

CONTRIBUTIONS TOWARDS A MONOGRAPH OF  
PHOMA (COELOMYCETES) - I

1. Section Phoma: Taxa with very small conidia in vitro

J. DE GRUYTER<sup>1</sup> & M.E. NOORDELOOS<sup>2</sup>

Eighteen taxa in section *Phoma* with conidia usually shorter than 5.5 µm are keyed out and described on account of their characteristics in vitro. Two taxa from section *Sclerophomella* are added because they have very similar characters in vitro. The following new binomials have been proposed: *Phoma dictamnica* Boerema, de Gruyter & Noordel., nom. nov., *Phoma dorenboschii* Noordel. & de Gruyter, spec. nov., *Phoma minutispora* P.N. Mathur, nom. nov., and *Phoma opunticola* Boerema, de Gruyter & Noordel., spec. nov. Host-fungus and fungus-host indices are provided and short comments on the ecology and distribution of the taxa are given.

During the past 30 years Boerema and co-workers at the Plant Protection Service at Wageningen, the Netherlands, have been working on the taxonomy of *Phoma* in pure culture, in particular with respect to those species that are plant-inhabiting. In the course of this research several hundreds of taxa have been studied, resulting in a fairly large number of publications and a well-documented system of not yet published data. In the course of this project the characters obtained by studying living material in vitro is found to be indispensable for the differentiation and delimitation of taxa. The main reason is that many species of *Phoma* are plurivorous and in vivo most variable qua morphology of pycnidia and conidia. On account of the characteristics in vitro and in vivo the genus has been subdivided in a number of sections, see e.g. Van der Aa et al. (1990). The section *Phoma* is characterized by thin-walled glabrous ostiolate pycnidia producing in vitro and in vivo only aseptate conidia.

Boerema, de Gruyter and Noordeloos are planning a comprehensive publication on all the *Phoma* taxa concerned, with a classification, keys, descriptions, host-pathogen indices and notes (Boerema, de Gruyter & Noordeloos, in prep.). This paper is the first in a series of precursors of this big project, that has to be completed in the course of the forthcoming years.

The present paper gives a key and the diagnostic features of a selection of 20 *Phoma* species that have relatively small conidia in vitro, with a length usually not exceeding 5.5 µm. Most of them belong to section *Phoma*, but two species from another section are included because of comparable small conidia in vitro. The authors have tried as much as possible to interpret old names for the taxa concerned. In four cases new binomials had to be created. Indices on the fungus relations are added and short comments on the ecology and distribution of the taxa are also given.

1) Plant Protection Service, P.O. Box 9102, NL-6700 HC Wageningen, The Netherlands.

2) Rijksherbarium/Hortus Botanicus, P.O. Box 9514, NL-2300 RA Leiden, The Netherlands.

## MATERIAL AND METHODS

All isolates studied were present in the collection of the Plant Protection Service as freeze-dried cultures. These were brought in culture again and transferred to oat-meal agar in petri-dishes. For the colony descriptions 5 mm mycelium plugs, taken from the edge of the active growing cultures, were transferred on oat-meal agar (OA), malt agar (MA), and cherry-decoction agar (CA) and placed in an incubator in complete darkness, at 22°C. After 7 days the diameter of the colonies was measured, and the morphology of the colonies, aerial mycelium and other structures were studied. The colours of aerial mycelium, colonies and reverse were described according to the colour-code of Rayner (1970). After 7 days the petri-dishes were placed in an incubator with a day-night regime of 13 hours NUV light and 11 hours darkness to stimulate the pigmentation of the colonies and the formation of pycnidia. Two weeks after incubation the colonies were described again, and the morphology of pycnidia, conidiogenous cells and conidia were studied from the OA cultures. The NaOH spot-test was done on MA by addition of a drop of 1N NaOH on the colony margin, and the colour-change was noted. Also the colour of the conidial slime-mass excreted by mature pycnidia was noted. Chlamydo-spores, if present, were studied on OA and MA. Drawings were made with help of a drawing tube. Conidia dimensions refer to 30 measurements with oil-immersion at  $\times 1250$ . Q stands for the length/width ratio of the conidia.

## KEY TO THE PHOMA SPECIES TREATED IN THIS PAPER

- |   |                             |
|---|-----------------------------|
| 1a. Conidia very small, length in average not exceeding 3 $\mu\text{m}$ . . . . .   | 2                           |
| b. Conidia in average between 3 and 5 $\mu\text{m}$ long . . . . .  | 5                           |
| 2a. Conidia subglobose to broadly ellipsoid, average Q < 1.5 . . . . .  | 3                           |
| b. Conidia ellipsoid to subcylindrical, average Q = 2–3 . . . . .   | 4                           |
| 3a. Conidia 2.0–2.8 $\times$ 1.6–2.0 $\mu\text{m}$ , subglobose to broadly ellipsoid, Q = 1.1–1.6, with one large guttule; colonies on MA with distinct pinkish-reddish or apricot colours; chlamydo-spores present; growth-rate slow, 20–25 mm . . . . . | 1. <i>Phoma minutispora</i> |
| b. Conidia 2.4–3.2(–5.5) $\times$ 1.8–2.4(–3.0) $\mu\text{m}$ , Q = 1.3–1.8, broadly ellipsoid with one to three acentric guttules; colonies on MA with grey-olivaceous tinges; chlamydo-spores absent; growth-rate moderate to fast, 45–70 mm . . . . .  | 2. <i>Phoma anserina</i>    |
| 4a. Colonies growing relatively fast, growth-rate at least 30–40 mm; colonies distinctly pigmented with olivaceous-grey and citrine tinges; conidia usually eguttulate; pathogenic to <i>Opuntia</i> spp. . . . .   | 3. <i>Phoma opunticola</i>  |
| b. Colonies slow-growing, growth-rate about 20 mm, more or less unpigmented, but exudating a yellow pigment that diffundates into the agar; conidia sometimes with one or two, small, polar guttules . . . . .  | 4. <i>Phoma flavigena</i>   |
| 5a. Conidia oblong in average Q < 2 . . . . .   | 6                           |
| b. Conidia with average Q > 2 . . . . .   | 11                          |
| 6a. Growth-rate at least 35–50 mm . . . . .   | 7                           |
| b. Growth-rate slow, about 20 mm . . . . .  | 10                          |
| 7a. Colonies not pigmented or with yellowish, pink or salmon colours, olivaceous tinges, if present, never dominant . . . . .   | 8                           |
| b. Colonies greenish-olivaceous or olivaceous-grey to olivaceous-black . . . . .  | 9                           |

- 8a. Colonies colourless, sometimes with faint olivaceous-grey tinges and/or sectors, producing a yellow pigment that stains the agar, reverse honey to umber  
5. *Phoma putaminum*
- b. Colonies peach to salmon, reverse similar, not producing a yellow pigment  
6. *Phoma capitulum*
- 9a. Colonies greenish-olivaceous; conidia sometimes with small guttules; pathogenic to *Coffea arabica* ..... 7. *Phoma costarricensis*
- b. Colonies distinctly dark olivaceous-grey to olivaceous-black; conidia with two, distinct, polar guttules; on dead stems of *Valeriana* spp. .... 8. *Phoma valerianae*
- 10a. Colonies with distinct apricot or scarlet tinges on OA; NaOH spot-test positive  
9. *Phoma multipora*
- b. Colonies grey-olivaceous, greenish-olivaceous or medium yellow on OA; NaOH spot-test negative ..... 10. *Phoma fimeti*
- 11a. Conidia cylindrical to bacilliform, average  $Q > 3$ ; growth-rate slow, up to 20 mm, colonies on OA chestnut to ochraceous with only weak olivaceous tinges; pycnidia thick-walled, consisting of about 4–8 layers of cells; conidia  $3.0\text{--}3.6 \times 0.8\text{--}1.0$   $\mu\text{m}$ , average  $3.2 \times 0.9$   $\mu\text{m}$ ; pathogenic to *Olea europaea* ..... 19. *Phoma incompta*
- b. Conidia oblong to subcylindrical, average  $Q$  between 2 and 3 ..... 12
- 12a. Growth-rate about 20 mm; pathogenic to *Apium graveolens* ... 11. *Phoma apiicola*
- b. Growth-rate at least 40–50 mm ..... 13
- 13a. 'Ice-fern' crystals are readily formed within two weeks on MA; conidia  $3.0\text{--}5.5 \times 1.5\text{--}2.0(-2.5)$   $\mu\text{m}$ , in average  $4.2\text{--}4.4 \times 1.7\text{--}1.8$   $\mu\text{m}$ ,  $Q = 1.5\text{--}3.5$   
12. *Phoma dorenboschii*
- b. No 'Ice-fern' crystals formed ..... 14
- 14a. Chlamydospores absent ..... 15
- b. Chlamydospores present ..... 19
- 15a. Pycnidia with short, but distinct neck, elongated in a later stage ..... 16
- b. Pycnidia papillate, usually with a neck, not elongated in a later stage ..... 17
- 16a. Colonies with distinct bright yellow-green tinges (citrine); conidia  $3.2\text{--}4.2 \times 1.6\text{--}2.0$   $\mu\text{m}$ ,  $Q = 1.8\text{--}2.6$ ; pathogenic to *Anigozanthus* spp. .... 3. *Phoma anigozanthi*
- b. Colonies with olivaceous-grey to olivaceous-black colour; conidia  $3.6\text{--}5.6 \times 1.6\text{--}2.2$   $\mu\text{m}$ ,  $Q = 2.0\text{--}3.0$  ..... 14. *Phoma viburnicola*
- 17a. Colonies olivaceous-grey, olivaceous, or olivaceous-black with citrine tinges; growth-rate 40–50 mm; conidia usually eguttulate; pathogenic to *Eucalyptus* spp. and *Eugenia* spp. .... 15. *Phoma eucalyptica*
- b. Colonies colourless to greenish-olivaceous or dull green; pycnidia with distinct ostioles; more or less papillate ..... 18
- 18a. Conidia  $3.0\text{--}5.9 \times 1.2\text{--}2.1$   $\mu\text{m}$ , in average  $3.7\text{--}4.4 \times 1.6\text{--}2.0$   $\mu\text{m}$ ,  $Q = 1.8\text{--}2.6$ ; NaOH spot-test negative; saprophytic on many, mainly tropical plants  
16. *Phoma tropica*
- b. Conidia  $4.0\text{--}6.0 \times 2.0\text{--}2.8$   $\mu\text{m}$ , in average  $4.8 \times 2.3$   $\mu\text{m}$ ,  $Q = 1.7\text{--}2.3$ ; NaOH spot-test positive; pathogenic to *Hedera* spp. .... 17. *Phoma hedericola*
- 19a. Pycnidia relatively thin-walled, consisting of about 3 layers of cells  
18. *Phoma eupyrena*
- b. Pycnidia thick-walled, consisting of about 7–8 layers of cells; pathogenic to *Dictamnus albus* ..... 20. *Phoma dictamnica*

## HOST-FUNGUS INDEX

Ubiquitous species on various herbaceous and/or woody plants: *Phoma anserina*; *P. capitulum*; *P. eupyrena*; *P. fimeti*; *P. minutispora*; *P. putaminum*; *P. tropica*; *P. viburnicola*.

Isolated from soil: *P. anserina*; *P. capitulum*; *P. eupyrena*; *P. fimeti*; *P. minutispora*; *P. multipora*; *P. putaminum*.

Isolated from water: *P. eucalyptica*; *P. flavigena*.

Isolated from specific plants:

<i>Anigozanthus</i> spp. (Amaryllidaceae)	<i>P. anigozanthi</i>
<i>Apium graveolens</i> (Umbelliferae)	<i>P. apiicola</i>
<i>Callistephus</i> (Compositae)	<i>P. dorenboschii</i>
<i>Coffea arabica</i> (Rubiaceae)	<i>P. costarricensis</i>
<i>Dictamnus albus</i> (Rutaceae)	<i>P. dictamnicola</i>
<i>Eucalyptus</i> spp. and <i>Eugenia</i> spp. (Myrtaceae)	<i>P. eucalyptica</i>
<i>Hedera</i> spp. (Araliaceae)	<i>P. hedericola</i>
<i>Olea europaea</i> (Oleaceae)	<i>P. incompta</i>
<i>Opuntia</i> spp. (Cactaceae)	<i>P. opunticola</i>
<i>Physostegia virginiana</i> (Labiatae)	<i>P. dorenboschii</i>
<i>Valeriana</i> spp. (Valerianaceae)	<i>P. valerianae</i>

## FUNGUS-HOST INDEX

<i>P. anigozanthi</i>	<i>Anigozanthus</i> spp. (Amaryllidaceae)
<i>P. apiicola</i>	<i>Apium graveolens</i> (Umbelliferae)
<i>P. costarricensis</i>	<i>Coffea arabica</i> (Rubiaceae)
<i>P. dictamnicola</i>	<i>Dictamnus albus</i> (Rutaceae)
<i>P. dorenboschii</i>	<i>Physostegia virginiana</i> (Labiatae); <i>Callistephus</i> (Compositae)
<i>P. eucalyptica</i>	<i>Eucalyptus</i> spp. and <i>Eugenia</i> spp. (Myrtaceae)
<i>P. hedericola</i>	<i>Hedera</i> spp. (Araliaceae)
<i>P. incompta</i>	<i>Olea europea</i> (Oleaceae)
<i>P. opunticola</i>	<i>Opuntia</i> spp. (Cactaceae)
<i>P. valerianae</i>	<i>Valeriana</i> spp. (Valerianaceae)

## DESCRIPTIVE PART

Section *Phoma*1. *Phoma minutispora* P.N. Mathur, *nom. nov.* — Fig. 1

*Phoma oryzae* Cooke & Massee, *Grevillea* 16 (1887) 15; not *Phoma oryzae* Cattanea, *Arch. Bot. crittog.* Pavia 2-3 (1877) 118. — *Phyllosticta oryzae* (Cooke & Massee) Miyake, *J. Coll. Agric. imp. Univ. Tokyo* 2 (4) (1910) 252.

*Selected literature:* Padwick (1950), Shukla et al. (1984).

*Description in vitro*

OA: growth-rate 19–21 mm (14 days: 33–35 mm); colony regular or somewhat irregular in shape, predominantly grey with olivaceous tinges (grey-olivaceous to olivaceous-grey) with abundant, grey, floccose aerial mycelium; reverse olivaceous-black, towards margin grey-olivaceous to vinaceous-buff, centre vinaceous-buff (rarely colony salmon with poorly developed aerial mycelium, reverse salmon).

MA: growth-rate 25–26 mm (14 days: 46–49 mm); colony slightly irregular with undulating margin, pinkish-red (flesh to peach) with darker zone near margin, with thin, felted-velvety aerial mycelium; reverse apricot with darker sectors (greyish-sepia), after three weeks the general colour is more towards grey-olivaceous with bright apricot spots and sectors.

CA: growth-rate 24–25 mm (14 days: 43 mm); colony regular or irregular in shape with undulating margin, olivaceous-grey with woolly aerial mycelium; reverse very dark olivaceous-black at centre, towards margin buff (or colony salmon with olivaceous-grey tinges towards margin, with finely floccose aerial mycelium; reverse salmon-peach with olivaceous-black centre).

Pycnidia 100–250 × 80–200 µm, globose with one or up to 4, sometimes indistinct ostioles, without neck; olivaceous-black, abundantly formed within three weeks at centre and in concentric zones, both on and in the agar and in aerial mycelium, often associated with dense hyphal strands in the mycelium; exudate salmon. Conidiogenous cells 2–6 × 3–5 µm, more or less globose or bottle-shaped. Conidia 2.0–2.8 × 1.6–2.0 µm, average 2.4 × 1.8 µm, Q = 1.1–1.6, average Q = 1.4, broadly ellipsoid with one large guttule.

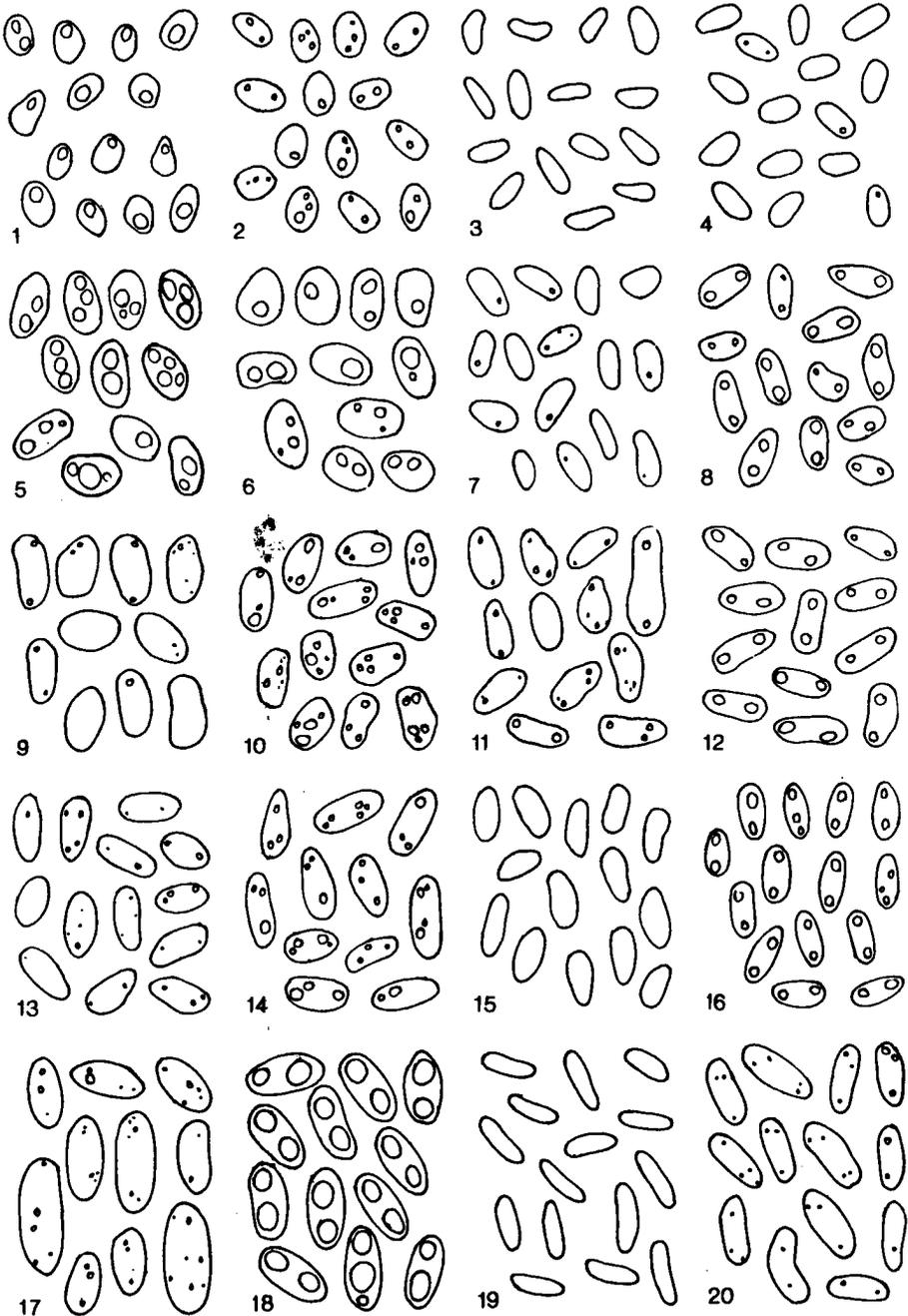
Chlamydo-spores few, about 6–15 µm in diameter, solitary, thick-walled, and usually also finely warty, generally formed at tip of hyphae, present after 4 weeks on OA.

NaOH spot-test: negative.

*Ecology and distribution.* Probably a common saprophytic soil fungus in south-west Asia, characterized by its extremely small conidia. Isolates made in India refer e.g. to dead leaf sheaths of rice, *Oryza sativa*, bark of *Ficus* sp. and soil. The fungus is also reported as an opportunistic human pathogen.

*Culture studied.* CBS 509.91 (PD 77/920) ex saline soil, India; CBS 711.76 (PD 91/1445) ex bark of *Ficus* sp. (Moraceae), India.

*Note.* This avowed substitute for *Phoma oryzae* Cooke & Massee has been adopted from a study on an Indian soil-isolate of the fungus by P.N. Mathur (Thesis Univ. Agra, 1967).



Figs. 1–20. Conidia ( $\times 1250$ ). 1. *Phoma minutispora*; 2. *P. anserina*; 3. *P. opunticola*; 4. *P. flavigena*; 5. *P. putaminum*; 6. *P. capitulum*; 7. *P. costarricensis*; 8. *P. valerianae*; 9. *P. multipora*; 10. *P. fimeti*; 11. *P. apicola*; 12. *P. dorenboschii*; 13. *P. anigozanthi*; 14. *P. viburnicola*; 15. *P. eucalyptica*; 16. *P. tropica*; 17. *P. hedericola*; 18. *P. eupyrena*; 19. *P. incompta*; 20. *P. dictamnica*.

## 2. *Phoma anserina* El. Marchal. — Fig. 2

*Phoma anserina* El. Marchal, Champ. copr. (1891) 11.

*Phoma marchali* Sacc., Sylloge Fung. 10 (1892) 188.

*Aposphaeria humicola* Oud., Ned. kruidk. Archf III, 2 (3) (1902) 721.

*Phoma radidis-callunae* Rayner, Bot. Gaz. 73 (1922) 231.

*Phoma suecica* van Beyma, Antonie van Leeuwenhoek 8 (1942) 110–111.

*Selected literature*: Boerema (1985).

### *Description in vitro*

OA: growth-rate 49–53 mm, regular, without aerial mycelium; colony colour pale to dark olivaceous, grey-olivaceous or olivaceous-black; reverse grey-olivaceous to olivaceous-black, but with distinct lead-grey tinge.

MA: growth-rate 57–73 mm, regular, with floccose pale olivaceous-grey aerial mycelium; colony colour greenish-olivaceous to grey-olivaceous or olivaceous-black; reverse grey-olivaceous, olivaceous black.

CA: growth-rate 61–73 mm, regular, without aerial mycelium or with finely floccose-woolly olivaceous-grey aerial mycelium; colony colour ranging from pale olivaceous-grey to grey-olivaceous or olivaceous-black; reverse grey-olivaceous to olivaceous-black.

Pycnidia 112–136 × 112–176 µm, solitary, globose with 1, rarely 2 or 3 small ostioles, without or sometimes with a short neck; olivaceous to olivaceous-black, smooth, glabrous or with hyphal outgrowths ('semi-pilose'), abundant, scattered, mostly on, but sometimes partly in or entirely in the agar; exudate white to rosy-buff. Conidiogenous cells 4–8 × 3–7 µm, phialidic, globose to bottle-shaped. Conidia 2.4–3.2(–5.5) × 1.8–2.4(–3.0) µm, average 2.8 × 1.9 µm, Q = 1.3–1.8, average Q = 1.5, broadly ellipsoid with 1 or 2 (3), acentric guttules.

Chlamydospores absent, but swollen elements may occur in some strains.

NaOH spot-test: negative.

*Ecology and distribution.* This is an 'omnivorous' soil fungus in temperate Eurasia and North America, which is also recorded from northern Africa. Commonly found on roots of herbaceous and woody plants and cysts of nematodes. Also frequently isolated from seeds and fruits.

*Culture studied.* CBS 364.91 (PD 81/290) ex fruit of *Ananas sativus* (Bromeliaceae) with fruit-rot; origin unknown; CBS 365.91 (PD 84/108) ex seed of *Cucumis sativus* (Cucurbitaceae), the Netherlands; CBS 363.91 (PD 79/712) ex seed of *Pisum sativum* (Papilionaceae), the Netherlands.

*Note.* Culture CBS 364.91 (PD 81/290) is distinctly less intensely pigmented than the other two cultures studied. Also the size of the conidia varies considerably from one strain to the other; the length which usually ranges from 2.4–3.2 µm may reach up to 5.5 µm.

## 3. *Phoma opunticola* Boerema, de Gruyter & Noordel., *spec. nov.* — Fig. 3

Coloniae in agar farinae avenae tarde crescentes (circa 30 mm), olivaceo-griseae vel citrinae sectoribus pallidis, reverso simili; pycnidia 40–150 µm in diam., globosa vel compressa, collo longo praedito, atra; conidia hyalina, simplicia, plerumque 2.4–3.6 × 1.0–1.4 µm, eguttulata. Parasitica in cladodiis vivis Opuntii. Holotypus: L 989.300-160 (siccus); CBS 376.91 (PD 77/1177) (vivus).

*Description in vitro*

OA: growth-rate 32 mm (14 days: 63 mm), regular, without aerial mycelium; colony colour olivaceous-grey to olivaceous-greenish or citrine with paler sectors, pycnidia in concentric zones, reverse similar.

MA: growth-rate 39–40 mm (14 days: 70 mm), regular, with felted, white aerial mycelium; colony greenish-olivaceous; reverse similar.

CA: growth-rate 36 mm (14 days: 75 mm), regular, with finely velvety, olivaceous-grey aerial mycelium; colony colour olivaceous to greenish-olivaceous, with distinct radially orientated hyphal strands; reverse similar.

Pycnidia 40–150  $\mu\text{m}$ , globose or somewhat compressed, with long neck somewhat bottle-shaped, black, glabrous to somewhat hairy with mycelium; with white to pale olivaceous-grey exudate; abundant, mostly in concentric rings, and associated with the radiating hyphal strands, on and partly also in the agar. Conidiogenous cells 2.5–6  $\times$  2–4  $\mu\text{m}$  in diameter, phialidic, broadly globose, thin-walled. Conidia 2.4–3.6  $\times$  1.0–1.4  $\mu\text{m}$ , in average 2.8  $\times$  1.2  $\mu\text{m}$ ,  $Q = 1.7\text{--}3.6$ , average  $Q = 2.4$ , ellipsoid to subcylindrical, eguttulate.

NaOH spot-test: not a fairly strong reaction, but usually a slight sienna discolouration is observed, that slowly turns bluish-green.

*Ecology and distribution.* A pathogen of *Opuntia* spp. causing necrotic spots on the leaf-like stems (cladodes): 'Necrotic Spot'. The fungus is indigenous to South America, but probably also occurs in other areas where the host is cultivated. It easily may be confused with the *Asteromella*-spermatial state of *Mycosphaerella opuntiae* (Ell. & Ev.) Dearness, commonly known as *Phyllosticta concava* Seaver.

*Culture studied.* CBS 376.91 (PD 77/1177) ex *Opuntia* sp. (Cactaceae), Peru.

#### 4. *Phoma flavigena* O. Const. & v.d. Aa — Fig. 4

*Phoma flavigena* O. Const. & v.d. Aa, Trans. Br. mycol. Soc. 79 (1982) 343.

##### *Description in vitro* (adopted from Constantinescu & v.d. Aa, 1982)

OA: growth-rate 18–23 mm, regular, with whitish, sparse aerial mycelium; colony colourless but the agar is strongly discoloured due to the release of a yellow pigment.

MA and CA: growth-rate 11–14 mm, regular, with abundant, greyish or yellowish aerial mycelium; colony colourless but the agar is strongly discoloured due to the release of a yellow pigment.

Pycnidia 50–210  $\mu\text{m}$  in diameter, solitary or confluent, globose, with a conspicuous neck, with distinct ostiole, brownish, abundant in concentric rings, immersed in the agar or in aerial mycelium; exudate buff or rosy-buff. Conidiogenous cells 4–7  $\times$  3–6  $\mu\text{m}$ , phialidic, truncate-conical or flask-shaped. Conidia 2–4  $\times$  1–2  $\mu\text{m}$ ,  $Q = 1.8\text{--}2.7$ , average  $Q = 2.3$ , ellipsoid to cylindrical, sometimes with one or two guttules.

NaOH spot-test: negative.

*Ecology and distribution.* Once isolated from fresh water, Romania.

*Culture studied.* CBS 314.80 (PD 91/1613).

## 5. *Phoma putaminum* Speg. — Fig. 5

*Phoma putaminum* Spegazzini, Atti Sov. crittogam. ital. 3 (1881) 66. — *Aposphaeria putaminum* (Speg.) Sacc., Sylloge fung. 3 (1884) 177. — *Coniothyrium putaminum* (Speg.) O. Kuntze, Revisio Gen. Pl. 3 (2) (1898) 459.

*Phoma radicolica* McAlpine, Fung. Dis. Stone-fruit Trees Melb. (1902) 126.

*Phoma dunorum* ten Houten, Kiemplziekt. Conif. [Thesis Univ. Utrecht] (1939) 88–89.

*Selected literature.* Boerema & Dorenbosch (1973).

### *Description in vitro*

OA: growth-rate 43–59 mm, regular, without aerial mycelium; colony colourless but exuding a pigment that stains the agar honey; reverse honey with greenish-olivaceous tinge.

MA: growth-rate 51–63 mm, regular, with sparse aerial mycelium of more or less erect hairs, that becomes floccose after 14 days; colony colour between ochraceous and umber with slight olivaceous tinge; reverse umber with honey margin.

CA: growth-rate 39–47 mm, somewhat irregular, with cottony, grey-olivaceous aerial mycelium; colony colour umber, towards margin hazel; reverse similar.

Pycnidia 60–300  $\mu\text{m}$ , mostly single but also confluent, globose, olivaceous to olivaceous-black, covered in mycelial hairs, especially in young pycnidia, with distinct ostiole, without or with a neck; scattered, especially towards margin of colony, and also in concentric zones, mostly partly in the agar, sometimes also entirely in the agar; exudate whitish-salmon. Conidiogenous cells 3–7  $\times$  3–7  $\mu\text{m}$ , phialidic, broadly globose to slightly elongated, thin-walled. Conidia 3.2–4.2  $\times$  2.0–2.6, average 3.8  $\times$  2.4, Q = 1.3–1.9, average Q = 1.6, broadly ellipsoid, mostly with 2 or 3 greenish guttules.

NaOH spot-test: negative.

*Ecology and distribution.* A soil-borne fungus, isolated from the subterranean parts of various herbaceous and woody plants. Generally it is regarded as a saprophyte, but it may act as an opportunistic parasite on roots etc. Most isolates originate from Europe and North America, but the fungus has also been recorded from the southern hemisphere.

*Culture studied.* CBS 372.91 (PD 75/690) ex *Ulmus* sp. (Ulmaceae), the Netherlands; CBS 373.91 (PD 83/119) ex *Buxus* sp. (Buxaceae), West Virginia, U.S.A.

## 6. *Phoma capitulum* Pawar, Mathur & Thirumalachar — Fig. 6

*Phoma capitulum* Pawar, Mathur & Thirumalachar, Trans. Br. mycol. Soc. 50 (1967) 261.

*Phoma ostiolata* Pawar, Mathur & Thirumalachar, Trans. Br. mycol. Soc. 50 (1967) 262, var. *ostiolata*.

*Phoma ostiolata* var. *brunnea* Pawar, Mathur & Thirumalachar, Trans. Br. mycol. Soc. 50 (1967) 263.

*Selected literature.* Boerema (1985).

### *Description in vitro*

OA: growth-rate 37 mm (14 days: 66–71 mm), regular with fine velvety-floccose, white aerial mycelium; colony colour salmon to flesh, with grey concentric pycnidial zones; reverse similar.

MA: growth rate 38–40 mm (14 days: 75 mm); regular, with fine peluchy to floccose, white to pale olivaceous-grey aerial mycelium; colony colour peach to salmon with pale olivaceous-grey tinges zone full of pycnidia; reverse between salmon and apricot.

CA: growth-rate 27–28 mm (14 days: 55–58 mm), irregular, with peluchy, white aerial mycelium; colony colour between salmon and flesh with greyish concentric pycnidial zones; reverse similar.

Pycnidia 50–105 × 50–80 μm, usually in clusters of up to 20 specimens in a row, born on radiating, dense, blackish hyphal strands; globose with 1–3 ostioles on a short neck; citrine to honey when young then olivaceous to olivaceous-black, smooth, glabrous, with thin walls; readily developing in concentric zones or sectors after 7–14 days, mostly on the agar, but also partly or entirely in the agar; exudate grey-saffron. Conidiogenous cells 3–7 × 4–7 μm, phialidic, globose, thin-walled. Conidia 3.2–4.4 × 2.0–3.0 μm, average 3.8 × 2.6 μm, Q = 1.2–2.0, average Q = 1.5, broadly and shortly ellipsoid with one or two guttules.

NaOH spot-test: negative.

*Ecology and distribution.* Isolated from saline soil, marine environment and oak-forest soil in India. It probably represents a common, 'halophilic' soil inhabiting fungus in south-west Asia.

*Culture studied.* CBS 337.65 (PD 91/1614; IMI 113 693; ATCC 16195; HACC 167) ex saline soil, India.

## 7. *Phoma costarricensis* Echandi — Fig. 7

*Phoma costarricensis* Echandi, Rev. Biol. Trop. 5 (1957) 83.

*Phyllosticta coffeicola* sensu Stevens, Ill. biol. Monographs 11 (2) (1927) 52–53; not *Phyllosticta coffeicola* Speg., Rev. Fac. Agron. Veter. La Plata (1896) 345 [= *Phomopsis* sp.].

### *Description in vitro*

OA: growth-rate 43 mm, regular, with scattered tufts of whitish aerial mycelium in marginal zone only; colony colour greenish-olivaceous; reverse grey-olivaceous.

MA: growth-rate 52 mm, regular, with floccose, olivaceous aerial mycelium; colony colour greenish-olivaceous, reverse olivaceous-black.

CA: growth-rate 57 mm, with poorly developed, more or less felted, adpressed, grey-olivaceous aerial mycelium; colony colour grey-olivaceous, zonated; reverse similar.

Pycnidia 50–200 × 50–140 μm, globose to bottle-shaped, usually with one ostiole, glabrous, smooth, brownish-olivaceous to olivaceous-black, abundant on and partly in the agar; exudate whitish. Conidiogenous cells 3–6 × 3–5 μm, phialidic, globose to bottle-shaped, thin-walled. Conidia (1.4–)2.8–4.0 × (1.0–)1.6–1.8 μm, average 2.6–3.3 × 1.3–1.6 μm, Q = 1.3–3.0, in average 2.0, eguttulated, or sometimes with small guttules.

NaOH spot-test: not a specific reaction, but a slight discolouration to sienna may occur.

*Ecology and distribution.* A pathogen of *Coffea arabica* causing lesions on leaves, stems and fruits: 'Coffee Blight'. The fungus was until recently only known from South and Central America, but is now also recorded in other parts of the world.

*Cultures studied.* CBS 506.91 (IMI 215 229; PD 91/876) ex twig of *Coffea* sp. (Rubiaceae), Nicaragua.

*Note.* In vivo the conidia generally are larger, mostly 5–6 × 2–3 μm.

## 8. *Phoma valerianae* P. Henn. — Fig. 8

*Phoma valerianae* P. Hennings, *Nyt. Mag. Naturvid.* 42 (1904) 29.

*Phyllosticta valerianae-tripteris* f. *minor* Unamuno, *Mems R. Soc. esp. Hist. nat.* 15 (1929) 348–349.

### *Description in vitro*

OA: growth-rate 65 mm, colony rather regular, greenish-grey with greenish-grey, flat, finely woolly aerial mycelium; reverse zonated with alternating grey-olivaceous and olivaceous-black zones, margin more like greenish-grey.

MA: growth-rate 36–37 mm, colony regular, dark grey-olivaceous, olivaceous-grey or greenish-grey, with very fine, compact, velvety, greenish-grey or olivaceous-grey aerial mycelium; reverse iron grey with pallid olivaceous-buff centre and marginal zone.

CA: growth-rate 48–50 mm, colony rather regular, smoke-grey to olivaceous-grey, darker grey-olivaceous towards margin, entirely densely velvety with whitish-grey aerial mycelium; reverse olivaceous-grey at centre with darker zones towards margin, marginal zone paler towards greenish-olivaceous.

Pycnidia 120–340  $\mu\text{m}$ , single rarely confluent, globose with distinct neck, olivaceous to olivaceous-black, glabrous, abundant in and on the agar; exudate amber. Conidiogenous cells 3–6  $\times$  4–6  $\mu\text{m}$  in diameter, phialidic, globose, thin-walled. Conidia 2.5–3.9  $\times$  1.4–2.1, average 3.2  $\times$  1.8,  $Q = 1.4$ –2.1, average 1.8, ellipsoid with two polar guttules.

NaOH spot-test: negative.

*Ecology and distribution.* In Europe frequently occurring on dead stems of *Valeriana* spp., and apparently seed-borne. Incidentally also isolated from other not related herbaceous plants.

*Culture studied.* CBS 499.91 (PD 73.672) ex *Valeriana officinalis* (Valerianaceae), basal stemrot, the Netherlands.

## 9. *Phoma multipora* Pawar, Mathur & Thirumalachar — Figs. 9, 21

*Phoma multipora* Pawar, Mathur & Thirumalachar, *Trans. Br. mycol. Soc.* 50 (1967) 260–261.

### *Description in vitro*

OA: growth-rate 20–23 mm (14 days: 39–48 mm), regular with weakly undulating outline, with only poorly developed, more or less felted, white to olivaceous-grey aerial mycelium; colony colour apricot to scarlet; reverse similar.

MA: growth-rate 18–22 mm (14 days: 34–43 mm), regular to irregular, with compact to fluffy, grey-olivaceous to olivaceous-grey aerial mycelium; colony colour grey-olivaceous at centre, towards margin olivaceous-grey with peach outer margin; reverse rust or sepia with apricot to cinnamon outer margin.

CA: growth-rate 20–22 mm (14 days: 42–46 mm), regular or slightly irregular in outline, with scanty, velvety, grey-olivaceous aerial mycelium; colony colour grey-olivaceous to olivaceous-grey, margin vinaceous; reverse dark vinaceous to dark brick or sepia.

Pycnidia 120–300  $\mu\text{m}$ , solitary, or confluent in groups of 2–5, globose, occasionally 'multi'-ostiolate, but usually with one or two wide ostioles without a distinct neck; citrine, then darker and more like olivaceous, glabrous or with very short swollen hyphal appendages around the ostiole ('semi pilose'), scattered in and on the agar; exudate rosy-buff or

vinaceous. Conidiogenous cells globose to bottle-shaped,  $3-6 \times 4-8 \mu\text{m}$ , phialidic. Conidia  $3.6-4.8 \times 1.6-2.4 \mu\text{m}$ , average  $4.3 \times 2.2 \mu\text{m}$ ,  $Q = 1.7-2.6$ , average  $Q = 2.0$ , broadly ellipsoid with or without a few guttules.

Chlamydospores absent, but in the mycelium swollen cells, that can be pigmented, may be formed.

NaOH spot-test: quickly changing to purplish-blue.

*Ecology and distribution.* This fungus is recorded from the subtropical regions of south-east Asia (India) and northern Africa (Egypt), and it probably is a halophilic soil-borne saprophyte. The records from India refer to soil in mangrove vegetations near the Bombay-coast and dead herbaceous stems near Lahore.

*Culture studied.* CBS 501.91 (PD 83/888), substrate unknown, Egypt; CBS 353.65 (PD 91/1560) ex saline soil, India.

*Note.* CBS 353.65 forms small orange-yellow crystals on OA.

#### 10. *Phoma fimeti* Brun. — Fig. 10

*Phoma fimeti* Brunaud, Bull. Soc. bot. Fr. 36 (1889) 338.

*Selected literature.* Dorenbosch (1970), Boerema & Dorenbosch (1973).

##### *Description in vitro*

OA: growth-rate 20–21 mm (14 days: 39–45 mm), regular, with velvety pale olivaceous-grey aerial mycelium; colony colour grey-olivaceous to greenish-olivaceous with a yellow pigment diffundating into the medium, with concentric pycnidial zones, reverse greenish-olivaceous to olivaceous-grey.

MA: growth-rate 18–23 mm (14 days: 33–40 mm), with floccose, olivaceous-grey aerial mycelium; colony colour olivaceous-grey with citrine margin; reverse olivaceous-grey to olivaceous-black.

CA: growth-rate 20–23 mm (14 days: 29–40 mm), with velvety, pale olivaceous-grey aerial mycelium; colony colour olivaceous-grey to grey-olivaceous with regular pycnidial zones, margin sometimes distinctly paler more like citrine-honey; reverse olivaceous-black, sometimes with citrine-honey margin, sometimes with leaden-grey tinges in marginal zone.

Pycnidia  $65-200 \times 60-200 \mu\text{m}$ , solitary or confluent, globose, usually with one ostiole on short neck; olivaceous-black with white to ochraceous exudate, glabrous, smooth, abundant, in concentric zones, on the agar, sometimes entirely in the agar, or in aerial mycelium. Conidiogenous cells  $2-7 \times 2-8 \mu\text{m}$ , phialidic, broadly globose, thin-walled. Conidia  $2.8-5.1 \times 1.7-3.2 \mu\text{m}$ , average  $3.8-4.1 \times 2.2-2.7 \mu\text{m}$ ,  $Q = 1.0-2.4$ , average  $Q = 1.4-1.8$ , broadly ellipsoid with two or more, polar guttules.

NaOH spot-test: negative.

*Ecology and distribution.* A saprophytic soil-borne fungus which has been isolated from dead tissue of various herbaceous and woody plants; widespread, almost cosmopolitan.

*Culture studied.* CBS 368.91 (PD 78/1096), ex *Juniperus communis* (Cupressaceae), Switzerland; CBS 369.91 (PD 88/614) ex Southern Pine Pole, U.S.A.; CBS 370.91 (PD 70/999) ex *Apium graveolens* (Umbelliferae), the Netherlands.

### 11. *Phoma apiicola* Kleb. — Fig. 11

*Phoma apiicola* Kleb., Z. PflKrankh. 20 (1910) 22.

*Selected literature.* Goossens (1928).

#### *Description in vitro*

OA: growth-rate 17–22 mm, regular or with irregular margin, pale olivaceous-grey with concentric zones of darker olivaceous-grey tinges, caused by numerous pycnidia; aerial mycelium poorly developed and compact, greyish; reverse smoke-grey to grey-olivaceous, sometimes with greenish-olivaceous or olivaceous-buff tinges.

MA: growth-rate 17–21 mm, colony regular, pale olivaceous-grey, densely woolly-hairy at centre with grey aerial mycelium; marginal zone almost without aerial mycelium; reverse ochraceous with umber centre.

CA: growth-rate 13–17 mm, regular, hazel with rather compact, greyish-olivaceous aerial mycelium; marginal zone without aerial mycelium; reverse isabelline-brownish, more like honey at margin.

Pycnidia 168–304 × 160–240 μm, globose with distinct, short neck and with distinct ostiole; olivaceous, smooth, glabrous, solitary or confluent, readily developing in concentric zones, both in and on the agar, in places with hardly any aerial mycelium; exudate yellowish-white. Conidiogenous cells 4–7 × 3–6 μm, phialidic, globose to bottle shaped. Conidia 3.4–4.4 × 1.6–2.0 μm, average 3.8 × 1.7 μm, Q = 2.0–2.5, average Q = 2.3, ellipsoid, sometimes slightly constricted in the middle, usually with two very small guttules (occasionally a small percentage larger conidia may be produced: 6.4–9.6 × 2.0–4.0 μm, average 7.5 × 2.5 μm, Q = 2.4–3.5, average Q = 3.0).

Chlamydospores absent, but swollen cells may occur in the mycelium.

NaOH spot-test: negative.

*Ecology and distribution.* Wide-spread on celeriac and celery (*Apium graveolens*) in temperate regions of Europe and North America: 'Root Rot', 'Scab' and 'Crown Rot'. This fungus is also responsible for seedling canker. Soil-borne, sometimes also found on seed.

*Culture studied.* CBS 504.91 (PD 78/1073) ex *Apium graveolens* (Umbelliferae), the Netherlands; CBS 505.91 (PD 82/201) ex *Apium graveolens* (Umbelliferae), the Netherlands.

*Note.* On MA sometimes crystals are formed.

### 12. *Phoma dorenboschii* Noordel. & de Gruyter, *spec. nov.* — Fig. 12

Coloniae in agaro maltoso post septem diem 47–55 mm in diam. marginem sinuata, pallide olivaceo-griseae demum olivaceo-atrae, reversus similior. Chlamydosporae absentae. Crystalla in agaro hyalina, stellata vel filiformia dichotoma. Pycnidia in agaro et mycelio aereo copiosa, subglobosa vel elongata, solitaria vel agglutinata, ochracea demum olivaceo-atra, 88–360 μm in diam. Conidiophora phyalidea. Conidia hyalina, glabra, cylindracea, unicellulata, biguttulata, 3.0–5.5 × 1.5–2.0(–2.5) μm. Typus L 988.202-121 (siccus); CBS 426.90 (PD 86/551) (vivus); ex *Physostegia virginiana* (Labiatae), the Netherlands.

#### *Description in vitro*

OA: growth-rate 52–54 mm, colony regular with sinuate outline; with sparse subfelty to floccose aerial mycelium; pale buff to buff, dull green or olivaceous-grey finally olivaceous-grey; reverse similar.

MA: growth-rate 47–55 mm, colony regular with sinuate outline, with compact, felted or finely floccose, aerial mycelium; whitish, greenish-olivaceous to greenish-black, sometimes concentrically zonate; reverse honey, olivaceous-black or greenish-olivaceous.

CA: growth-rate 60–70 mm, colony regular with sinuate outline, with whitish, floccose aerial mycelium; pale grey-olivaceous to grey-olivaceous or iron-grey with greenish-olivaceous outer margin; reverse cinnamon to grey-olivaceous or olivaceous black.

Pycnidia 88–360  $\mu\text{m}$ , globose or elongate with up to 5 ostioles with an elongated neck; ochraceous then greenish-black, glabrous, single or confluent, abundant in aerial mycelium and both on and in the agar; exudate buff. Conidiogenous cells phialidic, globose, 4–6  $\times$  3–6  $\mu\text{m}$ . Conidia 3.0–5.5  $\times$  1.5–2.0(–2.5)  $\mu\text{m}$ , average 4.2–4.4  $\times$  1.7–1.8  $\mu\text{m}$ , Q = 1.5–3.5, average Q = 2.5, oblong to subcylindrical, usually with two small, polar guttules.

Crystals: whitish, bryoid 'ice-fern' crystals are formed within one week in malt-agar at centre of colony.

NaOH spot-test: negative.

*Ecology and distribution.* On stems and leaves of *Physostegia virginiana* and *Callistephus* sp., causing leaf spots and anthracnoses; found in the Netherlands only, but probably of foreign origin.

*Culture studied.* CBS 426.90 (PD 86/551, type-strain) ex *Physostegia virginiana* (Labiatae), the Netherlands; CBS 320.90 (PD 86/932) ex *Physostegia virginiana* (Labiatae), the Netherlands.

*Note.* *Phoma dorenboschii* is named in honour of Ms. Miek Dorenbosch who contributed substantially to our knowledge of *Phoma* taxa in pure culture during her about 30 years career as a mycologist at the Plant Protection Service, Wageningen. So far known it is the only species in sect. *Phoma* that forms ice-fern crystals in pure culture (Noordeloos et al., 1992).

### 13. *Phoma anigozanthi* Tassi — Fig. 13

*Phoma anigozanthi* Tassi, Boll. R. Orto bot. (Boll. Lab. Orto Bot.) Siena 3 (2) (1900 ['1899']) 148.

#### *Description in vitro*

OA: growth-rate 43–44 mm, regular, flat, without aerial mycelium; colony distinctly zonated with concentric zones, citrine to greenish-olivaceous with paler margin; reverse similar.

MA: growth-rate 51 mm, regular, with abundant hairy to floccose-woolly, white then grey-olivaceous aerial mycelium; colony greenish-olivaceous towards margin more like citrine; reverse similar.

CA: growth-rate 53–54 mm, regular, with hardly any aerial mycelium; colony colour greenish-olivaceous then olivaceous-black with citrine margin; reverse similar.

Pycnidia 120–240  $\times$  128–240  $\mu\text{m}$ , solitary or confluent, 2–5 pycnidia together, irregularly globose to bottle-shaped, with one to three ostioles on a short neck (that develops into a longer neck in a later stage); olivaceous to olivaceous-black, glabrous, smooth, exuding a pale vinaceous or salmon-saffron conidial slime; readily developing on the agar and in the aerial mycelium, rarely in the agar, abundant after 7 days in distinct concentric rings. Conidiogenous cells phialidic, globose or lageniform, sometimes elon-

gated,  $2.5-6 \times 2.5-5 \mu\text{m}$ . Conidia  $3.2-4.2 \times 1.6-2.0 \mu\text{m}$ , average  $3.7 \times 1.8 \mu\text{m}$ ,  $Q = 1.8-2.6$ , average  $Q = 2.1$ , ellipsoid, sometimes with very small polar guttules.

NaOH spot-test: green at first, then turning orange-red.

*Ecology and distribution.* A pathogen of *Anigozanthus* spp. (Kangaroo-Paw; Amaryllidaceae), causing leafspots and dieback: 'Leaf Blotch'. The fungus is probably indigenous to Australia, but so far only recorded in Europe.

*Culture studied.* CBS 381.91 (PD 79/1110) ex *Anigozanthus* sp. (Amaryllidaceae), the Netherlands.

#### 14. *Phoma viburnicola* Oud. — Fig. 14

*Phoma viburnicola* Oud., Versl. gewone Vergad. wis- en natuurk. Afd. K. Akad. Wet. Amst. 9 (1900) 298; Ned. Kruidk. Archf III, 2 (1) (1900) 247.

*Phyllosticta opuli* Sacc., *Michelia* 1 (2) (1878) 146; not *Phoma opuli* Thüm., *Hedwigia* 2 (1882) 24.

*Selected literature.* Boerema & Griffin (1974).

##### *Description in vitro*

OA: growth-rate 47–48 mm, regular, with some greyish aerial mycelium at centre, colony colour pale olivaceous-grey to grey-olivaceous with more or less colourless margin; reverse similar.

MA: growth-rate 47–49 mm, regular, with dense woolly, white or olivaceous aerial mycelium; especially in central part; colony colour olivaceous-grey to greenish-olivaceous, margin olivaceous-black or grey-olivaceous; reverse grey-olivaceous to olivaceous-black.

CA: growth-rate 56–58 mm, regular, with dense woolly or floccose, white to grey aerial mycelium; colony colour olivaceous-grey to grey-olivaceous; reverse grey-olivaceous to olivaceous-black.

Pycnidia  $140-300 \times 100-260 \mu\text{m}$ , globose to elongated, bottle-shaped, solitary or confluent in clusters of 2–3 specimens, olivaceous to olivaceous-black round ostiole, with 1 or 2 to 3 ostioles, with very short neck, that develops into a longer neck in a later stage; glabrous, smooth, scattered or in concentric rings, both in and on the agar as well as in the aerial mycelium; exudate whitish. Conidiogenous cells  $3-6 \times 3-6 \mu\text{m}$ , phialidic, globose, thin-walled. Conidia  $3.6-5.6 \times 1.6-2.2 \mu\text{m}$ , average  $4.5 \times 1.8$ ,  $Q = 2.0-3.0$ , average  $Q = 2.5$ , ellipsoid, with polar guttules.

NaOH spot-test: not specific, a slight discolouring to sienna may occur.

*Ecology and distribution.* In Europe a widespread occurring opportunistic pathogen of woody plants (in our work encountered in members of Caprifoliaceae, Cupressaceae, Hippocastanaceae, Aquifoliaceae, Rubiaceae, Liliaceae and Rosaceae). The fungus is originally described from leaf spots and stem lesions on *Viburnum* spp., but serious disease symptoms on those shrubs are usually caused by *Phoma viburni* (Roum. & Sacc.) Boerema & Griffin, a quite different species with significantly larger and sometimes in part uniseptate conidia.

*Culture studied.* CBS 371.91 (PD 81/413) ex *Chamaecypariss lawsoniana* (Cupressaceae), The Netherlands; CBS 500.91 (PD 83/322) ex *Ilex aquifolium* (Aquifoliaceae), the Netherlands.

### 15. *Phoma eucalyptica* Sacc. — Fig. 15

*Phoma eucalyptica* Sacc., Sylloge Fung. 3 (1884) 78 [as '(Thüm.)', but nom. nov.]. — *Coniothyrium eucalypti* Thüm. in Instituto Coimbra 27 sub Contr. Fl. myc. Lusit. II n. 341. (1880 ['1879 e 1880']); quoted in Hedwigia 19 (1880) 151; not *Phoma eucalypti* Cooke & Kickx, Sylloge Fung. 3 (1884) 78.

#### *Description in vitro*

OA: growth-rate 43–47 mm, regular, with or without adpressed and sparse, woolly, olivaceous-grey aerial mycelium; with distinct radiating hyphal strands or not; colony colour olivaceous-grey with citrine outer margin; reverse olivaceous with citrine margin.

MA: growth-rate 50–54 mm, regular, with white to olivaceous-grey, woolly aerial mycelium; colony colour olivaceous-black with brown tone with slightly paler margin; reverse similar.

CA: growth-rate 50–53 mm, regular with distinct radially orientated hyphal strands, with sparse, finely floccose, olivaceous-grey aerial mycelium; colony colour brown-olivaceous to olivaceous, often with paler, citrine margin; reverse similar.

Pycnidia 120–250 × 80–200 µm, solitary or confluent in clusters of 2–5 specimens, globose, with 1–5 ostioles, usually papillate or with distinct neck, olivaceous to olivaceous-black, with white to vinaceous-buff or saffron exudate; glabrous, abundant, scattered or in concentric zones, on and in the agar. Conidiogenous cells 3–7 × 2–8 µm, phialidic, broadly globose to bottle-shaped, thin-walled. Conidia 2.8–4.2 × 1.0–2.0 µm, in average 3.2–3.5 × 1.4–1.8 µm, Q = 1.7–3.4, in average Q = 2.0–2.5, eguttulate, ellipsoid to subcylindrical.

Chlamydospores absent, but simple, globose or ellipsoid swollen cells may be present in MA after 4 weeks.

NaOH spot-test: not a specific reaction, but a slight discolouration to sienna may occur.

*Ecology and distribution.* Opportunistically parasitic on members of the Myrtaceae in association with 'Shoot Wilt' of *Eucalyptus* spp., especially *E. globulus* (Australian Gumtree), and with 'Leaf Necrosis' and blister symptoms on *Eugenia* spp., especially *E. aromatica* (clove-tree). Common in Australasia; once also isolated from seawater near Yugoslavia.

*Culture studied.* CBS 508.91 (PD 73/1413) ex seawater, Yugoslavia; CBS 377.91 (PD 79/210) ex *Eucalyptus* sp. (Myrtaceae), leaf, W. Australia; CBS 378.91 (PD 82/107) ex *Eugenia aromatica* (Myrtaceae); 'Blister disease'.

### 16. *Phoma tropica* R. Schneid. & Boerema — Fig. 16

*Phoma tropica* R. Schneider & Boerema, Phytopath. Z. 83 (1975) 361–365.

#### *Description in vitro*

OA: growth-rate 50–53 mm, regular, without or with poorly developed downy, dark olivaceous aerial mycelium; colony colourless to greenish-olivaceous to dull green, outer margin light green; reverse similar.

MA: growth-rate 52–54, regular, without or with poorly developed aerial mycelium, colony dull green, more olivaceous at centre and more honey to fawn at margin or entirely olivaceous-grey; reverse similar or slightly darker.

CA: growth-rate 53–60 mm, regular, without or with poorly developed aerial mycelium; colony greenish-olivaceous to olivaceous or grey-olivaceous to olivaceous-black, with greenish-olivaceous margin; reverse similar or darker.

Pycnidia 100–350(–400)  $\mu\text{m}$ , single or confluent, with 1 to 5 distinct ostioles, but hardly any neck; greenish-olivaceous to olivaceous black, at first around ostiole, glabrous, very abundant, on and partly in the agar, entirely scattered over colony or in concentric rings; exudate white-yellowish. Conidiogenous cells 2–6  $\times$  3–6  $\mu\text{m}$ , phialidic, globose, thin-walled. Conidia 3.0–5.9  $\times$  1.2–2.1  $\mu\text{m}$ , average 3.7–4.4  $\times$  1.6–2.0  $\mu\text{m}$ ,  $Q = 1.6$ –3.2, average  $Q = 2.2$ , ellipsoid with two distinct, polar guttules.

NaOH spot-test: negative

*Ecology and distribution.* A saprophyte from tropical regions that is commonly found in heated glasshouses in Europe, where it occurs on dead tissue of a wide variety of ornamental plants.

*Culture studied.* CBS 497.91 (PD 79/209) ex *Coffea arabica* (Rubiaceae), origin unknown; CBS 498.91 (PD 75/698) ex *Poinsettia* sp. (Euphorbiaceae), the Netherlands.

## 17. *Phoma hedericola* (Dur. & Mont.) Boerema — Fig. 17

*Phoma hedericola* (Dur. & Mont.) Boerema, Trans. Br. mycol. Soc. 67 (1976) 295. — *Phyllosticta hedericola* Dur. & Mont., Flora d'Algérie crypt. 1 (1849) 611 [as '*hederaecola*']. — *Phyllosticta destructiva* var. *hederae* (Dur. & Mont.) Oudemans, Ned. Kruidd. Archf II, 1 (3) (1873) 257 [name change].

*Selected literature.* Boerema (1976).

### *Description in vitro*

OA: growth-rate 55–61 mm, regular, with or without sparse, whitish aerial mycelium; colony colourless with olivaceous sectors or centre, with numerous clustered pycnidia over whole colony; reverse similar.

MA: growth-rate 40–52 mm, regular, with or without floccose, white aerial mycelium; colony more or less colourless or with olivaceous sector; reverse pale luteous.

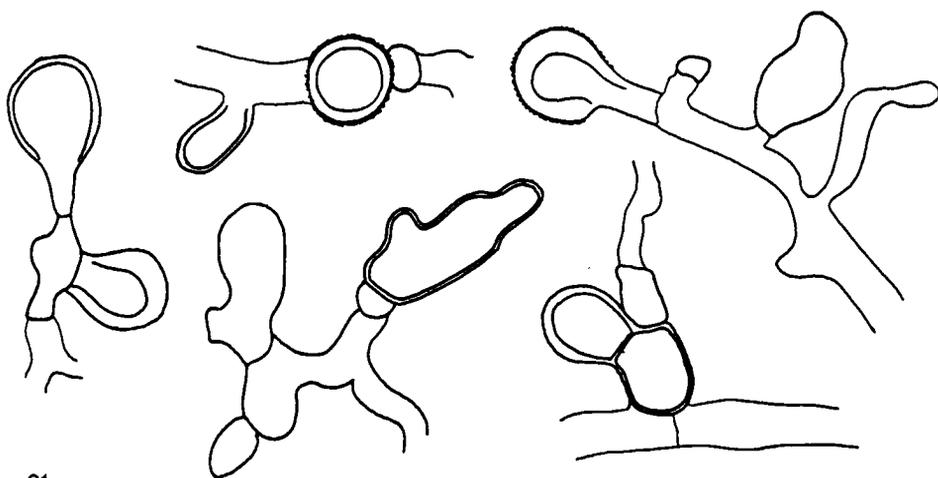
CA: growth-rate 35–61 mm, slightly irregular, with floccose, white to olivaceous-grey aerial mycelium; colony colourless with olivaceous sectors or entirely grey-olivaceous to olivaceous-black; reverse similar.

Pycnidia 90–140  $\times$  80–140  $\mu\text{m}$ , solitary or confluent, globose or irregularly shaped, with 1 to 2, sometimes 3 ostioles, without distinct neck; olivaceous, with white conidial slime, glabrous or with hyphal strands, readily or slowly developing, scattered all over the colony, mostly on the agar, sometimes in the agar or in the aerial mycelium; exudate whitish. Conidiogenous cells 4–6  $\times$  3–6  $\mu\text{m}$ , globose, thin-walled. Conidia (3.5–)4.0–6.0  $\times$  (1.5–)2.0–2.8  $\mu\text{m}$ , average 4.8  $\times$  2.3  $\mu\text{m}$ ,  $Q = 1.7$ –2.3, average  $Q = 2.0$ , broadly ellipsoid with two or more, small, usually polar guttules.

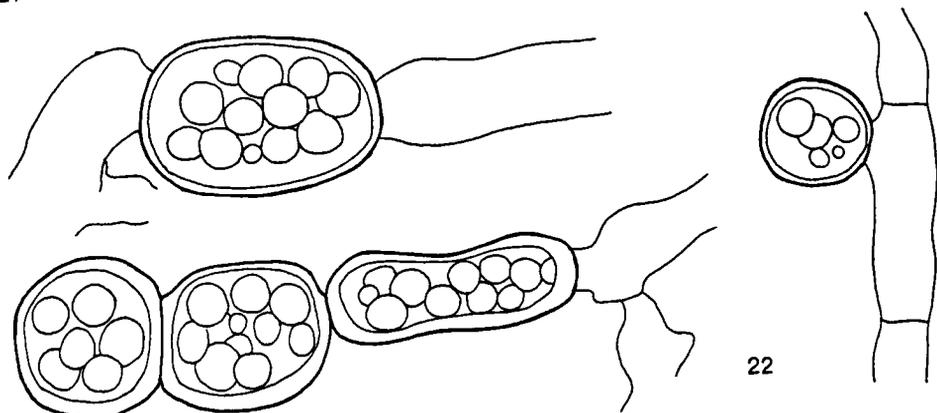
NaOH spot-test: yellowish-green turning into reddish-rust.

*Ecology and distribution.* A pathogen of *Hedera* spp. (Araliaceae), causing necroses on leaves and stems: 'Leaf Spot'. Probably cosmopolitan.

*Culture studied.* CBS 366.91 (PD 70/811) ex *Hedera helix* (Araliaceae), the Netherlands; CBS 367.91 (PD 87/229) ex *Hedera helix* (Araliaceae), the Netherlands.



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Fig. 21. *Phoma multipora*. Chlamydospores ( $\times 1250$ ). — Fig. 22. *Phoma eupyrena*. Chlamydospores ( $\times 1250$ ).

### 18. *Phoma eupyrena* Sacc. — Figs. 18, 22

*Phoma eupyrena* Sacc., *Michelia* 1 (5) (1879) 525.

*Selected literature.* Dorenbosch (1970), Morgan-Jones & Burch (1988).

#### *Description in vitro*

OA: growth-rate 48–54 mm, regular, with small tuft of olivaceous aerial mycelium at centre only; colony colour dull green or herbage green to olivaceous-black; reverse similar.

MA: growth-rate 48–60 mm, regular, with abundant woolly, whitish-grey to olivaceous-grey aerial mycelium; colony colour variable from dull green to olivaceous-buff, greenish-olivaceous to olivaceous-black; reverse greenish-olivaceous to olivaceous-black.

CA: growth-rate 53–56 mm, regular, with woolly to floccose, white to grey-olivaceous aerial mycelium; colony colour dull green to olivaceous-grey or grey-olivaceous, with some olivaceous-black sectors; reverse similar.

Pycnidia 120–260 × 100–260 μm, very variable in size, solitary or confluent, more or less globose with very distinct neck; ochraceous then olivaceous to olivaceous-black, glabrous, smooth, abundant on and (partly) in the agar, scattered or arranged in more or less concentric rings; exudate whitish. Conidiogenous cells 3–8 × 3–7 μm, phialidic, broadly globose, thin-walled. Conidia 4.2–5.6 × 1.8–2.4 μm, average 4.9 × 2.1 μm, Q = 2.0–2.9, average Q = 2.4, ellipsoid with two large, polar guttules.

Chlamydospores simple, 8–20 × 6–15 μm, intercalary or terminal, single or in chains of globose, relatively thick-walled elements, ochraceous-olivaceous with numerous dark greenish guttules.

NaOH spot-test: negative.

*Ecology and distribution.* A cosmopolitan, soil-inhabiting fungus, which may cause damping-off of seedlings of herbaceous and woody plants; formerly considered as a specific fungus of Potato.

*Culture studied.* CBS 375.91 (PD 78/745) ex *Phaseolus vulgaris* (Papilionaceae), the Netherlands; CBS 374.91 (PD 78/391) ex *Solanum tuberosum* (Solanaceae), the Netherlands.

### Section *Sclerophomella*

(compare Boerema, Loerakker & Wittern, 1986)

Species characterized by thick-walled pycnidia with late formation of an opening (pore instead of ostiole).

#### 19. *Phoma incompta* Sacc. & Mart. — Fig. 19

*Phoma incompta* Sacc. & Mart., Sylloge Fung. 10 (1892) 146.

*Selected literature.* Malathrakis (1979).

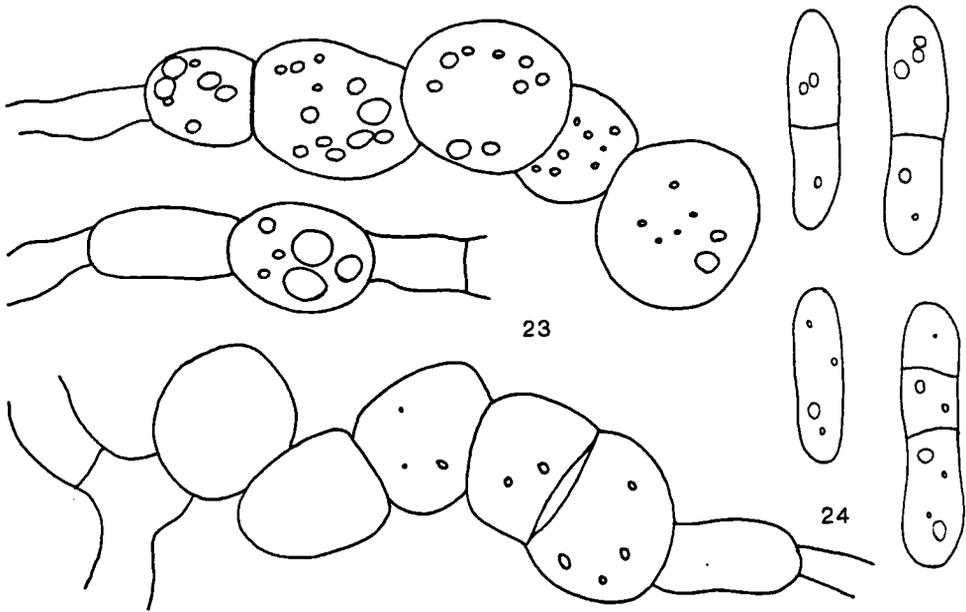
#### *Description in vitro*

OA: growth-rate 21–22 mm (14 days: 40–42 mm), regular, without or with sparse, woolly, grey-olivaceous aerial mycelium; colony colour chestnut, towards margin ochraceous; reverse similar or with weak greenish tinge, distinctly zonated from pycnidial concentric rings.

MA: growth-rate 19–21 mm (14 days: 24–35 mm), regular, with abundant, white to olivaceous buff or greenish-olivaceous aerial mycelium; colony colour greenish-olivaceous to dark herbage green with darker centre (towards olivaceous-grey); reverse between sepia and olivaceous, with outer margin more like citrine.

CA: growth-rate 14–19 mm (14 days: 27–34 mm), regular, with woolly, pale green aerial mycelium; colony colour pale greenish-olivaceous with amber coloured spots; reverse umber to fuscous-black with ochraceous margin.

Pycnidia 50–300 × 50–250, single but usually confluent in dense clusters, thick-walled, dark olivaceous to rusty-blackish, with an indistinct opening visible as a pallid spot, and occurring only late in the pycnidial development; exudate sordid white to pale violaceous; covered in mycelial hairs, abundant in concentric rings, mainly on, but also in the agar. Conidiogenous cells 3–7 × 2–8 μm, phialidic, globose, thin-walled. Conidia 3.0–3.6 × 0.8–1.0 μm, av. 3.2 × 0.9 μm, Q = 3.0–4.5, av. 3.7, slenderly cylindrical, eguttulate.



Figs. 23–24. *Phoma dictamnicola*. 23. Chlamydospores ( $\times 1250$ ); 24. conidia in vivo ( $\times 1250$ ).

Chlamydospores absent, but swollen cells may occur in the mycelium.  
NaOH spot-test: red-brown with bluish margin.

**Ecology and distribution.** A pathogen of *Olea europaea* (olive) in southern Europe (Greece, Italy). In naturally infected trees it may cause the characteristic symptoms of a vascular wilt disease: 'Shoot Wilt'. It has also been found on the fruits.

**Culture studied.** CBS 652.77 (PD 76/1013) ex *Olea europaea* (Oleaceae), Greece; CBS 526.82 (PD 82/786) ex *Olea europaea* (Oleaceae), Italy.

20. *Phoma dictamnicola* Boerema, de Gruyter & Noordel., *nom. nov.* — Figs. 20, 23, 24.

*Ascochyta nobilis* Kabát & Bubák, Ost. bot. Z. 54 (1904) 3; not *Phoma nobilis* Sacc., Michelia 2 (3) (1882) 616 [= *Phomopsis* sp.].

*Phyllosticta dictamni* Fairman, Annls mycol. 8 (1910) 324; not *Phoma dictamni* Fuckel, Jb. Nassau. Ver. Naturk. 23–24 [= *Symb. mycol.*] (1870 [1869 und 1870]) 125.

**Description in vitro**

OA: growth rate 47–48 mm, colonies regular, with very conspicuous whitish-greyish, adpressedly woolly-felted aerial mycelium all over the colony, total colour greyish-olivaceous to greenish-olivaceous at margin, reverse beige at centre, towards margin greenish-olivaceous.

MA: growth rate 54–67 mm, colony irregular, with densely woolly-felted, whitish aerial mycelium; total impression pale olivaceous-grey; reverse honey with olivaceous-black patches, caused by abundant production of pycnidia.

CA: growth rate 68 mm, colony regular, with abundant, whitish, floccose aerial mycelium; reverse rather pale beige.

Pycnidia 250–450 µm, solitary or in clusters of 2–3, thick-walled, more or less globose, without distinct neck; opening occurs only late in the pycnidial development, greenish-olivaceous; abundant, especially towards the margin of the colony, usually in the agar, part of them half in the agar; exudate not observed. Conidiogenous cells 4–7 × 4–7 µm, phialidic, globose, thin-walled. Conidia [in vitro always aseptate and relatively small] 3.8–5.4 × 1.4–2.4 µm, average 4.6 × 1.8 µm, Q = 2.0–3.1, average Q = 2.6, ellipsoid, sometimes reniform, without visible guttules.

Chlamydo-spores 8–12 µm in diameter, simple, usually intercalary chains of globose, greenish-olivaceous cells.

NaOH spot-test: negative.

*Ecology and distribution.* A serious pathogen of *Dictamnus albus*, frequently found in Eurasia and North America: 'Leaf Spot'. The small conidial dimension in vitro may lead to confusion with the spermatial state *Asteromella dictamni* Petrak (syn. *Phyllosticta dictamnicola* Lobik) of *Mycosphaerella dictamni* Petrak (anam. *Septoria dictamni* Fuckel).

*Culture studied.* CBS 507.91 (PD 74/148) ex *Dictamnus albus* (Rutaceae), the Netherlands.

*Note.* *Phoma dictamnicola* produces in vivo on the leaf spots often variable number of relatively large 1-septate conidia. In vitro, and on dead stems, however, the conidia always remain small and aseptate.

#### REFERENCES

- Aa, H.A. van der, M.E. Noordeloos & J. de Gruyter. 1990. Species concept in some larger genera of the Coelomycetes. *Stud. Mycol.* 32: 3–19.
- Boerema, G.H. 1976. The *Phoma* species studied in culture by Dr. R.W.G. Dennis. *Trans. Br. mycol. Soc.* 67: 289–319.
- Boerema, G.H. 1985. Mycologisch-Taxonomisch onderzoek aan Bodem *Phoma*'s. *Versl. Meded. Plziektenk. Dienst Wageningen* 163 (Jaarb. 1984): 34–40.
- Boerema, G.H. & M.M.J. Dorenbosch. 1973. The *Phoma* and *Ascochyta* species described by Wollenweber and Hochapfel in their study on fruit-rotting. *Stud. Mycol.* 3.
- Boerema, G.H. & M.J. Griffin. 1974. *Phoma* species from *Viburnum*. *Trans. Br. mycol. Soc.* 63: 109–114.
- Boerema, G.H., J. de Gruyter & M.E. Noordeloos (in prep). Specific and infraspecific taxa of *Phoma* differentiated on account of cultural characteristics.
- Boerema, G.H., W.M. Loerakker & I. Wittern. 1986. Zum Auftreten von *Phoma nigrificans* (P. Karst.) comb. nov. (Teleomorph *Didymella macropodii* Petrak) an Winterraps (*Brassica napus* L. var. *oleifera* Metzger). *Jl Phytopath.* 15: 269–273.
- Constantinescu, O. & H.A. van der Aa. 1982. *Phoma flavigena* sp. nov., from fresh water in Romania. *Trans. Br. mycol. Soc.* 79: 343–345.
- Dorenbosch, M.M.J. 1970. Key to nine ubiquitous soil-borne *Phoma*-like fungi. *Persoonia* 6: 1–4.
- Goossens, J.A.A.M.H. 1928. Onderzoek over de door *Phoma apiicola* Klebahn veroorzaakte schurftziekte van knolselderij en over synergetische vormen en locale rassen van deze zwam. *Tijdschr. PlZiekt.* 34: 271–348.
- Malathrakis, N.E. 1979. A study of an olive tree disease caused by the fungus *Phoma incompta* Sacc. et Mart. [in Greek]. 123 pp. Thesis Agric. Coll. Athens.
- Morgan-Jones, G. & K.B. Burch. 1988. Studies in the genus *Phoma*. X. Concerning *Phoma eupyrena*, an ubiquitous, soil-borne species. *Mycotaxon* 31 (2): 427–434.

- Noordeloos, M.E., J. de Gruyter, G.W. van Eijk & H.J. Roelijmans (in manuscr.). Phoma-like fungi forming Ice-fern crystals in pure culture: taxonomic implications of morphology, cultural characteristics, pathology and biochemistry.
- Padwick, G.W. 1950. Manual of rice diseases. CMI Kew.
- Rayner, R.W. 1970. A mycological colour chart. CMI Kew.
- Shukla, N.P., R.K. Rajak, G.P. Agarwal & D.K. Gupta. 1984. Phoma minutispora as a human pathogen. Mykosen 27: 255–258.