

CONTRIBUTIONS TOWARDS A MONOGRAPH OF
PHOMA (COELOMYCETES) – I

2. Section *Phoma*: Additional taxa with very small conidia
and taxa with conidia up to 7 µm long

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Twenty-seven taxa in section *Phoma* with conidia not exceeding 7 µm in length are keyed out and described on account of their characteristics in vitro. Four new species are introduced: *Phoma aurea* de Gruyter, Noordel. & Boerema, *Phoma crystallifer* de Gruyter, Noordel. & Boerema, *Phoma flavescens* de Gruyter, Noordel. & Boerema and *Phoma subherbarum* de Gruyter, Noordel. & Boerema. As new names are proposed *Phoma chenopodiicola* de Gruyter, Noordel. & Boerema, *Phoma pereupyrena* de Gruyter, Noordel. & Boerema and *Phoma selaginellicola* de Gruyter, Noordel. & Boerema. New combinations of species originally classified in *Phyllosticta* Auct. include: *Phoma ajacis* (Thümen) v.d. Aa & Boerema, *Phoma arachidis-hypogaeae* (Vasant Rao) v.d. Aa & Boerema, *Phoma haematocycla* (Berk.) v.d. Aa & Boerema, *Phoma piperis* (Tassi) v.d. Aa & Boerema and *Phoma poolensis* var. *verbascicola* (Ell. & Kellerm.) v.d. Aa & Boerema. Host-fungus and fungus-host indices are provided, and short comments on the ecology and distribution of the taxa are given.

The study of *Phoma* species in vivo and in vitro has led to the differentiation of a number of sections within the genus, see e.g. Van der Aa, Noordeloos & de Gruyter (1990). The first paper in this series of precursors of a planned monograph of *Phoma*, Contributions I–1 (De Gruyter & Noordeloos, 1992), deals with 18 species of section *Phoma* with very small conidia in vitro, i.e. having a length usually not exceeding 5.5 µm. While working on the taxa with conidia up to 7 µm long, several species were encountered that actually belong to the group with conidia up to 5.5 µm long. These taxa have also been included in the present paper. Among the species treated in this paper, *inter alia* the type species of the genus *Phoma* is to be found, the ubiquitous saprophyte *P. herbarum* Westend. This species (Fig. 1) displays also the typical characteristics of section *Phoma*: thin-walled ostiolate pycnidia producing in vivo and in vitro only one-celled hyaline conidia. The pycnidia are mostly glabrous, but may show some hyphal outgrowths (semi-pilose). The conidiogenous cells are, in young pycnidia, more or less globose, later becoming bottle-shaped, which means a variation between ampulliform and doliiform. In old pycnidia it is often difficult to differentiate the conidiogenous cells from those of the inner pycnidial wall. *Phoma herbarum* does not form any chlamydospore, but the section also includes a number of species producing unicellular chlamydospores. Species with multicellular chlamydospores have been classified in sect. *Peyronellaea*, treated in Contributions II of this series

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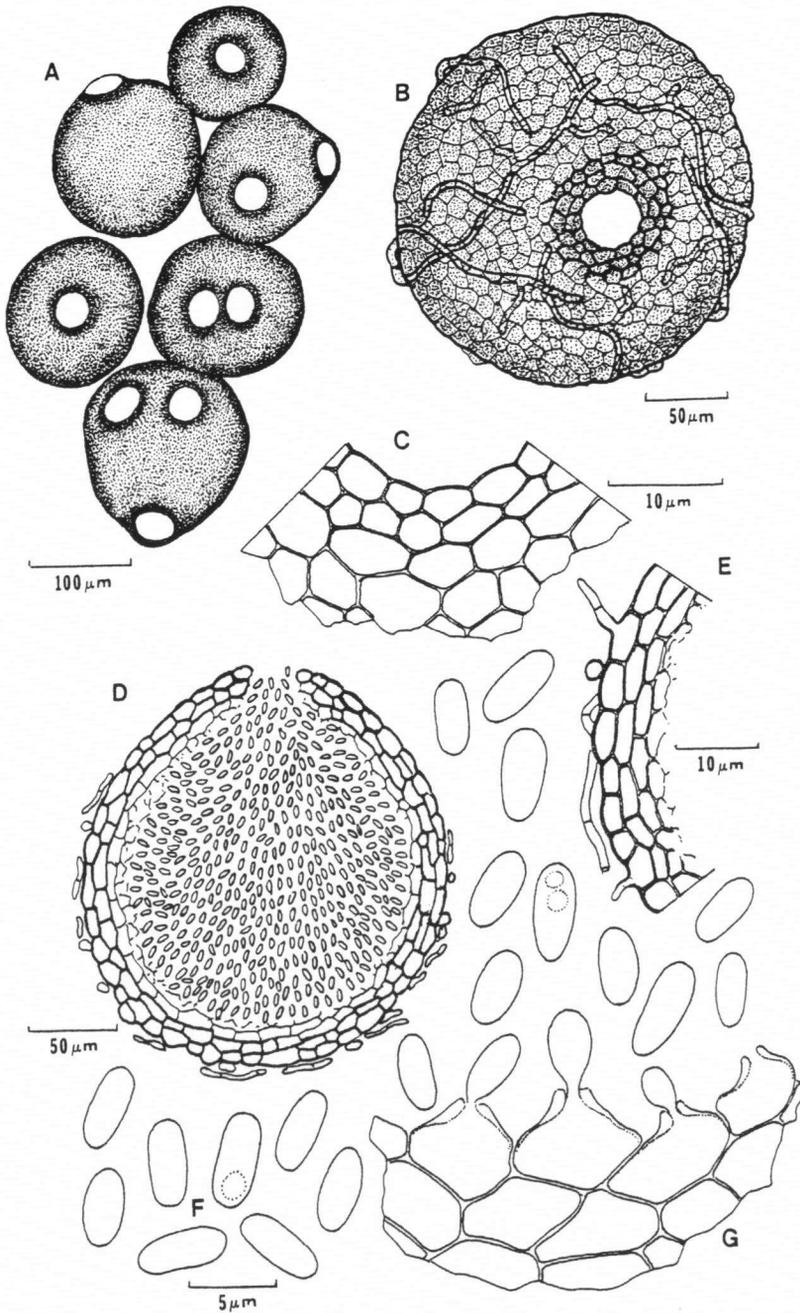


Fig. 1. *Phoma herbarum*, type species of *Phoma* sect. *Phoma*. A & B. pycnidia from 14-day-old colonies; C. surface view of pycnidial wall in vicinity of ostiole; D. vertical section of pycnidium; E. portion of pycnidial wall in section; F. conidia; G. conidiogenous cells. — Drawings after Morgan-Jones (1988a), with permission.

(Boerema, 1993). Most species of sect. *Phoma* are not associated with a teleomorph; one of the exceptions is also discussed in this paper, viz. *P. adianticola* (Young) Boerema, which in vitro may produce apart from pycnidia also pseudothecia belonging to the genus *Didymella* Sacc.

MATERIAL AND METHODS

The material and methods are the same as described in the first contribution of this series (De Gruyter & Noordeloos, 1992); some additional information is given here. The media used have the following compositions:

MA: 40 g malt extract-oxid L39, 15 g oxid agar no. 1, 1 l tapwater.

OA: 20 g oat-flakes, boiled in 0.5 l tapwater, filtered through cheesecloth and filled up to 1 l with tapwater, 15 g oxid agar no. s3.

CA: 0.1 l cherry juice, 20 g oxid agar no. 3, 0.9 l tapwater.

The petridishes used are 9 cm in diameter and 16 mm high, with ridges in the lid.

The size of the conidiogenous cells has been indicated by height \times width.

KEY TO THE SPECIES TREATED IN THIS PAPER

- 1a. Growth-rate very slow on OA, only 14–35 mm in one week 2
- b. Growth-rate at least 40 mm on OA in one week 4
- 2a. Colonies with distinct dull green to herbage green tinges on OA; dull green on MA and CA; pathogenic to *Lupinus* spp. (so far only known from North and South America)
 1. *P. lupini*
- b. Colonies without green tinges, usually colourless or pale rosy-buff, ochre or buff 3
- 3a. Conidia in average $5.6 \times 2.7 \mu\text{m}$ with two, large polar guttules (so far only known from soil in the Netherlands) 2. *P. flavescens*
- b. Conidia in average $4.2 \times 1.6 \mu\text{m}$; without guttules or with 1–2 inconspicuous guttules; pathogenic to *Phormium tenax* 3. *P. haematocycla*
- 4a. NaOH reaction positive, at least on MA 5
- b. NaOH reaction negative 14
- 5a. NaOH discolouring diffusible pigments on MA to blue-purplish, red, yellow-green, or orange-purplish 6
- b. NaOH causing initially a yellow-green discolouration, gradually changing to red (E+ reaction) 9
- 6a. Growth-rate up to 50 mm on OA 7
- b. Growth-rate 60–65 mm on OA 8
- 7a. MA usually staining reddish, NaOH reaction blue or purplish; pycnidia finally olivaceous black; plurivorous saprophyte (world-wide recorded) 4. *P. herbarum*
- b. MA staining yellow, NaOH reaction red; pycnidia honey with olivaceous tinge around ostiole; specific necrophyte of *Senecio* spp. 5. *P. senecionis*
- 8a. MA staining scarlet, NaOH reaction yellow-green; pathogenic to *Adiantum* spp. and other Polypodiaceae 6. *P. adianticola*

- b. MA staining yellow, NaOH reaction orange, later purplish; specific necrophyte of *Linum* spp. 7. *P. lini*
- 9a. Colony colourless on OA, but general impression salmon caused by abundant conidial mass exuding from pycnidia 10
- b. Colony different 11
- 10a. Growth-rate 65–80 mm; pathogenic to *Bellis perennis* 8. *P. bellidis*
- b. Growth-rate 40–60 mm; specific necrophyte of *Eupatorium cannabinum*
9. *P. eupatorii*
- 11a. Colonies with dull green or citrine tinges on OA and MA, and coarsely floccose aerial mycelium; pathogenic to *Crinum* spp. and other Amaryllidaceae ... 10. *P. crinicola*
- b. Colonies on OA almost colourless or with grey olivaceous, olivaceous grey or pale olivaceous sectors 12
- 12a. Colony colourless with grey olivaceous or olivaceous grey on OA, CA staining red; pathogenic to *Delphinium* spp. 11. *P. ajacis*
- b. Colony almost colourless on OA and CA, sometimes with (grey) olivaceous sectors 13
- 13a. Pycnidia after some transfers often non-ostiolate; esp. pathogenic to *Antirrhinum majus* 12a. *P. poolensis* var. *poolensis*
- b. Pycnidia always ostiolate; pathogenic to *Verbascum* spp.
12b. *P. poolensis* var. *verbasicola*
- 14a. Colonies staining agar flesh to rust coloured due to the release of a coloured pigment; plurivorous saprophyte (so far only known from North and South America)
13. *P. subherbarum*
- b. Colonies without such pigment production 15
- 15a. Citrine green crystals formed on CA within three weeks; esp. pathogenic to *Arachis hypogaea* 14. *P. arachidis-hypogaeae*
- b. If crystals present, then not citrine green 16
- 16a. Chlamydo-spores present 17
- b. Chlamydo-spores absent 20
- 17a. Growth-rate between 40–55 mm; pathogenic to *Acacia* spp. 15. *P. henningsii*
- b. Growth-rate > 65 mm 18
- 18a. Specifically associated with *Olea europaea* (so far only known from southern Europe) 16. *P. insulana*
- b. Plurivorous; non-specific on various hosts (esp. known from India) 19
- 19a. Colonies distinctly pigmented grey olivaceous to olivaceous or olivaceous grey, reverse iron grey to leaden black; pycnidia sometimes with tubular outgrowths; conidia always with 2 distinct uniform polar guttules; plurivorous opportunistic pathogen
17. *P. pereupyrena*
- b. Colonies colourless to weakly olivaceous, at least on OA and CA, on MA often more distinctly pigmented; pycnidia sometimes with long neck, conidia with 2–4 guttules; plurivorous opportunistic pathogen 18. vars of *P. multirostrata*
- 20a. Conidia in average more than 4.5 µm long 21
- b. Conidia in average less than 4.5 µm long 25

- 21a. Colonies with distinct grey olivaceous to olivaceous colour, plurivorous saprophyte (esp. known from southern Eurasia) 19. *P. labilis*
 b. Colonies colourless or with brown, buff, ochre, primrose, luteous or greenish tinges 22
- 22a. Crystals present especially on OA and MA; colonies colourless to buff, orange-brown on MA; specific necrophyte of Leguminosae 20. *P. crystallifer*
 b. Crystals absent 23
- 23a. Colonies with ochre, primrose or yellow tinges, especially on MA (so far only known from a dead plant in New Zealand) 21. *P. aurea*
 b. Colonies colourless to grey olivaceous, olivaceous grey, greenish olivaceous or citrine 24
- 24a. Colonies grey olivaceous to greenish olivaceous, with citrine tinges by pigmentation of the agar; plurivorous saprophyte (world-wide recorded) 22. *P. nebulosa*
 b. Colonies colourless to grey olivaceous or olivaceous grey, often with ochre tinges; specific necrophyte of *Chenopodium* spp. 23. *P. chenopodiicola*
- 25a. Real chlamydospores absent, but swollen cells are present, intercalary or terminal, solitary or in short chains, 5–12 µm diam.; colony pale buff to grey olivaceous (OA); specific necrophyte of *Malus pumila* 24. *P. bismarckii*
 b. Swollen cells absent; colony colourless to (olivaceous) buff 26
- 26a. On all media fine needle-like crystals present; colony on OA colourless without aerial mycelium; pathogenic to *Piper* and *Peperomia* spp. 25. *P. piperis*
 b. Crystals absent; colony on OA colourless to (olivaceous) buff; with fine velvety aerial mycelium; pathogenic to *Selaginella* spp. 26. *P. selaginellicola*

HOST/SUBSTRATUM-FUNGUS INDEX

Plurivorous (but sometimes with special host relation, see below): *P. bismarckii*, *P. herbarum*, *P. labilis*, *P. multirostrata* vars, *P. nebulosa*, *P. pereupyrena*, *P. subherbarum*.

Isolated from soil: *P. flavescens*, *P. herbarum*, *P. labilis*, *P. multirostrata* vars, *P. nebulosa*.

Isolated from seeds and fruits: *P. ajacis*, *P. bellidis*, *P. bismarckii*, *P. herbarum*, *P. insulana*, *P. lupini*, *P. pereupyrena*, *P. poolensis* vars, *P. subherbarum*.

Isolated from water: *P. lini*.

Frequently found on specific plants:

<i>Acacia</i> spp. (Mimosaceae)	<i>P. henningsii</i>
Amaryllidaceae (esp. <i>Crinum</i> spp.)	<i>P. crinicola</i>
<i>Antirrhinum majus</i> (Scrophulariaceae)	<i>P. poolensis</i> var. <i>poolensis</i>
<i>Arachis hypogaea</i> (Leguminosae)	<i>P. arachidis-hypogaeae</i>
<i>Bellis perennis</i> (Compositae)	<i>P. bellidis</i>
<i>Chenopodium</i> spp. (Chenopodiaceae)	<i>P. chenopodiicola</i>

<i>Delphinium</i> spp. (Ranunculaceae)	<i>P. ajacis</i>
<i>Eupatorium cannabinum</i> (Compositae)	<i>P. eupatorii</i>
Leguminosae	<i>P. crystallifer</i>
<i>Linum</i> spp. (Linaceae)	<i>P. lini</i>
<i>Lupinus</i> spp. (Leguminosae) (only America)	<i>P. lupini</i>
<i>Malus pumila</i> (Rosaceae)	<i>P. bismarckii</i>
<i>Olea europaea</i> (Oleaceae) (only southern Europe)	<i>P. insulana</i>
<i>Phormium tenax</i> (Liliaceae)	<i>P. haematocycla</i>
Piperaceae (<i>Peperomia</i> spp. and <i>Piper</i> spp.)	<i>P. piperis</i>
Polypodiaceae (<i>Adiantum</i> , <i>Polystichum</i> and <i>Pteris</i> spp.)	<i>P. adianticola</i>
<i>Selaginella</i> spp. (Selaginellaceae)	<i>P. selaginellicola</i>
<i>Senecio</i> spp. (Compositae)	<i>P. senecionis</i>
<i>Verbascum</i> spp. (Scrophulariaceae)	<i>P. poolensis</i> var. <i>verbascicola</i>
<i>Zea mays</i> (Gramineae) (only America)	<i>P. subherbarum</i>

FUNGUS-HOST INDEX

<i>P. adianticola</i>	Polypodiaceae (<i>Adiantum tenerum</i> , <i>Polystichum adiantiforme</i> and <i>Pteris ensiformis</i>)
<i>P. ajacis</i>	<i>Delphinium</i> spp. (Ranunculaceae)
<i>P. arachidis-hypogaeae</i>	<i>Arachis hypogaea</i> (Leguminosae)
<i>P. bellidis</i>	<i>Bellis perennis</i> (Compositae)
<i>P. bismarckii</i>	<i>Malus pumila</i> (Rosaceae)
<i>P. chenopodiicola</i>	<i>Chenopodium</i> spp., esp. <i>Ch. album</i> and <i>Ch. quinoa</i> (Chenopodiaceae)
<i>P. crinicola</i>	Amaryllidaceae (<i>Crinum</i> spp. and <i>Nerine bowdenii</i>)
<i>P. crystallifer</i>	Leguminosae
<i>P. eupatorii</i>	<i>Eupatorium cannabinum</i> (Compositae)
<i>P. haematocycla</i>	<i>Phormium tenax</i> (Liliaceae)
<i>P. henningsii</i>	<i>Acacia</i> spp. (Mimosaceae)
<i>P. insulana</i>	<i>Olea europaea</i> (Oleaceae)
<i>P. lini</i>	<i>Linum</i> spp. (occ. <i>L. usitatissimum</i>) (Linaceae)
<i>P. lupini</i>	<i>Lupinus</i> spp. (esp. <i>L. mutabilis</i>) (Leguminosae)
<i>P. piperis</i>	Piperaceae (<i>Piper</i> spp., esp. <i>P. longus</i> and <i>Peperomia</i> spp.)
<i>P. poolensis</i> var. <i>poolensis</i>	<i>Antirrhinum majus</i> (Scrophulariaceae)
<i>P. poolensis</i> var. <i>verbascicola</i>	<i>Verbascum</i> spp. (Scrophulariaceae)
<i>P. selaginellicola</i>	<i>Selaginella</i> spp., esp. <i>S. helvetica</i> (Selaginellaceae)
<i>P. senecionis</i>	<i>Senecio</i> spp. (Compositae)
<i>P. subherbarum</i>	<i>Solanum</i> spp. series <i>Tuberosa</i> (Solanaceae) and <i>Zea mays</i> (Gramineae)

DESCRIPTIVE PART

1. *Phoma lupini* Ell. & Ev. — Fig. 2

Phoma lupini Ellis & Everhart, Bull. Washburn [Coll.] Lab. nat. Hist. 1 (1884) 6; not *Phoma lupini* Buchwald in Möller, Fungi Faerøes 2 (1958) 153. — *Sphaeropsis lupini* (Ell. & Ev.) O. Kuntze, Revisio Gen. Pl. 3 (2) (1898) 526. — *Stictochorella lupini* (Ell. & Ev.) H. Sydow in H. Sydow & Petrak, Annls mycol. 22 (1924) 397; later homonym of *Stictochorella lupini* H. Sydow, see below. — *Asteromella lupini* (Ell. & Ev.) Petrak, Sydowia 9 (1955) 495.

Stictochorella lupini H. Sydow in H. Sydow & Petrak, Annls mycol. 20 (1922) 202.

Phyllosticta ferax Ellis & Everhart, Proc. Acad. Phil. (1894) 355.

Phyllosticta lupini Lee Bonar, Mycologia 20 (1928) 297 [cf. Petrak, Sydowia 10 (1956) 303].

Selected literature. Frey & Yabar (1983).

Description in vitro

OA: growth-rate 26–32 mm (14 days: 48–57 mm), regular, with floccose or finely floccose, white to grey, or some dull green aerial mycelium; colony dull green to dark herbage green; reverse dull green, with olivaceous or dark herbage green centre.

MA: growth-rate 27–32 mm (14 days: 48–60 mm), regular, with fluffy, white to dull green aerial mycelium; colony pale to dull green; reverse concentrically zonate sepia and greyish blue, outer margin hazel to buff.

CA: growth-rate 25–33 mm (14 days: 52–64 mm), regular, with floccose or finely floccose, white to olivaceous grey aerial mycelium; colony dull green; reverse dull green to olivaceous black, paler at margin.

Pycnidia 40–175 µm in diam., globose to irregular, solitary or confluent, glabrous, with 1(–3) non-papillate or slightly papillate ostioles; citrine to honey then olivaceous black; walls made up of 3–5 layers of cells, outer layers pigmented; with rosy vinaceous to pale vinaceous conidial exudate; on and in the agar, often also in aerial mycelium. Conidiogenous cells 3–8 × 3–6 µm, globose to bottle-shaped, on and in the agar, often also in aerial mycelium. Conidia 3.2–5.2(–6.4) × 1.4–2.4 µm, av. 4.0–4.4 × 1.5–1.9 µm, Q = 1.5–4.0, av. Q = 2.1–2.9; ellipsoidal without or sometimes with 1 (2) inconspicuous guttules.

Chlamydospores absent.

NaOH spot test: negative.

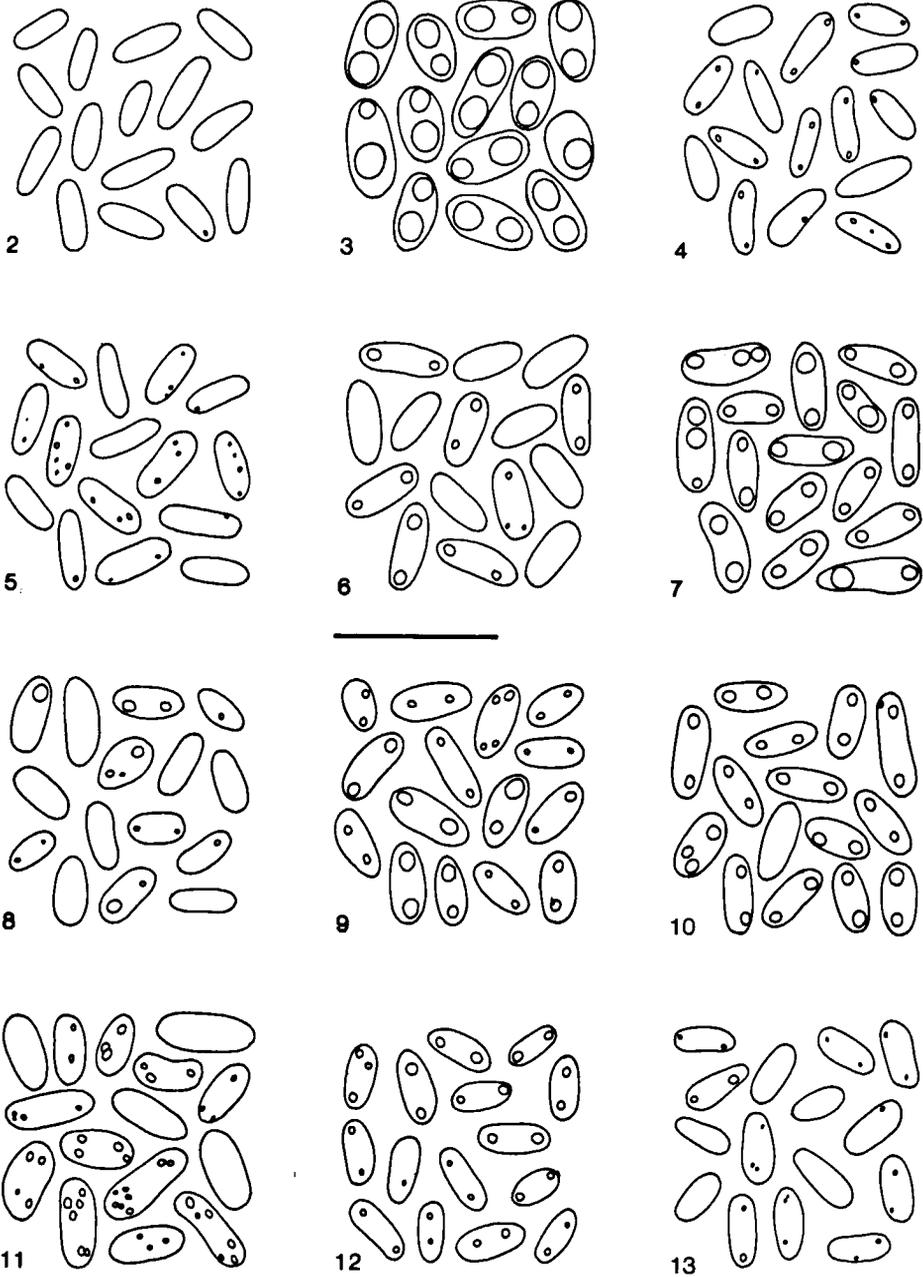
Ecology and distribution. A seed-borne pathogen known from various *Lupinus* spp. indigenous to North and South America. On account of its small conidia this pathogen has erroneously been interpreted as only a spermatial state. The fungus may infect all above ground parts of the lupines: Leaf, Stem and Pod Spot. In the Andean highlands of South America, above 3800 m, this appeared to be the most common pathogen of *Lupinus mutabilis*, an important albuminous food crop of the Indians.

Culture studied. CBS 248.92 (PD 79/141) ex *Lupinus mutabilis* (Leguminosae), Peru.

Note. In North and South America similar disease symptoms on lupines also may be caused by *Ascochyta lupini* Boerema & R. Schneider, see Boerema (1984).

2. *Phoma flavescens* de Gruyter, Noordel. & Boerema, *spec. nov.* — Fig. 3

Coloniae in agaro maltoso tarde crescentes, incoloratae, flavescens, sine mycelio acro, in NaOH immutabiles; pycnidia circa 140 µm in diam., solitaria vel agglutinata, glabra, haud papillata, ostiolata;



Figs. 2–13. Conidia. 2. *Phoma lupini*; 3. *P. flavescens*; 4. *P. haematocycla*; 5. *P. herbarum*; 6. *P. senecionis*; 7. *P. adianticola*; 8. *P. lini*; 9. *P. bellidis*; 10. *P. eupatorii*; 11. *P. crinicola*; 12. *P. ajacis*; 13. *P. poolensis* var. *poolensis*. — Bar = 10 μ m.

conidiophora phyalidea; conidia hyalina, glabra, ellipsoidea, unicellulata, $4.2-6.8 \times 2.1-3.4 \mu\text{m}$, proprio biguttulata; chlamydosporae desunt. Typus: L 989.300-189 (siccus); CBS 178.93 (PD 82/1062) (vivus); ex soil, the Netherlands.

Description in vitro

OA: growth-rate 14–15 mm (14 days: 25 mm), regular, without aerial mycelium; colony colourless, becoming luteous in a later stage due to the production of a yellow pigment; reverse similar.

MA: growth-rate 13–14 mm (14 days: 23–26 mm), irregular with lobed outline, without aerial mycelium; colony ochraceous with white margin; reverse similar.

CA: growth-rate 10–11 mm (14 days: 21–25 mm), irregular with lobed outline, without aerial mycelium; colony ochraceous; reverse similar.

Pycnidia 20–140 μm in diam., globose, solitary or confluent, with rather indistinct non-papillate ostiole, glabrous or covered by hyphae; citrine to honey, later olivaceous to olivaceous black; walls made up of 2–4 layers of cells, outer layers pigmented; conidial exudate not observed; on and in the agar. Conidiogenous cells $4-6 \times 3-6 \mu\text{m}$, globose to bottle-shaped. Conidia $4.2-6.8 \times 2.1-3.4 \mu\text{m}$, av. $5.6 \times 2.7 \mu\text{m}$, $Q = 1.5-2.7$, av. $Q = 2.1$, ellipsoidal with 2 large polar guttules.

Chlamydospores absent.

NaOH spot test: negative.

Ecology and distribution. This species is thus far known only from an isolate of a soil-sample drawn from a potato field in the Noordoostpolder, the Netherlands. The epithet *flavescens* refers to the luteous discolouring on OA in a final stage.

Culture studied. CBS 178.93 (PD 82/1062) ex soil, the Netherlands.

3. *Phoma haematocycla* (Berk.) v.d. Aa & Boerema, *comb. nov.* — Fig. 4

Phyllosticta haematocycla Berk., Enum. Fungi. coll. Portugal by Welw. (1853) 5 [sometimes erroneously quoted with the author citation 'Berk. & Welw.'] [basonym; neotype dried culture of CBS 175.93, isolate from *Phormium tenax*, New Zealand, L 990.290-099].

Description in vitro

OA: growth-rate 24–25 mm (14 days: 33–36 mm), regular, with appressed velvety-felted, white aerial mycelium; colony colourless to rosy buff; reverse similar.

MA: growth-rate 21–22 mm (14 days: 28–29 mm), regular, with velvety to woolly, smoke grey aerial mycelium; colony buff; reverse ochraceous to fulvous.

CA: growth-rate 18–19 mm (14 days: 23–25 mm), regular, with compact velvety, white to smoke grey aerial mycelium; colony ochraceous; reverse fulvous to rust.

Pycnidia 60–130 μm in diam., globose to subglobose, solitary or confluent, glabrous, with 1(–3) papillate ostioles; olivaceous, later olivaceous black; wall made up of 2–5 layers of cells, outer layer(s) pigmented; with white to rosy buff conidial exudate; mainly on the agar. Conidiogenous cells $4-7 \times 3-5 \mu\text{m}$, globose to bottle-shaped. Conidia $3.8-4.6 \times 1.4-1.8 \mu\text{m}$, av. $4.2 \times 1.6 \mu\text{m}$, $Q = 2.2-3.1$, av. $Q = 2.6$, ellipsoidal with or without 1–2 inconspicuous polar guttules.

Chlamydospores absent, but hyphal swellings present, about 8–9 μm diam., intercalary or terminal.

NaOH spot test: negative.

Ecology and distribution. A common specific pathogen of New Zealand flax, *Phormium tenax*, causing red-encircled ('haematocykla') spots on the leaves: Leaf Spot. The type material of *P. haematocykla* could not be found. To fix the identity of the species a dried culture of the isolate studied has been indicated as neotype.

Culture studied. CBS 175.93 (LEV 14846, PD 92/370) ex *Phormium tenax* (Liliaceae), New Zealand.

4. *Phoma herbarum* Westend. — Figs. 1, 5

Phoma herbarum Westendorp, Bull. Acad. r. Belg. Cl. Sci. 19 (3) (1852) 118.

Phoma leguminum Westendorp, Herb. crypt. [Ed. Beyaert & Feys] Fasc. 23 (1847) No. 1135; Bull. Acad. r. Belg. Cl. Sci. II, 11 (1861) 645 [cf. holotype, BR; as collective name often misapplied].

Phoma oleracea Saccardo, Michelia 2 (1) (1880) 91.

Phoma pigmentivora Masee, Bull. misc. Inf. R. bot. Gdns Kew 8 (1911) 326.

Phoma hibernica Grimes, O'Connor & Cummins, Trans. Br. mycol. Soc. 17 (1932) 99–101.

Phoma lignicola Rennerfelt, Svenska SkogsvFör. Tidskr. 35 (1936) 60.

Aposphaeria violacea Bertel, Öst. bot. Z. 54 (1904) 205, 233, 288. — *Phoma violacea* (Bertel) Eveleigh, Trans. Br. mycol. Soc. 44 (1961) 577.

For additional synonyms see Boerema (1970, 1976; 26 names including 14 infraspecific taxa). The history of this lectotype species of *Phoma* Sacc. is discussed by Boerema (1964) and Morgan-Jones (1988a).

Description in vitro

OA: growth-rate 38–50 mm, regular, without aerial mycelium; colony flesh-coloured with greenish tinge caused by abundant pycnidia or greenish olivaceous to olivaceous; reverse similar.

MA: growth-rate 38–41 mm; regular, with well-developed or poorly developed, fluffy to floccose, white, flesh-coloured or olivaceous grey aerial mycelium; colony reddish brown with rusty margin or greenish olivaceous with buff margin; reverse chestnut with rust-peach margin or leaden black with grey olivaceous margin.

CA: growth-rate 38–47 mm, regular, with white, felty to finely floccose aerial mycelium; colony sienna or olivaceous grey to olivaceous black with citrine margin; reverse dark vinaceous to olivaceous black with leaden grey centre.

Pycnidia 50–300 µm in diam., globose to elongate, solitary or confluent, glabrous or with short hyphal outgrowths, with usually one, sometimes papillate ostiole; honey-citrine to olivaceous, finally olivaceous black; wall consisting of 1–4(–6) layers of cells, outer layer(s) pigmented; with white to buff or rosy vinaceous conidial exudate; abundant, formed on and in the agar. Conidiogenous cells 3–6 × 3–6 µm, globose to bottle-shaped. Conidia 4.0–5.6 × 1.4–2.0 µm, av. 4.5–4.8 × 1.6–1.8 µm, Q = 2.0–3.5, av. Q = 2.6–2.9, oblong to ellipsoidal without or with inconspicuous guttules.

Chlamydospores absent.

NaOH spot test: positive: red pigment on MA changes to blue or purplish.

Ecology and distribution. This world-wide recorded fungus is unique in having a very wide substratum range. It has been isolated from dead material of all kinds of herbaceous and woody plants (esp. in spring), as well as from animal (incl. human) and inorganic material. Its common occurrence on dead seed coats explains why it often has been confused with specific seed-borne pathogens. The fungus is reported to be the causal

agent of a lethal disease of the air-bladder in salmon and trout. In man, the fungus is known from peripheral lung tissue with asthma patients. Other sources of repeated isolates are air, asbestos, butter, carpets, cement, cream, oil-paint, paper, plaster, rubber, soil, woodpulp and water.

Cultures studied. CBS 276.37 (PD 92/332) ex wood pulp, Sweden; CBS 615.75 (PD 73/665, ATCC 24909, IMI 199779) ex *Rosa* sp. (Rosaceae), the Netherlands; CBS 502.91 (PD 86/276) ex *Nerium* sp. (Apocynaceae), the Netherlands; CBS 503.91 (PD 87/499) ex *Thuja* sp. (Cupressaceae), the Netherlands.

Note. Fish-mycosis may also be caused by an undescribed species of *Phoma*, differing from *P. herbarum* by the production of unicellular chlamydo-spores and faster growth on OA and MA, see Hatai et al. (1986).

5. *Phoma senecionis* P. Sydow — Fig. 6

Phoma senecionis P. Sydow, Beibl. Hedwigia 38 (1899) 136.

Phyllosticta albobrunnea Bubák & Wróblewski, Hedwigia 57 (1916) 330.

Description in vitro

OA: growth-rate 47–49 mm, with sparse floccose, white aerial mycelium; colony regular, colourless; reverse similar to yellowish.

MA: growth-rate 27–30 mm, with fine compact, fluffy, white aerial mycelium; colony irregular, sienna to pale luteous, staining the agar yellow by a diffusible pigment; reverse fulvous with luteous marginal zone.

CA: growth-rate 45–47 mm, with fluffy-woolly, white aerial mycelium; colony irregular, olivaceous black with buff margin; reverse olivaceous black with hazel or honey margin.

Pycnidia 160–250 µm in diam., more or less globose, solitary or confluent, with 1 or 2 distinct ostioles, occasionally with a neck; glabrous, honey with olivaceous tinge around ostiole; wall consisting of 2–3 layers of cells, outer layer(s) pigmented; conidial exudate salmon; abundant, mainly in aerial mycelium. Micropycnidia present, 50–90 µm. Conidigenous cells 3–8 × 3–7 µm, globose to bottle-shaped. Conidia 4.0–6.4 × 1.6–2.4 µm, av. 5.1 × 2.0 µm, Q = 1.7–3.4, av. Q = 2.6, oblong to ellipsoidal with or without 2 polar guttules.

Chlamydo-spores absent, but in the agar dense strands of dark-coloured, short-celled hyphae are formed.

NaOH spot test: negative on OA and CA, but yellow pigment on MA stains red.

Ecology and distribution. This fungus with yellow-brown pycnidia has been found on and isolated from dead tissue of different *Senecio* spp. It probably occurs wherever the hosts are growing. It seems to be a saprophyte or necrophyte with a specific host relation.

Culture studied. CBS 160.78 (PD 92/1533, LEV 11451) ex *Senecio jacobaea* (Compositae), New Zealand.

6. *Phoma adianticola* (Young) Boerema — Fig. 7

Teleomorph: *Didymella* sp.

Phoma adianticola (Young) Boerema, Versl. Meded. Plziektenk. Dienst Wageningen 159 (Jaarb. 1982) (1983) 25. — *Phyllosticta adianticola* Young, Mycologia 7 (1915) 144.

Description in vitro

OA: growth-rate 60–65 mm, regular, with thin, appressed-felted, white aerial mycelium or without any; colony colourless, staining the agar flesh, saffron, apricot-fulvous or ochraceous caused by the release of a diffusible pigment; pycnidia in concentric zones, sometimes together with pseudothecia; reverse staining the agar in a similar way.

MA: growth-rate 42–70 mm, regular, or with undulating margin, with very thin, velvety olivaceous grey or smoke grey aerial mycelium; colony colourless or smoke grey to olivaceous, staining the agar sienna to scarlet at centre and yellow in marginal zone by diffusible pigment; reverse similar or darker scarlet to bay or blood-colour.

CA: growth-rate 47–55 mm, regular, with velvety to finely floccose, olivaceous grey aerial mycelium; colony olivaceous, by a fulvous pigmentation of the agar; reverse similar or more umber.

Pycnidia 80–250 μm in diam., globose to subglobose to irregularly shaped, usually confluent, glabrous or with hyphal outgrowths, with 1–5 ostioles, occasionally with a short neck; citrine, later olivaceous finally olivaceous black; wall made up to 3–5 layers of cells, outer layers pigmented; conidial exudate buff, pale luteous or peach; abundant, both on and (partly) in the agar. Conidiogenous cells 4–7 \times 3–6 μm , globose to bottle-shaped. Conidia 3.8–6.4 \times 1.6–2.4 μm , av. 4.6–4.7 \times 1.8–2.1 μm , Q = 1.8–3.5, av. Q = 2.2–2.6, ellipsoidal with usually two polar guttules.

Pseudothecia 120–180 \times 150–200 μm , subglobose or pyriform. Asci 40–45 \times 7–8 μm , 8-spored. Ascospores 12.0–15.5 \times 3.5–5.2 μm , 2-celled, the lower cell subcylindrical with a rounded or slightly truncate base, the upper cell widest near the septum, tapering gradually to a round apex.

Chlamydospores absent.

NaOH spot test: positive, yellow-green on MA and OA.

Ecology and distribution. A pathogen of Polypodiaceae, probably widespread, distributed in (sub)tropical America. First described from *Adiantum tenerum* on the island of Porto Rico. In the Netherlands repeatedly isolated from leaves of *Polystichum adiantiforme* imported from Florida, USA and Costa Rica. Later also from diseased prothallia of *Pteris ensiformis* grown in a Dutch nursery: Leaf Spot. The teleomorph is thus far only known from occasional observations in vitro (provisional description by Van der Aa & Boerema in manuscript).

Cultures studied. CBS 187.83 (= PD 82/128) and CBS 258.92 (PD 89/1887) ex *Polystichum adiantiforme* (Polypodiaceae), Costa Rica; CBS 260.92 (PD 86/1103) ex *Pteris ensiformis* (Polypodiaceae), glasshouse, the Netherlands.

7. *Phoma lini* Pass. — Fig. 8

Phoma lini Passerini, Diagn. Funghi nuov. 4 (1890) no. 81.

Description in vitro

OA: growth-rate 63–65 mm, regular, with very scanty, colourless aerial mycelium or without any; colony colourless or very pale greenish olivaceous; reverse similar.

MA: growth-rate 67–68 mm, regular, with sparse, fluffy, grey olivaceous to olivaceous aerial mycelium; colony grey olivaceous with dull green to olivaceous with greenish olivaceous spots, staining the agar yellow due to the release of a verdigris pigment; reverse

olivaceous to grey olivaceous with verdigris and honey-isabelline patches, forming an irregular pattern of three colours.

CA: growth-rate 62 mm, regular, with fluffy, greenish olivaceous to olivaceous aerial mycelium; colony olivaceous to malachit green, marginal zone colourless; reverse remarkable in being zonate with concentric rings of purplish grey alternating with dark slate blue, greenish grey and fuscous black.

Pycnidia 60–210 μm in diam., globose to irregularly shaped, solitary or confluent, glabrous, with one ostiole, without marked neck; honey to olivaceous then olivaceous black; wall made up of 3 layers of cells, outer layers pigmented; with sienna conidial exudate; abundant, in and on the agar. Conidiogenous cells about $3-5 \times 3-5 \mu\text{m}$ in diam., globose to bottle-shaped. Conidia $3.4-5.6 \times 1.6-2.2 \mu\text{m}$, av. $4.2 \times 1.8 \mu\text{m}$, $Q = 1.9-2.8$, av. $Q = 2.4$, ellipsoidal, occasionally with one or two polar guttules.

Chlamydospores absent.

NaOH spot test: positive: on MA a orange, later a purplish discolouring occur, both on the yellowish and greenish patches.

Ecology and distribution. A saprophyte in Europe frequently recorded on dead stems of *Linum* spp., but probably also occurring on other herbaceous plants. Occasional isolates of the fungus from stagnant water (the Netherlands, Yugoslavia) were associated with experiments on, or the practice of retting of flax, *Linum usitatissimum*. The fungus has been repeatedly confused with a foot rot pathogen of flax, *Phoma exigua* var. *linicola* (Naum. & Vass.) Maas (sect. *Phyllostictoides*: producing always some septate conidia), see Maas (1965).

Culture studied. CBS 253.92 (PD 70/998) ex Wisconsin tank, the Netherlands.

8. *Phoma bellidis* Neerg. — Fig. 9

Phoma bellidis Neergaard, Friesia 4 (1950) 74 [as '*Phoma (Phyllosticta)*'].

Description in vitro

OA: growth-rate 68 mm, regular, with poorly developed, felted, white aerial mycelium; colony colourless in centre with salmon shade due to pycnidial exudate; reverse similar.

MA: growth-rate 76–77 mm, regular, with finely floccose, white to pale grey aerial mycelium; colony olivaceous to pale olivaceous grey or grey olivaceous, with citrine margin; reverse leaden grey or leaden black, margin greenish olivaceous.

CA: growth-rate 78 mm, regular, with finely floccose, white or very pale olivaceous grey aerial mycelium; colony colourless to olivaceous; reverse isabelline.

Pycnidia 50–260 μm in diam., solitary or confluent, globose to irregularly composed, glabrous, with 1 to 5 ostioles, non-papillate or slightly papillate; citrine to honey, later olivaceous to olivaceous black; wall consisting of 2–3 layers of cells, outer layer(s) pigmented; with salmon to saffron conidial exudate; abundant, on or partly in the agar, rarely submerged. Conidiogenous cells $3-6 \times 4-8 \mu\text{m}$, globose to bottle-shaped. Conidia $3.8-6.4 \times 1.8-2.6 \mu\text{m}$, av. $4.9 \times 2.1 \mu\text{m}$, $Q = 1.9-3.1$, av. $Q = 2.3$, ellipsoidal with usually two, polar guttules.

Chlamydospores absent.

NaOH spot test: positive on MA: greenish then red (E+ reaction).

Ecology and distribution. This fungus has repeatedly been recorded on seed of daisy, *Bellis perennis*, from various European countries (Denmark, England, Italy, the Netherlands, Switzerland). It may cause the death of infected seeds and Damping-off of seedlings.

Culture studied. CBS 714.85 (= PD 74/265) ex *Bellis perennis* (Compositae), the Netherlands.

9. *Phoma eupatorii* Died. — Fig. 10

Phoma eupatorii Diedicke, *Annls mycol.* 10 (1912) 447.

Description in vitro

OA: growth-rate 50–51 mm, regular, without aerial mycelium; colony colourless, but general impression salmon caused by abundant conidial mass exuding from pycnidia; reverse similar.

MA: growth-rate 58–60 mm, somewhat irregular, with undulating margin with compact, finely floccose, white aerial mycelium; colony white to salmon, due to the aerial mycelium and exuding pycnidia; reverse ochraceous with chestnut centre, with concentric rings; agar staining ochraceous due to the release of a ochre pigment.

CA: growth-rate 43–47 mm, irregular, with undulating to crenate margin, with floccose to felted, white aerial mycelium; colony white to salmon, due to the aerial mycelium and exuding pycnidia; reverse similar.

Pycnidia 50–210 μm in diam., solitary or confluent, globose to irregularly shaped when confluent, glabrous, with one to 5 ostioles, occasionally with a short neck; honey to citrine, later olivaceous to olivaceous black; wall consisting of 3–4 layers of cells, outer layers pale coloured; abundant, covering the whole plate or in concentric rings on or partly in the agar, rarely submerged, often associated with dense, olivaceous hyphal strands. Conidiogenous cells 5–7 \times 4–6 μm , bottle-shaped. Conidia 4.2–5.6 \times 1.6–2.4 μm , av. 4.8 \times 1.9 μm , Q = 1.9–3.1, av. Q = 2.5, ellipsoidal with two polar guttules.

Chlamydospores absent.

NaOH spot test: positive on MA: yellow-green then reddish (E+ reaction).

Ecology and distribution. This seems to be a common necrophyte of *Eupatorium cannabinum* ('Hemp Agrimony') found in different parts of Europe. The fungus frequently occurs on dead flower heads and may be seed-borne. On dead stems the pycnidia are connected by a subepidermal mycelial network, comparable with the hyphal strands *in vitro*.

Culture studied. CBS 123.93 (PD 77/1148) ex *Eupatorium cannabinum* (Compositae), the Netherlands.

10. *Phoma crinicola* (Siem.) Boerema — Fig. 11

Phoma crinicola (Siem.) Boerema in Boerema & Dorenbosch, *Versl. Meded. Plziektenk. Dienst Wageningen* 153 (Jaarb. 1978) (1979) 18. — *Phyllosticta crinicola* Siemaszko, *Acta Soc. Bot. Pol.* 1 (1923) 22.

Description in vitro

OA: growth-rate 65–70 mm in 5 days, regular; with coarsely floccose, dull green to olivaceous aerial mycelium; colony colourless to dull green or olivaceous; reverse similar.

MA: growth-rate 78–80 mm in 5 days, regular; with coarsely floccose, dull green aerial mycelium; colony dull green or citrine; reverse leaden grey to olivaceous black with hazel spots.

CA: growth-rate 73–75 mm in 5 days, with compact, felted-floccose, olivaceous-grey or scattered white, aerial mycelium; colony olivaceous, somewhat concentrically zoned; reverse olivaceous to olivaceous black with radial sectors.

Pycnidia 70–185 μm in diam., globose to irregular, solitary or confluent, with or without distinct ostiole, without neck, glabrous or with hyphal outgrowths; citrine to honey, later olivaceous to olivaceous black; walls made up of 2–4 layers of cells, outer layers pigmented; with white conidial exudate; abundant, on and in the agar, often also in aerial mycelium. Conidiogenous cells 4–7 \times 4–7 μm , globose to bottle-shaped. Conidia 3.8–6.4 \times 1.8–2.8 μm , av. 4.8 \times 2.3 μm , Q = 1.7–3.1, av. Q = 2.1–2.2, ellipsoidal to cylindrical, without or with 2 or more small, usually polar guttules.

Chlamydospores absent, but clusters of short, swollen cells may be present.

NaOH spot test: positive, greenish, then red (E+ reaction).

Ecology and distribution. A pathogen of Amaryllidaceae so far only found in Europe. Originally described from a wild species of *Crinum* in Poland. In the Netherlands it is frequently isolated from the hybrid *Crinum powellii*; also from *Nerine bowdenii*: Leaf Spot, Bulb Rot.

Cultures studied. CBS 109.79 (= PD 77/747) ex *Crinum powellii* (Amaryllidaceae), the Netherlands; CBS 118.93 (PD 70/195) ex *Crinum* sp., the Netherlands.

Note. On dead leaves of *Crinum* sp. perithecia of an ascomycete were observed by Siemaszko l.c., in association with the pycnidia. He described this ascomycete as *Mycosphaerella crinicola* Siem. However, in inoculation experiments done on the Plant Protection Service, a teleomorph of *Phoma crinicola* has not been found.

11. *Phoma ajacis* (Thümen) v.d. Aa & Boerema, *comb. nov.* — Fig. 12

Phyllosticta ajacis Thümen in Bolle & Thümen, Boll. Soc. adriat. Sci. nat. 6 (1880) 329 [basonym; neotype dried culture of CBS 177.93, isolate from *Delphinium* sp., probably *D. ajacis*, L 989.300-136].

Description in vitro

OA: growth-rate 72–75 mm, regular, with well-developed or poorly developed, floccose, white to pale olivaceous grey aerial mycelium; colony colourless with grey olivaceous or olivaceous grey shade; reverse similar.

MA: growth-rate 73–77 mm, regular, with compact, woolly, white aerial mycelium; colony colourless to olivaceous grey with greenish olivaceous or citrine margin; reverse leaden black to olivaceous black with citrine margin.

CA: growth-rate 74–81 mm, regular, with compact, floccose, white aerial mycelium; colony olivaceous grey to olivaceous, staining the agar red due to the release of a pigment; reverse apricot to scarlet.

Pycnidia 130–300 μm in diam., globose, solitary or confluent, glabrous, with one or two ostioles, occasionally papillate; citrine-honey, later olivaceous to olivaceous black; walls made up of 3–5 layers of cells, outer layers pigmented; with white conidial exudate; abundant, mainly on, sometimes partly in the agar, hardly in aerial mycelium. Conidiogenous cells 4–6 \times 4–6 μm , globose to bottle-shaped. Conidia 3.4–5.6 \times 1.6–2.4 μm ,

av. $4.2-4.7 \times 1.8 \mu\text{m}$, $Q = 1.6-3.3$, av. $Q = 2.3-2.6$, oblong to ellipsoidal with two, distinct polar guttules.

Chlamydo-spores absent.

NaOH spot test: positive, yellow-green or blue-green later orange finally brick (OA), or yellow-green or green with red margin (MA) (E+ reaction).

Ecology and distribution. In southern Eurasia probably a widely occurring seed-borne pathogen of annual species of *Delphinium*: Leaf Spot. The fungus also has been found in association with Stem Rot. The original material of this fungus on *Delphinium ajacis* is apparently not preserved. To fix the species a typical dried culture of the fungus has been selected as neotype.

Cultures studied. CBS 176.93 (= PD 86/547) ex *Delphinium* sp. (Ranunculaceae), the Netherlands; CBS 177.93 (= PD 90/115) ex *Delphinium* sp. (Ranunculaceae), Kenya.

Note. Similar leaf spots on *Delphinium* spp. may be caused by a large-spored *Ascochyta*-like fungus, known as *Ascochyta aquilegiae* (Rabenh.) Höhnelt, compare Mel'nik (1977).

12a. *Phoma poolensis* Taub. var. *poolensis* — Fig. 13

Phoma poolensis Taubenh. Dis. Greenhouse Crops (1919) 203, var. *poolensis* [autonym created by the separation of the variety *verbascicola*, see below].

Phoma oleracea var. *antirrhini* Saccardo, Sylloge Fung. 3 (1884) 135 [no priority in species rank].

Phyllosticta antirrhini P. Sydow, Beibl. Hedwigia 38 (1889) 134 [sometimes wrongly quoted as '*Phoma*'].

Phoma antirrhini Dzhalongija, Nov. Sist. Nizsh. Rost. (1965) 157.

Selected literature. Guba & Anderson (1919).

Description in vitro

OA: growth-rate 67–68 mm, regular, with appressed floccose, white aerial mycelium; colony almost colourless but with olivaceous tinge; reverse similar or greenish olivaceous.

MA: growth-rate 69–71 mm, regular, with finely woolly, white aerial mycelium; colony grey-olivaceous; reverse olivaceous black or grey olivaceous with honey marginal zone.

CA: growth-rate 74–75 mm, regular, with finely floccose, white aerial mycelium; colony colourless with olivaceous sectors; reverse grey olivaceous.

Pycnidia 60–170 μm in diam., globose to subglobose, solitary or confluent, glabrous, without visible ostiole or neck; honey to olivaceous; walls made up of 2–3 layers of cells, outer layer(s) pigmented; with buff conidial exudate. Conidiogenous cells $2-7 \times 3-6 \mu\text{m}$, globose to bottle-shaped; on and in the agar. Conidia $3.6-5.2 \times 1.6-2.0 \mu\text{m}$, av. $4.3 \times 1.7 \mu\text{m}$, $Q = 2.0-3.0$, av. $Q = 2.5$, ellipsoidal, usually with two inconspicuous polar guttules.

Chlamydo-spores absent.

NaOH spot test: positive on MA: yellow-green, later reddish (E+ reaction).

Ecology and distribution. A world-wide recorded pathogen of cultivated varieties of snapdragon, *Antirrhinum majus*: Leaf Spot and (Basal) Stem Rot. It is frequently encountered on seed of this host: Damping-off in seedlings; sometimes apparently quite destructive. The fungus also has been isolated from other Scrophulariaceae. Comparative inoculation experiments demonstrated the occurrence of different host forms, which may

have been promoted by the common seed transmission. Isolates from *Verbascum* spp., characterized by distinctly ostiolate pycnidia and somewhat wider range of conidial dimensions, are distinguished as a separate variety, see below.

Cultures studied. CBS 113.20 (PD 92/774) ex *Anthirrhinum majus* (Scrophulariaceae), USA; CBS 116.93 (PD 71/884) ex *Anthirrhinum majus*, the Netherlands; CBS 115.93 (PD 74/206) ex *Scrophularia nodosa* (Scrophulariaceae), the Netherlands.

Note. Transfers of isolates of this fungus commonly display an abnormality which is also known of some other species of *Phoma*. Namely that the development of an ostiole fails to materialize, so that fully mature pycnidia are still non-ostiolate. For release of the conidia the pycnidial wall then has to burst open. Experiments by Rajak & Rai (1983, 1984) demonstrated that certain species of *Phoma* are predisposed to this phenomenon and also that the pH and the nutrient composition of the agar-media may influence it. The occurrence of such non-ostiolate mature pycnidia in vitro must not be confused with the fact that in some species of *Phoma* the formation of an opening in the pycnidia occurs only at the end of the pycnidial growing process (porus instead of ostiolum, e. g. a feature of section *Plenodomus*, see Boerema, Van Kesteren & Loerakker, 1981).

12b. *Phoma poolensis* var. *verbascicola* (Ell. & Kellerm.) v.d. Aa & Boerema, *comb. nov.* — Fig. 14

Phyllosticta verbascicola Ell. & Kellerm., Bull. Torrey bot. Club 11 (1884) 115 [basionym; cf. holotype NY].

Description in vitro

OA: growth-rate 62–68 mm, regular, with scanty, floccose, white aerial mycelium; colony almost colourless, sometimes with pale olivaceous sectors; reverse colourless to grey olivaceous.

MA: growth-rate 59–63 mm, regular, with rather compact, woolly to floccose, white aerial mycelium; colony colourless or grey olivaceous; reverse saffron to cinnamon with olivaceous centre or entirely olivaceous with pale luteous or honey spots near margin.

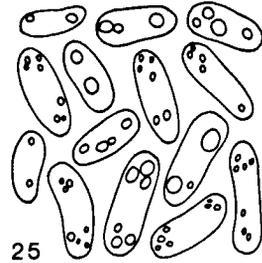
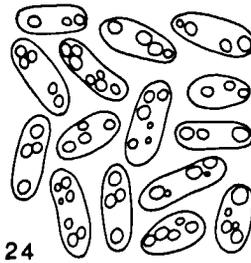
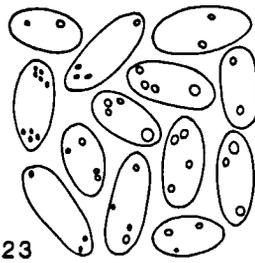
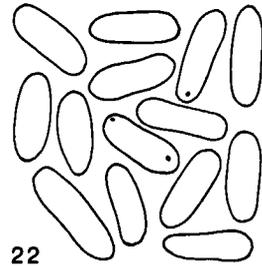
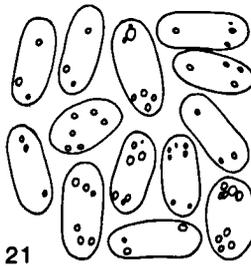
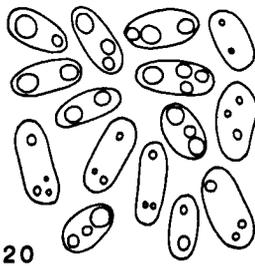
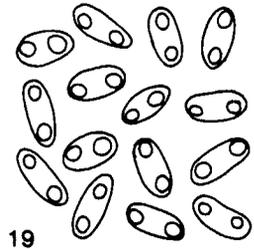
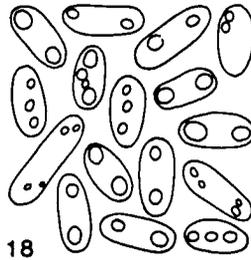
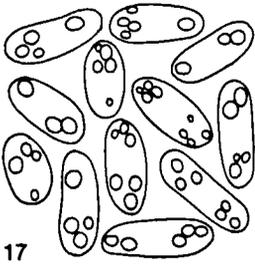
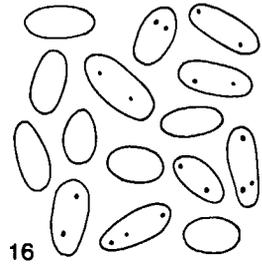
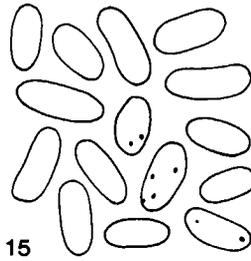
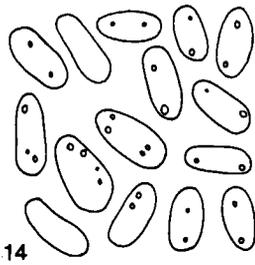
CA: growth-rate 66–72 mm, regular, with scanty, floccose, white or greyish aerial mycelium; colony colourless; reverse colourless to pale olivaceous.

Pycnidia 70–225 μm in diam., globose, solitary or more or less confluent, glabrous, with 1–2(–5) papillate ostioles; citrine to honey at first, later olivaceous to olivaceous black; walls made up of 2–3 layers of cells, outer layer(s) pigmented; with colourless or white conidial exudate; on and in the agar. Conidiogenous cells 2–6 \times 4–6 μm , globose to bottle-shaped. Conidia 3.4–5.6 \times 1.6–2.4 μm , av. 4.2–4.8 \times 1.7–1.8 μm , Q = 1.5–3.5, av. Q = 2.4–2.8, ellipsoidal with two (or more), rather inconspicuous polar guttules.

Chlamydospores absent.

NaOH spot test: positive on MA: yellow-green, later reddish (E+ reaction).

Ecology and distribution. This characteristic variety on *Verbascum* species is probably widely distributed in Eurasia and North America. Inoculation experiments have shown that it possesses pathogenic capacities with regard to the hosts, and may cause necrotic lesions on leaves and stems and damping-off of young plants. The fungus did not cause disease symptoms on snapdragon, *Anthirrhinum majus*, the principle host of the type



Figs. 14–25. Conidia. 14. *Phoma poolensis* var. *verbascicola*; 15. *P. subherbarum*; 16. *P. arachidis-hypogaeae*; 17. *P. henningsii*; 18. *P. insulana*; 19. *P. pereupyrena*; 20. *P. multirostrata*; 21. *P. labilis*; 22. *P. crystallifer*; 23. *P. aurea*; 24. *P. nebulosa*; 25. *P. chenopodiicola*. Bar = 10 μ m.

variety *P. poolensis* var. *poolensis*. In vitro it can be distinguished by the stable production of distinctly ostiolate pycnidia and the somewhat wider size range of the conidia.

Cultures studied. CBS 114.93 (PD 74/228) ex *Verbascum* sp. (Scrophulariaceae), the Netherlands; CBS 127.93 (PD 92/347) ex *Verbascum densiflorum*, the Netherlands.

Note. Collections of this fungus on dead stems and seed capsules of *Verbascum* spp. usually have been identified as *Phoma verbascicola* (Schw.) Cooke, but the type material of the basionym of this binomial, *Sphaeria verbascicola* Schweinitz (PH, duplicate BPI), contains only immature ascomata, probably belonging to *Pleospora scrophulariae* (Desm.) Höhnelt [also interpreted as referring to a species of *Mycosphaerella*: *M. verbascicola* (Schw.) Fairman].

13. *Phoma subherbarum* de Gruyter, Noordel. & Boerema, *spec. nov.* — Fig. 15

Coloniae in agar maltoso celeriter crescentes, incoloratae, sine mycelio acrio, agarum rubescentes, in NaOH immutabiles; pycnidia 100–200 µm in diam., solitaria vel agglutinata, glabra, papillata, ostiolata; conidiophora phyalidea; conidia hyalina, glabra, ellipsoidea, unicellulata, 4.0–5.2(–6.4) × 1.6–2.2, eguttulata; chlamydo sporae desunt. Typus: L 992.177-439 (siccus); CBS 250.92 (PD 92/371, DAOM 171914) (vivus); ex *Zea mays* (Gramineae); Canada.

Description in vitro

OA: growth-rate 78–81 mm, regular, without aerial mycelium; colony colourless with saffron-flesh and olivaceous zones; reverse similar.

MA: growth-rate 82–83 mm, regular, with appressed felted or floccose, olivaceous grey or smoke grey aerial mycelium; colony flesh to rust; reverse rust to chestnut.

CA: growth-rate 77–80 mm, regular, without or with very sparse smoke grey or olivaceous grey aerial mycelium; colony colourless to flesh, sometimes with olivaceous to greenish olivaceous spots and sectors; reverse flesh-coral with olivaceous spots, or olivaceous to olivaceous black with dull green margin.

Pycnidia 90–200 µm in diam., globose to subglobose or irregularly shaped, solitary or confluent, glabrous, or with short hyphal outgrowths, with 1(–3) papillate ostioles; sienna, later olivaceous black; wall made up of up to 3 layers of cells, outer layers dark pigmented; with white to rosy-buff conidial exudate; abundant in and on the agar; micro-pycnidia present, 30–70 µm in diam. Conidigenous cells 3–5 × 3–7, globose to bottle-shaped. Conidia 4.0–5.2(–6.4) × 1.6–2.2 µm, av. 4.5 × 1.8 µm, Q = 2.0–3.6, av. Q = 2.5, oblong to ellipsoidal, without guttules.

Chlamydo spores absent.

NaOH spot test: negative.

Ecology and distribution. This saprophyte, resembling in many respects the ubiquitous *Phoma herbarum* Westend. (no. 4), seems to be a fungus from (South?) American origin. The isolates studied were obtained from necrotic leaves of wild potatoes (*Solanum* spp. series *Tuberosa*) in Peru (Andes, alt. 2500 m) and the surface of overwintered seeds of maize (*Zea mays*), collected in Canada (Ottawa: 'most common fungus isolated from discoloured seed').

Cultures studied. CBS 249.92 (PD 78/1088) ex *Solanum* sp. series *Tuberosa* (Solanaceae), Peru; CBS 250.92 (PD 92/371, DAOM 171914, identical with DAOM 171915 and DAOM 171916) ex *Zea mays* (Gramineae), Canada.

14. *Phoma arachidis-hypogaeae* (Vasant Rao) v.d. Aa & Boerema, *comb. nov.* — Fig. 16

Phyllosticta arachidis-hypogaeae Vasant Rao, Sydowia 16 ['1962'] (1963) 275–276 [basionym; cf. holotype AMH 134].

Selected literature. Patil (1986).

Description in vitro

OA: growth-rate 47–48 mm, regular with undulating margin, with poorly developed, flat, finely floccose, white to greenish grey aerial mycelium; colony colourless to buff with grey olivaceous centre, reverse olivaceous at centre, towards margin buff.

MA: growth-rate 46 mm, irregularly undulating, with compact, woolly-floccose, dark herbage green to greenish glaucous aerial mycelium; colony colour difficult to see caused by compact aerial mycelium, at margin citrine; reverse zonate citrine to cinnamon with olivaceous black, at centre olivaceous black.

CA: growth-rate 20–24 mm, irregular, probably inhibited by the medium, with abundant, compact, coarsely floccose, citrine-green aerial mycelium; colony olivaceous black with citrine margin; reverse citrine-green at centre, then with purplish grey concentric zone, margin buff.

Pycnidia 80–200 µm in diam., globose or bottle-shaped, solitary or in rows along hyphal strands, not confluent, glabrous, papillate, citrine-honey; then olivaceous to olivaceous black; walls made up of 3–5 layers of cells, outer layers pigmented; with whitish conidial exudate; abundant, mainly on and in the agar but also in aerial mycelium. Conidio-genous cells 3–8 × 3–7 µm, globose to bottle-shaped. Conidia 3.2–5.2 × 1.8–2.4 µm, av. 4.3 × 2.1 µm, Q = 1.6–2.7, av. Q = 2.1, oblong to ellipsoidal without or with two indistinct polar guttules.

Chlamydospores absent.

Crystals present on CA after three weeks, citrine green.

NaOH spot test: not specific, only on MA a slight reddish discolouring occurs.

Ecology and distribution. In India frequently found on living leaves of groundnut, *Arachis hypogaea*: Leaf Spot. The fungus is probably indigenous to that subcontinent. Inoculation experiments have shown that the fungus could also infect various other plants, esp. Leguminosae. Another plurivorous species of *Phoma* in India repeatedly isolated from groundnut plants is *P. multirostrata* (Mathur et al.) Dorenbosch & Boerema (no. 18).

Culture studied. CBS 125.93 (= PD 77/1029) ex *Arachis hypogaea* (Leguminosae), India.

15. *Phoma henningsii* Sacc. — Figs. 17, 29

Phoma henningsii Saccardo, Sylloge Fung. 10 (1892) 139. — *Phoma acaciae* P. Hennings, Bot. Jb. 14 (1892) 368–369; not *Phoma acaciae* Penzig & Saccardo, Atti Ist. ven. Sci. VI, 2 (1884) 650 [= Funghi Mortola n. 23].

Description in vitro

OA: growth-rate 43–44 mm, without aerial mycelium, only a short white-felted zone near margin; colony regular, colourless; reverse colourless to pale olivaceous.

MA: growth-rate 51–53 mm, with floccose, grey olivaceous aerial mycelium; colony regular, honey with olivaceous tinge; reverse isabelline with olivaceous tinge, margin honey.

CA: growth-rate 46–47 mm, with fine velvety-floccose, smoke grey aerial mycelium; colony pale olivaceous with buff margin; reverse concentrically zonate buff-olivaceous and isabelline.

Pycnidia 70–220 μm in diam., globose, solitary or confluent, with usually one, non-papillate ostiole, glabrous; honey to citrine, later olivaceous to olivaceous black; wall consisting of 2–4 layers of cells, outer layer(s) pigmented; conidial exudate salmon to pale vinaceous; abundant, in concentric rings (partly) in the agar. Conidiogenous cells 3–8 \times 3–8 μm , globose to bottle-shaped. Conidia 4.8–7.4 \times 2.2–3.2 μm , av. 5.9 \times 2.5 μm , Q = 1.6–3.1, av. Q = 2.4, ellipsoidal, with 2 (3) large polar guttules.

Chlamydospores present, 6.0–10.0 μm in diam., olivaceous, with greenish guttules, intercalary or terminal, in chains or clusters.

NaOH spot test: negative or weakly yellow on MA, not specific.

Ecology and distribution. This fungus has been recorded in East Africa as a harmful wound parasite of *Acacia* spp. On account of its saprophytic vigour and the conidial dimensions in vivo it has been confused with *Phoma herbarum* Westend. (no. 4).

Culture studied. CBS 104.80 (PD 74/1017) ex *Acacia mearnsii* (Mimosaceae), Kenya.

16. *Phoma insulana* (Mont.) Boerema & Malathr. — Figs. 18, 30

Phoma insulana (Mont.) Boerema & Malathrakis in Boerema, Versl. Meded. Plziektenk. Dienst Wagenin- gen 158 (Jaarb. 1981) (1982) 28. — *Phyllosticta insulana* Montagne, Anns Sci. nat. (Bot.) IV, 5 (1856) 343.

Description in vitro

OA: growth-rate 68 mm, regular, nearly without aerial mycelium; colony olivaceous with colourless concentric ring near margin; reverse olivaceous with greenish olivaceous outer margin.

MA: growth-rate 70–72 mm, regular, with downy compact grey olivaceous aerial mycelium in central part, margin without aerial mycelium; colony olivaceous with brick sectors near margin; reverse olivaceous black with brick and leaden grey sectors.

CA: growth-rate 65–66 mm, regular, with finely fluffy-floccose grey olivaceous aerial mycelium; colony olivaceous with grey olivaceous; reverse olivaceous black with olivaceous and leaden grey sectors.

Pycnidia 140–270 μm , globose, solitary or confluent, in centre confluent pycnidia up to 470 μm , glabrous, with 1–5 ostioles, non-papillate or with distinctly papillate neck; citrine to honey then olivaceous black; walls made up to 2–3 layers of cells, outer layer(s) pigmented; with white conidial exudate; scattered on or partly in the agar. Conidiogenous cells 2–8 \times 4–6 μm , globose to bottle-shaped. Conidia 3.2–5.6(–6.8) \times 1.6–2.4 μm , av. 4.6 \times 1.8 μm , Q = 1.7–3.3, av. Q = 2.5, ellipsoidal, with 2 (3), usually polar guttules.

Chlamydospores (4.0–)5.5–10.5(–14.5) μm in diam., solitary or in chains, intercalary or terminal, olivaceous, with green guttules.

NaOH spot test: negative.

Ecology and distribution. In southern Europe this fungus in autumn commonly occurs on discolouring leaves and ripening fruits of the olive, *Olea europaea*. In Crete it appeared

to be one of the fungi involved in the natural processing of olive fruits (such fruits are greatly estimated by local people as table fruits).

Culture studied. CBS 252.92 (PD 80/1144) ex *Olea europaea* (Oleaceae), Greece.

17. *Phoma pereupyrena* de Gruyter, Noordel. & Boerema, *nom. nov.* — Figs. 19, 31

Polyopeus pomi Horne, J. Bot., Lond. 58 (1920) 240; not *Phoma pomi* Schulzer von Muggenburg & Saccardo, Hedwigia 23 (1884) 109 [= *Phoma macrostoma* Mont. var. *macrostoma*]; not *Phoma pomi* Passerini, Atti R. Accad. naz. Lincei R. 4 (2) (1888) 96 [= *Asteromella mali* (Briard) Boerema].

Description in vitro

OA: growth-rate 68 mm, regular, with felted to downy, olivaceous grey aerial mycelium; colony grey olivaceous to olivaceous with radiating hyphae; reverse olivaceous grey, iron grey or grey olivaceous.

MA: growth-rate 71–72 mm, regular, with abundant, woolly-floccose, olivaceous grey aerial mycelium; colony olivaceous grey to grey olivaceous; reverse leaden grey to leaden black.

CA: growth-rate 70–71 mm, regular, with floccose, olivaceous grey aerial mycelium; colony iron grey to olivaceous grey at margin, with distinct radiating mycelial strands; reverse leaden grey to leaden black, with olivaceous margin.

Pycnidia 50–210 µm in diam., globose to irregular, solitary or confluent, glabrous or semi-pilose, with 1–3 ostioles, non-papillate, slightly papillate or occasionally with long tubular outgrowths; citrine to honey, later olivaceous to olivaceous black; walls consisting of 5–8 layers of cells, outermost 2 layers with thickened, dark pigmented walls; exudate white to straw-coloured; abundantly formed on or partly in the agar. Conidiogenous cells 3–7 × 3–6 µm, globose to bottle-shaped. Conidia 3.4–5.2 × 1.6–2.0 µm, av. 4.0 × 1.7 µm, Q = 2.0–2.8, av. Q = 2.4, ellipsoidal with two polar guttules.

Chlamydospores solitary or in chains, intercalary, globose or elongate, (3.5–)6–9 (–13) µm in diam., olivaceous, with green guttules.

NaOH spot test: negative.

Ecology and distribution. In Eurasia this fungus has been isolated from above-ground parts (fruits and leaves) of quite different woody and herbaceous plants. It seems to be a plurivorous opportunistic parasite. The fungus *in vitro* shows much resemblance to the widely occurring soil fungus *Phoma eupyrena* Sacc. (treated in Contributions I–1), but can be recognized by its larger conidia and different cultural behaviour. Its original classification in a separate genus, *Polyopeus* Horne, is based on the fact that under certain conditions the pycnidia in culture develop several long tubular outgrowths or 'necks', compare Kidd & Beaumont (1924).

Culture studied. CBS 267.92 (PD 76/1014) ex *Coffea arabica* (Rubiaceae), India.

18. *Phoma multirostrata* (Mathur et al.) Dorenb. & Boerema var. *multirostrata* — Figs. 20, 32

Phoma multirostrata (Mathur & al.) Dorenbosch & Boerema, Mycopath. Mycol. appl. 50 (1973) 255–256, var. *multirostrata*. — *Sphaeronaema multirostratum* Mathur et al. in Mathur & Thirumalachar, Sydowia 13 (1959) 146 [as '*S. multirostrata*'].

Phoma ushtrina Rai & Misra, Curr. Sci. 50 (1981) 377.

Phoma multirostrata var. macrospora Boerema

Phoma multirostrata var. *macrospora* Boerema, Versl. Meded. Plziektenk. Dienst Wageningen 164 (Jaarb. 1985) (1986) 29.

Phoma multirostrata var. *macrospora* Mathur & Thirumalachar [in 1965 deposited in CBS-collection, but never published: 'collection name'].

Sphaeronaema indicum Mathur et al., Sydowia 13 (1959) 146a [as '*S. indica*'].

Phoma lucknowensis Saksena, Nand & Sarbhoy, Mycopath. Mycol. appl. 34 (1968) 93; not *Phoma lucknowensis* Agarwal & Misra, Curr. Sci. 50 (1981) 66.

Phoma terrestris Saksena, Nand & Sarbhoy, Mycopath. Mycol. appl. 29 (1966) 86 [as '*terrestre*']; not *Phoma terrestris* Hansen, Phytopathology 19 (1929) 699.

Phoma multirostrata var. microspora (Allescher) Boerema

Phoma multirostrata var. *microspora* (Allescher) Boerema, Versl. Meded. Plziektenk. Dienst Wageningen 164 (Jaarb. 1985) (1986) 30. — *Phoma decorticans* var. *microspora* Allescher, Rabenh. Krypt.-Flora [ed. 2], Pilze 6 [Lief. 63] (1898 [vol. dated '1901']) 284.

Phoma microspora Balasubramanian & Narayanasamy, Indian Phytopath. 33 (1980) 136; not *Phoma microspora* Saccardo apud Roumeguère, Revue Mycol. 1885 (1885) 158; not *Phoma microspora* Patouillard in Hariot, Champ. Cap Horn (1889) 196.

Phoma lucknowensis Agarwal & Misra, Curr. Sci. 50 (1981) 66 [pycnidial primordia misinterpreted as 'dictyochlamydospores']; not *Phoma lucknowensis* Saksena, Nand & Sarbhoy, Mycopath. Mycol. appl. 34 (1968) 93.

For full synonymy of this fungus see Boerema (1986). It includes 7 other combinations in *Phoma* and 6 in *Phyllosticta*. The history of the species is discussed by Morgan-Jones (1988b).

Description in vitro

OA: growth-rate 67–72 mm, regular, with poorly developed, felted, white to grey olivaceous aerial mycelium or without any; colony colourless to weak olivaceous; reverse olivaceous.

MA: growth-rate 78–82 mm, regular, with felty to floccose or woolly, pale olivaceous grey to olivaceous buff aerial mycelium; colony olivaceous to olivaceous buff, outer margin fulvous; reverse leaden grey to olivaceous black.

CA: growth-rate 76–82 mm, regular, with velvety or finely floccose to woolly, white to olivaceous grey aerial mycelium; colony colourless to hazel; reverse hazel with olivaceous at center.

Pycnidia (75–)150–300(–450) μm in diam., globose to subglobose, or irregular with much elongated neck, solitary or confluent, glabrous, with one or more ostioles; honey to citrine, later olivaceous to olivaceous black; walls made up of 2–5 layers of cells, outer layer(s) pigmented; with white to cream conidial exudate; on and in the agar. Conidigenous cells 3–7 \times 3–6 μm , globose to bottle-shaped. Conidia (2.6–) 3.2–6.0 (–7.5) \times 1.4–2.4 (–3.0) μm , av. 3.9–5.5 \times 1.9–2.4 μm , Q = 1.1–2.7, av. Q = 2.0–2.1, ellipsoidal with 2 or more guttules.

Chlamydospores 5–11 μm in diam., oblong to ellipsoidal, in short chains or clustered, intercalary, olivaceous with green guttules.

NaOH spot test: on MA weak brownish red, not specific.

Ecology and distribution. Most records of this variable warmth preferring or thermotolerant fungus are from India (centre of origin?), but the fungus appears to have a world-

wide distribution in subtropical regions and warm greenhouses. The type-variety refers to soil-isolates with extremely large pycnidia. Similar isolates with smaller pycnidia and variable conidial dimensions – the varieties *macrospora*, *microspora* and intermediate variants – have been obtained from necrotic lesions on leaves and stems of all kinds of herbaceous plants. Inoculation experiments with different isolates from plants have shown that the fungus can be characterized as a plurivorous soil-borne opportunistic plant pathogen.

Cultures studied. CBS 274.60 (IMI 81598, PD 92/1756) ex soil from poultry farm, India; CBS 368.65 (HACC 154, PD 92/1757), India; CBS 110.79 (PD 67/622) ex stem of *Cucumis sativus*, the Netherlands.

Note. The data given are from the original descriptions of the cultures studied, i.e. the type of *Phoma multirostrata* (Mathur et al.) Dorenb. & Boerema var. *multirostrata* (CBS 274.60), *Phoma multirostrata* var. *macrospora* Boerema (CBS 368.65) and *Phoma multirostrata* var. *microspora* (Allescher) Boerema (CBS 110.79), as given by Boerema (1986). These data agree with those of Morgan-Jones (1988b). However, the original isolates appear to be degenerated, because in a recent study the pycnidia and conidia remained small, and in the pycnidia of isolate CBS 110.79 no conidia were formed.

19. *Phoma labilis* Sacc. — Fig. 21

Phoma labilis Saccardo, *Michelia* 2 (2) (1881) 341.

Description in vitro

OA: growth-rate 62–63 mm, regular, with scanty, appressed, whitish to grey olivaceous aerial mycelium; colony grey olivaceous to olivaceous; reverse similar.

MA: growth-rate 64–66 mm, regular, with woolly-floccose grey olivaceous aerial mycelium with white sectors; colony grey olivaceous with citrine outer margin; reverse olivaceous black with leaden grey tinges.

CA: growth-rate 66–69 mm, regular, with compact, felted, white aerial mycelium; colony colourless with olivaceous sectors or entirely olivaceous; reverse luteous-amber, ochraceous with or without olivaceous sectors.

Pycnidia 70–250 μm in diam.; globose, glabrous, solitary or confluent, usually with one papillate ostiole; citrine or honey, later olivaceous to olivaceous black; walls made up of 2–4 layers, outer layers pigmented; with white to pale luteous or ochraceous conidial exudate; abundant on and in the agar. Conidiogenous cells 5–7 \times 4–8 μm , globose to bottle-shaped. Conidia 4.0–6.6 \times 2.0–3.0 μm , av. 5.3–5.4 \times 2.4–2.5 μm , $Q = 2.2$ –2.7, av. $Q = 2.2$, oblong to ellipsoidal with two (or more) polar guttules.

Chlamydospores absent.

NaOH spot test: positive: both on MA and OA a reddish brown discolouring, not specific.

Ecology and distribution. Isolates of this warmth-preferring saprophyte have been obtained from soil and various herbaceous and woody plants grown in southern Eurasia (Italy, Turkey, Israel, Kuwait, Indonesia). In the Netherlands the fungus has been recorded in glasshouses. *Phoma labilis* tends to lose the ability to produce pycnidia quite quickly (see note). Most isolates have not survived the freeze drying treatment.

Cultures studied. CBS 479.93 (PD 70/93) ex *Rosa* sp. (Rosaceae), Israel; CBS 124.93 (PD 87/269) ex *Lycopersicon esculentum* (Solanaceae), the Netherlands.

Note. The degeneration of this fungus often starts in sectors with a yellow pigmentation. Transfers from such a sterile yellow sector in CBS 479.93 once resulted in a well sporulating *Acremonium* culture, identified by Dr. W. Gams (CBS Baarn) as *A. ochraceum* W. Gams.

20. *Phoma crystallifer* de Gruyter, Noordel. & Boerema, *spec. nov.* — Fig. 22

Coloniae in agaro maltoso moderatim crescentes, bubalinae, cum mycelio acrio olivaceo-cinereo, reversus plumbeus, in NaOH immutabiles; crystalliferae, pycnidia usque ad 250 µm in diam., solitaria vel agglutinata, glabra, papillata, ostiolata; conidiophora phyalidea; conidia hyalina, glabra, ellipsoidea, uni-celulata, 4.0–5.8 × 1.6–2.2 µm, eguttulata vel obscure guttulata; chlamydo sporae desunt. Typus: L992.177-456 (siccus); CBS 193.82 (PD 80/1249) (vivus); ex *Chamaespartium* sp. (Leguminosae), Austria.

Description in vitro

OA: growth-rate 53–54 mm, regular, without or with scanty pale olivaceous grey or smoke grey aerial mycelium; colony colourless; with radially arranged rows of greyish pycnidia; reverse buff.

MA: growth-rate 26–35 mm (14 days: 39–48 mm), irregular, with woolly, olivaceous grey to grey olivaceous aerial mycelium; colony buff, with orange-brown tinges caused by abundant pycnidia; reverse between saffron and buff with darker concentric zones (sepia).

CA: growth-rate 19–23 mm (14 days: 32–35 mm), irregular, with floccose olivaceous grey or grey olivaceous aerial mycelium; colony colourless to buff with darker sepia clusters of pycnidia; reverse grey olivaceous to olivaceous black with leaden grey reflex.

Pycnidia 80–250 µm in diam., globose to subglobose, solitary or confluent, glabrous or with short hyphal outgrowths, with 1–2 papillate ostioles; honey to citrine, later olivaceous to olivaceous black; walls made up of up to 7 layers of cells, outer layers pigmented; with white conidial exudate; on and in the agar. Also micropycnidia are present, 40–60 µm in diam. Conidiogenous cells 3–7 × 3–6 µm, globose to bottle-shaped, sometimes more elongate. Conidia 4.0–5.8 × 1.6–2.2, av. 5.3 × 1.9 µm, Q = 2.4–3.4, av. Q = 2.8, oblong to ellipsoidal without or with some inconspicuous, polar guttules.

Chlamydo spores absent; swollen cells, sometimes clustered, may be present.

Crystals white to pale luteus, abundant, especially on OA and MA.

NaOH spot test: negative.

Ecology and distribution. In Central Europe this species is probably a common necrophyte of Leguminosae. The name *crystallifer* indicates the formation of crystals in vitro. The crystals are not dendritic, in contrast with those of some other *Phoma* species occurring on Leguminosae (Noordeloos et al., 1993). On dead stems of the leguminous hosts, the fungus in old compiling works has been referred to as '*Phoma melaena* (Fr.) Mont. & Dur.', which was used as collective name for different *Phoma*-like species associated with 'very black patches'¹.

Culture studied. CBS 193.82 (PD 80/1249) ex *Chamaespartium* sp. (Leguminosae), Austria.

¹) The identity of the basionym *Sphaeria melaena* Fr. : Fr. is not yet fixed. Sutton (1980) listed Petrak's (1921) interpretation as *Podoplaconema melaenum* (Fr.) Petrak, referring to stromatic non-ostiolate small-spored pycnidia found on *Silene nutans* (Caryophyllaceae).

21. *Phoma aurea* de Gruyter, Noordel. & Boerema, *spec. nov.* — Fig. 23

Coloniae in agar maltoso moderatim crescentes, ochraceae, margine luteolae, mycelio acrio albido flocculoso, in NaOH immutabiles vel ferruginascentes demum olivascens; pycnidia circa 150 μm in diam., solitaria glabra, haud papillata, uni-ostiolata; conidiophora phyalidea; conidia hyalina, glabra, ellipsoidea, unicellulata, 4.4–6.8 \times 2.2–3.2 μm , pauci-guttulata; chlamydosporae desunt. Typus: L 992.177-422 (siccus); CBS 269.93 (PD 78/1087) (vivus); ex *Medicago polymorpha* (Leguminosae), New Zealand.

Description in vitro

OA: growth-rate 46–48 mm, regular, with poorly developed, flat, pure white aerial mycelium in scattered floccules over whole dish; colony weakly olivaceous buff to greenish olivaceous; reverse similar, but with olivaceous tinge (after three weeks the colony is distinctly more pigmented to olivaceous).

MA: growth-rate 56–58 mm, regular, with very fine, compact, white aerial mycelium; colony weakly ochraceous (aureate) with primrose outer margin; reverse slightly more intensely ochraceous, at margin pale luteous.

CA: growth-rate 45–49 mm, regular, with white, powdery aerial mycelium; colony salmon with grey olivaceous tinge caused by the presence of abundant pycnidia; reverse similar, but more intense.

Pycnidia 50–150 μm in diam., globose, solitary, glabrous, with one ostiole, non-papillate or slightly papillate; citrine-honey, later olivaceous; walls made up of 3–4 layers of cells, outer layers pigmented; with whitish grey conidial exudate; abundant, mainly on and in the agar but also rarely in aerial mycelium. Conidiogenous cells 4–6 \times 4–6 μm , globose to bottle-shaped. Conidia 4.4–6.8 \times 2.2–3.2 μm , av. 5.5 \times 2.6 μm , Q = 1.6–2.8, av. Q = 2.1, oblong to ellipsoidal, often acuminate, with 2-many, small guttules.

Chlamydospores absent.

NaOH spot test: not specific, only on OA a slight discolouring to rust, later olivaceous tints occur.

Ecology and distribution. This fungus is so far known only of an isolate from dead stems of *Medicago polymorpha* in New Zealand. It may be a common saprophyte in Australasia. The epithet *aurea* refers to golden-coloured colonies on MA.

Culture studied. CBS 269.93 (= PD 78/1087) ex *Medicago polymorpha* (Leguminosae), New Zealand.

22. *Phoma nebulosa* (Pers. : Fr.) Berk. — Fig. 24

Phoma nebulosa (Pers. : Fr.) Berkeley, Outl. Br. Fung. (1860) 314 [as *Ph. nebulosa* 'Mont.']. — *Sphaeria nebulosa* Persoon, Obs. mycol. 2 (1799) 69; Syn. meth. Fung. (1801) 31; Fries, Syst. mycol. 2 [Sect. 2] (1823) 430. — *Exormatostoma nebulosa* (Pers. : Fr.) S.F. Gray, Nat. Arr. Br. Pl. 1 (1821) 522 [as 'nebulosum']. — *Sphaeropsis nebulosa* (Pers. : Fr.) Fries, Summ. Veg. Scand. 2 [Sectio posterior] (1849) 419.

Selected literature. Boerema (1976).

Description in vitro

OA: growth-rate 44–55 mm, regular, with rather coarsely floccose, white aerial mycelium mainly in central part, or without aerial mycelium; colony grey olivaceous at centre,

towards margin colourless to citrine, greenish olivaceous or dull green, with greyish zones with pycnidia; reverse similar.

MA: growth-rate 47–55 mm, regular, with coarsely woolly, white to citrine aerial mycelium; colony colourless to grey olivaceous zonate, with agar staining citrine due to a pigment production; reverse similar.

CA: growth-rate 48–54 mm, regular, with white floccose to fluffy aerial mycelium; colony greenish olivaceous at centre, towards margin colourless; reverse slightly more green with olivaceous black centre, also with rosy-buff tinges.

Pycnidia 100–250 μm in diam., subglobose, usually with distinct neck, especially in submerged pycnidia; solitary or confluent, glabrous, with 1 to 2 ostioles; citrine to honey, later olivaceous to olivaceous black; walls made up of 3–5 layers of cells, outer layers pigmented; with white to buff conidial exudate; abundant, mostly on, sometimes (partly) in the agar. Also micropycnidia are formed, mostly in the agar, 45–80 μm . Conidiogenous cells 5–8 \times 3–6 μm , globose to bottle-shaped, often with conspicuous neck. Conidia 3.6–6.6 \times 1.4–2.0, av. 4.4–5.4 \times 1.7–1.8 μm , Q = 2.0–3.7, av. Q = 2.4–3.2, oblong to ellipsoidal with 2-many, usually polar-orientated guttules.

Chlamydospores absent.

Crystals: no true crystals formed, but at centre of colony agglutinated, yellow gelatinous pigment clots observed on MA.

NaOH spot test: negative.

Ecology and distribution. In Europe a common soil-borne saprophyte, isolated from dead tissue of various herbaceous and woody plants (cf. isolates from Austria, Belgium, Germany, Great Britain and the Netherlands). The fungus has also been recorded in New Zealand, North America (United States) and India. The history of this species is a concatenation of different interpretations. The present *Phoma*-concept is fixed by a lectotype in Persoon's herbarium (L 910.269-51).

Cultures studied. CBS 503.75 (IMI 194766, ATCC 32163, PD 74/4) ex *Urtica dioica* (Urticaceae), Austria; CBS 117.93 (PD 83/90) ex *Mercurialis perennans* (Euphorbiaceae), the Netherlands; CBS 112.93 (PD 90/99) ex *Acer negundo* (Aceraceae), the Netherlands; CBS 113.93 (PD 90/1312) ex *Cannabis sativa* (Cannabaceae), the Netherlands.

23. *Phoma chenopodiicola* de Gruyter, Noordel. & Boerema, *nom. nov.* — Fig. 25

Gloeosporium chenopodii P. Karsten & Hariot, J. Bot., Paris 3 (1889) 207 [cf. holotype PC]. — *Plenodomus* (= *Phoma*) *chenopodii* (P. Karsten & Har.) von Arx, Verh. Kon. Ned. Akad. Wet. (Afd. Natuurk.) reeks 2, 51 (3) [= Revis. *Gloeosporium*, ed. 1] (1957) 73; not *Phoma chenopodii* Ahmad, Sydowia 2 (1948) 79; not *Phoma chenopodii* Pavgi & Singh, Mycopath. Mycol. appl. 30 (1966) 265.

Description in vitro

OA: growth-rate 39–55 mm, regular, without aerial mycelium or with scanty, compact, white aerial mycelium; colony colourless to grey olivaceous or greenish olivaceous, or olivaceous grey; reverse olivaceous black with ochre margin, or grey to greenish olivaceous with vinaceous buff margin.

MA: growth-rate 39–62 mm, regular or with crenate margin, with finely floccose, whitish, olivaceous grey or grey olivaceous aerial mycelium; colony greenish olivaceous,

grey olivaceous to olivaceous grey; reverse leaden grey, olivaceous black to olivaceous buff or violaceous black, sometimes zonate, outermost margin somewhat saffron.

CA: growth-rate 38–62 mm, regular, with finely floccose, white to pale olivaceous grey to grey olivaceous aerial mycelium; colony grey olivaceous, olivaceous grey to olivaceous with colourless sectors or zones, with whitish margin; reverse fuscous black, purplish grey or olivaceous mixed with grey olivaceous, with olivaceous or ochraceous margin, sometimes rather pale: hazel with olivaceous sectors.

Pycnidia 100–250 µm in diam., more or less globose, usually confluent, glabrous, with 1 or 2 distinct ostioles, sometimes papillate or with elongate neck; olivaceous to olivaceous black; walls made up of 3–5 layers of cells, outer layers pigmented; with white to saffron conidial exudate; abundant, mainly on the agar but also (partly) submerged in the agar. Conidiogenous cells 4–8 × 4–6 µm. Conidia 4.0–6.8(–9.8) × 1.6–2.6(–4.0) µm, av. 4.8–5.5 × 2.0–2.2 µm, Q = 1.8–3.0, av. Q = 2.4–2.6, oblong to ellipsoidal with 2-many, small guttules.

Chlamydo-spores absent.

NaOH spot test: negative.

Ecology and distribution. In Europe a common necrophyte on *Chenopodium album*. It probably has a world-wide distribution on this host by seed transmission. In South America it is repeatedly found on a cultivated variety of the related *Chenopodium quinoa*. In vivo the pycnidia are often deeply immersed, which may explain the original classification in *Gloeosporium*. The fungus has been confused with the plurivorous *Phoma exigua* Desm. which in Europe also commonly occurs on dead stems of *C. album*. [The latter fungus may produce similar continuous conidia, but usually also 1-septate conidia occur: sect. *Phyllostictoides*, see Van der Aa et al., 1990.]

Cultures studied. CBS 128.93 (PD 79/140) ex *Chenopodium quinoa* cv. Sajana (Chenopodiaceae), Peru; CBS 129.93 (PD 79/803) ex *Chenopodium quinoa* cv. Sajana, Peru; CBS 130.93 (PD 91/1314) ex *Chenopodium album*, the Netherlands.

24. *Phoma bismarckii* Kidd & Beaumont — Fig. 26

Phoma bismarckii Kidd & Beaumont, Trans. Br. mycol. Soc. 10 (1924) 104–105.

Description in vitro

OA: growth-rate 69–76 mm, regular, without or with scanty pruinose, white to grey olivaceous aerial mycelium; colony very pale buff to grey olivaceous, with grey tone caused by the presence of abundant pycnidia; reverse similar or slightly more greyish olivaceous to olivaceous.

MA: growth-rate 80–82 mm, regular, with floccose, white to grey olivaceous aerial mycelium; colony olivaceous grey to grey olivaceous; reverse leaden grey with olivaceous black sectors, margin grey olivaceous to greenish olivaceous, sometimes with distinct sectors.

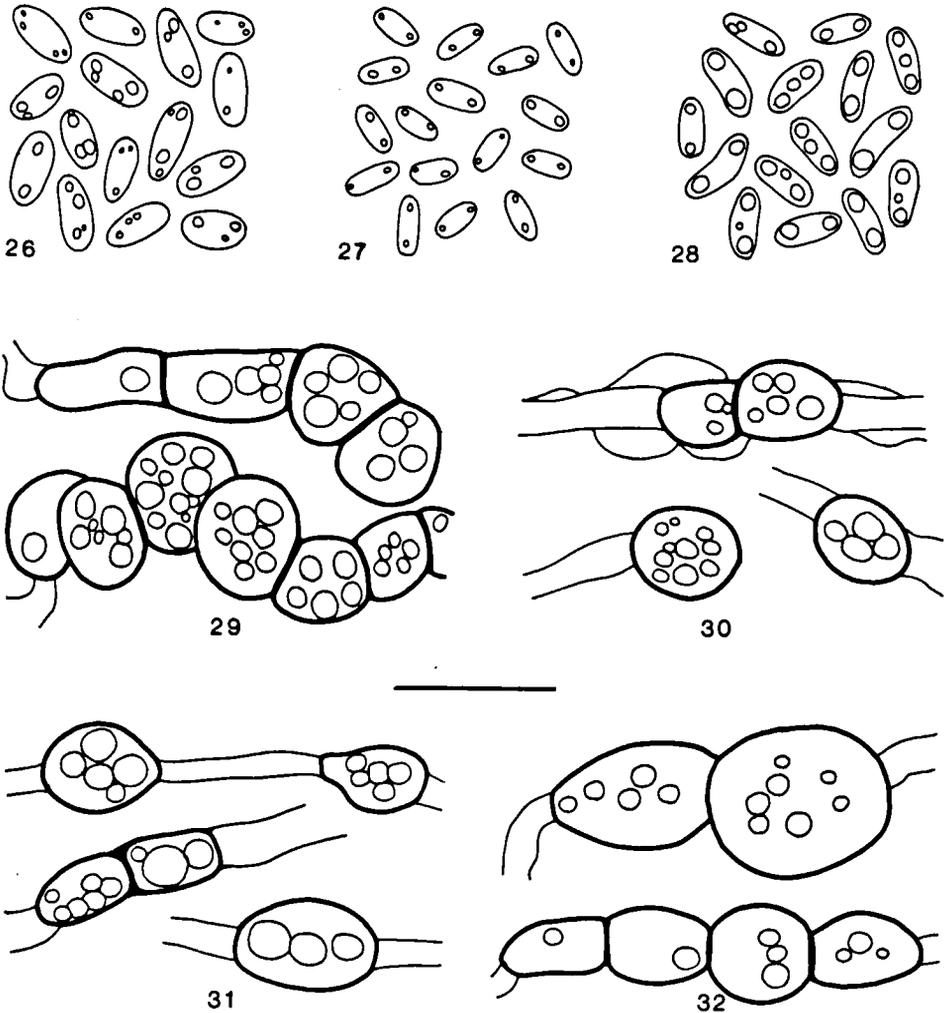
CA: growth-rate 81–83 mm, regular, with finely floccose, white to olivaceous grey aerial mycelium in sectors; colony with almost colourless to olivaceous or vinaceous buff sectors; reverse with vinaceous buff and olivaceous sectors.

Pycnidia 50–250 µm in diam., globose or irregular, solitary or confluent, glabrous or with hyphal outgrowths, with distinct ostiole, sometimes papillate; citrine to honey, later

olivaceous; walls made up of 3–5 layers of cells, outer layers pigmented; with white, pale vinaceous or buff conidial exudate; abundant, on the agar and in the aerial mycelium. Conidiogenous cells 2–7 × 4–6 μm, globose to bottle-shaped. Conidia 3.4–5.2 × 1.6–2.6 μm, av. 4.2–4.6 × 2.1–2.2 μm, Q = 1.7–2.8, av. Q = 2.0–2.1, oblong to ellipsoidal with two polar guttules.

Chlamydospores absent, but grey-olivaceous swollen cells are present, intercalary or terminal, solitary or in short chains, globose, 5–12 μm in diam.

NaOH spot test: negative, but a not specific reddish discolouring may occur.



Figs. 26–28. Conidia. 26. *Phoma bismarckii*; 27. *P. piperis*; 28. *P. selaginellicola*. — Figs 29–32. Chlamydospores. 29. *Phoma henningsii*; 30. *P. insulana*; 31. *P. pereupyrena*; 32. *P. multirostrata*. — Bar = 10 μm.

Ecology and distribution. This species has world-wide occasionally been recorded on dead branches of apple trees, *Malus pumila*. Its occurrence in association with lenticel rot of apples 'Bismarck' has led to the assumption that it was conspecific with *Phoma pomorum* Thümen (chlamydosporic sect. *Peyronellaea*, Contributions II, Boerema, 1993), but *P. bismarckii* does not produce any chlamydospore in culture. In New Zealand the fungus also has been isolated from leaf spots on *Carya pecan*, which points to a plurivorous behaviour.

Cultures studied. CBS 119.93 (PD 78/1101) ex *Malus pumila* (Rosaceae), Japan; CBS 120.93 (LEV 10607, PD 92/1720) ex *Carya pecan* (Juglandaceae), New Zealand.

Note. In North America this species has been identified as *Phoma pyrina* (Fr.) Ellis, Proc. Acad. nat. Sci. Philad. (1895) 28 [reprint p. 9] [as '(Schw.)', i.e. based on a specimen labelled *Sphaeria pyrina* Fr. in herb. Schweinitz]. However, *Sphaeria pyrina* Fr. in Kunze, Mycol. Hefte 2 (1823) 53 : Fr., Syst. mycol. 2 (2) (1823) 494 refers to a species of *Myxofusicoccum* or *Paradiscula*, see Boerema & Dorenbosch (1973: 16) and Sutton (1977: 166).

25. *Phoma piperis* (Tassi) v.d. Aa & Boerema, *comb. nov.* — Fig. 27

Phyllosticta piperis Tassi, Boll. R. Orto bot. [Boll. Lab. Orto Bot.] Siena 3 (2) (1900 ['1899']) 28 [basionym; holotype Siena].

Description in vitro

OA: growth-rate 55 mm, without well-developed aerial mycelium, only a few tufts of white mycelium; colony regular, colourless; reverse colourless to pale greyish buff.

MA: growth-rate 51–54 mm, with fine granulose smoke grey aerial mycelium; colony regular, greenish olivaceous; reverse pale olivaceous grey to olivaceous grey with grey olivaceous to buff outer margin.

CA: growth-rate 45–47 mm, with sparse pruinose, smoke-grey aerial mycelium; colony irregularly lobed, saffron-buff; reverse similar, but with sienna to umber tinge at centre.

Pycnidia 75–160 µm in diam., globose or bottle-shaped, solitary or confluent, glabrous or with hyphal outgrowths, with one or two ostioles, papillate to elongate neck; honey to citrine, later olivaceous to olivaceous black; wall consisting of 2–5 layers of cells, outer layer(s) pigmented; conidial exudate buff; abundant, mainly on, but sometimes also (partly) in the agar. Conidiogenous cells 2–5 × 3–5 µm, globose to bottle-shaped. Conidia 3.2–4.8 × 1.4–1.6 µm, av. 3.5 × 1.6 µm, Q = 2.0–3.0, av. Q = 2.2, oblong, with 2 indistinct polar guttules.

Chlamydo-spores absent.

On all media fine white to buff, needle-like crystals are formed.

NaOH spot test: negative.

Ecology and distribution. This fungus is described and well-known as causal organism of irregular leaf spots on shrubs of *Piper longus* (Indian long pepper) and other species of *Piper*. Members of the tropical South American genus *Peperomia*, in Europe commonly grown in glasshouses, may also be attacked by this fungus: Leaf Spot.

Culture studied. CBS 268.93 (PD 88/720) ex *Peperomia pereskiaefolia* (Piperaceae), the Netherlands.

26. *Phoma selaginellicola* de Gruyter, Noordel. & Boerema, *nom. nov.* — Fig. 28

Phyllosticta selaginellae Saccardo, Malpighia 11 (1897) 304. Holotype in Herb. Saccardo, PAD (leg. Carestia) no. 355; not *Phoma selaginellae* Cooke & Masee, Grevillea 16 (1888) 102.

Description in vitro

OA: growth-rate 48–54 mm, regular, with fine, velvety olivaceous grey aerial mycelium; colony colourless to (olivaceous) buff; reverse (olivaceous) buff with grey concentric zones to grey olivaceous.

MA: growth-rate 52 mm, regular, with fine velvety to woolly, olivaceous grey aerial mycelium; colony olivaceous grey to olivaceous black with grey olivaceous to greenish olivaceous marginal zone; reverse dark slate blue.

CA: growth-rate 44–45 mm, irregular, with crenate margin, aerial mycelium finely velvety, olivaceous grey; colony olivaceous grey to olivaceous black; reverse leaden grey to leaden black.

Pycnidia 125–330 µm in diam., globose, solitary, glabrous, with one usually non-papillate ostiole; citrine to honey, changing quickly to olivaceous black; walls made up of 3–6 layers of cells, outer layers pigmented; with straw conidial exudate; abundant, mainly on the agar, partly also in aerial mycelium. Conidiogenous cells 3–6 × 3–5 µm, globose to bottle-shaped. Conidia 3.2–4.6 × 1.4–1.6 µm, av. 4.0 × 1.6 µm, Q = 2.1–3.1, av. Q = 2.6, ellipsoidal, sometimes curved, with two or three guttules.

Chlamydospores absent.

NaOH spot test: negative.

Ecology and distribution. This seems to be an opportunistic parasite of *Selaginella* spp. In Italy the fungus is repeatedly found on wilting leaves of wild plants of *S. helvetica*. In a Dutch nursery it occurred in association with leaf necroses of a selected cultivar of the same species. The conidial size is variable in vivo and probably dependant on the age and ecological situation of the host.

Culture studied. CBS 122.93 (PD 77/1049) ex cultivar of *Selaginella helvetica* (Selaginellaceae), the Netherlands.

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