

CONTRIBUTIONS TOWARDS A MONOGRAPH OF PHOMA
(COELOMYCETES) – VII

Section *Sclerophomella*: Taxa with thick-walled pseudoparenchymatous pycnidia

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This paper deals with ten species of *Phoma*, characterized by thick-walled pseudoparenchymatous pycnidia. They superficially resemble the thick-walled pycnidial phenotype in species of *Phoma* sect. *Plenodomus*, but scleroplectenchyma is lacking and teleomorphs belong to *Didymella*, not *Leptosphaeria*. Keys and indices of host-fungus and fungus-host relations are provided and short comments on the ecology and distribution of the taxa are given.

The species of *Phoma* section *Sclerophomella* (Höhn.) Boerema et al. (Boerema, 1997) are characterized by thick-walled pseudoparenchymatous pycnidia (Fig. 1A, B) which superficially resemble the thick-walled pycnidial phenotype in species of *Phoma* sect. *Plenodomus* (Contributions III–1/2; Boerema et al., 1994, 1996). Just as in sect. *Plenodomus* the pycnidium is initially closed, the opening occurs only late in the growing process, i.e. the pycnidium has a pore instead of a predetermined ostiole. In some species there is also retarded development of the pycnidial cavity, formation of a 'pyncosclerotium', containing a compact mass of cells which afterwards disintegrates (histolysis) (Fig. 1C). However, scleroplectenchyma (hyaline cells with thick walls and a relatively small lumen), characteristic for sect. *Plenodomus* is always lacking. Members of sect. *Sclerophomella* are related to the ascomycetous genus *Didymella* Sacc. ex Sacc. and not to *Leptosphaeria* as is the case in sect. *Plenodomus*.

In vitro, the hyaline conidia of species in sect. *Sclerophomella* are mainly aseptate, i.e. *Phoma*-like. Secondary septation of the conidia may occur and is a typical phenomenon in the type species of the section, *Phoma complanata* (Tode: Fr.) Desm. In host tissue, the pycnidia of this species usually contain only aseptate conidia of 'common *Phoma*-size'. But sometimes a high percentage of the conidia becomes larger and 1-septate. They may be distinctly *Ascochyta*-like, resembling the large conidial dimorph in *Phoma* sect. *Heterospora* (Contribution IV, Boerema et al., 1997). Old pycnidia often contain many swollen, dark, 1-septate conidia as in species of *Phoma* sect. *Peyronellaea* (Contribution II, Boerema, 1993). In vitro, the conidia of *P. complanata* are highly variable in shape and size, but usually aseptate in fresh cultures; in old cultures distinctly large *Ascochyta*-like conidia may occur.

In the description of the original genus *Sclerophomella* by von Höhnelt (1917: 237) the conidiogenesis in the type species was misinterpreted. The ontogeny of the conidia in *P. complanata* agrees completely with conidiogenesis in *P. herbarum*, the type species of *Phoma* (electron-microscopic study by Boerema & Bollen, 1975). Another generic synonym of the section, *Sclerochaetella* Höhn. (Höhnelt, 1917: 251–252), is based on a sample of *P. complanata* mixed with a *Vermicularia* species (Contribution III–2 under *Diploplenodomus rivini* (Allesch.) Petr.; Boerema et al., 1996).

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- 6a. Pycnidium globose to depressed globose, usually at first containing a compact mass of cells ('pyncnosclerotium') which afterwards disintegrates and finally results in a pycnidial cavity lined with conidiogenous cells; conidia aseptate, $4.5\text{--}8 \times 2\text{--}3 \mu\text{m}$; on dead stems of herbaceous plants in Europe 6. *P. versabilis*
- b. Pycnidia globose to irregular; typical 'pyncnosclerotia' absent 7
- 7a. Growth-rate 60–82 mm on OA and 59–79 mm on MA; colony colourless to primrose, sometimes with citrine-green to olivaceous tinges on MA, reverse similar; conidia highly variable, mainly aseptate, usually $4\text{--}10 \times 2\text{--}3 \mu\text{m}$, occasionally also distinctly larger, 1-septate, ascochytoïd, up to $34 \times 10 \mu\text{m}$; on Umbelliferae 7. *P. complanata*
- b. Growth-rate 48–56 mm on OA and 31–46 mm on MA; colony grey olivaceous to olivaceous grey on MA, sometimes with greenish olivaceous sectors, reverse leaden grey to leaden black; conidia aseptate, $4.5\text{--}10.5 \times 1.5\text{--}4 \mu\text{m}$; on wild and cultivated Cruciferae 8. *P. nigrificans* teleomorph *Didymella macropodii*

Note

Two insufficiently known species of this section (nos 9 & 10) are discussed in the Addendum; they can be differentiated only by their conidial dimensions in vivo and by their specific host relations: i.e. no. 9. *P. boerhaviae*, produces relatively large aseptate conidia, $8\text{--}13.5 \times 2.5\text{--}4 \mu\text{m}$ and is a specific pathogen of *Boerhavia diffusa* in India and Pakistan (spots on leaves and twigs); no. 10. *P. syriaca*, has conidia $6\text{--}8 \times 3.5\text{--}6 \mu\text{m}$, and was found together with the teleomorph, *Didymella syriaca*, on dead stems of *Phlomis brevilabris* in Lebanon.

HOST-FUNGUS INDEX

Plurivorous	<i>P. versabilis</i> (6)
Frequently found on specific plants:	
<i>Boerhavia</i> sp. (Nyctaginaceae)	<i>P. boerhaviae</i> (9)
Cruciferae (e.g. <i>Armoracia rusticana</i> , <i>Brassica napus</i> var. <i>oleifera</i>)	<i>P. nigrificans</i> (8) (teleom. <i>Didymella macropodii</i>)
<i>Dictamnus albus</i> (Rutaceae)	<i>P. dictamnicola</i> (2)
<i>Gentiana sino-ornata</i> (Gentianaceae)	<i>P. gentianae-sino-ornatae</i> (3)
<i>Melampyrum</i> spp. (Scrophulariaceae; semi-parasitic)	<i>P. sylvatica</i> (5) (also <i>P. alectorolophi</i> , see below)
<i>Olea europaea</i> (Oleaceae)	<i>P. incompta</i> (1)
<i>Phlomis brevilabris</i> (Labiatae)	<i>P. syriaca</i> (10)
Scrophulariaceae (semi-parasitic <i>Melampyrum</i> , <i>Rhinanthus</i> and <i>Pedicularia</i> spp.)	<i>P. alectorolophi</i> (4) (teleom. <i>Didymella alectorolophi</i>)
Umbelliferae (e.g. <i>Pastinaca sativa</i> , <i>Petroselinum crispum</i> and <i>Daucus carota</i>)	<i>P. complanata</i> (7)

FUNGUS-HOST INDEX

<i>P. alectorolophi</i> (4) (teleom. <i>Didymella alectorolophi</i>)	Scrophulariaceae (semi-parasitic <i>Melampyrum</i> , <i>Rhinanthus</i> and <i>Pedicularia</i> spp.)
<i>P. boerhaviae</i> (9)	<i>Boerhavia</i> sp. (Nyctaginaceae)
<i>P. complanata</i> (7)	Umbelliferae (e.g. <i>Pastinaca sativa</i> , <i>Petroselinum crispum</i> and <i>Daucus carota</i>)
<i>P. dictamnica</i> (2)	<i>Dictamnus albus</i> (Rutaceae)
<i>P. gentianae-sino-ornatae</i> (3)	<i>Gentiana sino-ornata</i> (Gentianaceae)
<i>P. incompta</i> (1)	<i>Olea europaea</i> (Oleaceae)
<i>P. nigrificans</i> (8) (teleom. <i>Didymella macropodii</i>)	Cruciferae (e.g. <i>Armoracia rusticana</i> , <i>Brassica napus</i> var. <i>oleifera</i>)
<i>P. sylvatica</i> (5)	<i>Melampyrum</i> spp. (Scrophulariaceae; semi-parasitic)
<i>P. syriaca</i> (10)	<i>Phlomis brevilabris</i> (Labiatae)
<i>P. versabilis</i> (6)	plurivorous

DESCRIPTIVE PART

Section *Sclerophomella*1. *Phoma incompta* Sacc. & C. Mart.

Phoma incompta Sacc. & C. Mart., Sylloge Fung. 10 (1892) 146.
Selected literature. Malathrakis (1979).

Additional data in the provisional treatment under *Phoma* sect. *Sclerophomella* in Contribution I-1 no. 19.

Description in vitro

A detailed description *in vitro* has been given in Contribution I-1. Distinctive are the usually dense clustered, initially closed thick-walled pycnidia, dark olivaceous to rusty-blackish in colour, the relatively slow growth-rate on OA, MA and CA (up to 22 mm), the production of a diffusible pigment on OA and MA staining the agar ochraceous to ochre and relatively small, aseptate conidia, (2-)3-4(-5) × 0.5-1(-1.5) μm (Q = 3-4.5), narrowly cylindrical.

NaOH spot test: positive, red-brown with bluish margin.

Description in vivo (Olea europaea)

The pycnidia on the host, especially those occurring on the dead shoots of heavily infected olive trees, are often aggregated, strikingly black, globose and poroid. The conidia are usually somewhat larger than those *in vitro*, mostly 3-5 × 1.5-2 μm, av. 4.3 × 1.6 μm.

Ecology and distribution. A specific pathogen of the olive, *Olea europaea*, causing Shoot Wilt and recorded in southern Europe (Crete, Greece and Italy). The main symptoms are a progressive withering of young shoots, which later die without defoliation, and a dark discol-

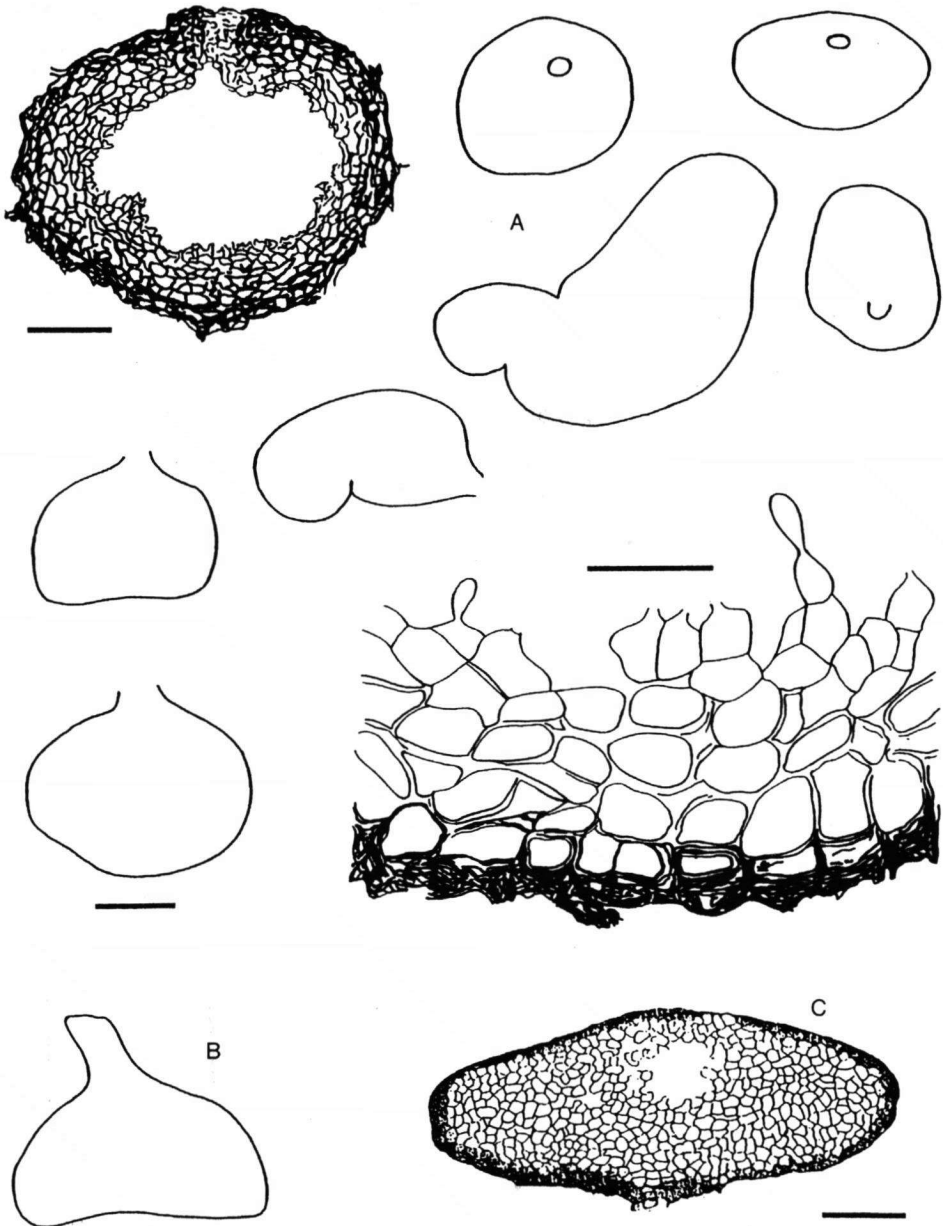


Fig. 1. A. *Phoma complanata*, type species of section *Sclerophomella*. Vertical section of thick-walled pycnidium in vivo, shape of pycnidia in vitro and detail of pycnidial wall with conidiogenous cells. — B. *Phoma nigrificans*. Pycnidium with elongated neck. — C. *Phoma versabilis*. Vertical section of 'pyncnosclerotium', the central cells gradually disintegrate, which process finally results in a pycnidial cavity. Vertical section: bar = 50 μm ; pycnidial shapes: bar = 100 μm ; and detail pycnidial wall: bar = 10 μm .

uration of the xylem which extends all along the infected branches (Malathrakis, 1979). In the rainy season infection occurs through wounds, especially leaf scars. The disease may be confused with Verticillium Wilt of olive caused by *Verticillium dahliae* Kleb. (Tosi & Zizzerini, 1994).

Representative culture. CBS 526.82 (PD 82/786) ex *Olea europaea* (Oleaceae), Italy.

2. *Phoma dictamnica* Boerema et al.

Phoma dictamnica Boerema, de Gruyter & Noordel. in de Gruyter & Noordel., Persoonia 15 (1) (1992) 90–91. — *Ascochyta nobilis* Kabát & Bubák, Öst. bot. Z. 54 (1904) 3; not *Phoma nobilis* Sacc., *Michelia* 2 (3) (1882) 16 [= *Phomopsis* sp.].

Selected literature. De Gruyter & Noordeloos (1992).

Description in vitro

A detailed description in vitro has been given in the provisional treatment under sect. *Sclerophomella* in Contribution I–1 (de Gruyter & Noordeloos, 1992). Distinctive are the subglobose, initially closed thick-walled pycnidia, greenish olivaceous in colour, the moderate to fast growth-rate on OA, MA and CA (47–68 mm), the absence of pigment production and the relatively small, always aseptate conidia, 4–5.5 × 1.5–2.5 µm (Q = 2.0–3.1), ellipsoidal to reniform and eguttulate.

Description in vivo (Dictamnus albus)

The pycnidia which form in irregular leaf spots and on dead stems are subglobose-conical with a central pore, dark brown to black in colour. The conidia are extremely variable. Those from pycnidia on dead stems resemble the conidia in vitro, usually aseptate 4–5 × 2 µm, but sometimes also larger, 6–8 × 3–4 µm and then often 1-septate. The pycnidia on the leaf spots always contain relatively large conidia, usually partly aseptate (8–)11–14(–14.5) × 3–3.5 µm, but mainly 1(–2)-septate, 13.5–15.5(–16) × 3.5–4.0(–4.5) µm: ascochytoïd dimorph.

Ecology and distribution. A specific pathogen of the ‘firework plant’, *Dictamnus albus* (Rutaceae), frequently recorded in Eurasia and North America. The fungus causes white or light-brown irregular spots on the tips or margins of the leaves: Leaf Spot. The pathogen probably overwinters as pycnidia on dead stems.

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

3. *Phoma gentianae-sino-ornatae* Punith. & Harling — Figs. 2A, B

Phoma gentianae-sino-ornatae Punith. & Harling, Mycol. Res. 97 (11) (1993) 1299.

Selected literature. Punithalingam & Harling (1993).

Description in vitro (partly adopted from Punithalingam & Harling, 1993)

OA: growth-rate 30–32 mm, (14 days: 58–59 mm), regular, with woolly to floccose, white to smoke grey aerial mycelium; colony colourless to grey olivaceous or vinaceous buff to fawn, reverse similar to olivaceous black.

MA: growth-rate 19–20 mm, (14 days: 35–38 mm), regular to irregular, with compact, finely floccose, white to olivaceous grey/grey olivaceous aerial mycelium; colony similar due to the compact aerial mycelium; reverse leaden grey to olivaceous black, greenish olivaceous at margin.

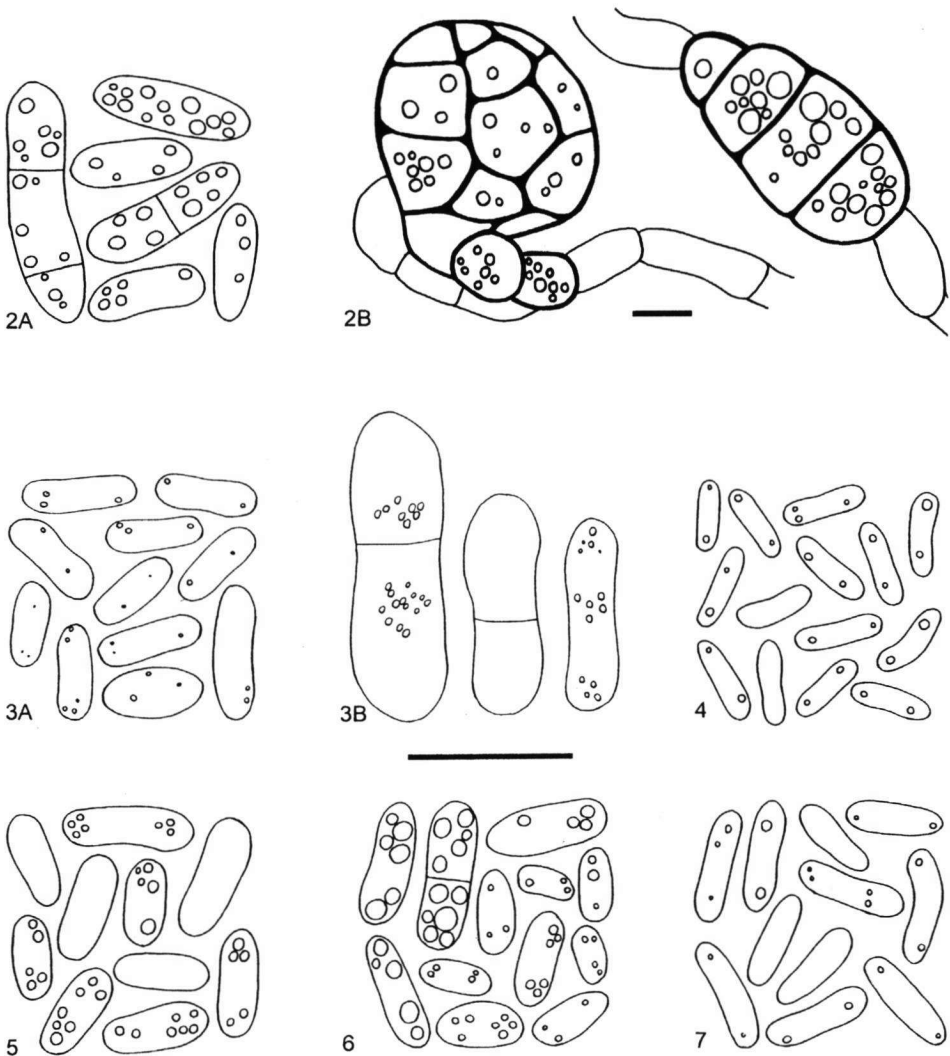


Fig. 2. *Phoma gentianae-sino-ornatae*. A. Conidia; B. chlamydospores and pseudosclerotium. — Fig. 3. *Phoma alectorolophi*. A. Conidia in vitro; B. conidia in vivo. — Figs. 4–7. Conidia. 4. *Phoma sylvatica*; 5. *Phoma versabilis*; 6. *Phoma complanata*; 7. *Phoma nigrificans*. — Bar = 10 μ m.

CA: growth-rate 23–24 mm, (14 days: 35–37 mm), regular, with floccose to woolly, grey olivaceous to dull green aerial mycelium; colony grey olivaceous to dull green; reverse similar to olivaceous, with leaden grey to olivaceous patches.

Pycnidia 180–250 μ m diam., subglobose, usually solitary, glabrous, with 1 papillate pore, olivaceous, later olivaceous black; walls made up of 2–7 layers of cells, outer layers pigmented; conidial exudate whitish. Conidiogenous cells 4–8 \times 4–8 μ m, globose to bottle-

shaped. Conidia aseptate, $(4.5\text{--})6\text{--}9.5(\text{--}11) \times 2.5\text{--}4 \mu\text{m}$, av. $7.7 \times 2.8 \mu\text{m}$, $Q = 1.9\text{--}3.6$, av. $Q = 2.8$, ellipsoidal to ovoid, sometimes curved, with several guttules, occasionally 1(–2)-septate, up to $16 \times 3.5 \mu\text{m}$.

Chlamydo-spores and minute pseudosclerotia are formed in the agar, dark olivaceous to olivaceous black, chlamydo-spores unicellular to multicellular, 8–20 μm diam., pseudo-sclerotia olivaceous black, 35–110 μm diam.

Ecology and distribution. So far this fungus is only recorded in Scotland, where it has been isolated from rotting roots of living *Gentiana sino-ornata* plants, showing a severe root rot and blackening of tissue. The disease, first noticed in 1989, is characterized by the occurrence of numerous minute pseudosclerotia on and within the infected tissue. [These pseudosclerotia are anatomically similar to those of *Macrophomina phaseolina* (Tassi) Goid., cf. Punithalingam & Harling, 1993.]

Representative culture. IMI 341116 (CBS 878.97, PD 95/2514) ex *Gentiana sino-ornata* (Gentianaceae), United Kingdom.

4. *Phoma alectorolophi* Boerema et al. — Figs. 3A, B

Teleomorph: *Didymella alectorolophi* Rehm.

Phoma alectorolophi Boerema, de Gruyter & Noordel., *Persoonia* 16 (3) (1997) 366–367.

Selected literature. Corbaz (1957, under *D. alectorolophi* and *D. pedicularidis* Arx); Boerema et al. (1997).

Description in vitro

OA: growth-rate 67–68 mm, regular, with floccose, white aerial mycelium; colony colourless to pale greenish olivaceous at margin; reverse similar.

MA: growth-rate 51–53 mm, regular, with velvety, white aerial mycelium; colony colourless with concentric citrine zones; reverse similar.

CA: growth-rate 58–60 mm, regular, with scanty, woolly, white aerial mycelium; colony colourless with pale olivaceous centre; reverse similar.

Pycnidia 90–310 μm diam., globose to irregular, solitary or confluent, glabrous, with 1–2 often indistinct, sometimes papillate pores, honey to citrine, later olivaceous, walls made up of 2–5 layers of cells, outer layers pigmented, with white to salmon exuded conidial masses; abundant, on and in the agar; micropycnidia present, 60–90 μm diam., often remaining sterile.

Conidiogenous cells $4\text{--}7 \times 5\text{--}9 \mu\text{m}$, bottle-shaped. Conidia usually aseptate, variable in size, $4\text{--}9(\text{--}14) \times 2\text{--}6 \mu\text{m}$, but mostly $4\text{--}7.5 \times 2\text{--}3.5 \mu\text{m}$, av. $6.0 \times 2.2 \mu\text{m}$, $Q = 2.0\text{--}3.2$, av. $Q = 2.7$, cylindrical to oblong ellipsoidal, with or without a few, small guttules. Occasionally some large 1-septate ascochytoïd conidia occur, $(10\text{--})14\text{--}18 \times (4\text{--})5\text{--}6(\text{--}8) \mu\text{m}$, ellipsoidal or ovoid, septum usually not median.

Chlamydo-spores absent.

NaOH spot test: positive on OA and MA; greenish, then red (E^+ reaction).

Dendritic crystals present.

Description in vivo (especially on *Rhinanthus angustifolius*)

Pycnidia (on dry calyces, capsules, peduncles and stems) subglobose to flattened, up to 300 μm diam., usually followed by pseudothecia (single identity proved by Corbaz, 1957).

Pycnidial primordia stromatic ('pyncnosclerotia' often indistinguishable from immature ascomata). The pycnidia usually produce only aseptate conidia in vivo. They are mostly oval to cylindrical and less variable than those in vitro, (4–)5–7(–9) × 2–2.5(–4) µm. So far larger ascochytooid conidia have only occasionally been found in old pycnidia.

Pseudothecia (on dead stems) subglobose with flattened base, mostly 250–300 × 140–160 µm, laterally and basally thick-walled-pseudoparenchymatous, unstable (cells easily come off). Pseudoparaphyses filiform, 2–3 µm wide, septate at intervals of about 10 µm, persisting. Ascospores (16–)18–21(–24) × (4.5–)5–7.5(–8) µm, obovoid to oval, 1-septate, constricted at the septum, upper cell usually larger and wider than the lower cell.

In addition to immature ascomata with only pseudoparaphyses⁴, similar structures containing numerous microconidia (or spermatia) were occasionally observed, 2–3.5 × 1–1.5 µm.

Ecology and distribution. This fungus has been recorded on dead tissue of three genera of semi-parasitic Scrophulariaceae in Europe: i.e. *Melampyrum*, *Rhinanthus* and *Pedicularia*. The fungus has been repeatedly confused with *Phoma complanata* (Tode: Fr.) Desm. (this paper no. 7) and *Phoma sylvatica* Sacc. (this paper no. 5).

Representative culture. CBS 132.96 (PD 93/853) ex *Rhinanthus angustifolius* (Scrophulariaceae), the Netherlands.

5. *Phoma sylvatica* Sacc. — Fig. 4

Possible teleomorph: *Didymella winteriana* (Sacc.) Petr.

Phoma sylvatica Sacc., *Michelia* 2 (2) (1881) 337; *Sylloge Fung.* 3 (1884) 128 [as '*silvatica*']. — *Plenodomus sylvaticus* (Sacc.) Ruppr., *Sydowia* 13 (1959) 21 [as '*silvatica*'; misapplied].

Selected literature. Boerema et al. (1996).

Description in vitro

OA: growth-rate 68–75 mm, regular to slightly irregular, with floccose, (pale) olivaceous grey aerial mycelium; colony colourless to rosy buff, with grey olivaceous to olivaceous grey at centre; reverse similar.

MA: growth-rate 58–65 mm, regular to slightly irregular, with woolly, dull green to (pale) olivaceous grey aerial mycelium; colony (pale) olivaceous grey, with dull green sectors, to dull green; reverse greenish olivaceous to dull green, partly with vinaceous buff tinges, olivaceous black at centre.

CA: growth-rate 59–61 mm, irregular, with compact, woolly to floccose, (pale) olivaceous grey aerial mycelium; colony (pale) olivaceous grey to olivaceous, staining the agar sienna to scarlet due to the release of a diffusible pigment; reverse olivaceous to sepia.

Pycnidia 110–330 µm diam., globose to subglobose, solitary or confluent, with mycelial outgrowths, with 1(–2) often indistinct, non-papillate or slightly papillate pore(s), greenish

4) Immature ascomata with pseudoparaphyses erroneously have been reported under different Coelomycete names; compare Grove (1935: 99):

Sphaeronaema rhinanthi Lib., *Plant. Crypt. Ard. No. 63.* — *Zythia rhinanthi* (Lib.) Fr., *Summa veg. Scand.* 408.

Phoma deusta Fuckel, *Symb. mycol.* 377.

Phoma melampyri P. Karst., *Acta Soc. Fauna Fl. fenn.* 27 (4) (1905) 14.

olivaceous to olivaceous black, walls made up of 5–9 layers of cells (occasionally up to 20 layers of cells were observed), outer layers pigmented, conidial exudate not observed; on and in the agar, more or less in concentric zones.

Conidiogenous cells 3–6 × 3–6 μm, bottle-shaped. Conidia aseptate, 3.5–6 × 1–2 μm, av. 5.0–5.1 × 1.5–1.6 μm, Q = 2.7–4.7, av. Q = 3.3–3.4, cylindrical, sometimes slightly allantoid, with usually 2 small, polar guttules.

Chlamydospores absent.

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

Crystals absent.

Description in vivo (Melampyrum sylvaticum)

Pycnidia (on dead stems, scattered or in groups) mostly 150 μm diam., with a relatively thick wall made up of polygonal cells. Conidia similar to those in vitro, mostly (3.5–)4–5 × 1–1.5(–2) μm. [Pseudothecia of *D. winteriana* also occur on dead stems, often in close association with the pycnidia of *P. sylvatica* and are comparable in size and anatomical appearance with those of *D. alectorolophi* (no. 4) but differ by a thinner peridium, c. 20 μm thick, shorter asci, usually 45–60 μm long, and smaller ascospores, often 15–18 × c. 4 μm. (For a fuller description see Munk, 1957: 337.)]

Ecology and distribution. Widespread in Europe on different species of *Melampyrum* (Scrophulariaceae, semi-parasites on roots of Gramineae). *Phoma sylvatica* is often confused with *Phoma petrakii* Boerema & Kest., a member of sect. *Plenodomus*, also common on stems of *Melampyrum* spp. (Contribution III–1, Boerema et al., 1994). The supposed teleomorph, *Didymella winteriana* (Petraik, 1922: 323), has been confused with *Didymella alectorolophi* Rehm (anamorph *Phoma alectorolophi* Boerema et al.; this paper no. 4), recorded and isolated from different semi-parasitic Scrophulariaceae in Europe, including *Melampyrum sylvaticum*. A single identity of *P. sylvatica* with *D. winteriana* is plausible but has not yet been proved with isolates in pure culture.

Representative culture. CBS 874.97 (PD 93/764) and CBS 135.93 (PD 83/87) ex *Melampyrum sylvaticum* (Scrophulariaceae), the Netherlands.

6. *Phoma versabilis* Boerema et al. — Figs. 1C, 5

Phoma versabilis Boerema, Loer. & Hamers, Persoonia 16 (2) (1996) 154.

Description in vitro

OA: growth-rate 40–43 mm, regular, with finely floccose to woolly, white to pale olivaceous grey aerial mycelium; colony colourless to dark herbage green/dull green at margin; reverse similar.

MA: growth-rate 30–32 mm, (14 days: 63–64 mm), regular to slightly irregular, with woolly, pale olivaceous grey to olivaceous grey aerial mycelium; colony dark herbage green to dull green; reverse leaden grey to leaden black, dull green to buff near margin.

CA: growth-rate 40–43 mm, regular, with scanty, floccose to finely woolly, white to pale olivaceous grey aerial mycelium; colony colourless, with a dull green to olivaceous black appearance due to developing pycnidia; reverse similar.

Pycnidia 100–260 μm diam., globose to globose-depressed, solitary to confluent, without distinct opening, honey/citrine to olivaceous/olivaceous black, initially containing a compact mass of cells ('pyncnosclerotia') which afterwards disintegrates and finally results in a

pycnidial cavity lined with conidiogenous cells, or occasionally with a pore, walls made up of 3–8 layers of cells, outer layers pigmented, with buff to rosy buff exuded conidial masses, abundant, on and in the agar; micropycnidia present, 30–60 µm diam.

Conidiogenous cells 5–7 × 4–7 µm, bottle-shaped. Conidia aseptate, 4.5–8 × 2–3 µm, av. 5.8 × 2.4 µm, Q = 1.6–3.1, av. Q = 2.4, ellipsoidal to ovoid, with or without several guttules.

Chlamydospores absent.

NaOH spot test: negative, but on OA and MA a non-specific reddish discolouration may occur.

Crystals absent.

Description in vivo

Pycnidia globose-depressed, dark brown, immersed; initially containing a compact mass of cells ('pyncnosclerotia') which afterwards disintegrates and finally results in a pycnidial cavity lined with dolioform or ampulliform conidiogenous cells. Conidia variable in size, mostly 5–7 × 2–2.5 µm.

Ecology and distribution. Recorded on dead stems of diverse herbaceous plants in Europe. The species has much in common with *Phoma alectorolophi* (no. 4) and *Phoma sylvatica* (no. 5).

Representative culture. CBS 876.97 (PD 82/1008) ex *Silene* sp. (Caryophyllaceae), the Netherlands.

7. *Phoma complanata* (Tode: Fr.) Desm. — Figs. 1A, 6

Phoma complanata (Tode: Fr.) Desm., Anns Sci. nat. (Bot.) III, 16 (1851) 299–300. — *Sphaeria complanata* Tode, Fungi mecklenb. Sel. 2 (1791) 22; Fries, Syst. mycol. 2 [Sect. 2] (1823) 508. — *Sclerophomella complanata* (Tode: Fr.) Höhn., Hedwigia 59 (1918) 238. — '*Plenodomus complanatus* (Tode: Fr.) Ruppr.', manuscript name (Herb. Ludwig, B).

Pyrenochaeta rivini Allesch. in P. Sydow, Hedwigia 36 (1897) 161. — *Sclerochaetella rivini* (Allesch.) Höhn., Hedwigia 59 (1918) 251. — *Diploplenodomus rivini* (Allesch.) Petr., Anns mycol. 42 (1944) 62 [synonyms based on specimen with discordant setae-bearing element, see Boerema et al., 1996].

Phoma anethicola Allesch. in Rab. Kryptog.-Flora [ed. 2] Pilze 6 [Lief. 63] (1898) 298. — *Phoma herbarum* var. *anethi* Westend. in Thüm., Fungi austr., Cent. 10 (1874) No. 982 [nomen nudum; Boerema, 1970].

Phoma punctoidea P. Karst., Acta Soc. Fauna Flora fenn. 27 (4) (1905) 7 [Type in H].

Selected literature. Cerkaskas (1985), Boerema et al. (1996, 1997).

Description in vitro

OA: growth-rate 60–82 mm, regular, with finely floccose to woolly, sometimes compact white to pale olivaceous grey aerial mycelium; colony colourless or buff to greenish olivaceous; reverse primrose to salmon or citrine green to olivaceous in centre.

MA: growth-rate 59–79 mm, regular, with velvety to finely floccose woolly, compact white to pale olivaceous grey/grey olivaceous aerial mycelium; colony colourless to primrose, sometimes with citrine green to olivaceous tinges; reverse similar.

CA: growth-rate 49–79 mm, regular to slightly irregular, with woolly to floccose, white aerial mycelium; colony colourless/saffron to greenish olivaceous or olivaceous; reverse saffron/fulvous to olivaceous.

Pycnidia 80–240 µm diam., globose to irregular, solitary to confluent, glabrous, with usually 1 non-papillate pore, honey/citrine to rosy buff, later olivaceous black, walls made up of 2–6 layers of cells, outer layers pigmented, with buff to rosy buff exuded conidial masses; on and in the agar.

Conidiogenous cells 3–8 × 5–6.5 µm, globose to bottle-shaped, thin-walled. Conidia highly variable, mostly aseptate, 3–11 × 1.5–4 µm (in some strains usually 5–10 × 2–3 µm, av. 7.4 × 2.4 µm, in others 3–8 × 3.5–4 µm), av. 4.3–6.5 × 2.2–2.8 µm, Q = 1.3–3.9, av. Q = 1.9–3.0, they may be subglobose/ellipsoidal, but also cylindrical to fusiform, with or without guttules. Occasionally in fresh cultures some larger 1-septate conidia occur, up to 16 × 4 µm; in older cultures particularly large ascochytoïd conidia, 22–34 × 6–10 µm, av. 27.2 × 8.1 µm, may be present.

Chlamydo-spores absent.

NaOH spot test: negative.

Crystals absent.

Description in vivo (Umbelliferae)

Pycnidia (on dead stems and in lesions on leaves, petioles and roots, scattered or aggregated, immersed or partly immersed) up to 300–400 µm diam., subglobose with a dark brown to black outer wall and a central pore. Conidia usually aseptate, 5–9 × 2–3.5 µm, but sometimes a high percentage of the conidia becomes large and 1-septate, often (10–)12–15(–16) × 2.5–3.5(–4) µm. Pycnidia on old stem lesions may contain distinctly large 1-septate ascochytoïd conidia, av. c. 27 × 8 µm, resembling those found in old cultures. The conidial mass, initially buff to flesh coloured, darkens with age to brown or black; the conidia then mostly appear 1-septate, swollen and dark.

Ecology and distribution. A very common fungus in temperate Eurasia and North America on last year's dead stems of wild Umbelliferae. A seed-borne pathogen of parsnip (*Pastinaca sativa*), parsley (*Petroselinum crispum*) and carrot (*Daucus carota*): Canker (lesions on petioles and roots), Leaf Spot.

Representative culture. CBS 268.92 (PD 75/3) ex *Angelica sylvestris* (Umbelliferae), the Netherlands.

8. *Phoma nigrificans* (P. Karst.) Boerema et al. — Figs. 1B, 7

Teleomorph: *Didymella macropodii* Petr.

Phoma nigrificans (P. Karst.) Boerema, Loer. & Wittern, JI Phytopath. [Phytopath. Z.] 115 (1986) 270. — *Sphaeronaema nigrificans* P. Karst., Meddn. Soc. Fauna Flora fenn. 16 (1888) 17. — '*Rhynchophomella nigrificans*' in Herb. P. Karsten, H [manuscript name].

Plenodomus macropodii Petr., Hedwigia 68 (1929) 237.

Selected literature. Loerakker & Boerema (1987), Jedryczka et al. (1995).

Description in vitro

A detailed description has been given by Marcinkowska & de Gruyter, 1996. Distinctive are the thick-walled, greenish olivaceous, later olivaceous pycnidia, with one, initially indistinct opening and the relatively large, aseptate conidia, 5–10 × 1.5–4 µm (av. 6.4–6.6 × 1.9–2.7 µm), ellipsoidal to allantoid, with small guttules. The growth-rate is 48–61 mm on OA and CA and 31–46 mm on MA.

Description in vivo (Cruciferae)

Pycnidia (on the base of dead stems and in black discoloured stem lesions; scattered or in groups, first immersed, later superficial) mostly 175–375 µm diam., black, massive, depressed globose, usually with a conspicuous neck ('*Plenodomus*-like'), thick-walled (mostly 50–70 µm, up to 120 µm at the base) pseudoparenchymatous. Conidia oblong-ellipsoidal to subcylindrical, mostly 6–8.5(–10) × 1.5–2.5(–3) µm, eguttulate or with a small guttule at each end.

Pseudothecia (on basal parts of dead stems, usually together with pycnidia) relatively large, often 300–450 µm diam., depressed globose with a short papillate and poroid neck, thick-walled (40–70 µm thick) pseudoparenchymatous. Asci clavate to short cylindrical, mostly 65–80 × 10–12 µm, relatively thick-walled, 4–8-spored, irregularly biseriata. Ascospores cylindrical to ellipsoidal, straight or slightly curved, broadly rounded at both ends, mostly 14.5–19 × 4–5.5 µm, unequally 2-celled, upper cell sometimes wider, only slightly constricted at the septum. Pseudoparaphyses scarce, atypical, firm filiform, septate and branched. (For detailed description see the original diagnosis in Petrak, 1929: 219.)

Ecology and distribution. This is a cold-tolerant pathogen in northern Eurasia recorded on wild and cultivated Cruciferae, including oilseed rape, *Brassica napus* var. *oleifera*. The primary host seems to be horseradish, *Armoracia rusticana*. The fungus causes blackleg symptoms resembling those on *Brassica* crops caused by *Phoma lingam* (Tode: Fr.) Desm., teleom. *Leptosphaeria maculans* (Desm.) Ces. & De Not. (treated in Contributions III–1, Boerema et al., 1994). It has been suggested that in northern Europe isolates from *Brassica* species termed 'Tox° isol. *L. maculans*' are really *P. nigrificans* (Jedryczka et al., 1995). *Phoma nigrificans* can be easily distinguished from *P. lingam* by its larger conidia and its lower optimal temperature for growth in vitro (Boerema et al., 1986).

Representative culture. CBS 100190 (PD 82/736) ex *Brassica napus* (Cruciferae), Germany; CBS 100191 (Phb) ex *Thlaspi arvense* (Cruciferae), Poland.

Addendum (9–10)

In our opinion the species treated below belong to the section *Sclerophomella*, but active growing cultures were not studied in the usual way. Therefore, we have been confined to the original diagnosis and descriptions and to our own observations on dried material.

9. *Phoma boerhaviae* Shreem.

Phoma boerhaviae Shreem., Indian J. Mycol. Pl. Path. 2 (1972) 84.

Phoma nyctaginea var. *boerhaviae* S. Ahmad, Sydowia 2 (1948) 78.

Description in vitro (adapted from Shreemali, 1972)

On 'Asthana and Hawker's medium': Hyphae light brown to dark brown, richly branched, poorly septate, 3.8–2.7 µm wide. Pycnidia globose with elongated neck, dark brown to black, solitary, wall thick and persistent, 168 × 130.4 µm (av. 142.6 µm) diam.

Conidia cylindrical, hyaline, aseptate, 8–13.5 × 2.5–4 µm (av. 10.6 × 3.8 µm).

Chlamydospores absent.

Description in vivo (*Boerhavia diffusa*)

Pycnidia (in lesions on twigs and on dead branches) pinhead size, containing elongated ellipsoidal aseptate conidia, often 7.5–10.6 × 3.5–4.5 µm (Ahmad, 1948).

Ecology and distribution. Known from *Boerhavia diffusa* (Nyctaginaceae) in South-West Asia (India, Pakistan), but probably also elsewhere with the host. It produced leaf spots and dark grey lesions girdling the twigs. The fungus has been confused with the plurivorous, soil-borne opportunistic plant pathogen *Phoma multirostrata* (Mathur et al.) Dorenb. & Boerema, see Boerema (1986: 31).

Representative culture. IMI 130821 (dried).

10. *Phoma syriaca* (Petr.) Boerema et al.

Probable teleomorph: *Didymella syriaca* Petr.

Phoma syriaca (Petr.) Boerema, Loer. & Hamers, Persoonia 16 (2) (1996) 180. — *Plenodomus syriacus* Petr., Sydowia 1 (1947) 42.

Description in vivo (Phlomis brevilabris)

Pycnidia (subepidermal, scattered or arranged in small groups on dead stems) 200–350 µm diam., subglobose with at the sides dark twisting short-celled hyphae, thick-walled (35–50 µm thick), initially closed. Conidia notably broad, ovate-ellipsoidal; occasionally with somewhat truncate ends, mostly 6–8 × 3.5–6 µm.

[Pseudothecia (also subepidermal on dead stems in association with above pycnidia) mostly 200–300 µm diam., depressed globose, thick-walled-pseudoparenchymatous. Asci initially clavate, later cylindrical, mostly 80–110 × 23–28 µm, thick-walled, 8-spored, more or less biseriolate. Ascospores straight or slightly curved, 18–23(–27) × 9–11 µm, 1-septate at about the middle, upper cell wider than lower cell, slightly constricted to scarcely, constricted at the septum. Pseudoparaphyses scarce, filiform, septate, but soon dissolving.]

Ecology and distribution. So far only known from *Phlomis brevilabris* (Labiatae) in the subalpine region of Mt. Sania (1700–1900 m), Lebanon, but probably also elsewhere with the host.

Representative specimens. Two packets of Flora syriaca No. 1340 (as type specimens of *Plenodomus syriaca* n. sp. and *Didymella syriaca* n. sp.) in Herb. Petrak (W).

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