

**CONTRIBUTIONS TOWARDS A MONOGRAPH OF PHOMA  
(COELOMYCETES) VI – 2**

**Section Phyllostictoides: Outline of its taxa**

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Thirty taxa in *Phoma* sect. *Phyllostictoides*, characterised by secondary septation of a variable number of conidia, are described in vitro. Two *Phyllostictoides*-like species are (re)classified in sect. *Sclerophomella* on account of certain pycnidial characteristics. Short notes on the ecology and distribution are added. Newly proposed taxa are: *Phoma acetosellae* (A.L. Sm. & Ramsb.) Aa & Boerema comb. nov., *Phoma argillacea* (Bres.) Aa & Boerema comb. nov. (teleomorph *Didymella applanata* (Niessl) Sacc.), *Phoma nepeticola* (Melnik) Dorenb. & de Gruyter comb. nov. (teleomorph *Didymella catariae* (Cooke & Ellis) Sacc.), *Phoma destructiva* var. *diversispora* de Gruyter & Boerema var. nov., *Phoma heliopsidis* (H.C. Greene) Aa & Boerema comb. nov., *Phoma laundoniae* Boerema & De Gruyter spec. nov. and *Phoma rhei* (Ellis & Everh.) Aa & Boerema comb. nov. A key is given to the cultural characteristics of all species and varieties at present recognised within the section (including the two *Phyllostictoides*-like species of *Sclerophomella*), as well as indices on host-fungus and fungus-host relations.

In Contribution VI-1 (Van der Aa et al., 2001) the characteristics, nomenclature and synonymy of *Phoma exigua* Desm., the type species of *Phoma* sect. *Phyllostictoides* Zherbele ex Boerema (Boerema, 1997), have been discussed. The present concept of that species separates a number of host-specific varieties, but *P. exigua* var. *exigua* is a plurivorous, cosmopolitan wound and weakly parasitic fungus, which has been isolated from more than 200 host genera in Eurasia. Its morphological variability clearly illustrates the various characters of the section *Phyllostictoides*: pycnidia thin-walled, pseudoparenchymatous, glabrous, but sometimes with hyphal outgrowths, usually with a predetermined opening or ostiole, but sometimes remaining closed for a long time before final formation of a pore.

The conidia have a broad range of shapes and dimensions and are mainly aseptate in vitro, but in vivo the larger conidia often become two or even more celled by secondary septation. The percentage of septate conidia depends on environmental conditions and may vary in vivo between 5 and 95%. Under normal laboratory conditions the majority of conidia always remain one-celled, but some larger conidia usually become septate.

Apart from the type of substrate, humidity and desiccation, temperature may greatly influence conidial characters of these *Phoma* species in vivo (see the discussions under *Phoma ligulicola* Boerema var. *ligulicola* (no. 5a) and *Phoma medicaginis* var. *macrospora* Boerema, Pieters & Hamers (no. 7b)).

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The name of the section *Phyllostictoides* is in line with the occurrence of many species in association with leaf spots and leaf necroses. Conform to the Saccardoan system for anamorph genera, most collections of these species were formerly arranged under '*Phyllosticta*'. The frequent occurrence of two-celled conidia in vivo explains why specimens on leaves were also classified in '*Ascochyta*', and in '*Diplodina*' when associated with stems.

The section includes species with and without chlamydo-spores; if present they are unicellular, solitary or formed in series or complexes. Various species of this section are anamorphs of species of *Didymella* Sacc. ex Sacc.

In the present paper, thirty taxa classified in section *Phyllostictoides* are described according to their characteristics in vitro, with notes on ecology and distribution. On account of their pycnidial characteristics two species, initially also included in sect. *Phyllostictoides*, are now classified in sect. *Sclerophomella* (Boerema & de Gruyter, 1998) and treated in an Appendix. A key and indices to host-fungus and fungus-host relationships of all taxa of the section (thus including the varieties of *P. exigua*) are provided. The key also includes the two species of sect. *Sclerophomella* in the Appendix. In the same way the sections *Phoma*, *Peyronellaea*, *Plenodomus*, *Heterospora*, *Sclerophomella* (documentation in the introduction of Contribution VI-1, Van der Aa et al., l.c.) and *Paraphoma* (De Gruyter & Boerema, 2002) have earlier been treated.

#### MATERIAL AND METHODS

The isolates and herbarium specimens were studied as described in Contributions I-1 and I-2 of this series (de Gruyter & Noordeloos, 1992; De Gruyter et al., 1993). Additional information on terminology (indication of colours, colony outline and mean diameter after 7 days, Q or length-width ratio) is given in Contribution VII (Boerema & de Gruyter, 1998). The isolates studied are currently kept in the culture collections of CBS, Utrecht (formerly Baarn) and the Plant Protection Service, PD, Wageningen. For synonyms in the genus *Phyllosticta* see Contribution VI-1 (Van der Aa et al., 2001).

#### KEY TO THE SPECIES AND VARIETIES OF SECTION PHYLLOSTICTOIDES

Differentiation on characteristics in vitro. The numbers refer to the species and varieties treated in the descriptive parts of Contribution VI-1 & VI-2 (Van der Aa et al., 2001; this article) on the section *Phyllostictoides*. The letter A and number preceding the varieties of *Phoma exigua* refer to those recognised in Contribution VI-1. The other numbers refer to the species and varieties treated in the present Contribution VI-2 (incl. Appendix).

- 1a. Growth-rate slow on OA, < 35 mm after 7 days . . . . . 2
- b. Growth-rate moderate to fast on OA, > 35 mm after 7 days . . . . . 6
- 2a. (Dendritic) crystals are produced on OA and MA, chlamydo-spores present, conidia 4–14 × 3–5 µm, mainly aseptate, on average 5–7 × 3–4 µm, 1-septate on average 10–12 × 4–5 µm; specific pathogen of *Arachis hypogaea*; world-wide in peanut-growing areas . . . . . 1. *P. arachidicola* (teleomorph *Didymella arachidicola*)
- b. Crystals and chlamydo-spores absent . . . . . 3
- 3a. NaOH test on OA positive, greenish, then red (E<sup>+</sup> reaction) . . . . . 4
- b. NaOH test on OA negative . . . . . 5

- 4a. Growth variable, with irregularly scalloped or lobed margin on OA and MA, (25–)50–85 mm, i. e. sometimes slow, but mostly moderate to fast growing; colonies colourless or with grey to greenish tinges, or olivaceous to olivaceous black, conidia very variable in shape and dimensions, one-celled or becoming 1-septate, very occasionally 2-septate; aseptate conidia  $2.5\text{--}12 \times 2\text{--}3.5 \mu\text{m}$ , on average  $4\text{--}7 \times 2\text{--}3.5 \mu\text{m}$ , 1(–2)-septate conidia  $5.5\text{--}13 \times 2.5\text{--}5 \mu\text{m}$ , on average  $7\text{--}10 \times 2.5\text{--}3.5 \mu\text{m}$ ; plurivorous wound and weakly parasitic fungus; world-wide

A1. *P. exigua* var. *exigua*

NB A separate key with table to the host-specific varieties of this fungus is given in Van der Aa et al., 2001.

- b. Growth-rate relatively slow on OA and MA, 20–45 mm; colonies compact, olivaceous grey to olivaceous black, conidia like those of the typical variety; seed-borne pathogen of *Linum usitatissimum*; recorded in Europe and New Zealand
- 5a. Colonies on OA irregular, grey olivaceous to olivaceous, citrine near margin, with finely floccose to woolly, white aerial mycelium, aseptate conidia  $6.5\text{--}11.5 \times 2.5\text{--}3(–3.5) \mu\text{m}$ , conidiogenous cells relatively large,  $5\text{--}13 \times 6\text{--}12 \mu\text{m}$ , septate conidia up to  $13 \times 5 \mu\text{m}$ ; pathogenic on *Rumex acetosella*; in Europe and North America

A2. *P. exigua* var. *linicola*

- b. Colonies on OA irregular, olivaceous buff/pale luteous to citrine/olivaceous, with very sparse, velvety, white aerial mycelium, aseptate conidia  $4\text{--}7.5(–13) \times 2\text{--}4 \mu\text{m}$ , conidiogenous cells  $4\text{--}7 \times 4\text{--}7 \mu\text{m}$ , septate conidia up to  $13 \times 4 \mu\text{m}$ ; cosmopolitan pathogen of *Rubus idaeus*

3. *P. argillacea* (teleomorph *Didymella applanata*)

- 6a. Growth-rate moderate on OA, 35–50 mm after 7 days ..... 7
- b. Growth-rate fast on OA, at least 50 mm after 7 days ..... 19
- 7a. NaOH test on OA positive, greenish, then red (E<sup>+</sup> reaction) ..... 8
- b. NaOH test on OA if positive, not an E<sup>+</sup> reaction ..... 9
- 8a. Growth-rate variable on OA and MA, (25–)50 mm, i. e. mostly moderate to fast growing; colonies lobed or scalloped, colourless or with various grey to greenish tinges, or olivaceous to olivaceous black; plurivorous wound and weakly parasitic fungus (see further 4a) ..... A1. *P. exigua* var. *exigua*
- b. Growth-rate moderate on OA, 40–50 mm, relatively slow on MA and CA, 20–25(–30) mm; on OA colonies rather dark, grey olivaceous to olivaceous grey/olivaceous black, with white to pale olivaceous grey/glaucous grey aerial mycelium, for conidia see 4a; specific pathogen of *Nerium oleander*; in Europe and United States ..... A3. *P. exigua* var. *heteromorpha*
- 9a. Av. l/b ratio (Q) aseptate conidia < 3, av. l/b ratio (Q) septate conidia > 3, colonies on OA irregular due to recolonising sectors, greenish olivaceous/citrine to grey olivaceous, olivaceous buff near margin, with sparse, finely floccose, white to pale grey olivaceous aerial mycelium, aseptate conidia  $(4\text{--})5\text{--}7(–11.5) \times 2.5\text{--}5 \mu\text{m}$ , septate conidia  $9.5\text{--}14.5 \times 2.5\text{--}5 \mu\text{m}$ ; common pathogen of *Nepeta cataria*; also on other *Nepeta* spp. in Eurasia and North America
4. *P. nepeticola* (teleomorph *Didymella catariae*)
- b. Av. l/b ratio (Q) aseptate and septate conidia < 3 ..... 10

- c. Av. l/b ratio (Q) aseptate and septate conidia > 3, colonies on OA citrine green/greenish olivaceous to herbage green, aseptate conidia (5.5–)7–9 (–12) × 2–3(–4) μm, septate conidia 9.5–13 × 2.5–3.5 μm, pathogen of *Polemonium caeruleum*. Pycnidial wall composed of relatively thick-walled pseudoparenchyma sect. *Sclerophomella* (Appendix) . . . . 28. *P. polemonii*
- 10a. Both *Phoma* anamorph and *Didymella* teleomorph are formed in vitro, colonies grey olivaceous to dull green, conidia aseptate, (3.5–)5–8(–13.5) × 2–3(–4) μm, septate conidia up to 15 × 5 μm; pathogen on wild and cultivated Compositae; in Europe and Australia
- 5b. *P. ligulicola* var. *inoxydabilis*  
(teleomorph *Didymella ligulicola* var. *inoxydabilis*)
- NB The faster growing type variety of this fungus does not produce pseudothecia in vitro and only occasionally in vivo:
- 5a. *P. ligulicola* var. *ligulicola*  
(teleomorph *Didymella ligulicola* var. *ligulicola*, see this key 28b)
- b. Only a *Phoma* anamorph is formed in vitro . . . . . 11
- 11a. Colonies on OA peach/sienna to red/blood colour or dark vinaceous, due to the occurrence of a red pigment in the hyphae, with NaOH a violet colour may develop (not an E<sup>+</sup> reaction), conidia (4–)5–8(–11) × 2–3(–4) μm, septate conidia 8.5–14 × 2.5–4 μm; plurivorous weak- and wound parasite; world-wide
- 6a. *P. macrostoma* var. *macrostom*
- NB This fungus may lose the ability to produce red pigment in the hyphae:
- 6b. *P. macrostoma* var. *incolorata*, see this key 18a
- b. Red pigment in hyphae absent, NaOH test on OA negative . . . . . 12
- 12a. Especially on MA (dendritic) crystals are formed. In older cultures chlamydospores may be produced, conidia aseptate, 5–7(–10.5) × 1.5–4 μm, septate conidia sparse and of similar size; seed-borne pathogen of *Medicago sativa*; world-wide
- 7a. *P. medicaginis* var. *medicaginis*  
7b. *P. medicaginis* var. *macrospora*
- NB The differentiation of these two varieties is based on conidial diversity in vivo, especially at low temperatures. They are similar on agar media.
- b. Crystals absent, chlamydospores absent . . . . . 13
- 13a. Colonies rather dark on OA, greenish olivaceous to grey olivaceous/olivaceous grey, or olivaceous to olivaceous black, aseptate conidia and septate conidia of similar size . . . . . 14
- b. Colonies on OA colourless to grey olivaceous to dull green/citrine green or rosy buff, aseptate conidia and septate conidia of similar size . . . . . 15
- c. Colonies on OA with pale primrose tinges, aseptate conidia 4–10.5 × 2–5 μm, septate conidia of similar size or significantly larger, 12–20.5 × 3.5–5 μm (ascochytoid); pathogen of *Lycium halimifolium*; in Europe and North America. Pycnidia thick-walled, often closed → sect. *Sclerophomella* (Appendix) . . . . . 29. *P. protuberans*
- 14a. Colonies on OA greenish olivaceous/grey olivaceous to olivaceous, aseptate conidia (3.5–)5–7(–9.5) × 2.5–3.5 μm, septate conidia 6.5–13.5 × 3–4.5 μm; pathogen of *Sedum telephium*; in Europe . . . . . 8. *P. telephii*
- b. Growth-rate moderate on OA, 40–50 mm, relatively slow on MA and CA, 20–25(–30) mm; on OA colonies rather dark, grey olivaceous to olivaceous grey/

- olivaceous black, with white to pale olivaceous grey/glaucous grey aerial mycelium, for conidia see 4a; specific pathogen of *Nerium oleander*; in Europe and United States . . . . . A3. *P. exigua* var. *heteromorpha*
- 15a. Colonies on MA colourless to dull green, grey olivaceous/olivaceous grey or rosy buff . . . . . 16
- b. Colonies on MA hazel/olivaceous or primrose/olivaceous buff/honey . . . . . 18
- 16a. Colonies on OA colourless to grey olivaceous, with pale olivaceous grey to glaucous grey aerial mycelium, for conidia see 4a; an opportunistic pathogen on *Populus* spp. (occasionally on *Salix* sp.); in Europe . . . A4. *P. exigua* var. *populi*
- b. Colonies on OA colourless to (rosy) buff, dull green or olivaceous. . . . . 17
- 17a. Colonies on MA colourless to dull green, conidial exudate rosy buff to rosy vinaceous, aseptate conidia 4–7(–9) × 1.5–2.5(–3) µm, septate conidia 8.5–11.5 × 2–3.5 µm; pathogen of *Lycopersicon esculentum*; in Europe
9. *P. destructiva* var. *diversispora*
- NB The type variety of *P. destructiva* produces only aseptate conidia and therefore has been included in sect. *Phoma*.
- b. Colonies on MA colourless to rosy buff, or pale olivaceous grey to dull green, conidial exudate buff, aseptate conidia (4–)5–7(–8.5) × (1.5)2–3(–3.5) µm, septate conidia up to 10 µm; pathogen on *Digitalis* spp.; in Europe and New Zealand
10. *P. digitalis*
- 18a. Colonies on MA primrose/olivaceous buff, often with pale honey/olivaceous sectors, conidial exudate white to buff/rosy buff, pigmentless variety of *P. macrostoma* (see 11a) weak- and wound parasite; world-wide
- 6b. *P. macrostoma* var. *incolorata*
- b. Colonies on MA hazel to olivaceous, conidial exudate off-white to primrose, aseptate conidia (5–)6–8.5(–11) × 2–3.5 µm, septate conidia up to 13.5 × 4 µm; on fruits of *Prunus persica*; in New Zealand . . . . . 11. *P. laundoniae*
- 19a. Crystals formed, especially on MA; a diffusing pigment may be produced on OA and MA . . . . . 20
- b. Crystals absent, non-diffusable pigment produced on OA and MA . . . . . 26
- 20a. Chlamydo-spores present . . . . . 21
- b. Chlamydo-spores absent . . . . . 23
- 21a. Crystals needle-like, citrine green to yellow green, chlamydo-spores only present when induced by bacteria, 1.8–3.7 µm diameter . . . . . 24
- b. Crystals bryoid to dendritic, whitish, chlamydo-spores always produced . . . . . 22
- 22a. Colonies on OA greenish/yellowish olivaceous to olivaceous, (a)septate conidia 4–7.5 × 2–3.5 µm, chlamydo-spores 8–20 µm diameter, crystals readily produced on MA after 7 days; pathogen of leguminous plants; world-wide
13. *P. pinodella*
- b. Colonies on OA colourless to pale olivaceous grey or greenish olivaceous/grey olivaceous, aseptate conidia 5–8 × 2–3.5 µm, septate conidia up to 12.5 × 5 µm, chlamydo-spores 8–16 µm, crystals specifically produced in fresh isolates on MA; pathogen on *Glycine max*; Eurasia . . . . . 14. *P. sojicola*
- 23a. Diffusible pigment crystallises as yellow speckles on MA, growth-rate on OA and MA extremely fast, > 80 mm after 7 days, aseptate conidia 5–10 × 2.5–4 µm, septate conidia up to 14 × 5 µm; pathogen of *Matteuccia struthiopteris*; South America, Canada, Europe . . . . . 15. *P. matteucciicola*

- b. Crystals needle-like on MA, citrine green to yellow green, growth-rate on OA and MA < 80 mm after 7 days . . . . . 24
- 24a. Growth-rate fast on MA, similar to those on OA, 65–80 mm, colonies on OA buff/honey/amber due to diffusible pigments, crystals on MA present, needle-like, citrine green to yellow green, (a)septate conidia (3.5–)5–7(–11.5) × (1.5–)2–3(–3.5) μm, pathogen of *Chenopodium quinoa* in South America, known causes gangrene of tubers of *Solanum tuberosum* in Europe . . . . . 12. *P. foveata*
- b. Growth-rate on MA slow to moderate, up to 50 mm, also diffusible pigment on OA and needle-like crystals present on MA . . . . . 25
- 25a. Growth-rate on MA 50 mm, colonies on OA honey to pale luteous due to a diffusible pigment, on MA crystals needle-like, citrine green to yellow green, aseptate conidia (5.5–)6.5–11 × 2–4 μm, septate conidia 9–14.5 × 3–5 μm; pathogen of *Rudbeckia* spp.; in North America and Europe . . . . . 16. *P. rudbeckiae*
- b. Growth-rate on MA slow to moderate, 30–40 mm, colonies on OA pale luteous to amber, due to a diffusible pigment, crystals on MA needle-like, citrine green to yellow green, aseptate conidia (3–)5–6.5(–8.5) × 1.5–3 μm; necrophyte on *Artemisia* spp.; in Europe . . . . . 17. *P. artemisiicola*
- 26a. NaOH test positive, green, later red (E<sup>+</sup> reaction) . . . . . 27
- b. NaOH test negative or if positive, not an E<sup>+</sup> reaction . . . . . 31
- 27a. Growth on MA irregular, with a scalloped or lobed margin, growth-rate on MA somewhat slower than those on OA . . . . . 28
- b. Growth on MA regular to slightly irregular, growth-rate on MA similar to that on OA . . . . . 29
- 28a. Growth-rate on OA variable, (25–)50–85 mm; colonies colourless or with various grey to greenish tinges, or olivaceous to olivaceous black; plurivorous wound and weakly parasitic fungus (see further 4a) . . . . . A1. *P. exigua* var. *exigua*
- b. Growth-rate on OA 68–72 mm, colonies colourless/greenish olivaceous to dull green/olivaceous, discolouring to sienna due to a diffusible pigment, for conidial dimensions see 10a; specific pathogen on *Dendranthema*-Grandiflorum hybrids (florist's chrysanthemum) . . . . . 5a. *P. ligulicola* var. *ligulicola*  
(teleomorph *Didymella ligulicola* var. *ligulicola*)
- NB The slower growing E<sup>-</sup> variety of this fungus produces pseudothecia also in vitro:  
5b. *P. ligulicola* var. *inoxydabilis*  
(teleomorph *Didymella ligulicola* var. *inoxydabilis*, see this key 10a.)
- 29a. Av. l/b ratio (Q) aseptate conidia > 3, growth-rate on OA 65–75 mm, colonies grey olivaceous/olivaceous grey, aseptate conidia 4–9.5 × 1.5–2.5 μm, septate conidia up to 12 × 3.5 μm; pathogen of *Nemophila* spp.; in Europe and North America . . . . . 18. *P. nemophilae*
- b. Av. l/b ratio (Q) aseptate conidia < 3 . . . . . 30
- 30a. Growth-rate on OA 68–82 mm after 7 days, colonies dark, greenish olivaceous to grey olivaceous/olivaceous grey, conidial exudate off-white to buff, conidia mainly aseptate, (3.5–)5–8(–10.5) × 2–3.5 μm; pathogen of *Sambucus nigra*; in Eurasia . . . . . 19. *P. sambuci-nigrae*
- b. Growth-rate on OA 60–63 mm after 5 days, colonies colourless to olivaceous grey/grey olivaceous, conidial exudate buff to rosy buff/salmon, (a)septate conidia relatively small, 4.5–6.5 × 2–3 μm; pathogenic on *Mentha* spp., occasionally on other Labiatae; world-wide . . . . . 20. *P. strasserii*

- 31a. Aseptate conidia  $4-10.5 \times 2-5 \mu\text{m}$ , septate conidia of similar size or significantly larger,  $12-20.5 \times 3.5-5 \mu\text{m}$  (ascochytoïd) . . . . . 13c
- b. Septate conidia not significantly larger . . . . . 32
- 32a. Growth-rate on MA < 60 mm . . . . . 33
- b. Growth-rate on MA > 60 mm . . . . . 37
- 33a. Growth-rate on MA up to 40 mm, colonies on OA colourless to grey olivaceous, with pale olivaceous grey to glaucous grey aerial mycelium, for conidia see 4a; an opportunistic pathogen on *Populus* spp. (occasionally on *Salix* sp.); in Europe  
A4. *P. exigua* var. *populi*
- b. Growth-rate on MA > 40 mm . . . . . 34
- 34a. Growth-rate on OA < 60 mm . . . . . 35
- b. Growth-rate on OA > 60 mm . . . . . 36
- 35a. Colonies on OA and MA with peach/sienna to red/blood colour or dark vinaceous, due to the occurrence of a red pigment in the hyphae, with NaOH a violet colour may appear (not an E<sup>+</sup> reaction), for conidial dimensions see 11a; plurivorous weak- and wound parasite; world-wide . . . 6a. *P. macrostoma* var. *macrostoma*
- b. Colonies on OA colourless or with pale grey olivaceous/dull green sectors, on MA primrose/olivaceous buff, often with pale honey/olivaceous sectors; pigment in hyphae absent, NaOH negative (pigmentless variety of *P. macrostoma* (see above) (see 18a) . . . . . 6b. *P. macrostoma* var. *incolorata*
- 36a. Colonies on MA dull green to citrine, (a)septate conidia  $5-9(-15) \times 2-5 \mu\text{m}$ , chlamydo-spores absent; pathogen of *Rumex obtusifolius*; in New Zealand  
21. *P. rumicicola*
- b. Colonies on MA buff to grey olivaceous/olivaceous black, chlamydo-spores sometimes formed,  $10-25 \mu\text{m}$  diameter, for conidia see 4a; pathogen of *Vigna unguiculata* and *Phaseolus vulgaris*; in Africa and Europe  
A5. *P. exigua* var. *diversispora*
- 37a. Av. l/b ratio (Q) aseptate conidia > 3, colonies on OA colourless with an olivaceous/grey olivaceous to dull green stellate pattern, aseptate conidia  $(5-)-6-8(-10.5) \times 1.5-3 \mu\text{m}$ , septate conidia up to  $13 \times 3.5 \mu\text{m}$ ; pathogenic on Compositae (*Heliopsis* spp., *Ambrosia artemisiifolia*); in North America . . 22. *P. heliopsidis*
- b. Av. l/b ratio (Q) aseptate conidia < 3 . . . . . 38
- 38a. On woody plants . . . . . 39
- b. On herbaceous plants . . . . . 42
- 39a. Colonies relatively dark on OA and MA, olivaceous grey to grey olivaceous/dull green, with olivaceous black to leaden black in reverse, (a)septate conidia  $(3-)-4-7(-9) \times 2-3 \mu\text{m}$ ; pathogen of *Coffea arabica*; in Africa and Brazil  
23. *P. tarda*
- b. Colonies on OA colourless to greenish olivaceous/grey olivaceous to olivaceous grey, on MA similar, with leaden grey or olivaceous in reverse . . . . . 40
- 40a. Colonies on OA with abundant, compactly tufted, white aerial mycelium, covering entire greenish olivaceous colony; for conidia see 4a; specific pathogen of *Syringa vulgaris* (occasionally on *Forsythia*); world-wide . . . A7. *P. exigua* var. *lilacis*
- b. Colonies on OA sparse to abundant, velvety to finely floccose tufted, mainly (pale) olivaceous grey aerial mycelium; colony colourless to grey olivaceous/olivaceous grey . . . . . 41

- 41a. Colonies on OA abundant velvety/finely floccose, tufted, mainly (pale) olivaceous grey aerial mycelium, for conidia see 4a; pathogen of *Viburnum* spp. (occasionally on *Lonicera*); in Europe and North America . . . . . A8. *P. exigua* var. *viburni*
- b. Colonies on OA velvety to finely floccose/woolly, partly tufted, mainly (pale) olivaceous grey aerial mycelium, for conidia see 4a; pathogenic on *Forsythia* spp.; in Europe . . . . . A9. *P. exigua* var. *forsythiae*
- 42a. Av. l/b ratio (Q) aseptate conidia > 2.6 . . . . . 43
- b. Av. l/b ratio (Q) aseptate conidia < 2.6 . . . . . 44
- 43a. Growth-rate fast on OA, MA and CA, 70–80 mm, colonies on OA dull green, aseptate conidia 3.5–5.5(–7) × 1–2 µm, septate conidia up to 9 × 3 µm; seed-borne pathogen of Valerianaceae; in Europe . . . . . 24. *P. valerianellae*
- b. Growth-rate on OA and CA fast, 65–70 mm, on MA 60–65 mm, colonies on OA olivaceous buff to greenish olivaceous/grey olivaceous, conidia (3.5–)5–8(–10.5) × 1.5–3 µm, septate conidia up to 18 × 3 µm; pathogen of *Rheum* spp.; world-wide . . . . . 25. *P. rhei*
- 44a. Aseptate conidia relatively small, 4.5–6.5 × 2–3 µm, colonies on OA colourless to olivaceous grey/grey olivaceous; pathogenic on *Mentha* spp., occasionally on other Labiatae; world-wide (see further 30b) . . . . . 20. *P. strasseri*
- b. Aseptate conidia variable in shape and size, 3.5–8(–10) × 2–3.5 µm, septate conidia of similar size or larger, up to 15.5 × 4.5 µm . . . . . 45
- 45a. Growth-rate on OA and CA very fast, 75–85 mm, somewhat slower on MA, 65–75 mm, colonies on OA olivaceous/iron grey or grey olivaceous/olivaceous, on MA greenish olivaceous to olivaceous, chlamydospores sometimes produced, for conidia see 4a; pathogen of *Phaseolus vulgaris*; in South- and Central America  
A6. *P. exigua* var. *noackiana*
- b. Growth-rate on OA, MA and CA similar, fast, 60–85 mm, chlamydospores absent  
46
- 46a. Colonies on OA colourless/dull green to olivaceous/olivaceous grey, reverse buff to dull green/olivaceous, to leaden grey/leaden black, aseptate conidia 4–8 × 2–3 µm, septate conidia up to 10 × 4.5 µm, pseudothecia of *Didymella* teleomorph may be produced; seed-borne pathogen of *Cucurbitaceae*; world-wide  
26. *P. cucurbitacearum* (teleomorph *Didymella bryoniae*)
- b. Colonies on OA colourless/olivaceous buff to grey olivaceous, reverse grey olivaceous/olivaceous grey to olivaceous, olivaceous buff near margin, aseptate conidia (3.5–)5–8.5(–10) × 2–3.5(–4.5) µm, septate conidia up to 15.5 × 4.5 µm, in old cultures sterile, stilboid bodies may be formed; pathogen of *Lycopersicon esculentum*; in Eurasia and Africa  
27. *P. lycopersici* (teleomorph *Didymella lycopersici*)

#### HOST-FUNGUS INDEX

The numbers A1–9 indicate the varieties of *Phoma exigua* described in Contribution VI-1. The other numbers refer to the species and varieties treated in the present Contribution VI-2 [incl. Appendix]. Data on diseases and distribution are added.

#### *Plurivorous species*

Weak- and wound parasite, especially common on herbaceous plants      no. A1: *P. exigua* var. *exigua* [cosmopolitan]



- Weak- and wound parasite, especially common on woody plants
- no. 6a: *P. macrostoma* var. *macrostoma*  
no. 6b: *P. macrostoma* var. *incolorata*  
[cosmopolitan]
- Pathogen with preference for leguminous plants  
(Disease: Black Stem, Foot Rot, Leaf Spot)  
no. 13: *P. pinodella*  
[cosmopolitan]
- With specific or preferred host*
- Apocynaceae  
*Nerium oleander*  
(Disease: Dieback, Leaf Necrosis)  
no. A3: *P. exigua* var. *heteromorpha*  
[recorded in Europe and North America]
- Vinca* spp., esp. *V. minor*  
(Disease: Stem Blight, Leaf Spot)  
no. A3: *P. exigua* var. *heteromorpha*  
no. A10: *P. exigua* 'var. *inoxydabilis*'  
[applied to different E strains from Europe and North America; identity doubtful, type lost]
- Caprifoliaceae  
*Lonicera* sp.  
no. A8: *P. exigua* var. *viburni*  
[only occasionally isolated, Europe]
- Sambucus nigra*  
(Disease: Leaf Spot, Shoot Dieback)  
no. 19: *P. sambuci-nigrae*  
[recorded in Eurasia]
- Viburnum* spp.  
(Disease: Leaf Spot, Stem Lesions, Shoot Blackening)  
no. A8: *P. exigua* var. *viburni*  
[recorded in Eurasia and North America]
- Chenopodiaceae  
*Chenopodium quinoa*  
(Disease: Brown Stalk Rot)  
no. 12: *P. foveata*  
[recorded in South America]
- Compositae  
*Ambrosia artemisiifolia*  
no. 22: *P. heliopsisidis*  
[indigenous to North America]
- Artemisia* spp.  
no. 17: *P. artemisiicola*  
[recorded in southern Europe]
- Dendranthema-Grandiflorum* hybrids  
(formerly known as e.g. *Chrysanthemum morifolium* and *C. indicum*)  
(Disease: Chrysanthemum Ray (flower) Blight; but it may affect all plant parts)  
no. 5a: *P. ligulicola* var. *ligulicola*  
[cosmopolitan]
- Heliopsis* spp.  
(Disease: Leaf Spot, Stem Lesions)  
no. 22: *P. heliopsisidis*  
[indigenous to North America]

- Rudbeckia* spp., esp. *R. lacina*  
(Disease: Leaf Spot) no. 16: *P. rudbeckiae*  
[known from North America and Europe]
- Tanacetum* (*Chrysanthemum*/  
*Pyrethrum*) *cinerariifolium*,  
*T. parthenium*, no. 5b: *P. ligulicola* var. *inoxydabilis*  
[recorded in Europe and Australia]
- Zinnia violacea* (*elegans*)
- Crassulaceae
- Sedum telephium* no. 8: *P. telephii*  
(Disease: Purple Blotch Disease) [indigenous to Europe]
- Cucurbitaceae
- esp. *Cucumis sativus*, *C. melo*, no. 26: *P. cucurbitacearum*  
*Cucurbita pepo* *Citrullus vulgaris*  
(Disease: Gummy Stem Blight; (teleomorph *D. bryoniae*)  
but it may affect all plant parts) [cosmopolitan]
- Hydrophyllaceae
- Nemophila insignis* and *N. atomaria* no. 18: *P. nemophilae*  
(Disease: Damping-off of seed- [known on seeds in Europe and North  
lings and Decay of stems and leaves) America (United States)]
- Labiatae
- Mentha* spp., occasionally other no. 20: *P. strasseri*  
Labiatae, viz. *Monarda didyma* and [known from Europe, Japan, New Zealand,  
*Stachys officinalis* North America and Russia]  
(Disease: Rhizome and Stem Rot)
- Nepeta cataria* and other *Nepeta* spp. no. 4: *P. nepeticola*  
(Disease: Leaf Spot, Stem Lesions) (teleomorph *D. catariae*)  
[recorded in Eurasia and North America]
- Leguminosae
- Plurivorous with preference for no. 13: *P. pinodella*  
leguminous plants [world-wide distributed]  
(Disease: Black Stem, Foot Rot,  
Leaf Spot)
- Arachis hypogaea* no. 1: *P. arachidicola*  
(Disease: Net Blotch, Web Blotch or (teleomorph *D. arachidicola*)  
Leaf Blotch) [known from Africa, Asia, North and  
South America]
- Glycine max* no. 14: *P. sojicola*  
(Disease: Leaf - and Pod Spot)
- Medicago sativa* no. 7a: *P. medicaginis* var. *medicaginis*  
(Disease: Black Stem Disease, [cosmopolitan]  
Spring Black Stem) no. 7b: *P. medicaginis* var. *macrospora*  
[widespread in Eurasia and North America]

- Phaseolus vulgaris*  
(Disease: Black Node Disease) no. A5: *P. exigua* var. *diversispora*  
[known from Europe and East Africa]  
no. A6: *P. exigua* var. *noackiana*  
[recorded in South- and Central America]
- Vigna unguiculata*  
(Disease: Black Node Disease) no. A5: *P. exigua* var. *diversispora*  
[indigenous to Africa]
- Linaceae
- Linum usitatissimum*  
(Disease: Damping-off, Foot Rot) no. A2: *P. exigua* var. *linicola*  
[known from Europe and New Zealand]
- Oleaceae
- Forsythia* hybrids  
(Disease: Shoot Blight) no. A9: *P. exigua* var. *forsythiae*  
[known from Europe]
- Syringa vulgaris*  
(Disease: Damping-off; Leaf  
Necrosis, Dieback of Shoots) no. A7: *P. exigua* var. *lilacis*  
[known from Europe, North America and  
New Zealand]
- Polemoniaceae
- Polemonium* spp., esp. *P. caeruleum*  
(Disease: Leaf Spot) no. 28: *P. polemonii* (Appendix)  
[recorded in Eurasia and North America  
(United States)]
- Polygonaceae
- Rheum* spp.  
(Disease: Leaf Spot) no. 25: *P. rhei*  
[cosmopolitan]
- Rumex acetosella*  
(Disease: Leaf Spot, Stem Necrosis) no. 2: *P. acetosellae*  
[recorded in Europe and North America  
(United States)]
- Rumex obtusifolius*  
(Disease: Leaf Spot) no. 21: *P. rumicicola*  
[probably cosmopolitan]
- Polypodiaceae
- Matteuccia struthiopteris*,  
*Dryopteris filix-mas* and *Blechnum*  
*spicant*  
(Disease: Gangrene Disease) no. 15: *P. matteucciiicola*  
[recorded in Canada and Europe]
- Rosaceae
- Prunus persica* no. 11: *P. laundoniae*  
[isolated in New Zealand]
- Rubus idaeus*  
(Disease: Cane Blight or Spur Blight,  
irregular leaf necroses) no. 3: *P. argillacea*  
(teleomorph *D. applanata*)  
[world-wide, so far known under teleo-  
morphic name]

- Rubiaceae  
*Coffea arabica* no. 23: *P. tarda*  
 (Disease: Leaf Blight and Stem Die-back) [known from Africa (Ethiopia, Kenya, Cameroon), Brazil]
- Salicaceae  
*Populus* spp., esp. *P. nigra* and no. A4: *P. exigua* var. *populi*  
*P. (x) euramericana* [recorded in Europe]  
 (Disease: Necrotic Black Lesions)
- Salix* sp. no. A4: *P. exigua* var. *populi*  
 [only occasionally isolated]
- Scrophulariaceae  
*Digitalis* spp., especially *D. purpurea* No. 10: *P. digitalis*  
 (Disease: Leaf Spot) [recorded in Europe and New Zealand]
- Solanaceae  
*Capsicum annuum* no. A11: '*P. exigua* var. *capsici*'  
 (Seed infection: 'fruit rot-leaf spot') [invalidly published infraspecific taxon from China; identity doubtful, may refer to *Phoma destructiva* var. *diversispora* (no. 9)]
- Solanum tuberosum* no. 12: *P. foveata*  
 (Disease: Gangrene) [recorded in South America and Europe]
- Lycium halimifolium* no. 29: *P. protuberans* (Appendix)  
 (Disease: Leaf Spot) [known from Europe and North America]
- Lycopersicon esculentum* no. 27: *P. lycopersici*  
 (Disease: Canker, Stem and Fruit Rot) [common in Eurasia and Africa]
- Lycopersicon esculentum* no. 9: *P. destructiva* var. *diversispora*  
 (Disease: Necrotic Spot on leaves, leaf stalks and stems, Fruit Rot) [first recognised in the Netherlands, but probably also elsewhere, see above with *Capsicum annuum*]
- Valerianaceae no. 24: *P. valerianellae*  
*Valerianella locusta* var. *oleracea*, [common in Europe]  
*Valeriana* spp.  
 (Disease: Damping-off)

## FUNGUS-HOST INDEX

The A-numbers refer to the varieties of *Phoma exigua* described in Contribution VI-1 (Van der Aa et al., 2001). The other numbers point to species and varieties treated in the descriptive part of this paper, Contribution VI-2 [incl. Appendix].

<i>P. acetosellae</i> (2)	<i>Rumex acetosella</i> (Polygonaceae)
<i>P. arachidicola</i> (1) (teleom. <i>D. arachidicola</i> )	<i>Arachis hypogaea</i> (Leguminosae)
<i>P. argillacea</i> (3) (teleomorph <i>D. applanata</i> )	<i>Rubus idaeus</i> (Rosaceae)
<i>P. artemisiicola</i> (17)	<i>Artemisia</i> spp. (Compositae)
<i>P. cucurbitacearum</i> (26) (teleomorph <i>D. bryoniae</i> )	esp. <i>Cucumis sativus</i> , <i>C. melo</i> , <i>Cucurbita pepo</i> , <i>Citrullus vulgaris</i> (Cucurbitaceae)
<i>P. destructiva</i> var. <i>diversispora</i> (9)	<i>Lycopersicon esculentum</i> (Solanaceae)
<i>P. digitalis</i> (10)	<i>Digitalis</i> spp., especially <i>D. purpurea</i> (Scrophulariaceae)
<i>P. exigua</i> var. <i>exigua</i> (A1) ' <i>P. exigua</i> var. <i>capsici</i> ' (A11) (not valid; identity doubtful)	plurivorous (esp. herbaceous plants) <i>Capsicum annuum</i> (Solanaceae)
<i>P. exigua</i> var. <i>diversispora</i> (A5)	<i>Phaseolus vulgaris</i> , <i>Vigna unguiculata</i> (Leguminosae)
<i>P. exigua</i> var. <i>forsythiae</i> (A9)	<i>Forsythia</i> hybrids (Oleaceae)
<i>P. exigua</i> var. <i>heteromorpha</i> (A3)	<i>Nerium oleander</i> , <i>Vinca minor</i> (Apocynaceae)
<i>P. exigua</i> 'var. <i>inoxydabilis</i> ' (A10) (type lost; identity doubtful)	<i>Vinca</i> spp. esp. <i>V. minor</i> (Apocynaceae)
<i>P. exigua</i> var. <i>lilacis</i> (A7)	<i>Syringa vulgaris</i> <i>Forsythia</i> hybrid (occasionally) (Oleaceae)
<i>P. exigua</i> var. <i>linicola</i> (A2)	<i>Linum usitatissimum</i> (Linaceae)
<i>P. exigua</i> var. <i>noackiana</i> (A6)	<i>Phaseolus vulgaris</i> (Leguminosae)
<i>P. exigua</i> var. <i>populi</i> (A4)	<i>Populus</i> spp., esp. <i>P. nigra</i> and <i>P. (x) euramericana</i> <i>Salix</i> sp. (occasionally) (Salicaceae)
<i>P. exigua</i> var. <i>viburni</i> (A8)	<i>Viurnum</i> spp. <i>Lonicera</i> sp. (occasionally) (Caprifoliaceae)
<i>P. foveata</i> (12)	<i>Chenopodium quinoa</i> (Chenopodiaceae) <i>Solanum tuberosum</i> (Solanaceae)

- P. heliopsidis* (22) *Heliopsis* spp., *Ambrosia artemisiifolia*  
(Compositae)
- P. laundoniae* (11) *Prunus persica*  
(Rosaceae)
- P. ligulicola* var. *ligulicola* (5a)  
(teleomorph *D. ligulicola* var. *ligulicola*)  
*Dendranthema*-*Grandiflorum* hybrids  
(formerly known as e.g. *Chrysanthemum morifolium* and *C. indicum*)  
(Compositae)
- P. ligulicola* var. *inoxydabilis* (5b)  
(teleomorph *D. ligulicola* var. *inoxydabilis*)  
*Tanacetum* (*Chrysanthemum*/*Pyrethrum*) *cinerariifolium*, *T. parthenium*, *Zinnia violacea* (*elegans*)  
(Compositae)
- P. lycopersici* (27)  
(teleomorph *D. lycopersici*)  
*Lycopersicon esculentum*  
(Solanaceae)
- P. macrostoma* var. *macrostoma* (6a)  
*P. macrostoma* var. *incolorata* (6b)  
*P. matteucciicola* (15)  
plurivorous (esp. woody plants)  
plurivorous (esp. woody plants)  
*Matteuccia struthiopteris*, *Dryopteris filix-mas*, *Blechnum spicant*  
(Polypodiaceae)
- P. medicaginis* var. *medicaginis* (7a)  
*Medicago sativa*  
(Leguminosae)
- P. medicaginis* var. *macrospora* (7b)  
*Medicago sativa*  
(Leguminosae)
- P. nemophilae* (18)  
*Nemophila insignis* and *N. atomaria*  
(Hydrophyllaceae)
- P. nepeticola* (4)  
(teleomorph *D. catariae*)  
*Nepeta cataria*, *Nepeta* spp.  
(Labiatae)
- P. pinodella* (13)  
plurivorous, with preference Leguminosae
- P. polemonii* (28; Appendix)  
*Polemonium* spp., esp. *P. caeruleum*  
(Polemoniaceae)
- P. protuberans* (29; Appendix)  
*Lycium halimifolium*  
(Solanaceae)
- P. rhei* (25)  
*Rheum* spp.  
(Polygonaceae)
- P. rudbeckiae* (16)  
*Rudbeckia* spp., esp. *R. lacina*  
(Compositae)
- P. rumicicola* (21)  
*Rumex obtusifolius*  
(Polygonaceae)
- P. sambuci-nigrae* (19)  
*Sambucus nigra*  
(Caprifoliaceae)
- P. sojicola* (14)  
*Glycine max*  
(Leguminosae)

<i>P. strasseri</i> (20)	<i>Mentha</i> spp, occasionally other Labiatae, viz. <i>Monarda didyma</i> and <i>Stachys officinalis</i> (Labiatae)
<i>P. tarda</i> (23)	<i>Coffea arabica</i> (Rubiaceae)
<i>P. telephii</i> (8)	<i>Sedum telephium</i> (Crassulaceae)
<i>P. valerianellae</i> (24)	<i>Valerianella locusta</i> var. <i>oleracea</i> , <i>Valeriana</i> spp. (Valerianaceae)

## DESCRIPTIVE PART

Characteristics based on study in culture. Species with a teleomorph are also described in vivo<sup>1</sup>.

### 1. *Phoma arachidicola* Marasas, Pauer & Boerema — Figs. 1, 30

Teleomorph: *Didymella arachidicola* (Khokhr.) Taber et al.

*Phoma arachidicola* Marasas, Pauer & Boerema, *Phytophylactica* 6 (1974) 200.

*Selected literature.* Marasas et al. (1974), Taber et al. (1984), Noordeloos et al. (1993).

#### *Description in vitro*

A detailed description in vitro has been given in a provisional treatment dealing with *Phoma* species producing dendritic crystals (Noordeloos et al., 1993). Distinctive are the white, fan-shaped or plumose, dendritic crystals formed on malt agar after 7 days, consisting of pinodellalide A and B. The growth-rate on OA and MA is slow, up to 35 mm after 7 days. Thick-walled, brownish chlamydospores are produced, (sub-) globose or ellipsoidal, 5–15 µm diam. Conidia 4–14 × 3–5 µm, subglobose to broadly ellipsoidal, Q = 1.5–2.1, mainly aseptate, on average 5–7 × 3–4 µm, 1-septate conidia on average 10–12 × 4–5 µm (Marasas et al., 1974).

#### *Description in vivo (Arachis hypogaea)*

Pycnidia (on leaf blotches, scattered, immersed in the necrotic tissue) subglobose, 80–200 µm diam. The pycnidial cell walls are somewhat translucent. Conidia, in contrast with their being mainly aseptate occurrence in vitro, predominantly 1-septate, (7–)12–16(–17.5) × (3–)4–5(–6) µm.

Pseudothecia (not always occurring; mostly on detached leaflets, scattered, immersed in the necrotic tissue) subglobose, sometimes short beaked, (60–)70–140 (–150) µm diam. Pseudothecial wall dark brown to blackish brown. Asci cylindrical to cylindrical-clavate, 37–58(–60) × 11–15(–17) µm. Ascospores more or less biserial in the ascus, ellipsoidal, septate in the middle, upper cell wider, constricted at the sep-

1) For the type species *Phoma exigua* Desm. see Contributions VI-1 (Van der Aa et al., 2001).

tum, (12.5–)13–16 × 5–6.5(–7) µm (for detailed description and illustration, see Punithalingam, 1982b sub *Didymosphaeria arachidicola*).

*Ecology and distribution.* Widespread pathogen of peanut (*Arachis hypogaea*) in Africa, Asia, North and South America: Net Blotch, Web Blotch or Leaf Blotch. The disease is characterised by diffuse tan-coloured specks or streaks on the leaflets that merge to form circular, tan-coloured to dark brown blotches with greyish margins. A complete disintegration of the leaves is often the result. In Russia the anamorph has erroneously been referred to as *Ascochyta adzamethica* Shosh and *Ascochyta arachidis* Woron. (holotype LEV), synonyms respectively of the plurivorous *Phoma exigua* Desm. var. *exigua* (cf. Van der Aa et al., 2001) and *Phoma sorghina* (Sacc.) Boerema et al., (sect. *Peyronellaea*, Boerema, 1993).

*Representative culture.* CBS 315.90 (ATTC 96181, PD 80/1190) ex *Arachis hypogaea* (Leguminosae), Zimbabwe.

*Note.* The dendritic crystals produced in pure culture, proved to be chemically identical to those found in cultures of *Phoma pinodella* (no. 13), see Noordeloos et al. (1993).

## 2. *Phoma acetosellae* (A.L. Sm. & Ramsb.) Aa & Boerema, *comb. nov.* — Fig. 2

*Phyllosticta acetosellae* A.L. Sm. & Ramsb., Trans. Br. mycol. Soc. 4 (1912) 173 [basionym; holotype on fading leaves of *Rumex acetosella*, Glangonner, Lanaekshire, Scotland, coll. D.A. Boyd, 29 June 1912, BM].

### *Description in vitro*

OA: growth-rate 25–30 mm after 7 days (50–55 mm after 14 days), irregular, with finely floccose to woolly, white aerial mycelium; colony grey olivaceous to olivaceous, citrine near margin; reverse similar.

MA: growth-rate 20–25 mm after 7 days (35–40 mm after 14 days), irregular, with compact, finely floccose to woolly, white aerial mycelium; colony white to olivaceous grey; reverse olivaceous black to leaden black, pale luteous near margin.

CA: growth-rate 15–20 mm after 7 days (20–35 mm after 14 days), irregular, with woolly, white to pale olivaceous grey aerial mycelium; colony white to pale olivaceous grey due to aerial mycelium, with salmon tinges due to exuding conidial mass; reverse similar.

Pycnidia 90–350 µm diam., globose to subglobose, solitary or confluent, glabrous or sparsely covered by mycelial hairs, with usually 1(–2) papillate ostiole(s), honey to citrine, later olivaceous black; walls made up of 3–7 layers of cells, outer layer(s) pigmented; with rosy buff to salmon conidial exudate; scattered or in concentric zones, on the agar or submerged, as well as in aerial mycelium. Conidiogenous cells 5–13 × 6–12 µm, globose to bottle shaped. Conidia aseptate, 6.5–11.5 × 2.5–3(–3.5) µm, av. 8.2 × 2.7 µm, Q = 2.5–4.1, av. Q = 3.0, ellipsoidal to allantoid, usually with small guttules; some 1-septate conidia, up to 13 × 5 µm, may occur.

Chlamydospores absent.

NaOH spot test: negative.

Crystals absent.

*Ecology and distribution.* In Europe *Phoma acetosellae* is a common fungus on



ageing leaves of *Rumex acetosella*: Leaf Spot, Stem Necroses. The fungus is also recorded in North America (United States) and can probably be found everywhere the host occurs. For comparison with other *Phoma*-like fungi described from *Rumex* spp., see Boerema et al., 1980.

*Representative culture.* CBS 631.76 (PD 2000/1314) ex *Rumex acetosella* (Polygonaceae), France.

### 3. *Phoma argillacea* (Bres.) Aa & Boerema, *comb. nov.* — Fig. 3

Teleomorph: *Didymella applanata* (Niessl) Sacc.

*Phyllosticta argillacea* Bres., Hedwigia (1894) 206 [basionym; holotype on leaves of *Rubus idaeus*, near Königstein, coll. W. Krieger, 14 Aug. 1893, in: Krieger, Fungi saxon. (1893) No. 1187, S; idem syntype, UJ]. — *Ascochyta argillacea* (Bres.) Bond.-Mont., Mater. micol. Obsléd. Ross. 5 (4) (1922) 21 [misapplied]. — *Ascochyta argillacea* (Bres.) Grove, Br. Coelomycetes 1 (1935) 313 [misapplied].

*Selected literature* [sub *Didymella applanata*]. Koch (1931), Punithalingam (1982a).

#### *Description in vitro*

OA: growth-rate 20–35 mm after 7 days (50–75 mm after 14 days), regular, with very sparse, velvety, white aerial mycelium; colony olivaceous buff/pale luteous to citrine/olivaceous; reverse similar.

MA: growth-rate 15–20 mm after 7 days (30–55 mm after 14 days), irregular due to recolonising sectors, with compact, finely floccose to woolly, white to pale grey olivaceous aerial mycelium; colony greenish olivaceous to grey olivaceous, ochraceous near margin; reverse olivaceous to fuscous black, umber in centre, ochraceous near margin.

CA: growth-rate 15–25 mm after 7 days (40–55 mm after 14 days), irregular due to recolonising sectors, with felty, white aerial mycelium; colony umber to olivaceous, fawn near margin; reverse dark brick to sepia in centre.

Pycnidia 40–320 µm diam., globose to subglobose, solitary or confluent, glabrous or sparsely covered by mycelial hairs around ostiole, with 1 (–3) non-papillate or papillate ostiole(s), citrine/sienna, later olivaceous black; walls made up of 3–9 layers of cells, outer layer(s) pigmented; with buff to rosy buff conidial exudate; scattered, on the agar or submerged. Conidiogenous cells 4–7 × 4–7 µm, globose to bottle shaped. Conidia aseptate, 4–7.5 (–13) × 2–4 µm, av. 6.8 × 2.6 µm, Q = 1.9–3.8, av. Q = 2.6, ellipsoidal to allantoid, usually with small guttules; some 1-septate conidia, up to 13 × 4 µm, may occur.

Chlamydo-spores absent.

NaOH spot test: negative (on OA a pale reddish, non-specific colouring may develop).

Crystals absent.

#### *Description in vivo (Rubus idaeus)*

Pycnidia (scattered on stem lesions, throughout the summer and autumn, immersed in the cortex with erumpent ostioles, also scattered in necrotic lesions on leaves) subglobose, up to 260 µm diam. Conidia similar to those in vitro, mainly aseptate, on

infected cones usually  $5\text{--}11 \times 2\text{--}4 \mu\text{m}$ , mostly shorter,  $5\text{--}8 \times 3\text{--}4 \mu\text{m}$  on leaves.

Pseudothecia (on grey patches on stems late in autumn, gregarious, subepidermal in the cortex with erumpent ostioles, usually intermingled with pycnidia) subglobose, up to  $270 \mu\text{m}$  diam. Asci cylindrical to subclavate,  $(50\text{--})60\text{--}65\text{--}(75) \times 10\text{--}13\text{--}(15) \mu\text{m}$ . Ascospores almost biseriata in the ascus, obovoid to oblong, septate in the middle, sometimes inequilateral, upper cell wider, constricted at the septum,  $(12\text{--})13.5\text{--}16.5\text{--}(18) \times (5\text{--})5.5\text{--}7 \mu\text{m}$  (for detailed descriptions and illustrations see Punithalingam, 1982a and Corlett, 1974).

*Ecology and distribution.* A cosmopolitan pathogen of raspberry (*Rubus idaeus*), well-known under the teleomorphic name, but so far with an unnamed *Phoma*-anamorph. The disease is called Cane Blight or Spur Blight, but leaves may also be affected, showing irregular or 'V' shaped leaf necroses. The basionym of the above proposed anamorphic name was described from such leaf necroses on raspberry. The fungus is also recorded occasionally from other species of *Rubus*. The misapplications in *Ascochyta* refer to a quite different species, *A. idaei* Oudem.

*Representative culture.* CBS 102634 (PD 75/248) ex *Rubus idaeus* (Rosaceae), the Netherlands; CBS 205.63 (PD 20005479) ex *Rubus idaeus* (Rosaceae), the Netherlands.

#### 4. *Phoma nepeticola* (Melnik) Dorenb. & de Gruyter, *comb. nov.* — Fig. 4

Teleomorph: *Didymella catariae* (Cooke & Ellis) Sacc.

*Ascochyta nepeticola* Melnik, Novosti Sist. Nizsh. Rast. (1968) 178 [basionym]. — *Ascochyta nepetae* É. J. Marchal & Verpl., Bull. Soc. r. Bot. Belg. 59 (1926/27) 23 [illegitimate later homonym, see below].

*Ascochyta nepetae* Davis, Trans. Wisc. Acad. Sci. 19, 2 (1919) 711; not *Phoma nepetae* Sousa da Câmara, Bolm Agric., Lisb. II, Ser. 1 (1936) 32 [= *Phomopsis nepetae* (Sousa da Câmara) Sousa da Câmara, Agron. lusit. 11 (1949) 59], nor *Phoma nepetae* Brezhnev, Uchen. Zap. leningr. gos. Univ. Ser. biol. 7 (1939) 181 [illegitimate later homonym; agrees with *Phoma leonuri* Letendre, sect. *Plenodomus*, see Boerema et al., 1994].

##### *Description in vitro*

OA: growth-rate  $40\text{--}45 \text{ mm}$  after 7 days ( $65\text{--}75 \text{ mm}$  after 14 days), irregular due to recolonising sectors, with sparse, finely floccose, white to pale grey olivaceous aerial mycelium; colony greenish olivaceous/citrine to grey olivaceous, olivaceous buff near margin; reverse similar.

MA: growth-rate  $35\text{--}40 \text{ mm}$  after 7 days ( $64\text{--}75 \text{ mm}$  after 14 days), irregular due to recolonising sectors, with compact, finely floccose to woolly, white to pale grey olivaceous aerial mycelium; colony greenish olivaceous to grey olivaceous, ochraceous near margin; reverse olivaceous to fuscous black, umber in centre, ochraceous near margin.

CA: growth-rate  $30\text{--}35 \text{ mm}$  after 7 days ( $40\text{--}45 \text{ mm}$  after 14 days), irregular due to recolonising sectors, with felty, white aerial mycelium; colony umber to olivaceous, fawn near margin; reverse dark brick to sepia in centre.

Pycnidia  $70\text{--}240 \mu\text{m}$  diam., globose to subglobose, solitary or confluent, glabrous or sparsely covered by mycelial hairs, with usually one non-papillate or slightly papillate ostiole, honey to olivaceous, later olivaceous black; walls made up of  $3\text{--}7\text{--}(9)$

layers of cells, outer layer(s) pigmented; with buff to rosy buff conidial exudate; scattered or in concentric zones, on the agar or submerged. Conidiogenous cells 7–9 × 4–9 µm, globose to bottle shaped. Conidia aseptate, (4–)5–7(–11.5) × 2.5–5 µm, av. 6.4 × 3.0 µm, Q = 1.4–3.9, av. Q = 2.2, subglobose to ellipsoidal, usually with small guttules, and 1-septate, 9.5–14.5 × 2.5–5.0 µm, av. 12.3 × 3.6 µm, Q = 2.5–4.6, av. Q = 3.5, ellipsoidal to allantoid, usually with small guttules.

Fresh isolates, started from single and multi ascospores of *Didymella catariae* on dead stems of *Nepeta cataria*, also produced some pseudothecia intermingled with pycnidia in cultures on OA. They were similar in appearance to those on the host (see description below).

Chlamydospores absent.

NaOH spot test: negative (on OA a pale reddish, non-specific colour may develop).

Crystals absent.

*Note.* In 4-week-old cultures the earliest pycnidia produced elongated/septate conidiogenous cells, resembling those of *Pyrenochaeta*. This phenomenon is well known in older cultures of *Phoma* spp.

#### *Description in vivo (Nepeta cataria)*

Pycnidia (on leaf necroses and dry stems, subepidermal/semi-immersed, scattered) variable in dimensions, 80–200(–300) µm diam., depressed globose with more or less papillate ostiole. Pycnidial wall thin on leaves, thicker on stems. Conidia subcylindrical or sometimes slightly flexuous, mainly 1-septate, 8–15(–17) × (2.5–)3–4.5(–5) µm.

Pseudothecia (on dead stems, subepidermal, scattered or crowded) globose to subglobose, relatively small, 120–200 µm diam. with papillate pore. Asci subclavate, (52–)76–96 × (12.5–)13.5–17.5(–20) µm. Ascospores biseriolate, ellipsoidal, septate in the middle and with rounded to acute ends, constricted at the septum, (13.5–)16–18.5 × 5–7(–8) µm (information additional to original description).

*Ecology and distribution.* A common pathogen of *Nepeta cataria*, a medicinal herb (catmint) indigenous to the eastern Mediterranean, but becoming naturalized throughout Europe, and also known in North America. The fungus is also recorded on other species of *Nepeta*, and apparently widely distributed in Eurasia and North America (Canada, USA). According to the 'Ascochyta monography' by Melnik (1977) the fungus should also affect other Labiatae, such as *Leonurus cardiaca* and *Mentha* spp. This is quite plausible, but still needs to be confirmed by pathogenicity tests. Melnik listed the anamorph under *Ascochyta leonuri* Ellis & Dearn., as distinct from *Phoma leonuri* Letendre, treated under sect. *Plenodomus* (Boerema et al., 1994; teleomorph *Leptosphaeria slovacica* Picb.).

*Representative culture.* CBS 102635 (PD 77/1131) ex *Nepeta cataria* (Labiatae), the Netherlands (leg. M.M.J. Dorenbosch, isolate from ascospores of *Didymella catariae*).

#### 5a. *Phoma ligulicola* Boerema var. *ligulicola* — Fig. 5a

Teleomorph: *Didymella ligulicola* (Baker et al.) Arx var. *ligulicola*.

*Phoma ligulicola* Boerema, in: Van der Aa, Noordeloos & de Gruyter, Stud. Mycol. 32 (1990)



Figs. 1–9. Conidia. 1. *Phoma arachidicola*; 2. *Phoma acetosellae*; 3. *Phoma argillacea*; 4. *Phoma nepeticola*; 5a. *Phoma ligulicola* var. *ligulicola*; 5b. *Phoma ligulicola* var. *inoxydabilis*; 6a. *Phoma macrostoma* var. *macrostoma*; 6b. *Phoma macrostoma* var. *incolorata*; 7a. *Phoma medicaginis* var. *medicaginis*; 7b. *Phoma medicaginis* var. *macrospora*; 8. *Phoma telephii*; 9. *Phoma destructiva* var. *diversispora* — Bar = 10  $\mu$ m.

9, var. *ligulicola*. — *Ascochyta chrysanthemi* F. Stevens, Bot. Gaz. 44 (1907) 246; not *Phoma chrysanthemi* Voglino, Malpighia 15 (1902) 332 [see below under *P. ligulicola* var. *inoxydabilis*].  
*Selected literature*. EPPO (1980a), Van der Aa et al. (1990).

#### *Description in vitro*

OA: growth-rate 68–72 mm after 7 days, regular to slightly irregular, with sparse to abundant, felted to floccose, white to pale olivaceous grey aerial mycelium; colony colourless/greenish olivaceous to dull green/olivaceous, often in a zonate pattern, more or less discolouring to sienna due to a diffusible pigment; reverse grey olivaceous to fawn-hazel or olivaceous grey.

MA: growth-rate 48–63 mm after 7 days, irregular, with felty, pale olivaceous grey to smoke grey aerial mycelium; colony grey olivaceous/dull green to olivaceous black, often in a zonate pattern, sometimes with a salmon shade due to conidial mass, a discolouring of the agar to pale luteous due to a diffusible pigment may occur; reverse similar.

CA: growth-rate 68–72 mm after 7 days, irregular, with felted white to pale olivaceous grey aerial mycelium; colony zonate, olivaceous, agar staining sienna to scarlet due to a diffusible pigment; reverse similar.

Pycnidia 80–270 µm diam., globose to subglobose, solitary to confluent, glabrous or with mycelial outgrowths, with usually one, sometimes slightly papillate ostiole; citrine to honey, later olivaceous to olivaceous black; walls made up of 2–7 layers of cells, outer layers pigmented; with saffron conidial exudate; on or in the agar. Conidigenous cells 3–8 × 5–8 µm, globose to bottle-shaped. Conidia mostly aseptate, 3.5–7.5(–12) × 2–3(–4) µm, av. 5.4–5.6 × 2.4–2.5 µm, Q = 1.5–3.1, av. Q = 2.2–2.3, ellipsoidal to oblong, with several small guttules; 1-septate conidia 9–15 × 3–5 µm, av. 11.3–3.5 µm, Q = 2.5–4.5, av. Q = 3.3, but sometimes they are distinctly large, up to 23 × 8 µm (ascochytoïd; quoted in the Addendum of sect. *Heterospora*, Boerema et al., 1997).

Pseudothecia not observed in vitro.

Chlamydospores absent.

NaOH spot test: positive on OA and MA: greenish, then red (E<sup>+</sup> reaction).

Crystals absent.

#### *Description in vivo (Dendranthema-Grandiflorum hybrids)*

Pycnidia in blackened petals and in brownish black leaf blotches and stem lesions, subepidermal, aggregated or scattered of two sizes: small, 72–180 µm, in the petals, and larger, 111–325 µm, in the leaf and stem lesions, depressed globose with one inconspicuous ostiole. Conidia mostly irregular cylindrical-ellipsoidal and extremely variable in dimensions, usually partly aseptate (10–40%), (6–)8.5–13(–22) × 2.5–8 µm, and partly 1- or 2-septate (60–90%), (9–)13–15.5(–23) × (3–)4–5(–6.5) µm (ascochytoïd). The septation of the conidia should be related to the temperature.

Pseudothecia (occasionally found on old blackened leaf and stem lesions) subglobose and more erumpent than pycnidia, 96–224 µm diam. Asci cylindrical to slightly narrowed near apex, (45–)50–85(–90) × (7–)8–10(–12) µm, 8-spored, irregularly biseriate. Ascospores 12–16 × 4–6(–7) µm, ellipsoid or fusiform, approximately

medianly uniseptate, constricted at the septum, hyaline with guttules (for details and illustrations see Punithalingam, 1980).

*Ecology and distribution.* A specific pathogen of florists' chrysanthemum, *Dendranthema-Grandiflorum* hybrids (formerly known as e.g. *Chrysanthemum morifolium* and *C. indicum*). At present, this pathogen occurs nearly everywhere the host is cultivated. The fungus seems to be indigenous to Japan, but was first recorded in the south-eastern United States as the cause of *Chrysanthemum* Ray (flower) Blight. It may attack all plant parts, roots, stems, leaves and flowers. Cuttings are particularly susceptible; hence the rapid world-wide spread of the fungus since the late 1940s. The suggestion that the disease was present in Europe before the first observations were made in the United States, appeared to be due to confusion with a different teleomorph described in Italy (*Mycosphaerella chrysanthemi* (Tassi) Tomilin, see Walker & Baker, 1983) and the existence of a related fungus, occurring on various other wild and cultivated Compositae [distinguished as *P. ligulicola* var. *inoxydabilis* Boerema, listed below, e.g. characterised by the absence of antibiotic E, slower growth and frequent production of the teleomorph in vitro].

*Representative cultures.* CBS 137.96 (PD 84/75) ex *Dendranthema (Chrysanthemum) morifolium* (Compositae), the Netherlands.

### 5b. *Phoma ligulicola* var. *inoxydabilis* Boerema — Fig. 5b

Teleomorph: *Didymella ligulicola* var. *inoxydabilis* Boerema

*Phoma ligulicola* var. *inoxydabilis* Boerema, in: Van der Aa, Noordeloos & de Gruyter, Stud. Mycol. 32 (1990) 10.

*Phoma chrysanthemi* Voglino, Malpighia 15 (1902) 332 [1901] [type in TO agrees with *P. ligulicola*]. — *Phomopsis chrysanthemi* (Voglino) Costa & Sousa da Câmara, Port. Acta biol. Ser. B, Sist. (ecol., biogeogr., paleontol.) 3 (1952) 301 [misapplied].

#### *Description in vitro*

OA: growth-rate 45–50 mm after 7 days, slightly irregular, with floccose, white aerial mycelium; colony grey olivaceous to dull green; reverse greenish olivaceous/olivaceous to dull green/olivaceous black in centre.

MA: growth-rate 35–40 mm after 7 days, irregular, with woolly, white to pale olivaceous grey aerial mycelium; colony (pale) olivaceous grey to grey olivaceous, buff near margin; reverse olivaceous black, dull green near margin.

CA: growth-rate 45–50 mm after 7 days, irregular, with floccose, white to pale olivaceous grey aerial mycelium; colony dull green, buff near margin, olivaceous black centre; reverse similar.

Pycnidia 90–400 µm diam., globose to subglobose, solitary or confluent, glabrous or with mycelial outgrowths, with 1–3 papillate ostiole(s), citrine/honey, later olivaceous to olivaceous black; walls made up of 2–6 layers of cells, outer layer(s) pigmented; with off-white to buff exuded conidial masses; scattered, both on and in the agar as well as in aerial mycelium. Conidiogenous cells 4–9 × 4–9 µm, globose to bottle shaped. Conidia mainly aseptate, (3.5–)5–8(–13.5) × 2–3(–4) µm, av. 6.4 × 2.6 µm, Q = 1.3–3.7, av. Q = 2.5, ellipsoidal to allantoid, with several small guttules; 1-septate conidia up to 15 × 5 µm.

Pseudothecia with similar dimensions develop, intermingled with the pycnidia. Their characteristics agree with those of *Didymella ligulicola* in vivo (see 5a; asci mostly 60–65 × 5.5–7 µm, ascospores two-celled, 13.5–16.5 × 5.5–7 µm).

Chlamydo-spores absent.

NaOH spot test: negative.

Crystals absent.

*Ecology and distribution.* This fungus has been found in Europe and Australia, but probably also occurs elsewhere on wild and cultivated Compositae. The various isolates studied were obtained from *Tanacetum* (*Chrysanthemum/Pyrethrum*) *cinerariifolium*, feverfew, *Tanacetum* (*Chrysanthemum/Pyrethrum*) *parthenium* and zinnia, *Zinnia violacea* (*elegans*). In fresh cultures on agar media it produces both the anamorph and teleomorph, which morphologically agree with those of *Phoma/Didymella ligulicola*. However, apart from the frequent production of the teleomorph in vitro, it differs by the absence of antibiotic E (therefore, no discolouration with addition of a drop of NaOH, no oxidation-reaction: hence ‘*inoxydabilis*’), a slower growth-rate, no production of a diffusible pigment, and less conidial variability. It is plausible that *Phoma chrysanthemi* Voglino, described in Italy, refers to this variety and not to var. *ligulicola* which reached Europe only in the late 1940s.

*Representative culture.* CBS 425.90 (PD 81/520) ex *Tanacetum* (*Chrysanthemum/Pyrethrum*) *parthenium* (Compositae), the Netherlands.

#### 6a. *Phoma macrostoma* Mont. var. *macrostoma* — Fig. 6a

*Phoma macrostoma* Mont., *Annls Sci. nat. (Bot.)* III, 11 (1849) 52, var. *macrostoma* [as ‘*macrostomum*’].

*Phyllosticta berberis* Rabenh., *Klotzschii Herb. Mycol.* [Ed. Rabenh.] 1 (1853) No. 1865 [cf. isotype, L, B].

*Phoma phyllostictioides* Desm., *Pl. crypt. France II* [ed. 3] Fasc. 14 (1859) No. 694.

*Phyllosticta alcides* Sacc., *Michelia* 1 (2) (1878) 135 [holotype not available in PAD; cf. secondary collection in: *Krieger, Fungi saxon* No. 1882, U].

*Phyllosticta humuli* Sacc. & Speg., *Michelia* 1 (2) (1878) 144 [cf. description and isol. from similar fresh collection].

*Phyllosticta robiniae* Sacc., *Michelia* 1 (2) (1878) 146 [cf. lectotype, PAD].

*Phyllosticta chionanthi* Thüm., *Micoth. univ. Cent.* 15 (1879) No. 1489 [cf. isotype, B, L].

*Phyllosticta alnigena* Thüm., *Hedwigia* 19 (1880) 180 [cf. description and secondary collection].

*Phyllosticta pterocaryae* Thüm., *Hedwigia* 19 (1880) 181 [cf. isotype, B, PRC].

*Phoma pomi* Schulzer & Sacc., *Hedwigia* 23 (1884) 109; not *Phoma pomi* Pass., *Atti Accad. naz. Lincei Rc* [Cl. Sci. fis. mat. nat.] 4 (2) (1888) 96 [= *Asteromella mali* (Briard) Boerema (Boerema & Dorenbosch, 1965)].

*Phyllosticta amaranthi* Ellis & Kellerm., *J. Mycol.* 1 (1885) 4 [cf. holotype, NY].

*Phyllosticta spaethiana* Allesch. & Syd., *Hedwigia* 36 (1897) 160 [cf. holotype, M].

*Phyllosticta mespilina* Montemart. ex Briosi & Cavara, *Funghi parass. Fasc.* 12 (1897) No. 298 [cf. isotype, BR].

*Phyllosticta caraganae* Syd., *Hedwigia* 38 (1899) 134 [cf. isotype, B, S].

*Phyllosticta cercocarpi* Syd., *Hedwigia* 38 (1899) 135 [cf. isotype, B, S].

*Phyllosticta humulina* Sacc. & Syd., in: *Allescher, Rabenh. Krypt. Flora* [ed. 2], *Pilze* 6 [Lief. 64] (1899) 347 [vol. dated ‘1901’]. — *Phyllosticta japonica* Fautrey, *Revue mycol.* 13 (1891) 9; not *Phyllosticta japonica* Thüm., *Instituto Coimbra* 28 sub *Contr. Fl. myc. Lusit.* III n 47 (1881

['1880 e 1881']); quoted in *Hedwigia* 21 (1882) 27–28 [cf. isotype, B].

*Phyllosticta saxifragicola* Brunaud, in: Sacc. & Syd., *Sylloge Fung.* 14 (1899) 853 [description fits exactly with *Phyllosticta saxifragae* Brunaud, listed as synonym by Boerema & Dorenbosch, 1970].

*Phyllosticta cydoniicola* Henn., *Hedwigia* 41 (1902) 158 [as '*cydoniaeicola*']; illegitimate homonym of *Phyllosticta cydoniicola* Allesch., *Hedwigia* 36 (1897) 158 [as '*cydoniaeicola*'] [cf. holotype, B].

*Phyllosticta bauhinicola* Henn., *Hedwigia* 41 (1902) 306 [cf. holotype, B and isotype, S].

*Phyllosticta alniperdia* Oudem., *Ned. Kruidk. Archf.* III, 2 (1904) 1114 [cf. holotype, L].

*Phyllosticta grossulariae* var. *ribis-rubri* D. Sacc., *Mycoth. ital.* (1905) No. 1683 [nomen nudum] [cf. isotype, L].

*Phyllosticta lupulina* Kabát & Bubák, in: Bubák & Kabát, *Ost. Bot. Z.* 55 (1905) 77 [cf. description and similar collection].

*Phyllosticta pernicioso* Kabát & Bubák, *Hedwigia* 44 (1905) 350. — *Phyllosticta apatella* var. *pernicioso* (Kabát & Bubák) Cif., *Annlis mycol.* 20 (1922) 36 [cf. isotype, B].

*Phyllosticta celtidicola* Bubák & Kabát, *Annlis mycol.* 5 (1907) 42 [cf. description].

*Phyllosticta adeloica* Speg., *Revista Mus. La Plata* 25 (1908) 32 [cf. (holo?) type, S; no material available in LPS].

*Phyllosticta apicalis* Davis, *Trans. Wisc. Acad. Sci.* 16 (1909) 761 [cf. description and similar collection].

*Phyllosticta belgradensis* Bubák & Ranoj., *Annlis mycol.* 8 (1910) 381 [cf. holotype, S].

*Phyllosticta tala* Speg., *An. Mus. nac. His. nat. B. Aires* III, 20 (1910) 340 [cf. holotype, LPS].

*Phyllosticta ribiseda* Bubák & Kabát, *Hedwigia* 50 (1911) 39 [cf. isotype, B, PRC].

*Phyllosticta spiraeae-salicifoliae* Kabát & Bubák, *Hedwigia* 50 (1911) 39 [cf. isotype, B, PRC].

*Phyllosticta serebriankowii* Bubák, *Hedwigia* 52 (1912) 265 [cf. isotype, B, L].

*Phyllosticta grossulariae* f. *rubri* Cif., *Annlis mycol.* 20 (1922) 39 [sometimes cited as var. *rubri*] [cf. description and illustration].

*Phyllosticta angulata* Wenzl, *Phytopath. Z.* 9 (1936) 349 [cf. description and secondary collection confirmed in vitro, CBS 300.39].

*Phyllosticta physocarp* H.C. Greene, *Amer. Midl. Nat.* 41 (1949) 737 [cf. description and secondary collection confirmed in vitro].

*Phyllosticta betulicola* Cejp in: Cejp, Dolejš & Zavrel, *Zprávy. Vlastiv. Ustavu v. Olomouci, Císlo* 143 (1969) 3; not *Phyllosticta betulicola* Vasyag. in: Byzova et al., *Fl. spor. Rast. Kazakhst.* 5, 1 (1967) 59 [= *Asteromella* sp.] [cf. holotype, PRC].

For other synonyms see Boerema & Dorenbosch (1970, 1973) and Boerema (1976). It includes 8 other combinations in *Phoma* and also 8 in *Phyllosticta*.

The synonyms in *Phyllosticta* listed above, will be treated in detail by Van der Aa in a revision of all species described in the genus *Phyllosticta* Pers. s.l.

#### *Description in vitro*

OA: growth-rate 45–60 mm after 7 days, regular, with or without sparse, finely floccose white to pale olivaceous grey aerial mycelium; colony peach/sienna to red/blood colour or dark vinaceous, due to a pigment in the hyphae; reverse similar.

MA: growth-rate 45–55 mm after 7 days, regular to slightly irregular, with (coarsely) floccose, white to pale olivaceous grey aerial mycelium; colony primrose to pale luteous, peach/sienna to blood colour in centre; reverse similar.

CA: growth-rate 45–50 mm after 7 days, regular to slightly irregular, with (sparse) floccose, white to pale olivaceous grey aerial mycelium; colony rosy vinaceous to vinaceous; reverse similar, brown vinaceous in centre.

Pycnidia 80–300 µm diam., globose to irregular, solitary or confluent, glabrous,



with 1 or 2 non-papillate or papillate, relatively wide ostiole(s) (20–45 µm diam.), sometimes with an elongated neck in a later stage, citrine/honey, later olivaceous/sienna to olivaceous black; walls made up of 2–5 layers of cells, outer layer(s) pigmented; with salmon to flesh conidial exudate; scattered, both on and in the agar. Conidiogenous cells 4–12 × 4–9 µm, globose to bottle shaped. Conidia aseptate, (4–)5–8(–11) × 2–3(–4) µm, av. 6.5 × 2.6 µm, Q = 1.7–3.2, av. Q = 2.4, variable in shape, subglobose, ellipsoidal to oblong, or allantoid, usually with small guttules; 1(–3)-septate conidia 8.5–14 × 2.5–4 µm.

The fungus is characterised by a dull red-violet pigment in the cytoplasm and guttules of the hyphal cells.

Chlamydospores absent.

NaOH spot test: on OA a reddish to purplish colour may appear.

Crystals absent.

*Ecology and distribution.* A cosmopolitan plurivorous weak- and wound parasite, especially common on woody members of the Rosaceae. Its epithet refers to the relative large ostioles of the pycnidia. The characteristic red-violet pigment in the hyphae may disappear, see var. *incolorata*, listed below. As opportunistic parasite of woody plants the fungus often occurs on lesions caused by other pathogens. Its pycnidia may intermix with conidiophores of hyphomycetes, such as *Spilocaea pomi* Fr.: Fr. (anamorph of apple scab; see Stadelmann & Schwinn, 1982) and *Cercospora microsora* Sacc. (Leaf and Shoot Spot of lime trees; the mixed occurrence described as *Pyrenochaeta pubescens* Rostr., see Loerakker, 1986).

*Representative culture.* CBS 529.66 (PD 2000/4248) ex *Malus pumila* (Rosaceae), the Netherlands.

#### 6b. *Phoma macrostoma* var. *incolorata* (A. S. Horne) Boerema & Dorenb. — Fig. 6b

*Phoma macrostoma* var. *incolorata* (A.S. Horne) Boerema & Dorenb., *Persoonia* 6 (1) (1970) 55 [as '*macrostomum* var. *incolorata*']. — *Polyopeus purpureus* var. *incoloratus* A.S. Horne, *J. Bot.*, Lond. 58 (1920) 240.

*Polyopeus purpureus* var. *latirostratus* A.S. Horne, *J. Bot.*, Lond. 58 (1920) 240.

*Polyopeus purpureus* var. *nigrirostratus* A.S. Horne, *J. Bot.*, Lond. 58 (1920) 240.

#### *Description in vitro*

The general characters of this variety *in vitro* are similar to those of *Phoma macrostoma* var. *macrostoma*. The differentiation *in vitro* is based on the absence of the red-violet pigment in the cytoplasm and guttules of the hyphal cells. As a result, the colony on OA is colourless. However, pale grey olivaceous/dull green sectors in a stellate pattern may occur. The conidial exudate is white to buff/rosy buff. The NaOH spot test is negative. On MA the colony is primrose/olivaceous buff, often with pale honey olivaceous sectors. On CA the general colony colour is colourless to pale greenish olivaceous/olivaceous in a stellate pattern.

*Ecology and distribution.* This cultural variety often occurs as a colourless sector (saltant) in the red-violet coloured colonies of the type variety. The absence of pigment should be associated with a lower production of cholesterol (Rajak & Rai, 1983). In nature var. *incolorata* appears to be less common than var. *macrostoma*, but it is also

ubiquitous on woody plants, incidental on herbaceous substrates and cosmopolitan. It is sometimes confused with *Phoma exigua* Desm. var. *exigua* (Contr. VI-I no. 1) and *Phoma pomorum* Thüm. var. *pomorum* (sect. *Peyronellaea*, Boerema, 1993).

*Representative culture.* CBS 109173 (PD 83/908) ex *Malus sylvestris* (Rosaceae), the Netherlands.

**7a. *Phoma medicaginis* Malbr. & Roum. var. *medicaginis* — Fig. 7a**

*Phoma medicaginis* Malbr. & Roum. apud Roumeguère, Fungi gall. exs. Cent. 37 (1886) No. 3675 and Revue mycol. 8 (1886) 91, var. *medicaginis*.

*Phoma medicaginis* var. *medicaginis* f. *microspora* Rössner, Phytopath. Z. 63 (1968) 119 [nomen nudum].

*Phoma cuscutae* Negru & Verona, Mycopath. Mycol. appl. 30 (1966) 308.

*Phoma jatropae* Shreem., Indian. Mycol. Pl. Path. 8 (1978) 220–221.

*Selected literature.* Rössner (1968), Boerema et al. (1993), Noordeloos et al. (1993).

*Description in vitro*

A detailed description of morphology in vitro has been given in a provisional treatment dealing with *Phoma* species producing dendritic crystals (Noordeloos et al., 1993). Distinctive are the white, bryoid, dendritic crystals, consisting of brefeldin A, produced on malt agar after 7 days. Chlamydospores are occasionally produced in old cultures. The growth-rate on OA and MA is moderate, 35–45 mm after 7 days. Conidia are unicellular, rarely 1-septate, 5–7 (–12.5) × 1.5–4 µm, subcylindrical, Q = 1.5–3.5. The type variety of *P. medicaginis* does not produce any septate conidia in vivo. At low temperatures this absence of septate conidia is the most conspicuous character distinguishing it from var. *macrospora* (no. 7b), which may produce 10–63% relatively large septate conidia in winter (Rössner, 1968). Both varieties also differ in pathogenicity.

*Ecology and distribution.* The type variety of *P. medicaginis* is a cosmopolitan seed-borne pathogen of lucerne, *Medicago sativa*: Black Stem Disease. However, this disease is also caused by the more pathogenic *P. medicaginis* var. *macrospora* Boerema, Pieters & Hamers (no. 7b), which can not be distinguished from var. *medicaginis* on agar media at room temperature.

*Phoma medicaginis* var. *medicaginis* may also attack other Leguminosae such as yellow trefoil, *Medicago lupulina* and sweet clovers, *Melilotus* spp. The fungus has also been repeatedly isolated from non-leguminous plants (e.g. under the synonyms *P. cuscutae* and *P. jatropae*).

*Representative culture.* CBS 533.66 (PD 66/370, ATCC 16929) ex *Medicago sativa* (Leguminosae), the Netherlands.

*Note.* What was formerly classified as *P. medicaginis* var. *pinodella* is now regarded as a distinct species: *Phoma pinodella* (L. K. Jones) Morgan-Jones & K. B. Burch, see no. 13 (supported by chemical study of the dendritic crystals in pure cultures, see Noordeloos et al., 1993).

**7b. *Phoma medicaginis* var. *macrospora* Boerema, Pieters & Hamers — Fig. 7b**

*Phoma medicaginis* var. *macrospora* Boerema, Pieters & Hamers, Neth. J. Pl. Path. 99, Suppl. 1 (1993) 19. — *Phoma herbarum* f. *medicaginum* Westend. ex Fuckel, Jb. Nassau. Ver. Naturk. 23 [= Symb. mycol.] (1870) 134 ['1869 und 1870'] [listed by Saccardo, Sylloge Fung. 3 (1884) 133 as 'f. *medicaginis* Fuck.']. — *Phoma herbarum* f. *medicaginum* Westend., Fungi europ. exs./Klotzschii Herb. mycol. Cont. [Ed. Rabenh.], Cent. 5 (1862) No. 455b [in phytopathological literature often cited as '*P. herbarum* var. *medicaginis*'].

*Phoma medicaginis* var. *medicaginis* f. *macrospora* H. Rössner, Phytopath. Z. 63 (1968) 119 [nomen nudum].

*Ascochyta imperfecta* Peck, N.Y. St. Mus. Bull. [Bull. N.Y. St. Mus.] 157 (1912) 21.

*Selected literature.* Rössner (1968), Boerema et al. (1993).

### *Characteristics in vitro*

On agar media at room temperature the mainly aseptate conidia of *P. medicaginis* var. *macrospora* are not essentially larger than those of the type variety *medicaginis*. The varietal epithet *macrospora* refers to the relatively large 1–3-septate conidia (up to 28 × 6 µm; 'ascochytoïd' as in sect. *Heterospora*: Boerema et al., 1997), which may be produced in large quantities (up to 63%) at low temperatures, i.e. under winter conditions (Rössner, 1968). At low temperatures the type variety usually only produces the smaller aseptate conidia. These differences in conidial dimensions and septation at low temperature are also associated with differences in pathogenicity (see below).

*Ecology and distribution.* *Phoma medicaginis* var. *macrospora* appears to be a relatively strong pathogen of lucerne, *Medicago sativa*, its principal host. It commonly occurs in Eurasia, but is particularly widely distributed in North America (United States and Canada): Spring Black Stem of alfalfa (lucerne). The variety probably originates from the cold mountainous regions in South-West Asia. The fact that only cold-resistant varieties of lucerne (blue alfalfa) are generally grown in North America may explain why var. *macrospora* appears to be so widely distributed in North America.

*Representative culture.* CBS 112.53 (PD 20010849) ex *Medicago sativa* (Leguminosae), USA.

*Note.* The conidial variability of this fungus indicates that temperature may have been one of the factors involved in the evolutionary differentiation within the genus *Phoma*, as represented by the present sections *Phoma*, *Phyllostictoides* and *Heterospora*.

## 8. *Phoma telephii* (Vestergr.) Kesteren — Fig. 8

*Phoma telephii* (Vestergr.) Kesteren, Neth. J. Pl. Path. 78 (1972) 117. — *Ascochyta telephii* Vestergr., Öfvers. K. VetenskAkad. Förh. 54 (1897) 41.

*Ascochyta sedi-purpurei* Rothers, Zashchita Rast. 6 (1929) 263 [cf. Melnik, 1977].

*Phoma tabifica* Kesteren, Gewasbescherming 2 (1971) 74.

*Selected literature.* Van Kesteren (1972).

### *Description in vitro*

OA: growth-rate 40–53 mm after 7 days, regular, with sparse felty, (pale) olivaceous grey aerial mycelium; colony greenish olivaceous/grey olivaceous to olivaceous, olivaceous buff to citrine near margin; reverse similar.

MA: growth-rate 35–44 mm after 7 days, regular to slightly irregular, with woolly

to floccose, white to olivaceous grey aerial mycelium; colony grey olivaceous/olivaceous grey to olivaceous, citrine near margin; reverse olivaceous to olivaceous black, buff to citrine near margin.

CA: growth-rate 40–45 mm after 7 days, regular to slightly irregular, with white to olivaceous grey aerial mycelium; colony colourless to grey olivaceous/olivaceous grey, (rosy) buff near margin; reverse dull green to olivaceous/olivaceous black, partly cinnamon, (rosy) buff near margin.

Pycnidia 50–350  $\mu\text{m}$  diam., globose/subglobose to irregular, solitary or confluent, glabrous or with short mycelial outgrowths, with 1(–2) sometimes papillate ostiole(s), citrine/honey, later olivaceous to olivaceous black; walls made up of 3–10 layers of cells, outer layer(s) pigmented; with white to salmon exuded conidial masses; scattered, both on and in the agar as well as in aerial mycelium. Conidiogenous cells 5–14  $\times$  5–8  $\mu\text{m}$ , globose to bottle shaped. Conidia mainly aseptate, (3.5–)5–7(–9.5)  $\times$  2.5–3.5  $\mu\text{m}$ , av. 6.5  $\times$  3.0  $\mu\text{m}$ , Q = 1.2–3.4, av. Q = 2.2, ellipsoidal to allantoid, with several small, scattered guttules; 1-septate conidia 6.5–13.5  $\times$  3–4.5  $\mu\text{m}$ , av. 8.9  $\times$  3.5  $\mu\text{m}$ , Q = 1.8–3.6, av. Q = 2.6.

Chlamydospores absent.

NaOH spot test: negative.

Crystals absent.

*Ecology and distribution.* A common pathogen of the various species of *Sedum* indigenous to Europe. The fungus causes sunken purple spots on stems and leaves: Purple Blotch Disease. The perennial plants may suffer seriously from this disease.

*Representative culture.* CBS 109175 (PD 79/524) ex *Sedum spectabile* (Crassulaceae), the Netherlands.

### 9. *Phoma destructiva* var. *diversispora* de Gruyter & Boerema, var. nov. — Fig. 9

Coloniae *Phomae destructivae* similes sed praeter conidia continua, 4–7(–9)  $\times$  1.5–2.5(–3)  $\mu\text{m}$  etiam conidia uniseptata, 8.5–11.5  $\times$  2–3.5  $\mu\text{m}$ , producunt.

Typus: CBS 162.78 (exsiccatuus in Herb. CBS), isolatus e maculis foliorum *Lycopersici esculenti* in calidariis culti in Neerlandia a M. M. J. Dorenbosch, Sept. 1977.

#### *Description in vitro*

OA: growth-rate 46–51 mm after 7 days, regular, with (finely) floccose, olivaceous grey aerial mycelium; colony dull green in centre, reverse similar.

MA: growth-rate 52–53 mm after 7 days, regular to somewhat irregular, with compact woolly, pale olivaceous grey aerial mycelium; colony dull green, colourless patches may occur; reverse dull green to olivaceous buff near margin, leaden grey to olivaceous black in centre.

CA: growth-rate 42–48 mm after 7 days, regular to somewhat irregular, with grey olivaceous to olivaceous grey aerial mycelium; colony dull green; reverse dull green with leaden grey to olivaceous black in centre.

Pycnidia 90–260  $\mu\text{m}$ , globose to irregular, solitary or confluent, glabrous, with 1–3 papillate ostiole(s), honey/citrine to olivaceous, later olivaceous black; walls made up of 2–4 layers of cells, outer layer(s) pigmented; with rosy buff to rosy vinaceous conidial exudate; abundant, scattered or obviously concentrically zoned, both on and in the agar, and in aerial mycelium. Conidiogenous cells 4–8  $\times$  4–11  $\mu\text{m}$ , globose to

bottle-shaped. Conidia mainly aseptate,  $4-7(-9) \times 1.5-2.5(-3) \mu\text{m}$ , av.  $5.8 \times 2.2 \mu\text{m}$ ,  $Q = 2.2-3.8$ , av.  $Q = 2.7$ , subglobose to ellipsoidal, or allantoid, with several distinct guttules; a number of larger 1-septate conidia are always produced,  $8.5-11.5 \times 2-3.5 \mu\text{m}$ .

Chlamydospores absent.

NaOH spot test: negative.

Crystals absent.

*Ecology and distribution.* This newly recognised variety of *Phoma destructiva* Plowr.<sup>2</sup> demonstrates the close relationship between sections *Phoma* and *Phyllostictoides*. Typical isolates of *P. destructiva* var. *destructiva* [fruit rot and foliar lesions of tomato and pepper (paprika); apparently common in (sub-)tropical regions and probably of American origin] produce pycnidia with only aseptate conidia and therefore must be classified in sect. *Phoma*. Although similar in cultural characters, isolates of *P. destructiva* var. *diversispora* always produce in addition to aseptate conidia a number of somewhat larger, 1-septate conidia, characteristic of sect. *Phyllostictoides*. The sub-specific classification is supported by AFLP studies (Abeln et al., 2002). The type-strain of *P. destructiva* var. *diversispora*, CBS 162.78, was genetically different from two typical strains of var. *destructiva*, CBS 378.73 and CBS 133.93, but they all clearly belonged to one cluster.

Since 1977 var. *diversispora* has been frequently recorded on tomato crops in glass-houses in the Netherlands (comp. Boerema & van Kesteren, 1980). It causes light brown necroses on leaves, leaf stalks and stems, with dark pycnidia often in concentric rings: Necrotic Spot. It may also cause Fruit Rot.

*Representative culture.* CBS 162.78 (PD 77/725) ex *Lycopersicon esculentum* (Solanaceae), the Netherlands.

## 10. *Phoma digitalis* Boerema — Fig. 10

*Phoma digitalis* Boerema, in: Boerema & Dorenb., Versl. Meded. plziektenk. Dienst Wageningen 153 (Jaarb. 1978) (1979) 19[–20]. — *Ascochyta molleriana* G. Winter, Bolm Soc. broteriana 1883 [= Contr. Fl. mycol. Lusit. V] (1884) 26; not *Phoma molleriana* (Thüm.) Sacc., Sylloge Fung. 3 (1884) 110 [= *Ceuthospora molleriana* (Thüm.) Petr.].

*Selected literature.* Boerema & Dorenbosch (1979).

### *Description in vitro*

OA: growth-rate 45–50 mm after 7 days, regular, with finely floccose, white aerial mycelium; colony colourless to (rosy) buff, or dull green to olivaceous; reverse similar.

MA: growth-rate 35–40 mm after 7 days, regular, with finely floccose to finely woolly, white to pale olivaceous grey aerial mycelium; colony colourless to rosy buff, or pale olivaceous grey to dull green; reverse apricot to saffron, dull green to hazel/olivaceous in centre, salmon near margin.

CA: growth-rate 40–45 mm after 7 days, regular, with finely floccose to finely wool-

2) *Phoma destructiva* Plowr., Gdnrs' Chron. II [New Series], 16 (1881) 621. — *Diplodina destructiva* (Plowr.) Petr., Annls mycol. 10 (1921) 19 [misapplied]; syn. *Phyllosticta lycopersici* Peck, Bull. N.Y. St. Mus. nat. Hist. 40 (1887) 55. For detailed description and history see Morgan-Jones & Burch (1988b).

ly, white to pale olivaceous grey aerial mycelium; colony white to rosy buff, or (pale) olivaceous grey to dull green; reverse saffron to ochraceous, fulvous to olivaceous in centre.

Pycnidia relatively small, 40–120 µm diam., globose/subglobose to irregular, solitary or confluent, glabrous, with usually one indistinct, non-papillate or papillate ostiole, citrine to olivaceous, later olivaceous black; walls made up of 3–5 layers of cells, outer layer(s) pigmented; with buff conidial exudate; scattered, on the agar or submerged, as well as in aerial mycelium. Conidiogenous cells 3–6 × 3–7 µm, globose to bottle shaped. Conidia aseptate, (4–)5–7(–8.5) × (1.5–)2–3(–3.5) µm, av. 5.9 × 2.3 µm, Q = 2.2–3.2, av. Q = 2.6, ellipsoidal to allantoid, usually with or without small guttules; some 1-septate conidia, up to 10 µm, may occur.

Chlamydospores absent.

NaOH spot test: negative.

Crystals absent.

*Ecology and distribution.* Widespread on *Digitalis* spp., especially *D. purpurea* in Europe: Leaf Spot. Also found in New Zealand, probably everywhere on the host. Mainly seed-borne. Often erroneously identified in old literature as *Ascochyta digitalis* (Fuckel) Fuckel = *Ramularia* sp.

*Representative culture.* CBS 229.79 (Lev. 7660, PD 2000/1504) ex *Digitalis purpurea* (Scrophulariaceae), New Zealand; CBS 109180 (PD 90/835-1) ex *Digitalis* sp., the Netherlands.

## 11. *Phoma laundoniae* Boerema & de Gruyter, *spec. nov.* — Fig. 11

Pycnidia in vitro 80–280 µm diam., globosa vel subglobosa, solitaria vel confluentia, glabra, 1(–2) ostioli sessilibus vel raro papillatis praedita, mellea, deinde olivacea vel olivaceo-nigra. Cellulae conidiogenaе 5–8 × 4–8 µm, globosae vel doliiformes. Conidia plerumque continua, (5–)6–8.5(–11) × 2–3.5 µm, ellipsoidea vel allantoidea, nonnullis guttulis sparsis repleta; pauca conidia uniseptata ad 13.5 × 4 µm.

Typus: CBS 109174 (exsiccatus in Herb. CBS), isolatus e laesionibus in fructu *Pruni persicae*, Levin, in Nova Zealantia, a G.F. Laundon, Dec. 1981.

### *Description in vitro*

OA: growth-rate 45–47 mm after 7 days, regular, with felty to finely floccose, grey olivaceous to olivaceous grey aerial mycelium; colony citrine green to dull green; reverse dull green to olivaceous/olivaceous black, partly leaden grey.

MA: growth-rate 40 mm after 7 days, regular, with felty, grey olivaceous to olivaceous grey aerial mycelium; colony hazel to olivaceous; reverse hazel to grey olivaceous/olivaceous, olivaceous black in centre.

CA: growth-rate 44–46 mm after 7 days, regular, with grey olivaceous, finely woolly to floccose aerial mycelium; colony grey olivaceous to olivaceous; reverse similar, olivaceous black in centre.

Pycnidia 80–280 µm diam., globose to subglobose, solitary or confluent, glabrous, with 1(–2) occasionally papillate ostiole(s), honey, later olivaceous to olivaceous black; walls made up of 2–7 layers of cells, outer layer(s) pigmented; with off-white to primrose conidial exudate; in concentric zones, both on and in the agar as well as in aerial

mycelium. Conidiogenous cells  $5-8 \times 4-8 \mu\text{m}$ , globose to bottle shaped. Conidia mainly aseptate,  $(5-6-8.5(-11) \times 2-3.5 \mu\text{m}$ , av.  $7.4 \times 2.8 \mu\text{m}$ ,  $Q = 2.0-3.6$ , av.  $Q = 2.7$ , ellipsoidal to allantoid, with several small, scattered guttules; 1-septate conidia up to  $13.5 \times 4 \mu\text{m}$ , sparse.

Chlamydospores absent.

NaOH spot test: On OA a pale reddish non-specific colour may appear.

Crystals absent.

*Ecology and distribution.* This fungus has been isolated from lesions on fruits of *Prunus persica* at Levin, New Zealand. *Phoma* species found in association with peach and other stone fruit-trees in New Zealand were formerly often identified as *Phyllosticta circumscissa* Cooke, originally described from apricot in South Australia. Later it was concluded that these records refer to *Phoma pomorum* Thüm. (sect. *Peyronellaea*, Boerema, 1993), see Pennycook (1989). Quite possibly, this newly recognised *Phoma* species was often involved in the earlier New Zealand records. It has been named after Dr. Gillian Fiona Laundon (1938–1984; né Geoffrey Frank) at the time mycologist at the Plant Health Diagnostic Station, Levin, New Zealand.

*Representative culture.* CBS 109174 (Lev 18930, PD 2000/9942) ex *Prunus persica* (Rosaceae), New Zealand.

## 12. *Phoma foveata* Foister — Fig. 12

*Phoma foveata* Foister, Trans. Proc. bot. Soc. Edinb. 33 (1940) 66–67[–68] [vol. dated '1943']. — *Phoma solanicola* f. *foveata* (Foister) Malc., Ann. appl. Biol. 46 (1958) 639. — *Phoma exigua* var. *foveata* (Foister) Boerema, Neth. J. Pl. Path. 73 (1967) 192. — *Phoma exigua* Desm. f. sp. *foveata* (Foister) Malc. & E.G. Gray, Trans. Br. mycol. Soc. 51 (1968) 619.

*Selected literature.* EPPO (1980b), Boerema et al. (1987).

### *Description in vitro*

OA: growth-rate 70–75 mm after 7 days, regular, with felty to floccose/woolly, white to (pale) olivaceous grey aerial mycelium; colony greenish olivaceous/olivaceous, buff to honey/amber due to the release of pigments; reverse similar.

MA: growth-rate 65–80 mm after 7 days, regular, with felty to floccose/woolly, (pale) olivaceous grey to herbage green aerial mycelium; colony amber to herbage green, occasionally honey in centre, sienna to rust near margin, due to pigments, with greenish yellow/citrine green due to abundant crystal production; reverse similar, usually with dark green to dark bluish green centre.

CA: growth-rate 65–75 mm after 7 days, regular, with felty to floccose/woolly, white to (pale) olivaceous grey aerial mycelium; colony fawn/hazel to olivaceous, or brick to coral; reverse similar.

Pycnidia 75–370  $\mu\text{m}$  diam., globose to subglobose, solitary or confluent, glabrous or with mycelial outgrowths, with 1(–3) non-papillate or papillate ostiole(s) (ostioles often absent, or visible only as a pale spot), honey to sienna, later olivaceous to olivaceous black; walls made up of 4–8 layers of cells, outer layer(s) pigmented; with whitish to pale buff conidial exudate; scattered, both on and in the agar. Conidiogenous cells  $4-11 \times 4-9 \mu\text{m}$ , globose to bottle shaped, sometimes with elongated neck. Conidia aseptate,  $(3.5-5-7(-11.5) \times (1.5-2-3(-3.5) \mu\text{m}$ , av.  $6.7-6.8 \times 2.6 \mu\text{m}$ ,  $Q = 1.6-$

4.0, av. Q = 2.6–2.7, ellipsoidal to allantoid, with several small, scattered guttules; 1-septate conidia of similar size, relatively sparse.

Chlamydo-spores absent. However, chlamydo-spores and pseudosclerotia, induced by some isolates of the bacterium *Serratia plymuthica*, have been reported recently in isolates of *P. foveata* (Camyon & Gerhardson, 1997). The chlamydo-spores were olivaceous to olivaceous black, 1.8–3.7 µm diam., produced singly, in chains or clustered. Pseudosclerotia were irregular, 60–340 µm, resembling those produced by the soil borne *Phoma chrysanthemicola* Hollós (sect. *Peyronellaea*, Boerema, 1993).

NaOH spot test positive, pigments discolouring violet/red, occasionally also greenish, then red (E<sup>+</sup> reaction).

Crystals needle-like, citrine green to yellow green, especially on MA, also small yellowish to brownish crystals are formed both in the hyphae and in the agar; they represent the crystalline forms of several anthraquinone pigments, viz. pachybasin, chrysophanol, emodin and phomarin (Bick & Rhee, 1966).

The production of pigments is used in diagnostic tests (EPPO, 1986).

*Ecology and distribution.* This fungus causes lesions on potato tubers, *Solanum tuberosum*, in Europe, known as Gangrene. It was initially treated in the literature as a variety of the ubiquitous *Phoma exigua* Desm. (Contr. VI-1 no. 1), which may also cause gangrene-like lesions on potatoes. However, it has been proved that the fungus is indigenous to the Andes regions of South America, causing Brown Stalk Rot of *Chenopodium quinoa*, a grain commonly grown there in association with potatoes (Otazu et al., 1979). At present various potato cultivars show tuber-resistance to this fungus.

*Representative culture.* CBS 530.66 (PD 65/1049) ex *Solanum tuberosum* (Solanaceae), the Netherlands; CBS 557.97 (PD 98/2327) ex *Solanum tuberosum* (Solanaceae), Sweden; CBS 109176 (PD 94/1394) ex *Solanum tuberosum* (Solanaceae), Bulgaria.

*Note.* Anthraquinone pigments and crystals are also found in cultures of other *Phoma* species: for example *Phoma humicola* Gilman & Abbott (sect. *Phoma*, de Gruyter et al., 1998; compare Boerema, 1985), *Phoma matteucicola* Aderk., de Gruyter, Noordel. & Strongman (this paper no. 15; compare Von Aderkas & Brewer, 1983) and a pathogen causing a severe leaf spot disease of *Citrus medica* in India (Rai & Rajak, 1986).

### 13. *Phoma pinodella* (L. K. Jones) Morgan-Jones & Burch — Figs. 13, 31

*Phoma pinodella* (L. K. Jones) Morgan-Jones & Burch, Mycotaxon 29 (1987) 485. — *Ascochyta pinodella* L. K. Jones, Bull. N. Y. St. agric. Exp. Stn 547 (1927) 10. — *Phoma medicaginis* var. *pinodella* (L. K. Jones) Boerema, in: Boerema, Dorenbosch & Leffring, Neth. J. Pl. Path. 71 (1965) 88.

*Phoma trifolii* E. M. Johnson & Valleau, Bull. Ky agric. Exp. Stn 339 (1933) 73–74.

*Selected literature.* Boerema et al. (1993), Noordeloos et al. (1993).

#### *Description in vitro*

A detailed description of the morphology *in vitro* has been given in a paper on species producing dendritic crystals (Noordeloos et al., 1993). Distinctive are the white, bryoid to dendritic crystals produced on malt agar after 7 days, consisting of pinodellalide A and B. Also characteristic are the thick-walled, brownish chlamydo-spores, (sub-)



globose or subcylindrical, 8–20 µm diam. The growth-rate on OA is 50–65 mm after 7 days, on MA 52–55 mm after 7 days. Colonies on OA are greenish/yellowish olivaceous to olivaceous. The conidia are unicellular, rarely septate, 4–7.5 × 2–3.5 µm, subglobose to ellipsoidal,  $Q = 1.4–2.9$ .

Recently, Bowen et al. (1997) reported the finding of asci and ascospores in cultures of a single Australian isolate of *P. pinodella* (see below).

*Ecology and distribution.* This well-known pathogen of leguminous plants (Black Stem, Foot Rot, Leaf Spot) is in fact plurivorous and isolated from a wide range of plants. Being seed borne, it is now apparently distributed world-wide in arable soils.

The fungus is often confused with *Mycosphaerella pinodes* (Berk. & Bloxam) Vesterg., anam. *Ascochyta pinodes* L. K. Jones, which agrees in host range, disease symptoms, production of chlamydospores and dendritic crystals of pinodellalide A and B (Noordeloos et al., 1993). However, the cultural characteristics of *M. pinodes* are different, mature pycnidial conidia are always septate (ascochytoïd) and ascomata of the teleomorph usually also develop in fresh cultures. Both fungi are probably related (Boerema et al., 1993). In this context it is very notable that the asci and ascospores reported by Bowen et al. (1997) in cultures of an Australian isolate of *P. pinodella* were similar morphologically to those of *M. pinodes* in vitro, albeit considerably larger.

*Representative culture.* CBS 531.66 (PD 2000/4244) ex *Trifolium pratense* (Leguminosae), USA.

*Note.* Our initial classification of this fungus as a variety of *Phoma medicaginis* Malbr. & Roum. (no. 7a) was mainly introduced to stop the chaotic confusion between the black stem fungi of lucerne and red clover in the USA. *Phoma medicaginis* probably originates from South-West-Asia and North Africa. The chemical study of the dendritic crystals produced in pure cultures of both fungi supported the differentiation on species level, see Noordeloos et al. (1993).

#### 14. *Phoma sojicola* (Abramov) Kővics, de Gruyter & Aa — Figs. 14, 32

*Phoma sojicola* (Abramov) Kővics, de Gruyter & Aa, Mycol. Res. 103 (1999) 1066. — *Ascochyta sojicola* Abramov, Bolezni i Vrediteli Soievkyh Bobov no Dal'nem Vostoke (1931) 62 [–70] [as 'sojaecola'].

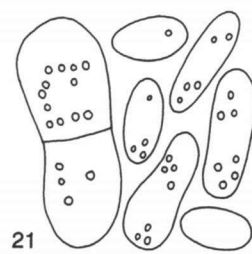
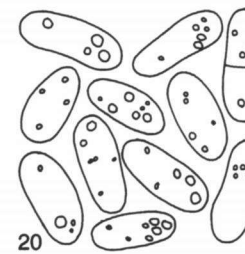
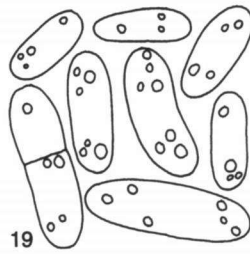
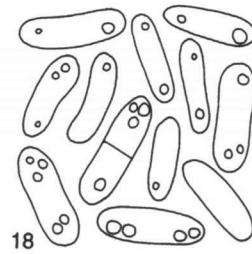
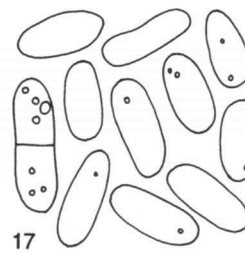
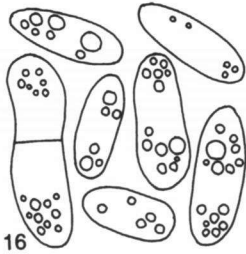
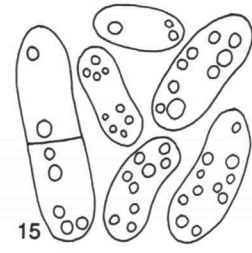
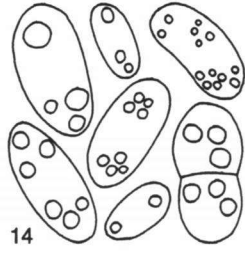
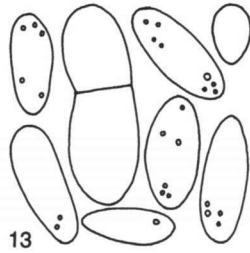
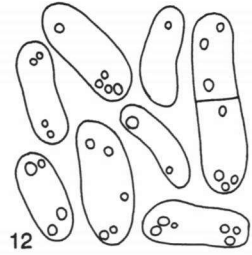
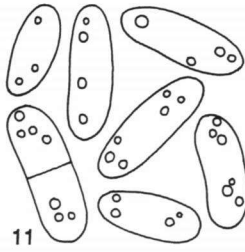
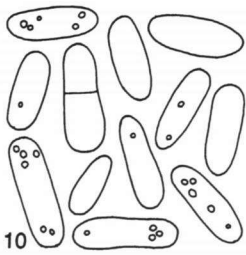
*Ascochyta sojicola* Nelen, Novosti Sist. nizsh. Rast. 14 (1977) 105 [homonym] [as 'sojaecola'; erroneously also listed with the author citation 'Abramov ex Nelen'].

*Selected literature.* Kővics et al. (1999).

#### *Description in vitro*

A detailed description of the morphology in vitro has been given in a paper dealing with this *Phoma* species and other hyaline-spored coelomycetes pathogenic on soybean (Kővics et al., 1999). Distinctive are the white dendritic crystals, only produced in fresh cultures. Also characteristic are the thick-walled, brownish chlamydospores, (sub-)globose or subcylindrical, 8–16 µm diam. The growth-rate on OA and MA is 50–65 mm after 7 days, colonies on OA are colourless to pale olivaceous grey or greenish olivaceous/grey olivaceous. The conidia are mainly unicellular, 5–8 × 2–3.5 µm, oblong to ellipsoidal,  $Q = 1.6–3.0$ , occasionally 1-septate, up to 12.5 × 5 µm.

*Ecology and distribution.* This seed-borne fungus appeared to be the most common



Figs. 10–21. Conidia. 10. *Phoma digitalis*; 11. *Phoma laundoniae*; 12. *Phoma foveata*; 13. *Phoma pinodella* 14. *Phoma sojicola*; 15. *Phoma matteucciicola*; 16. *Phoma rudbeckiae*; 17. *Phoma artemisiicola*; 18. *Phoma nemophilae*; 19. *Phoma sambuci-nigrae*; 20. *Phoma strasseri*; 21. *Phoma rumicicola*. — Bar = 10  $\mu$ m.

*Phoma* species involved with the Leaf and Pod Spot disease of soybean, *Glycine max*, in Eurasia. Pathogenicity tests, however, have shown that various plurivorous species of *Phoma* [e.g. *P. exigua* var. *exigua*, (Contr. VI-1 no. 1) and *P. pinodella*, no. 13] may cause similar symptoms on soybean, see Kövics et al., 1999.

*Representative culture.* CBS 100580 (ATCC MYA-406, D/054, PD 98/1135) from seed of *Glycine max* (Leguminosae), Hungary.

### 15. *Phoma matteucciicola* Aderk., de Gruyter, Noordel. & Strongman — Fig. 15

*Phoma matteucciicola* Aderk., de Gruyter, Noordel. & Strongman, Can. J. Pl. Path. 14 (1992) 227 [as '*matteuccicola*'].

*Selected literature.* Von Aderkas et al. (1992).

#### *Description in vitro*

A detailed description of the morphology *in vitro* has been given by Von Aderkas et al. (1992). A distinctive character is the production of a diffusible, yellow/citrine pigment, crystallising as yellow speckles (anthraquinone pigments). The growth-rate on OA, MA and CA is extremely fast, > 80 mm after 7 days. Chlamydospores are absent. Conidia are unicellular, 5–10 × 2.5–4 µm, occasionally 1-septate, 4–8(–14) × 3–5 µm, subglobose to broadly ellipsoidal, Q = 1.5–2.1.

NaOH spot test: positive on OA and MA: bluish green to rusty brown (E<sup>+</sup> reaction).

*Ecology and distribution.* This fungus was first reported by Von Aderkas & Brewer (1983) as causal agent of a midrib rot of fronds of the ostrich fern, *Matteuccia struthiopteris*, in Canada: Gangrene Disease. The host, well-known as a garden fern, is used as a spring vegetable in Canada and USA. Inoculation experiments showed a lethal effect on the gametophyte stage of the fern. The pathogen, initially confused with *Phoma foveata* Foister (no. 12), has also been recorded recently from fern nurseries in Switzerland (Grimm & Vögeli, 2000). There it was also shown to be a virulent pathogen of the ferns *Dryopteris filix-mas* and *Blechnum spicant*.

*Representative culture.* CBS 259.92 (IMI 286996, PD 91/272) ex *Matteuccia struthiopteris* (Polypodiaceae), Canada.

### 16. *Phoma rudbeckiae* Fairm. — Fig. 16

*Phoma rudbeckiae* Fairm., Proc. Rochester Acad. Sci. 1 (1890) 51.

*Phyllosticta rudbeckiae* Ellis & Everh., Proc. Acad. nat. Sci. Philad. (1895) 430. — *Ascochyta rudbeckiae* (Ellis & Everh.) H.C. Greene, Am. Midl. Nat. 41 (1949) 753 [as '*rudbeckae*'].

#### *Description in vitro*

OA: growth-rate 65 mm after 7 days, slightly irregular, with woolly to floccose, white aerial mycelium; colony honey to pale luteous due to a diffusible pigment, with ochraceous tinges due to abundant pycnidia; reverse saffron to pale luteous, sienna in centre.

MA: growth-rate 50 mm after 7 days, slightly irregular, with compact, woolly to floccose, white/salmon to pale olivaceous grey aerial mycelium; colony similar due to aerial mycelium, with pale luteous to amber, due to a diffusible pigment; reverse amber to ochraceous/fulvous, and partly umber.

CA: growth-rate 65 mm after 7 days, slightly irregular, with floccose, white to oliva-

ceous grey aerial mycelium; colony saffron to umber; reverse sienna to umber.

Pycnidia 60–360 µm diam., globose to subglobose, solitary or confluent, glabrous or sparsely covered by short mycelial hairs, with 1–2 non-papillate ostiole(s), honey/olivaceous to saffron/fulvous, later olivaceous black; walls made up of 3–7 layers of cells, outer layer(s) pigmented; with salmon to saffron conidial exudate; scattered, mainly on the agar. Conidiogenous cells 4–8 × 4–8 µm, globose to bottle shaped. Conidia aseptate, (5.5–)6.5–11 × 2–4 µm, av. 7.8 × 2.9 µm, Q = 1.8–3.4, av. Q = 2.7, or septate, 9–14.5 × 3–5 µm, Q = 2.4–4.4, av. Q = 3.4, ellipsoidal to allantoid, usually with several distinct guttules.

Chlamydo spores absent.

NaOH spot test positive, violet/red discolouring of the pigments occur.

Crystals needle-like, citrine green to yellow green, especially on MA.

*Ecology and distribution.* A specific pathogen of *Rudbeckia* spp., esp. *R. lacinata*, indigenous to North America, like the hosts. Now also found in Europe: Leaf Spot; lesions rather large, opaque-blackish and with a clearly defined outline. [Mature pycnidia on the spots may contain a high percentage of conidia that become 1-septate (8–12 × 2–3 µm). On dead tissue the pycnidia usually contain relatively small aseptate conidia (4–6 × 2–3 µm).]

*Representative culture.* CBS 109180 (PD 79/175) ex *Rudbeckia bicolor* (Compositae), the Netherlands.

### 17. *Phoma artemisiicola* Hollós — Fig. 17

*Phoma artemisiicola* Hollós, Mat. Természettud. Közl. 35 (1926) 40 [as '*artemisiaecola*']; not *Phoma artemisiicola* Lucas & Sousa da Câmara, Agron. lusit. 16 (1954) 90.

#### *Description in vitro*

OA: growth-rate 50–70 mm after 7 days, regular to irregular, with sparse, felty, white to pale olivaceous grey aerial mycelium; colony pale luteous to amber, due to a diffusible pigment, with fulvous/umber to dull green; reverse similar.

MA: growth-rate 30–40 mm after 7 days, irregular, with compact, finely woolly, white/buff to pale (grey) olivaceous aerial mycelium; colony fulvous/umber to dull green, with pale luteous to amber due to a diffusible pigment; reverse similar, chestnut in centre, with citrine green to yellow green due to abundant crystals.

CA: growth-rate 30–45 mm after 7 days, irregular, with felty to finely woolly, white/pale olivaceous grey to salmon aerial mycelium; colony sienna, ochraceous to orange due to a diffusible pigment; reverse chestnut, rust near margin.

Pycnidia 80–280 µm diam., globose to subglobose, solitary or confluent, glabrous, with usually 1(–3) non-papillate or slightly papillate ostiole(s), honey to sienna, later olivaceous; walls made up of 2–5 layers of cells, outer layer(s) pigmented; with buff to rosy buff conidial exudate; scattered, on the agar or submerged. Conidiogenous cells 3–8 × 5–8 µm, globose to bottle shaped. Conidia (3–)5–6.5(–8.5) × 1.5–3 µm, av. 6.2 × 2.4 µm, Q = 2.0–3.3, av. Q = 2.6, ellipsoidal to allantoid, usually with or without small indistinct guttules; some 1-septate conidia of similar size may occur.

Chlamydo spores absent.

NaOH spot test: positive, on OA and MA a violet/red discolouring of the pigments.

Crystals needle-like, citrine green to yellow green, especially on MA.

*Ecology and distribution.* This fungus has been recorded on dead stems of the wild

*Artemisia vulgaris* in Hungary and cultivated plants of *Artemisia dracunculus* in France (Kitchen-garden). In the latter case the fungus was thought to be the cause of premature death of the plants. It may be that some records of *Phoma artemisiae* also refer to this species.

*Representative culture.* CBS 102636 (PD 73/1409) ex *Artemisia dracunculus* (Compositae), France.

### 18. *Phoma nemophilae* Neerg. — Fig. 18

*Phoma nemophilae* Neerg., Bot. Tidsskr. 44 (1938) 361.

#### *Description in vitro*

OA: growth-rate 65–75 mm after 7 days, regular to slightly irregular, with finely floccose, white to olivaceous grey aerial mycelium; colony grey olivaceous to olivaceous grey; reverse similar, with olivaceous patches.

MA: growth-rate 65–70 mm after 7 days, regular to slightly irregular, with finely floccose, white to olivaceous grey aerial mycelium; colony pale olivaceous grey to olivaceous grey; reverse similar, and olivaceous near margin.

CA: growth-rate 60–65 mm after 7 days, regular to slightly irregular, with finely floccose, white to pale olivaceous grey aerial mycelium; colony colourless to pale olivaceous grey, grey olivaceous near margin; reverse (pale) olivaceous grey to olivaceous, grey olivaceous near margin.

Pycnidia 60–260 µm diam., globose/subglobose to irregular, solitary or confluent, glabrous or with some mycelial outgrowths, with 1–5 usually papillate ostiole(s), later developing into an elongated neck, citrine/honey to sienna, later olivaceous to olivaceous black; walls made up of 3–5 layers of cells, outer layer(s) pigmented; with off-white exuded conidial masses; scattered, both on and in the agar, micropycnidia present, 20–60 µm. Conidiogenous cells 3–7 × 3–7 µm, globose to bottle shaped. Conidia mainly aseptate, 4–9.5 × 1.5–2.5 µm, av. 6.5 × 1.9 µm, Q = 2.5–4.1, av. Q = 3.3, cylindrical to allanthoid, with several small, scattered guttules; 1-septate conidia up to 12 × 3.5 µm, sparse.

Chlamydo-spores absent.

NaOH spot test: positive on OA and MA: greenish, then red (E<sup>+</sup> reaction).

Crystals absent.

*Ecology and distribution.* Common in seeds of *Nemophila insignis* and *N. atomaria* in Europe. Also recorded in North America (United States). May cause damping-off of seedlings and decay of stems and leaves of older plants.

*Representative culture.* CBS 715.85 (PD 74/364) ex *Nemophila insignis* (Hydrophyllaceae), the Netherlands.

### 19. *Phoma sambuci-nigrae* (Sacc.) Monte, Bridge & B. Sutton — Fig. 19

*Phoma sambuci-nigrae* (Sacc.) Monte, Bridge & B. Sutton, Mycopathologia 115 (1991) 102. — *Phoma herbarum* f. *sambuci-nigrae* Sacc., Sylloge Fung. 3 (1884) 133. — *Phoma exigua* var. *sambuci-nigrae* (Sacc.) Boerema & Höweler, Persoonia 5 (1) (1967) 26.

*Phyllosticta sambucina* Allesch. ex Mig., Thomé, Kryptog Flora Pilze 4 (1) (1921) 33; not

*Phoma sambucina* Sacc., *Michelia* 2 (1) (1880) 97 [= *Phomopsis sambucina* (Sacc.) Traverso, Fl. ital. Cryptog. 2 (1) (1906) 269].

*Selected literature.* Boerema & Höweler (1967).

#### *Description in vitro*

OA: growth-rate 68–82 mm after 7 days, regular to slightly irregular, with (finely) floccose, (pale) olivaceous grey to grey olivaceous aerial mycelium; colony greenish olivaceous to grey olivaceous/olivaceous grey, greenish olivaceous/citrine near margin; reverse grey olivaceous/olivaceous to olivaceous grey/leaden grey, greenish olivaceous near margin.

MA: growth-rate 70–82 mm after 7 days, regular to slightly irregular, with finely floccose to woolly, (pale) olivaceous grey aerial mycelium; colony grey olivaceous to olivaceous grey; reverse leaden grey to leaden black/olivaceous black.

CA: growth-rate 77–82 mm after 7 days, regular to slightly irregular, with finely floccose to finely woolly, (pale) olivaceous grey aerial mycelium; colony grey olivaceous/olivaceous grey to olivaceous, olivaceous black in centre, scarlet near margin; reverse olivaceous grey/leaden grey to leaden black/olivaceous black, scarlet near margin.

Pycnidia 80–240  $\mu\text{m}$  diam., globose to subglobose, solitary or confluent, glabrous, with or without 1–3 non-papillate ostiole(s), citrine/honey, later olivaceous to olivaceous black; walls made up of 2–5 layers of cells, outer layer(s) pigmented; with off-white to buff conidial exudate; scattered, both on and in the agar. Conidiogenous cells 4–10.5  $\times$  4–8  $\mu\text{m}$ , globose to bottle shaped. Conidia mainly aseptate, (3.5–)5–8 (–10.5)  $\times$  2–3.5  $\mu\text{m}$ , av. 7.0  $\times$  2.5  $\mu\text{m}$ , Q = 1.8–3.3, av. Q = 2.8, variable in shape, subglobose, ellipsoidal to oblong, or allantoid, usually with small guttules; 1-septate conidia of similar size, sparse.

Chlamydospores absent.

NaOH spot test: positive on OA and MA: greenish, then red (E<sup>+</sup> reaction).

Crystals absent.

*Ecology and distribution.* Widespread on elder, *Sambucus nigra*, in Eurasia: Leaf Spot, Shoot Dieback. Recent comparative studies have shown that this pathogen of elder is most uniform and stable in its cultural characteristics. Therefore it deserves the species rank in spite of its morphological similarity with the ubiquitous *Phoma exigua* Desm. var. *exigua* (Contr. VI-1 no. 1).

*Representative culture.* CBS 109170 (PD 75/796) ex *Sambucus nigra* (Caprifoliaceae), the Netherlands.

## 20. *Phoma strasseri* Moesz — Fig. 20

*Phoma strasseri* Moesz, Bot. Közl. 22 (1924) 45. — *Phoma menthae* Strasser, Verh. zool.-bot. Ges. Wien 60 (1910) 317; not *Phoma menthae* Roum., Revue mycol. 9 (1887) 26.

*Selected literature.* Horner (1971).

#### *Description in vitro*

OA: growth-rate 60–63 mm after 5 days, regular, with tufts of floccose, white to olivaceous grey aerial mycelium; colony colourless to olivaceous/grey olivaceous; reverse similar.

MA: growth-rate 65–69 mm after 5 days, regular, with floccose to woolly, white to olivaceous grey aerial mycelium; colony whitish due to aerial mycelium, or olivaceous grey to iron grey; reverse dark slate blue to leaden black.

CA: growth-rate 60–62 mm after 5 days, regular, with some woolly, grey olivaceous aerial mycelium; colony grey olivaceous to olivaceous near margin; reverse similar.

Pycnidia 100–230  $\mu\text{m}$  diam., globose, solitary or confluent, glabrous or with mycelial outgrowths, with 1–3 usually non-papillate ostiole(s), citrine/honey, later olivaceous to olivaceous black; walls made up of 1–3 layers of cells, outer layer(s) pigmented; with buff to rosy buff/salmon conidial exudate; scattered, both on and in the agar. Conidiogenous cells 2–6  $\times$  3–5  $\mu\text{m}$ , globose to bottle shaped. Conidia mainly aseptate, 4.5–6.5  $\times$  2–3  $\mu\text{m}$ , av. 5.6  $\times$  2.5  $\mu\text{m}$ ,  $Q = 1.7\text{--}2.8$ , av.  $Q = 2.3$ , ellipsoidal, with several small, scattered guttules; 1-septate conidia of similar size, sparse.

Chlamydospores absent.

NaOH spot test usually negative, however, some strains showed a positive reaction becoming greenish, then red ( $E^+$  reaction).

Crystals absent.

*Ecology and distribution.* A serious pathogen of mint, *Mentha* spp. (Labiatae), found in Europe, Japan, New Zealand and North America: Rhizome and Stem Rot. Occasionally the fungus has also been isolated from other Labiatae, viz. *Monarda didyma* (North America) and *Stachys officinalis* (Bulgaria). There is also a report from *Valeriana* sp., but that appeared to be based on a coincidental isolation.

*Representative culture.* CBS 261.92 (ATCC 24146, PD 92/318) ex *Mentha piperita* (Labiatae), Oregon, USA.

## 21. *Phoma rumicicola* Boerema & Loer. — Fig. 21

*Phoma rumicicola* Boerema & Loer. in: Boerema, Loerakker & Laundon, N. Z. J. Bot. 18 (1980) 473.

*Selected literature.* Boerema et al. (1980).

### *Description in vitro*

OA: growth-rate 55–70 mm after 7 days, regular, with felty to floccose, white to pale olivaceous grey to grey olivaceous aerial mycelium; colony colourless to buff to pale grey olivaceous/olivaceous grey, partly citrine, or cinnamon near margin; reverse colourless to grey olivaceous/olivaceous grey, or dull green with partly vinaceous buff, olivaceous black in centre.

MA: growth-rate 40–50 mm after 7 days, regular, with velvety to finely floccose, white to grey olivaceous aerial mycelium; colony dull green to citrine; reverse olivaceous, partly saffron to olivaceous/olivaceous black, or leaden grey to leaden black, dull green near margin.

CA: growth-rate 55–75 mm after 7 days, regular to slightly irregular, with floccose to woolly, white to grey olivaceous aerial mycelium; colony colourless to olivaceous, partly saffron; reverse pale vinaceous to brown vinaceous/fuscous black.

Pycnidia 130–250  $\mu\text{m}$  diam., globose to irregular, solitary or confluent, glabrous, with 1(–4) non-papillate or papillate ostiole(s), citrine/honey, later olivaceous to olivaceous black; walls made up of 2–5 layers of cells, outer layer(s) pigmented; with off-white to pale vinaceous conidial exudate; scattered, mainly on the agar. Conidiogenous

cells 4–12 × 6–12 µm, globose to bottle shaped. Conidia aseptate, 5–9(–15) × 2–5 µm, av. 9.5 × 3.7 µm, Q = 1.6–4.5, av. Q = 2.6, ellipsoidal, with several small, scattered guttules; 1-septate conidia are of similar size.

Chlamydo-spores absent.

NaOH spot test: negative.

Crystals absent.

*Ecology and distribution.* This fungus is probably a common pathogen of *Rumex obtusifolius* wherever grown: Leaf Spot. It remained unrecognised because it causes leaf spots similar to those of *Ramularia rubella* (Bonord.) Nannf. Its presence can be easily confirmed by isolation.

*Representative culture.* CBS 683.79 (Lev. 15094, PD 2000/4243) ex *Rumex obtusifolius* (Polygonaceae), New Zealand.

*Note.* The fungus resembles *P. acetosellae*, (no. 1), common on *Rumex acetosella*. However, *P. rumicicola* can be easily differentiated by its faster growth-rate, and larger conidia, see also Boerema et al., 1980.

## 22. *Phoma heliopsisidis* (H. C. Greene) Aa & Boerema, *comb. nov.* — Fig. 22

*Phyllosticta heliopsisidis* H. C. Greene, Trans. Wisc. Acad. Sci. Arts Lett. 50 (1961) 158 [basionym; holotype on leaf of *Heliopsis helianthoides* coll. H. C. Greene, along Milwaukee Railroad, Iowa County, Wisconsin, USA, Sept. 1964, WIS].

### *Description in vitro*

OA: growth-rate 78–82 mm after 7 days, regular to slightly irregular, with velvety, olivaceous grey aerial mycelium; colony colourless with an olivaceous/grey olivaceous to dull green stellate pattern; reverse similar.

MA: growth-rate 78–82 mm after 7 days, regular to slightly irregular, with finely woolly to floccose, grey olivaceous to dull green aerial mycelium; colony grey olivaceous to dull green, or olivaceous black in centre and citrine/citrine green near margin; reverse similar to leaden grey/leaden black in centre.

CA: growth-rate 80–83 mm after 7 days, regular to slightly irregular, with finely woolly, olivaceous grey aerial mycelium; colony greenish olivaceous/dull green to olivaceous/olivaceous black; reverse grey olivaceous/olivaceous to leaden grey/leaden black.

Pycnidia 70–300 µm diam., globose/subglobose to irregular, solitary or confluent, glabrous or with mycelial outgrowths, with 1–3(–5) papillate ostiole(s), later developing into an elongated neck, citrine/honey, quickly becoming olivaceous/olivaceous black; walls made up of 2–5 layers of cells, outer layer(s) pigmented; with salmon/peach or buff to pale vinaceous conidial exudate; scattered, both on and in the agar as well as in aerial mycelium. Conidiogenous cells 4–8 × 4–8 µm, globose to bottle shaped. Conidia mainly aseptate, (5–)6–8(–10.5) × 1.5–3 µm, av. 7.6 × 2.4 µm, Q = 2.5–4.0, av. Q = 3.2, ellipsoidal to allantoid, with several distinct guttules; 1-septate conidia 9–13 × 2–3.5 µm, av. 10.4 × 2.6 µm, Q = 2.7–4.9, av. Q = 4.0.

Chlamydo-spores absent.

NaOH spot test: on MA a pale reddish non-specific colour may appear.

Crystals absent.



**Ecology and distribution.** A pathogen of Compositae, possibly widely distributed in North America, mostly affecting leaves, but also the stem and inflorescences. The records refer to collections on *Heliopsis* spp. in USA (type and plants imported into the Netherlands) and on *Ambrosia artemisiifolia* (common ragweed) in Canada (the island of Montréal, DAOM 221138).

**Representative culture.** CBS 109182 (PD 74/231) ex *Heliopsis* sp. (Compositae), the Netherlands.

### 23. *Phoma tarda* (R. B. Stewart) H. Vermeulen — Fig. 23

*Phoma tarda* (R. B. Stewart) Vermeulen, Coffee Berry Dis. Kenya (1979) 14 [Thesis Agric. Univ. Wageningen]. — *Ascochyta tarda* R. B. Stewart, Mycologia 49 (1957) 430.

*Ascochyta coffeae* Henn., Hedwigia 41 (1902) 307; not *Phoma coffeae* Delacr., Bull. Soc. Mycol. France 13 (1897) 122 [= *Macrophoma coffeae* (Delacr.) Sacc. & Syd.].

**Selected literature.** Stewart (1957).

#### *Description in vitro*

OA: growth-rate 53–76 mm after 5 days, slightly irregular, with floccose to woolly, olivaceous grey to smoke grey aerial mycelium; colony olivaceous grey to grey olivaceous/dull green; reverse olivaceous grey to olivaceous/olivaceous black.

MA: growth-rate 57–76 mm after 5 days, regular to slightly irregular, with compact floccose to woolly, (pale) olivaceous grey to grey olivaceous aerial mycelium; colony olivaceous grey to grey olivaceous/dull green; reverse olivaceous to leaden black/olivaceous black.

CA: growth-rate 58–73 mm after 5 days, regular to slightly irregular, with floccose, olivaceous grey to smoke grey aerial mycelium; colony olivaceous grey to (grey) olivaceous; reverse grey olivaceous/olivaceous to leaden black/olivaceous black.

Pycnidia 120–255 µm diam., globose to subglobose, solitary or confluent, glabrous, with non-papillate or papillate ostiole(s), olivaceous to olivaceous black; walls made up of 2–7 layers of cells, outer layer(s) pigmented; with white conidial exudate; scattered, mostly on the agar. Conidiogenous cells 4–9 × 4–8 µm, globose to bottle shaped. Conidia aseptate, (3–)4–7(–9) × 2–3 µm, av. 5.1 × 2.4 µm, Q = 1.2–4, av. Q = 2.1, subglobose to ellipsoidal/allantoid, eguttulate or with some small guttules; 1-septate conidia of similar size or larger.

Chlamydospores absent. However, somewhat dark, olivaceous swollen cells occur.

NaOH spot test: on OA pale purplish grey non-specific colour may appear.

Crystals absent.

**Ecology and distribution.** Recorded as a noxious pathogen of Arabian or arabica coffee, *Coffea arabica*, in Africa (Eritrea, Ethiopia, Kenya, Cameroon): Leaf Blight and Stem Dieback. The specific epithet *tarda* refers to the 'late appearance' of septa in the conidia. The fungus has also been recently isolated from coffee shrubs in Brazil, and appears to have been first described in that country. In the description by Stewart (1957) it is noted that pseudothecia of an unnamed species of *Didymella* ('*Mycosphaerella*') frequently occur in natural infections. There may be marked differences in susceptibility of *C. arabica* selections.

**Representative culture.** CBS 109183 (IMI 300060, PD 2000/10506) ex *Coffea arabica* (Rubiaceae), Cameroon.

## 24. *Phoma valerianellae* Gindrat, Semecnik & Bolay — Fig. 24

*Phoma valerianellae* Gindrat, Semecnik & Bolay, Revue hort. suisse 40 (1967) 350–351 [‘rejected’ by Gindrat, Revue hort. suisse 41 (1968) 181, but validly published, see Boerema, Persoonia 6 (1) (1970) 43–44].

*Phoma valerianellae* Boerema & C.B. de Jong, Phytopath. Z. 61 (1968) 368–369 [homonym].

*Phoma herbarum* f. *valerianae* Sacc., Michelia 2 (2) (1881) 337.

*Selected literature.* Boerema & De Jong (1968).

### *Description in vitro*

OA: growth-rate 70–75 mm after 7 days, regular, with (finely) floccose, white to olivaceous grey aerial mycelium; colony dull green; reverse grey olivaceous to buff, leaden grey in centre.

MA: growth-rate 75–80 mm after 7 days, regular, with compact floccose, white to olivaceous grey aerial mycelium; colony dull green to olivaceous grey; reverse leaden black.

CA: growth-rate 75–80 mm after 7 days, regular, with floccose, white to olivaceous grey aerial mycelium; colony olivaceous grey to olivaceous black, dull green near margin; reverse ochraceous to dull green, leaden black to olivaceous black in centre.

Pycnidia 60–285 µm diam., globose to subglobose, solitary or confluent, glabrous or sparsely covered by short mycelial hairs, with usually 1–2 (–5) papillate ostiole(s), honey to citrine, later olivaceous / olivaceous black; walls made up of 3–7 layers of cells, outer layer(s) pigmented; with white to pale luteous / ochraceous conidial exudate; scattered, on the agar or submerged, as well as in aerial mycelium. Conidiogenous cells 5–10 × 4–8 µm, globose to bottle shaped. Conidia aseptate, 3.5–5.5 (–7) × 1–2 µm, av. 4.5 × 1.5 µm, Q = 2.4–3.4, av. Q = 2.9, ellipsoidal to cylindrical, usually with small guttules; some 1-septate conidia, up to 9 × 3 µm, may occur.

Chlamydospores absent.

NaOH spot test: negative.

Crystals absent.

*Ecology and distribution.* A seed-borne pathogen of Valerianaceae in Europe. It is particularly common and widespread on corn salad, *Valerianella locusta* var. *oleracea*, and other species of *Valerianella*. The fungus may attack roots, stems and leaves in the seedling stage: Damping-off. On *Valeriana* spp. it may be confused with a seed-borne saprophytic species, *Phoma valerianae* Henn. (sect. *Phoma*, De Gruyter & Noordeloos, 1992).

*Representative culture.* CBS 329.67 (PD 66/302) ex *Valerianella locusta* var. *oleracea* (Valerianaceae), the Netherlands.

## 25. *Phoma rhei* (Ellis & Everh.) Aa & Boerema, *comb. nov.* — Fig. 25

*Ascochyta rhei* Ellis & Everh., Proc. Acad. nat. Sci. Philad. (1893) 160 [basionym] [for citation, see note]. — *Phyllosticta rhei* Ellis & Everh., J. Mycol. 5 (1889) 145 and Proc. Acad. nat. Sci. Philad. (1891) 77 [complementary description, see note]; not *Phyllosticta rhei* Roum., Revue mycol. 9 (1887) 152 [holotype on leaf of *Rheum officinalis* collected in Nenfield, New Jersey, USA, Aug. 26, 1889, NY]. — *Phyllosticta halstediana* Allesch., Rabenh. Krypt.-Flora [ed. 2], Pilze 6 [Lief. 61] (1898) 144 [vol. dated ‘1901’] [see note].

*Note.* According to Art. 58 of the Botanical Code the combination *Ascochyta rhei*, based on the illegitimate homonym *Phyllosticta rhei* Ellis & Everh. (1889), is treated as having priority from 1893 and should be cited *Ascochyta rhei* Ellis & Everh., not *A. rhei* (Ellis & Everh.) Ellis & Everh. The complementary description of *Phyllosticta rhei* by Ellis & Everh., referring to an additional collection made by B.N. Halsted in New Brunswick, New Jersey, Aug. 1890, was listed separately in Saccardo's *Sylloge Fungorum*. This explains the new name *Phyllosticta halstediana* introduced by Allescher in 1898.

*Description in vitro*

• OA: growth-rate 68–71 mm after 7 days, regular, with sparse felty to finely floccose, white to pale olivaceous grey aerial mycelium; colony olivaceous buff to greenish olivaceous/grey olivaceous, with dull green/olivaceous stellate pattern or zones; reverse similar, partly leaden grey/leaden black.

MA: growth-rate 61–64 mm after 7 days, regular, with coarsely floccose to woolly, white to pale olivaceous grey aerial mycelium; colony dull green to olivaceous/olivaceous black; reverse leaden grey to leaden black/olivaceous black, honey/citrine near margin.

CA: growth-rate 67–69 mm after 7 days, regular, with (finely) floccose, white to pale olivaceous grey aerial mycelium; colony colourless to olivaceous/olivaceous grey stellate pattern, grey olivaceous near margin; reverse similar, partly saffron, and olivaceous black.

Pycnidia 70–280 µm diam., globose to subglobose, solitary or confluent, glabrous or with some mycelial outgrowths, with 1 (or 2) non-papillate or papillate ostiole(s), citrine/honey, later olivaceous to olivaceous black; walls made up of 3–7 layers of cells, outer layer(s) pigmented; with white conidial exudate; scattered, both on and in the agar as well as in aerial mycelium. Conidiogenous cells 3–8 × 5–8 µm, globose to bottle shaped. Conidia mainly aseptate, (3.5–)5–8(–10.5) × 1.5–3 µm, av. 6 × 2.1 µm, Q = 1.6–4.9, av. Q = 2.8, cylindrical, to ellipsoidal/allantoid, with several small guttules; 1-septate conidia up to 18 × 3 µm, sparse.

Chlamydospores absent.

NaOH spot test: negative.

Crystals absent.

*Ecology and distribution.* A cosmopolitan pathogen of cultivated rhubarb plants, *Rheum* spp.: Leaf Spot. The frequent occurrence of septate conidia in vivo is the reason that the species has repeatedly been considered as belonging to *Ascochyta* (Ellis & Everhart, 1889, 1893; Melnik, 1977; Farr et al., 1989).

*Representative culture.* CBS 109177 (Lev 15165, PD 2000/9941) ex *Rheum rhabarbarum* (Polygonaceae), New Zealand.

**26. *Phoma cucurbitacearum* (Fr.: Fr.) Sacc. — Fig. 26**

Teleomorph: *Didymella bryoniae* (Auersw.) Rehm.

*Phoma cucurbitacearum* (Fr.: Fr.) Sacc., *Sylloge Fung.* 3 (1884) 148. — *Sphaeria cucurbitacearum* Fr.: Fr., *Syst. mycol.* 2 [Sect. 2] (1823) 502 [type material not known to be extant; the interpretation as anamorphic is confirmed by a collection of *S. cucurbitacearum* Fr. in Schweinitz's herbarium, PH, which is predominantly anamorphic with only a few immature ascomata]. —

*Laestadia cucurbitacearum* (Fr.: Fr.) Sacc., Sylloge Fung. 2 (1883) xxxiii [Add. vol. 1] [with description of teleomorph, but referring to Schweinitz]. — *Sphaerella cucurbitacearum* (Fr.: Fr.) Cooke, J. Bot., Lond. 21 (1883) 67–71 [with reference to Saccardo's *Laestadia cucurbitacearum*].

*Phyllosticta cucurbitacearum* Sacc., Michelia 1 (2) (1878) 145 [cf. type PAD].

*Ascochyta cucumis* Fautrey & Roum., Revue mycol. 13 (1891) 79. — *Mycosphaerella cucumis* (Fautrey & Roum.) W.F. Chiu & Walker, J. agric. Res. 78 (1949) 98 [name of anamorph, in spite of attribution to a teleomorphic genus: Art. 59.3].

*Phyllosticta citrullina* Chester, Bull. Torrey bot. Club 18 (1891) 374. — *Ascochyta citrullina* (Chester) C. O. Sm., Delaware Coll. agric. Exp. Stn Bull. 70 (1905) 7. — *Diplodina citrullina* (Chester) Grossenb., Tech. Bull. N. Y. St. agric. Exp. Stn 9 (1909) 226 [as '(C. O. Smith) Grossenb.'].

*Ascochyta bryoniae* Kabát & Bubák, in: Bubák & Kabát, Sber. K. böhm. Ges. Wiss. [Math.-naturw. Kl.] 1903 [11] (1904) 3.

*Ascochyta melonis* Potebnia, Annls mycol. 8 (1910) 63.

*Ascochyta bryoniae* H. Zimm. in: Petrak, Fl. Boh. Et Morav. (1914) No. 954 [nom. nud.; cf. isotype LE].

*Diplodina cucurbitae* Nevovsky, in: Byzova et al., Fl. spor. Rast. Kazakhst. [Crypt. Fl. Kazakhst.] 5 (2) (1968) 319.

*Selected literature.* Boerema & van Kesteren (1972), Keinath et al. (1995).

### *Description in vitro*

OA: growth-rate 49–71 mm after 5 days, regular, with woolly to floccose, white to olivaceous grey aerial mycelium; colony colourless/dull green to olivaceous/olivaceous grey; reverse buff to dull green/olivaceous, to leaden grey/leaden black.

MA: growth-rate 44–68 mm after 5 days, regular, compact, with woolly to coarsely floccose, white to smoke grey/olivaceous grey aerial mycelium; colony dull green to olivaceous grey, sometimes in a zonate pattern; reverse similar.

CA: growth-rate 47–72 mm after 5 days, regular, with woolly to coarsely floccose, white to olivaceous grey aerial mycelium; colony buff with grey olivaceous to olivaceous grey in a zonate pattern; reverse buff to honey-isabelline, or with olivaceous grey/olivaceous black.

Pycnidia 80–380 µm in diam., globose to irregular, solitary to confluent, glabrous or with mycelial outgrowths, with 1 (or 2), sometimes papillate ostiole(s), later developing into an elongated neck; citrine to honey, later olivaceous to olivaceous black; walls made up of 3–6 layers of cells, outer layers pigmented with internal cellular outgrowths up to 10 layers; with white to buff conidial exudate; on the agar and in aerial mycelium. Conidiogenous cells 4–8 × 3–7 µm, globose to bottle shaped. Conidia 4–8 × 2–3 µm, av. 5.3 × 2.2–2.3 µm, Q = 1.6–3.7, av. Q = 2.3–2.5, variable in shape, subglobose to ellipsoidal, or allantoid, with several small guttules; 1-septate conidia sparse, up to 10–4.5 µm. Pseudothecia may develop, hardly distinguishable from the pycnidia. The characters agree with the description *in vivo* below.

Chlamydospores absent.

NaOH spot test: negative.

Crystals absent.

### *Description in vivo* (especially on *Cucumis sativus*)

Pycnidia (in yellow-brown lesions on stems and leaves, subepidermal, usually followed by pseudothecia; also on infected seedlings and in dark cracked sunken lesions on fruits) 120–190 µm diam., subglobose to flattened ellipsoidal with a distinct ostiole. Conidia extremely variable in size and septation. Sometimes they are mostly aseptate with some 1-septate and a few 2-septate, but usually they are mostly 1(–2)-septate,

with a small percentage unicellular. The dimensions are commonly (6–)8–10(–13) × (2.5–)3–4(–5) μm, but the septate ones can be larger up to 20–24 × 4–5 μm (ascochytoïd; quoted in the Addendum of sect. *Heterospora*; Boerema et al., 1997). Pycnidia on seed coats usually contain only small aseptate conidia, (3.5–)4–8(–8.5) × 2–3 μm, thus resembling those in vitro.

Pseudothecia (in stems, leaves and fruits, subepidermal, together with pycnidia) globose to subglobose with somewhat conical neck, (125–)140–200(–215) μm diam. Asci cylindrical to subclavate, (50–)60–70(–90) × (9–)10–13(–15) μm, 8-spored, biserial. Ascospores (13–)14–18 × 4–6(–7) μm, ellipsoidal to nearly obovoid with rounded ends, 1-septate, faintly guttulate (for a more detailed description and illustration see Punithalingam & Holliday, 1972; Corlett et al., 1986).

*Ecology and distribution.* A cosmopolitan seed-borne pathogen of Cucurbitaceae, especially cucumber, *Cucumis sativus*, melon and muskmelon, varieties of *Cucumis melo*, pumpkin and courgette, varieties of *Cucurbita pepo*, and water melon, *Citrullus vulgaris*. The disease, known as Gummy Stem Blight, includes a variety of symptoms which are referred to as leaf spot, stem canker, vine wilt and black fruit rot. The name of the disease refers to the gummy exudate on stem and fruit lesions. The cosmopolitan distribution of the fungus may explain the recorded variation in pathogenicity and the extreme conidial variability of the anamorph in vivo. This extreme variability could also explain why the pycnidia of *Phoma cucurbitacearum* have often been confused with those of saprophytic species of *Phoma*.

*Representative cultures.* CBS 133.96 (PD 79/127) ex *Cucurbita pepo* (Cucurbitaceae), New Zealand; CBS 109171 (PD 91/310) ex *Cucurbita* sp., (Cucurbitaceae), the Netherlands.

## 27. *Phoma lycopersici* Cooke — Fig. 27

Teleomorph: *Didymella lycopersici* Kleb.

*Phoma lycopersici* Cooke, Grevillea 13 (1885) 94.

*Phoma lycopersici* (Plowr.) Jacz., Nouv. Mém. Soc. [imp.] Nat. Mosc. 15 (1898) 350–351 [illegitimate homonym]. — *Sphaeronaema lycopersici* Plowr., Gdnrs' Chron. II [New Series] 16 (1881) 621.

*Ascochyta lycopersici* Brunaud, Bull. Soc. bot. Fr. 34 [II, 9] (1887) 431.

*Ascochyta socia* Pass., Boll. Com. agr. Parmense (1889) 2; not *Ascochyta socia* (F. Tassi) Allesch., Rabenh., Krypt.-Flora [ed. 2], Pilze 7 [Lief. 88] (1903) 871–872.

*Diplodina lycopersici* Hollós, Anns hist.-nat. Mus. natn. hung. 5 (1907) 461.

*Phoma ferrarisii* O. Cif., Staz. Sper. agr. ital. 55 (1912) 149.

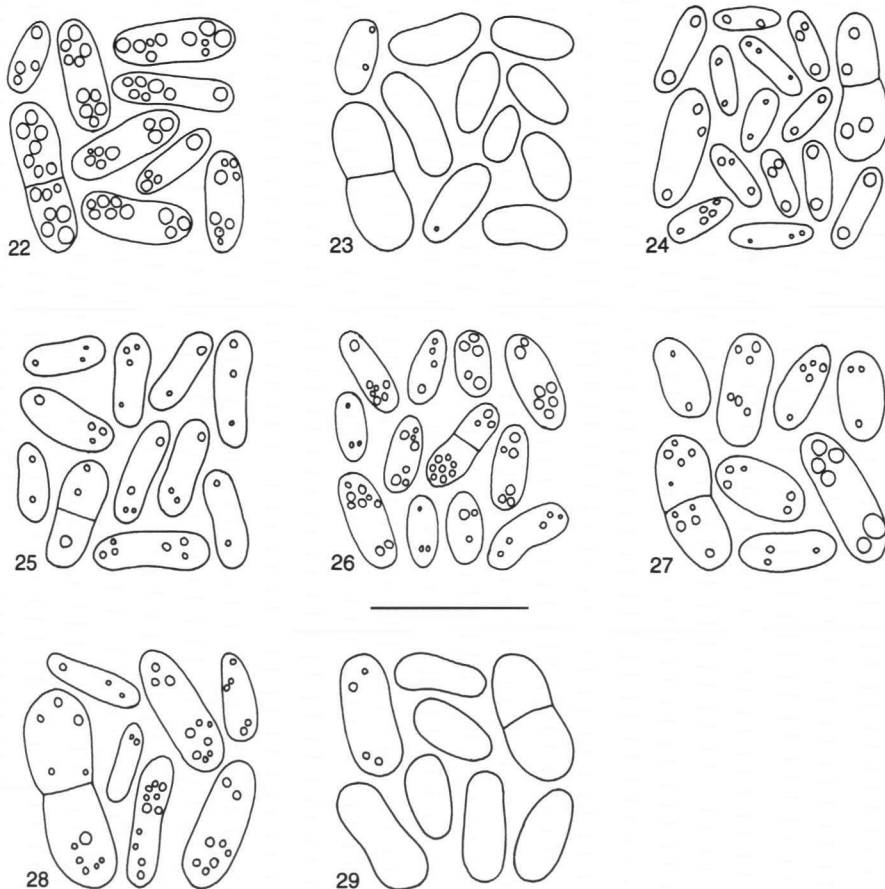
*Diplodina lycopersicola* Bond.-Mont., Mater. mikol. Obsléd. Rossii 5 (1922) 4.

*Selected literature.* Morgan-Jones & Burch (1988a).

### *Description in vitro*

OA: growth-rate 66–76 mm after 7 days, regular, with (finely) floccose, white to olivaceous grey/grey olivaceous aerial mycelium; colony colourless/olivaceous buff to grey olivaceous; reverse grey olivaceous/olivaceous grey to olivaceous, olivaceous buff near margin.

MA: growth-rate 71–76 mm after 7 days, regular, with floccose, white to olivaceous grey aerial mycelium; colony greenish olivaceous/grey olivaceous to olivaceous grey; reverse similar, leaden grey to leaden black/olivaceous black in centre.



Figs. 22–29. Conidia. 22. *Phoma heliopsisidis*; 23. *Phoma tarda*; 24. *Phoma valerianellae*; 25. *Phoma rhei*; 26. *Phoma cucurbitacearum*; 27. *Phoma lycopersici*; 28. *Phoma polemonii*; 29. *Phoma protuberans*. — Bar = 10  $\mu\text{m}$ .

CA: growth-rate 64–75 mm after 7 days, regular, with (finely) floccose, white to (pale) olivaceous grey aerial mycelium; colony colourless to vinaceous buff, with partly olivaceous grey/olivaceous; reverse grey olivaceous/olivaceous grey, to olivaceous/olivaceous black to purplish grey in centre, buff/vinaceous buff near margin.

Pycnidia 70–200  $\mu\text{m}$  diam., globose to subglobose, solitary or confluent, glabrous or with short mycelial outgrowths, with 1(–3) non-papillate or slightly papillate ostiole(s), citrine/honey, later olivaceous to olivaceous black; walls made up of 3–5 layers of cells, outer layer(s) pigmented; with whitish to buff conidial exudate; scattered, both on and in the agar. Conidiogenous cells 4–8.5  $\times$  4–8.5  $\mu\text{m}$ , globose to bottle shaped. Conidia mainly aseptate, (3.5–)5–8.5(–10)  $\times$  2–3.5(–4.5)  $\mu\text{m}$ , av. 6.0  $\times$  2.8  $\mu\text{m}$ , Q = 1.0–3.2, av. Q = 2.1, variable in shape, subglobose to ellipsoidal, or allantoid, with several small guttules; 1-septate conidia up to 15.5  $\times$  4.5  $\mu\text{m}$ .

Characteristic for this fungus in old cultures is the abundant production of sterile 'stilboid' bodies with the same wall structure as in pycnidia.

Chlamydo-spores absent.

NaOH spot test: on MA a yellow/brownish non-specific colour may appear.

Crystals absent.

*Description in vivo* (on *Lycopersicon esculentum*)

Pycnidia (in lesions on stems [cankers] and fruits [fruit rot], solitary or gregarious, initially immersed, but becoming erumpent) subglobose, up to 200 µm diam. Conidia as in vitro, aseptate or 1-septate, usually (5–)6–10 × 2–3 µm.

Pseudothecia (only rarely found on dead stems) subglobose, up to 300 µm diam. Asci cylindrical to subclavate, 50–95 × 6–10 µm. Ascospores irregularly biseriate, ellipsoidal, slightly constricted at the septum, 12–18 × 5–6 µm (for illustrations see Holliday & Punithalingam, 1970).

*Ecology and distribution.* Widespread on tomato (*Lycopersicon esculentum*) in Eurasia and Africa: Stem and Fruit Rot (Canker). The fungus has often been confused with two other *Phoma* species occurring on tomato, the 'American' *Phoma destructiva* Plowr. (see under *P. destructiva* var. *diversispora*, no. 9) and the plurivorous *Phoma exigua* Desm. var. *exigua* (Contr. VI-1 no. 1). Molecular genetic analysis fully supports the differentiation of these species (Abeln et al., 2002).

*Representative culture.* CBS 109172 (PD 84/143) ex *Lycopersicon esculentum* (Solanaceae), the Netherlands.

## APPENDIX

### Section *Sclerophomella*

(compare Boerema & de Gruyter, 1998)

Both species treated below produce relatively thick-walled pycnidia usually with late development of an opening (pore instead of a predetermined ostiole). Their conidial dimorphism matches well with the conidial variability found in the type species of *Sclerophomella*.

#### 28. *Phoma polemonii* Cooke — Fig. 28

*Phoma polemonii* Cooke, Grevillea 13 (1885) 94 (cf. original specimen, see Grove, 1935: 98).

*Phoma polemonii* Oudem., Versl. Meded. K. Akad. Wet. [Afd. Natuurk.] reeks 3, 2 (1885) 161 [illegitimate homonym]. — *Phoma oudemansii* Berl. & Voglino, Sylloge Fung. 10 (1892) 174.

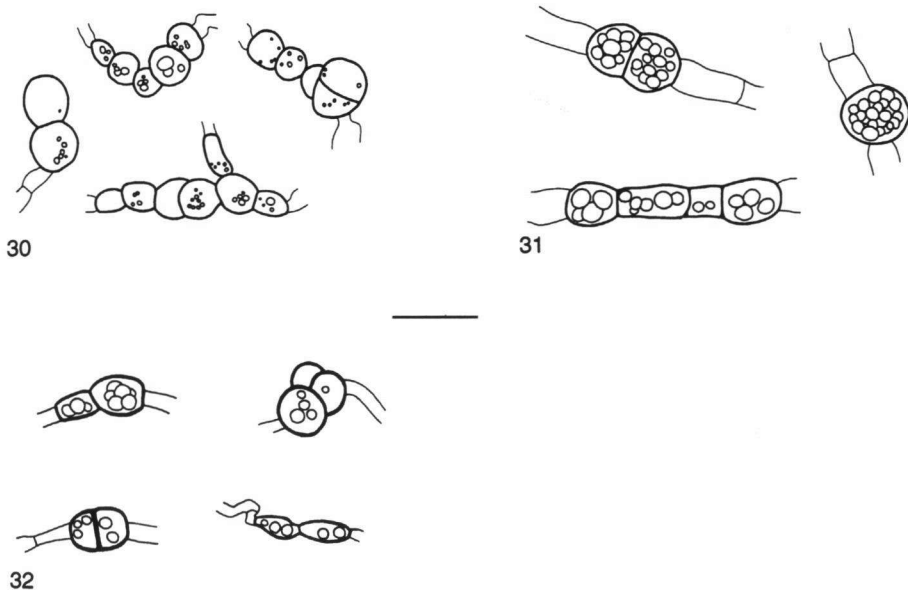
*Ascochyta polemonii* Cavara, Revue mycol. 21 (1899) 104.

*Ascochyta polemonii* Rostr., Bot. Tidsskr. 26 (1905) 311 [illegitimate homonym].

*Description in vitro*

OA: growth-rate 35–46 mm after 7 days, regular to slightly irregular, with coarsely floccose, white/pale olivaceous grey to citrine/grey olivaceous aerial mycelium; colony citrine green/greenish olivaceous to herbage green; reverse similar, olivaceous in centre.

MA: growth-rate 23–37 mm after 7 days, regular to slightly irregular, with compact, velvety/floccose, white to grey olivaceous aerial mycelium; colony greenish olivaceous to grey olivaceous, often in a zonate pattern; similar, leaden grey/olivaceous black in centre.



Figs. 30–32. Chlamydospores. 30. *Phoma arachidicola*; 31. *Phoma pinodella*; 32. *Phoma sojicola*. — Bar = 10  $\mu\text{m}$ .

CA: growth-rate 21–27 mm after 7 days, regular to slightly irregular, with compact, floccose, white/olivaceous grey to greenish olivaceous aerial mycelium; colony greenish olivaceous/grey olivaceous to olivaceous grey; reverse similar, leaden grey/olivaceous black in centre.

Pycnidia 95–220  $\mu\text{m}$  diam., globose/subglobose to irregular, solitary or confluent, glabrous, at maturity 1(–3) poroid papillate, often developing into elongated necks, citrine/honey, later olivaceous to olivaceous black; walls composed of 2–7 layers of relatively thick-walled pseudoparenchyma, outer layer(s) pigmented; with whitish/smoke grey conidial exudate; scattered, both on and in the agar. Conidiogenous cells 3.5–8.5  $\times$  3.5–8.5  $\mu\text{m}$ , globose to bottle shaped. Conidia variable, mainly aseptate, (5.5–)7–9(–12)  $\times$  2–3(–4)  $\mu\text{m}$ , av. 8.2  $\times$  2.4  $\mu\text{m}$ , Q = 2–4.3, av. Q = 3.5, ellipsoidal to allantoid, with several small, scattered guttules. The 1-septate conidia measure 9.5–13  $\times$  2.5–3.5  $\mu\text{m}$ , av. 10.9  $\times$  3.1  $\mu\text{m}$ , Q = 2.9–4.2, av. Q = 3.6.

Chlamydospores absent.

NaOH spot test: On OA and MA a pale sienna to rust colour may appear, not specific.

Crystals absent.

*Ecology and distribution.* A specific pathogen of *Polemonium* spp., widespread in Europe and also found in the United States. The fungus causes brown-yellow leaf spots, and colonizes fading leaves and stems. Most records and synonyms refer to the perennial *P. caeruleum* (Jacob's ladder). In spring and summer the subepidermal pycnidia may contain a high percentage of 1(–2) septate conidia, (10–)12–13(–14)  $\times$  2.5–3(–4)  $\mu\text{m}$ ). However, as a necrophyte on old stems and leaves the pycnidia usually contain only smaller aseptate conidia, 5–8(–10)  $\times$  2–2.5(–3)  $\mu\text{m}$ .



*Representative culture.* CBS 109181 (PD 83/757) ex *Polemonium caeruleum* (Polemoniaceae), the Netherlands.

## 29. *Phoma protuberans* Lév. — Fig. 29

*Phoma protuberans* Lév., *Annls Sci. nat. (Bot.)* III, 5 (1846) 281.

*Phyllosticta lycii* Ellis & Kellerm., *Am. Nat.* 17 (1883) 1166.

*Selected literature.* Van der Aa & van Kesteren (1971).

### *Description in vitro*

OA: growth-rate 40–72 mm after 7 days, regular, with floccose, white to pale olivaceous grey aerial mycelium; colony colourless-pale primrose to grey olivaceous; reverse primrose with olivaceous grey/grey olivaceous sectors.

MA: growth-rate 45–67 mm after 7 days, regular, with floccose to woolly, white to pale olivaceous aerial mycelium; colony grey olivaceous to olivaceous grey; reverse leaden grey to olivaceous black.

CA: growth-rate 40–83 mm after 7 days, regular, with finely floccose-woolly, white to pale olivaceous aerial mycelium; colony colourless, to olivaceous in small radiating sectors in centre; reverse similar.

Pycnidia 90–210  $\mu\text{m}$  diam., irregularly globose, with a conical or cylindrical beak of interwoven hyphae, solitary to confluent, glabrous, closed or with 1 non-papillate pore, greenish olivaceous to olivaceous, later olivaceous black; walls 2–12(!) cell layers thick, outer layers pigmented; with buff to salmon conidial exudate; in the agar and in aerial mycelium. Conidiogenous cells 6–12  $\times$  6–11  $\mu\text{m}$ , globose to bottle-shaped. Conidia variable, aseptate or septate. Aseptate conidia 4–10.5  $\times$  2–5  $\mu\text{m}$ , av. 6.7  $\times$  3.1  $\mu\text{m}$ , Q = 1.3–4.1, av. Q = 2.2, ellipsoidal to subcylindrical, usually without guttules. The septate conidia usually have about the same dimensions as the aseptate conidia, but also may be significantly larger, 12–20.5  $\times$  3.5–5  $\mu\text{m}$  (ascochytoid).

Chlamydospores absent.

NaOH spot test: negative.

Crystals absent.

*Ecology and distribution.* A specific pathogen of *Lycium halimifolium* occasionally found in Europe and North America: Leaf Spot (circular lesions which are at first brown but turning pale-yellow or whitish). The shrubby solanaceous host is indigenous to southern Eurasia; the fungus probably occurs wherever the host is planted or naturalized.

*Representative culture.* CBS 381.96 (PD 71/706) ex *Lycium halimifolium* (Solanaceae), the Netherlands.

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