

# LEAF SPOT DISEASES OF EUCALYPTS IN NEW ZEALAND CAUSED BY *PSEUDOCERCOSPORA* SPECIES

UWE BRAUN

Martin-Luther-University, Institute of Geobotany and Botanical Garden,  
Neuwerk 21, D-06099 Halle (Saale), Germany

and MARGARET A. DICK

New Zealand Forest Research Institute,  
Private Bag 3020, Rotorua, New Zealand

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## ABSTRACT

Specimens of *Pseudocercospora* on eucalypt foliage collected over the past 22 years and held in the New Zealand Forest Research Institute Mycological Herbarium (NZFRI-M) were examined. In addition to the previously recorded *Pseudocercospora eucalyptorum* Crous *et al.*, three new species of *Pseudocercospora* — *P. acerosa* sp. nov., *P. crousii* sp. nov., and *P. pseudobasitruncata* sp. nov. — have now been described. These descriptions can be used to identify the species found in New Zealand, and contribute to the worldwide key to *Pseudocercospora* spp. on eucalypts.

**Keywords:** leaf spot diseases; new species; *Eucalyptus*; *Pseudocercospora eucalyptorum*; *Pseudocercospora* spp.

## INTRODUCTION

*Cercospora eucalypti* Cooke & Massee and *C. epicoccoides* Cooke & Massee, described on *Eucalyptus* spp. from Australia, were the only species on this host genus treated by Chupp (1954) in his monograph of *Cercospora* Fresen. Until 1989, all collections of *Cercospora*-like hyphomycetes on eucalypts were assigned to these species, mostly to *C. eucalypti*. Dick (1982, 1990) recorded *C. eucalypti* from New Zealand on a wide range of hosts. Crous *et al.* (1989) examined type material of *C. eucalypti* and *C. epicoccoides* and pointed out that they do not represent species of *Cercospora* or allied genera, but two different coelomycetes, which were later placed in *Phaeophleospora* (Crous *et al.* 1997). Guo & Liu (1989) misapplied the name *C. eucalypti* and reallocated it to *Pseudocercospora*, based on Chinese material and Chupp's (1954) treatment, but they did not examine type material. Crous *et al.* (1989) introduced the new name *Pseudocercospora eucalyptorum* Crous *et al.* for a common, widespread cercosporoid leaf spot fungus on a wide range of hosts, which was usually deposited in herbaria as "*Cercospora eucalypti*".

The genus *Eucalyptus*, which originates in Australia and some islands immediately north of the island continent, comprises more than 450 species. Numerous taxa are now planted as forest or ornamental trees in various part of the world, stretching from Australia and New Zealand to Asia, Africa, South America, and the United States. It could be supposed that the enormous diversity of *Eucalyptus* has to be connected with a large diversity of cercosporoid hyphomycetes pathogenic to this genus. During the course of comprehensive examinations of leaf spot diseases of eucalypts caused by *Mycosphaerella* species and their anamorphs, Crous (1998) treated 57 species. Twenty-three of the anamorph species were representatives of *Cercospora* and allied genera, and 17 of these were species of *Pseudocercospora*. Crous (1999) monographed *Mycosphaerella* including cercosporoid anamorphs on other hosts of the Myrtaceae, excluding *Eucalyptus*. A comparison of cercosporoid leaf spot diseases on various hosts of the Myrtaceae showed that eucalypts have their own specific species distinct from taxa on other myrtaceous hosts.

On account of the new, more comprehensive, taxonomic knowledge of cercosporoid hyphomycetes on eucalypts, a re-examination of collections from New Zealand deposited at NZFRI-M was made to determine which species were masked under "*Cercospora eucalypti*/*Pseudocercospora eucalyptorum*". It could be demonstrated that four species of *Pseudocercospora* are present in New Zealand, i.e., *Pseudocercospora eucalyptorum* and three new undescribed species.

## MATERIALS AND METHODS

All collections were mounted in distilled water and examined by standard light microscopy (Olympus BX 50, Hamburg, Germany). Colourless structures were stained with cotton blue in lactophenol. The collections are held at NZFRI-M (New Zealand Forest Research Institute, Mycological Herbarium, Rotorua, New Zealand). Additional collections examined (one each) were from the herbaria at Martin-Luther-Universität, Halle, Germany (HAL), and CABI Bioscience, United Kingdom (IMI).

For each specimen examined, the location is followed by a two-letter code identifying the geographic region (Crosby *et al.* 1976) in which it was collected (Table 1). Further information on the distribution of the fungi, and the incidence and severity of disease caused by each species, is held in the New Zealand Forest Research Forest Health Database (Forest Research Institute 1990).

TABLE 1—Codes identifying the biological regions from which the specimens originated

AK	Auckland
BP	Bay of Plenty
BR	Buller
MC	mid-Canterbury
ND	Northland
NN	Nelson
SL	Southland
TO	Taupo
WI	Wanganui
WA	Wairarapa

### DESCRIPTIONS OF SPECIES

#### 1. *Pseudocercospora acerosa* U.Braun & M.Dick sp. nov. (Fig. 1)

Etym.: “acerosus”, derived from the broadly acicular conidia.

Differt a *P. eucalyptorum* conidiophoris longioribus et latioribus, saepe ramosis, conidiis late acicularibus, basibus latioribus.

Holotype: on *Eucalyptus baxteri* (Benth.) J. M. Black (Myrtaceae), New Zealand, Christchurch, Hagley Park (MC), 26 Sept. 2001, P.M.Bradbury (NZFRI-M 4580).

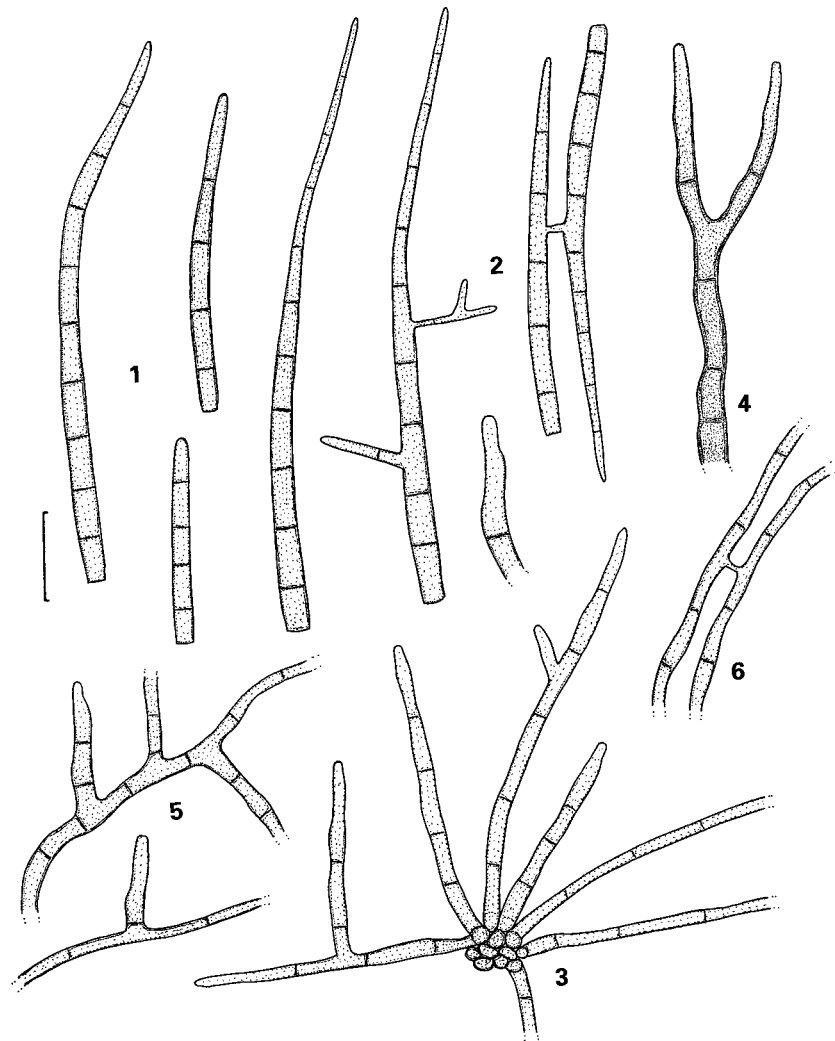


FIG. 1—*Pseudocercospora acerosa*. (1) Conidia, (2) germinating conidium (left) and anastomosing conidia (right), (3) fasciculate conidiophores, (4) conidiophore, (5) superficial hyphae with solitary conidiophores, (6) anastomosing superficial hyphae. Bar = 20  $\mu$ m.

Leaf spots amphigenous, subcircular to angular-irregular, 1–10 mm diam. or confluent, pale to medium dark brown, dingy greyish brown, margin indefinite or with a narrow darker border or marginal line, reddish brown to dark brown, margin or sometimes entire spots somewhat raised. Caespituli amphigenous, mostly hypophyllous, punctiform to effuse, dark greyish brown. Primary mycelium internal; secondary mycelium external, sparingly to well developed, superficial; hyphae septate, branched, 1.5–5  $\mu\text{m}$  wide, subhyaline to pale olivaceous or olivaceous-brown, smooth (and also conidia) occasionally anastomosing. Stromata absent or 10–60  $\mu\text{m}$  diam., substomatal, occasionally intraepidermal, olivaceous-brown, composed of swollen hyphal cells, 2–8  $\mu\text{m}$  diam., thick-walled. Conidiophores in small to moderately large loose fascicles, arising from internal hyphae or stromata, or solitary, arising from superficial hyphae, lateral or terminal, erect to decumbent, cylindrical-filiform to geniculate-sinuous, unbranched or often branched, 20–220  $\times$  3–8  $\mu\text{m}$ , at the base sometimes up to 11  $\mu\text{m}$  wide, continuous to pluriseptate throughout, occasionally constricted at the septa, pale olivaceous, olivaceous-brown, yellowish to medium brown, smooth, wall thin to somewhat thickened, above all in the lower half and near the base; conidiogenous cells integrated, terminal, 10–40  $\mu\text{m}$  long, conidiogenous loci inconspicuous, occasionally subdenticulate. Conidia solitary, 40–180  $\times$  (2.5–)3–5.5(–6)  $\mu\text{m}$ , short conidia subcylindrical, rarely obclavate, longer conidia broadly acicular (i.e., gradually attenuated from a truncate base towards the apex), 4- to 15-septate, subhyaline, pale olivaceous to olivaceous-brown, smooth, wall thin to slightly thickened, apex obtuse in short conidia and obtuse to subacute in longer conidia, base truncate, rarely slightly narrowed at the very base (short obconically truncate), (2.5–)3–4(–5)  $\mu\text{m}$  wide, hila unthickened, non-pigmented. Conidia often germinating, forming long narrow germ tubes that may develop into thin superficial mycelium, or conidia forming secondary conidiophores (microcyclic conidiogenesis).

Distribution and host range: on *Eucalyptus baxteri* and *E. nitens* (Deane & Maiden) Maiden. South Island, New Zealand.

Material examined: On *E. baxteri*, Christchurch, Hagley Park (MC), 26 Sep. 2001, P.M. Bradbury (holotype). On *E. nitens*, Waikuku (MC), 22 Jun. 1999, P.M. Bradbury (NZFRI-M 4003); Nelson, Golden Downs Forest (NN), 12 Apr. 1999, H.M. McKenzie (NZFRI-M 3951); Fortification Block (SL), 19 Nov. 2001, M. Dick (NZFRI-M 4618).

*Pseudocercospora acerosa* sp. nov. is close to *P. eucalyptorum* and has often been confused with this species, but differs in having much-longer broadly acicular conidia with wider hila and much-longer broader frequently branched conidiophores. The general habit of *P. acerosa* resembles *P. crousii* U. Braun & M. Dick, described in this paper, but the latter species can be easily distinguished by its obclavate conidia with distinctly obconically truncate bases.

## 2. *Pseudocercospora crousii* U. Braun & M. Dick sp. nov. (Fig. 2)

Etym.: P. W. Crous, South African mycologist and phytopathologist, author of a monograph of *Mycosphaerella* species and their anamorphs on eucalypts.

Differt a *P. paraguayensis* conidiis latioribus, conidiophoris longioribus, per stoma emergentibus et a *P. eucalyptorum* et *P. acerosa* conidiis obclavatis vel obclavatis-cylindratis.

Holotype: on *Eucalyptus regnans* F. Muell (Myrtaceae), New Zealand, Whakarewarewa Forest (BP), 18 Sep. 2001, M. Dick (NZFRI-M 4550).

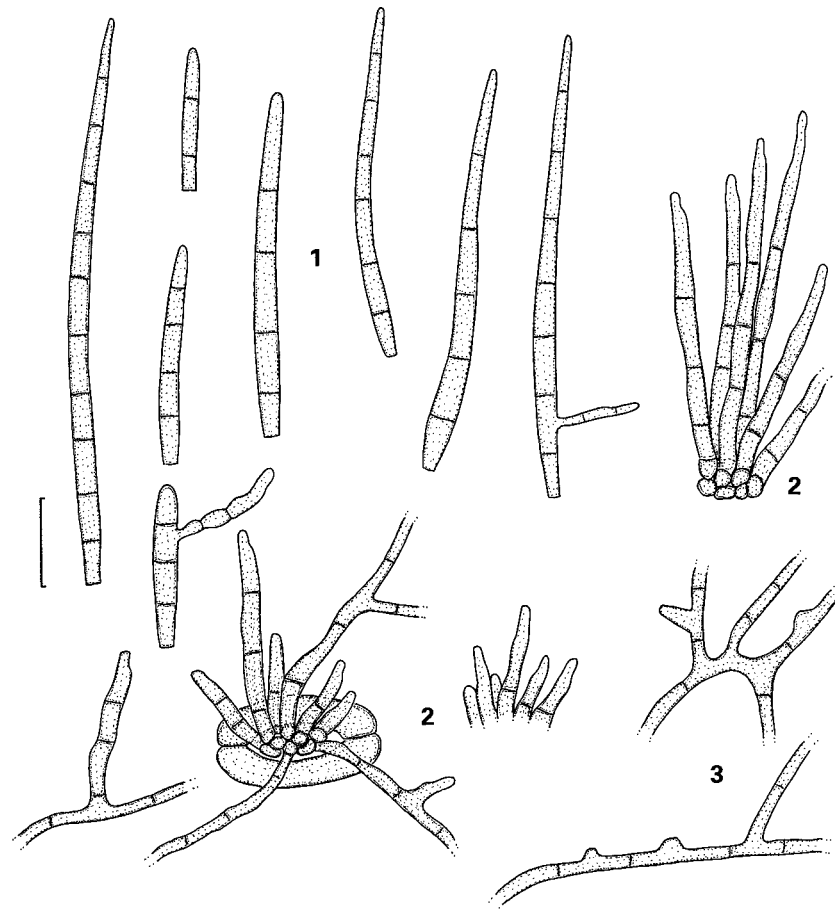


FIG. 2—*Pseudocercospora crousii*. (1) Conidia, (2) fasciculate conidiophores, (3) superficial hyphae with solitary conidiophores. Bar = 20  $\mu$ m.

Leaf spots amphigenous, subcircular to angular-irregular, sometimes oblong, 1–15 mm diam., sometimes confluent and larger, brown, reddish brown, later greyish brown to greyish white, with a darker narrow margin or marginal line, often somewhat raised, brown to purplish violet, finally often blackish. Caespituli amphigenous, mostly hypophyllous, punctiform to subeffuse, brown, greyish brown, often not very conspicuous. Primary mycelium internal; secondary mycelium external, superficial; septate, branched, 1–4.5  $\mu$ m wide, subhyaline to pale olivaceous, smooth, thin-walled, hyphae occasionally anastomosing. Stromata lacking or small, 10–30  $\mu$ m diam., substomatal, olivaceous-brown. Conidiophores in small to moderately large fascicles, loose to moderately dense, arising from internal hyphae or substomatal stromata, emerging through stomata, or conidiophores solitary, arising from creeping hyphae, lateral, occasionally terminal, erect, straight, subcylindrical to geniculate-sinuous, unbranched or often branched, 5–100  $\times$  2.5–5.5  $\mu$ m, aseptate to pluriseptate throughout, wall thin to slightly thickened, smooth, conidiophores occasionally reduced to conidiogenous cells, but conidiogenous cells usually integrated, terminal,

5–30 µm long, conidiogenous loci inconspicuous. Conidia solitary, obclavate or obclavate-cylindrical, short conidia sometimes cylindrical, (20–)35–115(–140) × 3–5 µm, 4- to 10-septate, subhyaline to pale olivaceous or olivaceous-brown, smooth or almost so, wall thin to slightly thickened, apex obtuse to subacute, base obconically truncate, (1–)1.5–2 (–3) µm diam., hila unthickened, non-pigmented.

Distribution and host range: on *Eucalyptus delegatensis* R.T.Baker, *E. dendromorpha* (Blakely) L.A.S.Johnson & Blaxell, *E. fastigata* Deane & Maiden, *E. muelleriana* Howitt, *E. obliqua* L'Herit, *E. oreades* R.T.Baker, *E. pilularis* J.Sm., *E. regnans*, *E. regnans* × *E. obliqua*, and *E. stenostoma* L.A.S.Johnson & Blaxell. New Zealand. Entries in the Forest Health Database (FHDB) document that *E. regnans* is the worst affected of these host species, with severe defoliation often attributed to infection by *Pseudocercospora* sp. Although all collections examined were from the North Island of New Zealand, the FHDB records indicate that this fungus is also found in the northern part of the South Island.

Material examined (all collections from New Zealand): On *E. delegatensis*, Pouakani (TO), 1 May 1981, R.M.J.McKenzie (NZFRI-M 2354); Lismore Forest (WI), 2 Sep. 1981, M.Stoodley (NZFRI-M 2352). On *E. dendromorpha*, Mamaku, Jeff Rd. (BP), 29 Sep. 1988, F.Crockett and M.Dick (NZFRI-M 3275). On *E. fastigata*, Pouakani North (TO), 17 Jun. 1986, R.M.J.McKenzie (NZFRI-M 3147). On *E. muelleriana*, Omatoroa (BP), 6 Jun. 1997, E.Hay (NZFRI-M 3778). On *E. obliqua*, Rotoehu Forest (BP), 1 Jul. 1982, A.Zandvoort (NZFRI-M 2355). On *E. oreades*, Rotoehu Forest (BP), 23 Jul. 1982, M.Dick (NZFRI-M 2357). On *E. pilularis*, Auckland, Remuera Golf Course (AK), 12 Aug. 1999, T.M.Withers (NZFRI-M 4006); Auckland, Remuera, Abbotts Way (AK), 20 Dec. 1999, T.M.Withers (NZFRI-M 4061); Paengaroa, Allport Rd (BP), 30 Jun. 2000, J.Pascoe (NZFRI-M 3203). On *E. regnans*, Whakarewarewa Forest (BP), 18 Sep. 2001, M.Dick (holotype); Rotoehu Forest (BP), 1 Apr. 1981, A.Zandvoort (NZFRI-M 2353). On *E. regnans* × *E. obliqua*, Rotoehu Forest (BP), 23 Jul. 1982, M.Dick (NZFRI-M 2356). On *E. stenostoma*, Kaingaroa Forest (TO), 11 Jan. 1988, D.Hayes (NZFRI-M 3237).

This species is close to *P. paraguayensis* (T.Kobay.) Crous, but differs in having wider conidia and much longer conidiophores emerging through stomata. *Pseudocercospora eucalyptorum* and *P. acerosa* are also similar, but they have cylindrical and broadly acicular conidia with much wider, non-attenuated, truncate bases.

**3. *Pseudocercospora eucalyptorum*** Crous, M.J.Wingf., Marasas & B.Sutton (Fig. 3) Mycological Research 93: 394 (1989)  
Ref.: Crous (1998: 132–134, Fig. 118, 119, 130).

Leaf spots amphigenous, subcircular to usually angular-irregular, 0.5–7 mm diam., often confluent, at first often yellowish, later pale to dark brown, purplish violet, finally usually greyish brown to dingy grey, margin indefinite or with a darker border, brown or red-purple to purplish violet, occasionally somewhat raised. Caespituli amphigenous, punctiform to subeffuse, greyish brown to dingy grey. Primary mycelium internal; secondary mycelium external, superficial; hyphae creeping, emerging through stomata, sparingly branched, septate, 1.5–3 µm wide, subhyaline to pale olivaceous or olivaceous-brown, smooth, thin-walled. Stomata lacking to well-developed, 10–200 µm diam., up to 50 µm deep, substomatal, somewhat erumpent, olivaceous-brown. Conidiophores in small, loose to large, dense

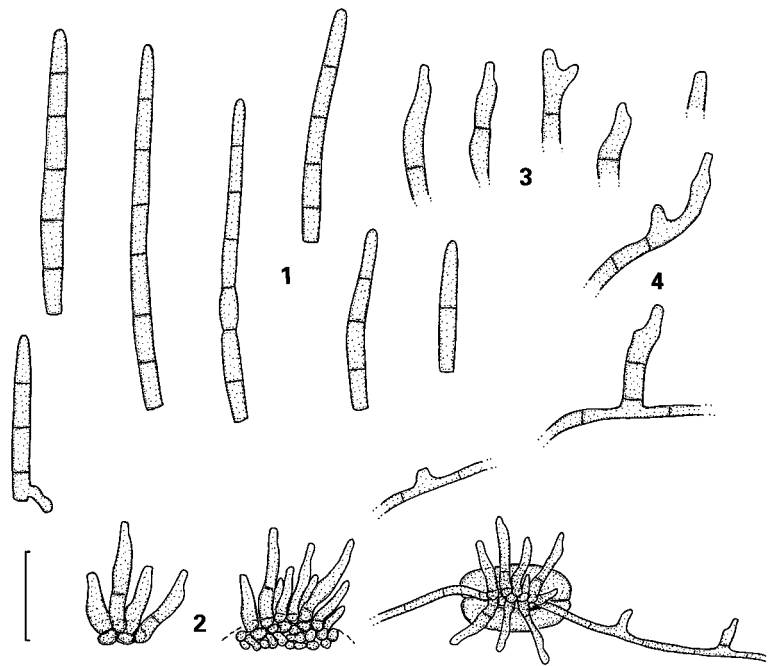


FIG. 3—*Pseudocercospora eucalyptorum*. (1) Conidia, (2) fasciculate conidiophores, (3) conidiophores, (4) superficial hyphae with solitary conidiophores. Bar = 20  $\mu$ m.

fascicles, arising from internal hyphae or stromata, emerging through stomata, large fascicles often almost sporodochial, or solitary, arising from creeping hyphae, lateral, rarely terminal, erect, straight, subcylindrical to geniculate-sinuous, unbranched or occasionally branched, 10–60  $\times$  2.5–6  $\mu$ m, 0- to 3-septate, subhyaline to olivaceous or light brown, wall thin to slightly thickened, smooth to faintly rough-walled, conidiophores reduced to conidiogenous cells or conidiogenous cells integrated, terminal, 10–25  $\mu$ m long, conidiogenous loci inconspicuous or subdenticulate, truncate, but wall unthickened and non-pigmented. Conidia solitary, cylindrical or subcylindrical, 15–70  $\times$  (2–)3–4(–4.5)  $\mu$ m (*in vitro* up to 100  $\mu$ m, and up to 10-septate), 1- to 7(8)-septate, subhyaline to pale olivaceous or olivaceous-brown, smooth to faintly rough-walled, wall thin to slightly thickened, apex obtuse, rounded, base truncate or only slightly obconically truncate at the very base, (1.5–)2–3  $\mu$ m wide, hila unthickened, non-pigmented.

Material examined (all collections from New Zealand): On *E. nitens*, Rotorua, Longmile Rd (BP), 5 May 1997, collector unknown (NZFRI-M 3783); Kinleith Forest (TO), Oct. 1981, R.M.J. MacKenzie (NZFRI-M 2350); Kinleith Forest, Tram Rd (BP), 6 May 1985, R.M.J. MacKenzie (NZFRI-M 3066); Victoria Forest (BR), 24 Mar. 2000, B.H. Doherty (NZFRI-M 4170); Kinleith Forest, Toatoa Rd. (TO), 8 Nov. 1983, R.M.J. MacKenzie (NZFRI-M 2358); Rotoehu Forest (BP), 27 Oct. 1981, A. Zandvoort (NZFRI-M 2351). On *E. scoparia* Maiden, Palmerston North, Victoria Esplanade (WI), 12 Jan. 1998, B.J. Rogan (NZFRI-M 3802). On *Eucalyptus* sp., Whangarei, Okara Park (ND), 10 Mar. 1980,

D.Kershaw (NZFRI-M 2349); Auckland, Mt Albert, Owairaka Avenue (AK), 18 Jul. 2001, C.F.Hill (HAL 1739); Gladstone (WA), 12 Nov. 1974, J.E.Sheridan (IMI 189775d).

*Pseudocercospora eucalyptorum* is common throughout the North Island (only one of the specimens examined was from the South Island) of New Zealand, particularly on *E. nitens*. *Eucalyptus nitens*, which is also the type host of this species, has been widely planted in New Zealand to provide a source of short fibre for the pulp and paper industry.

4. *Pseudocercospora pseudobasitruncata* U.Braun & M.Dick **sp. nov.** (Fig. 4)

Etym.: “pseudo-” and “basitruncata”, resembling the species *P. basitruncata* characterised by having conidia with truncate base.

Differt a *P. basitruncata*, *P. cubae* et *P. natalensis* conidiis longioribus, 4–7  $\mu\text{m}$  latis.

Holotype: on *Eucalyptus nitens* (Myrtaceae), New Zealand, Kaingaroa Forest (TO), 11 Jul. 1984, D.J.Slater-Hayes (NZFRI-M 2068).

Leaf spots amphigenous, subcircular to angular-irregular, 1–10 mm diam. or confluent and larger, pale to dark brown or blackish brown, later pale greyish brown to dingy grey, margin narrow, somewhat raised, reddish-purplish or pale to dark brown or with a raised marginal line and diffuse reddish-purplish halo. Caespituli amphigenous, punctiform, occasionally subeffuse, brownish, inconspicuous. Primary mycelium internal; secondary mycelium absent or occasionally with a few superficial hyphae, sparingly branched, septate, smooth, pale olivaceous, 2–3  $\mu\text{m}$  wide, emerging through stomata, but without solitary conidiophores. Stromata lacking or small, 10–35  $\mu\text{m}$  diam., substomatal, brown. Conidiophores in small to moderately large fascicles, usually 3–20, loose, emerging through stomata, erect, straight, subcylindrical to somewhat geniculate-sinuuous, unbranched, 10–70

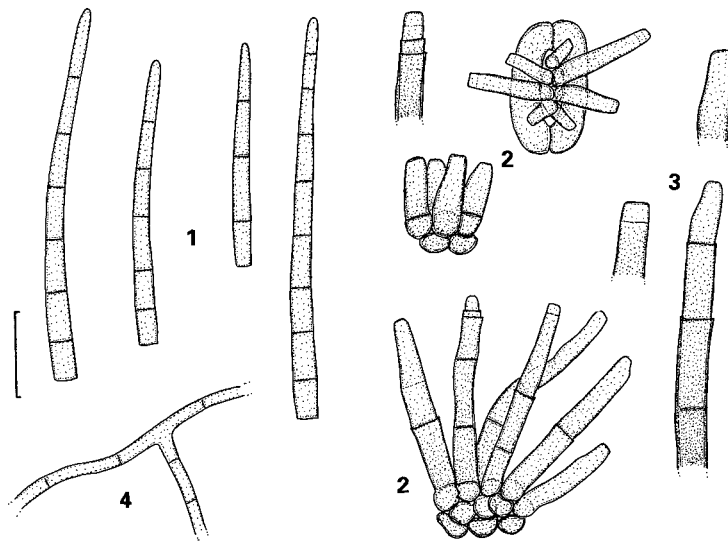


FIG. 4—*Pseudocercospora pseudobasitruncata*. (1) Conidia, (2) fasciculate conidiophores, (3) conidiophores, (4) superficial hypha. Bar = 20  $\mu\text{m}$ .



× 4–7 µm, 0- to 4-septate, wall thin to somewhat thickened, pale to medium dark olivaceous or olivaceous-brown, smooth to somewhat rough-walled; conidiogenous cells integrated, terminal, 10–30 µm long, proliferation usually percurrent, with 1–3 conspicuous annellations, occasionally sympodial, conidiogenous loci flat, truncate, 3–5 µm wide, unthickened, non-pigmented. Conidia solitary, most conidia broadly acicular (i.e., gradually attenuated from a truncate base towards the apex), some shorter conidia obclavate-cylindrical, 40–100 × 4–7 µm, 3- to 10-septate, pale olivaceous-brown, apex obtuse, base truncate, occasionally short obconically truncate, 4–5 µm wide, hila unthickened, non-pigmented.

Material examined: only known from the type collection in the central North island.

*Pseudocercospora pseudobasitruncata* resembles *P. basitruncata* Crous, described on *Eucalyptus* sp. from Colombia, but differs from it as well as from *P. cubae* Crous and *P. natalensis* Crous & T. Coutinho, two additional species with conspicuous annellations, in having much longer and above all wider conidia.

### KEY TO THE SPECIES OF *PSEUDOCERCOSPORA* OCCURRING ON *EUCALYPTUS* IN NEW ZEALAND

1. Superficial mycelium lacking or with only a few creeping hyphae; conidiophores in small to moderately large fascicles, mostly unilocal, conidiogenous cells mostly subcylindrical, proliferation usually percurrent, with 1–3 conspicuous annellations; conidia broadly acicular, gradually attenuated from a truncate base towards the apex, conidia cylindrical-obclavate, 40–100 × 4–7 µm, base truncate, occasionally obconical  
 ..... *P. pseudobasitruncata*
1. Superficial mycelium usually well-developed; conidiophores fasciculate and often also solitary, arising from creeping hyphae, lateral; conidiogenous cells often geniculate-sinuuous, proliferation sympodial, rarely mixed with a few percurrent proliferations and inconspicuous annellations; conidia (2–)3–5(–6) µm wide  
 ..... 2
2. Conidia obclavate or obclavate-cylindrical, base attenuated, distinctly obconically truncate  
 ..... *P. crousii*
2. Conidia cylindrical, subcylindrical or broadly acicular, base not attenuated, truncate  
 ..... 3
3. Conidia cylindrical or subcylindrical, 15–70(–80) × (2–)3–4(–4.5) µm, base truncate, occasionally slightly obconically truncate, (1.5–)2–3 µm wide  
 ..... *P. eucalyptorum*
3. Short conidia cylindrical, longer conidia broadly acicular, gradually attenuated from a truncate base towards the apex, 40–180 × (2.5–)3–5.5(–6) µm, base (2.5–)3–4(–5) µm wide  
 ..... *P. acerosa*

Three different species of cercosporoid hyphomycetes are found on *E. nitens* in New Zealand, viz, *Pseudocercospora acerosa*, *P. eucalyptorum*, and *P. pseudobasitruncata*, whereas each of the other 12 eucalypt hosts reported here supports only one species of *Pseudocercospora*. Although *Eucalyptus* is an Australian genus, most cercosporoid species infecting the genus have been described from other parts of the world and have not yet been collected in Australia. Based on the general assumption of a close co-evolution between hosts and their pathogenic fungi, it can be supposed that *Mycosphaerella* spp. and their anamorphs originate from Australia, but little is known about these fungi on eucalypts in their natural habitats. Eucalypts have been cultivated for less than 200 years, more than 90% of the plantation forests have been established since 1955 and about half in the last two decades (Turnbull 1991), which is a period much too short for the evolution of "new species" outside Australia. Crous & Wingfield (1997) speculated that pathogens of some other hosts of the Myrtaceae could have adapted to eucalypts, but this assumption could not be confirmed in detailed examinations carried out by Crous (1999).

It is probable that additional species of *Pseudocercospora* may occur in New Zealand. Therefore, it is deemed useful to provide a revised general key, based on the key by Crous (1998), supplemented by the new species described in the present paper.

#### REVISED KEY TO THE SPECIES OF *PSEUDOCERCOSPORA* ON *EUCALYPTUS* FOLIAGE WORLDWIDE

1. Conidiophores fasciculate, usually subcylindrical and unilocal, determinate or percurrently proliferating, with 1–3 conspicuous annellations; conidia broadly acicular (gradually tapering from a truncate base towards the apex), short conidia subcylindrical-obclavate, 40–100 × 4–7 μm, base 4–5 μm wide; on *Eucalyptus nitens*; New Zealand  
..... *P. pseudobasitruncata* U.Braun & M.Dick
1. Conidiophores fasciculate as well as solitary, arising from creeping hyphae, or conidial shape different, or conidial base obconically truncate and usually < 4 μm wide  
..... 2
2. Conidia distinctly cylindrical or acicular (gradually tapering from base to apex), base truncate (or only slightly attenuated at the very base)  
..... 3
2. Conidia obclavate to obclavate-subcylindrical, base distinctly attenuated (short to long obconically truncate)  
..... 11
3. Conidia consistently cylindrical or subcylindrical, not attenuated towards the apex  
..... 4
3. At least long conidia distinctly acicular, base truncate, gradually tapering towards an obtuse or subacute apex  
..... 6

4. Conidiophores consistently solitary, arising from creeping superficial hyphae as short lateral projections; conidia narrow,  $35\text{--}100 \times 2\text{--}3 \mu\text{m}$ , 3- to 11-septate; on *E. urophylla* S.T.Blake; Indonesia  
..... *P. gracilis* Crous & Alfenas
4. Conidiophores solitary, arising from creeping hyphae, as well as fasciculate or even forming sporodochial conidiomata  
..... 5
5. Leaf spots more or less angular-irregular; conidia  $15\text{--}70\text{--}(80) \times 2\text{--}4.5 \mu\text{m}$ , 1- to 7-septate (*in vivo*), subhyaline to pale olivaceous or olivaceous-brown, smooth to faintly rough-walled, often with irregular swellings; on a wide range of eucalypts, widespread  
..... *P. eucalyptorum* Crous *et al.*
5. Leaf spots subcircular; conidia longer,  $(45\text{--})70\text{--}80\text{--}(110) \times (2.5\text{--})3\text{--}3.5 \mu\text{m}$ , 3- to 9-septate, darker, light to medium brown, verruculose, swellings lacking; on *E. robusta* Smith; Malaysia  
..... *P. robusta* Crous & M.J.Wingf.
6. Conidia  $40\text{--}180 \times (2.5\text{--})3\text{--}5.5\text{--}(6) \mu\text{m}$ , 4- to 15-septate, base  $(2.5\text{--})3\text{--}4\text{--}(5) \mu\text{m}$  wide; conidiophores in loose, divergent fascicles, often decumbent, or solitary, long,  $20\text{--}220 \times 3\text{--}8 \mu\text{m}$ , pluriseptate throughout; on *E. baxteri* and *E. nitens*; New Zealand  
..... *P. acerosa* U.Braun & M.Dick
6. Conidia narrower,  $2\text{--}3\text{--}(4) \mu\text{m}$ , base also narrower,  $1.5\text{--}3 \mu\text{m}$ ; conidiophores in denser fascicles, arising from stromata, erect, shorter,  $10\text{--}60 \mu\text{m}$  long  
..... 7
7. Conidia relatively short,  $(20\text{--})30\text{--}40\text{--}(50) \mu\text{m}$ , 0- to 3-septate, olivaceous; on *Eucalyptus* sp.; Cuba  
..... *P. cubae* Crous
7. Conidia longer, exceeding  $50 \mu\text{m}$ , pluriseptate  
..... 8
8. Superficial secondary mycelium lacking; conidiophores in small fascicles, not arising from stromata; conidia  $(40\text{--})60\text{--}100 \times 2\text{--}3 \mu\text{m}$ , (4-)6- to 10(12)-septate; on *E. citriodora* Hooker; Australia  
..... *P. eucalyptigena* U. Braun
8. Superficial secondary mycelium with solitary conidiophores present or conidiophores in large fascicles arising from well-developed stromata and/or conidia shorter  
..... 9
9. Caespituli grey on leaves; with irregular annellations on conidiogenous cells; conidia olivaceous to medium brown,  $(25\text{--})45\text{--}70\text{--}(100) \times 2.5\text{--}3\text{--}(4) \mu\text{m}$ ; on *E. grandis* Maiden and *Eucalyptus* sp.; Colombia  
..... *P. basitruncata* Crous
9. Caespituli brown on leaves; annellations inconspicuous and aggregated on conidiogenous cells when present  
..... 10

10. Leaf spots angular to subcircular, light to dark brown, 1–9 mm diam.; annellations fine, aggregated at apices of conidiogenous cells when present; conidia olivaceous to light brown, smooth or only faintly rough-walled,  $(30\text{--})50\text{--}85\text{--}(110) \times (2\text{--})2.5\text{--}3\text{--}(3.5) \mu\text{m}$  *in vivo* (*in vitro* often longer); on *E. nitens*; South Africa  
 ..... *P. natalensis* Crous & T.Coutinho
10. Leaf spots subcircular, light brown to grey, 3–15 mm diam.; annellations lacking; conidia darker, light to medium brown, verruculose,  $(35\text{--})45\text{--}75\text{--}(85) \times 2.5\text{--}3 \mu\text{m}$  (*in vivo*), *in vitro* up to  $200 \times 1.5\text{--}2 \mu\text{m}$ ; on *E. saligna* Smith; South Africa  
 ..... *P. irregulariramosa* Crous & M.J.Wingf.  
 (*Mycosphaerella irregulariramosa* Crous & M.J.Wingf.)
11. Conidia with irregular swellings, medium brown, becoming olivaceous near the apex, verruculose, 1- to 7-septate,  $(17\text{--})45\text{--}65\text{--}(90) \times 3.5\text{--}4\text{--}(5) \mu\text{m}$ , hila 1.5–2  $\mu\text{m}$  wide; conidiogenous cells verruculose, proliferation sympodial and percurrent with irregular annellations; on *Eucalyptus* sp.; Peru  
 ..... *P. irregularis* Crous
11. Conidia uniformly obclavate, without swellings  
 ..... 12
12. Conidiogenous loci and conidia with a minute thickening along the rim (*Paracercospora*-like), lateral branchlets frequently present, conidia  $(35\text{--})50\text{--}70\text{--}(80) \times 2\text{--}(3) \mu\text{m}$ ; on *E. camaldulensis* Denh. and *E. pellita* F.Muell.; Thailand  
 ..... *P. basiramifera* Crous
12. Conidiogenous loci and hila completely unthickened  
 ..... 13
13. Leaf spots lacking; conidiophores reduced to very short denticle-like conidiogenous cells, solitary, arising from creeping hyphae, lateral,  $3\text{--}10 \times 2\text{--}3.5 \mu\text{m}$ ; conidia  $(25\text{--})40\text{--}90\text{--}(150) \mu\text{m}$  long; on *Eucalyptus* sp.; Indonesia  
 ..... *P. heimii* Crous & M.J.Wingf.
13. Conidiophores much longer  
 ..... 14
14. Conidiogenous cells distinctly denticulate  
 ..... 15
14. Conidiogenous cells non-denticulate  
 ..... 16
15. Lesions irregular, varying from specks to angular or subcircular spots, 1–8 mm diam., margin red-purple; conidia olivaceous, 1- to 5-septate,  $(25\text{--})40\text{--}50\text{--}(70) \times 2\text{--}2.5\text{--}(3) \mu\text{m}$ ; on *E. globulus* Labill. and *Eucalyptus* sp.; Dominican Rep. and Japan  
 ..... *P. denticulata* Crous
15. Lesions irregular, elongated, 5–15 mm diam.; conidia olivaceous-brown, pluriseptate,  $55\text{--}300 \times 2.5\text{--}3 \mu\text{m}$ ; on *E. obliqua*, *E. urophylla*, *Eucalyptus* sp.; Indonesia, Madagascar  
 ..... *P. heimii* Crous (*Mycosphaerella heimii* Bouriquet ex Crous)

16. Conidiophores medium brown, almost smooth to verruculose, thick-walled, in loose fascicles,  $30\text{--}120 \times 3\text{--}6 \mu\text{m}$ ; conidia light to medium brown, smooth to verruculose, 0- to 8-septate,  $(35\text{--})45\text{--}70(\text{--}80) \times (3\text{--})3.5\text{--}4(\text{--}4.5) \mu\text{m}$ ; mycelium only internal; on *E. deglupta* Blakely; Malaysia, Papua-New Guinea  
..... *P. deglupta* Crous
16. Conidiophores shorter than  $60 \mu\text{m}$  or with secondary superficial mycelium and solitary conidiophores  
..... 17
17. Conidiophores reduced to conidiogenous cells, up to  $20 \mu\text{m}$  long  
..... 18
17. Conidiophores mostly septate, doliiiform to ampulliform when non-septate  
..... 19
18. Conidiophores occurring on spermogonia;  $5\text{--}20 \times 2.5\text{--}4 \mu\text{m}$ ; conidia  $28\text{--}65 \times 2\text{--}3 \mu\text{m}$ ; leaf spots subcircular to irregular,  $10\text{--}20 \text{mm}$  diam., also associated with tip die-back; on *E. grandis*  $\times$  *E. saligna*; South Africa  
..... *P. epispermogoniana* Crous & M.J. Wingf.
18. Not on spermogonia; leaf spots subcircular,  $2\text{--}10 \text{mm}$  diam.; conidiophores and conidia only formed *in vitro*, conidiophores  $2\text{--}7 \times 1.5\text{--}2.5 \mu\text{m}$ , conidia  $50\text{--}200 \times 2\text{--}3 \mu\text{m}$ ; on *E. bicostata* Labill. and *E. grandis*  $\times$  *E. camaldulensis*; South Africa  
..... *P. crystallina* Crous & M.J. Wingf.  
(*Mycosphaerella crystallina* Crous & M.J. Wingf.)
19. Conidiophores in loose fascicles, emerging through stomata, or solitary, arising from superficial hyphae,  $5\text{--}100 \mu\text{m}$  long, aseptate to pluriseptate throughout, often branched; conidia  $(20\text{--})35\text{--}115(\text{--}140) \times 3\text{--}5 \mu\text{m}$ , (2-)3- to 12(15)-septate; on a wide range of *Eucalyptus* spp.; New Zealand  
..... *P. crousii* U. Braun & M. Dick
19. Conidiophores solitary or fasciculate, at least partly erumpent through the cuticle, erect, shorter,  $10\text{--}30 \mu\text{m}$  long, 0- to 2-septate; conidia narrower  $(25\text{--})30\text{--}70(\text{--}80) \times (1.5\text{--})2\text{--}3(\text{--}3.5) \mu\text{m}$ , 1- to 7(8)-septate  
..... 20
20. Leaf spots angular, confined by leaf veins, light to medium brown,  $1\text{--}4 \text{mm}$  diam., border hardly or slightly raised, margin thin, indefinite or reddish; conidiophores cylindrical, 0- to 2-septate,  $10\text{--}30 \times 2\text{--}4 \mu\text{m}$ ; conidia (1-)3- to 7(8)-septate,  $(25\text{--})30\text{--}70(\text{--}80) \times (1.5\text{--})2\text{--}3(\text{--}3.5) \mu\text{m}$ , subhyaline to pale olivaceous; on *E. citriodora*, *E. globulus*, *E. nitens*, *Eucalyptus* sp.; Brazil, India\*, Israel, Paraguay, Taiwan, Vanuatu\*  
..... *P. paraguayensis* (T. Kobay.) Crous

\* Bagaynarayana *et al.* (1995) and Braun *et al.* (1999) recorded *Pseudocercospora eucalyptorum* on *Eucalyptus* sp. from India and Vanuatu, respectively. In these papers, *P. eucalypti* Goh & W.H. Hsieh (Hsieh & Goh 1990) was cited as a synonym of *P. eucalyptorum*. However, Crous (1998) pointed out that *P. eucalypti*, with narrowly obclavate conidia, was a synonym of *P. paraguayensis*, and that *P. eucalyptorum* with its consistently cylindrical conidia was a separate species. The collections from India and Vanuatu have narrow obclavate conidia and belong, indeed, to *P. eucalypti* (syn. *P. paraguayensis*). The records of "*P. eucalyptorum*" from these two locations must therefore be cancelled and corrected to *P. paraguayensis*.

20. Leaf spots subcircular to irregular, 1–15 mm diam., dark brown, border raised, margin indefinite; conidiophores 0- to 1-septate, doliiform to ampulliform, 12–25 × 2.5–4.5 µm; conidia 1- to 5-septate, (25–)30–45(–60) × 2.5–3(–3.5) µm; on *E.urophylla*; Colombia

..... *P. columbiensis* Crous & M.J.Wingf.  
(*Mycosphaerella columbiensis* Crous & M.J.Wingf.)

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