ung. 6: 144. 1886.

For additional synonyms see Braun (1998).

*Mycelium* consisting of hyaline, septate, branched, smooth, 1–3 µm diam hyphae. *Conidiophores* hyaline, thin-walled, smooth, erect, septate, straight to geniculate-sinuous, cylindrical-oblong, unbranched, (8–)10–50(–80) × 1.5–2(–3) µm or reduced to conidiogenous cells. *Conidiogenous cells* integrated in mycelium or terminal on conidiophores, cylindrical-oblong, (7.5–)18.5–24.5(–33) × 1.5–2(–2.5) µm, with 1–3 apical conidiogenous loci almost flat, thickened, darkened and refractive. *Conidia* hyaline, thin-walled, smooth, catenate, with hila thickened, darkened and refractive. *Ramoconidia* subcylindrical to clavate, sometimes with broader apexes and narrower at the centre, (9–)14–18(–28) × (2.5–)3–3.5(–4) µm, 0–1-septate, with two apical hila. *Intercalary conidia* subcylindrical, sometimes slightly curved, ovoid, (8.5–)11.5–13(–19) × (2.5–)3(–4) µm, in branched chains of up to six conidia. *Terminal conidia* obovoid, aseptate, (4.5–)7–8(–11.5) × (2–)2.5–3(–5) µm (on SNA, CBS 108971).

*Culture characteristics*: On MEA surface strongly folded, rosy-buff with smoke-grey areas, low convex with margins concave and crenate, colony reverse fawn to cinnamon, folded, grows 1.7 mm after 2 wk at 25 °C. On OA surface flat, aerial mycelium white with a rose tinge raised in the centre, produces a transparent exudate, with margins undulate, sparse aerial mycelium, rosy-buff, colony reverse saffron, grows 1.8 mm after 2 wk at 25 °C. On PDA, surface low convex, white with a light grey tinge, fluffy, with margins slightly undulate, colony reverse salmon with olivaceous grey patches, grows 1.8 mm after 2 wk at 25 °C.

*Specimens examined*: **Germany**, on *Lamium album* [Fuckel, Fungi Rhen. Exs. 136; **lectotype**, designated in Braun (1998), in HAL]. **Netherlands**, Utrecht Prov., Baarn, de Hooge Vuursche, leaf spot of *Lamium album*, 22 Jun. 2000, G. Verkley (**epitype** designated here CBS H-22639, MBT371840, culture ex-epitype CBS 108970); *idem*. CBS 108971.

*Description in vivo*: See Braun (1998: 183).

*Substrate and distribution*: on *Lamium* (*Lamiaceae*); Asia, Caucasus, Europe, N. Africa, N. America.

*Notes*: There are two varieties of *R. lamii*, namely *R lamii* var. *lamii* (on *Lamium album*, Germany, lectotype in HAL), and *R. lamii* var. *minor* (on *Prunella vulgaris*, USA, Winsconsin, holotype in NY). The latter variety has smaller conidiophores and smaller and narrower conidia. Strains originally identified as *R. lamii* appeared in three distinct clades in the phylogeny (Fig. 2, clades 1, 46 and 67) showing that more than one species is present in this complex. The strains in clade 67 (Fig. 2) were collected in the Netherlands and are morphologically good representatives of *R. lamii* (Fig. 54), and are therefore designated as ex-epitype strains, whereas the other strains are assigned to *R. leonuri* and *R. agastaches*, respectively. All three phylogenetic analyses provided high support to this species clade (Fig. 2, clade 67, 1/100/100).

***Ramularia leonuri*** Sorokīn, Trudy Obshch. Estestvoisp. Imp. Kazansk. Univ. 2: 30. 1872. Fig. 55.

≡ *Ramularia sorokinii* Sacc. & Syd., Syll. fung. 14: 1065. 1899, nom. illeg. (superfl.).

= *Ramularia leonuri* Sacc. & Penz., Michelia 2: 638. 1882.

*Mycelium* consisting of hyaline, septate, branched, smooth, 1–1.5 µm diam hyphae. *Conidiophores* hyaline, thin-walled, smooth, erect, 1–3-septate, straight, cylindrical-oblong, unbranched, (11.5–)20–25.5(–28) × 1.5–2 µm or reduced to conidiogenous cells. *Conidiogenous cells* integrated in mycelium, cylindrical-oblong, (4–)11–15(–19) × 1–2(–3) µm, with one conidiogenous locus, thickened and darkened. *Conidia* hyaline,

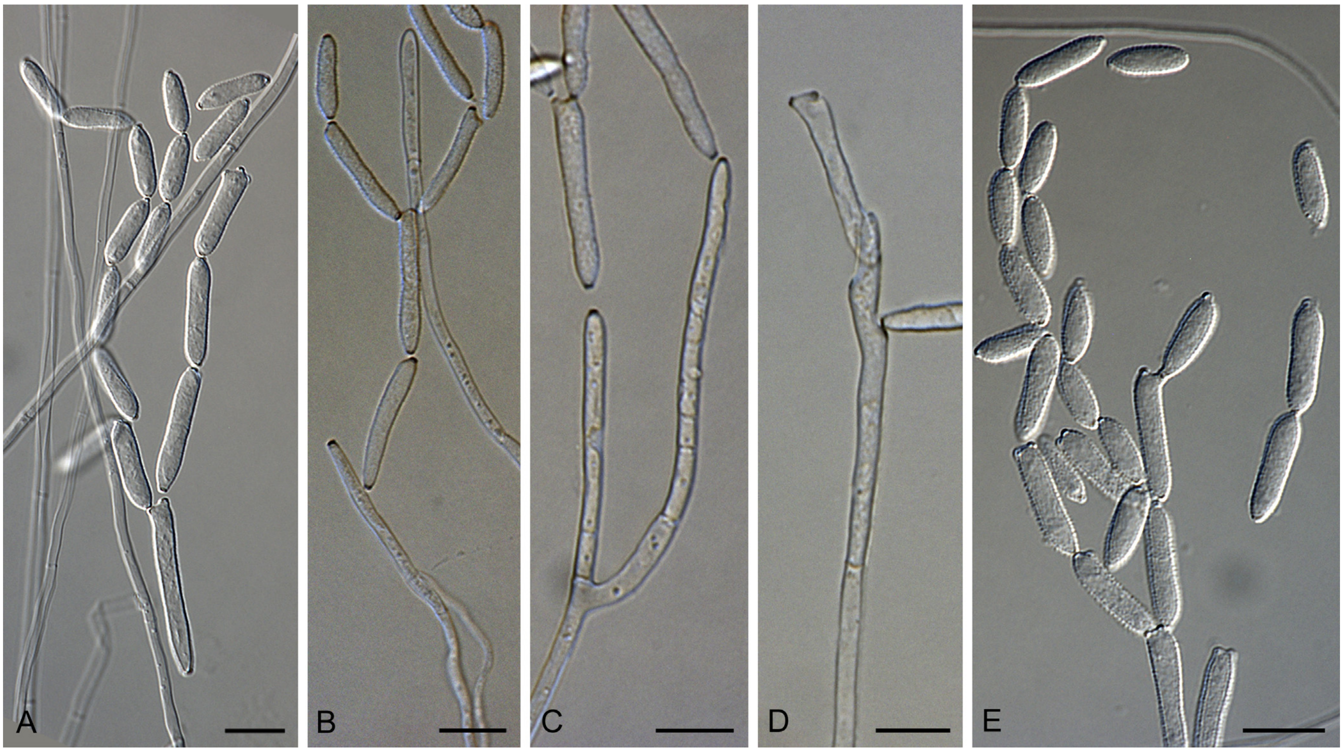

**Fig. 54.** *Ramularia lamii* var. *lamii* (CBS 108971). A–E. Structures formed in culture. A, E. Conidia. B–D. Conidiophores, conidiogenous cells and conidia. Scale bars = 10 µm.

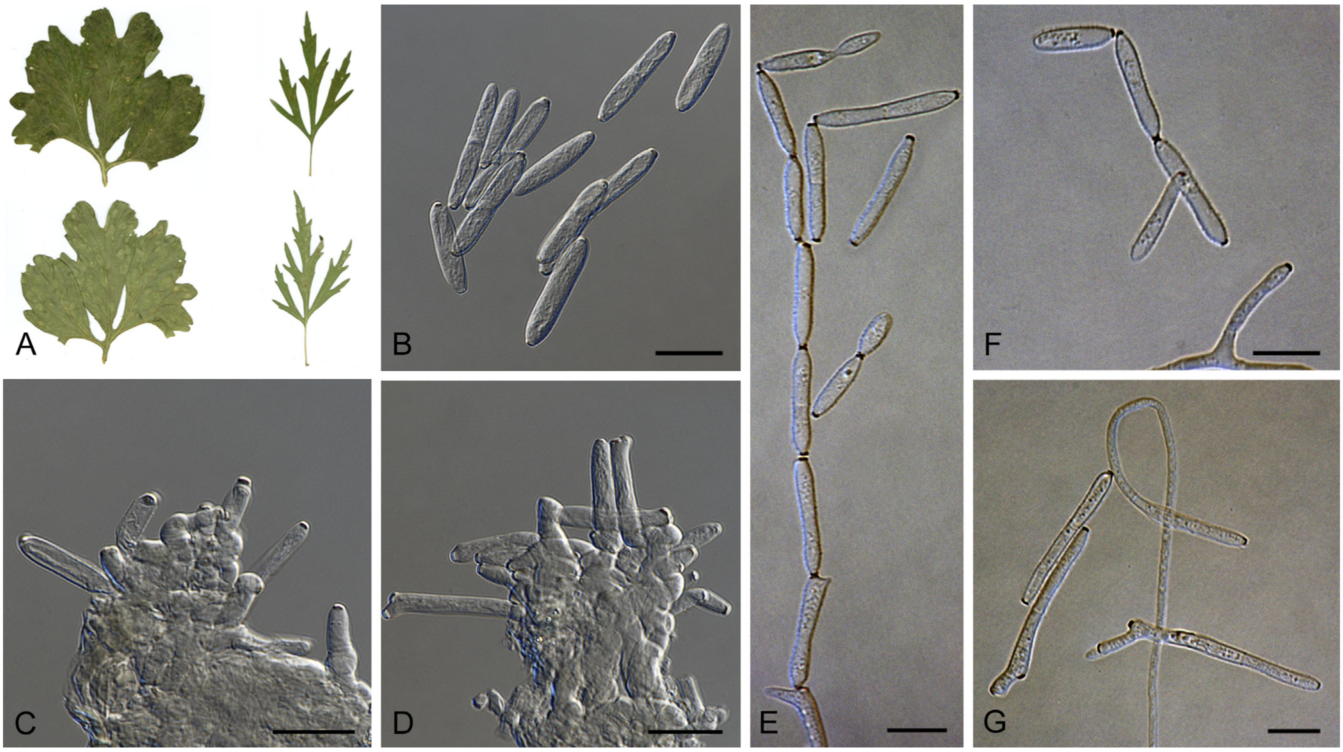

**Fig. 55.** *Ramularia leonuri* (CPC 11314). A–D. Observations from herbarium material. E–G. Structures formed in culture. A. Leaf spot symptoms on the host. B, E. Conidia. C, D. Conidiophores and conidiogenous cells. F, G. Conidiophores and conidia. Scale bars = 10 µm.

thin-walled, smooth, catenate, with hila thickened and darkened. *Ramoconidia* subcylindrical to clavate, aseptate to 1-septate and narrower at the septa, (18–)21–23.5(–28) × (2–)2.5–3 µm, with two conidiogenous apical hila. *Intercalary conidia*, aseptate to 1-septate, subcylindrical, sometimes curved, (14.5–)18.5–21(–28) × (1.5–)2.5–3(–3.5) µm, in chains of up to five conidia. *Terminal conidia*, aseptate, subcylindrical to obovoid, (6.5–)13–15(–25) × (2–)2.5–3(–4) µm.

*Culture characteristics*: On MEA, 27 mm diam, surface smooth, low convex, radially striated, cracking in the centre, with entire margins, convex and feathery, colony reverse iron-grey with ochreous margin; on OA, 20 mm diam, surface flat, fluffy uniform, white with buff tinge, with margins buff and with no aerial mycelium, undulate, colony reverse buff; on PDA, 25 mm diam, surface concave, smooth and white, margins entire, feathery and low convex, colony reverse olivaceous grey and buff.

*Specimens examined*: **France**, Rouen, on *Leonurus cardiaca*, Letendre, herb. Saccardo (**holotype** of *R. leonuri* Sacc. & Syd. PAD); **Russia**, Jaroslavl, Bernichino, on *Leonurus cardiaca*, 22 Aug. 1909, Serebrianikov [Tranz. & Serebr., Mycoth. Ross. 48; **neotype** of *R. leonuri* Sorokïn, designated in Braun (1998), in LE 200619]; **South Korea**, Hongcheon, on *Leonurus sibiricus*, 9 Oct. 2007, H.D. Shin, KUS-F22992, CBS H-22522, culture CBS 141112 = CPC 14570; *idem*. CPC 14571, CPC 14572; Jinju, on *Leonurus sibiricus*, 14 May 2004, H.D. Shin, KUS-F20195, cultures CPC 11312–11314; Yangpyeong, on *Leonurus sibiricus*, 23 Jul. 2004, H.D. Shin, KUS-F20502, cultures CPC 11411–11413.

*Notes*: *Ramularia leonuri* on *Leonurus cardiaca*, reduced to synonymy under *R. lamii* var. *lamii* by Braun (1998), is morphologically indistinguishable from the Korean material on *L. sibirica*. Therefore, we prefer to apply this name to this collection, at least tentatively, although cultures of *R. leonuri* from France and Russia are not yet available for comparison. The *R. leonuri* clade was highly supported by phylogenetic analyses (Fig. 2, Clade 1, 1/100/100) and is currently known only from South Korea. These strains were previously identified as *R. lamii* var. *lamii* but the type of *R. lamii* clusters in a different clade (Fig. 2, clade 67). *Ramularia leonuri* and *Ramularia lamii* var. *lamii* are morphologically very similar but *R. leonuri* produces shorter conidiophores, smaller conidiogenous cells and longer terminal conidia (Fig. 55).

***Ramularia lethalis*** Ellis & Everh., Proc. Acad. Nat. Sci. Philadelphia 43: 86. 1891. Fig. 56.

*Mycelium* consisting of hyaline, septate, branched, smooth, 1–2 µm diam hyphae. *Conidiophores* reduced to conidiogenous cells. *Conidiogenous cells* hyaline, thin-walled, smooth, integrated in mycelium, cylindrical-oblong to geniculate-sinuous, (6–)10–12(–15) × 1–2 µm, with 1–3 apical conidiogenous loci almost flat to protuberant, thickened and darkened. *Conidia* hyaline, thin-walled, smooth to verruculose, catenate, mostly aseptate and rarely 1-septate, with hila thickened and darkened. *Ramoconidia* subcylindrical to ellipsoid, (4–)6–7(–12) × (1.5–)2.5–3 µm, with 2–3 conidiogenous apical hila. *Intercalary conidia*, fusoid-ellipsoid, (4–)5(–6.5) × (1.5–)2–3µm, in chains of up to three conidia. *Terminal conidia*, aseptate, ellipsoid-obovoid, (2–)3–4 × (1–)2–2.5 µm.

*Culture characteristics*: On MEA, 8 mm diam, surface raised, irregular, mycelium smooth and white, with entire margin, convex and feathery, colony reverse ochraceous; on OA, 10 mm diam, surface raised, irregular, mycelium smooth, white with buff tinge, margins undulate, colony reverse buff; on PDA, 9 mm diam, surface smooth, mycelium flat and white, entire margins, colony reverse buff with olivaceous patches.

*Description in vivo*: See Braun (1998: 46).

*Specimens examined*: **Netherlands**, Utrecht, Hollandse Hout, on leaves of *Acer pseudoplatanus*, 5 Apr. 2012, S.I.R. Videira, cultures CBS 141113 = CPC 25910. **Canada**, Ontario, London, on *Acer rubrum*, Oct. 1890, Dearness [Ellis & Everh., N. Amer. Fungi 2596; **lectotype**, designated in Braun (1998), in NY 830534].

*Substrate and distribution*: On *Acer*; Caucasus, Europe (the Netherlands) and North America.

*Notes*: Three species of *Ramularia* are known from *Acer*, namely *R. lethalis*, *R. unterseheri* and *R. vizellae*. *Ramularia lethalis* (Fig. 56) was originally described on *Acer rubrum* from Canada (lectotype in NY). The strain used in this study forms a single lineage and is positioned in a very long branch, which supports this species as unique (Fig. 2, clade 84). Morphological characters of the isolate used in this study agree with the description of *R. lethalis* from literature (Braun 1998). This is a first report of this pathogen in Europe and on *Acer pseudoplatanus*.

***Ramularia ligustrina*** Maubl., Bull. Trimestriel Soc. Mycol. France 22: 70. 1906.

*Specimen examined*: **Italy**, Torino, on living leaf of *Ligustrum vulgare*, unknown collector and date, isol. and dep. M. Ribaldi, Oct. 1952, culture CBS 379.52.

*Substrate and distribution*: On *Ligustrum vulgare*; Caucasus (Armenia), Europe (Bulgaria, France, Germany, Italy and Moldova).

*Notes*: *Ramularia ligustrina* was described as a pathogen on *Ligustrum vulgare* in France, but was considered doubtful by Braun (1998) since type material or other collections agreeing with the description could not be traced. The species is insufficiently known but the name is tentatively accepted here given its distinct phylogeny (Fig. 2, clade 69), pending further collections.

***Ramularia macrospora*** Fresen., Beitr. Mykol. 3: 88. 1863.
≡ *Cylindrosporium macrosporum* (Fresen.) J. Schröt., Krypt.-Fl. Schlesien 3.2(4): 490. 1897.
= *Scolicotrichum ochraceum* Fuckel, Fungi Rhen. Exs., Cent. 22: no. 2108. 1868.
= *Ramularia prismatocarpi* Oudem., Ned. Kruidk. Arch. 3: 155. 1877.
= *Cercospora phyteumatis* A.B. Frank, Krankh. Pfl., 1. Aufl.: 601. 1880.
= *Ramularia adenophorae* Moesz, Bot. Közlem. 35 (1–2): 67. 1938.
= *Ramularia rapunculoidis* Nannf., in Lundell & Nannfeldt, Fungi Exs. Suec. 39–40: 31. 1950.
For additional synonyms see (Braun 1998)

*Description in vivo*: See Braun (1998: 125).

*Specimen examined*: **Austria**, Ötztal, Sölden, Hoch- Sölden, alt. 1800 m., on leafspots of *Phyteuma betonicifolium*, 25 Jul. 2000, G. Verkley, No. 1011.1, cultures CBS 109015, 109016.

*Substrate and distribution*: On *Adenophora*, *Asyneuma*, *Campanula*, *Gadellia*, *Legousia*, and *Phyteuma* (*Campanulaceae*), *Aristolochia punjabensis* (*Aristolochiaceae*); Asia, Caucasus, Europe, N. America, Pakistan.

*Notes*: *Ramularia macrospora* was described as a pathogen on *Campanula pyramidalis* from Germany (iconotype Pl. XI, figs 29–32). The strains used in this study cluster in the *Ramularia* clade (Fig. 1, clade XIV) but were not used in the multigene analysis because it was not possible to amplify and sequence the *tef1*-α partial gene. Although *R. macrospora* is usually associated with members of the *Campanulaceae* (Braun 1998), it was recently observed infecting a host from the *Aristolociaceae* (Mukhtar *et al.* 2012).

***Ramularia major*** (Unger) U. Braun, Nova Hedwigia 47: 340. 1988.
*Basionym*: *Cylindrospora major* Unger, Exanth. Pfl.: 168: 1833.
= *Fusidium petasitidis* Pass., in Thüm., Mycoth. Univ. 1473. 1879.
= *Ramularia cervina* Speg., Dec. Mycol. Ital.: 107. 1879.
≡ *Cylindrospora cervina* (Speg.) J. Schöt., in Cohn, Krypt.-Fl. Schlesien 3.2(4): 488. 1897.
= *R. variegata* Ellis & Holw., in Arth., Rep. Bot. Minnesota: 34. 1886.

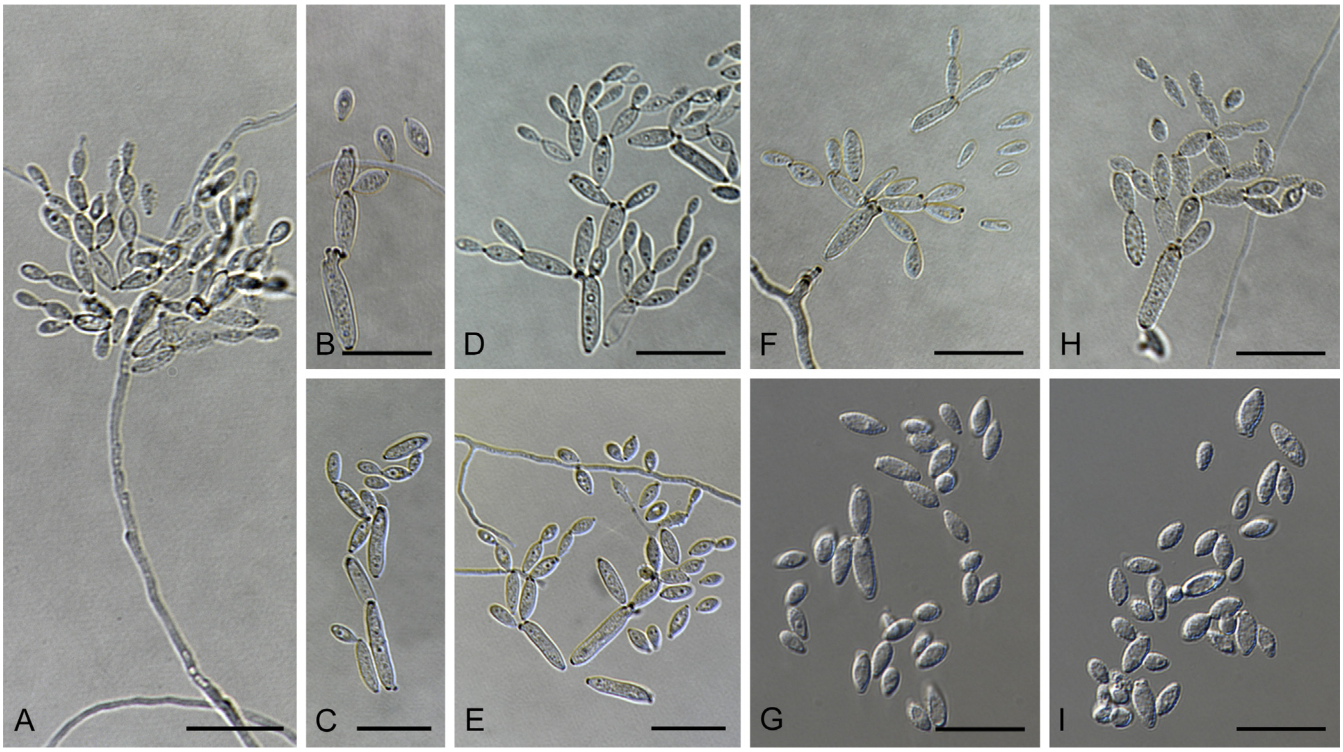

**Fig. 56.** *Ramularia lethalis* (CBS 141113). A–I. Structures formed in culture. A, F. Conidiophores reduced to conidiogenous cells and conidia. B–E, G, H, I. Conidia. Scale bars = 10 µm.

= *R. petasitis-tomentosae* Săvul. & Sandu, Hedwigia 73: 121. 1933.
For additional synonyms see Braun (1998) or MycoBank.

*Description in vivo*: See Braun (1998: 86).

*Specimens examined*: **Germany**, Thuringia, Erfurt, on *Petasites hybridus*, 7 Oct. 1910, Diedicke [**neotype**, designated in Braun (1998), in JE]. **South Korea**, Chuncheon, on *Petasites japonicus*, 25 Oct. 2005, H.D. Shin, KUS-F21578, CBS H-22523, cultures CBS 141114 = CPC 12542; *idem*. CPC 12543, CPC 12544.

*Substrate and distribution*: On *Adenostyles*, *Homogyne*, and *Petasites* (*Asteraceae*); Asia, Caucasus, Europe, N. America.

*Notes*: *Ramularia major* was originally described on *Petasites hybridus* from Germany (neotype in JE) and is a common pathogen associated with a few related hosts of the family *Asteraceae* worldwide (Braun 1998). The strains used in this study form a highly supported clade (Fig. 2, clade 10, 1/100/100), which is tentatively maintained as representative of the species until material from the type host and location are recollected and examined.

**Ramularia mali** Videira & Crous, Persoonia 34: 58. 2015.

*Specimen examined*: **Italy**, Piemont, on *Malus domestica* fruit in cold storage, May 2011, unknown collector, dep. R. Piemonte & G. Michelatti (**holotype** CBS H-21618, culture ex-type CBS 129581).

*Substrate and distribution*: Thus far only known from the type collection.

*Notes*: See Videira *et al.* (2015a). This species formed a single lineage (Fig. 2, clade 33) basal to the *R. glenii* clade (Fig. 2, clade 32). In a single lineage next to *R. mali* we can observe *Ramularia* sp. B, which is sterile in culture and could not be described.

***Ramularia malicola*** Videira & Crous, **sp. nov.** MycoBank MB816850. Fig. 57.

*Etymology*: Named after the host it was isolated from, *Malus*.

*Mycelium* consisting of hyaline, septate, branched, smooth, 2–4 µm diam hyphae. *Conidiophores* hyaline, thin-walled, smooth, erect, multiseptate, straight, cylindrical-oblong, unbranched, (45–)100–120(–158) × (2.5–)4–5(–6) µm or reduced to conidiogenous cells. *Conidiogenous cells* integrated in mycelium, cylindrical-oblong, (16.5–)25–32(–42) × (3–)4(–5) µm, with one apical conidiogenous locus, thickened and darkened. *Conidia* formed singly, hyaline, thin-walled, smooth, aseptate, ellipsoid, obovoid, (11–)21–27(–40) × (4.5–)6–7(–8) µm, with hila thickened and darkened.

*Culture characteristics*: On MEA, 15 mm diam, surface raised and strongly folded, rosy-vinaceous with erumpent white mycelium, with small ochreous droplets, with margins crenate, colony reverse ochreous; on OA, 10 mm diam, surface raised, folded, rosy-vinaceous with erumpent white mycelium, with margins crenate, feathery, colony reverse brick; on PDA, 15 mm diam, surface raised and strongly folded, rosy-vinaceous with erumpent white mycelium, with small buff droplets, with margins crenate, colony reverse ochreous.

*Specimen examined*: **USA**, Missouri, New Franklin, on *Malus* sp., Sep. 2000, J. Batzer (**holotype** CBS H-22524, ex-type culture CBS 119227).

*Note*: *Ramularia malicola* formed a single lineage (Fig. 2, clade 80) that is sister to *R. rubella* (Fig. 2, clade 79). This species is morphologically similar to *R. rubella* but differs by forming wider conidia (Fig. 57). *Ramularia malicola* was first isolated in a study related to sooty blotch and flyspeck on

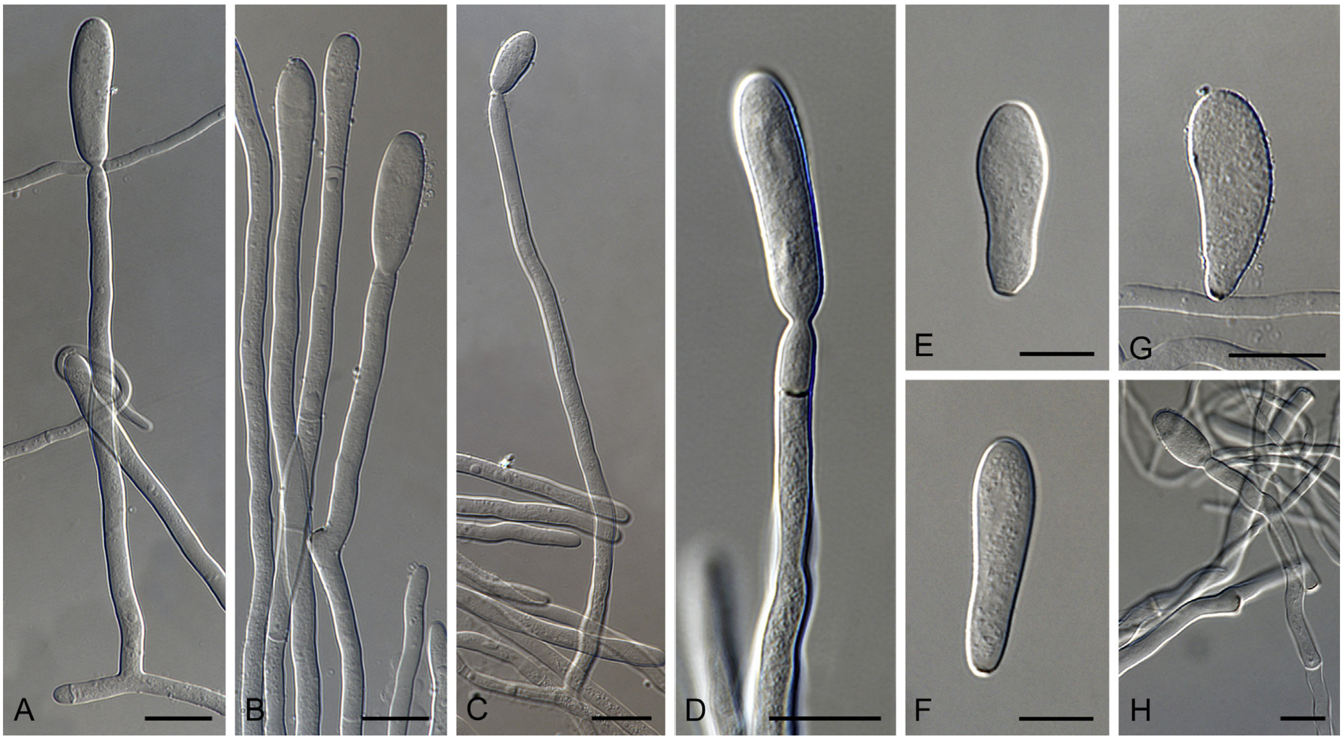

**Fig. 57.** *Ramularia maliicola* (CBS 119227). A–H. Structures formed in culture. A–D. Conidiophores and conidia. E–G. Conidia. H. Conidiogenous cells. Scale bars = 10 µm.

apple in the USA (Batzer *et al.* 2005). It was present in samples collected from two orchards and caused punctate symptoms on the fruit. It was described as *Ramularia* sp. P5 based on the morphological characteristics that included hyaline, single-celled, ovularia-type conidia, irregular in shape, 5.2–14.5 × 1.5–7 µm (CLA media), produced on brown conidiophores that had dendritic branches with a single central basal cell. In this study, the conidiophores observed were always hyaline but a different culture medium was used to that of Batzer *et al.* (2005).

***Ramularia miae*** Crous, Fungal Planet No. 3. 2006.

*Specimens examined*: **South Africa**, on *Wachendorfia thyrsiflora*, 4 Jan. 2006, M.K. Crous & P.W. Crous (**holotype** CBS H-19763, ex-type culture CBS 120121 = CPC 12736), *idem*. cultures CPC 12737, CPC 12738; on *Gazania rigens* var. *uniflora*, 9 Aug. 2011, P.W. Crous, culture CPC 19835; on *Leonotis leonurus*, 30 Jul. 2011, P.W. Crous, culture CPC 19770; on *Wachendorfia thyrsiflora*, 28 Oct. 2012, M.J. Wingfield, culture CPC 21692.

*Substrate and distribution*: On *Gazania rigens* var. *uniflora* (*Asteraceae*), *Leonotis leonurus* (*Lamiaceae*) and *Wachendorfia thyrsiflora* (*Haemodoraceae*); South Africa.

*Notes*: See Crous and Groenewald (2006) and Videira *et al.* (2015a). The phylogenetic analyses provide high support for this species clade (Fig. 2, clade 29, 1/100/100).

***Ramularia neodeusta*** Videira & Crous, **sp. nov.** MycoBank MB817159.

*Etymology*: Named after its morphological similarity to *Ramularia deusta*.

Cultures sterile. *Ramularia neodeusta* (Fig. 2, clade 15), differs from its closest phylogenetic neighbour, *R. vallisumbrosae* (Fig. 2, clade 16), by unique allelles in five loci based on alignments of the separate loci deposited in TreeBASE as Study S19315: *rpb2* positions 12(C), 15(A), 27(G), 39(A), 45(G), 54(C), 63(G), 75(A), 87(A), 99(C), 120(G), 135(C), 150(C), 151(T), 165(C), 168(T), 171(T), 186(G), 189(C), 195(T), 201(G), 204(T), 234(C), 240(G), 246(C), 252(C), 253(T), 264(A), 285(T), 297(G), 303(G), 318(C), 321(G), 324(C), 327(A), 330(G), 333(A), 336(A), 354(A), 357(A), 363(G), 375(G), 378(C), 387(T), 405(G), 411(T), 420(T), 441(G), 447(G), 456(T), 468(T), 478(G), 480(G), 483(C), 489(C), 492(T), 499(T), 504(C), 505(A), 507(T), 511(G), 519(G), 524(A), 532(C), 540(C), 546(A), 570(A), 576(T), 582(G), 591(C), 597(A), 630(A), 639(T), 642(A), 651(A); ITS positions 77(A), 81(T), 82(C), 108(G), 109(A), 110–111 deletion (TC), 342(A), 419(A), 420(G), 472(G), 500(C); *actA* positions 19(T), 31(G), 34(T), 49(C), 59(C), 61(A), 62(T), 63–67 insertion (GAGCA), 68(G), 69(C), 73(C), 82–83 deletion (AC), 86–88 deletion (CGA) 95(A), 96(G), 98(A), 99(A), 101(C), 108(T), 115(T), 116(T), 121(A), 122(T), 153(C), 164(C), 167(T), 182(T), 186(T), 208(C), 210(A), 211(T), 233(A), 238(C); *gapdh* positions 13(G), 18(A), 30(C), 39(A), 41(A), 42(C), 44(G), 47(G), 49(C), 60(G), 65(A), 66(G), 68(C), 101(G), 106(A), 113 deletion (C), 114(C), 116(G), 131(C), 140(C), 167(C), 200(C), 206(T), 207(C), 208(G), 210(T), 258(T), 259(C), 260(C), 262–263 insertion (TA), 264(C), 265 insertion (A), 267 insertion (G), 268(A), 269(A), 270(T), 271(A), 281(G), 282(G), 284(C), 286(C), 287(C), 288(G), 290(T), 292(C), 298(T), 299(T), 305(T), 307(T), 308(C), 313 deletion (G), 314(C), 315(C), 374(C), 389(C), 431(T), 449(A), 455(C), 506(T), 548(C), 554(C), 566(T), 584(T), 593(T), 614(C), 623(T), 626(T); tef1-α positions 14(T), 15(T), 16(T), 20(T), 22(C), 23(C), 24(T), 26 deletion (C), 27(T), 29 deletion (T), 45 deletion (CTC), 48(A), 49(C), 52(A), 57(G), 58(C), 86(C), 95(A), 99(T), 107(A), 129(T), 145(T), 178 deletion (T), 195(C), 212(T), 226–228 insertion (TAA), 232(A), 241(A), 242(A), 247(T), 255(C), 256(C), 257(A), 269(A), 271(T), 291(C), 292(C), 294(A), 304(T), 307–310 insertion (CTAT), 311(G), 313(A), 316(C), 398(T), 400(C), 401(T), 404(A), 406(C), 407(A), 409(A), 410(C), 411–424 insertion (TTCTCAACAAACTT), 427(T), 431(A), 432(A), 434(T), 447(C), 448(A), 450(T), 455(C), 578(T).

*Specimens examined*: **New Zealand**, on leaf of *Vicia faba*, 25 Oct. 2005, C.F. Hill (**holotype** CBS H-22525, culture ex-type CBS 141115 = CPC 13567); on leaf of *Lathyrus odoratus*, 23 Oct. 2005, C.F. Hill, culture CPC 13568.

*Notes*: This strain was initially identified as *R. deusta* var. *alba*, a species that was previously reported from New Zealand on *Lathyrus pratensis* and *L. latifolius*. However, an authentic strain of *R. deusta* can be found in clade 62 (Fig. 2). Therefore, the strains in this clade represent a new species that is highly supported (Fig. 2, clade 15, 1/100/100). Unfortunately the strains were sterile and therefore a molecular description is provided.

***Ramularia nyssicola*** (Cooke) Videira & Crous, Persoonia 34: 60. 2015.

*Basionym*: *Sphaerella nyssicola* Cooke, Hedwigia 17: 40. 1878.

≡ *Mycosphaerella nyssicola* (Cooke) F.A. Wolf, Mycologia 32: 333. 1940.

*Description*: See Minnis *et al.* (2011).

*Specimens examined*: **USA**, Maryland, Prince George's County, Glen Dale, on overwintered leaves *Nyssa ogeche* × *sylvatica* hybrid, R.T. Olsen, culture CBS 127664; same location, substrate and collector, 18 Jun. 2009 (**epitype** BPI 880897, AR 4656, culture ex-epitype CBS 127665).

*Substrate and distribution*: On *Nyssa* (*Cornaceae*); N. America (eastern USA).

*Notes*: See Minnis *et al.* (2011), who designated an epitype for the species, and Videira *et al.* (2015a) who reassigned the species to the genus *Ramularia*. The phylogenetic analyses provide high support to this species clade (Fig. 2, clade 81, 1/100/100).

***Ramularia osterici*** Videira, H.D. Shin & Crous, **sp. nov.** MycoBank MB816851. Fig. 58.

*Etymology*: Named after the host genus on which it occurs, *Ostericum.*

*Mycelium* consisting of hyaline, septate, branched, smooth, 1–2.5 µm diam hyphae. *Conidiophores* hyaline, erect, 1–3(–5)-septate, straight, cylindrical-oblong, unbranched (13–)34–51(–140) × (1.5–)2–2.5(–3) µm or reduced to conidiogenous cells. *Conidiogenous cells* hyaline, smooth, integrated in mycelium or terminal in conidiophores, cylindrical-oblong, (10–)17.5–21(–30) × (2–)2.5–3(–4) µm, with one apical conidiogenous locus, almost flat, thickened, darkened, refractive. *Conidia* hyaline, smooth, catenate, with hila thickened, darkened, refractive. *Ramoconidia* subcylindrical, clavate, with broader apices and narrower centre, (10–)14.5–17.5(–30) × (2–)3(–4) µm, 0–1-septate, with two apical hila. *Intercalary conidia* subcylindrical, fusoid, sometimes curved, 0–1-septate, (9.5–)12.5–14(–18) × (2.5–)3(–4) µm, in branched chains of up to eight conidia. *Terminal conidia* subcylindrical to obovoid, (4.5–)8–9.5(–14.5) × (2–)2.5–3(–3.5) µm.

*Culture characteristics*: On MEA, 10 mm diam, surface raised, strongly folded, smooth, pale smoke-grey with margins undulate, colony reverse iron-grey; on OA, 13 mm diam, surface convex, fluffy aerial mycelium, white to buff, with margins undulate, colony reverse buff; on PDA, 14 mm diam, surface raised, folded, with fluffy aerial mycelium white to buff, with margins undulate, colony reverse buff with iron-grey patches.

*Specimens examined*: **South Korea**, Pyeongchang, on *Ostericum grosseserratum* (≡ *Angelica grosseserrata*, = *Ostericum koreanum*), 20 Sep. 2003, H.D. Shin (**holotype** KUS-F19687, **isotype** CBS H-22545, culture ex-type CBS 141116 = CPC 10750); *idem*. CPC 10751, CPC 10752.

*Substrate and distribution*: On *Ostericum* (*Apiaceae*); Asia (South Korea).

*Notes*: *Ramularia osterici* is morphologically similar to *R. archangelicae*, but with shorter and broader ramoconidia, intercalary and terminal conidia (Fig. 58), and it does not produce any pigment in culture. Strains CBS 108991 (*R. archangelicae*) and CPC 10751 (*R. osterici*) are identical based on their ITS sequences but differ in several nucleotides in the other six genes amplified: 1 (LSU), 24 (*actA*), 32 (*gapdh*), 45 (*tef1*-α), 25 (*his3*), 26 (*cmdA*). The *R. osterici* clade is highly supported (Fig. 2, clade 20, 1/100/100). This is the first *Ramularia* species described on *Ostericum* (*Apiaceae*).

***Ramularia parietariae*** Pass., in Rabenh., Fungi Eur. Exs., Ed. nov., Ser. sec., Cent. 2 (resp. Cent. 21), no. 2066: 1876.

≡ *Cylindrospora parietariae* (Pass.) J. Schröt., in Cohn, Krypt.-Fl. Schlesien 3.2(4): 493: 1897.

= *Ramularia parietariae* var. *minor* Bubák, Bull. Herb. Boiss., 2 Sér., 6: 486. 1906.

*Description in vivo*: See Braun (1998: 274).

*Specimens examined*: **Czech Republic**, Moravia, Pavlov, forest around the ruin, on leaf spot on *Parietaria officinalis*, 18 Sep. 2008, G. Verkley, cultures CBS 123730, CBS 123731. **Italy**, Parma, Gajone, on *Parietaria officinalis*, Oct. 1874, Passerini [Rabenh., Fungi Eur. Exs. 2066; **lectotype**, designated in Braun (1998), in HAL].

*Substrate and distribution*: On *Parietaria* (*Urticaceae*); Central Asia, Caucasus, Europe, Israel, N. Africa, N. America.

*Notes*: *Ramularia parietariae* was originally described on *Parietaria officinalis* from Italy (lectotype in HAL), but it is also pathogenic to other species of the genus *Parietaria*. Phylogenetic analyses showed that these strains cluster together in a highly supported clade (Fig. 2, clade 47, 1/100/100).

***Ramularia phacae-frigidae*** (E. Müll. & Wehm.) Videira & Crous, Fungal Biol. 119: 836. 2015.

*Basionym*: *Mycosphaerella phacae-frigidae* E. Müll. & Wehm., Sydowia 8: 190. 1954.

*Specimen examined*: **Switzerland**, Corveglia, above St. Moritz, on dead leaves of *Phaca frigida*, 20 Jul. 1953, E. Müller (**holotype** in ZT, ex-type culture CBS 234.55).

*Substrate and distribution*: On *Phaca frigida* (*Fabaceae*), Europe (Switzerland).

*Notes*: *Ramularia phacae-frigidae* was originally described as *Mycosphaerella phacae-frigidae*, a pathogen infecting *Phaca frigida* from Helvetia (holotype in ZT). Although Müller & Wehmeyer (1954) mentioned the presence of *Ramularia* and *Asteromella* morphs in his description of *Mycosphaerella phacae-frigidae*, he refrained from naming them. The allocation to

**Fig. 58.** *Ramularia osterici* (CPC 10751). A, B. Observations from herbarium material. C–G. Structures formed in culture. A. Leaf spot symptoms on the host. B–D, F, G. Conidiophores, conidiogenous cells and conidia. E. Conidia. Scale bars = 10 µm.

*Ramularia* was based on the phylogenetic position of the ex-type culture (Videira *et al.* 2015b), which in this study is located in clade 63 (Fig. 2).

***Ramularia plurivora*** Videira & Crous, Persoonia 34: 60. 2015.

*Description*: Videira *et al.* (2015a).

*Specimens examined*: **Netherlands**, Den Haag, Laboratory of Medical Microbiology, Hospital Leyenburg, from human bone marrow, 2005 (**holotype** CBS H-21619, culture ex-type CBS 118743 = CPC 12207); Hilversum, Central Biological and Serological Laboratory, on human skin from neck, 20 May 2005, culture CBS 118693 = CPC 12206; on melon in storage, 1 Jan. 2008, J.H. Houbraken, culture CPC 16123, CPC 16124. **Korea**, on *Coleosporium plectranthi* on *Plectranthus excisus*, 2004, H.D. Shin, CPC 11517.

*Substrate and distribution*: On human samples, on *Cucumis* sp., on *Coleosporium plectranthi on Plectranthus excisus*; in Europe (Netherlands) and East Asia (South Korea).

*Notes*: See Videira *et al.* (2015a). Phylogenetic analyses provided high support for this species clade (Fig. 2, clade 35, 1/100/100).

***Ramularia pratensis*** Sacc. **var. *pratensis***, Fungi ital. Del., Tab. 998. 1881, and Michelia 2: 550. 1882 emend. U. Braun, 1998. Fig. 59.

= *Ramularia rhei* Allesch., Hedwigia 35: 34. 1896.

= *Ovularia rumicis* A. G. Eliasson, Bih. Kungl. Svenska Vetenskapsakad. Handl. 22, Afd. 3, 12: 18. 1897.

= *Ramularia rumicis-crispi* Sawada, Rep. Dept. Agric. Gov. Res. Inst. Formosa 85: 89. 1943.

= *Ramularia oxyriae-digynae* Gjaerum, Norweg. J. Bot. 18: 110. 1971.

*Mycelium* consisting of hyaline, septate, branched, smooth, 1–2 µm diam hyphae. *Conidiophores* reduced to *conidiogenous cells*, hyaline, thin-walled, smooth, integrated in mycelium or terminal in conidiophores, cylindrical-oblong and narrower at the top, (5.5–)12–15(–27) × (1.5–)2(–3) µm, with 1–2 apical conidiogenous loci almost flat to short cylindrical; *conidiogenous loci* thickened, darkened, refractive, 1 µm diam. *Ramoconidia* hyaline, thin-walled, smooth, subcylindrical to obclavate, (5–)8.5–11(–19) × (2–)2.5–3(–4) µm, aseptate to 1–3-septate, with 2–3 apical hila. *Intercalary conidia* hyaline, smooth, aseptate or 1–3-septate, subcylindrical with apices rounded and broader, (5–)7–8(–11.5) × 2–2.5(–3) µm, in branched chains of up to seven conidia. *Terminal conidia*, hyaline, smooth, aseptate, obovoid, (3–)4.5–5(–6) × 2–2.5(–3) µm, *hila* thickened, darkened, refractive, 1 µm diam.

*Culture characteristics*: On MEA, 18 mm diam, surface low convex, folded, fluffy aerial mycelium, pale olivaceous grey and dirty white, with margins undulate, convex, feathery, colony reverse iron-grey and buff margin; on OA, 30 mm diam, surface flat, smooth aerial mycelium, dirty white, transparent exudate small droplets, margins with entire edge with no aerial mycelium, colony reverse violet slate; on PDA, 30 mm diam, surface flat, fluffy aerial mycelium, pale olivaceous grey and olivaceous grey, with margins crenate, with sparse aerial mycelium, colony reverse slate blue with buff margin.

*Description in vivo*: See Braun (1998: 123).

*Specimens examined*: **Canada**, Stittsville, Ontario, on *Verbascum* sp., 12 Jul. 2009, K.A. Seifert, culture CPC 16868. **Italy**, Padova, on *Rumex acetosa*, herb. Saccardo (**holotype** PAD); **Taiwan**, Hualian County, Hehuanshan, on living leaves of *Rumex* sp., 3 Apr. 2007, R. Kirschner & C.-J. Chen, culture CBS 122105. **Unknown country** and collection details, culture CPC 19448.

*Substrate and distribution*: On *Oxyria*, *Rheum*, and *Rumex* (*Polygonaceae*), and *Verbascum* (*Scrophulariaceae*); Asia, Caucasus, Europe, N. and S. America.

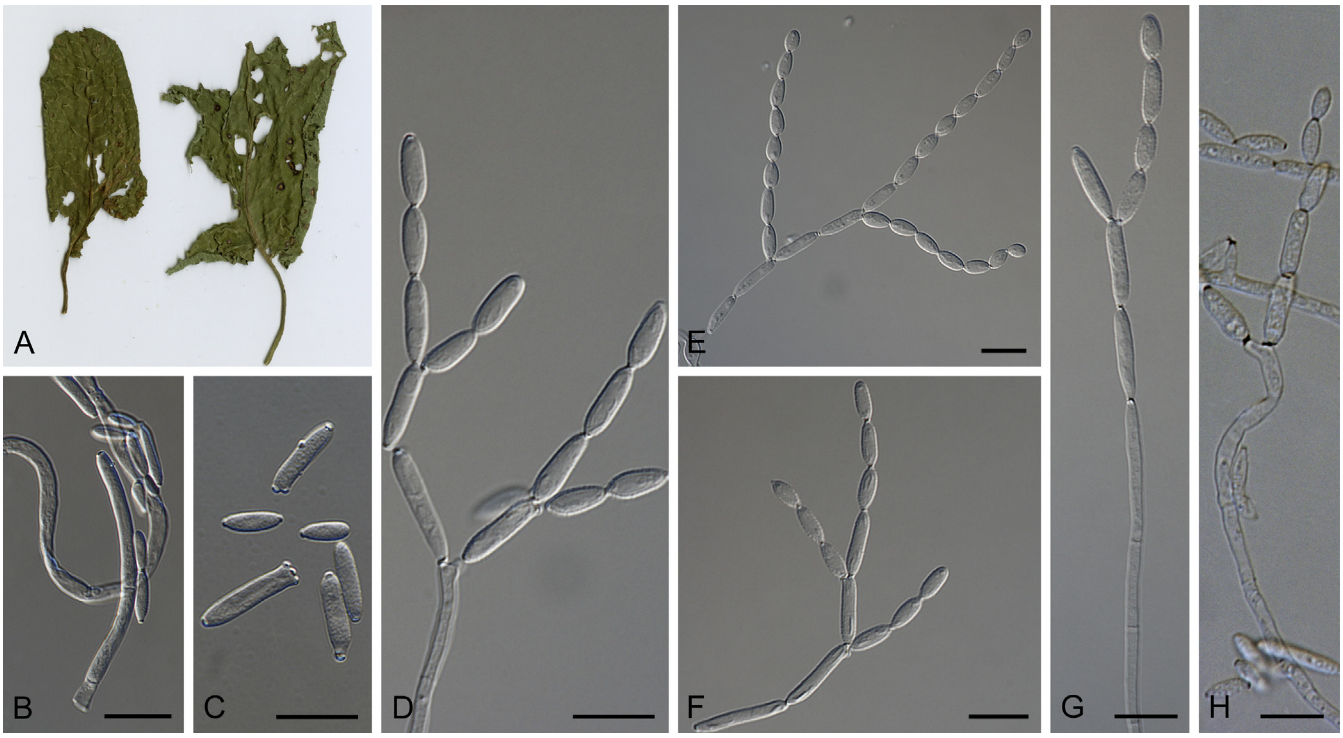

**Fig. 59.** *Ramularia pratensis* var. *pratensis* (CBS 122105). A–C. Observations from herbarium material. D–H. Structures formed in culture. A. Leaf spot symptoms on the host. B. Conidiogenous cells and conidia. D, G, H. Conidiophores, conidiogenous cells and conidia. C, E, F. Conidia. Scale bars = 10 µm.

*Notes*: Two varieties of *Ramularia pratensis* have been described, *R. pratensis* var. *pratensis* (on numerous *Rumex* species) with broader conidia, (6–)8–25(–35) × (1.5–)2–4(–5) µm), and *R. pratensis* var. *angustiformis* (*Rumex acetosella*, USA, holotype in NY) with very narrow conidia, 10–35 × 1.5–2 µm. It is the first time *R. pratensis* var. *pratensis* is reported from the host Verbascum (*Scrophulariaceae*). *Ramularia rhei*, currently a synonym of *R. pratensis* var. *pratensis*, has been reported as the causal agent of rhubarb leaf and petiole spot disease in the UK (Zhao *et al.* 2002). Rhubarb (*Rheum rhaponticum*) is a perennial crop that that is largely grown in northern Europe, the USA and Canada. Rhubarb petioles are mainly used in domestic food and in processed products such as jams, syrups and wine (Foust & Marshall 1991). Since the disease is not yet a problem of economic importance to rhubarb production in Europe, little research and investigation have been conducted on its biology and epidemiology, besides the work of Zhao *et al.* (2006) comparing the effect of temperature on conidial germination. This species clade is highly supported by the phylogenetic analyses (Fig. 2, clade 23, 1/100/100), and the strain CBS 122105 is considered a good representative of the species based on its morphological characters (Fig. 59).

***Ramularia proteae*** Crous & Summerell, Austral. Pl. Pathol. 29: 277. 2000.

*Specimen examined*: **Australia**, Tasmania, on *Protea longifolia*, Aug. 1999, A. Macfadyen (**holotype** DAR 74883, culture ex-type CBS 112161 = CPC 3075).

*Substrate and distribution*: Thus far only known from the type location.

*Notes*: *Ramularia proteae* was the first *Ramularia* species reported from a *Protea* host. It was observed causing a leaf spot disease on *P. longifolia* in Tasmania (Crous *et al.* 2000). *Ramularia proteae* is morphologically similar to *R. stellenboschensis*, described from South Africa but with smaller and fusoid conidia. This species clusters very close to *R. stellenbochensis* in the phylogenetic analyses (Fig. 1, clade XIV) and was not included in the multigene phylogeny because it was not possible to amplify the *tef1*-α partial gene.

***Ramularia pusilla*** Unger, Exanth. Pfl.: 169. 1833. Fig. 60.
≡ *Caeoma pusilla* (Unger) Bonord., Handb. Mykol.: 41. 1851.
≡ *Ovularia pusilla* (Unger) Sacc., Syll. Fung. 4: 140. 1886.
= *Ramularia pulchella* Ces., Bot. Zeitung (Berlin) 11: 238. 1853.

For additional synonyms see Braun (1998) or MycoBank.

*Mycelium* consisting of hyaline, septate, branched, smooth, 0.5–1 µm diam hyphae. *Conidiophores* hyaline, thin-walled, smooth, erect, 1–3-septate, cylindrical-oblong, straight and apically geniculate-sinuous, unbranched (7.5–)37–50(–96) × (1–)2(–3) µm. *Conidiogenous cells* terminal on conidiophores, cylindrical-oblong to geniculate-sinuous, narrower at the top, (6.0–)19–23(–37) × (1–)2(–3) µm, with multiple conidiogenous loci almost flat to protuberant and in a terminal or lateral position, thickened, darkened, refractive. *Conidia* formed singly, hyaline, thin-walled, smooth to verruculose, aseptate, ellipsoidal to obovoid, (5–)8–10(–15) × (3–)5–6(–8) µm, hila thickened, darkened, refractive. Sporulating on SNA.

*Culture characteristics*: On MEA, 12 mm diam, surface raised, with white fluffy mycelium with a rosy-buff tinge, margins lobate, feathery and convex, colony reverse buff; on OA, 15 mm diam, surface wavy, smooth, with white to buff aerial mycelium, margins entire, colony reverse fawn; on PDA, 12 mm diam, surface flat, smooth, with fluffy white to buff mycelium, with margins entire, colony reverse buff.

*Description in vivo*: See Braun (1998: 205).

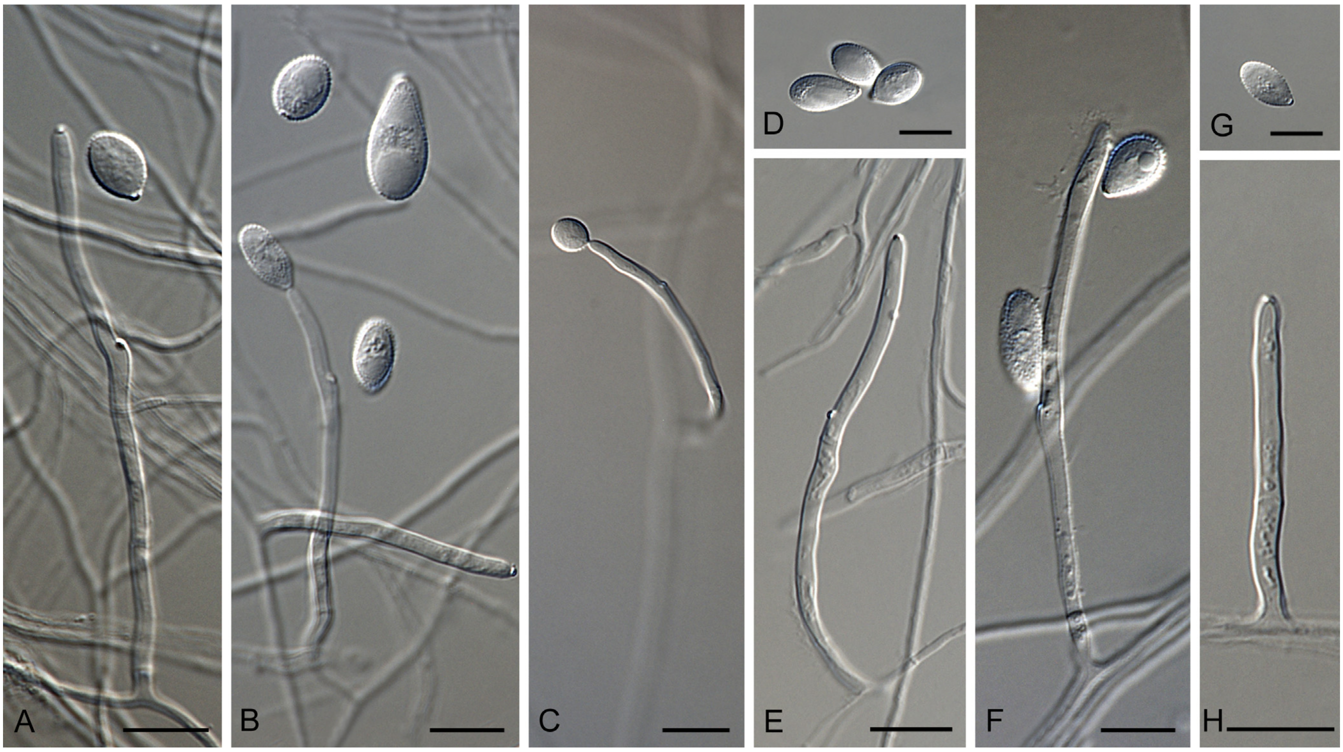

**Fig. 60.** *Ramularia pusilla* (CBS 124973). A–H. Structures formed in culture. A–C, F. Conidiophores and conidia. D, G. Conidia. E, H. Conidiophores. Scale bars = 10 µm.

*Specimens examined*: **Austria**, on *Poa nemoralis*, Unger, Exanth. Pfl., Pl. II, fig. 12, lectotype (iconotype, see Braun 1998). **Germany**, Frankfurt am Main, Botanical Garden, on leaves of *Poa annua*, 25 Feb. 2008, R. Kirschner (**epitype designated here** CBS H-22527, MBT204832, culture ex-epitype CBS 124973).

*Substrate and distribution*: *Agropyrum*, *Agrostis*, *Alopecurus*, *Anthoxanthum*, *Arctagrostis*, *Arrhenatherum*, *Bromus*, *Calamagrostis*, *Cinna*, *Cynosurus*, *Dactylis*, *Deschampsia*, *Elymus*, *Eremopyrum*, *Festuca*, *Glyceria*, *Helictotrichon*, *Hierochloë*, *Hordeum*, *Lolium*, *Melica*, *Muhlenbergia*, *Phalaris*, *Phleum*, *Poa*, *Puccinellia*, *Trisetum*, *Triticum*, *Vulpia*, and other undetermined grasses (*Poaceae*), almost circumglobal.

*Notes*: *Ramularia pusilla* is the type species of the genus *Ramularia* and has a broad host range within the family *Poaceae* and a worldwide distribution (Braun 1998). Two varieties of *Ramularia pusilla* are known, *R. pusilla* var. *pusilla* (on *Poa nemoralis*, Austria, iconotype) with conidiophores in small fascicles of 2–6, and *R. pusilla* var. *baldingerae* (on *Phalaris arundinacea*, Sweden, holotype in UPS), forming large tufts of conidiophores of 5–20. Strain CBS 124973 was examined by means of morphology and LSU sequence data in a previous study (Kirschner 2009), and was considered to be a good representative of the type species of the genus. In this study this strain forms a single lineage (Fig. 1, clade XIV; Fig. 2, clade 39) and is closely related to *R. collo-cygni*. The existing type material of this species consists of the original illustration (iconotype) since the original type material was not preserved and appropriate material for a neotypification could not be traced (Braun 1998). We hereby designate the strain CBS 124973 as ex-epitype culture of *R. pusilla* (Fig. 60).

***Ramularia rhabdospora*** (Berk. & Broome) Nannf., Fungi Exs.. Suec. Fasc. 39–40, Sched.: 32. 1950.

*Basionym*: *Cylindrosporium rhabdosporum* Berk. & Broome, Ann. Mag. Nat. Hist. 15: 34. 1875.

= *Ramularia plantaginis* Peck, Rep. (Annual) New York State Mus. Nat. Hist. 32: 43. 1879 (1880).

≡ *Ramularia peckii* Sacc. & P. Syd., Syll. Fung. 14: 1065. 1899, nom. illeg. (superfl.).

For additional synonyms see Braun (1998) or MycoBank.

*Description in vivo*: See Braun (1998: 197).

*Specimens examined*: **Germany**, on unknown host, unknown date, S. Petzoldt, culture CBS 312.92. **New Zealand**, Auckland, Grey Lynn, on *Plantago lanceolata*, unknown collector and date, isol. C.F. Hill, Jul. 2005, dep. C.F. Hill, culture CBS 118415. **UK**, Glamis, on *Plantago lanceolata*, Berkeley (**holotype** K).

*Substrate and distribution*: On *Plantago* (*Plantaginaceae*); Asia, Caucasus, Europe, N. and S. America, New Zealand.

*Notes*: *Ramularia rhabdospora* was originally described on *Plantago lanceolata* from England (holotype in K) but has since been reported from several other countries (Braun 1998). Two species have been described from the host *Plantago*, *R. rhabdospora* and *R. kriegeriana*. Traditionally, these species are distinguished by the ornamentation of the conidia that is echinulate in *R. rhabdospora* and verruculose in *R. kriegeriana*, which is correlated with the phylogenetic affinity of the host species. *Plantago lanceolata*, the principal host of *R. rhabdospora* belongs in *Plantago* subgen. *Psyllium*, and *P. major*, the principal host of *R. kriegeriana*, is a species of *Plantago* subgen. *Plantago* (Rønsted *et al.* 2002). Phylogenetically, these two strains cluster apart, with *R. rhabdospora* in clade 57 and *R. kriegeriana* in clade 65 (Fig. 2) and are morphologically easily distinguishable.

***Ramularia rubella*** (Bonord.) Nannf., in Lundell & Nannf., Fungi Exs.. Suec., Fasc. 39–40: 33. 1950. Fig. 61.

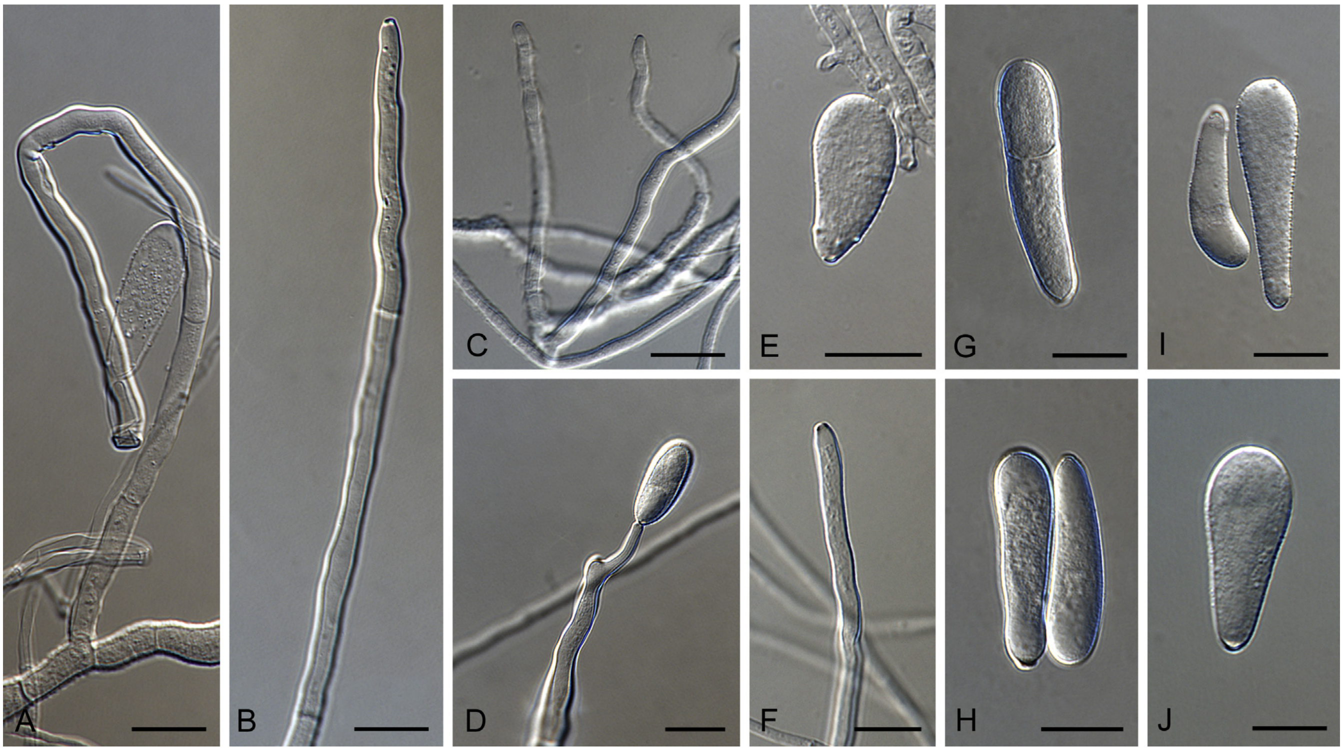

**Fig. 61.** *Ramularia rubella* (CBS 120161). A–J. Structures formed in culture. A, D. Conidiophore and conidia. B, C, F. Conidiophores. E, G–J. Conidia. Scale bars = 10 µm.

*Basionym*: *Crocysporium rubellum* Bonord., Bot. Zeitung (Berlin) 19: 201. 1861.

≡ *Ovullaria rubella* (Bonord.) Sacc., Syll. Fung. 4: 145. 1886.

= *Oidium monosporium* Westend., Bull. Soc. Roy. Bot. Belgique 2: 252. 1863.

= *Ramularia obovata* Fuckel, Hedwigia. 5: 50. 1866.

= *Ramularia circumfusa* Ellis & Everh., Proc. Acad. Nat. Sci. Philadelphia 47: 437. 1895.

For additional synonyms see Braun (1998).

*Mycelium* consisting of hyaline, septate, branched, smooth to verruculose, 1.5–3 µm diam hyphae. *Conidiophores* hyaline, thin-walled, smooth to verruculose, erect, multiseptate, cylindrical-oblong, straight, unbranched (31–)73–115(–282) × (2–)2.5–3(–5) µm. *Conidiogenous cells* terminal on conidiophores, cylindrical-oblong, 16–40 × 2–3 µm, with one conidiogenous locus, almost flat and in a terminal or lateral position thickened, darkened, refractive. *Conidia* formed singly, hyaline, thin-walled, smooth to verruculose, mostly aseptate and rarely 1-septate, ellipsoid to obovoid, (15–)26–35(–54) × (5–)6–7(–9) µm; *hila* thickened, darkened, refractive.

*Culture characteristics*: On MEA, 7 mm diam, surface raised, irregular, with flat mycelium, white, with undulate margins and colony reverse olivaceous; on OA, 8 mm diam, surface raised in the centre and flattening towards the edge, smooth rosy-buff mycelium, radially striated, producing tiny droplets of exudate in the centre, with undulate edge and colony reverse ochraceous; on PDA, 9 mm diam, surface raised, irregular, smooth mycelium, white to rosy-buff, producing tiny droplets of exudate, with crenate margins, colony reverse iron-grey.

*Description in vivo*: See Braun (1998: 210).

*Specimens examined*: [**Germany**, Guestphalia, On *Rumex aquaticus*, Bonorden, holotype not preserved]. **Luxembourg**, Kantenbach, on leaf spot on *Rumex obtusifolius*, unknown collector and date, isol. L. Marvanová, 25 Sep. 1967, dep. L. Marvanová, Oct. 1967, culture CBS 433.67. **Mexico**, Montecillo, on *Rumex* sp., 22 Sep. 2008, M. de Jesús Yáñez-Morales, cultures CPC 15748–15750; Montecillo, on *Rumex* sp., 1 Oct. 2008, M. de Jesús Yáñez-Morales, culture CPC 15821. **Netherlands**, Utrecht, on *Rumex* sp., May 2013, U. Damm, (**neotype designated here**, herbarium CBS H-22528, MBT204835, culture ex-neotype CBS 141117 = CPC 25911); Gelderland Prov., Wageningen, on *Prunus* sp., 23 May 2011, W. Quaedvlieg, cultures CPC 19471, CPC 19472. **New Zealand**, Auckland, Mt. Albert, on *Rumex obtusifolius*, unknown collector and date, isol. C.F. Hill, Jul. 2005, dep. C.F. Hill, culture CBS 120161. **Sweden**, Uppland, Haga, Årtopet, on *Rumex longifolius*, 16 Sep. 1988, E. Gunnerbeck, culture CBS 114440.

*Substrate and distribution*: On *Polygonum s. lat.* and *Rumex* (*Polygonaceae*); almost circumglobal.

*Notes*: *Ramularia rubella* was originally described on *Rumex aquaticus* from Germany, but it has a wide geographical distribution in association with the host *Rumex*, while it is very rarely observed infecting *Polygonum s. lat.* (Braun 1998). As a necrotroph, *Ramularia rubella* shows promise as a biological control agent against *Rumex obtusifolius* by causing severe defoliation, shoot and root weight loss (Huber-Meinicke *et al.* 1989). The available strains form a highly supported clade based on the employed phylogenetic methods (Fig. 2, clade 79, 1/100/100). The morphological description of the isolates (Fig. 61) in this clade is in agreement with the one presented in literature (Braun 1998), except the conidiophores were reduced to conidiogenous cells in culture. Because of the long, solitary conidia and sometimes broad conidiogenous loci and hila, some of the strains were initially confused with *Cercosporella*.

***Ramularia rufibasis*** (Berk. & Broome) Gunnerb. & Constant., Thunbergia 15: 77. 1991.

*Basionym*: *Peronospora rufibasis* Berk. & Broome, Ann. Mag. Nat. Hist. 15: 34. 1875.

≡ *Ovularia rufibasis* (Berk. & Broome) Massee, Brit. fung.-fl. 3: 322. 1893.
≡ *Phacellium rufibasis* (Berk. & Broome) U. Braun, Nova Hedwigia 54: 471. 1992.
= *Ramularia destructiva* W. Phillips & Plowr., Grevillea 6(37): 22. 1877.
= *Ovularia monilioides* Ellis & G. Martin, Amer. Naturalist 19: 76. 1885.

*Description in vivo*: See Braun (1998: 328).

*Specimens examined*: **Sweden**, Uppland, Järlåsa, on leaves of *Myrica gale*, 17 Sep. 1990, E. Gunnerbeck, culture CBS 114567. **UK**, Glamis, on *Myrica gale*, herb. Berkeley (**holotype** of *Peronospora rufibasis* in K); King's Lynn, on *Myrica gale*, May 1876, Plowright [Rabenh., Fungi. Eur. Exs. 2267; **lectotype** of *Ramularia destructiva*, designated in Braun (1998), in HAL]. **USA**, Massachusetts, Magnolia, *Myrica gale*, Jun. 1884, C.H. Clarke [**lectotype** of *Ovularia monilioides*, designated in Braun (1998), in NY 938246].

*Substrate and distribution*: On *Comptonia* and *Myrica* (*Myricaceae*); Asia, Canary Islands, Europe, N. America)

*Notes*: *Ramularia destructiva*, described on *Myrica gale* from England (holotype in K), was reassigned to the genus *Phacellium* as *Phacellium rufibasis* (Braun 1992) due to the production of synnematous conidiophores. The genus *Phacellium* is now considered a synonym of *Ramularia* as the production of synnemata was deemed as an unreliable character to separate these two genera. The strain used in this study clusters within the genus *Ramularia* (Fig. 1, clade XIV), and formed a single lineage (Fig. 2, clade 82) basal to *R. nyssicola* (clade 81), but positioned on a very long branch, which supports this species as unique. Unfortunately, the strain was sterile in culture and morphological data could not be evaluated. This lineage is for now maintained as a representative of *R. rufibasis*, until fresh material is collected and more information becomes available. This species causes the Ramularia dieback disease of *Myrica faya* in its natural habitat, affecting young shoots and causing leaf spots (Gardner & Hodges 1990). *Myrica faya* is considered an invasive plant in Hawaii and this pathogen represents a potentially good biocontrol agent, but no studies for field applications have been conducted thus far.

***Ramularia rumicicola*** Videira, H.D. Shin & Crous, **sp. nov.** MycoBank MB816852. Fig. 62.

*Etymology*: Named after the host genus from which it was collected, *Rumex*.

*Mycelium* consisting of hyaline, septate, branched, smooth, 1–2 µm diam hyphae. *Conidiophores* hyaline, thin-walled, smooth, erect, septate, straight, cylindrical-oblong, unbranched, (11.5–)33.5–50(–74) × (1.5–)2(–3) µm or reduced to conidiogenous cells. *Conidiogenous cells* integrated in mycelium or terminal in conidiophores, cylindrical-oblong to geniculate-sinuous, (8–)10.5–13(–18) × (1.5–)2(–3) µm, with 1–2 apical conidiogenous loci, thickened, darkened, refractive. *Conidia* hyaline, thin-walled, smooth, catenate, with hila thickened, darkened and refractive. *Ramoconidia* subcylindrical, (8.5–)13.5–16(–20) × 2–2.5(–3) µm, 0–1-septate, with 2–3 apical hila. *Intercalary conidia* subcylindrical to fusoid, 0–1-septate, (7.5–)11–13(–19) × 2–2.5(–3) µm, in branched chains of up to seven conidia. *Terminal conidia* subcylindrical to obovoid, aseptate, (5–)7.5–9(–13) × 2–2.5(–3) µm.

*Culture characteristics*: On MEA, 30 mm diam, surface concave, radially striated, smooth mycelium, white with greyish tinge, with margins undulate and feathery, colony reverse iron grey; on OA, 35 mm diam, surface flat and buff with a purplish grey centre except for a slice of white and grey olivaceous fluffy mycelium, margins entire, colony reverse buff with iron grey centre; on PDA, 40 mm diam, surface flat with short hairy mycelium, dark grey olivaceous, with margins entire, sparse in mycelium and feathery, colony reverse iron grey at the centre and grey olivaceous margin.

*Specimen examined*: **South Korea**, Jinju, on *Rumex crispus*, 14 May 2004, H.D. Shin (**holotype** KUS-F20194, isotype CBS H-22529, culture ex-type CBS 141118 = CPC 11294); *idem*. CPC 11295, CPC 11296.

*Notes*: *Ramularia rumicicola* formed a highly supported clade (Fig. 2, clade 24, 1/100/100). It differs from *R. pratensis* by having larger ramo-, intercalary and terminal conidia, and by culture characteristics (Fig. 62).

***Ramularia rumicis*** Kalchbr. & Cooke, Grevillea 8: 23. 1880.
= *Ramularia decipiens* Ellis & Everh., J. Mycol. 1: 70. 1885.

*Description in vivo*: See Braun (1998: 216).

*Specimens examined*: **South Africa**, Cape, Somerset-East, on *Rumex obtusifolius*, MacOwan 1180 [**lectotype**, designated in Braun (1998), in B]. **Sweden**, Uppland, Dalby, Jerusalem, on *Rumex aquaticus*, 7 Sep. 1988, E. Gunnerbeck, culture CBS 114300.

*Substrate and distribution*: On *Rumex* (*Polygonaceae*); Asia, Caucasus, Europe, Africa, N. America.

*Notes*: *Ramularia rumicis* was originally described on *Rumex obtusifolius* from South Africa (lectotype in B) and has a very wide geographical distribution (Braun 1998). This species forms a single lineage (Fig. 2, clade 26). In literature (Braun 1998), a total of seven *Ramularia* species, including four varieties, have been described from *Rumex*. *Ramularia rubella* (Fig. 2, clade 79) and *R. pratensis* var. *pratensis* (Fig. 2, clade 23) have a circumglobal distribution. *Ramularia bulgarica* (on *Rumex alpinus*, Bulgaria, holotype in BPI) is only known from Europe. *Ramularia occidentalis* var. *occidentalis* (on *Rumex britannica*, lectotype in NY), *Ramularia pseudodecipiens* (on *Rumex venosus*, holotype in NY) and *R. pratensis* var. *angustifolia* (on *Rumex acetosella*, holotype in NY) are only known from the USA. Braun (1998) stated that *R. bulgarica* is closely related to *R. pratensis* but no culture was available for this study.

***Ramularia* sp. D** Fig. 63

*Mycelium* consisting of hyaline, septate, branched, smooth, 1–2 µm diam hyphae. *Conidiophores* hyaline, thin-walled, smooth, erect, septate, cylindrical-oblong, straight, unbranched (44–)71–92(–129) × 2 µm, or reduced to conidiogenous cells. *Conidiogenous cells* integrated in the mycelium or terminal in the conidiophore, cylindrical-oblong, (24–)26.5–30(–35) × 2(–2.5) µm, with one *conidiogenous locus* almost flat, thickened, darkened and refractive. *Conidia* hyaline, thin-walled, smooth, catenate, aseptate, with *hila* thickened, darkened and refractive. *Ramoconidia* cylindrical-oblong, sometimes curved, (16–)21–24(–34) × (1.5–)

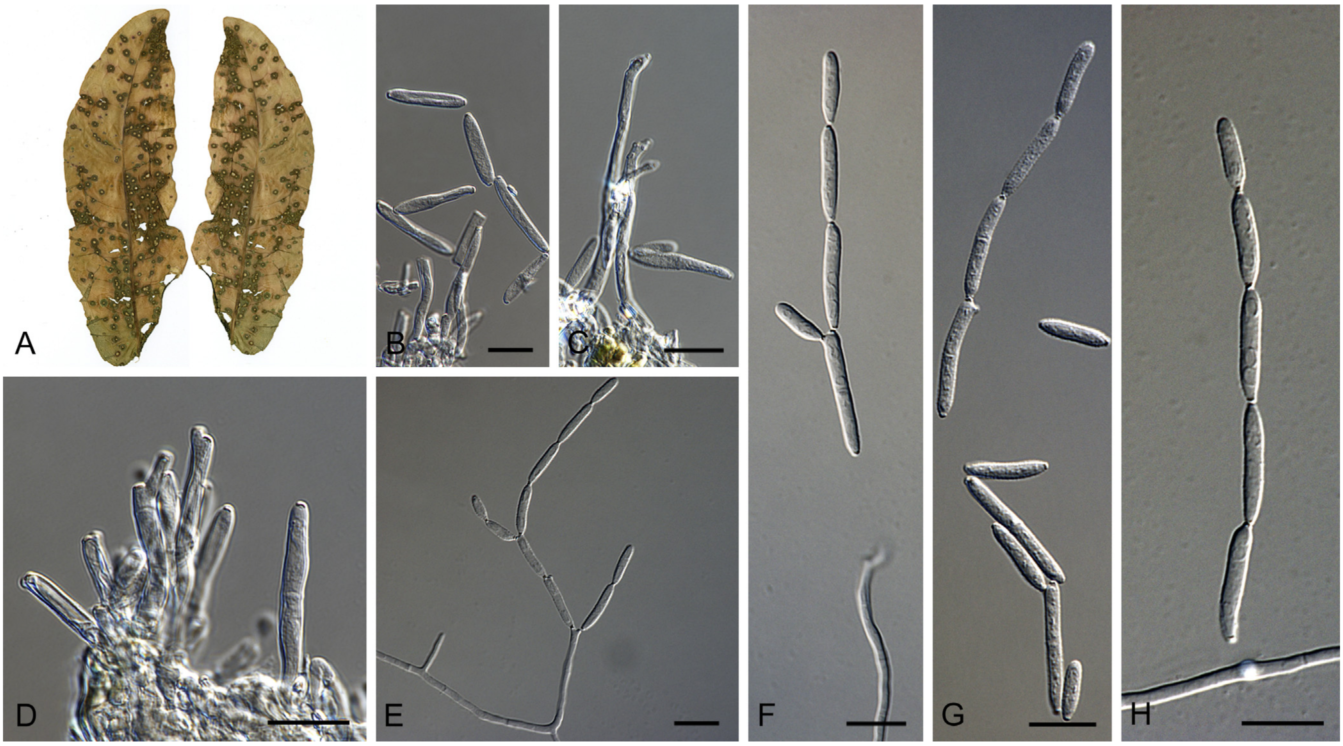

**Fig. 62.** *Ramularia rumicicola* (CBS 141118). A–D. Observations from herbarium material. E–H. Structures formed in culture. A. Leaf spot symptoms on the host. B, C, E, F. Conidiophores and conidia. D. Conidiophores and conidiogenous cells. G. Conidia. H. Conidiogenous cell and conidia. Scale bars = 10 µm.

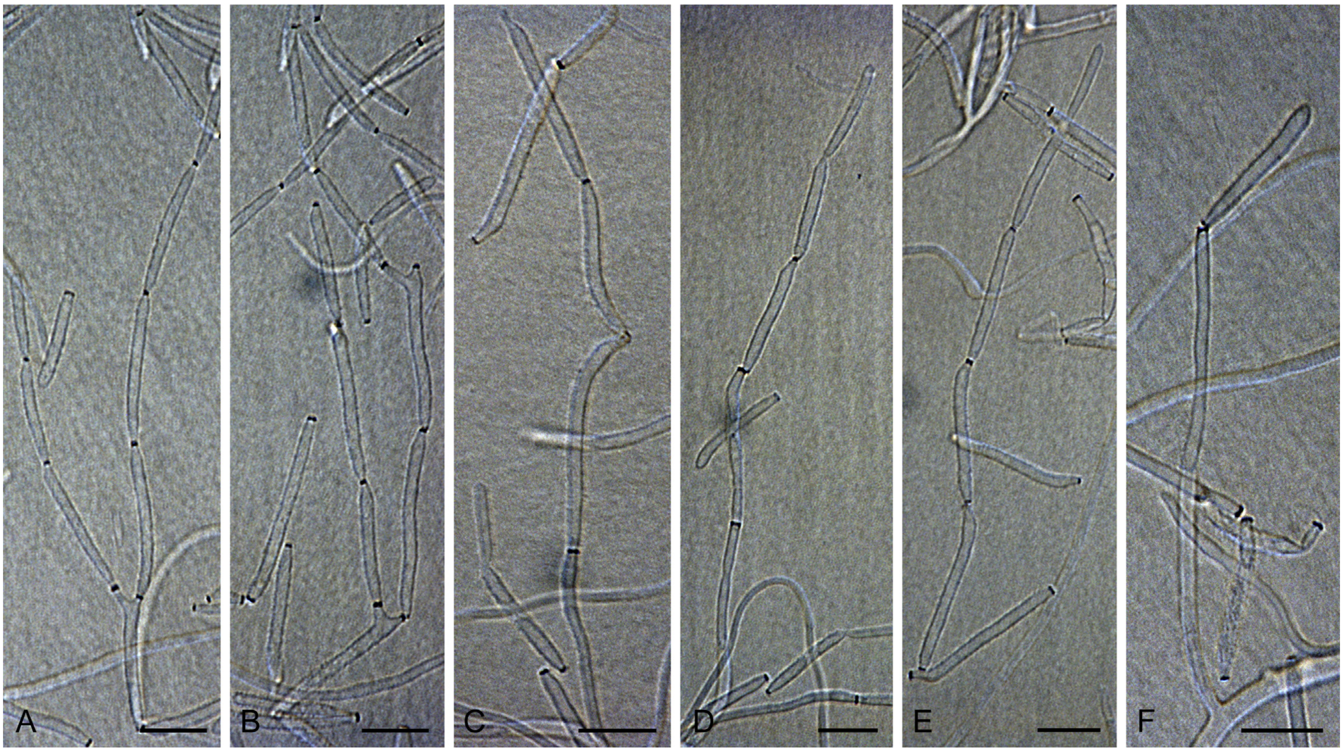

**Fig. 63.** *Ramularia* sp. D (CBS 135.23). A–F. Structures formed in culture. A, B, E. Conidia. C, D, F. Conidiophores, conidiogenous cells and conidia. Scale bars = 10 µm.

2(–3) µm, with two protruding apical hila. *Intercalary conidia* cylindrical-oblong, apical apex sometimes curved, (14–)20–22(–30) × (1.5–)2(–3) µm, in branched chains of up to five conidia. *Terminal conidia* cylindrical-obovoid, (7.5–)14–16(–22) × (1.4–)2–2.5 µm (on SNA, CBS 135.23).

*Culture characteristics*: On MEA, 10 mm diam, surface raised, fluffy aerial mycelium, white-buff, with margins lobate, colony reverse ochreous; on OA, 12 mm diam, surface flat, ochreous, with sparse white aerial mycelium, margins lobate, colony reverse cinnamon; on PDA, 11 mm diam, surface flat, fluffy white aerial mycelium, with margins lobate, colony reverse buff.

*Specimen examined*: **Unknown country**, on *Viola odorata*, unknown collector and date, isol. and dep. L. Solberg, May 1923, culture CBS 135.23.

*Notes*: Although this isolate was originally identified as *R. lactea*, the morphological characteristics of this strain (Fig. 63) do not match with that of the original description of *R. lactea* (Braun

1998). *Ramularia lactea* has shorter conidiophores (5–50 × 1.5–4 µm), and smooth to verruculose conidia (5–)8–18(–25) × (1.5–)2–5(–6) µm. Three other *Ramularia* species have been described from *Viola*, namely *R. coleosporii* (Fig. 2, clade 66), *R. agrestis* and *R. biflorae*. *Ramularia agrestis* var. *agrestis*, *R. agrestis* var. *deflectans* and *R. biflorae* all produce septate conidia that are longer and wider than *Ramularia* sp. D. *Ramularia* sp. D (Fig. 2, clade 44) formed a single lineage closely related to *R. abscondita*. Although we suspect this culture to represent a new species, more material of other taxa occurring on *Viola* is required to make a suitable comparison.

***Ramularia sphaeroidea*** Sacc., Michelia 1: 130. 1878. emend. U. Braun (1998: 151).

≡ *Ovularia sphaeroidea* (Sacc.) Sacc., Fungi ital. Del., Tab. 979. 1881.
= *Ramularia viciae* A.B. Frank, Krankh. Pfl., 1. Aufl.: 600. 1880.
= *Peronospora exigua* W.G. Smith, Diseases of Field and Garden Crops: 13. 1884.
= *Ovularia lotophaga* Ellis & Everh., Proc. Acad. Nat. Sci. Phil. 47: 432. 1895.
= *Pseudovularia trifolii* Speg., Anales Mus. Nac. Hist. Nat. Buenos Aires 20: 418. 1910.

For additional synonyms see Braun (1998) or MycoBank.

*Description in vivo*: See Braun (1998: 151).

*Specimens examined*: **Germany**, Berlin, Spandau, on *Lotus uliginosus*, Jul. 1875, Magnus (**holotype** PAD). **USA**, California, on *Vicia villosa* subsp. *varia*, Apr. 2002, S.T. Koike, culture CBS 112891.

*Substrate and distribution*: On *Chesneya*, *Glycyrrhiza*, *Lotus*, *Trifolium*, and *Vicia* (*Fabaceae*); Central Asia, Caucasus, Europe, N. and S. America, Australia, New Zealand.

*Notes*: *Ramularia sphaeroidea* was originally described on *Lotus uliginosus* from Germany (holotype in PAD), but it is able to infect other hosts from *Fabaceae* worldwide. Vetches (*Vicia* spp.) are planted alone or in combination with other plants as cover crops in vegetable production areas in California. From 2001 to 2003, purple vetches (*V. benhalensis*) and lana woollypod vetches (*V. villosa* subsp. *varia*) in the Salinas Valley (Monterey county, California) developed a foliar disease. Based on morphological and molecular (ITS) data (CBS 112891, GenBank AY352584), the fungus was identified as *Ramularia sphaeroidea*. Pathogenicity was confirmed by spraying healthy plants with a conidial suspension in water (Koike *et al.* 2004). This strain formed a single lineage (Fig. 2, clade 12), but positioned on a long branch, which supports this species as unique. This clade is tentatively maintained as representative of the species until material from the type host and location are recollected and examined.

***Ramularia stellariicola*** (M.J. Park *et al.*) Videira, H.D. Shin & Crous, **comb. nov.** MycoBank MB817160
*Basionym*: *Pseudocercosporella stellariicola* M.J. Park *et al.*, Mycotaxon 119: 270. 2012.

*Specimen examined*: **South Korea**, Namyangju, Korea University, on *Stellaria aquatica*, 3 May 2006, H.D. Shin & M.J. Park (**holotype** KUS-F21740, culture ex-type KACC 42363 = CBS 130592 = CPC 11297, CPC 11298).

*Substrate and distribution*: On *Stellaria aquatica* (*Caryophyllaceae*); Asia (South Korea).

*Notes*: At the time *Pseudocercosporella stellariicola* was described the ITS sequence placed it within the genus *Ramularia*, but morphologically it was better accommodated in *Pseudocercosporella*. However, this species is not congeneric with the type of *Pseudocercosporella*, *P. bakeri* (Fig. 1, clade XIX). Therefore, we propose a new combination in *Ramularia*. This species clusters in a highly supported clade (Fig. 2, clade 13, 1/100/100). No sexual morph of this species is known. Although it formed a sister clade to "*Mycosphaerella cerastiicola*", the latter species displays a cryptic septoria-like to pseudocercosporella-like asexual morph and differs in several nucleotides in the seven genes amplified: 2 (LSU), 9 (*rpb2*), 10 (ITS), 5 (*actA*), 9 (*gapdh*), 5 (*tef1*-α), 11 (*his3*). These taxa are maintained as separate species until further studies are conducted.

***Ramularia stellenboschensis*** Crous, Persoonia 27: 37. 2011.

*Specimen examined*: **South Africa**, Western Cape Province, Stellenbosch, J.S. Marais Botanical Garden, on leaves of *Protea* sp., associated with leaf spots of *Vizella interrupta*, 6 May 2010, P.W. Crous (**holotype** CBS H-20678, cultures ex-type CBS 130600 = CPC 18294).

*Substrate and distribution*: On *Protea* sp. (*Proteaceae*); Africa (South Africa).

*Notes*: *Protea* species are very popular due to their brightly coloured and textured flowers and fungal pathogens that damage the blooms are highly undesirable. *Ramularia stellenboschensis* was the first species of *Ramularia* described from *Proteaceae* in South Africa. This species formed a single lineage (Fig. 2, clade 22), but positioned in a long branch, basal to *R. hydrangeae-macrophyllae* (clade 21). It is closely related to *R. proteae* (Fig. 1, clade XIV) but differs from it by forming larger sudcylindrical conidia and by several nucleotides among the seven genes amplified: 16 (*rpb2*), 4 (ITS), 9 (*actA*), 12 (*gapdh*), 14 (*tub2*), 2 (*his3*), 20 (*cmdA*).

***Ramularia tovarae*** (Sawada) U. Braun, Internat. J. Mycol. Lichenol. 3: 283. 1988.
*Basionym*: *Ovularia tovarae* Sawada, Bull. Gov. Forest. Exp. Stat. Tokyo 105: 83. 1958.

*Description in vivo*: See Braun (1998: 212).

*Specimens examined*: **Japan**, on *Polygonum filiforme* [*Antenoron filiforme*, *Tovara filiforme*] (*Polygonaceae*), syntypes, 26 May 1948, 16 Jun 1948 and 7 Nov. 1947, Sawada (not seen!). **South Korea**, Hongcheon, on *Antenoron filiforme* (≡ *Polygonum filiforme*), 16 May 2003, H.D. Shin, KUS-F19471 (**epitype designated here**, MBT204827, HAL 1849 F, culture ex-epitype CBS 113305).

*Substrate and distribution*: Thus far only known from East Asia (Japan and South Korea), on *Polygonum filiforme* (*Polygonaceae*).

*Notes*: *Ramularia tovarae* was originally described on *Polygonum filiforme* from Japan and its distribution was limited to the type location. The only strain available representative of this species formed a single lineage (Fig. 2, clade 37), but positioned on a long branch that supports this species as unique. Although the strain did not sporulate in culture, the morphology observed in vivo corresponded to that described in literature (Braun 1998). Therefore, this specimen is considered as a good representative of the species and, despite being originary from South Korea, it is hereby designated as epitype.

***Ramularia tricherae*** Lindr., Acta Soc. Fauna Fl. Fenn. 23: 38. 1902.

= *Ramularia succisae* var. *knautiae* C. Massal., Nuovo Giorn. Bot. Ital. 21: 169. 1889.
≡ *Ramularia knautiae* (C. Massal.) Bubák, Österr. Bot. Z. 53: 50. 1903.
= *Ovularia tricherae* Vestergr., Bot. Not. 1899: 169. 1899.
= *Ramularia knautiae* var. *arvensis* C. Massal., Malpighia 20: 169. 1906.

*Description in vivo*: See Braun (1998: 144).

*Specimens examined*: **Austria**, Ötztal, Ötz near Habichen, on leaf spot on *Knautia dipsacifolia*, 24 Jul. 2000, G. Verkley, culture CBS 108989, CBS 108990. **Former Czechoslovakia**, on *Knautia drymeia*, unknown collector and date, isol. L. Marvanová, Nov. 1972, dep. L. Marvanová, Jan. 1973, culture CBS 236.73. **Netherlands**, Limburg Prov., Gerendal, on leaf spot on *Knautia arvensis*, 28 Jun. 2000, G. Verkley, cultures CBS 108973, CBS 108974, CBS 108994, CBS 108995.

*Substrate and distribution*: On *Knautia* (*Dipsacaceae*); Caucasus, Europe.

*Notes*: *Ramularia tricherae* was originally described on *Knautia arvensis* from Finland [syntypes not seen by Braun (1998)] and has been reported from many European countries. In literature, this species is associated with the sexual morph *Sphaerella sylvatica* Sacc. & Speg. (Saccardo 1878) [syn. *Mycosphaerella scabiosae* Tomilin (Tomilin 1971)] but this connection has not been experimentally proven (Laibach 1921, Braun 1998, Aptroot 2006, Videira *et al.* 2015b). Phylogenetic analyses provided high support for this species clade (Fig. 2, clade 59, 1/100/100).

***Ramularia trigonotidis*** Videira, H.D. Shin & Crous, **sp. nov.** MycoBank MB816853. Fig. 64.

*Etymology*: Named after the host genus from which it was collected, *Trigonotis.*

*Mycelium* consisting of hyaline, septate, branched, smooth, 1–2 µm diam hyphae. *Conidiophores* hyaline, thin-walled, smooth, septate, straight, cylindrical-oblong, geniculate-sinuous, unbranched, (16–)36–48(–94) × (1.5–)2(–3) µm, or reduced to conidiogenous cells. *Conidiogenous cells* terminal in conidiophores or intermediate in the mycelium, cylindrical-oblong, (7–)13–16.5(–31) × (1.5–)2(–3) µm, with one conidiogenous locus, almost flat to protuberant, thickened, darkened and refractive. *Conidia* hyaline, thin-walled, smooth, aseptate, catenate, with hila thickened, darkened and refractive. *Ramoconidia* subcylindrical, (12–)15–17(–25) × (2–)2.5–3(–4) µm, 0–1-septate, with two flat to protruding apical hila. *Intercalary conidia* subcylindrical, sometimes curved, (11–)14.5–16(–18) × (2–)2.5–3(–3.5) µm, in branched chains of up to five conidia. *Terminal conidia* cylindrical-oblong to ovoid, (4.5–)10.5–12.5(–16) × (2–)2.5–3(–4) µm (on SNA).

*Culture characteristics*: On MEA, 13 mm diam, surface convex, smooth, smoke grey with a rosy tinge, with margins undulate, white, convex, feathery, colony reverse iron grey; on OA, 9 mm diam, surface convex, fluffy aerial mycelium, white in centre pale vinaceous towards the edges, margins olivaceous grey, feathery, colony reverse olivaceous grey; on PDA, 12 mm diam, surface convex, pale vinaceous grey, smooth and uniform, with margins undulate, feathery, hazel, colony reverse brown vinaceous and buff at margin.

*Specimens examined*: **South Korea**, Hoengseong, on *Trigonotis radicans* subsp. *sericea* (= *T. nakaii*), 15 Oct. 2007, H.D. Shin (**holotype** KUS-F23007, isotype CBS H-22530, culture ex-type CBS 141119 = CPC 14764); *idem.* CPC 14765, CPC 14766.

*Substrate and distribution*: On *Trigonotis radicans* subsp. *sericea* (*Boraginaceae*); Asia (South Korea).

*Notes*: *Ramularia trigonotidis* (Fig. 64) is the first species of *Ramularia* described on *Trigonotis*, and the available strains form a highly supported clade (Fig. 2, clade 76, 1/100/100). In the phylogeny it is closely related to *R. actinidiae* (Fig. 2, clade 77), but the latter species produces conidiophores that are reduced to conidiogenous cells, and subcylindrical to fusoid conidia that are slightly narrower.

***Ramularia trollii*** Iwanoff, Trudy Imp. S.-Peterburgsk. Obshch. Estestvoisp., Vyp. 3, Otd. Bot. 30(3): 12. 1900. Fig. 65.

= *Didymaria trollii* Jacz., Bull. Soc. Imp. Naturalistes Moscou, n.s., 3: 435. 1898.

*Description in vivo*: See Braun (1998: 233).

*Specimens examined*: **Austria**, Tirol, Ober Inntal, Serfaus, Komperdell Alm near Kölnerhaus, on leaf spot on *Trollius europaeus*, 10 Aug. 2000, G. Verkley, cultures CBS 109118, CBS 109119. **Russia**, Prov. Vjatka, Distr. Kotelnitsh, on *Trollius europaeus*, 19 Jul 1921, Chochjakov, ex herb. Vjatskogo Obl. Mus. 78 [**neotype**, designated in Braun (1998), in LEP].

*Substrate and distribution*: On *Trollius* (*Ranunculaceae*); Europe, Asia.

*Notes*: The type material of *R. trollii* was not preserved and a neotype was proposed by Braun (1998) on the host *Trollius europaeus* from Russia (neotype in LEP). Thus far it has only been reported infecting *Trollius* hosts and is known from Asia and several European countries (Braun 1998). The representative isolates of this species clustered within the *Ramularia* clade (Fig. 1, clade XIV) and formed a highly supported clade based on the multigene phylogeny (Fig. 2, clade 17, 1/100/100). These strains were originally identified as *Pseudocercosporella trollii* but they produce catenate conidia with conspicuous hila that are consistent with the *R. trollii* description from literature (Braun 1998) (Fig. 65).

***Ramularia unterseheri*** Videira & Crous, Fungal Biology 119: 836. 2015.

*Specimens examined*: **Germany**, Greifswald, Elisenhain, on leaf litter of *Fagus sylvatica*, 4 Jan. 2008, M. Unterseher (**holotype** CBS H-22285, culture ex-type CBS 124884); Greifswald, Elisenhain, on living leaves from the understorey of *Fagus sylvatica*, 8 Jan. 2008, M. Unterseher, cultures CBS 124826, CBS 124838; Munich, in room inside a castle, May 2011, unknown collector, dep. A. Klein-Vehne, culture CBS 130721. **Netherlands**, Utrecht Prov., Baarn, on decaying leaves of *Acer pseudoplatanus*, 26 Apr. 2004, G. Verkley, culture CBS 117879 = CPC 11207.

*Substrate and distribution*: On *Fagus* (*Fagaceae*) and *Acer* (*Sapindaceae*); Europe (Germany, Netherlands).

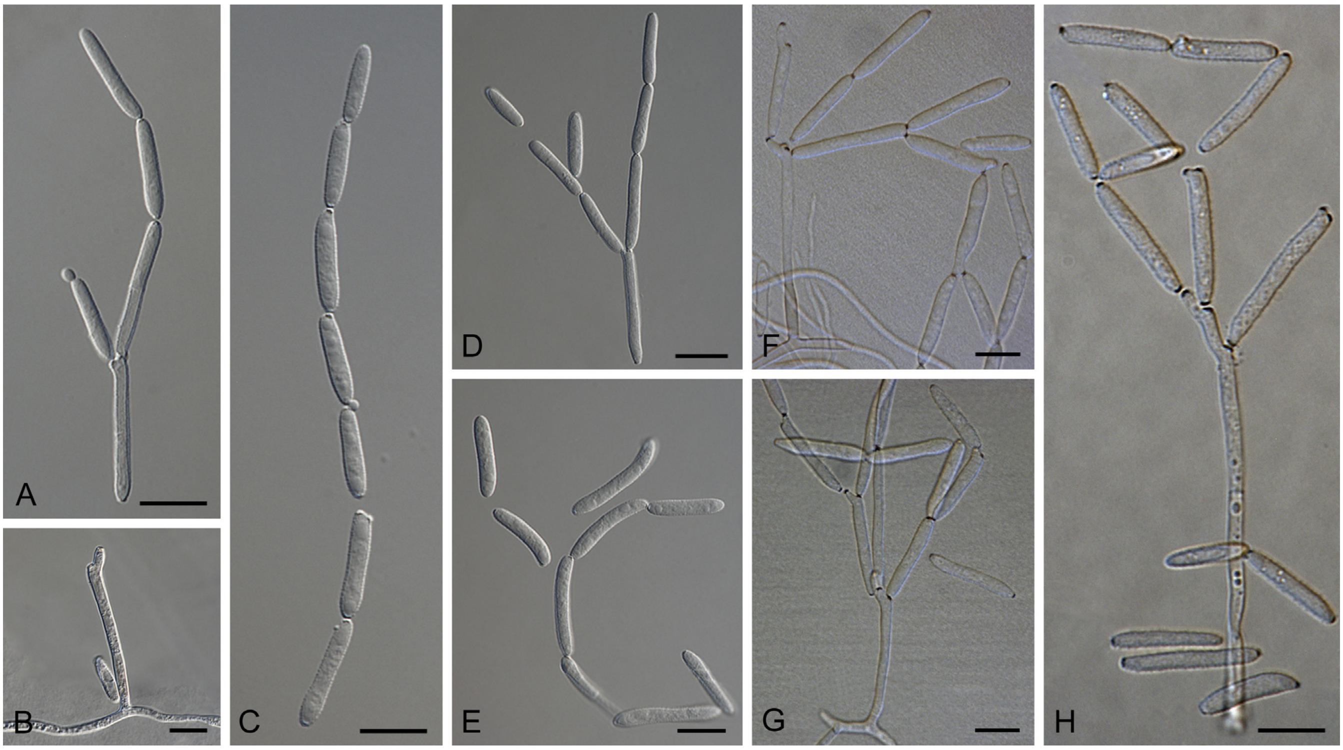

**Fig. 64.** *Ramularia trigonotidis* (CPC 14765). A−H. Structures formed in culture. A, C−E. Conidia. B. Conidiophore. F−H. Conidiophores, conidiogenous cells and conidia. Scale bars = 10 μm.

**Fig. 65.** *Ramularia trollii* (CBS 109118). A−E. Observations from herbarium material. F−G. Structures formed in culture. A. Leaf spot symptoms on the host. B, C, E. Conidiophores and conidia. D, F, G. Conidia. Scale bars = 10 μm.

*Notes*: See Videira *et al.* (2015b). The phylogenetic analyses places all the representatives of this species in one clade (Fig. 2, clade 86) closely related to *R. vizellae*.

***Ramularia uredinicola*** Khodap. & U. Braun, Mycotaxon 91: 358. 2005.

*Specimens examined*: **Iran**, Guilan Prov., on *Melampsora* sp. on *Salix babylonica*, 3 Jul 2004, S.A. Khodaparast (**holotype** IRAN 12316 F, isotype CBS H-22531, culture ex-type CBS 141120 = CPC 11852). **Italy**, Roma, on leaf *Melampsora* sp. on *Populus* sp., unknown collector and date, isol. and dep. G. Magnani, Mar. 1968, culture CBS 179.68. **South Korea**, Hoengseong, on *Melampsora* sp. on *Salix* sp., 21 Aug. 2004, H.D. Shin, culture CPC 11481, CPC 11482; Hoengseong, on *Melampsora* sp. on *Salix gracilistyla*, 22 Jun. 2006, H.D. Shin & M.J. Park, culture CBS 131769 = KACC 42535; Hongcheon, on

*Melampsora* sp. on *Populus alba* × *glandulosa*, 18 Oct. 2009, H.D. Shin & M.J. Park, culture CBS 131770 = KACC 44864; Hongcheon, on *Melampsora* sp. on *Salix pierotii* (= *S. koreensis*), 26 Oct. 2008, H.D. Shin & M.J. Park, culture CBS 131771 = KACC 44215; Suwon, on *Melampsora* sp. on *Salix matsudana* cv. *Tortuosa*, 30 Oct. 2008, H.D. Shin, M.J. Park, culture CBS 131772 = KACC 44218.

*Substrate and distribution*: Hyperparasite of *Melampsora* sp.; Asia (Iran, South Korea), Europe (Italy).

*Notes*: *Ramularia uredinicola* and *R. rosea* are closely related species (Khodaparast & Braun 2005) that form reddish or pink caespituli with age, probably due to the production of rubellins (Arnone *et al.* 1986, Miethbauer *et al.* 2003). However, they can be distinguished based on morphology and have different life-styles. *Ramularia uredinicola* is mycophylic and has longer and branched conidiophores, while *R. rosea* causes leaf spots on leaves. *Ramularia uredinis* is also mycophylic but the caespitulli do not turn reddish with age and the conidiophores are shorter and unbranched. *Ramularia coleosporii* and *R. uredinearum* are also mycophylic, but the caespitulli are always hyaline (Braun 1998, Khodaparast & Braun 2005). The strains used in this study from South Korea clustered in a highly supported clade (Fig. 2, clade 68, 1/100/100).

***Ramularia urticae*** Ces., in Rabenh., Herb. Viv. Mycol., Cent. XVII, no. 1680. 1852.

≡ *Cylindrospora urticae* (Ces.) J. Schröt., in Cohn, Krypt.-Fl. Schlesien 3.2(4): 492: 1897.
≡ *Septocylindrium urticae* (Ces.) Subram., Hyphomycetes: 310: 1971.
= *Sphaerella superflua* Fuckel, Jahrb. Nassauischen Vereins Naturk. 23–24: 102. 1870 (1869–1870).
≡ *Mycosphaerella superflua* (Fuckel) Petr., Ann. Mycol. 38: 235. 1940.

*Description in vivo*: See Braun (1998: 273).

*Specimens examined*: **Germany**, Weimar, Belvedere, leaf spot on *Urtica dioica*, 8 Oct. 1990, G. Arnold, culture CBS 162.91. **Italy**, Vercellis, on *Urtica dioica*, 1851, Cesati [Rabenh., Herb. Viv. Mycol. 1680; **lectotype**, designated in Braun (1998), in HAL]. **South Korea**, Hoengseong, on *Aconitum pseudo-laeve* var. *erectum*, 15 Oct. 2007, H.D. Shin, culture CPC 14807. **Sweden**, Uppland, Haga par., Årtopet, on *Urtica dioica*, 29 Sep. 1987, E. Gunnerbeck, culture CBS 113974. **Unknown country**, on unknown host, unknown collector and date, dep. P. Redaelli, Mar. 1926, culture CBS 105.26.

*Substrate and distribution*: On *Urtica* (*Urticaceae*); Asia Caucasus, Europe, N. America.

*Notes*: *Ramularia urticae* was originally described on *Urtica dioica* from Italy (lectotype in HAL). It has a broad geographical distribution but it is thus far only known from the host *Urtica*. Since the morphological characters of the strains CBS 105.26 and CPC 14807 were not observed, and they clustered close to strains of *R. urticae* in a well-supported clade (Fig. 2, clade 53, 1/94/91), they are tentatively considered as the same species. However, we refrain to expand the host range and geographical distribution of the species until further evidence is available.

***Ramularia valerianae*** (Speg.) Sacc. var. ***valerianae***, Fungi ital. Del., Tab. 1007. 1881.

*Basionym*: *Cylindrosporium valerianae* Speg., Michelia 1: 475. 1879.

= *Ramularia valerianae* var. *valerianae-montanae* Săvul. & Sandu, Hedwigia 73: 120. 1933.
= *Ramularia eamesii* Dearn & House, Bull. New York State Mus. Nat. Hist.. 233–234: 39. 1920.
= *Ramularia basarabica* Săvul. & Sandu, Hedwigia 73: 120. 1933.

*Description in vivo*: See Braun (1998: 276).

*Specimens examined*: **Austria**, Tirol, Ötztal, Horlachtal near Umhausen, forest near Stuibenfalle, on leaf spot on *Valeriana* sp., 3 Aug. 2000, G. Verkley, cultures CBS 109123, CBS 109122. **Italy**, Conegliano, on *Valeriana officinalis*, herb. Saccardo (**holotype** PAD).

*Substrate and distribution*: On *Valeriana* (*Valerianaceae*), Asia, Caucasus, Europe, N. America.

*Notes*: Two varieties of *R. valerianae* have been described thus far, *R. valerianae* var. *centranthi* (type on *Centranthus ruber*, France) and *R. valerianae* var. *valerianae* (on *Valeriana officinalis*, Italy, holotypus in PAD). They differ in the type of lesions they form on plant hosts that are angular-irregular, sometimes vein delimited, pale greenish to reddish brown in *R. valerianae* var. *valerianae* and subcircular to irregular, pale brown with greyish white centre and purple brown margins in *R. valerianae* var. *centranthi*. *Ramularia valerianae* var. *valerianae* also produces longer and wider conidia [(8–)10–50(–55) × (–1.5) 2–5.5(–7) µm] than *R. valerianae* var. *centranthi* [(6–)12–35 × 2–4 µm]. Strains of this species cluster in a highly supported clade (Fig. 2, clade 54, 1/100/100). Unfortunately these strains proved to be sterile in culture.

***Ramularia vallisumbrosae*** Cavara, Rev. Mycol. (Toulouse) 21: 101. 1899.

= *Ramularia narcissi* Chittenden, Gard. Chron. 39: 277. 1906.
= *Ramularia ucrainica* Petr., Ann. Mycol. 19 (1–2): 78. 1921.

*Description in vivo*: See Braun (1998: 48).

*Specimens examined*: **Italy**, Vallombrosa, Orto botanico, on *Narcissus* sp., 1899, Cavara [**lectotype**, designated in Braun (1998), PAD]. **UK**, Southwestern England, Cornwall, on *Narcissus* var. Victoria, unknown collector and date, isol. P.H. Gregory, dep. A. Beaumont, May 1938, culture CBS 271.38; Scilly Island, on *Narcissus* var. Golden Spur, unknown collector and date, isol. P.H. Gregory, Apr. 1938, dep. P.H. Gregory, Dec. 1938 (**epitype designated here** CBS H-22532, MBT204833, culture ex-epitype CBS 272.38).

*Substrate and distribution*: On *Leucojum*, *Narcissus*, and *Pancratium* (*Amaryllidaceae*); Europe, N. America.

*Notes*: *Ramularia vallisumbrosae* is the causal agent of white mould disease on leaves of daffodils (*Narcissus* cultivars) in commercial plantations in England and Scotland. The disease is not believed to be bulb-borne (Moore 1979), but poses a serious threat in these regions causing early defoliage die-down and associated reductions in bulb yield (O'Neill *et al.* 2002). This species formed a highly supported clade (Fig. 1, clade XIV; Fig. 2, clade 16, 1/100/100).

***Ramularia variabilis*** Fuckel, Jahrb. Nassauischen Vereins Naturk. 23–24: 361. 1870. Fig. 66.

≡ *Ovularia variabile* (Fuckel) E. Bommer & M. Rousseau, Bull. Soc. Roy. Bot. Belgique 23(1): 274. 1884.
≡ *Cylindrosporium variabilis* (Fuckel) J. Schröt., Krypt.-Fl. Schlesien 3.2(4): 490. 1897.
≡ *Entylomella variabilis* (Fuckel) Cif., Ann. Mycol. 26 (1–2): 17. 1928.
= *Sphaerella mariae* Sacc. & E. Bommer, Bull. Soc. Roy. Bot. Belgique 25(1): 173. 1886

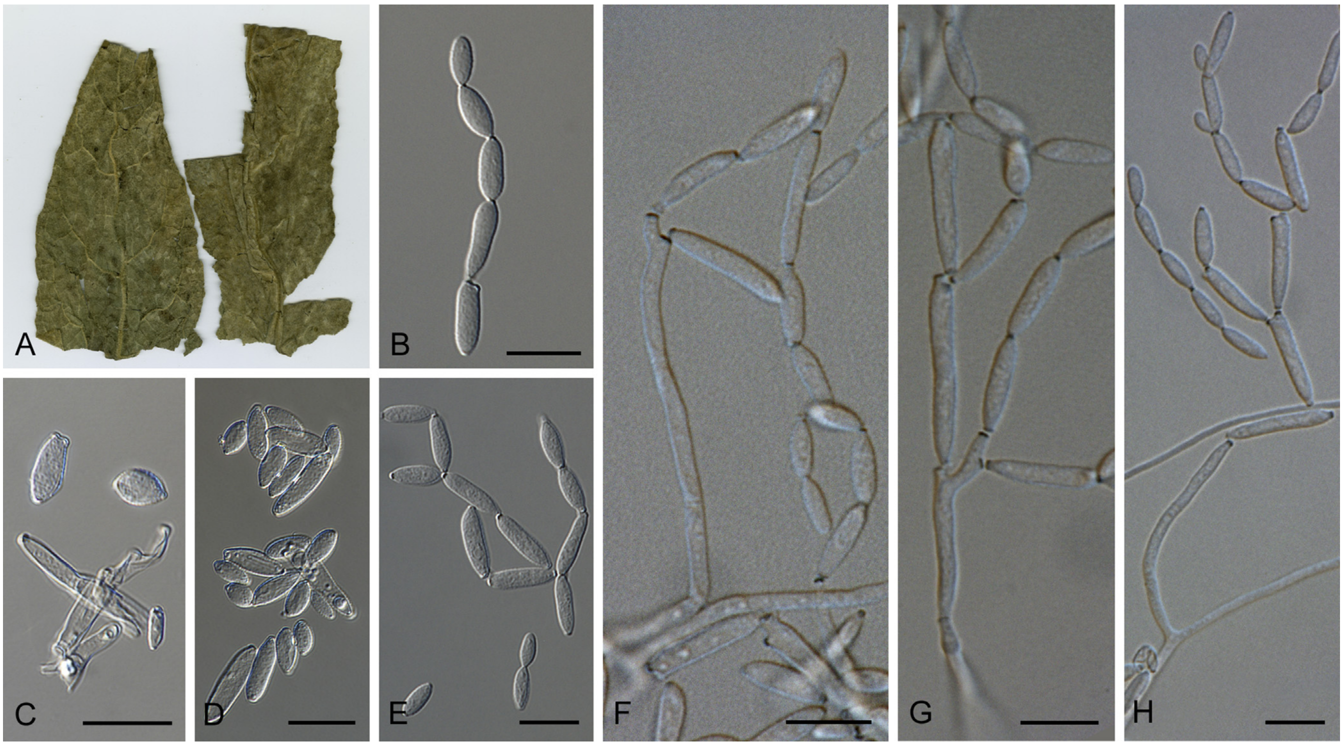

**Fig. 66.** *Ramularia variabilis* (CBS 141121). A, C, D. Observations from herbarium material. B, E–H. Structures formed in culture. A. Leaf spot symptoms on the host. B, D, E. Conidia. C, G. Conidiogenous cells and conidia. F, H. Conidiophores and conidia. Scale bars = 10 µm.

≡ *Mycosphaerella mariae* (Sacc. & E. Bommer) Lindau, Hilfsb. Sammeln Ascomyc.: 37. 1903.

*Mycelium* consisting of hyaline, septate, branched, smooth, 1–2 µm diam hyphae. *Conidiophores* hyaline, thin-walled, smooth, erect, 1–2-septate, cylindrical-oblong, straight to sinuous, unbranched, (10–)26.5–35(–54) × (1–)1.5–2(–3) µm, or reduced to conidiogenous cells. *Conidiogenous cells* terminal in conidiophores or intermediate in the mycelium, cylindrical-oblong, (5.5–)14.5–19(–29) × 1.5–2(–3) µm, with 1–3 conidiogenous loci almost flat to cylindrical-protuberant, thickened, darkened and refractive. *Conidia* hyaline, thin-walled, smooth to slightly verruculose, catenate, with hila thickened, darkened and refractive. *Ramoconidia* fusiform, (9.5–)14–17(–26.5) × (1.5–)2–2.5(–3) µm, 0–1-septate, with 2–3 apical hila. *Intercalary conidia* fusiform to oval, aseptate, (8–)11–13(–19.5) × (1.5–)2(–3) µm, in branched chains of up to five conidia. *Terminal conidia* obovoid, aseptate, (5–)7–8(–11) × (1.5–)2(–2.5) µm (on SNA).

*Culture characteristics*: On MEA, 11 mm diam, surface raised, folded, with sparse aerial mycelium, smooth, rosy-buff, with margins crenate and convex, colony reverse cinnamon with olivaceous grey patches; on OA, 9 mm diam, surface smooth, low convex, white with pale olivaceous grey tinge, with margins undulate, colony reverse fawn; on PDA, 10 mm diam, surface low convex, pale olivaceous grey, smooth, producing tiny transparent exudate droplets, with margins lobate, colony reverse olivaceous grey with a buff margin.

*Description in vivo*: See Braun (1998: 263).

*Specimens examined*: **Austria**, Graz, on *Verbascum* sp., Oct. 2012, C. Scheuer (**epitype designated here** CBS H-22533, MBT204834, culture ex-epitype CBS 141121 = CPC 25967). **Canada**, Stittsville, Ontario, on *Verbascum* sp., K.A. Seifert, 12 Jul. 2009, cultures CPC 16865, CPC 16866. **Germany**, on *Verbascum thapsus* [Fuckel, Fungi Rhen. Exs. 135; **lectotype**, designated in Braun (1998), in HAL].

*Substrate and distribution*: On *Digitalis*, *Verbascum* (*Scrophulariaceae*); Asia, Caucasus, Europe, N. America.

*Notes*: *Ramularia variabilis* has a broad geographical distribution and has been reported to infect plants from the genera *Digitalis* and *Verbascum*. In this study, the strains isolated from *Digitalis* and *Verbascum* were separated into distinct clades (Fig. 2), namely clades 50 and 58, respectively, clearly suggesting that two different species are involved (see *Ramularia digitalis-ambiguae*). Strain CPC 25967 was isolated from the same host and from a neighbouring country as the type, and is morphologically a good representative of this species (Fig. 66). All three phylogenetic methods applied to this dataset gave high support to this clade (Fig. 2, clade 50, 1/100/100). This species has been experimentally linked to the sexual morph *Mycosphaerella mariae* (Sacc. & Bommer) Lindau (von Arx 1949; Videira *et al.* 2015b).

***Ramularia veronicicola*** Videira & Crous, **nom. nov.** MycoBank MB817161.

*Basionym*: *Stysanus veronicae* Pass., Hedwigia 16(6): 123. 1877 (1876), non *Ramularia veronicae* Fuckel, 1870.

≡ *Isariopsis veronicae* (Pass.) Savile, Canad. J. Bot. 46: 465. 1968.
≡ *Phacellium veronicae* (Pass.) U. Braun, Nova Hedwigia 50: 511. 1990.

*Description in vivo*: See Braun (1998: 337).

*Specimens examined*: **Italy**, Parma, botanical garden, on *Veronica longifolia*, 1875/76, Passerini [Rabenh., Fungi Eur. Exs. 2268; **lectotype**, designated in Braun (1998), HAL]. **Sweden**, Uppland, Danmark par., Bergsbrunna, on *Veronica spicata*, 25 Sep. 1987, E. Gunnerbeck, culture CBS 113981.

*Substrate and distribution*: On *Veronica* (*Scrophulariaceae*); Europe, N. America.

*Notes*: Previously named *Phacellium veronicae*, this species was originally isolated on *Veronica longifolia* from Italy (lectotype in HAL). Based on phylogenetic analyses in this study, strain CBS 113981 clustered within the *Ramularia* clade (Fig. 1, clade XIV) and formed a single lineage (Fig. 2, clade 64) in the multigene phylogeny. Since *Phacellium* is now considered a synonym of *Ramularia*, a new combination is proposed. Because the epithet "*veronicae*" is already occupied in *Ramularia* for a different species (Fig. 2, clade 64) the new epithet "*veroniciola*" is introduced. *Ramularia veroniciola* is the causative agent of leaf spot disease on *Veronica* species that are perennial plants used as ornamentals. The pathogen causes brown roundish spots and develops conidiophores aggregated in synnemata. This species has been observed in several European countries and also in North America (Canada) (Braun 1998). It has recently been reported from China infecting *V. sibirica* and, although the disease incidence was low, it may become significant with the increase of the cultivated area (Bai *et al.* 2013; ITS sequence GenBank HE995799). During recent field surveys in Hungary, the disease incidence affecting *V. spicata* and *V. spuria* varied between 90–100 %, and reached a severity between 30–60 % (Horvát *et al.* 2015; ITS sequences GenBank HQ690097 and JQ920427). The ITS sequence of the isolate CBS 113981 is identical to GenBank JQ920427, and differs from GenBank HQ690097 in 1 nucleotide and from GenBank HE995799 in 10 nucleotides. Unfortunately this strain did not sporulate in culture, and the corresponding herbarium specimen was not preserved.

***Ramularia vizellae*** Crous, Persoonia 27: 37. 2011.

*Specimens examined*: **Netherlands**, Gelderland, Randwijk, on dead leaf litter from *Malus* sp., unknown collector and date, isol. G. Verkley, 26 Jun 2004, cultures CBS 115981, CBS 115982; Utrecht, Rhijnawen forest, on fruit scales of *Carpinus betulus*, 25 Apr. 2005, G. Verkley, culture CBS 117798; Utrecht Prov., Baarn, Park Groeneveld, on decaying leaves of *Quercus rubra*, collection date unknown, G. Verkley, culture CBS 117871; Utrecht Prov., Baarn, Park Kasteel Groeneveld, on *Amelanchier lamarckii*, 26 Apr. 2004, G. Verkley, culture CBS 117872. **South Africa**, Western Cape Prov., Hermanus Fernkloof Nature Reserve, on leaves of *Protea* sp., in association with *Vizella interupta*, 2 May 2010, P.W. Crous (**holotype** CBS H-20679, culture ex-type CBS 130601 = CPC 18283).

*Substrate and distribution*: On *Lotus*, *Phaseolus* (*Fabaceae*), *Acer*, *Aesculus* (*Sapindaceae*), *Protea* (*Proteaceae*), *Carpinus*, *Corylus* (*Betulaceae*), *Fagus*, *Quercus* (*Fagaceae*), *Amelanchier*, *Malus* (*Rosaceae*), *Brassica* (*Brassicaceae*), and *Tilia* spp. (*Malvaceae*); Europe (France, Germany, Netherlands, Switzerland, Germany), South Africa.

*Notes*: See Videira *et al.* (2015b). The phylogenetic analyses provide high support to this species clade (Fig. 2, clade 85, 1/100/99).

***Ramularia weberiana*** Videira & Crous, **sp. nov.** MycoBank MB817162.

*Etymology*: Named after the depositor of the strain, A. Weber.

Culture sterile. *Ramularia weberiana* (Fig. 2, clade 25), differs from its closest phylogenetic neighbour, *R. rumicicola* (Fig. 2, clade 24), by unique allelles in five loci based on alignments of the separate loci deposited in TreeBASE as Study S19315: *rpb2* positions 15(C), 57(G), 63(C), 102(A), 117(G), 196(C), 228(C), 249(T), 267(A), 327(C), 330(G), 348(T), 357(T), 358(C), 378(T), 402(T), 414(T), 435(C), 445(T), 459(T), 493(A), 519(A), 531(T), 588(T), 591(C), 594(T), 606(T), 615(T), 627(G), 633(C), 636(C), 654(G), 657(G); ITS positions 33(G), 47(A), 167(T); *actA* positions 83(T), 96(C), 98(T), 121(A), 164(A), 166(A), 185(T), 186(C), 211(C), 212(C); *gapdh* positions 14(A), 29 deletion (C), 38(G), 39(T), 43(A), 45(C), 120(T), 131(A), 132(T), 158(T), 167(T), 185(C), 208(C), 257(A), 258(T), 259(A), 260(C), 262(A), 281(T), 286(G), 287(T), 289(T), 291(A), 293–295 insertion (CCA), 315(A), 347(T), 380(T), 431(C), 438(T), 440(T), 446(T), 479(C), 524(C), 572(C), 593(T); *tef1*-α positions 8(T), 15(T), 17(C), 18(T), 48(C), 56(T), 59(T), 145(C), 196(C), 233(G), 248(C), 284(C), 286(T), 289(T), 290(T), 294(A), 295(C), 296(T), 401(C), 409(A), 425(T), 430(A), 578(T).

*Specimen examined*: **Unknown country**, on unknown host, unknown collector and date, isol. and dep. by A. Weber, Aug. 1923 (**holotype** CBS H-22534, culture ex-type CBS 136.23).

*Notes*: The strain in this clade represents a new species that is clearly distinct from other species based on the phylogenetic analyses (Fig. 2, clade 25). Unfortunately this strain did not sporulate in culture and a comparison with the descriptions available in literature was not possible.

***Ramularia weigelae*** Speg. (as *weigeliae*), Michelia 1(5): 475. 1879. Fig. 67.

≡ *Phaeoramularia weigelicola* H.D. Shin & U. Braun, Mycotaxon 58: 163. 1996.

≡ *Passalora weigelicola* (H.D. Shin & U. Braun) U. Braun & Crous, Mycosphaerella and its anamorphs: 1. Names published in Cercospora and Passalora: 475. 2003.

*Description in vivo*: See Braun (1998: 389).

*Specimen examined*: **South Korea**, on *Weigela subsessilis*, 4 Jun. 2003, H.D. Shin, KUS-F19549, culture CBS 113309.

*Substrate and distribution*: On *Weigela* (*Diervillaceae*); Asia, Europe.

*Notes*: *Ramularia weigelae* was originally described on *Weigela florida* from Italy (holotype). Braun (1998) stated that the type material of *R. weigelae* is probably not preserved but a specimen collected from South Korea corresponded to the description of the species. Since the conidiophores were pigmented, the species was transferred to *Phaeoramularia* as *P. weigelicola*. However, isolate CBS 113309 (Fig. 67), previously identified as *Phaeoramularia weigelicola*, clustered within the genus *Ramularia* (Fig. 1, clade XIV). The strain was not used in the multigene analysis since it lacked the *rpb2* partial gene sequence at the time the tree was run.

## Important phytopathogenic *Ramularia* species lacking cultures in this study

***Ramularia cercosporelloides*** U. Braun & Crous, Monogr. *Cercosporella*, *Ramularia* Allied Genera (Phytopath. Hyphom.) 2: 419. 1998.

≡ *Cercosporella carthami* Murashk., Izv. Zapadno-Sibirsk. Otd. Russk. Geogr. Obshch 5: 4. 1926.

*Description in vivo*: See Braun (1998: 419).

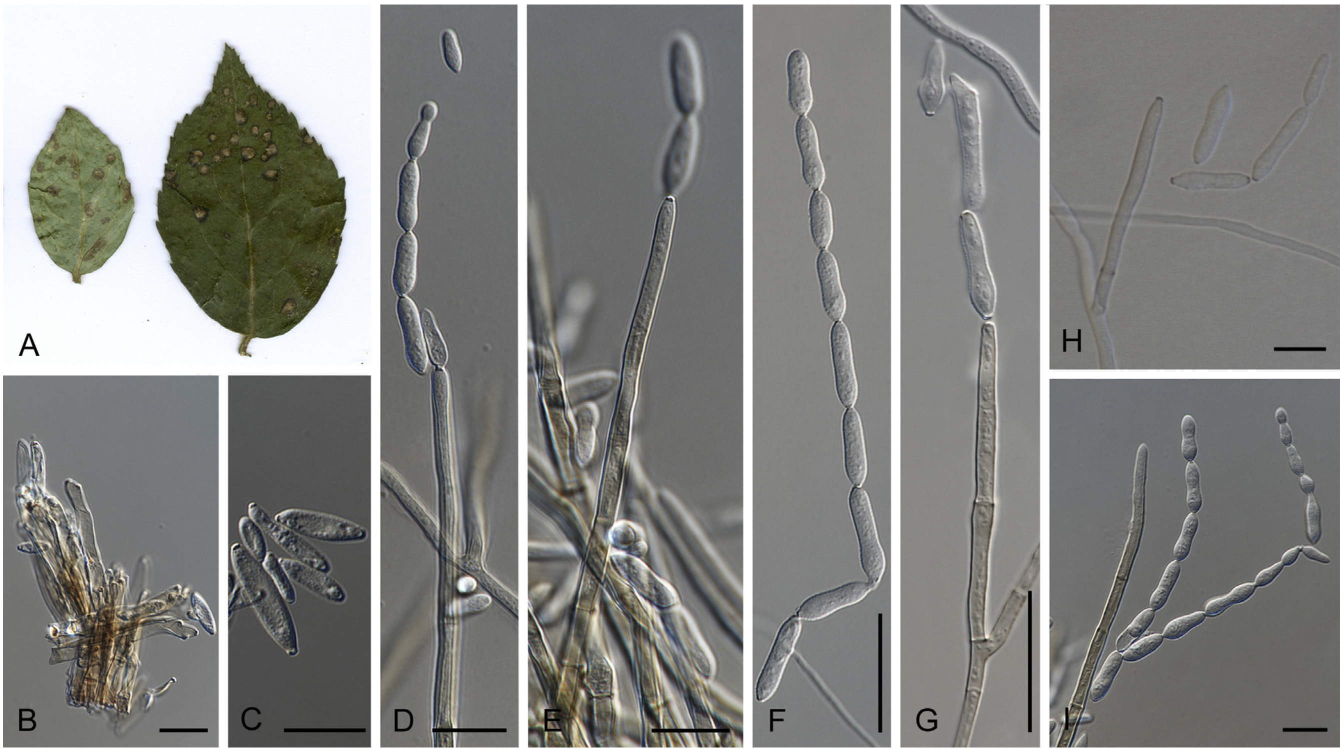

**Fig. 67.** *Ramularia weigelae* (CBS 113309). A–C. Observations from herbarium material. D–I. Structures formed in culture. A. Leaf spot symptoms on the host. B, D, E, G–I. Conidiophores and conidia. C, F. Conidia. Scale bars = 10 µm.

*Substrate and distribution*: On *Carthamus* (*Asteraceae*), Asia, Caucasus, Europe.

*Notes*: The type material of this species, on *Carthamus tinctorius* from Russia (near Omsk), could not be traced by Braun (1998) and the placement of the species in the genus *Ramularia* was based on the observation of a fresh specimen from the Netherlands on *Carthamus tinctorius* that is currently deposited in HAL. Some studies point to this pathogen as the causative agent of leaf spot disease on safflower in Sonora, Mexico, leading to severe yield losses on this crop. Morphological identification followed by pathogenicity tests of the isolates was performed by Huerta-Espino *et al.* (2006). However, in a more recent study (Quintana-Obregón *et al.*, 2013), isolates of the false mildew of safflower collected from the field were morphologically identified as *R. cercosporelloides* but, based on DNA sequences of the LSU and ITS regions, they were similar to *Cercosporella acroptili* (= *Ramularia acroptili*). Other studies point to *R. carthami* (now *R. cynarae*) as the causative agent (Montoya-Coronado *et al.* 2008, Borbon-Garcia *et al.* 2011). More work needs to be done to understand which fungus is causing the disease.

***Ramularia oryzae*** Deighton & D.E. Shaw, Trans. Brit. Mycol. Soc. 43: 516. 1960.

≡ *Mycovellosiella oryzae* (Deighton & D.E. Shaw) Deighton, Mycol. Pap. 144: 25. 1979.

*Description in vivo*: See Braun (1998: 201).

*Substrate and distribution*: On *Oryza* (*Poaceae*); Asia and Africa.

*Notes*: *Ramularia oryzae* was described on *Oryza sativa* from Papua New Guinea [holotype in K(IMI)] and has been reported from Asia and Africa (Braun 1998). White leaf streak, caused by *Mycovellosiella oryzae* (= *Ramularia oryzae*) was observed in Louisiana, USA, in 1996, developing on leaves of the rice cultivar Lemont. Pathogenicity tests were performed on the rice cultivars Lemont and Cypress by spraying a conidial suspension onto leaves at boot stage. Many elongated lesions were produced 3–4 wk after inoculation. With the same method, 45 other cultivars were tested. Most of the cultivars grown in southern US were moderately susceptible to susceptible. Foreign cultivars tested (BR-7, BR-11, Cica-4, Cica-7 to Cica-9, Oryzica llanos, Rax clear, Tequing, and Tetep) were resistant. As symptoms of both white leaf streak and narrow brown leaf spot were observed on the same leaf it is possible that the disease was present but not identified separately because of the similarity of the symptoms of the two diseases. At present it appears to be a minor problem for rice cultivation in Louisiana. White leaf streak has previously been reported from Papua New Guinea on cultivated *Oryza sativa*, and from the Solomon Islands, Sabah, Nigeria, and Sierra Leone on cultivated *O. glabberima*, and on wild perennial rice *O. berthii* (Webster & Gunnell 1992, Shahjahan *et al.* 1998, Zhou *et al.* 2010).

***Ramularia phaseoli*** (O.A. Drumm.) Deighton, Trans. Brit. Mycol. Soc. 50: 125. 1967.

*Basionym*: *Ovularia phaseoli* O.A. Drumm., Revista Ceres 6(33): 169. 1945.

≡ *Mycovellosiella phaseoli* (O.A. Drumm.) Deighton, Mycol. Pap. 137: 70. 1974.

= *Ramularia phaseolina* Petr., Sydowia 4(1–6): 584. 1950.

*Description in vivo*: See Braun (1998: 128).

*Substrate and distribution*: Asia, Africa, S. America on *Glycine* and *Phaseolus* (*Fabaceae*).

*Notes*: *Ramularia phaseoli* is a pathogen that was first observed on *Phaseolus vulgaris* from Brazil (lectotype in CUP). This species is the causative agent of floury leaf spot disease on leaves of dry beans. Leaf spots usually appear first on older leaves, progresses to new foliage, and a severe infection may cause plant defoliation. Conidiophores and conidia develop mostly on the lower surface of the leaf in white, floury mats. It is among the more serious diseases of common bean at relatively high altitudes in the tropics and has been reported from Eastern and Central Africa, Europe, Malaysia, Papua New Guinea, South and Central America. It is usually controlled with chemical sprays with benomyl and thiophanate methyl and by rotation with non-host crops such as cereals and corn (Schwartz *et al.* 2005).

***Ramularia primulae*** Thüm., Oesterr. Bot. Z. 28(5): 147. 1878.

≡ *Cylindrosporium primulae* (Thüm.) J. Schröt., Krypt.-Fl. Schlesien 3.2(4): 492. 1897.

*Description in vivo*: See Braun (1998: 228).

*Substrate and distribution*: On *Primula* (*Primulaceae*); Asia, Caucasus, Europe, N. and S. America, Australia, New Zealand.

*Notes*: *Ramularia primulae* was originally described on *Primula elatior* from Germany (neotype in PAD), but it has a worldwide distribution and has been reported infecting other species of the genus *Primula* (Braun 1998). This species is responsible for the Ramularia leaf spot disease on *Primula* spp. It is able to infect both *Primula* × *pruhonicensis* (polyanthus) and *P. malacoides* (fairy primrose) leaves creating tan or brown leaf spots that may be accompanied by chlorosis. Conidiophores and conidia develop preferentially on the lower surface of lesions forming white spore masses under humid conditions. It is a disease mainly prevalent in the USA, but easily controlled by removing infected plants from the general population and keeping the seedlings away from older plants to avoid inoculum transfer (Daughtrey *et al.* 1995).

## DISCUSSION

The genera covered in the present study include species with very diverse lifestyles that sometimes have a negative impact on the crops we depend on for food, feed and bioenergy. Although some species may cause significant yield losses, none of them are included in plant protection quarantine lists. The identification of species of *Ramularia* and allied genera has thus far mainly relied on host taxonomy and morphological characters such as the shape, size and septation of conidia and the type of conidiogenous loci and conidial hila. Reliable identification of these species based on morphological characters alone is difficult since their morphology is rather reduced. In order to improve the identification of cryptic species, the use of DNA phylogenetic markers, also known as DNA barcoding, is becoming an increasingly popular tool (Crous *et al.* 2009b, 2013, Groenewald *et al.* 2013, Verkley *et al.* 2013).

The present study provides a broad phylogenetic overview of *Ramularia* and allied genera, thereby establishing a foundation of reference sequences in public databases that can be used for species identification, and at the same time promote further research. The phylogenetic analysis of *Ramularia* allied genera generally provided good resolution with maximum to high bootstrap and posterior probability values for almost all terminal nodes and several of the deeper nodes. Phylogenetic support based on three different methods facilitated the resolution of several genera based on their type species, such as *Ramularia* and *Ramulariopsis*. The genus *Ramularia* proved to be polyphyletic, and not monophyletic as previously thought, and the species non-congeneric with the type *R. pusilla* were assigned to the new genera *Xenoramularia*, *Epicoleosporium* and *Teratoramularia*. This was also the first time species with a ramularia-like morphology were observed in the *Teratosphaeriaceae*, which renders morphology-based identifications more difficult, and underlines the necessity of molecular data for accurate identification. The genus *Cercosporella*, although not epitypified, was analysed in two different studies (Kirschner 2009; present study), and based on its phylogenetic position and morphology, is considered to be reliably represented by the species used in this study. The phylogenetic position of *Pseudocercosporella* was reiterated as confined to its type species, *P. bakeri*, and the pseudocercosporella-like species not congeneric with the type were reassigned to new or existing genera such as *Apseudocercosporella*, *Filiella*, *Microcyclosporella*, *Neopseudocercosporella*, *Pseudocercospora*, *Ramularia* and *Sphaerulina*. An isolate previously identified as representative of *Pseudocercosporella fraxinea* was found to belong to the genus *Acrodontium*, typified by *A. crateriforme*, which prompted a short review of this genus, with the eventual description of three new species.

Although many more genera allied to *Ramularia* are treated in literature, most have not yet been preserved in culture, such as *Hawksworthiana*, *Neoovularia*, *Neoramularia*, *Monodidymaria*, *Pseudodidymaria* and *Tretovularia*. These genera need to be recollected, cultured and compared by means of DNA sequence analysis. In order to facilitate their identification, photoplates of their type specimens or representative species were produced in this study. The relationship between these genera and *Ramularia* is based on morphological characters but their phylogenetic position is still unknown and they may even not belong to the *Mycosphaerellaceae*. One example of this relates to the genus *Thedgonia* that was morphologically related to *Pseudocercosporella*, and later found to belong to *Helotiales* (Crous *et al.* 2013). *Ramularia* and allied genera are much undersampled and are frequently described without culture or DNA sequence data. In the last 15 years, among the 41 novel *Ramularia* names released on MycoBank, only 13 included cultures and DNA sequence data while the rest relied only on morphological descriptions based on herbarium specimens.

The present study includes the largest number of *Ramularia* isolates and species ever subjected to DNA sequence analysis. Combined with a recent classic monograph of the genus (Braun 1998), it provides powerful tools to better understand and promote further research on these species. The phylogenetic overview of the species belonging to *Ramularia* generally provided good resolution with maximum to high bootstrap and posterior probability values for almost all terminal nodes, while several of the deeper nodes were only supported by the Bayesian analysis. Several species were morphologically and molecularly characterised, two new combinations and two new names were proposed, nine new species were described, and 12 species epitypified. The type species of *Ramularia*, *R. pusilla*, was epitypified providing a reliable phylogenetic anchor for this genus. The *Ramularia* species analysed in this study generally agree with the concept presented in literature (Braun 1998), which regards them as being host-specific. Of the 88 taxa subjected to analysis 39 were found to occur in only one host genus, a number that rises to 60 when the single lineages are also considered. With the phylogeny we observed that some species previously thought to have a broad host range and geographical distribution were in fact different species (e.g. *R. lamii* var. *lamii*, *R. agastaches*, *R. leonuri*). While some species are reported to have a broad host range in literature (Braun 1998), this was not observed in the phylogeny, which could be due to undersampling (e.g. *R. asteris*, *R. belunensis*, *R. collo-cygni*, *R. grevilleana*, *R. heraclei*, *R. inaequalis*, *R. macrospora*, *R. pusilla* and *R. sphaeroidea*). Only six of the 88 taxa analysed proved to have a broad host range (e.g. *R. cynarae*, *R. hydrangeae-macrophyllae*, *R. vizellae*, *R. unterseheri*, *R. glennii* and *R. eucalypti*). The clades representing *R. hydrangeae-macrophyllae*, *R. vizellae*, *R. endophylla*, *R. unterseheri* and *R. cynarae* show some intraspecific variation in the genes investigated. Among these, only *R. cynarae* has not been observed to develop a sexual morph. Although in literature 20 connections between asexual and sexual morphs are reported for *Ramularia* species alone, only seven have been proven thus far, including the newly observed *R. hydrangeae-macrophyllae*. Sexual reproduction is known to introduce variability in the genes and this may explain the variation observed.

The gene regions used in this study were selected based on their extensive use in fungal phylogenetic studies. They have proved suitable to explore phylogenetic relationships within and between genera of the *Mycosphaerellaceae* (Crous *et al.* 2013, Groenewald *et al.* 2013, Verkley *et al.* 2013). Based on the individual genes, ITS was able to discriminate 58 % of the species while *tef1*-α recognised 62 %, *actA* 72%, *gapdh* 76 % and *rpb2* 84 %. The K2P results show that the ITS barcode has a lower ability to discriminate species than protein-coding genes, since it displayed the smallest barcode gap and highest overlap percentage of inter-intra specific distances among all genes. The *gapdh*, with its big barcode gap and low overlap would be a good candidate for a secondary barcode gene, but its amplification proved to be challenging. The *rpb2* gene displayed the widest barcode gap of all genes, but it had a relatively higher overlap percentage when compared to the other genes. Nevertheless, it was able to discriminate 84 % of the *Ramularia* species studied here, and the amplification of *rpb2* with the primers developed in this study was successful for all the isolates. The best statistical support for each genus was obtained using *rpb2*, therefore this locus should in future be more extensively used to determine relations within *Mycosphaerellaceae*. A recent publication on fungal barcoding genes recommends *tef1*-α as a secondary universal DNA barcode for the fungal kingdom (Stielow *et al.* 2015). However, the fragment amplified by the primers used in that study is different from the fragment amplified in this study, and therefore cannot be compared directly.

Genomic studies of *Ramularia* species are presently unavailable but the amplification of the complete genome of two *Ramularia* species, *R. endophylla* (Grigoriev *et al.* 2013) and *R. collo-cygni* (Havis *et al.* 2015), are underway. They are likely to provide valuable insights into the genetic diversity of these species, their biological cycles and their hability to produce secondary metabolites that influence pathogenesis. *Ramularia collo-cygni*, *R. rubella* and *R. uredinicola* are able to produce a non-host specific phytotoxin, rubellin. They appear quite separate in the phylogenetic analysis suggesting this is a trait that evolved multiple times and is not confined to a single lineage. In this study, the species *R. archangelicae* and *R. calcea* have been observed to produce pigments of pink and brick colours, respectively, that diffused into the culture media, suggesting these species may also be able to produce rubellins. Besides the rubellins, no other secondary metabolites have been attributed to *Ramularia* and allied genera species, which indicates this is a fairly unexplored research line in this group of agricultural important species.

The present study includes several taxa that are of major concern for agriculture such as *Neopseudocercosporella capsellae* and *N. brassicicola* (*Brassica* spp.), *Ramulariopsis gossypii* (cotton), *Ramularia collo-cygni* (barley) and *Ramularia beticola* (sugar beet), since they affect important crops planted worldwide. We believe that this study serves as a backbone for future studies on the taxonomy of *Ramularia* and allied genera. Although many important species have been reliably identified and epitypified, many puzzles remain unsolved (e.g. the identity of *R. cercosporelloides*). More than 1000 names are known in *Ramularia* alone and this study covered only 88 taxa, which means many species still need to be recollected and characterised based on their DNA sequence data. With the reference cultures that this study has now made available to the community, further genomic research on the more important agricultural pathogens may shed some light on the mechanisms driving their evolution, and allow the development of more appropriate control measures.

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## REFERENCES

Arnone A, Camarda L, Nasini G, *et al.* (1986). Secondary mould metabolites Part 15, Structure elucidation of rubellins A and B, two novel anthraquinone metabolites from *Mycosphaerella rubella*. *Journal of the Chemical Society Perkin Transactions* **1**: 255–260.

Aptroot A (2006). *Mycosphaerella and its anamorphs 2. Conspectus of Mycosphaerella*. In: *CBS Biodiversity Series*, **5**. CBS-KNAW Fungal Biodiversity Centre, Utrecht, The Netherlands: 1–231.

Arx von JA (1949). Beiträge zur Kenntnis der Gattung Mycosphaerella. *Sydowia* **3**: 28–100.

Arx von JA (1983). Mycosphaerella and its anamorphs. *Proceedings van de Koninklijke Nederlandse Akademie van Wetenschappen Section C* **86**: 15–54.

Arzanlou M, Groenewald JZ, Gams W, *et al.* (2007). Phylogenetic and morphotaxonomic revision of *Ramichloridium* and allied genera. *Studies in Mycology* **58**: 57–93.

Bai QR, Han S, Xie YY, *et al.* (2013). *Veronica sibirica* leaf spots caused by *Phacellium veronicae*, a new disease in China. *Plant Disease* **97**(12): 1662.

Baker KF, Dimock AW, Davis LH (1950). *Ramularia cyclaminicola* Trel., the cause of Cyclamen stunt disease. *Phytopathology* **40**: 1027–1034.

Bakshi M, Arzanlou M, Babai-Ahari A, *et al.* (2015a). Is morphology in *Cercospora* a reliable reflection of generic affinity? *Phytotaxa* **213**: 22–34.

Bakshi M, Arzanlou M, Babai-Ahari A, *et al.* (2015b). Application of the consolidated species concept to *Cercospora* spp. from Iran. *Persoonia* **34**: 65–86.

Barnes I, Crous PW, Wingfield BD, *et al.* (2004). Multigene phylogenies reveal that red band needle blight of *Pinus* is caused by two distinct species of *Dothistroma*, *D. septosporum* and *D. pini*. *Studies in Mycology* **50**: 551–565.

Batzer JC, Gleason ML, Harrington TC, *et al.* (2005). Expansion of the sooty blotch and flyspeck complex on apples based on analysis of ribosomal DNA gene sequences and morphology. *Mycologia* **97**(6): 1268–1286.

Bensch K, Braun U, Groenewald JZ, *et al.* (2012). The genus *Cladosporium*. *Studies in Mycology* **72**: 1–401.

Berbee ML, Pirseyedi M, Hubbard S (1999). *Cochliobolus* phylogenetics and the origin of known, highly virulent pathogens, inferred from ITS and glyceraldehyde-3-phosphate dehydrogenase gene sequences. *Mycologia* **91**: 964–977.

Berner DK, Eskandari FM, Braun U, *et al.* (2005). *Cercosporella acroptili* and *Cercosporella centaureicola* sp. nov. – potential biological control agents of Russian knapweed and yellow starthistle, respectively. *Mycologia* **97**: 1122–1128.

Blomquist CL, Warfield CY (2011). First report of *Ramularia didyma* causing a leaf spot on *Ranunculus* (*Ranunculus asiaticus*) hybrids in California. *Plant Disease* **95**: 872.

Boerema GH, van Kesteren HA (1964). The nomenclature of two fungi parasitizing *Brassica*. *Persoonia* **3**: 17–28.

Bonorden HF (1861). *Fungi europaei exsiccati*. Klotzschii herbarii vivi mycologici continuatio, Editatio nova. Series secunda, Centuria: no. 288.

Borbon-Garcia A, Ochoa-Espinoza XM, Montoya-Coronado L, *et al.* (2011). CIANO-LIN: nueva variedad de cártamo linoléica. *Revista Mexicana de Ciencias Agrícolas* **2**: 791–794.

Braun U (1988). Studies on *Ramularia* and allied genera (I). *International Journal of Mycology and Lichenology* **3**: 271–285.

Braun U (1990). Taxonomic problems of the *Ramularia*/*Cercosporella* complex. *Studies in Mycology* **32**: 65–75.

Braun U (1991). Studies on *Ramularia* and allied genera (IV). *Nova Hedwigia* **53**: 291–305.

Braun U (1992). Studies on *Ramularia* and allied genera (V). *Nova Hedwigia* **54**: 459–478.

Braun U (1993). Studies on *Ramularia* and allied genera (VI). *Nova Hedwigia* **56**: 423–454.

Braun U (1995). *A monograph of Cercosporella, Ramularia and allied genera (phytopathogenic hyphomycetes)*: **Vol. 1**. IHW-Verlag, Eching, Munich, Germany.

Braun U (1998). *A monograph of Cercosporella, Ramularia and allied genera (phytopathogenic hyphomycetes)*: **Vol. 2**. IHW-Verlag, Eching, Munich, Germany.

Braun U, Hill CF (2002). Some new micromycetes from New Zealand. *Mycological Progress* **1**(1): 19–30.

Braun U, Hill CF (2008). New species and new records of foliicolous hyphomycetes from New Zealand. *Australasian Mycologist* **27**(2): 45–56.

Braun U, Hill CF, Schubert K (2006). New species and new records of biotrophic micromycetes from Australia, Fiji, New Zealand and Thailand. *Fungal Diversity* **22**: 13–35.

Braun U, Crous PW (2006). (1732) Proposal to conserve the name *Pseudocercospora* against *Stigmina* and *Phaeoisariopsis* (*Hyphomycetes*). *Taxon* **55**: 803.

Braun U, Crous PW, Nakashima C (2015). Cercosporoid fungi (*Mycosphaerellaceae*) 4. Species on dicots (*Acanthaceae* to *Amaranthaceae*). *IMA Fungus* **6**: 373–469.

Braun U, Pennycook SR (2003). Nomenclature and typification of *Ramularia grevilleana*. *Mycotaxon* **88**: 49–52.

Carbone I, Kohn LM (1999). A method for designing primer sets for speciation studies in filamentous ascomycetes. *Mycologia* **91**: 553–556.

Cromey MG, Harvey IC, Sheridan EJ, *et al.* (2004). Occurrence, importance and control of *Ramularia collo-cygni* in New Zealand. In: *Proceedings of the Second International Workshop on Barley Leaf Blights* (Yahyaoui AH, Brader L, Tekauz A, Wallwork H, Steffenson B, eds). ICARDA, Aleppo, Syria: 337–342.

Crous PW (1998). *Mycosphaerella* spp. and their anamorphs associated with leaf spot diseases of *Eucalyptus*. *Mycologia Memoir* **21**: 1–170.

Crous PW (2009). Taxonomy and phylogeny of the genus *Mycosphaerella* and its anamorphs. *Fungal Diversity* **38**: 1–24.

Crous PW, Aptroot A, Kang JC, *et al.* (2000). The genus *Mycosphaerella* and its anamorphs. *Studies in Mycology* **45**: 107–121.

Crous PW, Braun U (2003). *Mycosphaerella and its anamorphs: 1. Names published in Cercospora and Passalora*. In: *CBS biodiversity series no. 1*. Centraalbureau voor Schimmelcultures, Utrecht, 571 pp.

Crous PW, Braun U, Hunter GC, *et al.* (2013). Phylogenetic lineages in *Pseudocercospora*. *Studies in Mycology* **75**: 37–114.

Crous PW, Braun U, Wingfield MJ, *et al.* (2009a). Phylogeny and taxonomy of obscure genera of microfungi. *Persoonia* **22**: 139–161.

Crous PW, Gams W, Stalpers JA, *et al.* (2004a). MycoBank: an online initiative to launch mycology into the 21st century. *Studies in Mycology* **50**: 19–22.

Crous PW, Groenewald JZ (2006). Ramularia miae. *Fungal Planet* **No. 3**.

Crous PW, Groenewald JZ, Mansilla JP, *et al.* (2004b). Phylogenetic reassessment of *Mycosphaerella* spp. and their anamorphs occurring on *Eucalyptus*. *Studies in Mycology* **50**: 195–214.

Crous PW, Hawksworth DL, Wingfield MJ (2015). Identifying and naming plant-pathogenic fungi: past, present, and future. *Annual Review of Phytopathology* **53**: 246–267.

Crous PW, Hong L, Wingfield MJ, *et al.* (1999). *Uwebraunia* and *Dissoconium*, two morphologically similar anamorph genera with different teleomorph affinity. *Sydowia* **51**: 155–166.

Crous PW, Kang J-C, Braun U (2001). A phylogenetic redefinition of anamorph genera in *Mycosphaerella* based on ITS rDNA sequence and morphology. *Mycologia* **93**: 1081–1101.

Crous PW, Schoch CL, Hyde KD, *et al.* (2009b). Phylogenetic lineages in the *Capnodiales*. *Studies in Mycology* **64**: 17–47.

Crous PW, Shivas RG, Quaedvlieg W, *et al.* (2014). Fungal Planet description sheets: 214–280. *Persoonia* **32**: 184–306.

Crous PW, Shivas RG, Wingfield MJ, *et al.* (2012). Fungal Planet description sheets: 128–153. *Persoonia* **29**: 146–201.

Crous PW, Summerell BA, Carnegie AJ, *et al.* (2007). Foliicolous *Mycosphaerella* spp. and their anamorphs on *Corymbia* and *Eucalyptus*. *Fungal Diversity* **26**: 143–185.

Crous PW, Summerell BA, Carnegie AJ, *et al.* (2009c). Novel species of *Mycosphaerellaceae* and *Teratosphaeriaceae*. *Persoonia* **23**: 119–146.

Crous PW, Summerell BA, Swart L, *et al.* (2011). Fungal pathogens of *Proteaceae*. *Persoonia* **27**: 20–45.

Crous PW, Verkley GJM, Groenewald JZ, *et al.* (2009e). *Fungal biodiversity*. In: *CBS Laboratory Manual Series*, **1**. CBS-KNAW Fungal Biodiversity Centre, Utrecht, The Netherlands: 1–269.

Crous PW, Wingfield MJ (1996). Species of *Mycosphaerella* and their anamorphs associated with leaf blotch disease of *Eucalyptus* in South Africa. *Mycologia* **88**: 441–458.

Crous PW, Wingfield MJ, Park RF (1991). *Mycosphaerella nubilosa*, a synonym of *M. molleriana*. *Mycological Research* **95**: 628–632.

Daughtrey ML, Wick RL, Peterson JL (1995). *Compendium of flowering potted plant diseases*. The American Phytopathological Society, APS Press.

Davis RM, Raid RN (2002). *Compendium of umbelliferous crop diseases*. The American Phytopathological Society, APS Press.

De Hoog GS (1972). The genera *Beauveria*, *Isaria*, *Tritirachium* and *Acrodontium* gen. nov. *Studies in Mycology* **1**: 1–41.

De Hoog GS, Gerrits van den Ende AHG (1998). Molecular diagnostics of clinical strains of filamentous *Basidiomycetes*. *Mycoses* **41**: 183–189.

Deighton FC (1967). Studies on *Cercospora* and allied genera II. *Passalora*, *Cercosporidium*, and some species of *Fusicladium* on *Euphorbia*. *Mycological Papers* **1112**: 1–79.

Deighton FC (1972). *Ramulariopsis* Speg., *Pseudovularia* Speg., *Didymariopsis* Speg. and *Ramularia holci-lanati* (Cav.) Lindau. *Transactions of the British Mycological Society* **59**: 185–191.

Deighton FC (1973). Studies on *Cercospora* and allied genera IV. *Cercosporella* Sacc., *Pseudocercosporella* gen. nov. and *Pseudocercosporidium* gen. nov. *Mycological Papers* **133**: 1–62.

Dowson WJ (1924). A new disease of sweet peas. *Journal of the Royal Horticultural Society* **49**: 211–221.

Dudley WR (1889). The strawberry Leaf-Blight, *Sphaerella fragariae* (Tul.) Sacc. Cornell University. *Agricultural Experiment Station Bulletin* **14**: 171–184.

Ellis MA, Converse RH (1991). *Compendium of raspberry and blackberry diseases and insects*. The American Phytopathological Society, APS Press.

Ferraris T (1902). Materiali per una flora micologica del Piemonte. Miceti della valle d Aosta. *Malpighia* **16**: 441–481.

Foust CM, Marshall DE (1991). Culinary rhubarb production in North America – history and recent statistics. *Hortscience* **26**: 1360–1363.

Frank J, Crous PW, Groenewald JZ, *et al.* (2010). *Microcyclospora* and *Microcyclosporella*: novel genera accommodating epiphytic fungi causing sooty blotch on apple. *Persoonia* **24**: 93–105.

Gardner DE, Hodges JCS (1990). Diseases of *Myrica faya* (firetree, *Myricaceae*) in the Azores, Madeira and the Canary Islands. *Plant Pathology* **39**: 326–330.

Glass NL, Donaldson G (1995). Development of primer sets designed for use with PCR to amplify conserved genes from filamentous ascomycetes. *Applied and Environmental Microbiology* **61**: 1323–1330.

Grigoriev IV, Nikitin R, Haridas S, *et al*. (2013). MycoCosm portal: gearing up for 1000 fungal genomes. *Nucleic Acids Research*, 1–6. http://dx.doi.org/10.1093/nar/gkt1183.

Groenewald JZ, Nakashima C, Nishikawa J, *et al*. (2013). Species concepts in *Cercospora*: spotting the weeds among the roses. *Studies in Mycology* **75**: 115–170.

Gunasinghe N, You MP, Barbetti MJ (2016). Phenotypic and phylogenetic studies associated with the crucifer white leaf spot pathogen, *Pseudocercosporella capsellae*, in Western Australia. *Plant Pathology* **65**: 205–217.

Hanse B, Vermeulen GD, Tijink FGJ, *et al*. (2011). Analysis of soil characteristics, soil management and sugar yield on top and averagely managed farms growing sugar beet (*Beta vulgaris* L.) in the Netherlands. *Soil & Tillage Research* **117**: 61–68.

Harveson RM, Hanson LE, Hein GL (2009). *Compendium of beet diseases and pests*, Second Edition. The American Phytopathological Society, APS Press.

Havis ND, Brown JKM, Clemente G, *et al.* (2015). *Ramularia collo-cygni* – an emerging pathogen of barley crops. Disease control and pest management. *Phytopathology* **105**: 895–904.

Hawke RG (2004). An evaluation study of *Alchemilla*. *Plant Evaluation Notes of the Chicago Botanic Garden* **24**: 1–2.

Hawksworth DL (2011). A new dawn for the naming of fungi: impacts of decisions made in Melbourne in July 2011 on the future publication and regulation of fungal names. *MycoKeys* **1**: 7–20.

Hawksworth DL, Crous PW, Redhead SA, *et al.* (2011). The Amsterdam Declaration on fungal nomenclature. *IMA Fungus* **2**: 105–112.

Hebert PDN, Cywinska A, Ball SL, *et al*. (2003). Biological identifications through DNA barcodes. *Proceedings of the Royal Society of London Series B* **270**: 313–321.

Heiser I, Sachs E, Liebermann B (2003). Photodynamic oxygen activation by rubellin D, a phytotoxin produced by *Ramularia collo-cygni* (Sutton et Waller). *Physiological and Molecular Plant Pathology* **62**: 29–36.

Hillis DM, Bull JJ (1993). An empirical test of bootstrapping as a method for assessing confidence in phylogenetic analysis. *Systematic Biology* **42**: 182–192.

Horie H, Kobayashi T (1982). New diseases on ornamental trees (8): Leaf blight in *Ginkgo biloba* and leaf spot in *Chaenomeles sinensis*. *Annals of the Phytopathological Society of Japan* **48**: 135 (in Japanese).

Höhnel von F (1904). Mykologische Fragmente. *Annales Mycologici Editi in Notitiam Scientiae Mycologicae Universalis* (2): 38–60.

Horvát A, Palkovics L, Nagy G (2015). Occurrence of leaf spot caused by *Phacellium veronicae* on speedwell in Hungary. *Journal of Plant Pathology* **97**(2): 394.

Hostert ND, Blomquist CL, Thomas SL, *et al.* (2006). First report of *Ramularia carthami*, causal agent of Ramularia leaf spot of safflower, in California. *Plant Disease* **90**(9): 1260.

Huber-Meinicke G, Defago G, Sedlar L (1989). Ramularia rubella (Bon.) Nannf. as a potentional mycoherbicide against Rumex weeds. *Botanica Helvetica* **99**(1): 81–89.

Huerta-Espino J, Constantinescu O, Velásquez C, *et al*. (2006). First report of *Ramularia cercosporelloides* on *Carthamus tinctorius* in Northwestern Mexico. *Plant Disease* **90**: 1552.

Hughes SJ (1949). Studies on some diseases of sainfoin (*Onobrychis sativa*) II. The life history of *Ramularia onobrychidis* Allescher. *Transactions of the British Mycological Society* **32**: 34–59.

Hughes SJ (1953). Conidiophores, conidia and classification. *Canadian Journal of Botany* **31**: 577–659.

Inman AJ, Sivanesan A, Fitt BDL, *et al*. (1991). The biology of *Mycosphaerella capsellae* sp. nov., the teleomorph of *Pseudocercosporella capsellae*, cause of white leaf. *Mycological Research* **95**: 1334–1342.

Jakson SL, Maxwell A, Neumeister-Kemp HG, *et al.* (2004). Infection, hyperparasitism and conidiogenesis of *Mycosphaerella lateralis* on *Eucalyptus globulus* in Western Australia. *Australasian Plant Pathology* **33**: 49–53.

Katoh K, Standley DM (2013). MAFFT Multiple Sequence Alignment Software Version 7: Improvements in performance and usability. *Molecular Biology and Evolution* **30**: 772–780.

Kawato M, Shinobu R (1959). On *Streptomyces herbaricolour*, nov. sp., supplement: a simple technique for the microscopic observation. *Memoirs of Osaka University of the Liberal Arts and Education. Series B. Natural Sciences* **8**: 114–119.

Kearse M, Moir R, Wilson A, *et al*. (2012). Geneious Basic: an integrated and extendable desktop software platform for the organization and analysis of sequence data. *Bioinformatics* **28**: 1647–1649.

Khodaparast A, Braun U (2005). *Ramularia uredinicola* – a new species from Iran. *Mycotaxon* **91**: 357–359.

Kirk PM, Stalpers JA, Braun U (2013). A without prejudice list of generic names of fungi for protection under the International Code of Nomenclature for algae, fungi, and plants. *IMA Fungus* **4**(2): 381–443.

Kirkpatrick TL, Rothrock CS (2001). *Compendium of cotton diseases*. The American Phytopathological Society, APS Press.

Kirschner R (2009). *Cercosporella* and *Ramularia*. *Mycologia* **101**: 110–119.

Ķirulis A (1942). Mikroskopskā̆s sēnes kă augu slimību dabīge ienaidnieki Latvijă. *Jelgavas Lauks. Akad. Raksti, Lauks. Fakult.* **1**: 479–536.

Koike ST, Baameur A, Groenewald JZ, *et al*. (2011). Cercosporoid leaf pathogens from whorled milkweed and spineless safflower in California. *IMA Fungus* **2**: 7–12.

Koike ST, Smith RF, Crous PW, *et al*. (2004). Leaf and stem spot caused by *Ramularia sphaeroidea* on purple and lana woollypod vetch (*Vicia* spp.) cover crops in California. *Plant Disease* **88**: 221.

Laibach F (1921). Untersuchungen über einige *Ramularia*- und *Ovularia*-Arten und ihre Beziehungen zur Ascomycetengattung *Mycosphaerella* II. *Zentralblatt für Bakteriologie Abteilung II* **55**: 284–293.

Li HY, Sun GY, Zhai XR, *et al*. (2012). *Dissoconiaceae* associated with sooty blotch and flyspeck on fruits in China and the United States. *Persoonia* **28**: 113–125.

Lima LL, Barreto M, Scaloppi ÉAG (2010). Reação de cultivares de algodoeiro a *Ramularia areola*. *Summa Phytopathologica* **36**: 57–60.

Liu YJ, Whelen S, Hall BD (1999). Phylogenetic relationships among ascomycetes: evidence from an RNA polymerase II subunit. *Molecular Biology and Evolution* **16**: 1799–1808.

Maas JL (1984). *Compendium of strawberry diseases*. The American Phytopathological Society, APS Press.

Macedo DM, Pereira OL, Wheeler GS, *et al*. (2013). *Corynespora cassiicola* f. sp. *schinii*, a potential biocontrol agent for the weed *Schinus terebinthifolius* in the United States. *Plant Disease* **97**: 496–500.

Machado AR, Pinho DB, Silva M, *et al*. (2012). First report of leaf spot disease caused by *Cercosporella pfaffiae* on Brazilian ginseng (*Pfaffia glomerata*) in Brazil. *Plant Disease* **96**: 1702.

Maddison WP, Maddison DR (2011). *Mesquite: a modular system for evolutionary analysis*. Version 2.75. http://mesquiteproject.org.

Miethbauer S, Haase S, Schmidtke KU, *et al.* (2006). Biosynthesis of photodynamically active rubellins and structure of new anthraquinone derivatives produced by *Ramularia collo-cygni*. *Phytochemistry* **67**: 1206–1213.

Miethbauer S, Heiser I, Liebermann B (2003). The phytopathogenic fungus *Ramularia collo-cygni* produces biologically active rubellins on infected barley leaves. *Journal of Phytopathology* **151**: 665–668.

Minnis AM, Rossman AY, Olsen RT (2011). *Mycosphaerella nyssicola* revisited: a species distinct from *M. punctiformis*. *Mycotaxon* **115**: 311–322.

Montoya-Coronado L, Ochoa-Burgos F, Wong-Pérez J, *et al*. (2008). *CIANO-OL, CIANO-LIN, RC-1002-L, RC-1005-L y RC-1033-L variedades de cártamo altamente tolerantes a falsa cenicilla (Ramularia carthami). Folleto técnico numero* **60**. (ed.). Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuaria, Cd. Obregón, México (in Spanish).

Moore WC (1979). *Diseases of bulbs*. MAFF reference book HPD 1. HMSO, London, UK.

Mukhtar I, Khokhar I, Haider MS, *et al*. (2012). New record of *Ramularia* leaf spot on *Aristolochia punjabensis* L. in Pakistan. *African Journal of Microbiology Research* **6**: 6013–6015.

Müller EV, Wehmeyer LE (1954). Ein neuer, alpiner Ascomycete: *Mycosphaerella phacae-frigidae*. *Sydowia* **8**: 190–191.

Nugent LK, Sangvichen E, Sihanonth P, *et al*. (2006). A revised method for the observation of conidiogenous structures in fungi. *Mycologist* **20**: 111–114.

Nylander JAA (2004). *MrModeltest 2.0*. Program distributed by the author. Uppsala University, Uppsala, Sweden.

Oerke EC, Dehne HW (2004). Safeguarding production – losses in major crops and the role of crop protection. *Crop Protection* **23**: 275–285.

O'Donnell K, Cigelnik E (1997). Two divergent intragenomic rDNA ITS2 types within a monophyletic lineage of the fungus *Fusarium* are nonorthologous. *Molecular Phylogenetics and Evolution* **7**: 103–116.

O'Donnell K, Kistler HC, Cigelnik E, *et al.* (1998). Multiple evolutionary origins of the fungus causing Panama disease of banana: concordant evidence from nuclear and mitochondrial gene genealogies. *Proceedings of the National Academy of Sciences of the United States of America* **95**: 2044–2049.

O'Neill TM, Hanks GR, Kennedy R (2002). First report of white mould (*Ramularia vallisumbrosae*) on daffodils (*Narcissus*) in eastern England. *Plant Pathology* **51**: 400.

Oudemans CAJA (1873). Matériaux por la flore mycologique de la Néerlande. *Archives Néerlandaises des Sciences Exactes et Naturelles* **8**: 343–416.

Park J-H, Shin HD (2016). *Ramularia hydrangeicola* sp. nov. with distinctive traits on *Hydrangea serrata* f. *acuminata* in Korea. *Mycotaxon* **131**: 95–102.

Piotrowska M (2014). *Evaluating the risk of fungicide resistance evolution to succinate dehydrogenase inhibitors in Ramularia collo-cygni*. Ph.D. thesis, University of Edinburgh.

Quaedvlieg W, Binder M, Groenewald JZ, *et al.* (2014). Introducing the Consolidated Species Concept to resolve species in the *Teratosphaeriaceae*. *Persoonia* **33**: 1–40.

Quaedvlieg W, Kema GHJ, Groenewald JZ, *et al.* (2011). *Zymoseptoria* gen. nov.: a new genus to accommodate septoria-like species occurring on graminicolous hosts. *Persoonia* **26**: 57–69.

Quaedvlieg W, Verkley GJM, Shin HD, *et al.* (2013). Sizing up *Septoria*. *Studies in Mycology* **75**: 307–390.

Quintana-Obregón EA, Plascencia-Jatomea M, Burgos-Hérnandez, *et al.* (2013). Isolation and identification of fungi from leaves infected with false mildew on safflower crops in the Yaqui Valley, Mexico. *Revista Mexicana de Micologia* **37**: 19–27.

Rayner RW (1970). *A mycological colour chart*. Commonwealth Mycological Institute and British Mycological Society, Kew, Surrey, UK.

Rimmer SR, Shattuck VI, Buchwaldt L (2007). *Compendium of Brassica diseases*. The American Phytopathological Society, APS Press.

Ronquist F, Teslenko M, van der Mark P, *et al.* (2011). MrBayes 3.2: efficient Bayesian phylogenetic inference and model choice across a large model space. *Systematic Biology* **61**: 539–542.

Rønsted N, Chase MW, Albach DC, Bello MA (2002). Phylogenetic relationships within *Plantago* (Plantaginaceae): evidence from nuclear ribosomal ITS and plastid *trnL-F* sequence data. *Botanical Journal of the Linnean Society* **139**: 323–338.

Rossman AY, Crous PW, Hyde KD, *et al.* (2015). Recommended names for pleomorphic genera in *Dothideomycetes*. *IMA Fungus* **6**: 507–523.

Saccardo PA (1878). Fungi Veneti novi vel critici vel mycologiae Venetae addendi. Series IX. *Michelia* **1**(4): 361–445.

Seifert K, Morgan-Jones G, Gams W, *et al.* (2011). *The genera of Hyphomycetes*. In: *CBS biodiversity series 9*. Centraalbureau voor Schimmelcultures, Utrecht, 997 pp.

Saccardo PA (1880). Conspectus generum fungorum Italiae inferiorum nempe ad Sphaeropsideas, Melanconieas et Hyphomyceteas pertinentium systemate sporologico dispositorum. *Michelia* **2**(6): 1–38.

Schmitt I, Crespo A, Divakar PK, *et al.* (2009). New primers for promising single-copy genes in fungal phylogenetics and systematics. *Persoonia* **23**: 35–40.

Schoch CL, Seifert KA, Huhndorf S, *et al.* (2012). Nuclear ribosomal internal transcribed spacer (ITS) region as a universal DNA barcode marker for Fungi. *Proceedings of the National Academy of Sciences of the United States of America* **109**: 6241–6246.

Schwartz HF, Steadman JR, Hall R, *et al.* (2005). *Compendium of bean diseases*. The American Phytopathological Society, APS Press.

Shahjahan AKM, Rush MC, Jones JP (1998). First report of the occurrence of White Leaf Streak in Louisiana Rice. *Plant Disease* **82**: 1282.

Shin HD, Kim JD (2002). A new species of *Phacellium* on *Alangium*. *Mycotaxon* **81**: 341–344.

Smiley RW, Dernoeden PH, Clarke BB (1983). *Compendium of turfgrass diseases*. The American Phytopathological Society, APS Press.

Spegazzini C (1910). Mycetes Argentinenses (Series V). *Anales del Museo Nacional de Historia Natural Buenos Aires* **20**(13): 329–467.

Stamatakis A (2014). RAxML Version 8: a tool for phylogenetic analysis and post-analysis of large phylogenies. *Bioinformatics* **30**: 1844–1849.

Stielow JB, Lévesque CA, Seifert KA, *et al.* (2015). One fungus, which genes? Development and assessment of universal primers for potential secondary fungal DNA barcodes. *Persoonia* **35**: 242–263.

Stukenbrock EH, Quaedvlieg W, Javan-Nikhah M, *et al.* (2012). *Zymoseptoria ardabiliae* and *Z. pseudotritici*, two progenitor species of the septoria tritici leaf blotch fungus *Z. tritici* (synonym: *Mycosphaerella graminicola*). *Mycologia* **104**: 1397–1407.

Suto V (1999). *Mycosphaerella chaenomelis* sp. nov.: the teleomorph of *Cercosporella* sp., the causal fungus of frosty mildew in *Chaenomeles sinensis*, and its role as the primary infection source. *Mycoscience* **40**: 509–516.

Sutton BC, Waller JM (1988). Taxonomy of *Ophiocladium hordei*, causing leaf lesions on *Triticale* and other gramineae. *Transactions of the British Mycological Society* **90**: 55–61.

Sung G-H, Sung J-M, Hywel-Jones NL, *et al.* (2007). A multigene phylogeny of Clavicipitaceae (Ascomycota, Fungi): identification of localized incongruence using a combinational bootstraap approach. *Molecular Phylogenetics and Evolution* **44**: 1204–1223.

Swofford DL (2003). *PAUP*: phylogenetic analysis using parsimony (*and other methods), version 4*. Sinauer Associates, Sunderland, Massachusetts.

Tamura K, Peterson D, Peterson N, *et al.* (2011). MEGA5: Molecular Evolutionary Genetics Analysis using maximum likelihood, evolutionary distance, and maximum parsimony methods. *Molecular Biology and Evolution* **28**: 2731–2739.

Taylor JW, Jacobson DJ, Kroken S, *et al.* (2000). Phylogenetic species recognition and species concepts in fungi. *Fungal Genetics and Biology* **31**: 21–32.

Thach T, Munkb L, Hansenc AL, *et al.* (2013). Disease variation and chemical control of Ramularia leaf spot in sugar beet. *Crop Protection* **51**: 68–76.

Tomilin BA (1971). Ad nomenclaturam generis Mycosphaerella Johans. *Novosti Sistematiki Nizshikh Rastenii* **8**: 149–153.

Unger F (1833). *Die Exantheme der Pflanzen und einige mit diesen verwandte Krankheiten der Gewächse*. Gerold, Wien.

Unger F (1836). *Über den Einfluß des Bodens auf die Vertheilung der Gewächse, nachgewiesen in der Vegetation des nördlichen Tirols*. Wien.

Vassiljevsky (1925). *Bolezni Rastenij. Morbi Plantarum. Jahrbuch für Pflanzenkrankheiten*: **Vol. 14**. Leningrad [St. Petersburg]: 25.

Verkley GJM, Quaedvlieg W, Shin HD, *et al.* (2013). A new approach to species delimitation in *Septoria*. *Studies in Mycology* **75**: 213–305.

Verkley GJM, Crous PW, Groenewald JZ, *et al.* (2004). *Mycosphaerella punctiformis* revisited: morphology, phylogeny, and epitypification of the type species of the genus *Mycosphaerella* (*Dothideales*, *Ascomycota*). *Mycological Research* **108**: 1271–1282.

Videira SIR, Groenewald JZ, Kolecka A, *et al.* (2015a). Elucidating the *Ramularia eucalypti* species complex. *Persoonia* **34**: 50–64.

Videira SIR, Groenewald JZ, Verkley GJM, *et al.* (2015b). The rise of *Ramularia* from the *Mycosphaerella* labyrinth. *Fungal Biology* **119**: 823–843.

Vilgalys R, Hester M (1990). Rapid genetic identification and mapping of enzymatically amplified ribosomal DNA from several *Cryptococcus* species. *Journal of Bacteriology* **172**: 4238–4246.

Webster RK, Gunnell PS (1992). *Compendium of rice diseases*. The American Phytopathological Society, APS Press.

White TJ, Bruns T, Taylor J (1990). Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. In: *A guide to molecular methods and applications* (Innis MA, Gelfand DH, Sninsky JJ, White JW, eds). Academic Press, New York: 315–322.

Wijayawardene N, Crous PW, Kirk M, *et al.* (2014). Naming and outline of *Dothideomycetes* – 2014 including proposals for the protection or suppression of generic names. *Fungal Diversity* **69**: 1–55.

Wingfield MJ, de Beer ZW, Slippers B, *et al.* (2012). One fungus, one name promotes progressive plant pathology. *Molecular Plant Pathology* **212**: 604–613.

Zaller JG (2004). Ecology and non-chemical control of *Rumex crispus* and *R. obtusifolius* (*Polygonaceae*): a review. *Weed Research* **44**: 414–432.

Zhao Y, Grout BWW, Crisp PC (2002). Unexpected susceptibility of novel breeding lines of European rhubarb (*Rheum rhaponticum*) to leaf and petiole spot disease. *Acta Horticulturae* **637**: 139–144.

Zhao Y, Grout BW, Xu X (2006). Effects of temperature on germination and hyphal growth from conidia of *Ramularia rhei* and *Ascochyta rhei*, causing spot diseases of rhubarb (*Rheum rhaponticum*). *Plant Pathology* **55**: 664–670.

Zhou XG, Tabien RE, Way MO (2010). First report of white leaf streak of rice caused by *Mycovellosiella oryzae* in Texas. *Plant Disease* **94**: 639.