PERSOONIA

18 / 1
2002

AN INTERNATIONAL
MYCOLOGICAL JOURNAL

PERSOONIA

An International Mycological Journal

Published by the Nationaal Herbarium Nederland, Universiteit Leiden branch, The Netherlands

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PERSOONIA

Volume 18
2002–2005

AN INTERNATIONAL MYCOLOGICAL JOURNAL

Persoonia Vol. 18 — 2002–2005

CONTENTS

Dates of publication:

Part 1, pp. 1–148, 13 November 2002
Part 2, pp. 149–284, 21 November 2003
Part 3, pp. 285–448, 29 November 2004
Part 4, pp. 449–596, 8 July 2005

PERSOONIA
Volume 18, Part 1, 1–53 (2002)

CONTRIBUTIONS TOWARDS A MONOGRAPH OF PHOMA (COELOMYCETES) VI – 2
Section Phyllostictoides: Outline of its taxa

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

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

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

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

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

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

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

MATERIAL AND METHODS

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

KEY TO THE SPECIES AND VARIETIES OF SECTION PHYLLOSTICTOIDES

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

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

4a. Growth variable, with irregularly scalloped or lobed margin on OA and MA, (25–)50–85 mm, i. e. sometimes slow, but mostly moderate to fast growing; colonies colourless or with grey to greenish tinges, or olivaceous to olivaceous black, conidia very variable in shape and dimensions, one-celled or becoming 1-septate, very occasionally 2-septate; aseptate conidia 2.5–12 × 2–3.5 µm, on average 4–7 × 2–3.5 µm, 1(–2)-septate conidia 5.5–13 × 2.5–5 µm, on average 7–10 × 2.5–3.5 µm; plurivorous wound and weakly parasitic fungus; world-wide
A1. *P. exigua* var. *exigua*

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

b. Growth-rate relatively slow on OA and MA, 20–45 mm; colonies compact, olivaceous grey to olivaceous black, conidia like those of the typical variety; seed-borne pathogen of *Linum usitatissimum*; recorded in Europe and New Zealand
A2. *P. exigua* var. *linicola*

5a. Colonies on OA irregular, grey olivaceous to olivaceous, citrine near margin, with finely floccose to woolly, white aerial mycelium, aseptate conidia 6.5–11.5 × 2.5–3(–3.5) µm, conidiogenous cells relatively large, 5–13 × 6–12 µm, septate conidia up to 13 × 5 µm; pathogenic on *Rumex acetosella*; in Europe and North America
2. *P. acetosellae*

b. Colonies on OA irregular, olivaceous buff/pale luteous to citrine/olivaceous, with very sparse, velvety, white aerial mycelium, aseptate conidia 4–7.5(–13) × 2–4 µm, conidiogenous cells 4–7 × 4–7 µm, septate conidia up to 13 × 4 µm; cosmopolitan pathogen of *Rubus idaeus*
3. *P. argillacea* (teleomorph *Didymella applanata*)

6a. Growth-rate moderate on OA, 35–50 mm after 7 days 7

b. Growth-rate fast on OA, at least 50 mm after 7 days 19

7a. NaOH test on OA positive, greenish, then red (E^+ reaction) 8

b. NaOH test on OA if positive, not an E^+ reaction 9

8a. Growth-rate variable on OA and MA, (25–)50 mm, i.e. mostly moderate to fast growing; colonies lobed or scalloped, colourless or with various grey to greenish tinges, or olivaceous to olivaceous black; plurivorous wound and weakly parasitic fungus (see further 4a) ..... A1. *P. exigua* var. *exigua*

b. Growth-rate moderate on OA, 40–50 mm, relatively slow on MA and CA, 20–25(–30) mm; on OA colonies rather dark, grey olivaceous to olivaceous grey/olivaceous black, with white to pale olivaceous grey/glaucous grey aerial mycelium, for conidia see 4a; specific pathogen of *Nerium oleander*; in Europe and United States ..... A3. *P. exigua* var. *heteromorpha*

9a. Av. l/b ratio (Q) aseptate conidia < 3, av. l/b ratio (Q) septate conidia > 3, colonies on OA irregular due to recolonising sectors, greenish olivaceous/citrine to grey olivaceous, olivaceous buff near margin, with sparse, finely floccose, white to pale grey olivaceous aerial mycelium, aseptate conidia (4–)5–7(–11.5) × 2.5–5 µm, septate conidia 9.5–14.5 × 2.5–5 µm; common pathogen of *Nepeta cataria*; also on other *Nepeta* spp. in Eurasia and North America
4. *P. nepeticola* (teleomorph *Didymella catariae*)

b. Av. l/b ratio (Q) aseptate and septate conidia < 3 10

c. Av. l/b ratio (Q) aseptate and septate conidia > 3, colonies on OA citrine green/greenish olivaceous to herbage green, aseptate conidia (5.5–)7–9 (–12) × 2–3(–4) µm, septate conidia 9.5–13 × 2.5–3.5 µm, pathogen of *Polemonium caeruleum*. Pycnidial wall composed of relatively thick-walled pseudoparenchyma sect. *Sclerophomella* (Appendix) .... 28. *P. polemonii*

10a. Both *Phoma* anamorph and *Didymella* teleomorph are formed in vitro, colonies grey olivaceous to dull green, conidia aseptate, (3.5–)5–8(–13.5) × 2–3(–4) µm, septate conidia up to 15 × 5 µm; pathogen on wild and cultivated Compositae; in Europe and Australia

5b. *P. ligulicola* var. *inoxydabilis*
(teleomorph *Didymella ligulicola* var. *inoxydabilis*)

NB The faster growing type variety of this fungus does not produce pseudothecia in vitro and only occasionally in vivo:

5a. *P. ligulicola* var. *ligulicola*
(teleomorph *Dydimella ligulicola* var. *ligulicola*, see this key 28b)

b. Only a *Phoma* anamorph is formed in vitro 11

11a. Colonies on OA peach/sienna to red/blood colour or dark vinaceous, due to the occurrence of a red pigment in the hyphae, with NaOH a violet colour may develop (not an E+ reaction), conidia (4–)5–8(–11) × 2–3(–4) µm, septate conidia 8.5–14 × 2.5–4 µm; plurivorous weak- and wound parasite; world-wide

6a. *P. macrostoma* var. *macrostom*

NB This fungus may loose the ability to produce red pigment in the hyphae:

6b. *P. macrostoma* var. *incolorata*, see this key 18a

b. Red pigment in hyphae absent, NaOH test on OA negative 12

12a. Especially on MA (dendritic) crystals are formed. In older cultures chlamydospores may be produced, conidia aseptate, 5–7(–10.5) × 1.5–4 µm, septate conidia sparse and of similar size; seed-borne pathogen of *Medicago sativa*; world-wide

7a. *P. medicaginis* var. *medicaginis*
7b. *P. medicaginis* var. *macrospora*

NB The differentiation of these two varieties is based on conidial diversity in vivo, especially at low temperatures. They are similar on agar media.

b. Crystals absent, chlamydospores absent 13

13a. Colonies rather dark on OA, greenish olivaceous to grey olivaceous/olivaceous grey, or olivaceous to olivaceous black, aseptate conidia and septate conidia of similar size 14

b. Colonies on OA colourless to grey olivaceous to dull green/citrine green or rosy buff, aseptate conidia and septate conidia of similar size 15

c. Colonies on OA with pale primrose tinges, aseptate conidia 4–10.5 × 2–5 µm, septate conidia of similar size or significantly larger, 12–20.5 × 3.5–5 µm (ascochytoid); pathogen of *Lycium halimifolium*; in Europe and North America. Pycnidia thick-walled, often closed → sect. *Sclerophomella* (Appendix) ..... 29. *P. protuberans*

14a. Colonies on OA greenish olivaceous/grey olivaceous to olivaceous, aseptate conidia (3.5–)5–7(–9.5) × 2.5–3.5 µm, septate conidia 6.5–13.5 × 3–4.5 µm; pathogen of *Sedum telephium*; in Europe ..... 8. *P. telephii*

b. Growth-rate moderate on OA, 40–50 mm, relatively slow on MA and CA, 20–25(–30) mm; on OA colonies rather dark, grey olivaceous to olivaceous grey/

olivaceous black, with white to pale olivaceous grey/glaucous grey aerial mycelium, for conidia see 4a; specific pathogen of *Nerium oleander*; in Europe and United States ..... A3. *P. exigua* var. *heteromorpha*

15a. Colonies on MA colourless to dull green, grey olivaceous/olivaceous grey or rosy buff 16

b. Colonies on MA hazel/olivaceous or primrose/olivaceous buff/honey 18

16a. Colonies on OA colourless to grey olivaceous, with pale olivaceous grey to glaucous grey aerial mycelium, for conidia see 4a; an opportunistic pathogen on *Populus* spp. (occasionally on *Salix* sp.); in Europe ... A4. *P. exigua* var. *populi*

b. Colonies on OA colourless to (rosy) buff, dull green or olivaceous 17

17a. Colonies on MA colourless to dull green, conidial exudate rosy buff to rosy vinaceous, aseptate conidia 4–7(–9) × 1.5–2.5(–3) µm, septate conidia 8.5–11.5 × 2–3.5 µm; pathogen of *Lycopersicon esculentum*; in Europe
9. *P. destructiva* var. *diversispora*

NB The type variety of *P. destructiva* produces only aseptate conidia and therefore has been included in sect. *Phoma*.

b. Colonies on MA colourless to rosy buff, or pale olivaceous grey to dull green, conidial exudate buff, aseptate conidia (4–)5–7(–8.5) × (1.5)2–3(–3.5) µm, septate conidia up to 10 µm; pathogen on *Digitalis* spp.; in Europe and New Zealand
10. *P. digitalis*

18a. Colonies on MA primrose/olivaceous buff, often with pale honey/olivaceous sectors, conidial exudate white to buff/rosy buff, pigmentless variety of *P. macrostoma* (see 11a) weak- and wound parasite; world-wide
6b. *P. macrostoma* var. *incolorata*

b. Colonies on MA hazel to olivaceous, conidial exudate off-white to primrose, aseptate conidia (5–)6–8.5(–11) × 2–3.5 µm, septate conidia up to 13.5 × 4 µm; on fruits of *Prunus persica*; in New Zealand ..... 11. *P. laundoniae*

19a. Crystals formed, especially on MA; a diffusing pigment may be produced on OA and MA 20

b. Crystals absent, non-diffusable pigment produced on OA and MA 26

20a. Chlamydospores present 21

b. Chlamydospores absent 23

21a. Crystals needle-like, citrine green to yellow green, chlamydospores only present when induced by bacteria, 1.8–3.7 µm diameter 24

b. Crystals bryoid to dendritic, whitish, chlamydospores always produced 22

22a. Colonies on OA greenish/yellowish olivaceous to olivaceous, (a)septate conidia 4–7.5 × 2–3.5 µm, chlamydospores 8–20 µm diameter, crystals readily produced on MA after 7 days; pathogen of leguminous plants; world-wide
13. *P. pinodella*

b. Colonies on OA colourless to pale olivaceous grey or greenish olivaceous/grey olivaceous, aseptate conidia 5–8 × 2–3.5 µm, septate conidia up to 12.5 × 5 µm, chlamydospores 8–16 µm, crystals specifically produced in fresh isolates on MA; pathogen on *Glycine max*; Eurasia ..... 14. *P. sojicola*

23a. Diffusable pigment crystallises as yellow speckles on MA, growth-rate on OA and MA extremely fast, > 80 mm after 7 days, aseptate conidia 5–10 × 2.5–4 µm, septate conidia up to 14 × 5 µm; pathogen of *Matteuccia struthiopteris*; South America, Canada, Europe ..... 15. *P. matteucciicola*

b. Crystals needle-like on MA, citrine green to yellow green, growth-rate on OA and MA < 80 mm after 7 days 24

24a. Growth-rate fast on MA, similar to those on OA, 65–80 mm, colonies on OA buff/honey/amber due to diffusable pigments, crystals on MA present, needle-like, citrine green to yellow green, (a)septate conidia (3.5–)5–7(–11.5) × (1.5–)2–3(–3.5) µm, pathogen of *Chenopodium quinoa* in South America, known causes gangrene of tubers of *Solanum tuberosum* in Europe ..... 12. *P. foveata*

b. Growth-rate on MA slow to moderate, up to 50 mm, also diffusable pigment on OA and needle-like crystals present on MA 25

25a. Growth-rate on MA 50 mm, colonies on OA honey to pale luteous due to a diffusable pigment, on MA crystals needle-like, citrine green to yellow green, aseptate conidia (5.5–)6.5–11 × 2–4 µm, septate conidia 9–14.5 × 3–5 µm; pathogen of *Rudbeckia* spp.; in North America and Europe ..... 16. *P. rudbeckiae*

b. Growth-rate on MA slow to moderate, 30–40 mm, colonies on OA pale luteous to amber, due to a diffusable pigment, crystals on MA needle-like, citrine green to yellow green, aseptate conidia (3–)5–6.5(–8.5) × 1.5–3 µm; necrophyte on *Artemisia* spp.; in Europe ..... 17. *P. artemisiicola*

26a. NaOH test positive, green, later red (E^+ reaction) 27

b. NaOH test negative or if positive, not an E^+ reaction 31

27a. Growth on MA irregular, with a scalloped or lobed margin, growth-rate on MA somewhat slower then those on OA 28

b. Growth on MA regular to slightly irregular, growth-rate on MA similar to that on OA 29

28a. Growth-rate on OA variable, (25–)50–85 mm; colonies colourless or with various grey to greenish tinges, or olivaceous to olivaceous black; plurivorous wound and weakly parasitic fungus (see further 4a) ..... A1. *P. exigua* var. *exigua*

b. Growth-rate on OA 68–72 mm, colonies colourless/greenish olivaceous to dull green/olivaceous, discolouring to sienna due to a diffusable pigment, for conidial dimensions see 10a; specific pathogen on *Dendranthema*-Grandiflorum hybrids (florist's chrysanthemum) ..... 5a. *P. ligulicola* var. *ligulicola* (teleomorph *Didymella ligulicola* var. *ligulicola*)

NB The slower growing E^- variety of this fungus produces pseudothecia also in vitro:

5b. *P. ligulicola* var. *inoxydabilis* (teleomorph *Didymella ligulicola* var. *inoxydabilis*, see this key 10a.)

29a. Av. l/b ratio (Q) aseptate conidia > 3, growth-rate on OA 65–75 mm, colonies grey olivaceous/olivaceous grey, aseptate conidia 4–9.5 × 1.5–2.5 µm, septate conidia up to 12 × 3.5 µm; pathogen of *Nemophila* spp.; in Europe and North America ..... 18. *P. nemophilae*

b. Av. l/b ratio (Q) aseptate conidia < 3 30

30a. Growth-rate on OA 68–82 mm after 7 days, colonies dark, greenish olivaceous to grey olivaceous/olivaceous grey, conidial exudate off-white to buff, conidia mainly aseptate, (3.5–)5–8(–10.5) × 2–3.5 µm; pathogen of *Sambucus nigra*; in Eurasia ..... 19. *P. sambuci-nigrae*

b. Growth-rate on OA 60–63 mm after 5 days, colonies colourless to olivaceous grey/grey olivaceous, conidial exudate buff to rosy buff/salmon, (a)septate conidia relatively small, 4.5–6.5 × 2–3 µm; pathogenic on *Mentha* spp., occasionally on other Labiatae; world-wide ..... 20. *P. strasseri*

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

41a. Colonies on OA abundant velvety/finely floccose, tufted, mainly (pale) olivaceous grey aerial mycelium, for conidia see 4a; pathogen of *Viburnum* spp. (occasionally on *Lonicera*); in Europe and North America ..... A8. *P. exigua* var. *viburni*

b. Colonies on OA velvety to finely floccose/woolly, partly tufted, mainly (pale) olivaceous grey aerial mycelium, for conidia see 4a; pathogenic on *Forsythia* spp.; in Europe ..... A9. *P. exigua* var. *forsythiae*

42a. Av. l/b ratio (Q) aseptate conidia > 2.6 43

b. Av. l/b ratio (Q) aseptate conidia < 2.6 44

43a. Growth-rate fast on OA, MA and CA, 70–80 mm, colonies on OA dull green, aseptate conidia 3.5–5.5(–7) × 1–2 µm, septate conidia up to 9 × 3 µm; seed-borne pathogen of Valerianaceae; in Europe ..... 24. *P. valerianellae*

b. Growth-rate on OA and CA fast, 65–70 mm, on MA 60–65 mm, colonies on OA olivaceous buff to greenish olivaceous/grey olivaceous, conidia (3.5–)5–8(–10.5) × 1.5–3 µm, septate conidia up to 18 × 3 µm; pathogen of *Rheum* spp.; world-wide ..... 25. *P. rhei*

44a. Aseptate conidia relatively small, 4.5–6.5 × 2–3 µm, colonies on OA colourless to olivaceous grey/grey olivaceous; pathogenic on *Mentha* spp., occasionally on other Labiatae; world-wide (see further 30b) ..... 20. *P. strasseri*

b. Aseptate conidia variable in shape and size, 3.5–8(–10) × 2–3.5 µm, septate conidia of similar size or larger, up to 15.5 × 4.5 µm 45

45a. Growth-rate on OA and CA very fast, 75–85 mm, somewhat slower on MA, 65–75 mm, colonies on OA olivaceous/iron grey or grey olivaceous/olivaceous, on MA greenish olivaceous to olivaceous, chlamydospores sometimes produced, for conidia see 4a; pathogen of *Phaseolus vulgaris*; in South- and Central America A6. *P. exigua* var. *noackiana*

b. Growth-rate on OA, MA and CA similar, fast, 60–85 mm, chlamydospores absent 46

46a. Colonies on OA colourless/dull green to olivaceous/olivaceous grey, reverse buff to dull green/olivaceous, to leaden grey/leaden black, aseptate conidia 4–8 × 2–3 µm, septate conidia up to 10 × 4.5 µm, pseudothecia of *Didymella* teleomorph may be produced; seed-borne pathogen of *Cucurbitaceae*; world-wide 26. *P. cucurbitacearum* (teleomorph *Didymella bryoniae*)

b. Colonies on OA colourless/olivaceous buff to grey olivaceous, reverse grey olivaceous/olivaceous grey to olivaceous, olivaceous buff near margin, aseptate conidia (3.5–)5–8.5(–10) × 2–3.5(–4.5) µm, septate conidia up to 15.5 × 4.5 µm, in old cultures sterile, stilboid bodies may be formed; pathogen of *Lycopersicon esculentum*; in Eurasia and Africa 27. *P. lycopersici* (teleomorph *Didymella lycopersici*)

HOST–FUNGUS INDEX

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

Plurivorous species

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

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

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

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

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

FUNGUS–HOST INDEX

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

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

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

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

DESCRIPTIVE PART

Characteristics based on study in culture. Species with a teleomorph are also described in vivo[1].

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

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

Phoma arachidicola Marasas, Pauer & Boerema, Phytophylactica 6 (1974) 200.
Selected literature. Marasas et al. (1974), Taber et al. (1984), Noordeloos et al. (1993).

Description in vitro

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

Description in vivo (*Arachis hypogaea*)

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

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

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

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

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

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

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

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

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

Description in vitro

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

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

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

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

Chlamydospores absent.

NaOH spot test: negative.

Crystals absent.

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

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

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

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

Teleomorph: *Didymella applanata* (Niessl) Sacc.

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

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

Description in vitro

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

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

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

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

Chlamydospores absent.

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

Crystals absent.

Description in vivo (*Rubus idaeus*)

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

infected cones usually 5–11 × 2–4 µm, mostly shorter, 5–8 × 3–4 µm on leaves.

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

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

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

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

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

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

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

Description in vitro

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

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

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

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

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

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

Chlamydospores absent.

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

Crystals absent.

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

Description in vivo (*Nepeta cataria*)

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

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

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

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

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

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

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

9. var. *ligulicola*. — *Ascochyta chrysanthemi* F. Stevens, Bot. Gaz. 44 (1907) 246; not *Phoma chrysanthemi* Voglino, Malpighia 15 (1902) 332 [see below under *P. ligulicola* var. *inoxydabilis*].

Selected literature. EPPO (1980a), Van der Aa et al. (1990).

Description in vitro

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

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

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

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

Pseudothecia not observed in vitro.

Chlamydospores absent.

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

Crystals absent.

Description in vivo (*Dendranthema*-Grandiflorum hybrids)

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

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

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

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

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

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

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

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

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

Description in vitro

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

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

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

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

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

Chlamydospores absent.

NaOH spot test: negative.

Crystals absent.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Description in vitro

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

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

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

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

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

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

Chlamydospores absent.

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

Crystals absent.

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

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

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

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

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

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

Description in vitro

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

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

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

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

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

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

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

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

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

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

Description in vitro

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

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

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

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

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

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

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

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

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

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

Characteristics in vitro

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

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

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

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

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

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

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

Phoma tabifica Kesteren, Gewasbescherming 2 (1971) 74.

Selected literature. Van Kesteren (1972).

Description in vitro

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

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

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

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

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

Chlamydospores absent.

NaOH spot test: negative.

Crystals absent.

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

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

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

Coloniae *Phomae destructivae* similes sed praeter conidia continua, 4–7(–9) × 1.5–2.5(–3) µm etiam conidia uniseptata, 8.5–11.5 × 2–3.5 µm, producunt.

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

Description in vitro

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

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

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

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

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

Chlamydospores absent.

NaOH spot test: negative.

Crystals absent.

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

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

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

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

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

Selected literature. Boerema & Dorenbosch (1979).

Description in vitro

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

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

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

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

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

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

Chlamydospores absent.

NaOH spot test: negative.

Crystals absent.

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

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

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

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

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

Description in vitro

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

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

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

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

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

Chlamydospores absent.

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

Crystals absent.

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

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

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

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

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

Description in vitro

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Description in vitro

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

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

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

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

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

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

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

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

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

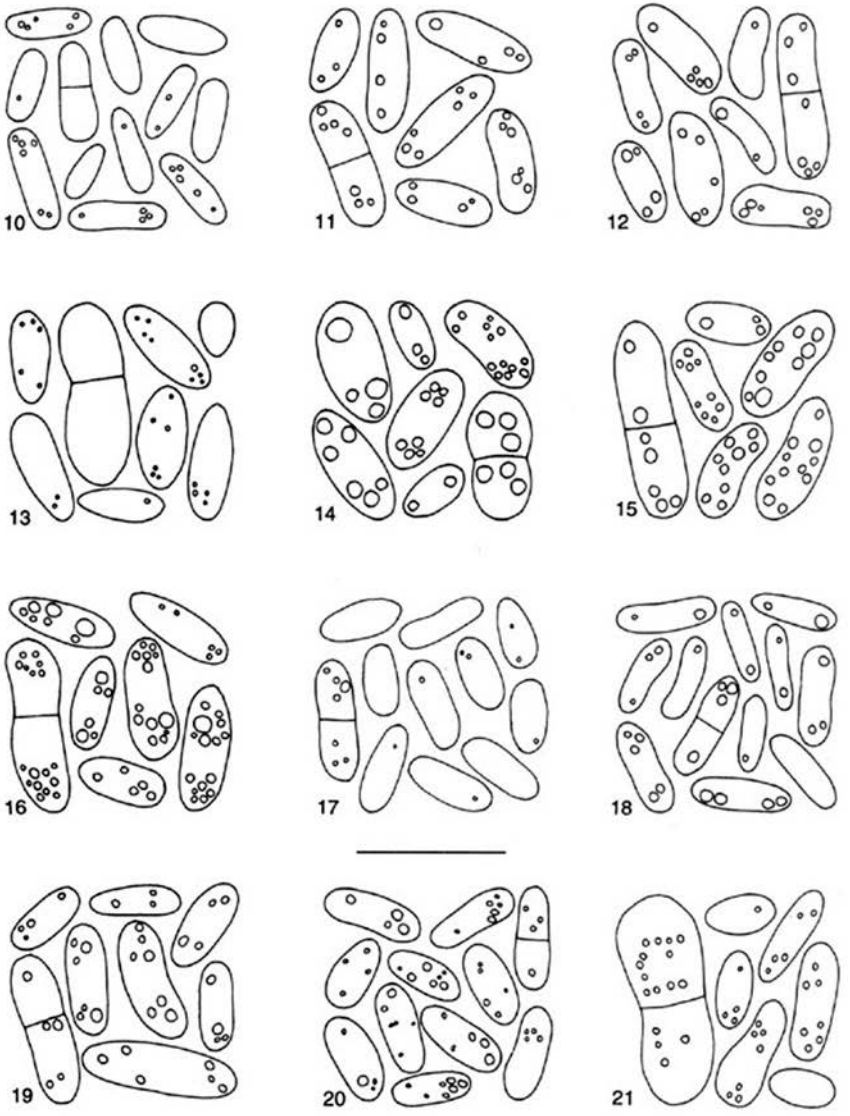
Ascochyta sojicola Nelen, Novosti Sist. nizsh. Rast. 14 (1977) 105 [homonym] [as '*sojaecola*'; erroneously also listed with the author citation 'Abramov ex Nelen'].

Selected literature. Kövics et al. (1999).

Description in vitro

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

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



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

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

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

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

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

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

Description in vitro

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

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

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

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

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

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

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

Description in vitro

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

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

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

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

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

Chlamydospores absent.

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

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

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

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

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

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

Description in vitro

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

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

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

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

Chlamydospores absent.

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

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

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

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

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

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

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

Description in vitro

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

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

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

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

Chlamydospores absent.

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

Crystals absent.

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

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

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

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

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

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

Selected literature. Boerema & Höweler (1967).

Description in vitro

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

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

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

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

Chlamydospores absent.

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

Crystals absent.

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

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

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

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

Selected literature. Horner (1971).

Description in vitro

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

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

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

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

Chlamydospores absent.

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

Crystals absent.

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

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

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

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

Selected literature. Boerema et al. (1980).

Description in vitro

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

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

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

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

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

Chlamydospores absent.

NaOH spot test: negative.

Crystals absent.

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

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

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

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

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

Description in vitro

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

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

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

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

Chlamydospores absent.

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

Crystals absent.

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

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

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

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

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

Selected literature. Stewart (1957).

Description in vitro

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

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

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

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

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

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

Crystals absent.

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

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

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

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

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

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

Selected literature. Boerema & De Jong (1968).

Description in vitro

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

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

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

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

Chlamydospores absent.

NaOH spot test: negative.

Crystals absent.

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

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

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

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

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

Description in vitro

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

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

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

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

Chlamydospores absent.

NaOH spot test: negative.

Crystals absent.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Description in vitro

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

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

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

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

Chlamydospores absent.

NaOH spot test: negative.

Crystals absent.

Description in vivo (especially on *Cucumis sativus*)

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

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

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

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

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

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

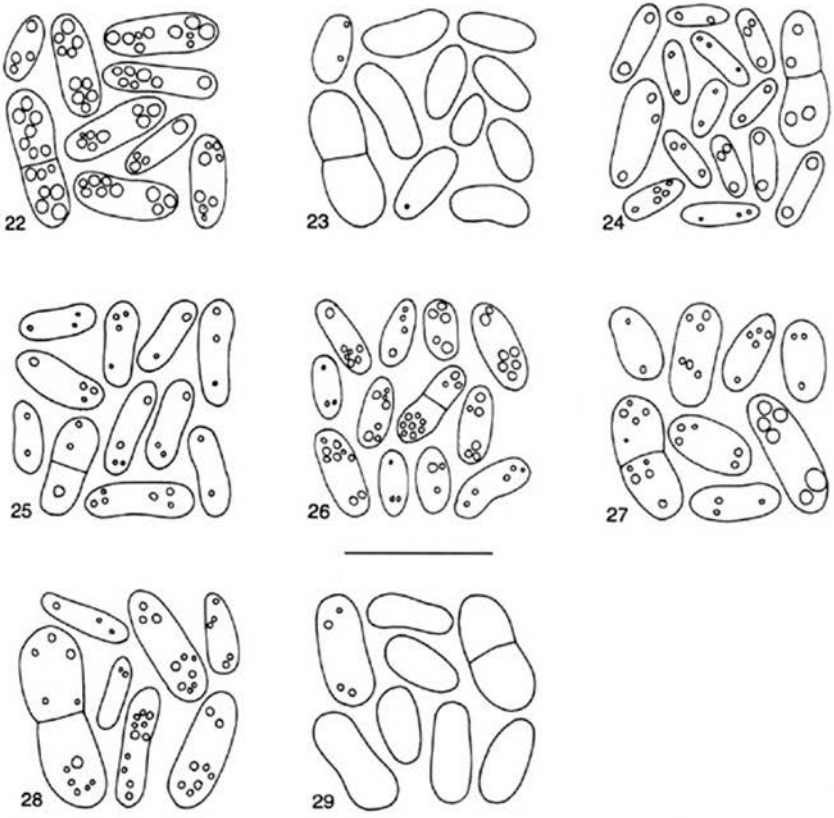
Teleomorph: *Didymella lycopersici* Kleb.

Phoma lycopersici Cooke, Grevillea 13 (1885) 94.
Phoma lycopersici (Plowr.) Jacz., Nouv. Mém. Soc. [imp.] Nat. Mosc. 15 (1898) 350–351 [illegitimate homonym]. — *Sphaeronaema lycopersici* Plowr., Gdnrs' Chron. II [New Series] 16 (1881) 621.
Ascochyta lycopersici Brunaud, Bull. Soc. bot. Fr. 34 [II, 9] (1887) 431.
Ascochyta socia Pass., Boll. Com. agr. Parmense (1889) 2; not *Ascochyta socia* (F. Tassi) Allesch., Rabenh., Krypt.-Flora [ed. 2], Pilze 7 [Lief. 88] (1903) 871–872.
Diplodina lycopersici Hollós, Annls hist.-nat. Mus. natn. hung. 5 (1907) 461.
Phoma ferrarisii O. Cif., Staz. Sper. agr. ital. 55 (1912) 149.
Diplodina lycopersicicola Bond.-Mont., Mater. mikol. Obslêd. Rossii 5 (1922) 4.
Selected literature. Morgan-Jones & Burch (1988a).

Description in vitro

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

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



Figs. 22–29. Conidia. 22. *Phoma heliopsidis*; 23. *Phoma tarda*; 24. *Phoma valerianellae*; 25. *Phoma rhei*; 26. *Phoma cucurbitacearum*; 27. *Phoma lycopersici*; 28. *Phoma polemonii*; 29. *Phoma protuberans*. — Bar = 10 µm.

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

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

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

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

Description in vivo (on *Lycopersicon esculentum*)
Pycnidia (in lesions on stems [cankers] and fruits [fruit rot], solitary or gregarious, initially immersed, but becoming erumpent) subglobose, up to 200 µm diam. Conidia as in vitro, aseptate or 1-septate, usually (5–)6–10 × 2–3 µm.
Pseudothecia (only rarely found on dead stems) subglobose, up to 300 µm diam. Asci cylindrical to subclavate, 50–95 × 6–10 µm. Ascospores irregularly biseriate, ellipsoidal, slightly constricted at the septum, 12–18 × 5–6 µm (for illustrations see Holliday & Punithalingam, 1970).

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

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

APPENDIX

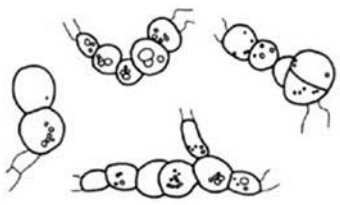
Section *Sclerophomella*
(compare Boerema & de Gruyter, 1998)

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

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

Phoma polemonii Cooke, Grevillea 13 (1885) 94 (cf. original specimen, see Grove, 1935: 98).
Phoma polemonii Oudem., Versl. Meded. K. Akad. Wet. [Afd. Natuurk.] reeks 3, 2 (1885) 161 [illegitimate homonym]. — *Phoma oudemansii* Berl. & Voglino, Sylloge Fung. 10 (1892) 174.
Ascochyta polemonii Cavara, Revue mycol. 21 (1899) 104.
Ascochyta polemonii Rostr., Bot. Tidsskr. 26 (1905) 311 [illegitimate homonym].

Description in vitro
OA: growth-rate 35–46 mm after 7 days, regular to slightly irregular, with coarsely floccose, white/pale olivaceous grey to citrine/grey olivaceous aerial mycelium; colony citrine green/greenish olivaceous to herbage green; reverse similar, olivaceous in centre.
MA: growth-rate 23–37 mm after 7 days, regular to slightly irregular, with compact, velvety/floccose, white to grey olivaceous aerial mycelium; colony greenish olivaceous to grey olivaceous, often in a zonate pattern; similar, leaden grey/olivaceous black in centre.



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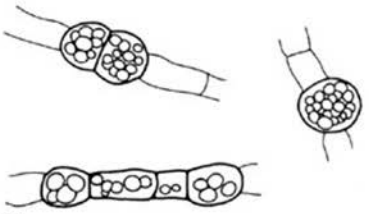

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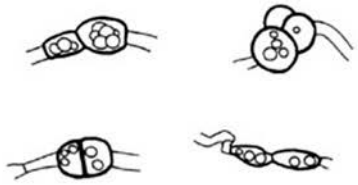

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Figs. 30–32. Chlamydospores. 30. *Phoma arachidicola*; 31. *Phoma pinodella*; 32. *Phoma sojicola*. — Bar = 10 µm.

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

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

Chlamydospores absent.

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

Crystals absent.

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

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

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

Phoma protuberans Lév., Annls Sci. nat. (Bot.) III, 5 (1846) 281.
Phyllosticta lycii Ellis & Kellerm., Am. Nat. 17 (1883) 1166.
Selected literature. Van der Aa & van Kesteren (1971).

Description in vitro

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

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

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

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

Chlamydospores absent.

NaOH spot test: negative.

Crystals absent.

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

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

ACKNOWLEDGEMENTS

The authors would like to thank the curators of the following herbaria: Berlin (B), London (BM), Meise (BR), Utrecht (CBS), Ottawa (DAOM), Leiden (L), St. Petersburg (LE, LEV), La Plata (LPS), München (M), New York (NY), Padova (PAD), Philadelphia (PH), Praha (PRC), Stockholm (S), Torino (TO), Utrecht (U), Wisconsin (WIS). Thanks are expressed to Dr. D. van der Mei for critical reading an earlier version of this manuscript. Dr. R.T.A. Cook kindly improved the English of this paper. Thanks are also due to Dr. W. Gams for the Latin translations of descriptions.

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ERRATA

Aa, H. A. van der, G. H. Boerema & J. de Gruyter: Contributions towards a monograph of Phoma (Coelomycetes) VI-1. Section Phyllostictoides: Characteristics and nomenclature of its type species *Phoma exigua*. Persoonia 17 (2000): 435 – 456.

Page 442: delete lines 21–22 from top: *Phyllosticta spaethiana* Allesch. & Sydow proved to be conspecific with *Phoma macrostoma* treated in the present paper (Contr. VI-2).

Page 443: delete line 24 from top: *Phyllosticta belgradensis* Bubák & Ranoj. refers also to *Phoma macrostoma* discussed in this paper (Contr. VI-2).
Line 9 from bottom: add illegitimate name; a later homonym of *Phyllosticta bellidis* Bond.-Mont., Bolez. Rast 12 (1923) 70 = *Phoma bellidis* Neergaard, Friesia 4 (1950) 74.

Page 444: delete line 27 from top: study of the holotype of *Phyllosticta bellidicola* Nelen, LE-41726, showed that the conidia were shorter than noted in the description; the real conidial dimensions and also the other characters agree with those of *Phoma bellidis* Neergaard, Friesia 4 (1950) 74.

Page 445: line 3 from top: Nov. Sist. niz. Rast should be read: Novosti. Sist. Nizsh. Rast.

Page 452: line 1 from top: Boerma should be read: Boerema.

BOOK REVIEWS

D. Boertmann. *Index Hygrocybearum. A catalogue to names and potential names in tribus Hygrocybeae Kühner (Tricholomatales, Fungi).* (Bibliotheca Mycologica 192. J. Cramer in der Gebrüder Borntraeger Verlagsbuchhandlung, Johannesstr. 3A, D-70176 Stuttgart. 2002.) Pp. 168. Price: € 44.–.

In this publication, which is merely a nomenclator of names in use in tribus Hygrocybeae, an account is given of 447 validly published and legitimate names in *Hygrocybe*, and 24 in the genus *Camarophyllus*. For each entry the accepted name is given, followed by the basionym and, if present, synonyms. Full data are presented on the type and its location. Furthermore, a list is provided of names from genera formerly synonymised with *Hygrocybe* and *Camarophyllus*, but now regarded as belonging to taxa outside *Hygrophoraceae*, are listed, supplemented with invalid and illegitimate names. Seventeen new combinations are proposed and two epitypes selected. The book forms a thorough base for monographic work in the group concerned, and serves as a reference for all working with the genus. It facilitates description of new taxa and will eventually help to stabilise nomenclature.

P. Franchi, L. Gorreri, M. Marchetti & G. Monti. *Funghi di ambienti dunali.* (Universitá degli studi di Pisa. 2001.) Pp. 213, numerous colour photographs in the text. Price: unknown.

This book gives an account of the macrofungi found in the coastal sand dunes along the Tyrenean Sea in the vicinity of Pisa (Italy). This region, the National Park of Migliarino San Rossore Massacuiccoli, consists of dunes with a variety of vegetation, from shifting sands with pioneer vegetation, such as Cakilo-Xanthietum italici, Sporobolo-Agropyretum juncei and Echinophoro-Ammophiletum arenaria, to fixed dunes with various wood types, mainly consisting of typical Mediterranean trees and shrubs like *Pinus pinaster*, *Cistus creticus*, *Arbutus unedo* and *Juniperus oxycedrus*. After a short introduction on landscape, vegetation and fungal ecology, the book gives a taxonomic account of the macrofungi found in this area. Many species are fully described and illustrated with good colour photographs and line-drawings of microscopical characters. As such this publication is an excellent guide to the fungi of Mediterranean dune ecosystems, and also enables comparison with similar ecosystems in the temperate Atlantic regions of Europe.

PERSOONIA
Volume 18, Part 1, 55–69 (2002)

MISCELLANEOUS NOTES ON PLEUROTUS

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The paper takes up four points: 1) A previously unnamed intersterility group in *Pleurotus* (ISG XIII) has been identified as *P. albidus*, which fruits from Central America to central Argentina. The species is genetically isolated and phylogenetically it is placed in the '*P. ostreatus*' group of monomitic *Pleurotus* basidiomata. 2) The distributional range of *P. abieticola* is extended to far northwestern Russia and northern China. 3) A partial nomenclator is furnished for *P. djamor* 4) The use of the term 'dimitic' is discussed as it pertains to *Pleurotus*.

The past decade or more has seen an increase in systematic research on *Pleurotus* ('oyster mushrooms'). In taxonomy, there has been an effort to circumscribe the infrageneric taxa morphologically (Hilber, 1982, 1997; Zervakis & Balis, 1991; Vilgalys et al., 1993; Petersen & Krisai-Greilhuber, 1996, 1999; Petersen & Hughes, 1997), to extend informative taxonomic characters to mating patterns (Vilgalys et al., 1993; Petersen & Hughes, 1993; Petersen, 1995a, b; Zervakis, 1998), physiology (Zervakis & Balis, 1991, 1992, 1996) and enzyme patterns (Zervakis & Labarère, 1992), and to reconstruct the phylogeny of the genus (Vilgalys & Sun, 1994; Zervakis et al., 1994; Vilgalys et al., 1996; Gonzalez & Labarère, 2000; Thorn et al., 2000; Montcalvo et al., 2000). As this research has emerged, the stringency of proposing new taxa has also increased, so the standard now assumed is that proposal of a new species name should be accompanied by data on its genetic isolation and phylogenetic placement.

As pointed out elsewhere (Petersen & Hughes, 1998), there are at least three means through which collections (= basidiomata and/or cultures) can be judged contaxic or segregated as separate taxonomic entities: 1) morphological similarity/dissimilarity, usually as judged through basidiomata; 2) ability or potential ability to interbreed, requiring gametic (= haploid, monokaryon) isolates with which to conduct crossing experiments; and 3) placement on a phylogenetic reconstruction, requiring data (phenetic or molecular) from other congeneric taxa for comparative purposes.

INTERSTERILITY GROUP XIII IS PLEUROTUS ALBIDUS

Vilgalys & Sun (1994) initiated a system of numbering intersterility groups (ISGs) in *Pleurotus* in the same way that *Armillaria* ISGs had been numbered previously (Anderson & Ullrich, 1979). In the first such enumeration, eight ISGs were identified in *Pleurotus*, but later (Vilgalys et al., 1996), 15 were listed in a phylogenetic recon-

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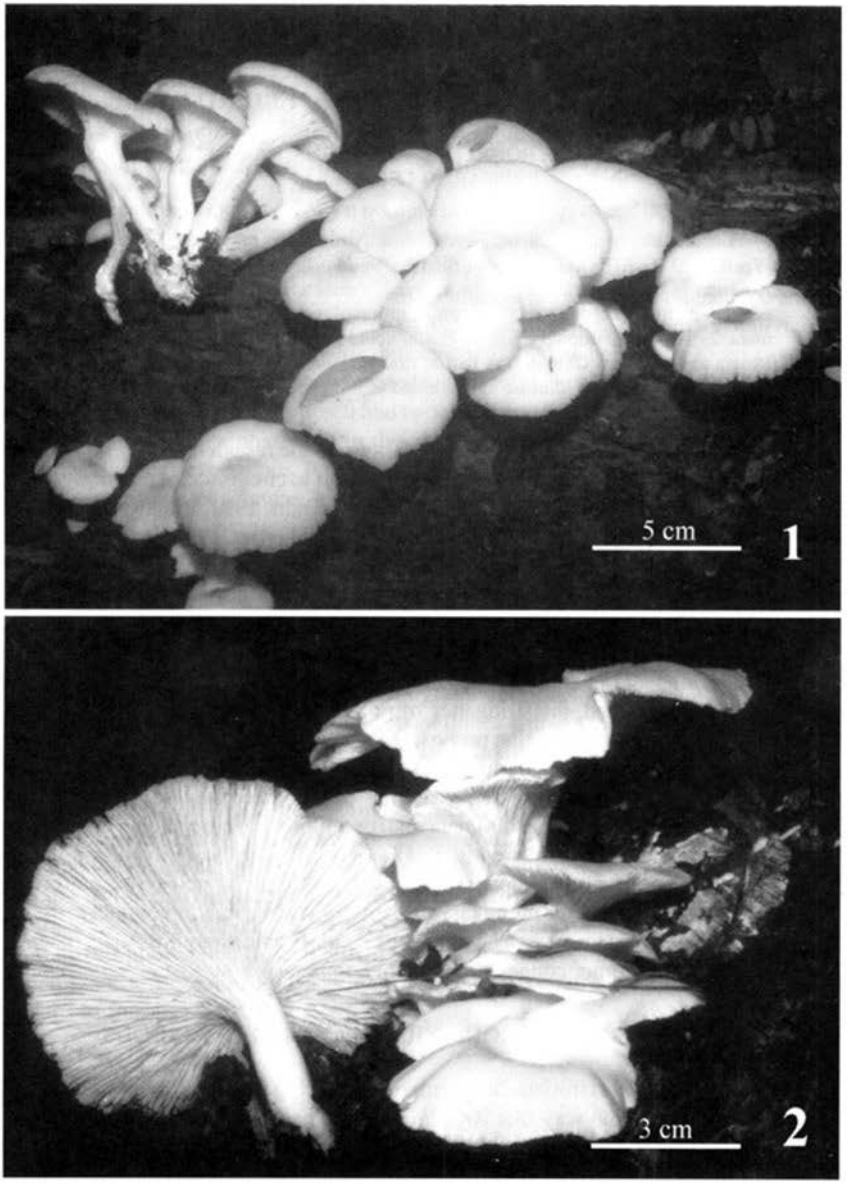


Figs. 1 & 2. Basidiomata of *Pleurotus albidus* in nature. BAFC 50.047 (also known as 'PSTAC').

struction. One of these, ISG XIII, labelled as 'Brazil' furnished no supporting morphological or herbarium data. Until this paper, ISG XIII has remained unsecured to a morphological or biological species.

In South and Central America, white, cornucopioid basidiomata of a *Pleurotus* taxon fruit on dead trunks (Figs. 1 & 2). Two collections were gathered and cultured in Costa Rica, while two others were isolated in central Argentina. Gametic cultures of the Argentine collections were brought to the Tennessee laboratory by EA. All four collections were found to be intercompatible, and for some time it was thought that they represented a new species of *Pleurotus*.

A visit to the Royal Botanic Gardens Herbarium (Kew, by RHP) allowed examination of type material of several *Pleurotus* species, to which was added that of *Panus laciniato-crenatus* Speg. Four species epithets were found to represent this organism, and a nomenclator is offered below.

MATERIALS AND METHODS

Morphological analyses

Basidiomata of Argentine collections were examined by RHP and EA separately, while those of 9498 and 10056 were examined by RHP. Macromorphological notes were taken on relevant type specimens by RHP. Micromorphological analyses and measurements of various structures were conducted using standard procedures (i.e. thin-sections of pileipellis, pileus trama and lamellae; squash mounts of lamellae using either bright field microscopy with or without aqueous phloxine or phase contrast microscopy without stain).

In descriptions below, colours appearing within quotation marks are from Ridgway (1912); those listed alphanumerically are from Kornerup & Wanscher (1978). BAFC = Herbarium, Universidad de Buenos Aires, Facultad de Ciencias; TENN = Herbarium, University of Tennessee.

Mating studies

Single-basidiospore isolates (SBIs) were obtained from two sources: 1) basidiomata collected in nature (i.e. BAFC 50.047, BAFC 50.261, TENN 57623, TENN 56526); or 2) from basidiomata of the BAFC collections fruited on *Liriodendron tulipifera* sawdust in the laboratory at TENN. SBIs from fruited basidiomata did not differ from those isolated from nature.

Two types of pairing experiments were performed: 1) self-crosses of BAFC 50.047 and 10056 (= TENN 57623) using 12 SBIs; and 2) intercollection pairings. Intercollection pairings comprised two methodologies: 1) pairing of four SBIs of four putative collections of *P. albidus* (i.e. those mentioned above) in which n = 4; and 2) pairings of SBIs of BAFC 50.047 and 10056 with a battery of standard SBIs (see Petersen, 1995a for use of standard battery) of the following: *P. abieticola* (see Petersen & Hughes, 1997), *P. eryngii*, *P. tuber-regium* (see Petersen & Nicholl, 1997), *P. djamor*, *P. populinus*, *P. cystidiosus*, *P. cornucopiae*, *P. opuntiae* (for use of the latter two names, see Petersen & Krisai-Greilhuber, 1999) *P. ostreatus* (see Petersen & Krisai-Greilhuber, 1996), and *P. pulmonarius* (see Petersen & Hughes, 1993). In all intercollection pairings, n = 4.

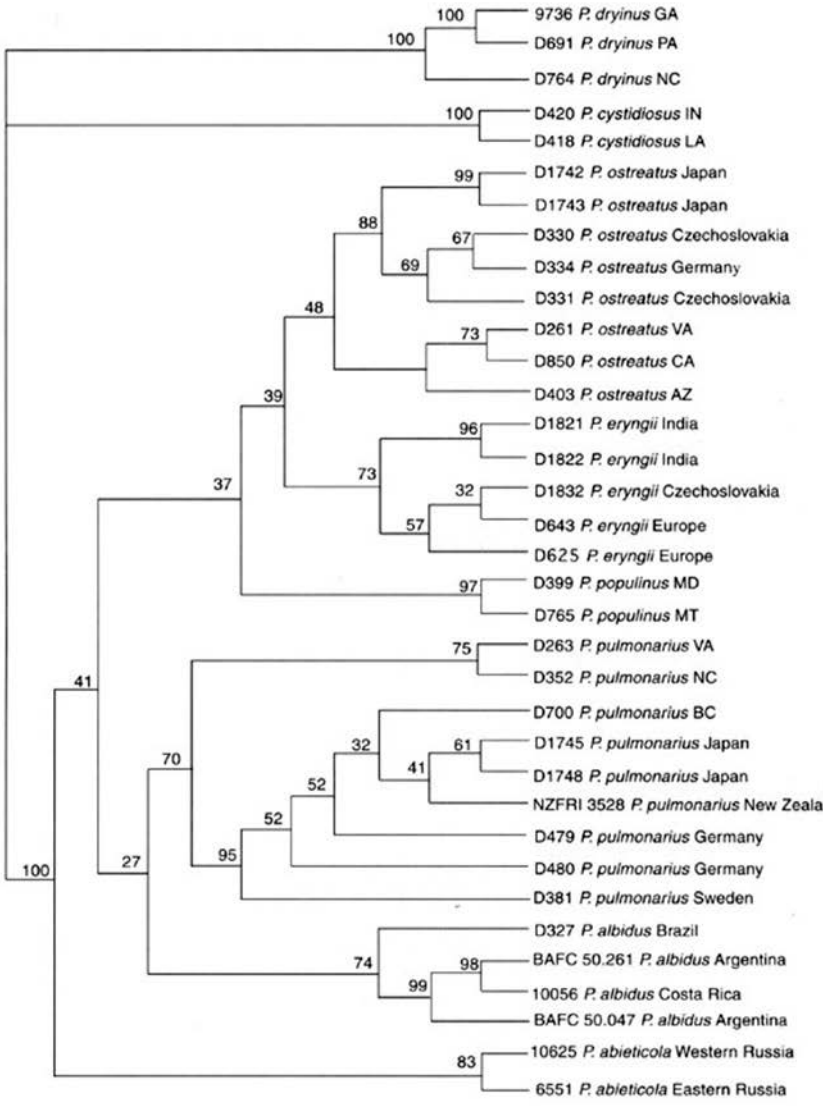


Fig. 3. Phylogenetic reconstruction of the *P.* '*ostreatus*' clade based on ITS DNA sequences. Note monophyly of *P. albidus* and *P. abieticola* collections. GenBank numbers for remaining collections are: 6551 = U 59326, 9763 = AF 345662, 10056 = AF 345661, 10625 = AF 345656, BAFC 50.047 = AF 345660, BAFC 50.261 = AF 345659, NZFRI = U 60648. Collections beginning with 'D' are from Vilgalys & Sun (1994). Numbers are bootstrap values for the nodes to the right of the number. Parsimony-informative characters = 151. Consistency index = 0.83. Homoplasy index = 0.17.

Molecular studies

Material used: for a summary of specimens used for molecular sequence data see Fig. 3.

DNA was extracted from monokaryon cultures as described by Hughes et al. (1999). The ribosomal ITS1-5.8S-ITS2 was amplified with primers ITS5 and ITS4 using 1 µl extracted DNA in a 50 µl reaction mixture. PCR parameters were 3 mins at 94 °C followed by 35 cycles of 1 min at 94 °C, 1 min at 52 °C and 1 min at 72 °C. The final extension was 3 mins at 72 °C. PCR products were purified with a Wizard PCR purification system (Promega), following manufacturer's directions. Both strands of the PCR product were reamplified for cycle sequencing using ITS2, ITS3, ITS4 and ITS5 primers (White et al., 1990). Products were sequenced using ABI automated sequencing systems at the University of Tennessee Sequencing Facility. Sequences were edited using the Genetics Computer Group Sequence Analysis Software Package gap and line-up programs (GCG 2000) and deposited with GenBank (see Fig. 3). Sequences were aligned using the GCG Seqlab program and adjusted manually. Regions of homology to the yeast (*Saccharomyces cerevisiae*) 18S gene to the *Heterobasidion annosum* 5.8S gene and to the yeast 25S gene were determined by sequence comparison. *Pleurotus* ITS1 and ITS2 sequences (Vilgalys & Sun, 1994) were retrieved from GenBank. For each collection, ITS1 sequences were reversed and complemented and appended to ITS2 sequences for the same collection with a gap representing a section of the 5.8S gene that was not sequenced in those studies. Vilgalys furnished an ITS sequence for strain D 327, the basis for ISG XIII (Vilgalys et al., 1996).

Gap coding and phylogeny estimations

Phylogenetic relationships were computed using PAUP 4.0 using a branch and bound search option. Node support was estimated from 100 bootstrapped replicates. There were few gaps and they were treated as a fifth base. *Pleurotus cystidiosus* and *P. dryinus* were used as outgroups based on studies showing that these species were basal to the monomitic *Pleurotus* clade (Vilgalys & Sun, 1994).

NOMENCLATOR AND TAXONOMIC DESCRIPTION

Pleurotus albidus (Berk.) Pegler, Kew Bull., Addit. ser. 10 (1983) 219.

≡ *Lentinus albidus* Berk., Hooker's J. Bot. 2 (1843) 633.
Holotype: K, Brazil, Prov. Minas-Geraes, Inficionade, 'ad citrum', X.1840, coll. *Gardner* [!].
= *Lentinus calvescens* Berk. & Curtis, Hooker's J. Bot. 8 (1856) 143.
Holotype: K, Brazil, Panuré, II.1853, 'on decaying trunks of trees', *Spruce* no. 136 [!].
= *Pleurotus jacksonii* Berk. & Cooke, J. Linn. Soc. 15 (1877) 363.
Holotype: K, Brazil, Mahues, no date, 'in lignis marsescentibus', *Traill*, s.n. [!].
= *Panus laciniato-crenatus* Speg., An. Soc. Cient. Arg. 9 (1880) 164.
≡ *Pleurotus laciniato-crenatus* (Speg.) Speg., Bol. Acad. Nac. Cienc. Córdoba 23 (1919 381–382.
Holotype: LPS, Argentina, Buenos Aires, 25.II.1880, leg. *O. Schnyder*, LPS no. 17095 [!].

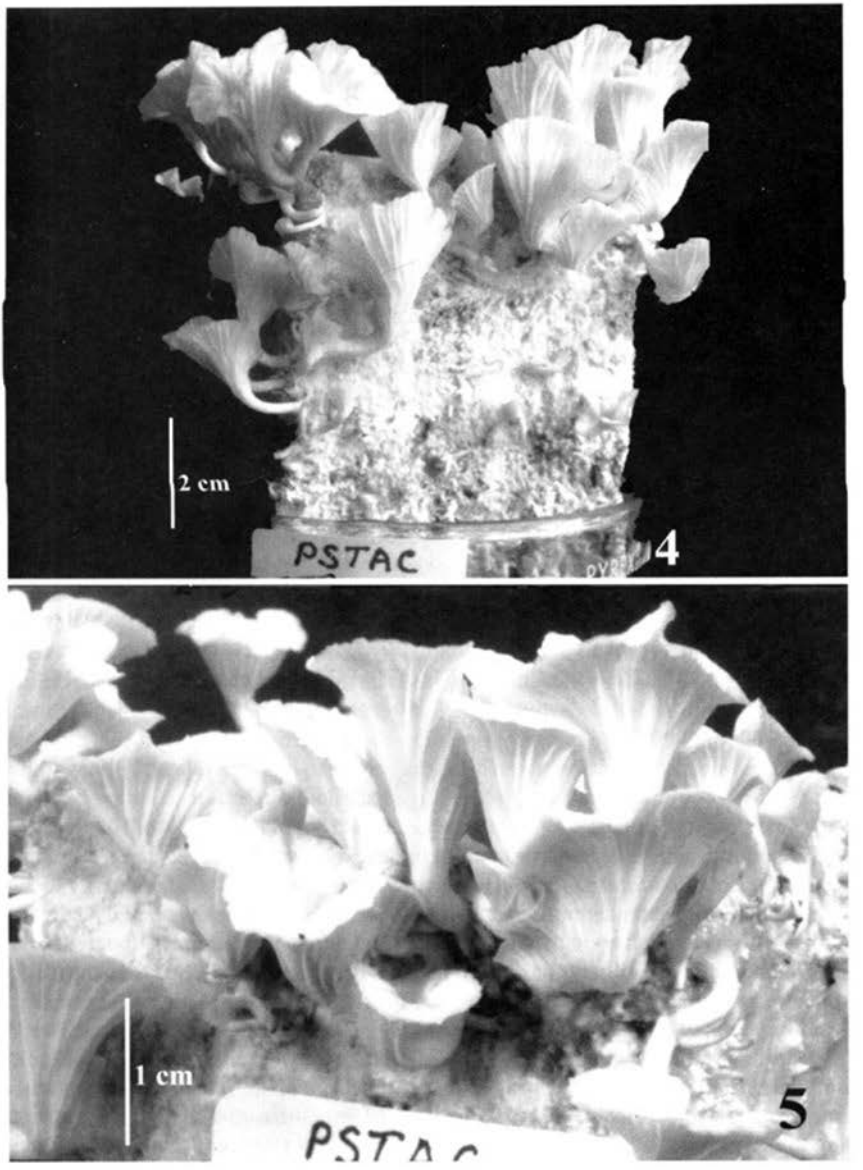
Basidiomata cornucopioid, clitocyboid, omphalioid to lentinoid (i.e. *L. crinitis*), usually gregarious in troops of 2–30 basidiomata. Pileus circular, infundibuliform, up to 135 mm broad, smooth to innately radially fibrillose, hygrophanous, white to

cream to dull greyish tan ['sayal brown' (6C5) inward, outward 'cartridge buff' (30A2) to 'pale olive buff' (3B2)]; margin entire to lacerate-crenate, thin, usually somewhat inturned (especially in drying); pileus often becoming pallid lemon yellow through drying. Lamellae deeply decurrent, extending as ridges through much of stipe length, tough (resisting fragmentation and squashing in KOH), subdistant, up to 6 mm deep, in at least three ranks, without interveining, white to dull off-white (to 'cartridge buff'); dried portions of lamellae turning dull golden yellow in 3% KOH. Stipe 35–80 × 5–13 mm, terete, upward fluted through lamellar bases, tapering downward, usually curved-ascendant, hollow to lightly stuffed, white, sometimes streaked with 'tilleul buff' (7B2); surface matt to minutely loosely felty. Taste mild; odor mild to resembling sweet lemon. Usually on dead wood including (but probably not limited to) *Salix* and *Ulmus*, rarely found on living trees.

Pileus surface a generally repent layer of hyphae; hyphae 2.5–4.5 µm diam., hyaline, thin- to thick-walled (wall up to 0.5 µm thick), often adherent (? through drying); occasional coralloid hyphal tips emergent; mucronate pileicystidia not observed. Pileus trama monomitic; hyphae 4.0–12.5 µm diam., hyaline, frequently branched, conspicuously clamped, interwoven. Lamellar trama tightly interwoven, with distinct mediostratum up to 320 µm broad, and lateral strata up to 32 µm thick. Hyphae of mediostratum as in pileus trama; gloeoplerous hyphae occasional to rare (or absent), 4.5–6.5 µm diam., yellow-refringent under phase contrast microscopy, glassy (not coscinoidal). Hyphae of lateral stratum pseudoparenchymatous, isodiametrical, hyaline. Subhymenium rudimentary, rarely over 15 µm thick. Hymenium composed of basidia and non-basidial elements; basidia 18.5–24 × 4.5–5.2 µm, narrowly clavate to subcylindrical, hyaline, clamped; sterigmata 4, slender, curved; non-basidial elements fusiform-mucronate, non-emergent, of similar length but somewhat stouter than basidia (these elements could be interpreted as pleurocystidia, but in all cases hymenial elements have proliferated somewhat, perhaps as a function of slow drying or confinement of the basidiomata for some time before drying). Cheilocystidia absent. Stipe trama monomitic; hyphae 4.5–18.5 µm diam., hyaline, consistently thick-walled (wall up to 4.0 µm thick), branched, conspicuously clamped, loosely interwoven. Stipe surface matt-plushy, white, forming a thatch; hyphae 2.5–5.5 µm diam., frequently branched and entangled, conspicuously clamped, thick-walled (wall 0.3–0.7 µm thick), hyaline.

Basidiospores (n = 45) (5.2–)8–9.5(–10.5) × (3.1–)3.5–4.5 µm; E = 2.00–2.38; Em = 2.15; Lm 8.53 µm, very variable in length, narrowly ellipsoid to subcylindrical and slightly adaxially flattened, smooth, hyaline, thin-walled, inamyloid, with one or two refringent guttules and some small granular inclusions; hilar appendix asymmetrical, small. Spore-print white to cream.

Specimens examined. ARGENTINA: Buenos Aires, Partido de la Costa, San Clemente del Tuyu, Parque Municipal, 13.VI.99, leg. & det. E. Alberto ('Ed 772'), on dead *Salix* species, BAFC no. 50.261; Buenos Aires, Llavallol, Sta. Catalina, 26.III.98, coll. E. Alberto, no. 'Ed 519', (also known as 'PSTAC'; see Figs. 4 & 5), det. Lechner & Albertó. Sobre tronco caido; muy abundante (as *P. cornucopiae*), BAFC no. 50.047; Buenos Aires, 25.II.1880, leg. O. Schnyder (holotype specimen of *Panus laciniato-crenatus*, LPS no. 17095); Buenos Aires, Santa Catalina Forest, 6.V.99, leg. E. Albertó & G. Pire, det. Albertó & Lechner ('Ed 751'), growing on dead wood, BAFC no. 50.413; Buenos Aires, La Lucila, 5.V.96 ('Ed 808'), basidiomata produced from dikaryon culture BAFC 2787.



Figs. 4 & 5. Basidiomata of *P. albidus* (BAFC 50.047) fruited on *Liriodendron* sawdust.

BRAZIL: Prov. Minas Geraes, Inficionade, *ad citrum*, X.1840, coll. *Gardner* (holotype specimen of *Lentinus albidus*, K).

COSTA RICA: Prov. Puntarenas, Co. Coto Brus, Hacienda la Amistad, trail from Ave. Pizoté, N 08°54.218', W 82°47.401', ~1328 m, 4.VII.98, coll. RHP, fieldbook no. 9498 (TENN 56526); Prov. Puntarenas, vic. Vulcan Arenal, Heliconia Hotel Sanctuary Reserve, 400 m before entrance to Sta Elena Reserve, N 10°20.32', W 84°47.55', 17.III.99, coll. J.L. Mata, fieldbook no. 10056 (TENN 57633).

TRINIDAD: St. Augustine, 20.VIII.47, *R.E.D. Bahn no. 1545*, annot. R.W.G. Dennis, K.

Cultural characters

Colony growth rate up to one cm per week on malt extract (15 mg/L) agar (20 g/L, Difco-bacto), white, substantially aerial, appearing combed to plumed; small orange exudate droplets produced in some aged cultures; hyphae all generative, 3.5–6.5 µm diam., clamped. Colony odour moderate, perfumed or floral, similar to that of cultures of *P. pulmonarius*. Microdroplets produced on aerial hyphae, up to 4.5 µm diam.

Mating experiments

Self-crosses using 12 SBIs of collections BAFC 50.047, BAFC 50.261, and 10056 independently revealed a tetrapolar mating system. SBIs of these three collections, as well as those from 9489, were all intercompatible (n = 4 throughout).

Once it was clear that hyphal construction of basidiomata of *P. albidus* was monomitic, SBIs of 10056 and 9498 were paired with SBIs of *P. ostreatus*, *P. pulmonarius*, *P. populinus*, and *P. abieticola* (see Petersen, 1995b for strains and SBI numbers). All pairings lacked clamp-connections. Because Spegazzini mentioned pinkish colours of lamellae, and because the only known *Pleurotus* species with such colours is *P. djamor* (Nicholl & Petersen, 2000), SBIs of BAFC 50.261, BAFC 50.047 and 9498 were paired with SBIs of *P. djamor* (strain 6346, see Petersen, 1995b). All such pairings lacked clamp-connections.

DISCUSSION

Three subtle morphological taxonomic characters seem to segregate one taxonomic complex within *Pleurotus*: 1) monomitic hyphal construction of basidiomata; 2) small size of microdroplets in culture; and 3) production of microdroplets on aerial hyphae (rather than from hyphae on the agar surface) in culture. This complex appears to be congruent with what Vilgalys has called the '*P. ostreatus* clade'(Vilgalys et al., 1993, 1996; Vilgalys & Sun, 1994; Vilgalys, 1997; Thorn et al., 2000). Within this complex, basidiomata of *P. ostreatus*, *P. pulmonarius, P. abieticola,* and *P. populinus* share a 'pleurotoid' stature (i.e. more or less shelf-like; radically eccentrically stipitate). Basidiomata of *P. eryngii* are centrally to eccentrically stipitate, but the species appears unique also as a root parasite of plants in the Umbelliferae. Thus, while it is not unprecedented to find omphalioid or clitocyboid stature within the complex, basidiomata of *P. albidus* are deeply infundibuliform and occur on wood, while those of *P. eryngii* are planar to slightly depressed, and appear to be root parasites with basidiomata produced through soil. Thus, *P. albidus* basidiomata are unique to the '*ostreatus* clade' (Fig. 3).

We have found additional records of Spegazzini specimens listed under *P. laciniato-crenatus*, and have examined the pertinent specimens. Data are as follows: 1) LPS

17060 (Uruguay, Montevideo, V.1914), a monomitic stipitate *Pleurotus*, probably correctly identified by Spegazzini; 2) LPS 17061 (Argentina, Tucuman, VII.1918), almost destroyed by insects and now unidentifiable; 3) LPS 17062 (Argentina, La Plata, IV.1919), a monomitic *Pleurotus* with several spore types, one of which gives dimensions as 8–12 × 3–4 µm, probably correctly identified by Spegazzini; 4) LPS 17074 (Paraguay, Villa Moira, 1893), a marasmielloid, laterally stipitate fungus, similar to *Neonothopanus nambi*; and 5) LPS 17099 (Paraguay, Garapeguá, 28.VI.1883), dimidiate, imbricate pleurotoid basidiomata with lobed, fimbriate margin, perhaps *Pleurotus djamor*.

No more recent reports (i.e. notes with herbarium specimens used in this study) of pinkish colouration of lamellae have been seen since Spegazzini's initial proposal of the species epithet. Such colouration is common in *P. djamor* (see Corner, 1981; Petersen, 1995a; Nicholl & Petersen, 2000), but Spegazzini's mention represents the only such report for the '*ostreatus* clade'.

In the process of separating basidiomata of *Pleurotus* from those of other superficially similar taxa (i.e. *Panus*), it is partially diagnostic to observe mucronate cheilocystidia (with a capitula of resinous liquid when fresh) or occasionally such pileicystidia. These have not been seen on these cornucopioid basidiomata. The condition of the relevant type specimens was relatively poor except for that of *Pleurotus laciniato-crenatus*. In all cases (including type specimens), pilei were thin, infundibuliform, and stipes were central to somewhat eccentric. Argentine strains Ed 519 (BAFC 50.261) and Ed 772 (BAFC 50.047) were fruited at Tennessee on *Liriodendron* sawdust blocks and Ed 808 (BAFC 2787) was fruited in Argentina on sawdust, and all produced similar basidiomata (Figs. 4 & 5). Although all such basidiomata were smaller than those from nature, all other morphological characters matched those of natural basidiomata, including both lacerate-crenate and entire pileus margin.

Singer (1950), although in a paper purporting to report on type specimens, apparently reported on his own fresh collections identified as *Pleurotus laciniato-crenatus*, and redescribed the taxon. He judged that "Although this species belongs in the *Pleurotus-ostreatus*-complex, I believe it to be an outstanding form of the latter." Singer's conclusion was correct, for although *Pleurotus ostreatus* exhibits a rather different habit (i.e. shelf-like, imbricate – in short, 'pleurotoid'), it is also monomitic. This conclusion is even more surprising, for Singer's experience with *Pleurotus* was marginal, especially in South America.

Horak (1968: 681) compared the type specimen of *Pleurotus laciniato-crenatus* to *P. eugrammus*. Although basidiome habit was decidedly different, he found micromorphology to be 'identisch'. Petersen & Krisai-Greilhuber (1999) redescribed *P. eugrammus* from type material, noting that hyphal construction was dimitic, this contrary to Horak's comparison of micromorphology. Petersen (below) has questioned the use of the term dimitic in *Pleurotus*, but the meaning of the term as applied to *Pleurotus* remains clear.

RANGE EXTENSIONS FOR PLEUROTUS ABIETICOLA

Pleurotus abieticola Petersen & Hughes (1997) was proposed based on two specimens on conifer logs in far-eastern Russia (Sichote Alin Biosphere Preserve). Those

collections were unique morphologically, genetically isolated (i.e. interINcompatible with a battery of other *Pleurotus* taxa) and ITS sequences formed an independent clade within the genus.

Now, three more collections can be reported which greatly extend the known distribution of the species. Two collections were made some years prior to description of *P. abieticola*, and were 'discovered' during an attempt to identify all collections of *Pleurotus* at TENN. From northern Jilin Province, China, basidiomata formed on conifer logs. The other collection was made in far northwestern Russia, north of St. Petersburg. Substratum was thought to be *Salix* or *Alnus*.

All three collections were intercompatible with the original two collections, but were interINcompatible with all other *Pleurotus* taxa. ITS sequences of collection 10625 also places this collection within the same clade as the original material (Fig. 3).

With these range extensions, the species should be sought in northern Scandinavia, in northern Japan, and on Kamchatka Peninsula. Basidiomata are easily confused with those of *P. ostreatus*, the pileus of which is also often brown. Specimens and field notes follow.

Specimens examined. CHINA: Jilin Prov., Songjianghe, Chang Bai Shan Preserve, 9.VIII.88, coll. R.H. Petersen, on ?*Picea*, field no. 1425 (TENN 48301). Pileus 'Verona brown' (6E5) over disc, 'wood brown' (7C4) outward. Lamellae close, 'tilleul buff' (7B2) outward, 'pale pinkish buff' (6A2) inward. Stipe eccentric, off-white, discoloured at base to 'avellaneous' (7B3). Odor negligible.

CHINA: Jilin Prov., Antu Co., Beihe, forest behind fire tower, 14.VIII.88, coll. R.H. Petersen, field no. 1456 (TENN 48298). Pileus 'pale pinkish cinnamon' (6A2) at margin, inward 'tilleul buff' (7B2), 'avellaneous' (7B3), to 'wood brown' (7C4) near stipe attachment. Lamellae 'pale pinkish buff' (6A2). Stipe nearly lateral, 'tilleul buff' (7B2).

RUSSIA: Leningrad Reg., Nyzhnesvirsky Reserve, trail to Svir River, N 60°36.775', E 33°07.628', 28.VIII.99, coll. S.A. Redhead, on *Salix* or *Alnus*, field no. 10625 (TENN 58284). Pileus hygrophanous, 'vinaceous buff' (9B2) where moist, 'pale pinkish cinnamon' (6A2) where dry. Lamellae deep, mostly 'pale pinkish cinnamon' (6A2), near margin 'tilleul buff' (7B2). Stipe distinct, matt, 'tilleul buff' (7B2).

A NOMENCLATOR FOR PLEUROTUS DJAMOR

Based on the parameters discussed above and previous experiments (Nicholl & Petersen, 2000), the following nomenclator can be offered for *Pleurotus djamor*. In most cases, links among these names are based solely on morphological analysis of type specimens ('[!]') often in less than pristine condition, but in all cases habit is pleurotoid and hyphal construction of stipe medullary tissue is 'dimitic'.

Pleurotus djamor (Rumph. apud Fr.) Boedijn, in: H.C.D. de Wit (ed.), Rumphius Memorial Vol. (1959) 292.

≡ *Agaricus djamor* Rumph. apud Fr., Syst. Mycol. 1 (1821) 185.
≡ *Agaricus arboreus secundus* Rumph., Fl. Amboin. 11 (1750) 125.
= *Agaricus caryophyllus* Berk., J. Linn. Soc. 13 (1872) 157 [!].
= *Agaricus emerici* Berk., Gard. Chron. 21 (2) (1880) 240 [!].
= *Agaricus eous* Berk., Hooker's J. Bot. 2 (1850) 83 [!]. [Type specimen unclear; description fits.]

≡ *Pleurotus eous* (Berk.) Sacc., Syll. Fung. 5 (1887) 361.
= *Agaricus flabellatus* Berk. & Curtis, J. Linn. Soc. 11 (1871) 528 [!].
= *Agaricus griseo-roseus* Mont., Syll. Gen. Spec. Cryptog. (1851) 114 [!].
≡ *Pleurotus griseo-roseus* (Mont.) Sacc., Syll. Fung. 5 (1887) 386.
= *Agaricus luteoalbus* Beeli, Bull. Soc. Roy. Bot. Belge 60 (1928) 163 [!].
= *Agaricus leptogramme* Berk. & Broome, J. Linn. Soc. 11 (1871) 529 [!].
= *Agaricus moselei* Berk., Challenger 37 (1878) [!].
= *Agaricus ninguidus* Berk., Hooker's J. Bot. 2 (1850) 84 [!].
≡ *Pleurotus ninguidus* (Berk.) Sacc., Syll. Fung. 5 (1887) 361.
= *Pleurotus ostreatoroseus* Singer, Publ. Inst. Mic., Univ. Recife 304 (1961) 10.
= *Agaricus pacificus* Berk., London J. Bot. 1 (1842) 451 [!].
= *Agaricus placentodes* Berk., Hooker's J. Bot. 4 (1852) 104 [!].
= *Agaricus prometheus* Berk. & Curtis, Amer. Acad. Arts & Sci. 4 (30) (1858) [!].
= *Pleurotus salmoneostramineus* Vasilyeva, [Russian title] Agar. & Bol. Primorsk Reg. (1973) 85.
= *Agaricus scabriusculus* Berk., J. Linn. Soc. Bot. 13 (1873) 157 [!].
≡ *Pleurotus scabriusculus* (Berk.) Sacc., Syll. Fung. 5 (1887) 374.
≡ *Pleurotus scabellus* Sacc., Syll. Fung. 5 (1887) 374 [*nom. nov.*, non *P. scabriusculus* Berk. Australian Fungi no. 18.]

In addition, another name represents pleurotoid basidiomata with partial veil covering lamellae in juvenile state. Vilgalys et al. (1996) has shown that *P. calyptratus* is partially sexually compatible with *P. djamor*, DNA sequences are contaxic, basidiomata are dimitic, and both names were included in ISG V.

Pleurotus djamor forma **calyptratus** (Lindblad apud Fr.) R.H. Petersen, *comb. & stat. nov.*

Basionym: *Agaricus calyptratus* Lindblad apud Fr., Monog. Hymen. Suecici (1857) 238.

≡ *Pleurotus calyptratus* (Lindblad apud Fr.) Sacc., Syll. Fung. 5 (1887) 341.
≡ *Tectella calyptratus* (Lindblad apud Fr.) Singer, Agar. Mod. Tax. (1951) 263.

Typification: Fries (ibid.) saw an illustration by Lindblad, now in the Stockholm Museum, and that illustration can serve as lectotype. An epitype should be sought among material from vic. Högholm in Sudermannia, referred to by Fries.

NOTES ON MITICITY IN PLEUROTUS

Corner (1932a, b) developed terms and definitions dealing with hyphal construction in polyporoid fungi and elaborated on these concepts in the clavarioid fungi (Corner, 1950). In 1953, Corner recapitulated definitions formulated in 1932, and defined a skeletal hypha as follows: "... unbranched, thick-walled, commonly aseptate, longitudinal, constructional hyphae of the first order in the growing region." Likewise, Corner (1953) circumscribed generative hyphae as follows: "The thin-walled hyphae usually remain thin-walled and are very inconspicuous for this reason ... or parts of them become thick-walled and mistakable for skeletal or binding hyphae ... Because they *produce* the system of skeletal hyphae ... and the system of binding hyphae ... I called them generative hyphae." [Italics ours]. Specifically, when only one hyphal type was present in basidiome tissues, those tissues were termed 'monomitic', those with two hyphal types were 'dimitic', and those with three were 'trimitic'. Corner's personal

experience allowed 'dimitic' to include a combination of generative plus skeletal hyphae or generative plus binding hyphae, but other variations of miticity (i.e. inclusion of gloeoplerous or laticiferous hyphae in combination with generative hyphae, etc.; see Pegler, 1983, 1996, for a more complete exposition) were largely overlooked for they did not seem important to the classification of the polypores.

These definitions were carried to the clavarioid fungi (Corner, 1950), where skeletal hyphae were found in certain basidiomata, and also in the rhizomorphs of some *Ramaria* taxa (Petersen, 1975). In *Lachnocladium*, skeletal hyphae were modified into highly branched structures, while in *Ramaria* they were largely unbranched. Later (Corner, 1970) further modifications to the original definition were made, chiefly that skeletal hyphae could appear as *intercalary* segments, arising from and reverting to the generative morphology (i.e. as found in *Ramaria gracilis*, *R. rubella* and others).

As time elapsed, these terms of miticity and hyphal types were augmented so that now they have become somewhat blurred. Nonetheless, these concepts were applied to other fungi, and in fact, di- or trimitic hyphal construction (sensu Corner) came to exclude members of the Agaricales, and became semi-diagnostic for members of the Aphyllophorales. If a basidioma was monomitic it could be placed in the Agaricales or the Aphyllophorales, but if it was dimitic or trimitic (sensu Corner), it was excluded from the Agaricales. While it was recognized that other hyphal types might be found in basidiomatal tissues (i.e. gloeoplerous hyphae, subdivided by staining affinities of contents; viz. the Gomphaceae, where gloeoplerous hyphae are cyanophilous, versus the Auriscalpiaceae where they are blackish in sulfobenzaldehyde), and while presence of such hyphal types alter Corner's terms (i.e. *Lentinellus*, in which basidiomata of several species exhibit generative, skeletal and gloeoplerous hyphal types, which Corner would term dimitic, gloeoplerous hyphae having never been included in his summary of hyphal construction), this discussion pertains to *Pleurotus* and definition of its basidiomatal tissue.

Corner (1983) became discontent with attempts to refine his basic mitic plan and put forward subcategories of dimiticity. Later (Corner, 1991) the expanded system was outlined again. Pegler (1996) furnished a history of research on miticity in Basidiomycotina, including *Pleurotus* under dimitic construction with "limited skeletal hyphae ... 'type d4' of Corner" (1983, 1991). The word 'limited', however, indicated the termination of individual skeletal hyphae within the tissue (I cannot conceptualize an alternative), not limitation as intercalary lengths limited by clamp-connections at origin from and reversion to generative hyphae.

Micromorphological examination of some *Pleurotus* basidiomata, especially of stipe medullary tissue, reveals the presence of two hyphal types (and occasionally, rare gloeoplerous hyphae). One hyphal type seems to form the flesh substance and, while often thick-walled, hyphae are frequently septate/clamped so in traditional Cornerian terminology are generative hyphae. A second hyphal type (again in basidiomata of only some species) appears long-celled, thick-walled, and refringent under phase contrast microscopy. Superficially, these resemble skeletal hyphae, and based on the presence of such hyphae, such tissues have been called dimitic (Stankovicova, 1974; Pegler, 1977). Although occasionally these skeletal hyphae are found in pileus and lamellar tramae, the most reliable tissue in which they are to be seen is the stipe medulla. When carefully analysed, however, these skeletal hyphal segments are seen often to be inter-

calary, and/or to bear occasional internal clamp-connections. They are not skeletal hyphae sensu Corner, therefore, and tissues which include them are not strictly dimitic sensu Corner. Pilát (1965) recognized this discrepancy in a discussion of *P. calyptratus*.

Stankovicova (1974) reported that certain species of *Pleurotus* were monomitic (i.e. *P. ostreatus*) while others (i.e. *P. calyptratus*, *P. 'sajor-caju* var. *dactyliophora'*) were considered dimitic or perhaps trimitic. The accurate identity of the latter taxon cannot be judged, for Pegler (1983) ascertained that true *P. sajor-caju* was a *Lentinus*, not *Pleurotus*. Stankovicova (1974) made no distinction between various types of skeletal hyphae.

Perhaps based on this hyphal construction (i.e. 'dimitic'), *Pleurotus* has been linked with the genera *Polyporus* (Pegler, 1983; Hibbett & Vilgalys, 1993) and *Lentinus* (Corner, 1981; Petersen & Nicholl, 1997). Taxa of all three genera produce large, non-amyloid basidiospores of comparable size and shape and basidiomata of 'pleurotoid' habit (i.e. imbricate, stipe-less basidiomata to stoutly, usually eccentrically or laterally stipitate habit). Early molecular evidence included *Pleurotus* in phylogenetic reconstructions concerned chiefly with *Lentinus* (Hibbett & Vilgalys, 1993), but later refinements showed that *Pleurotus* was actually within the Agaricales (Montcalvo et al., 2000; Thorn et al., 2000). With this phylogenetic alignment, *Pleurotus* appears to be one of very few agaric genera (or perhaps the only genus) with 'dimitic' hyphal construction.

Should a new term be coined for the 'dimitic' hyphal construction in some *Pleurotus* species? We think not, but awareness of this anomaly in *Pleurotus* is urged, with the suggestion that future descriptions be worded carefully to take such hyphal construction into account.

We tentatively conclude that *Pleurotus* includes three groups based on a combination of hyphal construction and general habit. In all cases occasional to rare gloeoplerous hyphae are also found.

Type I — Stipe trama: hyphae frequently clamped, often somewhat inflated, usually thick-walled, relatively uniform in appearance (i.e. skeletalized generative hyphae; monomitic). Lamella trama: hyphae as in stipe tissue but less thick-walled. Basidiomata strongly eccentrically stipitate with inconspicuous pileus extension over stipe [i.e. *P. ostreatus, P. populinus, P. pulmonarius, P. abieticola*) to centrally or subcentrally stipitate (i.e. *P. albidus, P. eryngii*), soft-fleshy; pileus trama usually over 5 mm thick near stipe , etc.].

Type II — Stipe medullary tissues comprising two elements: 1) generative hyphae as in type I; 2) imperfect skeletal hyphae long-celled, skeletalized (i.e. wall usually thicker than 0.7 μm thick), refringent under phase contrast microscopy; clamp-connections initiative to occasionally intercalary, especially near bases of hyphal branches. Lamella trama: usually as in Type I, occasionally with 'skeletal' hyphae as in stipe tissues of Type II. Basidiomata stoutly stipitate, usually large; stipe central (*P. dryinus, P. levis*) eccentric to almost lateral (*P. opuntiae, P.* cf. *gemmellarii, P. fossulatus*); pileus trama usually over 5 mm thick near stipe.

Type III — Stipe medullary tissues comprising two elements: 1) generative hyphae as in Type I; 2) imperfect skeletal hyphae similar to those of Type II; clamp-connections

rare, initiative and intercalary. Lamellar trama: juvenile basidiomata as in Type I or exhibiting 'skeletal' hyphae (usually late in age). Immature basidiomata laterally stipitate and then the stipe reduced to a knot; pileus trama usually less than 5 mm thick near stipe (*P. djamor* and its forms).

ACKNOWLEDGEMENTS

Dr. Rytas Vilgalys generously furnished an ITS sequence for D327 (ISG XIII): it appears in the phylogenetic reconstruction. This work was supported, in part, by National Science Foundation grant DEB-9521526 and DEB-9878011 (PEET grants). Dr. Albertó's time at Tennessee was supported by the Hesler Endowment Fund of the Botany Department, University of Tennessee.

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BOOK REVIEWS

J. Holec. *The genus Pholiota in central and western Europe*. (Libri botanici vol. 20, IHW Verlag, D-85378 Eching, Germany. 2001.) ISBN 3-930167-49-2. Pp. 220, 49 colour photographs, numerous line-drawings. In English. Price: € 65.–.

The genus *Pholiota*, an important genus in forestry since many species are parasitic on woody plants, has been monographed by the author on the basis of numerous collections from the whole of North-western and Central Europe. After the introductory chapters with extensive information on material and methods, an overview is given of the current state of knowledge on the genus and the characters used for delimitation of taxa. The taxonomic part gives an infrageneric classification, followed by keys to the subgenera and species. All accepted taxa are fully described and illustrated with line-drawings. In addition most species are illustrated in colour with at least one, but in many cases even two photographs. Notes are given on ecology and distribution, and all collections studied are cited per country of origin. The discussions are often elaborate and give much additional information as to the status of the taxon versus related species and interpretations in literature. Five new combinations have been made. The book concludes with a long, annotated list of type studies, excluded and doubtful taxa, and a very comprehensive list of references.

Holec's concept of *Pholiota* follows in great lines that of Jacobsson (Windahlia 19, 1990) and Noordeloos (Flora agaricina neerlandica, vol. 4, 1999) with slight alterations. *Kuehneromyces* is not included, and also the status of *Pholiota albocrenulata*, *P. oedipus*, and *P. myosotis* is discussed. On species level, a wide species concept is used for example in *P. conisans*, which includes both forms on wood and on grasses (*P.* '*graminis*'). The nomenclature of the group of *P. aurivella*, *P. adiposa*, and *P. cerifera* has been adjusted, and follows Noordeloos (l. c.). Within section *Spumosa*, Holec records besides the known European taxa *P. spumosa*, *P. mixta*, and *P. highlandensis*, a collection of *Pholiota brunnescens*, originally described from North America, and indicates that more taxa can be expected in this group. The present study is exemplary for how a good monograph should be made: it is very complete and consistent. As such it should be widely used and consulted by everyone working in taxonomy and forestry.

B. Kendrick. *The fifth kingdom*. CD-Rom. Version 2.1. (Mycologue Publications, 8727 Lochside Drive, Sidney, BC, V8L 1M8, Canada.) Price: US $ 75.– (personal edition).

The paper version of Kendrick's book has since long been used and appreciated in teaching at university level. Now the CD-Rom adds only more to the appreciation. It is an attractive and comprehensive 'book' with 24 chapters on all aspects in mycology and a glossary. Over 1200 colour pictures make this a perfect introduction to the kingdom of the fungi. The CD-Rom also provides an interactive key to 1900 mushrooms. It is a must for every institute that teaches mycology, and also advisable for every student in mycology and amateur-mycologists. Meanwhile, version 3.0 is now available.

PERSOONIA
Volume 18, Part 1, 71–84 (2002)

A STUDY OF NIVICOLOUS MYXOMYCETES IN SOUTHERN EUROPE, SIERRA DE GUADARRAMA, SPAIN

A. SÁNCHEZ[1], G. MORENO[1], C. ILLANA[1] & H. SINGER[2]

Eleven taxa of Myxomycetes collected from around melting snow banks in mountainous and alpine areas of the Sierra de Guadarrama (Madrid, Segovia) are presented. From a chronological point of view several new records for the Iberian Peninsula are interesting: *Lepidoderma carestianum*, *Lepidoderma granuliferum*, *Physarum albescens*, *Physarum alpestre* and *Trichia sordida* var. *sordida*. SEM micrographs of spores and capillitia of the most significant species are included.

Key words: nivicolous Myxomycetes, *Physarales*, *Stemonitales*, *Trichiales*, Spain, SEM, chronology, taxonomy.

INTRODUCTION

Nivicolous Myxomycetes have scarcely been studied in Spain. Gràcia (1986), who cited three species in the Catalanian Pyrenees, made the first contribution. Later Lado (1992) and Illana et al. (1993) paid attention to the Sierra de Guadarrama, from which they reported new records.

The Sierra de Guadarrama is a mountain range situated in the centre of the peninsula forming part of the provinces Segovia and Madrid. As our last mycological investigations in these mountains yielded success, we were encouraged to study this area more exhaustively; especially the Segovian part of the mountains, where the autochthonous vegetation is better conserved.

In this paper, 11 taxa of the orders *Stemonitales*, *Trichiales* and *Physarales* are presented. A second part will deal with nivicolous species of the genus *Diderma* and, in the last work, the collection of nivicolous *Lamproderma* will be presented.

MATERIAL AND METHODS

The investigated area, Sierra de Guadarrama, is part of Spain, which is surrounded by Portugal, France and Africa (Morocco). From May 1996 to June 1999, 35 samples were collected in 4 different localities situated in Segovia and Madrid as indicated on the map (Fig. 1).

1. Puerto de Cotos, Segovia (1850 m).
2. Puerto de Navacerrada, Segovia (2000–2100 m).
3. Puerto de Navafria, Segovia (1800 m).
4. Mountain pass of Navacerrada, Madrid (1800 m).

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2) Institut für Mikrobiologie, Leopold-Franzens-Universität Innsbruck, Technikerstrasse 25, A-6020 Innsbruck, Austria.

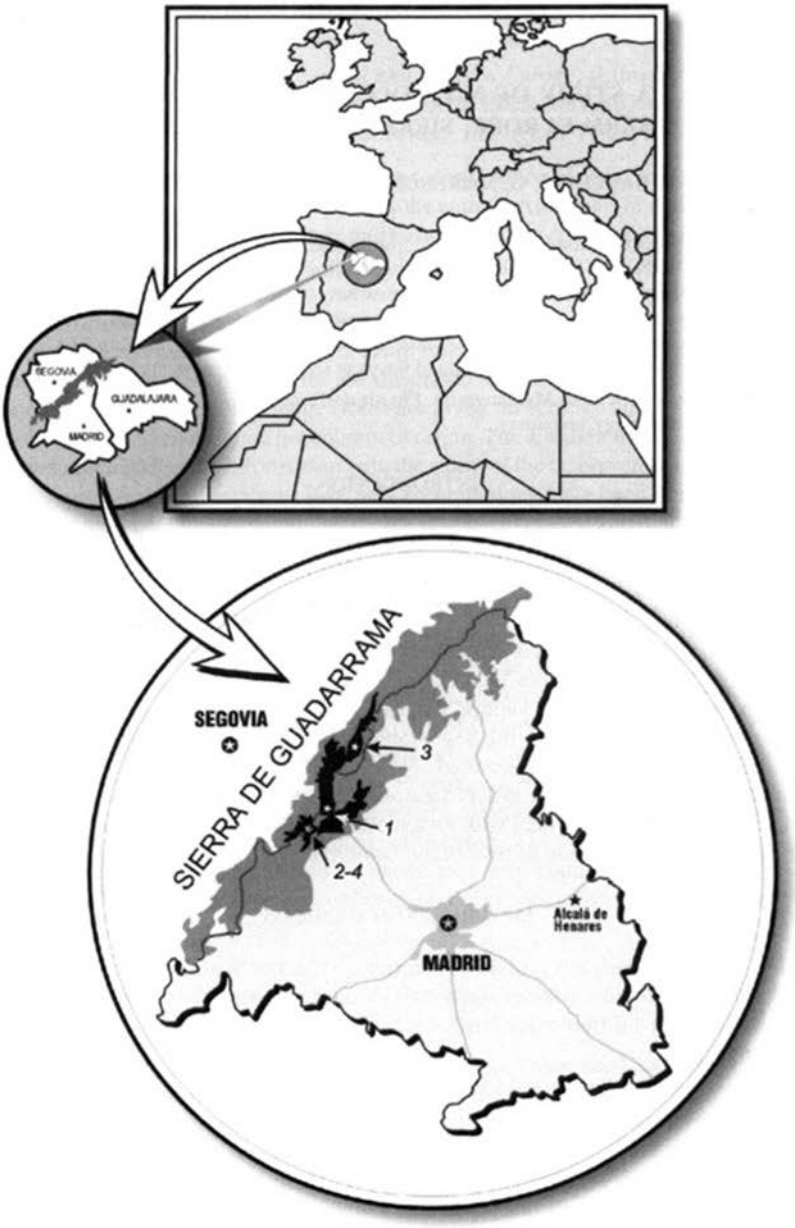


Fig. 1. Map showing the location of Sierra de Guadarrama and the localities from where material has been studied.

The position of the Sierra de Guadarrama in southernmost Europe and permanent snow cover for over three months until the spring melt (April–June) make this area interesting for taxonomic and chronological studies of nivicolous Myxomycetes.

The vegetation in this area consists mainly of *Pinus sylvestris* L., *Juniperus communis* subsp. *alpina* (Suter) Čelak. and *Cytisus oromediterraneus* Rivas Mart. et al.

The collected material was mounted in Hoyer's medium and studied with a Nikon (Optiphot) microscope. Scanning electron microscopy (SEM) micrographs were taken in the University of Alcalá de Henares using a Zeiss DSM-950.

SEM-preparation: sporocarps were rehydrated in concentrated ammonium hydroxide (28–30%) for 30 minutes, dehydrated in aqueous ethanol (70%) for 30 minutes, fixed for 2 hours in pure ethylene glycol dimethyl ether (= 1, 2-dimethoxymethane) and finally immersed in pure acetone for at least 2 hours followed by critical point drying and sputtering with gold-palladium.

Descriptions of the spore ornamentation under SEM follow the terminology proposed by Rammeloo (1974, 1975).

The specimens are deposited in the herbarium AH (University of Alcalá).

DESCRIPTION OF THE SPECIES

Arcyria versicolor

Arcyria versicolor W. Phillips, Grevillea 5 (1877) 115.

Arcyria versicolor differs from other red coloured species of this genus in its large sporocarps, the elastic capillitium of variable colour (olive brown to reddish orange), the reddish inner side of the trumpet-shaped calyculus and the large spores of 9–11 µm diameter.

Although this species is not strictly nivicolous, it often appears near melting snow banks. In Spain, two records are reported from the Sierra de Guadarrama of Madrid. We have made very abundant collections in the same area.

Collections examined. SPAIN: Puerto de Cotos 1850 m, Segovia, trunk of *Pinus sylvestris* L., 21.V.1996, leg. A. Sánchez, *AH 19532* & *AH 19533*; Puerto de Navacerrada 1900 m, Segovia, bark of dead trunk of *Pinus sylvestris* L., 4.VI.1996, leg. A. Sánchez, *AH 19531*.

Comatricha nigricapillitium

Comatricha nigricapillitium (Nann.-Bremek. & Bozonnet) A. Castillo, G. Moreno & Illana, Mycol. Res. 101 (1997) 1331.

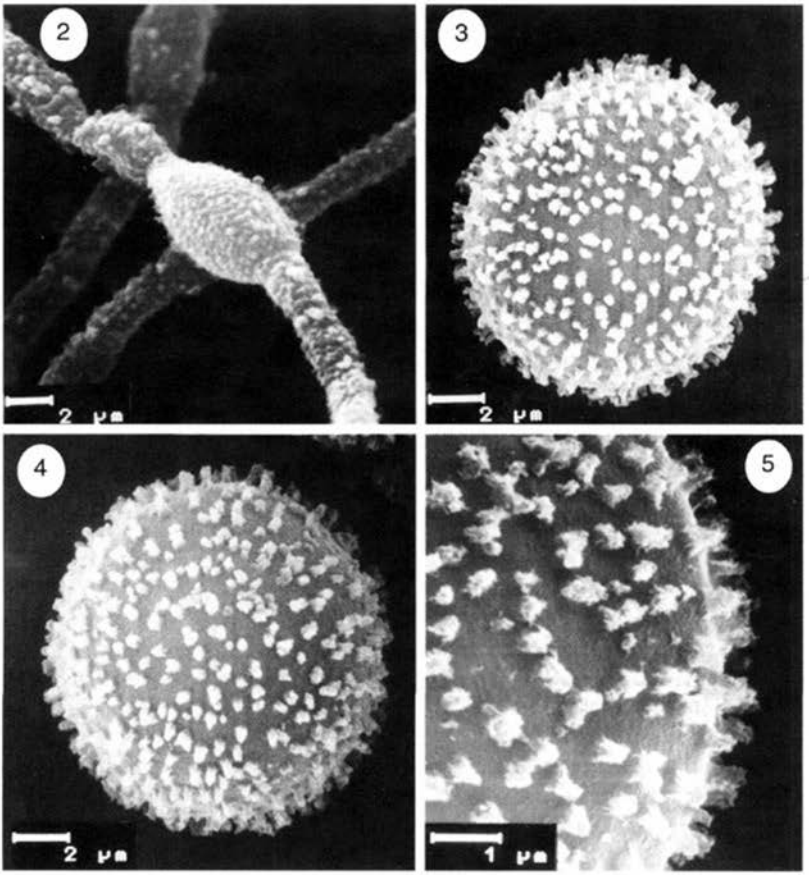
≡ *Lamproderma nigricapillitium* Nann.-Bremek. & Bozonnet, in Nannenga-Bremekamp, Proc. Kon. Ned. Akad. Wetensch., Ser. C, 92 (1989) 510.

= *Collaria chionophila* Lado, Anales Jard. Bot. Madrid 50 (1992) 9 & 11.

= *Comatricha chionophila* (Lado) G. Moreno, Criptogamie, Mycol. 14 (1993) 243.

This nivicolous species has recently been described and treated taxonomically by Illana et al. (1993) and Castillo et al. (1997). *Comatricha nigricapillitium* is a strictly nivicolous species, very common in the studied area.

Collections examined. SPAIN: Puerto de Navacerrada, 2100 m, Segovia, trunk of *Pinus sylvestris* L., 24.V.1997, leg. A. Sánchez, *AH 18431*; Puerto de Navacerrada 1900 m, Segovia, residues of industrial wood of *Pinus* sp., 21.IV.1997, leg. A. Sánchez, *AH 18523*.



Figs. 2–5. *Lepidoderma carestianum*. 2. Capillitium with ornamentation (*AH 18409*); 3 & 4. spores (*AH 18410*); 5. detail of spore ornamentation (*AH 18409*).

Enerthenema melanospermum

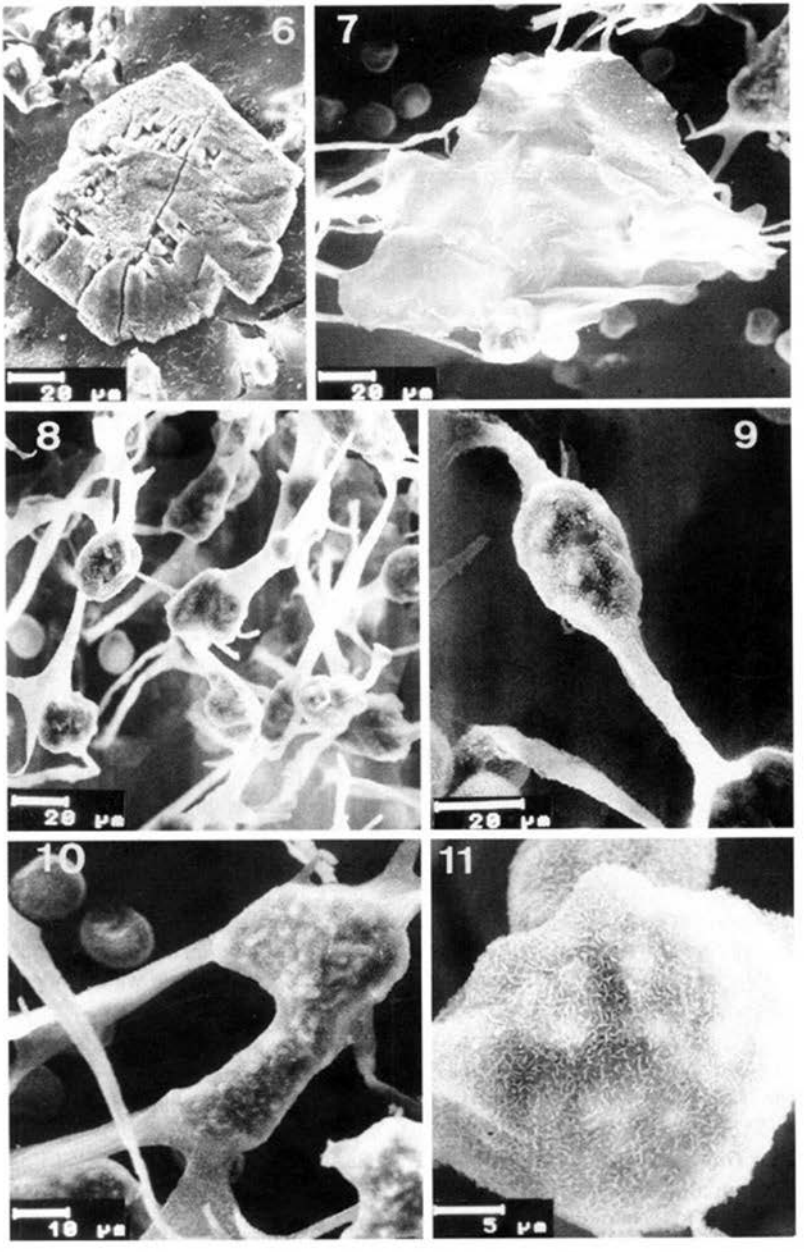
Enerthenema melanospermum T. Macbr. & G.W. Martin, J. Wash. Acad. Sci. 22 (1932) 91.

Enerthenema melanospermum is not strictly nivicolous. It was commented upon and previously collected in the Sierra de Guadarrama, Madrid (Illana et al., 1993).

Collections examined. SPAIN: Puerto de Navacerrada, 1900 m, Segovia, woody residues of *Pinus sylvestris* L., leg. A. Sánchez, 15.VI.1996, *AH 18421*; Puerto de Navacerrada, 2100 m., Segovia, industrial wood of *Pinus* sp., 1.V.1997, leg. A. Sánchez, *AH 18518*.

Lepidoderma carestianum — Figs. 2–5

Lepidoderma carestianum (Rabenh.) Rostaf., Sluzowce Monogr. (1874) 188.
= *Lepidoderma chailletii* Rostaf., Sluzowce Monogr. (1874) 189.



Figs. 6–11. *Lepidoderma granuliferum* (*AH 19504*). 6. Lime scale on peridium; 7. peridium; 8. capillitium with nodes; 9 & 10. capillitium nodes; 11. detail of node ornamentation.

Our collections coincide macro- and microscopically with the description of Neubert et al. (1995).

Lepidoderma carestianum is characterised by its sporangiate fructifications, sometimes varying to plasmodiocarps, gregarious, covered with large irregular, greyish white lime scales, its dark purple brown capillitium, becoming colourless at the extremities, its spores being 11–15 µm in diameter, globose and spinulose. In SEM the capillitium presents irregularly distributed warts (Fig. 2) and the spores show an ornamentation consisting of baculae with plane apices (Figs. 3–5). These are the first records for the Iberian Peninsula, Lado (1993) rejected earlier citations.

Lepidoderma carestianum is a strictly nivicolous species.

Collections examined. SPAIN: Puerto de Cotos 1900 m, Segovia, dead and living stalks of *Rubus ulmifolius* Schott, leg. A. Sánchez, 16.V.1996, *AH 18409*; Puerto de Navacerrada 1850 m, Segovia, living stalks of *Cytisus oromediterraneus* Rivas Mart. et al., leg. A. Sánchez, 12.III.1997, *AH 18411*; Puerto de Navafria 1800 m, Segovia, dead branches of *Pinus sylvestris* L., leg. A. Sánchez, 15.III.1997, *AH 18412 & AH 19519*; Puerto de Navafria 1850 m, Segovia, dead branches of *Pinus sylvestris* L., leg. A. Sánchez, 16.III.1997, *AH 18410*; Segovia, ibidem, 22.III.1997, *AH 19520*; Puerto de Navacerrada 1900 m, Segovia, woody residues, leg. A. Sánchez, 20.IV.1997, *AH 19521*.

Lepidoderma granuliferum — Figs. 6–15

Lepidoderma granuliferum (W. Phillips) R.E. Fr., Ark. Bot. 6 (7) (1906) 3.

Our collections coincide macro- and microscopically with the description of Neubert et al. (1995).

Lepidoderma granuliferum can easily be recognised by its plasmodiocarpous fructifications with characteristic lime scales (Fig. 6) covering the peridium (Fig. 7) and its capillitium with typical nodes or expansions (Figs. 8–10). In SEM both the threads of the capillitium and the nodes bear an ornamentation formed by small crests, resulting in a subreticular or wrinkled appearance (Figs. 11–13). The nodes furthermore bear coarse warts (Figs. 10–11). In SEM the spores are densely spinulose, the spines are very susceptible to collapse and bend easily (Figs. 14, 15).

This species is considered by the most authors to be nivicolous and is cited by Bozonnet, Meyer & Poulain (1991) in: 'Liste des espèces nivales de Myxomycètes'.

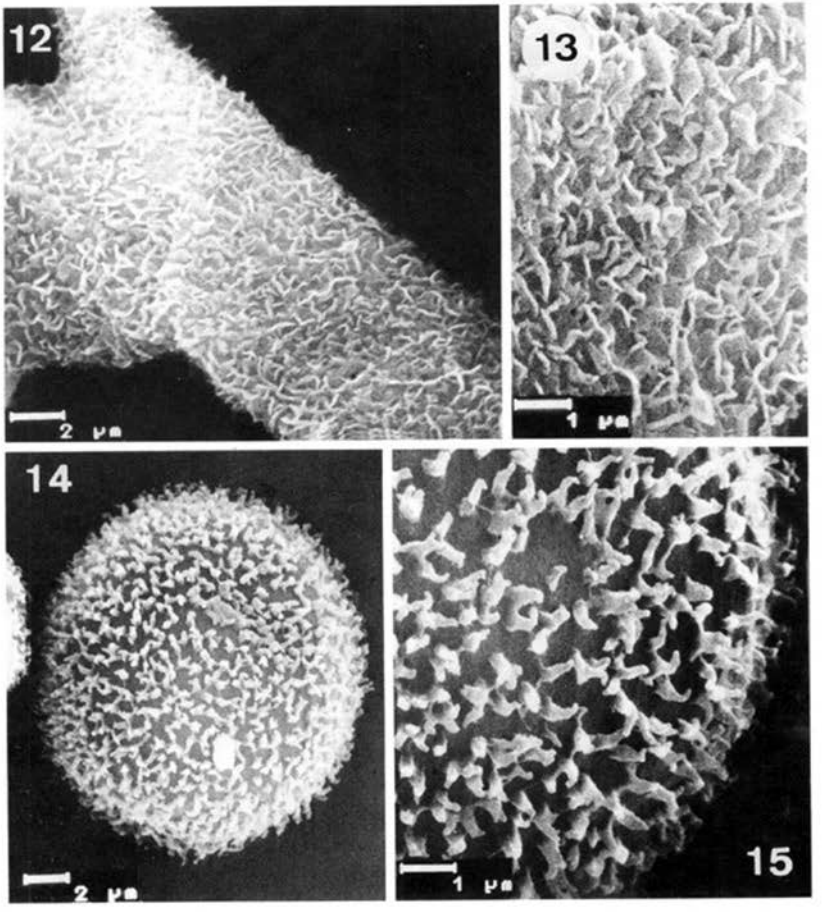
In Spain Pando & Lado (1990) have cited *Lepidoderma granuliferum* proceeding from a culture of living bark of *Juniperus thurifera*. This material does not correspond with this species and probably represents a different taxon. Hence we consider our citations as the first records for the Iberian Peninsula.

Collections examined. SPAIN: Puerto de Navacerrada 2100 m, Segovia, residues of dead stalks of Poaceae, 1.V.1997, leg. A. Sánchez, *AH 19504*; Puerto de Navacerrada 2150 m, Segovia, *Senecio pyrenaicus* L., 27.V.1999, leg. A. Sánchez, *AH 19398*; Puerto de Navacerrada 2000, 2050 & 2100 m, Segovia, *Senecio pyrenaicus* L., 7.VI.1999, leg. A. Sánchez, *AH 19379*, *AH 19311* & *AH 19380*.

Physarum albescens — Figs. 16, 17

Physarum albescens Ellis ex T. Macbr., N. Amer. Slime-Moulds, ed. 2 (1922) 86.

Sporocarps gregarious or scattered, sessile, with yellowish strand-like stalks formed as an extension of the hypothallus, obovoid or subglobose, 0.8–1 mm in diameter.

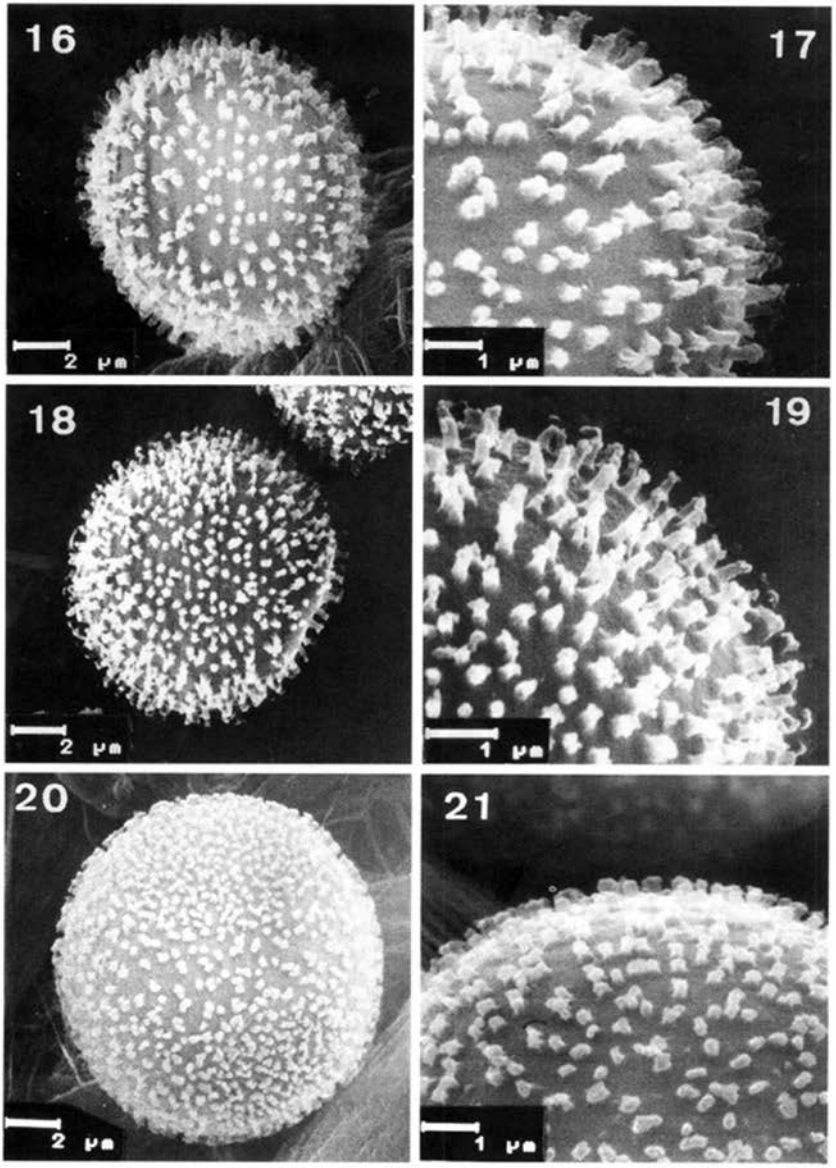


Figs. 12–15. *Lepidoderma granuliferum* (*AH 19504*). 12 & 13. Details of capillitium ornamentation; 14. spore; 15. detail of spore ornamentation.

Peridium double, the outer layer calcareous, white or pale yellow to greenish, the inner layer membranous, iridescent. Dehiscence irregular, the peridium persistent below as a shallow cup. Hypothallus membranous, pale yellow to brownish yellow, venulose. Capillitium abundant, consisting of flattened, calcareous, yellow nodes, connected by hyaline threads. Spores globose, black in mass, dark violaceous brown by transmitted light, 12–13 µm in diameter, verrucose. By SEM the spores bear baculae with irregular apices (Figs. 16, 17).

Physarum albescens is characterised by its obovoid or subglobose sporocarps with a double peridium (yellow to greenish), its capillitium with yellow nodes and its nivicolus habitat (Bozonnet, Meyer & Poulain, 1991).

Physarum albescens is a strictly nivicolous species. This is the first record from Spain.



Figs. 16 & 17. *Physarum albescens* (*AH 19505*). 16. Spore; 17. detail of spore ornamentation. — Figs. 18 & 19. *Physarum alpestre* (*AH 18412*). 18. Spore; 19. detail of spore ornamentation. — Figs. 20 & 21. *Physarum vernum* (*AH 19516*). 20. Spore; 21. detail of spore ornamentation.

Collections examined. SPAIN: Navacerrada, 2050 m, Segovia, on living and dead stems of *Cytisus oromediterraneus* Rivas Mart. et al., near melting snow, 23.IV.1997, leg. A. Sánchez, *AH 19505*; mountain pass of Navacerrada, 1900 m, Segovia, on a rock, near melting snow, 1.V.1997, leg. A. Sánchez, *AH 18519*.

Physarum alpestre — Figs. 18, 19

Physarum alpestre Mitchel, S.W. Chapm. & M.L. Farr, Mycologia 78 (1986) 68.

Plasmodiocarps scattered to gregarious, sessile, flat, 0.3–15 mm long, 0.3–10 mm wide, with two or more plasmodiocarps adherent to each other, sometimes also as sessile sporocarps. Hypothallus lacking. Peridium double: the outer layer persistent, calcareous, yellow, rarely white, smooth, bright; the inner layer thin, translucent, iridescent, membranous. Columella as a thickened base. Capillitium abundant, of angular, yellow, fusiform or branched, calcareous nodes, connected by hyaline threads. Spores globose, black in mass, dark violaceous brown by transmitted light, 12–13 µm in diameter. In SEM the spores bear baculae with irregular apices (Figs. 18, 19).

Physarum alpestre is a strictly nivicolous species and can be recognised by its typical yellow plasmodiocarps.

Physarum alpinum (Lister & G. Lister) G. Lister is distinguished from *P. alpestre* by its subglobose to pulvinate sporocarps (Mitchel et al., 1986).

This is the first record from Spain.

Collections examined. SPAIN: mountain pass of Navafría, 1820 m, Segovia, on trunks and bark of *Pinus sylvestris* L., near melting snow, 23.III.1997, leg. A. Sánchez, *AH 18412*; mountain pass of Navacerrada, 1850 m, Segovia, on branches of *Pinus sylvestris* L., near melting snow, 6.IV.1997, leg. A. Sánchez, *AH 18520*; mountain pass of Navacerrada, 1900 m, Segovia, on living leaves of *Digitalis purpurea* L., 21.IV.1997, leg. A. Sánchez, *AH 18521*; mountain pass of Navacerrada, 2100 m, Segovia, on herbaceous debris, 20.V.1997, leg. A. Sánchez, *AH 18522*.

Physarum vernum — Figs. 20, 21

Physarum vernum Sommerf. in Fr., Syst. Mycol. 3 (1829) 146.

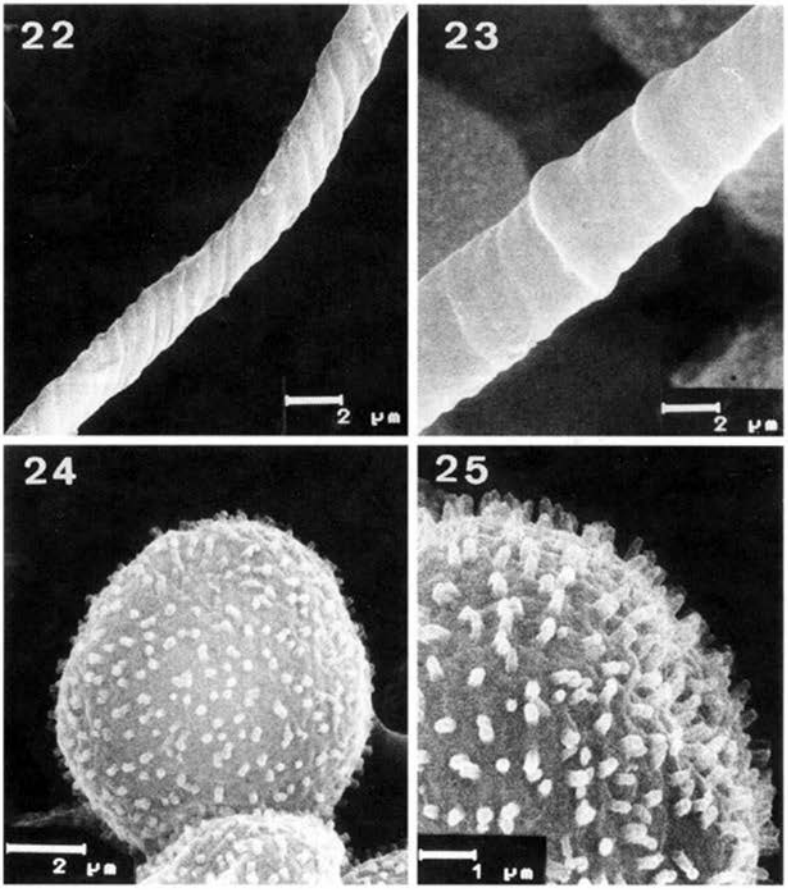
Physarum vernum is readily recognised by its greyish white sporocarps, its peridium covered with coarse granular lime, its whitish grey, irregular nodes of the capillitium and its spores in SEM with an ornamentation formed by short aggregated baculae (Figs. 20, 21).

According to Bozonnet, Meyer & Poulain (1991) this is a nivicolous species, nevertheless there are many records from Spain in Mediterranean areas (Lado, 1993).

Collections examined. SPAIN: mountain pass of Navacerrada, 1800 m, Madrid, on stems of *Cytisus oromediterraneus* Rivas Mart. et al., and Poaceae, 18.IV.1996, leg. M. Lizárraga, *AH 22215*. mountain pass of Navacerrada, 1850 m, Segovia, on stems of *Cytisus oromediterraneus* Rivas Mart. et al., 12.III.1997, leg. A. Sánchez, *AH 19516*; mountain pass of Navafria, 1850 m, Segovia, on branch of *Pinus sylvestris* L., 15.III.1997, leg. A. Sánchez, *AH 19517*; mountain pass of Navacerrada, 2200 m, Segovia, on stems of Poaceae, 24.V.1997, leg. A. Sánchez, *AH 19518*.

Prototrichia metallica — Figs. 22–25

Prototrichia metallica (Berk.) Massee, J. Roy. Microscop. Soc. London (1889) 350.

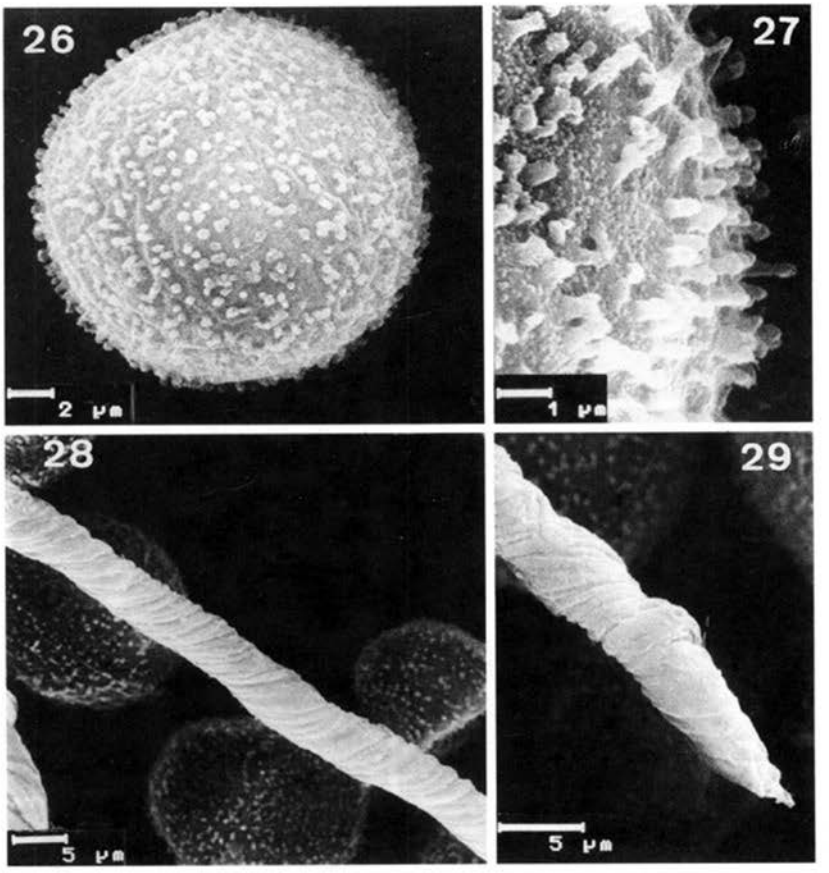


Figs. 22–25. *Prototrichia metallica* (*AH 19503*). 22. Capillitium; 23. detail of capillitium; 24. spore; 25. detail of spore ornamentation.

Prototrichia metallica is characterised by its stalked and sessile sporocarps, its thin, membranous and iridescent peridium, its spirally twisted capillitium (Figs. 22, 23) with many pointed penicillate free ends and its spinose spores with 10–12 µm in diameter (Figs. 24, 25).

This species is not strictly nivicolous, and has been cited previously from Spain (Lado, 1993), but this is the first record from Central Spain (Sierra de Guadarrama).

Collections examined. SPAIN: mountain pass of Navacerrada, 1950 m, Segovia, on wood of *Pinus sylvestris* L., near melting snow, 23.V.1997, leg. A. Sánchez, *AH 19503*; mountain pass of Navacerrada, 2000 m, Segovia, on a dead branch of *Pinus* sp., near melting snow, 17.VI.1999, leg. A. Sánchez, *AH 19576*.



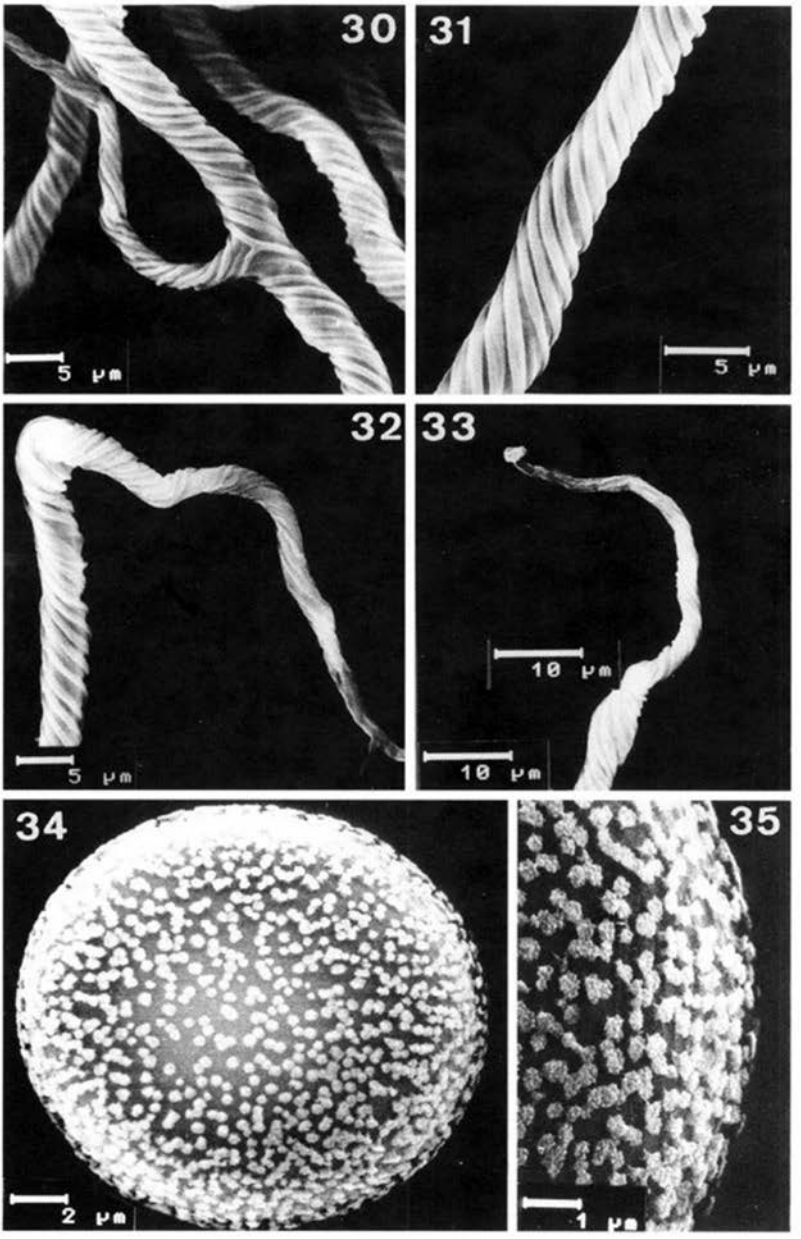
Figs. 26–29. *Trichia alpina* (*AH 18418*). 26. Spore; 27. detail of spore ornamentation; 28. capillitium; 29. free end of capillitium.

Trichia alpina — Figs. 26–29

Trichia alpina (R.E. Fr.) Meyl., Bull. Soc. Vaud. Sci. Nat. 53 (1920) 460.

The characteristic features of *Trichia alpina* are the sessile sporocarps or small, dark brown to blackish plasmodiocarps, and the nivicolous habitat. By SEM the capillitium consists of elaters decorated with smooth, densely wound spiral bands (Fig. 28) with short, sharp-pointed free ends (Fig. 29). The spores show an ornamentation formed by irregularly arranged baculae with irregular apices (Figs. 26, 27).

This species is strictly nivicolous, previously records were published from Spain in the Pyrenees (Lado & Pando, 1997).



Figs. 30–35. *Trichia sordida* var. *sordida* (*AH 18419*). 30. Capillitium with secondary branchlet; 31. capillitium; 32 & 33. free ends of capillitium; 34. spore; 35. detail of spore ornamentation.

Collections examined. SPAIN: mountain pass of Cotos, 1900 m, Segovia, on stems of *Rubus ulmifolius* Schott, 10.V.1996, leg. A. Sánchez, *AH 18418*; mountain pass of Navacerrada, 2100 m, Segovia, on debris of *Cryptogramma crispa* (L.) R. Br. ex Hook., 20.V.1997, leg. A. Sánchez, *AH 18516*; mountain pass of Navacerrada, 2200 m, Segovia, on herbaceous stems, 24.V.1997, leg. A. Sánchez, *AH 18427*.

Trichia sordida var. **sordida** — Figs. 30–35

Trichia sordida var. *sordida* Johannesen, Mycotaxon 20 (1984) 81–82.
= *Trichia bicolor* S.L. Stephenson & M.L. Farr, Mycologia 82 (1990) 513.
= *Trichia contorta* var. *engadinensis* Meyl., Bull. Soc. Vaud. Sci. Nat. 53 (1921) 460.

Trichia sordida var. *sordida* can be recognised by its subglobose sporocarps, its deep yellowish peridium with brown patches, and its 'trichioid', elateriform capillitium, ornamented with 4 or 5 smooth spiral bands (Fig. 31) with pointed free ends (Figs. 32, 33) and a few short secondary branchlets (Fig. 30). The spore ornamentation is dense and consists of baculae with plane, broad and coralloid apices (Figs. 34, 35). This collection coincides with the description of the type material presented by Illana et al. (1993).

Trichia sordida var. *sordidoides* Illana & G. Moreno is characterised by its 'hemitrichioid' capillitium with 4 to 5 smooth spiral bands, many short secondary branchlets and few free ends. The striking difference between the two variations is the form of the capillitium being 'trichioid' in *T. sordida* var. *sordida* and 'hemitrichioid' in *T. sordida* var. *sordidoides*. We did not observe intermediate capillitia between the two varieties. Hence we prefer to maintain the two varieties and do not follow the concept of Lado & Pando (1997), who unify these two taxa.

Illana et al. (1993) considered *T. contorta* var. *engadinensis* Meyl. and *Trichia bicolor* S.L. Stephenson as synonyms of *T. sordida* var. *sordida*, which was later accepted by Lado & Pando (1997).

Trichia sordida var. *sordida* is strictly nivicolous and is cited for the first time from the Iberian Peninsula. Previously only *T. sordida* var. *sordidoides* was known from the peninsula, i.e. from Puerto de Cotos in the Sierra de Guadarrama.

Collection examined. SPAIN: mountain pass of Navafria, 1850 m, Segovia, on bark of *Pinus sylvestris* L., near melting snow, 22.IV.1997, leg. A. Sánchez, *AH 18419*.

ACKNOWLEDGEMENTS

We wish to express our gratitude to Mr. D.W. Mitchel for the revision of the manuscript. We thank J.A. Pérez and A. Priego (Servicio de Microscopía Electrónica, Universidad de Alcalá) for their invaluable help with the SEM. We are grateful to Virginia Fernández for designing the map. H. Singer thanks the National Program of the Professorship Formation, Ministry of Education and Culture of Spain the conceded scholarship for the realization of his doctoral thesis in the University of Alcalá.

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PERSOONIA
Volume 18, Part 1, 85–102 (2002)

CONTRIBUTIONS TOWARDS A MONOGRAPH OF PHOMA (COELOMYCETES) – IX
Section Macrospora

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Nine species of *Phoma*, characterised by always producing relatively large conidia, usually between 7–25 × 2.5–8 µm, aseptate or partly septate, are documented and described in vitro. Three of these fungi could not be described in the usual way, because living cultures were no longer available. The following new taxa are proposed: *Phoma andropogonivora* (R. Sprague & Rogerson) comb. nov., *Phoma boeremae* nom. nov., *Phoma commelinicola* (E. Young) comb. nov. and *Phoma gossypiicola* nom. nov. The combination *Phoma rabiei* proposed by Khune is validated along with its teleomorph *Mycosphaerella rabiei* Kovatsch. Keys and indices on host-fungus and fungus-host relationships are provided and short comments on the ecology and distribution are given.

The *Phoma*-sections treated so far in this series of Contributions include species usually producing relatively small conidia, i.e. between (2–)3–11(–13) × (0.5–)1.5–4(–5) µm ('normal size', compare Boerema, 1997). This applies particularly to sections *Phoma* (De Gruyter & Noordeloos, 1992 and De Gruyter et al., 1993, 1998), *Peyronellaea* (Boerema, 1993) and *Paraphoma* (De Gruyter & Boerema, 2002). Other sections, however, include species that sometimes also produce significantly larger conidia. This is also characteristic of section *Heterospora*: "Taxa with large sized conidial dimorphs" (Boerema et al., 1997, 1999)[1]. Some quite large conidia also occur occasionally in species of the sections *Sclerophomella* (Boerema & de Gruyter, 1998), *Phyllostictoides* (Van der Aa et al., 2000 and De Gruyter et al., 2002) and *Plenodomus* (Boerema et al., 1994, 1996 and Boerema & de Gruyter, 1999).

The section *Macrospora* Boerema, de Gruyter & Noordel. (Boerema, 1997), treated in this paper, is characterised by always producing relatively large conidia both in vivo and in vitro, (7–)8–19(–25) × (2.5–)3–7(–9) µm. The conidia are initially aseptate, but they may become 1-septate by secondary septation.

So far, nine species studied in vitro have been included in this section. Of three of these species, discussed in an Addendum here, only some characteristics of growth in vitro could be noted since living cultures are no longer available.

The type species, *Phoma zeae-maydis* Punith. and some other species of the section were originally interpreted as large spored species of *Phyllosticta* ('Macrostiteae').

1) To be added to the species of sect. *Heterospora* discussed in those two papers are two South American pathogens, viz. *Phoma andigena* Turkenst. and *Phoma crystalliniformis* (Loer., R. Navarro, Lôbo & Turkenst.) Noordel. & de Gruyter, see Noordeloos et al., 1993 and Boerema et al., 1995.

Due to the large conidia and the occasional occurrence of a septum, some species were also classified in *Ascochyta*.

The ultrastructure of conidiogenesis in one of the species presently arranged under sect. *Macrospora*, viz. *Phoma rabiei* (Pass.) Khune has characteristics typical of the genus *Phoma*: a three-layered apical thickening of the conidiogenous cell prior to the formation of the first conidium, and conidial septa attaining from the very start the thickness of a final septum[2] (Singh et al., 1997).

Two species, including the type species, have been connected with a teleomorph belonging to *Mycosphaerella* Johanson.

MATERIAL AND METHODS

The isolates and herbarium specimens were studied as described in the previous Contributions I–1 and I–2 of this series (De Gruyter & Noordeloos, 1992 and De Gruyter et al., 1993). Additional information on terminology (colony colour, outline and diameter usually after 7 days, Q or conidial length-width ratio) is given in Contribution VII (Boerema & de Gruyter, 1998). The isolates studied are currently in the culture collections of CBS, Utrecht (formerly Baarn) and the Plant Protection Service, PD, Wageningen.

KEY TO THE SPECIES AND VARIETIES OF SECTION MACROPHOMA

Differentiation on characteristics in vitro

1a. Colonies on OA colourless to greenish or greyish 2
b. Colonies on OA red to bluish purple or violet 8
2a. Growth-rate on OA and MA slow, 15–30 mm; on OA colonies colourless to pale olivaceous grey, sometimes with a rosy buff tinge, conidia mainly aseptate, 7–15.5 × 3–5.5 µm, pathogen of *Cicer arietinum*, widespread in chickpea-growing areas ..... 1. *P. rabiei* teleomorph *Mycosphaerella rabiei*
b. Growth-rate on OA moderate to fast, > 30 mm 3
3a. Growth-rate on OA and MA fast, 60–80 mm 4
b. Growth-rate on OA and MA moderate, respectively 35–60 mm and 30–45 mm 5
4a. Growth-rate on OA 60 mm, on MA 67–69 mm; on OA colonies dark herbage green to dull green, yellow green near margin, conidia mainly aseptate, 8–15 × 3.5–5.5 µm; on dried stems and seed of cultivated species of *Medicago* in Europe and Australia ..... 2. *P. boeremae*
b. Growth-rate on OA 62–63 mm, on MA 79–80 mm; on OA colonies colourless/buff to pale olivaceous grey, conidia mainly aseptate, (10.5–)13–17(–21) × (4–)5–6.5 µm; pathogen on *Commelinaceae*, e.g. *Commelina nudiflora* and *Tradescantia subaspera*, in North and Central America, and New Zealand ..... 3. *P. commelinicola*

2) In true species of *Ascochyta* the first conidium arises as a thin-walled protrusion, which just before or after secession thickens gradually by a new inner wall layer, that by invagination concurrently divides the conidia into two- or more cells: wall-thickening septation, see Boerema, 1984.

5a. Colonies on OA greenish olivaceous to citrine green, NaOH spot test positive, bluish/green to red (not an E^+ reaction), conidia mainly aseptate, hyaline to pale yellowish, (7.5–)8.5–17.5 × 3.5–5.5(–7) µm, ellipsoidal to allantoid, sometimes curved, chlamydospores absent; specific pathogen of *Delphinium* spp. in Europe
4. *P. xanthina*

b. Colonies on OA colourless/rosy buff to grey olivaceous, with olivaceous grey/olivaceous black sectors, or dark herbage green/dull green to olivaceous, chlamydospores or chlamydospore-like cells present, NaOH spot test negative or pale reddish/brown, not specific 6

6a. Growth-rate on OA 40–41 mm; colonies colourless to grey olivaceous, with olivaceous grey to olivaceous black sectors, conidia mainly aseptate, (12–)15–17 (–25) × 3.5–5(–6.5) µm, chlamydospores may be present, up to 15 µm diameter; pathogen of *Zea mays*, also on *Sorghum* and *Setaria* spp., in North and South America, and southern Africa
5. *P. zeae-maydis* teleomorph *Mycosphaerella zeae-maydis*

b. Growth-rate on OA 45–60 mm; colonies dark herbage green/dull green to olivaceous or colourless/rosy buff to olivaceous 7

7a. Growth-rate on OA 45–55 mm; colonies dark herbage green/dull green to olivaceous, conidia aseptate, 10–12.5 × 2.5–3.5 µm, chlamydospores 8–12 µm diameter; pathogen of *Gossypium* spp., widespread in cotton-growing areas
6. *P. gossypiicola*

b. Growth-rate on OA 47–59 mm (slower growing strains with growth-rate of 43–44 mm occur); colonies colourless to rosy buff, sometimes slightly olivaceous at centre, conidia mainly aseptate, 14–19 × 3.5–4.5 µm, chlamydospore-like cells present, 12–19 µm diameter; pathogen of perennial bunch grasses, *Andropogon gerardii* and *Schizachyrium scoparium* (= *Andropogon scoparium*), in United States ..... 7. *P. andropogonivora* [Addendum]

8a. Growth-rate on OA slow, 10–15 mm; colonies olivaceous grey to red/bluish purple due to a pigment, conidia mainly aseptate, 8.5–12.5(–16) × 3–4.5(–5) µm; necrophyte on *Chenopodium album* and some other Chenopodiaceae (*Atriplex crassifolia*, *Beta vulgaris*), in Eurasia ..... 8. *P. chenopodii* [Addendum]

b. Growth-rate on OA fast; colonies grey olivaceous/olivaceous to red-violet due to a pigment, conidia mainly aseptate, 9.5–13.5 × 5.5–9 µm; pathogen of *Oryza sativa* in southern Europe and southeastern United States
9. *P. necator* [Addendum]

HOST–FUNGUS INDEX

Chenopodiaceae
- *Atriplex crassifolia*
- *Beta vulgaris*
- *Chenopodium album* (main host) (Necrophyte)

no. 8: *P. chenopodii* (Addendum) [Eurasia]

Commelinaceae	
Commelina nudiflora	no. 3: *P. commelinicola*
Tradescantia spp. e.g. *T. subaspera* (Disease: Leaf Necrosis)	[North and Central America, New Zealand]
Gramineae	
Andropogon gerardii	no. 7: *P. andropogonivora* (Addendum)
Schizachyrium scoparium (Disease: Leaf Spot)	[North America]
Oryza sativa (Disease: Wilt symptoms)	no. 9: *P. necator* (Addendum) [southern Europe, south-eastern USA]
Setaria and *Sorghum* spp.	no. 5: *P. zeae-maydis*
Zea maydis (main host) (Disease: Yellow Leaf Blight)	(teleomorph *Mycosphaerella zeae-maydis)* [North and South America, southern Africa]
Leguminosae	
Cicer arietinum (Disease: Anthracnose, Chickpea Blight)	no. 1: *P. rabiei* (teleomorph *Mycosphaerella rabiei*) [widespread on the host]
Medicago spp. e.g. *M. falcata* and *M. littoralis* (Necrophyte)	no. 2: *P. boeremae* [Europe, Australia]
Malvaceae	
Gossypium spp. (Disease: Wet Weather Blight)	no. 6: *P. gossypiicola* [widespread on the host]
Ranunculaceae	
Delphinium spp. (Disease: Leaf and Stem Necroses)	no. 4: *P. xanthina* [Europe]

FUNGUS–HOST INDEX

P. andropogonivora (7)	*Andropogon gerardii*, *Schizachyrium scoparium* (Gramineae)
P. boeremae (2)	*Medicago* spp., e.g. *M. falcata* and *M. littoralis* (Leguminosae)
P. chenopodii (8)	*Chenopodium album* (main host), *Atriplex crassifolia, Beta vulgaris* (Chenopodiaceae)
P. commelinicola (3)	*Commelina nudiflora, Tradescantia* spp. e.g. *T. subaspera* (Commelinaceae)

P. gossypiicola (6)	*Gossypium* spp. (Malvaceae)
P. necator (9)	*Oryza sativa* (Gramineae)
P. rabiei (1) (teleomorph *Mycosphaerella rabiei*)	*Cicer arietinum* (Leguminosae)
P. xanthina (4)	*Delphinium* spp. (Ranunculaceae)
P. zeae-maydis (5) (teleomorph *Mycosphaerella zeae-maydis*)	*Zea maydis* (main host), *Setaria* and *Sorghum* spp. (Gramineae)

DESCRIPTIVE PART

Characteristics based on studies in vitro. Species with a teleomorph are also described in vivo.

1. **Phoma rabiei** (Pass.) Khune[3] — Fig. 1

Zythia rabiei Pass., Comment. Soc. crittogam. ital. 2 (3) (1867) 437 [basionym]. — *Phoma rabiei* (Pass.) Khune in S.B. Mathur, Coelom. India (1979) 182 [without direct reference to basionym: not validly published; Art. 33.2]. — *Phoma rabiei* (Pass.) Khune & J.N. Kapoor, Indian Phytopath. 33 (1980) 120 [with citation of basionym, but without reference of page of publication: also not validly published; Art. 33.2]. — *Phyllosticta rabiei* (Pass.) Trotter, Revue Path. vég. Ent. agric. Fr. 9 (1918) 7. — *Ascochyta rabiei* (Pass.) Labr., Revue Path. vég. Ent. agric. Fr. 18 (1931) 228.

Phyllosticta cicerina Prill. & Delacr., Bull. Soc. mycol. Fr. 9 (1893) 273.

Selected literature. Punithalingam & Holliday (1972), Singh et al. (1997), Kaiser (1997).

Teleomorph: *Mycosphaerella rabiei* Kovatsch.

This teleomorph has been described in detail and illustrated by Kovatschevski (1936) but without a Latin diagnosis as needed after 1 January 1935. Therefore, the essentials of the description are here provided in Latin.

Pseudothecia globosa vel sursum depressa, ostiolis inconspicuis, eximie papillatis, plerumque 163–176 µm diameter et 120 µm alta. Asci cylindrico-clavati, plerumque 60 × 11 µm, octospori, plerumque uniseriati, raro biseriati in ascis. Ascosporae ovoideae, 1-septatae, cellula superior inferiore multo longior, ad septum valde constrictae, plerumque 15 × 7.5 µm.

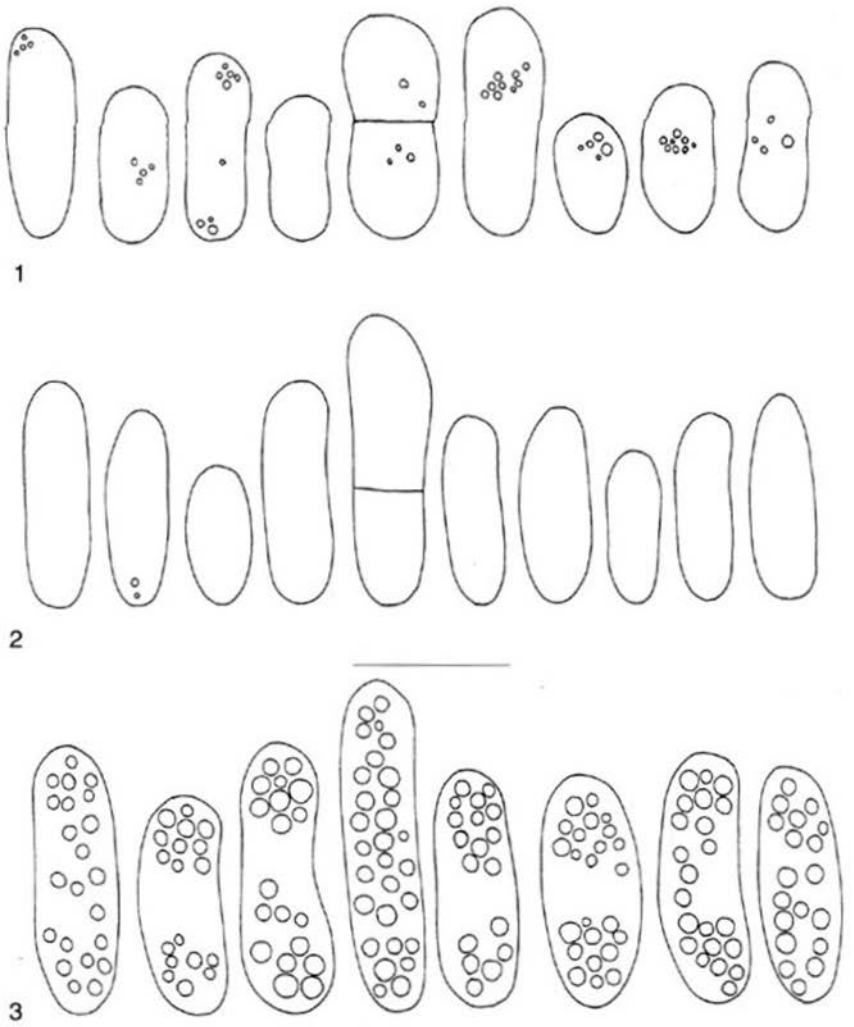
Typus: Pl. IV figs. 4–9 in Kovatschevski, 1936 (in the absence of the specimen from which it was figured, ICBN Art. 8.3).

Description in vitro

OA: growth-rate 18–26 mm after 7 days (after 14 days: 43–52 mm), regular to slightly irregular, aerial mycelium sparse to absent; colony colourless to pale olivaceous grey, sometimes with a rosy buff tinge; reverse similar.

MA: growth-rate 16–29 mm after 7 days (14 days: 30–46 mm), regular to irregular, with finely woolly to floccose, white to pale olivaceous grey aerial mycelium; colony greenish olivaceous dull green and somewhat iron grey in centre, buff to rosy buff near margin; reverse similar.

3) The invalid original combination is here validated by full and direct reference to the basionym.



Figs. 1–3. Conidia. 1. *Phoma rabiei*; 2. *Phoma boeremae*; 3. *Phoma commelinicola*. — Bar = 10 µm.

CA: growth-rate 15–28 mm after 7 days (after 14 days: 25–48 mm), regular to irregular, with felty to finely woolly, white to pale olivaceous grey aerial mycelium; colony colourless to buff or salmon, sometimes olivaceous grey; reverse similar.

Pycnidia 50–160 µm diameter, globose to subglobose, solitary or confluent, glabrous or with some short mycelial outgrowths, with usually one non-papillate or papillate ostiole, citrine/honey, later olivaceous to olivaceous black; walls made up of 2–5 layers of cells, outer layer(s) pigmented; with buff exuded conidial masses; in concentric

zones or scattered, both on and in the agar as well as in the aerial mycelium. Conidiogenous cells 4 × 10 µm, globose to bottle shaped. Conidia mainly aseptate, 7–15.5 × 3–5.5 µm, on average 9.6 × 3.8 µm, Q = 1.7–3.4, av. Q = 2.5, ellipsoidal to allantoid, with several small guttules; 1-septate conidia up to 18 × 5.5 µm.

Chlamydospores absent.

NaOH spot test: negative.

Crystals absent.

Description in vivo (*Cicer arietinum*)

Pycnidia in concentric rings on lesions on stems, leaves and pods, immersed, becoming erumpent, globose, (90–)140–160(–200) µm diameter, with non-papillate ostioles. Conidia similar to those in vitro, usually with some small polar guttules, mainly aseptate, some 1-septate; usually 6–16 × 3–7 µm.

Pseudothecia (observed on overwintered chickpea debris, especially on pods, and on artificially inoculated stem pieces and leaves) globose or depressed globose, (110–)160–175(–250) µm diameter (height 75–150 µm), with inconspicuous papillate ostioles. Asci cylindrical-clavate, 20–70 × 9–13.5 µm, 8-spored, usually uniseriate, rarely biseriate. Ascospores ovoid, 1-septate, upper cells much larger than the lower cells, strongly constricted at the septum, 12.5–19 × 6.5–7.5 µm (for detailed description and illustrations see Kovatschevski, 1936; see also the Latin description in this article).

Ecology and distribution. A noxious pathogen of chickpea, *Cicer arietinum*. The disease, Anthracnose, Chickpea Blight (or '*Ascochyta*' Blight), is the major disease in most chickpea-growing areas. Being seed-borne, the mycelium may be present in the seed coat and cotyledons, and conidia often contaminate the seed surface (Mathur, 1981). Despite the usually unicellular conidia in vivo, the anamorph has been confused with *Ascochyta pisi* Lib., type species of *Ascochyta* (conidia mainly septate in vivo and in vitro, 'wall-thickening septation'; see Khune & Kapoor, 1980). In phytopathological literature the anamorph is commonly called *Ascochyta rabiei* and 'the ascochyta pathogen of chickpea'.

The fungus shows great variation in virulence. It appears to be heterothallic, because compatible mating types are required for development of fertile pseudothecia. Both pycnidia and pseudothecia may develop on overwintered chickpea debris, but compared with pycnidia very few pseudothecia develop. For detailed information on the life cycle of this pathogen see Kaiser (1997).

Representative culture. CBS 581.83 ex *Cicer arietinum* (Leguminosae), Syria.

2. **Phoma boeremae** De Gruyter, *nom. nov.* — Figs. 2, 10

Macrophoma medicaginis Hollós, Math. Termész Közlém. Magy. Tudom-Akad. 35 (1) (1926) 37 [replaced synonym]; non *Phoma medicaginis* Malbr. & Roum. in Roum., Fungi gall. exs. Cent. 37 (1886) No. 3675 and Revue mycol. 8 (1886) 91 (sect. *Phyllostictoides*, De Gruyter et al., 2002).

Neotype: L 996.294.536, dried culture on MA, dated 7.XI.2001, made by J. de Gruyter, Plant Protection Service (PD), Wageningen, the Netherlands from living culture CBS 109942, isol. seed (VPRI 12312) of *Medicago littoralis* cv. Harbinger, Burnley Gardens, Victoria, Australia, Martin Mebalds, 22 Febr. 1982 [the type material of *Macrophoma medicaginis* was destroyed in World War II].

Description in vitro

OA: growth-rate 60 mm after 7 days, regular, with floccose, olivaceous grey to dull green aerial mycelium; colony dark herbage green to dull green, yellow green near margin; reverse similar.

MA: growth-rate 67–69 mm after 7 days, regular, with coarsely floccose, grey olivaceous to dull green aerial mycelium; colony dull green, citrine green near margin; reverse dull green and leaden black.

CA: growth-rate 66–67 mm after 7 days, regular, with floccose, grey olivaceous to olivaceous grey aerial mycelium; colony grey olivaceous to olivaceous; reverse similar, partly leaden black.

Pycnidia 40–320 µm diameter, globose/subglobose to irregular, solitary or confluent, glabrous or with mycelial outgrowths, with 1(–3) non-papillate or papillate ostiole(s), later often developing into an elongated neck, citrine/honey, later olivaceous to olivaceous black; walls made up of 4–9 layers of cells, outer layer(s) pigmented; with rosy buff to vinaceous exuding conidial masses; scattered, both on and in the agar. Conidiogenous cells 5–8 × 5–11 µm, globose to bottle shaped. Conidia mainly aseptate, 8–15 × 3.5–5.5 µm, on average 12.3 × 4.2 µm, Q = 1.7–3.8, av. Q = 2.9, oblong to ellipsoidal, eguttulate or with some small guttules.

Chlamydospores unicellular or multicellular-dictyo/phragmosporous, botryoid, intercalary or terminal, pale olivaceous, 6–22 µm diameter.

NaOH spot test: negative.

Crystals absent.

Ecology and distribution. The two records examined so far refer to dried stems and seed of cultivated species of *Medicago* in Europe and Australia. Under such dry conditions the conidia may look granular due to the presence of numerous guttules (compare Boerema et al., 1997: 352, 353).

Note. The description above is based on an isolate (neotype) obtained by the Australian Seed Testing Station at Burnley, Victoria, in 1984 and sent for identification to my friend Gerhard(us Hendrik) Boerema, then head of the Mycological Department of the Dutch Plant Protection Service. In an annotation dated June 1985 he had suggested that it might belong to *Macrophoma medicaginis* Hollós, described from dried stems of *Medicago falcata* in Hungary in 1926. It should be noted that the species of *Medicago* cultivated in Australia are all of Mediterranean origin and as expected the various other *Phoma* species found on seeds of *Medicago* in Australia are common in Europe. As the epithet *medicaginis* is no longer available for *Phoma*, I am very pleased to name this typically large spored *Phoma* species after Gerhard Boerema. Our present knowledge of *Phoma* taxonomy is based on his work, in co-operation with several colleagues over recent decades. Retired for 15 years already, he is still working on *Phoma*, and continues to stimulate me with his enthusiasm, experience and knowledge to do this taxonomic work.

Representative culture. CBS 109942 (PD 84/402) ex *Medicago littoralis* (Leguminosae), Australia.

3. **Phoma commelinicola** (E. Young) De Gruyter, *comb. nov.* — Fig. 3

Phyllosticta commelinicola E. Young, Mycologia 7 (1915) 144 [basionym; holotype on leaves of *Commelina nudiflora*, coll. *F.L. Stevens*, Hormigueros, Puerto Rico, 14.I.1913; herb. Stevens No. 214, ILL 11604].

Description in vitro

OA: growth-rate 62–63 mm after 7 days, regular, with woolly, white to pale olivaceous grey aerial mycelium; colony colourless/buff to pale olivaceous grey; reverse similar.

MA: growth-rate 79–80 mm after 7 days, regular, with woolly, white to pale olivaceous grey aerial mycelium; colony buff, with white to pale olivaceous grey overlay due to aerial mycelium; reverse buff to honey, partly olivaceous black.

CA: growth-rate 72–73 mm after 7 days, regular, with woolly, white to pale olivaceous grey aerial mycelium; colony buff, with white to pale olivaceous grey due to aerial mycelium; reverse buff/honey to ochraceous/apricot.

Pycnidia 70–320 µm diameter, globose to subglobose, solitary or confluent, glabrous, with 1 or 2 papillate or non-papillate ostiole(s), honey/sienna, later olivaceous to olivaceous black; walls made up of 2–7 layers of cells, outer layer(s) pigmented; with rosy buff exuding conidial masses; scattered, both on and in the agar as well as in the aerial mycelium. Micropycnidia present, 40–70 µm diameter. Conidiogenous cells 4–11 × 4–11 µm, globose to bottle shaped. Conidia mainly aseptate, (10.5–)13–17(–21) × (4–)5–6.5 µm, on average 15.3 × 5.3 µm, Q = 1.9–5.3, av. Q = 3.0, ellipsoidal, with several small, scattered guttules; 1-septate conidia of similar size, sparse.

Chlamydospores absent.

NaOH spot test: negative.

Crystals absent.

Ecology and distribution. This species, described from *Commelina nudiflora* in Porto Rico, was associated with dead or dying leaves ("pycnidia subepidermal, conidia 9.6–14.4 × 4.8–7.2 µm"). It also occurs on other Commelinaceae; the above in vitro description refers to an isolate from leaf spots on a *Tradescantia* sp. in New Zealand. The genus *Tradescantia* is indigenous to America. A specimen on *T. subaspera* was collected in Madison, Wisconsin, United States in 1959 (Greene, 1960: 88; specimen preserved in WIS: "Conidia (10–)12–15(–20) × 3.5–5 µm, no septa were noted, nevertheless, the aspect of the specimen suggests *Ascochyta*").

Representative culture. CBS 100409 (LYN 15707) ex *Tradescantia* sp. (Commelinaceae), New Zealand.

4. **Phoma xanthina** Sacc. — Fig. 4

Phoma xanthina Sacc., Michelia 1 (4) (1878) 359. — *Macrophoma xanthina* (Sacc.) Berl. & Voglino, Atti Soc. Veneto-Trent. Sci. nat. 10 ('1886' 1887) 181. — *Ascochytella xanthina* (Sacc.) Petr. & Syd., Annls mycol. 22 (1924) 347.

Description in vitro

OA: growth-rate 34–37 mm after 7 days (after 14 days: 54–66 mm), regular, with velvety to woolly, white to pale olivaceous grey/grey olivaceous aerial mycelium; colony greenish olivaceous/citrine green to grey olivaceous; reverse similar.

MA: growth-rate 34–42 mm after 7 days (after 14 days: 80–83 mm), regular, with compact woolly, white to grey olivaceous aerial mycelium; colony citrine green to herbage green/greenish olivaceous, olivaceous grey/iron grey in centre; reverse leaden grey/leaden black, herbage green near margin.

CA: growth-rate 32–37 mm after 7 days (after 14 days: 33–43 mm), regular, compact felty to woolly, pale olivaceous grey/grey olivaceous aerial mycelium; colony (pale) olivaceous grey/grey olivaceous to dull green; reverse leaden grey/leaden black, umber near margin.

Pycnidia 100–320 µm diameter, globose to subglobose, mostly solitary, glabrous or with mycelial outgrowths, with usually one non-papillate, often indistinct ostiole, citrine/honey, later olivaceous black; walls made up of 3–10 layers of cells, outer layer(s) pigmented; exuding conidial masses not observed; scattered, both on and in the agar as well as in aerial mycelium. Conidiogenous cells 6–13 × 14 µm, globose to bottle shaped. Conidia mainly aseptate, hyaline to pale yellowish, (7.5–)8.5–17.5 × 3.5–5.5(–7) µm, on average 12.5 × 4.5 µm, Q = 1.8–4.0, av. Q = 2.9, ellipsoidal to allantoid, eguttulate or with several scattered guttules; occasionally also 1-septate conidia of similar size or larger, up to 24 × 7 µm, ellipsoidal to allantoid, sometimes curved.

Chlamydospores absent.

NaOH spot test: positive, a bluish/green to red colour appears on OA, a reddish brown colour appears on MA (not an E^+ reaction).

Crystals absent, but small yellowish to brownish pigmented grains are produced in the media.

Ecology and distribution. So far only recorded from Europe. It is apparently a specific pathogen of *Delphinium* spp., causing stem- and leaf necroses. The latter often start as small leaf spots, which later coalesce. Conidia usually remain unicellular in vivo (Petrak & Sydow, 1924: "eine *Ascochytella*, bei welcher die Konidien ausnahmsweise 1-zellig geblieben sind"); common dimensions 9–17 × 5–7 µm. It should be noted that a *Phoma* sp. of the section *Heterospora* also frequently occurs on *Delphinium* spp. in Europe, viz. *Phoma delphinii* (Rabenh.) Cooke (see Boerema et al., 1997).

Representative culture. CBS 383.68 ex *Delphinium* sp. (Ranunculaceae), the Netherlands.

5. **Phoma zeae-maydis** Punith. — Figs. 5, 11

Teleomorph: *Mycosphaerella zeae-maydis* Mukunya & Boothr.

Phoma zeae-maydis Punith., Mycopathologia 112 (1990) 50. — *Phyllosticta maydis* Arny & R.R. Nelson, Phytopathology 61 (1971) 1171; non *Phoma maydis* Fautrey, Revue mycol. 16 (1894) 161 [agrees with *Phoma nebulosa* (Pers.: Fr.) Berk., see De Gruyter et al., 1993], nor *Phoma maydis* Ellis & Everh., A. Rep. Del. Agric. Exp. Stn 6 ('1893' 1895) 33 [nomen nudum].

Selected literature. Arny & Nelson (1971), Punithalingam (1990).

Description in vitro

OA: growth-rate 40–41 mm after 7 days, regular, with felty to finely floccose, white to pale olivaceous grey aerial mycelium; colony colourless to grey olivaceous, and olivaceous grey to olivaceous black sectors; reverse similar.

MA: growth-rate 36–37 mm after 7 days, irregular, with compact, finely floccose to woolly, white to olivaceous buff aerial mycelium; colony partly dull green to olivaceous, herbage green near margin; reverse similar, leaden grey/olivaceous black in centre.

CA: growth-rate 52–55 mm after 7 days, regular, with finely floccose, white to pale olivaceous grey aerial mycelium; colony greenish olivaceous/olivaceous to olivaceous grey sectors; reverse similar.

Pycnidia 120–160(–230) µm diameter, globose to subglobose, solitary or confluent, glabrous, with usually one papillate ostiole, citrine/honey, later olivaceous to olivaceous black; walls made up of 2 or 3 layers of cells, outer layer(s) pigmented; exuded conidial masses not observed; scattered, both on and in the agar.

Conidiogenous cells 4–10 × 3–8 µm, globose to bottle shaped. Conidia mainly aseptate, (12–)15–17(–25) × 3.5–5(–6.5) µm, on average 15.5 × 4.5 µm, Q = 3.2–4.9, av. Q = 3.8, ellipsoidal, with several small, scattered guttules; 1-septate conidia of similar size, sparse.

Chlamydospores may be formed, globose to subglobose, intercalary or terminal, in short chains or clustered, 8–20 µm diameter.

NaOH spot test: a reddish/brown, non-specific colour may develop.

Crystals absent.

Description in vivo (*Zea mays*)

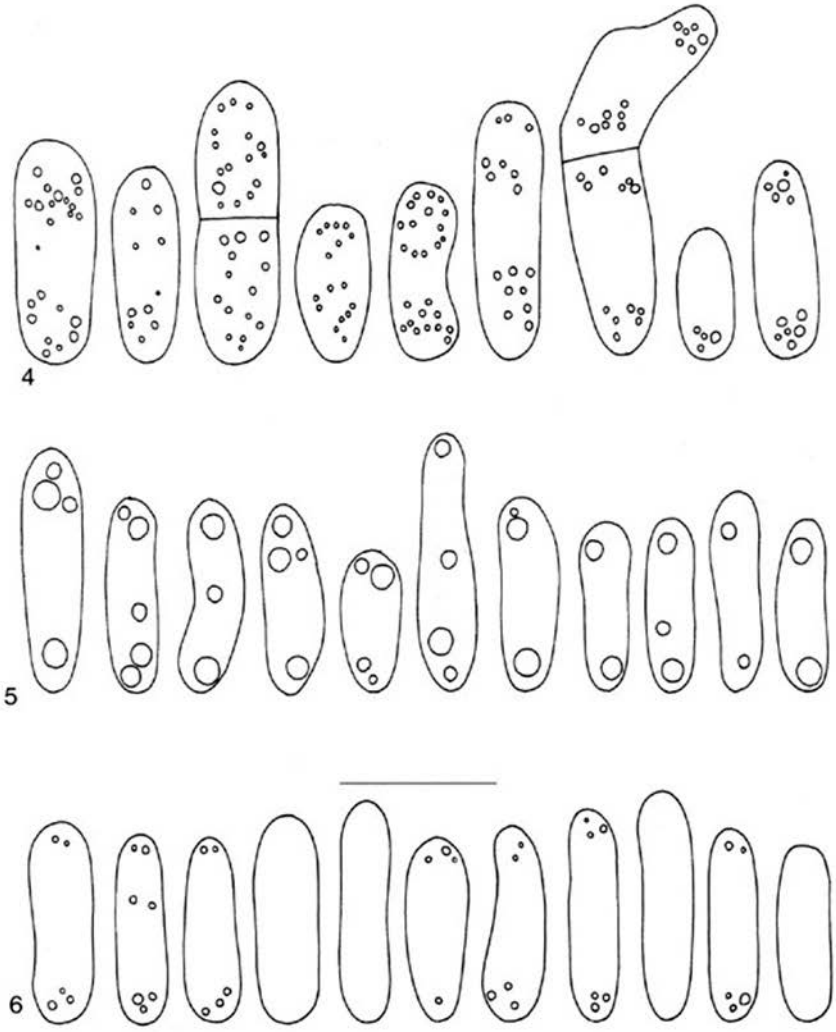
Pycnidia as tiny pinpoints in necrotic lesions on the leaves, chiefly epiphyllous, subglobose to globose, 120–160 µm diameter, with slightly papillate ostioles. Conidia similar to those in vitro, usually conspicuously biguttulate, aseptate, but germinating conidia often develop septa.

Pseudothecia observed naturally in spring on maize leaf debris, and obtained artificially in sterilised leaf tissue, subglobose to globose (86–)90–192(–200) µm diameter, initially closed, later with papillate ostioles. Asci cylindrical to subclavate, 40–65 × 9.5–12 µm, 8-spored, biseriate to irregularly biseriate. Ascospores ellipsoidal, 1-septate, upper cells usually larger than the lower cells, constricted at the septum, (14–)16–*17(–19) × 4–5(–6) µm (for detailed descriptions and illustrations see Mukunya &* Boothroyd, 1973 and Punithalingam, 1990).

Ecology and distribution. The main host of this fungus is *Zea mays* (Yellow Leaf Blight of maize), but it is also recorded on *Sorghum* and *Setaria* spp. Its distribution includes North America (Canada, United States), South America (Bolivia, Equador) and southern Africa. The fungus is probably homothallic, pseudothecia are only known from maize leaves overwintered in the field.

Ascospores may be the cause of early infection in the spring, whilst conidia cause infections in the growing season. The conidia are usually aseptate in vivo and mostly 10–15 × 3–4 µm.

Representative culture. CBS 588.69 (PD 69/1151) ex *Zea mays* (Gramineae), United States.



Figs. 4–6. Conidia. 4. *Phoma xanthina*; 5. *Phoma zeae-maydis*; 6. *Phoma gossypiicola*. — Bar = 10 µm.

6. **Phoma gossypiicola** De Gruyter, *nom. nov.* — Figs. 6, 12

Ascochyta gossypii Woron., Vêst. tiflis. bot. Sada 35 (1914) 25 [replaced synonym; holotype coll. *N. Woronichin* on a leaf of *Gossypium* sp. cult., near Abazinka, distr. Soci, Caucasus, 19 August 1913]; non *Phoma gossypii* Sacc., Michelia 2 (1) (1880) 144.

Ascochyta gossypii Syd., Annls mycol. 14 (1916) 194 [later homonym].

Selected literature. Holliday & Punithalingam (1970).

Description in vitro

OA: growth-rate 47–55 mm after 7 days, regular, with sparse velvety, olivaceous grey aerial mycelium; colony dark herbage green/dull green to olivaceous; reverse grey olivaceous/olivaceous to violaceous grey/leaden grey.

MA: growth-rate 29–35 mm after 7 days (14 days: 61–68 mm), regular, with sparse velvety, olivaceous grey aerial mycelium; colony olivaceous black, grey olivaceous to dull green near margin; reverse leaden grey to olivaceous black, grey olivaceous to dull green near margin.

CA: growth-rate 38–42 mm after 7 days, regular, with sparse velvety, grey olivaceous aerial mycelium; colony olivaceous to olivaceous black, grey olivaceous to dull green near margin; reverse leaden grey to olivaceous/olivaceous black.

Pycnidia 100–250 µm diameter, globose to subglobose, solitary or confluent, glabrous, with or without one usually non-papillate ostiole, honey, later olivaceous to olivaceous black; walls made up of 3–10 layers of cells, outer layer(s) pigmented; with off-white exuded conidial masses; scattered, both on and in the agar and in aerial mycelium. Conidiogenous cells 5–8 × 5–8 µm, globose to bottle shaped. Conidia aseptate, 10–12.5 × 2.5–3.5 µm, on average 11.5 × 3.1 µm, Q = 3.2–4.6, av. Q = 3.7, ellipsoidal, with several small, scattered guttules.

Chlamydospores present, globose to elongate, usually in chains, olivaceous, with greenish guttules, 8–12 µm diameter.

NaOH spot test: negative.

Crystals absent.

Ecology and distribution. This species is a well-known cause of leaf spots and stem cankers on cotton, *Gossypium* spp. (Wet Weather Blight). As noted above, the relatively large conidia always remain one-celled in vitro, but in vivo most conidia may become two- or even more-celled and longer, up to 14 µm. The fungus appears to be seed- and soil-borne and probably occurs everywhere cotton is grown. Isolates studied were from North America (United States), India and Africa (Sudan). The fungus may also attack other cultivated crops (Holliday & Punithalingam, 1970). However, the literature on its host range must be read with much reserve, because the fungus has been confused with other species such as *Phoma pomorum* Thüm. (sect. *Peyronellaea*) and *Phoma exigua* Desm. (sect. *Phyllostictoides*; see Boerema et al., 1973: 133 and Boerema & Dorenbosch, 1980: 27).

Representative culture. CBS 377.67 (PD 63/942) ex *Gossypium* sp. (Malvaceae), USA (Texas).

ADDENDUM

The classification in sect. *Macrospora* of the three species discussed below, is also based on an in vitro study, but living cultures are no longer available for detailed descriptions on OA, MA and CA.

7. **Phoma andropogonivora** (R. Sprague & Rogerson) De Gruyter, *comb. nov.* — Figs. 7, 13

Phyllosticta andropogonivora R. Sprague & Rogerson, Mycologia 50 (1958) 639 [basionym; holotype on leaf of *Andropogon gerardii*, Miami Co., Kansas, United States, coll. *C.T. Rogerson*,

WSP]. — *Ascochyta andropogonivora* (R. Sprague & Rogerson) Morgan-Jones in Morgan-Jones et al., Mycotaxon 42 (1991) 56.

Selected literature. Morgan-Jones et al., 1991.

Some characteristics in vitro (adopted from Morgan-Jones et al., 1991).

Growth-rate mostly moderate on PDA (comparable with OA), 47–59 mm after 7 days, at first whitish but becoming pale salmon (rosy buff), sometimes with a slightly olivaceous tinge at centre, with an even and densely woolly to felty mycelial mat; slower growing strains with growth-rate of 43–44 mm after 7 days are less salmon coloured, but with cream patches intermixed with orange-greyish areas and an olive-grey centre. Darker sectors appear, due to the formation of chlamydospore-like cells of 12–19 µm diameter, subglobose to globose, in long intercalary chains or in botryose clusters.

Pycnidia up to 240 µm diameter, (sub)globose to irregular, solitary or confluent, glabrous, with usually 1–3, non-papillate or very slightly papillate ostiole(s), pale to mid brown; walls made up of 3 or 4 layers of cells, outer layers pigmented, mostly superficial on the agar. Conidiogenous cells 6.5–9 × 4.5–7 µm, globose to bottle shaped. Conidia unicellular, rarely 1-septate, 14–19 × 3.5–4.5 µm, cylindrical, often slightly curved, usually with distinct polar guttules.

Ecology and distribution. This fungus causes a leaf spot on varieties of *Andropogon gerardii* and also on plants of *Schizachyrium scoparium* (= *Andropogon scoparius*), both perennial bunch grasses widely distributed in the Great Plains of the United States (big- or sand bluestem and little bluestem). In vivo, the conidia are generally aseptate (Morgan-Jones et al., 1991: "reclassified in *Ascochyta* mainly on the basis of the shape and size of its conidia"), and somewhat shorter and slightly broader than those in vitro, 13.5–15 × 4–4.5 µm.

Representative culture. Not obtained.

8. **Phoma chenopodii** S. Ahmad — Fig. 8

Phoma chenopodii S. Ahmad, Sydowia 2 (1948) 79.

Phoma chenopodii Pavgi & U.P. Singh, Mycopath. Mycol. appl. 30 (1966) 265 [later homonym].

Phyllosticta bacilliformis Padwick & Merh, Mycol. Pap. 7 (1943) 4; not *Phoma bacilliformis* Wehm., Mycologia 38 (1946) 316 [= *Asteromella* sp.].

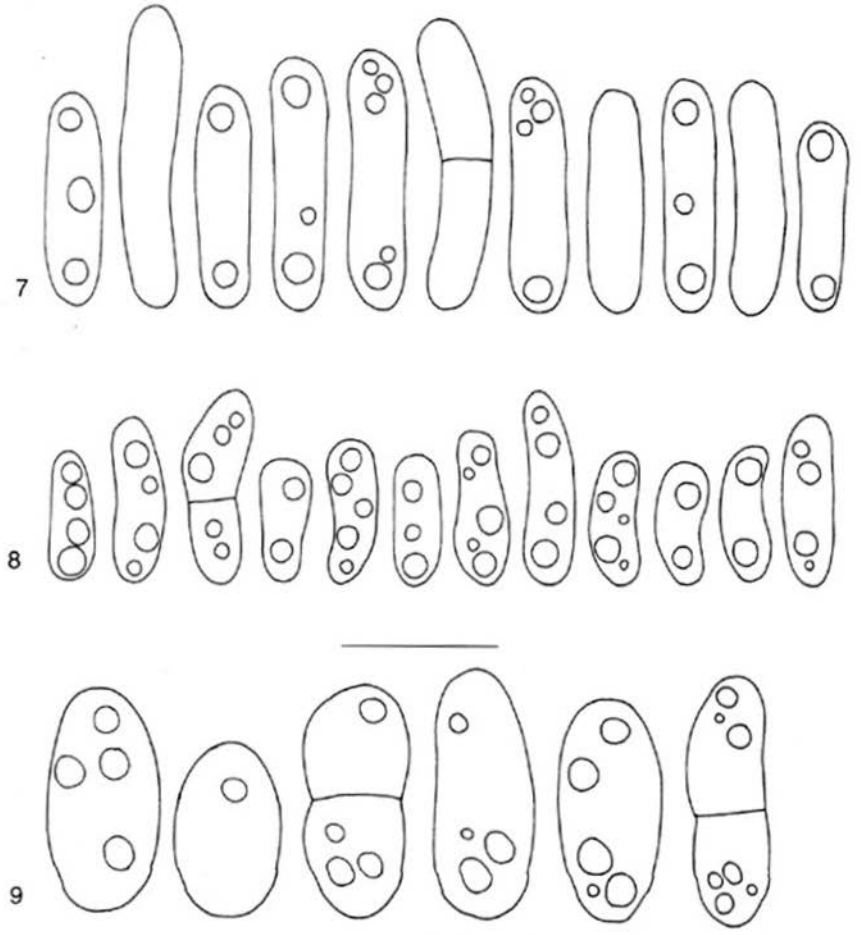
Some characteristics in vitro (documentation concerning lost Dutch cultures, see Boerema, 1984: 33, note).

Colonies on OA, MA and CA slow growing, 10–15 mm diameter after 7 days, regular or irregular (MA), olivaceous grey, with a red/bluish purple discolouration due to a pigment, especially on OA; aerial mycelium sparse, (pale) olivaceous grey.

Pycnidia subglobose, 100–200 µm diameter, slightly papillate, with inconspicuous ostiole. Conidia irregular subcylindrical to ellipsoidal, with several large guttules, 8.5–12.5(–16) × 3–4.5(–5) µm, mostly aseptate within the pycnidium, but often becoming 1-septate and occasionally 2-septate in the exuding mass (secondary septation preceding germination).

NaOH spot test: negative.

Representative cultures have been lost.



Figs. 7–9. Conidia. 7. *Phoma andropogonivora*; 8. *Phoma chenopodii*; 9. *Phoma necator*. — Bar = 10 µm. Drawing 7 after Morgan-Jones et al. (1991).

Note. The main host of this soil- and seed-borne necrophyte is *Chenopodium album*, but it has also been found on some other Chenopodiaceae, e.g., *Atriplex crassifolia* and *Beta vulgaris*. The above synonyms refer to specimens collected in Pakistan and India (herb. HCIO, IMI), but the fungus is also recorded in Russia and the Netherlands (Boerema, 1984). The relatively large conidia (7.5–16 × 3–5 µm in vivo) with septation usually occurring immediately before germination, explain why the fungus has sometimes been confused with a true *Ascochyta* occurring on Chenopodiaceae, viz. *Ascochyta caulina* (P. Karst.) Aa & Kesteren, the anamorph of *Pleospora calvescens* (Fr. ex Desm.) Tul. (see Boerema et al., 1987).

9. **Phoma necator** Thüm. — Fig. 9

Phoma necator Thüm., Labor. Versuchs-Station Wein-Obstbau Klosterneuburg 12 [Pilze Reispfl.] (1889) 12 [not '*necatrix*' as erroneously listed in compiling works].

Selected literature. Padwick, 1950; Bessi & De Carolis, 1974.

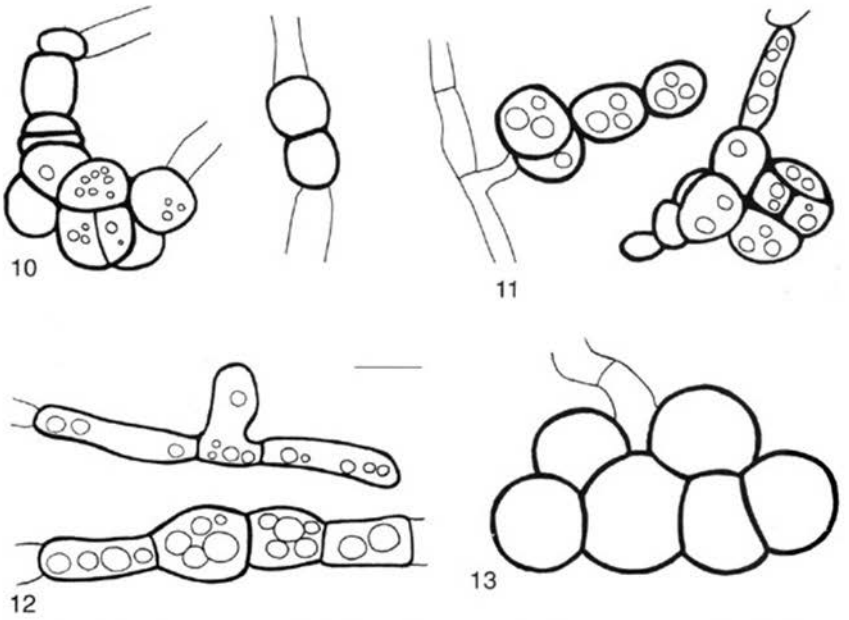
Some characteristics (from a dried Italian culture, see below).

Colonies on OA fast growing, irregular, grey olivaceous to olivaceous, with a red-violet discolouration of the medium due to a pigment, aerial mycelium abundant, grey olivaceous.

Pycnidia 110–325 µm diameter, globose to subglobose, solitary or confluent, glabrous, often covered by aerial mycelium, with usually one non-papillate or papillate ostiole, exuding conidial mass not observed, scattered, both on and in the agar. Conidia aseptate, 9.5–13.5 × 5.5–9 µm, on average 11.5 × 7 µm, Q = 1.3–2.0, av. Q = 1.6, guttulate, subglobose to ellipsoidal; 1-septate conidia up to 16 × 6 µm, constricted at septum.

Ecology and distribution. Associated with a rapid wilt of rice, *Oryza sativa*, in Austria, Italy and southeastern United States. The conidial dimensions in vivo should vary between 10–12 × 6–8 µm.

Representative dried culture. CBS 3509 ex *Oryza sativa* (Gramineae), Italy (leg. Bessi & De Carolis l.c.).



Figs. 10–13. Chlamydospores. 10. *Phoma boeremae*; 11. *Phoma zeae-maydis*; 12. *Phoma gossypiicola*; 13. *Phoma andropogonivora*. — Bar = 10 µm. Drawing 13 after Morgan-Jones et al. (1991).

ACKNOWLEDGEMENTS

The material for this study has been gratefully received from CBS, HCIO, ILL, IMI, WIS, WSP. I am grateful to Dr. R.T.A. Cook for revising the English text. Thanks are also due to Dr. W. Gams for the Latin translation.

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PERSOONIA
Volume 18, Part 1, 103–114 (2002)

NUCLEAR DNA CONTENT, LIFE CYCLE AND PLOIDY IN TWO NEOTTIELLA SPECIES (PEZIZALES, ASCOMYCOTA)

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Genome size, life cycle, and ploidy were determined for *Neottiella vivida* (Nyl.) Dennis and *N. rutilans* (Fr.) Dennis. The relative DNA content was measured from fruit-bodies using cytofluorometry; genome size was obtained by comparison with two standards: conidia of *Trichophea hemisphaerioides* (23.3 Mb) and a spore-print from *Pleurotus ostreatus* (25 Mb). *Neottiella vivida* and *N. rutilans* were found to have genomes of approximately 750 Mb and 530 Mb, respectively. The ploidy level of *N. rutilans* is 50, that of *N. vivida* was calculated to be 70. In *N. vivida*, meiotic division occurs in the ascus apex where giant mitochondria with a DNA content of 60 Mb, 54 Mb, and 30 Mb were found.

The two species are morphologically very similar and can be distinguished only by their ascospore ornamentation, which is reticulated in *N. rutilans* and warted in *N. vivida*. Due to endoreduplication in the uninucleate ascospores of *N. vivida*, the value of their nuclear DNA content is 2C. In *N. rutilans*, endoreduplication is not arrested at the 2C value but may proceed at a different rate in spores. Thus *N. rutilans* reveals heterogeneity in ploidy levels of sporal nuclei. In *N. vivida* and *N. rutilans*, differences in spore ornamentation may result from different patterns of gene expression regulated by the ploidy-dependent gene.

Quantification of changes in nuclear DNA has significantly contributed to a better understanding of the life cycle of several fungi (Olive, 1953; Bryant & Howard, 1969; Collins, 1979; Franklin et al., 1983; Anderson, 1982; Collins et al. 1983; Whisler et al., 1983; Horgen et al., 1985; Bresinsky et al., 1987; Wittmann-Meixner, 1989; Bayman & Collins, 1990; Weber, 1992).

Changes of nuclear DNA content occur at DNA replication and cell division, in the evolution of species, and during differentiation of cells in an organism. Ascomycetes with a sexual cycle double their ploidy upon fertilization in the ascus and reduce their ploidy by half at meiosis, producing ascospores. In the vegetative mycelium, the nuclear DNA content varies during the mitotic (G1 versus G2 phases) cycle of cell division. In the development of the organism, specialized polyploid cell types may arise through endocycles, i.e. cell cycles lacking cell division. Cells differing only by their ploidy are identical in terms of DNA sequence information, but are often quite different in terms of developmental, morphological, and physiological characteristics (Galitski et al., 1999; Hieter & Griffiths, 1999).

The term genome denotes the DNA of the haploid chromosome complement in terms of quality and quantity. The DNA content of the unreplicated haploid nuclear genome is known as its 1C-value (Swift, 1950). Dividing cells pass through a regular, repeated sequence of events known as the cell cycle. The cell cycle is divided into interphase and mitosis. Interphase is a period of chromosome duplication. Interphase can be divid-

ed into three phases, which are designed G1, S, and G2. Mitosis and cytokinesis together are referred to as the M phase of the cell cycle. The specialized resting, or dormant, state is called the G0 phase (G-zero phase). In the cell cycle, progression is mainly controlled at two crucial transition points, called checkpoints – one at the end of G1 and another at the end of G2. It is at the G1 checkpoint that the control system either arrests the cycle or triggers a process that will initiate the S phase (synthesis phase). At the G2 checkpoint, the control system again either arrests the cycle or initiates mitosis (Raven et al., 1999).

Species in Sclerotiniaceae and Leotiaceae (Helotiales) often have uninucleate spores with the 2C-value (Weber, 1992). The undivided nuclei of the large-budded fraction of *Saccharomyces cerevisiae* (Meyen ex Reese) Hansen are arrested in the anaphase or metaphase, i.e. in the G2 phase of the cell cycle (Hanna et al., 1995). However, the nuclei of spores of most species in Helotiales (Weber, 1992), as well as *Glomus versiforme* (P. Karst.) S.M. Berch (Bianciotto et al., 1995) and species in the genera *Pleurotus* (Fr.) P. Kumm. and *Phellinus* Quél. (Kullman, 2000) are arrested in the G0/G1 phase (at the 1C-value).

Hence, although measurements *per se* cannot reveal whether each individual nucleus actually progresses through the cell cycle or not, kinetic information can be inferred from DNA content (position of the cell cycle). Progression through the S-phase and mitosis is expressed by changes in nuclear DNA content. The position of the nuclei in the cell cycle can therefore be estimated on the basis of measurement of DNA content. When measuring nuclei in the haplophase (nuclei with a 'single set' of chromosomes), a distribution curve is obtained whose first maximum (basic DNA content), indicating nuclei in the cell cycle G0/G1 phase, corresponds to genome size (1C-value – the DNA content of the unreplicated haploid nuclear genome, unit) (see Kullman, 2000).

In studies of polyploidy in fungi, variation of nuclear relative DNA content due to the mitotic cycle was tested by Bresinsky et al. (1987), Wittman-Meixner & Bresinsky (1989), Weber (1992), and Weber & Bresinsky (1992). It was shown that basic nuclear DNA content is the same in young and old mycelia (irrespective of the medium and the age of the culture), as well as in fruit-bodies, sclerotia or conidia. In young mycelia, DNA values are comparable to those of the fruit-body. Most nuclei are in the G0/G1 phase of the cell cycle. In haplonts nuclear DNA content in this cell cycle phase corresponds to their genome size.

In the dikaryophase, two nuclei combine to form a zygote (nuclei in diplophase with a 'double set' of chromosomes). In fungi the zygote is the only diploid (2n) cell. In the ascus, the nucleus is divided immediately by meiosis (zygotic meiosis), thus restoring the haploid (n) condition in the life cycle (n – the haploid chromosome set, unit). The cell nuclei may undergo endoreduplication (DNA replication in absence of mitotic cell division) and endopolyploidy ('many set' of chromosomes) can be assumed to occur (× – the basic chromosome set, the basic DNA content in germ-line polyploids) (Nagel, 1978).

Since in some cases the content of nuclear DNA in the fruit-body (often in tips of paraphyses but also in all other cell types) appeared to be larger, endopolyploidy was assumed to occur in ascomycetes (Weber, 1992) and in basidiomycetes (Paxillus, Serpula, and *Leucogyrophana*) (Meixner & Bresinsky, 1988; Wittman-Meixner & Bresinsky, 1989).

In this study the nuclear behaviour of two moss parasites, the ascomycetes *Neottiella vivida* and *N. rutilans,* is examined. The main aim was to establish whether there occur changes in ploidy during fungal growth and morphogenesis, as well as to determine absolute genome sizes and ploidy levels in these species.

MATERIALS AND METHODS

Fruit-bodies of *Neottiella vivida* (Nyl.) Dennis, Norway, Tromsö, Brennfjell, 26 Aug. 1998, A. Jakobson (TAA 135733) and *N. rutilans* (Fr.) Dennis, Finland, Kilpisjärvi, Sana, 25 Aug. 1998, A. Jakobson (TAA 135730), were fixed in Carnoy (Romeis, 1948) and kept at 4°C until needed.

The slides used for measuring relative nuclear DNA content were also used for measuring spore dimensions with an 'AMPLIVAL' microscope equipped with an HI 100 immersion objective. The length (l) and width (w) of spores are presented in the following form: $l_{mean} \times w_{mean}$ µm, where l_{mean} and w_{mean} denote the mean values of the length and width of 20 spores from a specimen. The variation coefficient is equivalent to the standard deviation as a percentage divided by the mean value.

For staining nuclei the material was squeezed between the slide and the cover-slip and subjected to the DAPI-staining procedure described in Bresinsky et al. (1987), Wittmann-Meixner (1989), Weber (1992), and Büttner (1999). The relative DNA content in nuclei and mitochondria was measured by cytofluorometry at the Institute of Botany, Regensburg University, using a Zeiss UNIVERSAL photomicroscope, equipped with an III RS epifluorescence illuminator, and an 03 Zeiss microscope photometer. The measured fluorescence intensity (in arbitrary units = a.u.) is proportional to DNA content in the nucleus. When measuring nuclei in the haplophase, a distribution curve is obtained whose first maximum, indicating nuclei in the cell cycle G0/G1 phase, corresponds to the genome size.

The resulting fluorescence histograms can be analyzed for calculating the difference in nuclear DNA content between the specimens. By including an internal standard, relative DNA content is converted to the absolute amount. The genome size of an unknown specimen is obtained by dividing the mean relative DNA content of the unknown G0/G1 population of nuclei by the mean of the standard G0/G1 population of nuclei and by multiplying the result by the genome size of the standard. Usually DNA content is expressed in picograms (pg) or in base pairs (bp), kilobases (kb, a stretch of 1000 nucleotide pairs in DNA) and megabase pairs of nucleotides (Mb) (NB 1pg = 965 Mb, see Bennet & Leitch, 1995).

The genome size of *N. vivida* and *N. rutilans* was estimated by comparison with two standards: conidia from a pure culture of the ascomycete *Trichophaea hemisphaerioides* (Mounton) Graddon (TFC 97-71 from TAA 147708) and a spore-print from the oyster mushroom *Pleurotus ostreatus* (Jacq.: Fr.) P. Kumm. (TAA 142824). The genome size of *T. hemisphaerioides* was 23.3 Mb, and that of *P. ostreatus* 25 Mb (Kullman, 2000).

RESULTS AND DISCUSSION

From the standpoint of nuclear cytology, *N. vivida* and *N. rutilans* have a life cycle typical of ascomycetes (Rossen & Westergaard, 1966; Weber, 1992; Weber & Bresins-

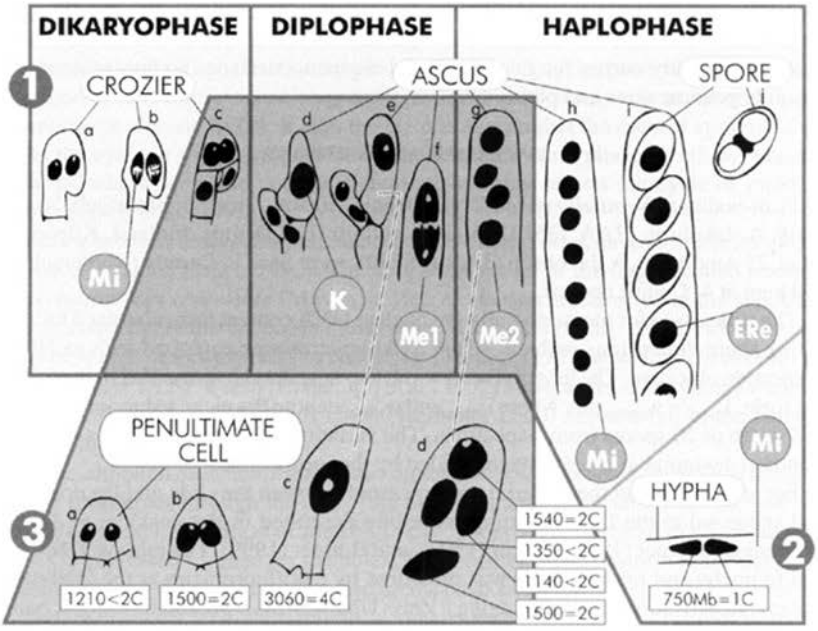

Fig. 1. Diagram representation of nuclear behaviour during development of the ascus in *N. vivida*. a. Crozier formation from dikaryotic ascogenous hypha; b. conjugate nuclear mitotic division (Mi); c. tip and basal crozier cells fuse and form ascus mother cell or another crozier by the side of the first one. Nuclei up to 2C; d, e. karyogamy (K) in a young ascus (zygote nucleus = 4C); f. two nuclei after the first meiotic division (Me1), 2C; g. four nuclei after the second meiotic division (Me2), 1C; h. eight nuclei after mitotic division (Mi), 1C; i. ascospore formation; endoreduplication (ERe) in young ascospores; j. Uninucleate mature ascospore. Nucleus with condensed chromatin between two oil globules.
Fig. 2. Anaphase nuclei with unreplicated DNA content (Mi) in haplontic hyphae of *N. vivida*.
Fig. 3. Synchronous DNA synthesis in all crozier cells before meiosis in the ascus of *N. vivida* (ascus mother cell is not demonstrated). a, b. DNA replication, nuclei up to 2C; c. karyogamy in a young ascus, 4C; d. four products of meiosis each approaching mitotic division (DNA synthesis in nuclei, up to 2C).

ky, 1992). The cycle includes a monokaryotic thallus (with nuclei in the haplophase), a dikaryophase, confined upon fructification, and asci which represent zygotes. Here the nuclei are in the diplophase of the life cycle. When the ascus nucleus divides, division is meiotic and meiospores are formed (Figs. 1, 3, 4a-h).

Somatic nuclear behaviour

The presence of up to double DNA content in the nuclei of hyphae and paraphyses indicates mitotic cell cycle phases G0/G1 and G2/M (Figs. 2, 6d, e). During the growth of a fruit-body nuclei divide within the hyphae but remain stable within the paraphyses at maturity (except for the nuclei of their apical cells).

In *N. vivida,* the mean DNA content in the nuclei of the paraphyses (DNA content of the nuclei at the tip was not measured in this case) was 750 Mb ± 9% and in the nuclei of the hyphae 770 Mb ± 36%. In the first case the measured nuclei were only in the G0/G1 phase, while in the second case, most nuclei were in the G0/G1 phase and some were in the G2/M phase. The mean DNA content of the hyphae is larger and more variable compared with the mean DNA content of the paraphyses due to the mitotic division of the first. Hence the nuclei of the paraphyses are more suitable for measurement of the C-value than the nuclei of the subhymenium hyphae.

When measuring fluorescence on nuclei, noise (additional light including the autofluorescence of cells) accounts for 6% when paraphyses are used, 12% when hyphae are used, and 12% when spores are used from total measured fluorescence (fluorescence of nuclear DNA-DAPI complex + noise). For this reason too, paraphyses should be preferred in determination of relative DNA content and genome size. In this case the 1C-value, i.e. genome size, was determined as 750 Mb for *N. vivida* and as 530 Mb for *N. rutilans* (see Materials and Methods).

Development of the ascus

The asci of *N. vivida* develop from croziers according to the *Neottiella*-type pattern of karyogamy (Read & Beckett, 1996; Chiu & Moore, 1999) (Fig. 1). Two nuclei in the hooked cell undergo conjugate mitoses (Mi) after which two septa are formed creating three cells (Fig. 1a–c). The three cells of the crozier are termed the terminal cell, the penultimate cell, and the stalk cell, representing respectively the first, the second, and the third cell of the crozier. The penultimate cell is binucleate, whereas the two other cells are uninucleate. At first, two prefusion nuclei with the basic DNA content are located in the terminal cell and in the stalk cell, respectively. The nucleus of the terminal cell then migrates into the stalk cell (Figs. 4a, 5). This binucleate cell, containing non-sister nuclei, may become the ascus mother cell, in which karyogamy (K) takes place (Fig. 5). In the young ascus, the first meiotic division (Me1) (Figs. 1f, 4c) and the second meiotic division (Me2) (Figs. 1g, 4d) give rise to four daughter nuclei with the basic DNA content, each of which divides by mitosis (Mi) to form eight ascospore nuclei (Figs. 1h, 4e). Formation of ascospores results from the infolding of the membranes around the nuclei (Figs. 1i, 4f). In a maturing spore, the nucleus with condensing chromatin remains between two vacuoles (Figs. 1j, 4h).

Changes in ploidy level during DNA replication and cell division at the time of sporulation — Fig. 6

After karyogamy the DNA content of the nucleus has the 4C-value. The mean DNA content was determined as 3060 Mb (Fig. 6a). The C-value can be measured exactly after the first meiotic division (Me1) when the formed nuclei have a stable DNA content (2C) until the next division (Figs. 1f, 4c). In such nuclei, the mean DNA content was 1500 Mb (then 1C = 1500 : 2 = 750 Mb, the same 1C-value like in paraphyses).

After the second meiotic division (Me2; Figs. 1g, 6b) and mitosis (Mi; Fig. 1h) the following DNA synthesis may occur asynchronously (Fig. 3d). After Me2, mean nuclear DNA content was 770 Mb and after Mi 810 Mb. Thereafter, eight uninucleate ascospores with the 2C-value are formed. In such nuclei, mean DNA content was measured at 1350 Mb for *N. vivida* (Fig. 6c).

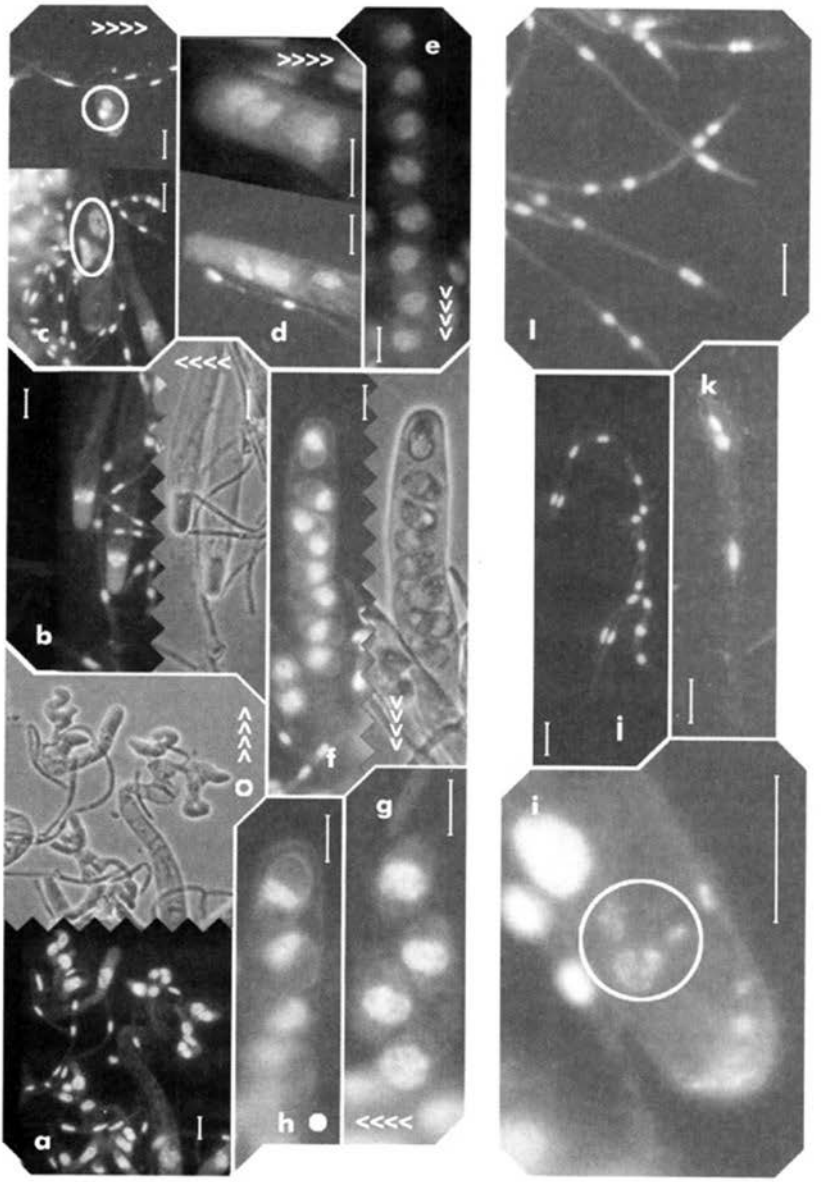

Fig. 4. Photomicrographs of fruit-body of *N. vivida* (a, b, d, f: fluorescence micrographs; c, e, g–l: normal micrographs). a. nuclei in croziers and young asci; b. zygote nucleus; c. nuclei in the course of the first meiotic division; d. nuclei in the course of the second meiotic division; e. nuclei after postmeiotic mitosis; f. young nuclei of ascospores; g. endoreduplication in spore; h. fertilizing spore with condensing chromatin, nucleus between vacuoli; i. giant mitochondria in the apex of an ascus; j. nuclei in a hypha; k. nuclei in a hair; l. nuclei in a paraphysis. Bar = 10 µm.

The spore nuclei of *Neottiella* species studied here undergo endoreduplication (DNA replication in absence of mitotic cell division). In *N. rutilans*, endoreduplication is not arrested at the 2C-value as in *N. vivida*, but may proceed at a different rate in spores. In *N. rutilans* spores with DNA values of 2C, 3C, 5C, and 6C have been measured and endopolyploidy can be assumed to occur at different levels. These uninucleate spores are heteroploid. No differences have been found in spore sizes between the two specimens studied: spore sizes in *N. rutilans* have been measured at 23.1 μm ± 5% × 12.8 μm ± 5% and in *N. vivida* at 22.8 μm ± 4% × 13.0 μm ± 3%.

Ascogenous hyphal differentiation

There is evidence that species may reveal considerable variation in the pattern of ascogenous hyphal differentiation; significant variation can even be found within a single genus (*Thelebolus* Tode: Fr., Kimbrough, 1981). The precise ontogeny of ascogenous hyphae is usually difficult to study. *Neottiella vivida* with extremely large nuclei is the most appropriate species for this kind of research.

In *N. vivida*, ascogenous hyphae may branch repeatedly. In this case both cells, the penultimate cell and the stalk cell (containing also the migrate nucleus from the terminal cell), elongate to form a new crozier (Figs. 4a, 5). However, in the case of the *Neottiella* type pattern of karyogamy, asci can be formed one after another from the terminal and the stalk cells, while the penultimate cell initiates formation of new croziers continuously (Fig. 5). All nuclei of ascogenous hyphae, except for nuclei in the initial penultimate cell, can be potentially used in karyogamy for formation of zygotes.

Time of premeiotic DNA synthesis

Premeiotic DNA replication in fungi is known to occur usually before and sometimes after karyogamy. In *N. vivida*, premeiotic DNA replication occurs before karyogamy, as in *N. rutilans* (Rossen & Westergaard, 1966) and *Neurospora crassa* Shear & B.O. Dodge (Iyengar et al., 1977), and synchronously in all four nuclei of the crozier cells (Figs. 3a, b, terminal and stalk cells are not shown) (Figs. 4a, 5). It is possible that delayed premeiotic DNA synthesis is a general condition in fungi with a homokaryotic fruit-body (Bayman & Collins, 1990).

DNA content of giant mitochondria

Giant mitochondria are visible in the ascus apex. The DNA content of giant mitochondria was determined to be 60 Mb, 54 Mb, and 30 Mb (Fig. 4i).

The mitochondrial genome size of eight ascomycetes was found to be from 18.9 b.k. (*Torulopsis glabrata* (H.W. Anderson) Lodder & N.F. de Vries) to 108 b.k. (*Brettanomyces custersii* Florenz.) (Weber, 1993). Obviously, the mitochondrion of *N. vivida* with high DNA content contains multiple strands of DNA. Different DNA contents of mitochondria reveal the existence of a different number of strands in their nucleoids. Kuroiwa et al. (1996) examined the development of giant mitochondria of the plant *Pelargonium zonale* Aiton during megasporogenesis and megagametogenesis. They found that DNA content within the stacked mitochondrion increased up to 40 times compared with that at the megaspore mother cell stage; a single stack of mitochondria contained 340–1700 Mb DNA.

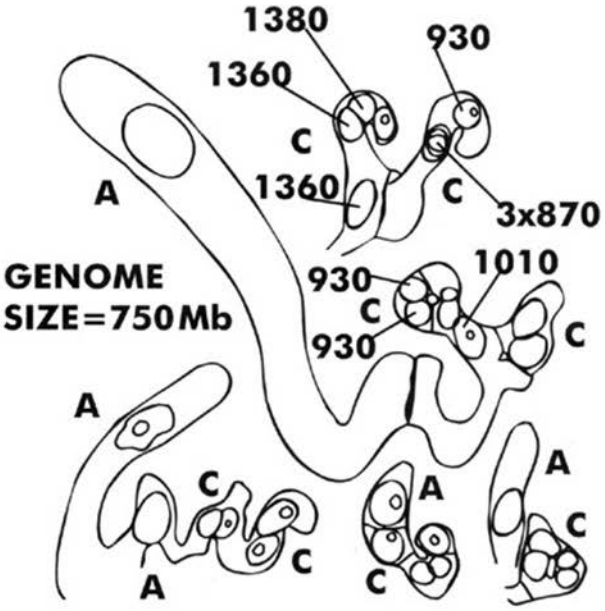

Fig. 5. Ascogenous hyphal differentiation. The penultimate or the stalk cell (containing also the nucleus migrating from the terminal cell) may elongate forming new croziers. All nuclei of ascogenous hyphae, except for nuclei of the initial, penultimate cell, can be potentially used for formation of zygotes in asci. A. ascus; C. crozier.

Nuclear genome size

In this study the genome size of *N. rutilans* was determined to be 530 Mb and that of *N. vivida* 750 Mb. Genome sizes for Pezizales ranged from 12 Mb for *Pulvinula* sp. (author's unpublished data) to 750 Mb for *N. vivida*. The majority of genome sizes reported earlier for other fungi fall in this range too (Durán & Gray, 1989; Wittman-Meixner, 1989; Zolan, 1995).

The overall genome size estimated in this study for *Neottiella* species was significantly larger than that of the ascomycetous yeast *Saccharomyces cerevisiae* (13 Mb, data are available on internet: ftp.ebi.ac.uk) and other filamentous fungi. For example, the following genome sizes have been determined: for *P. ostreatus* 21 Mb (Sagawa & Nagata, 1992) and 24 to 30 Mb (two subpopulations in one spore-print differing in DNA content by 4.9 Mb (20%), Kullman, 2000), 31 Mb (Peberdy et al., 1993) and 35 Mb (Larraya et al., 1999), for *Trichophaea hemisphaerioides* (Mouton) Graddon 23 Mb (Kullman, 2000), for *Penicillium paxilli* Bainier 23 Mb (Itoh et al.,1994), for *Histoplasma capsulatum* Darling 23 to 32 Mb (Carr & Shearer, 1998), for *Emericella (Aspergillus) nidulans* (Eidam) Vuill. 26 Mb (Timberlake,1978) to 31 Mb (Brody & Carbon, 1989), for *Podospora anserina* (Rabenh.) Niessl 34 Mb (Javerzat et al., 1993), for *Neurospora crassa* Shear & Dodge 39 Mb (Orbach, 1992) and 43 to 45 Mb (Radford

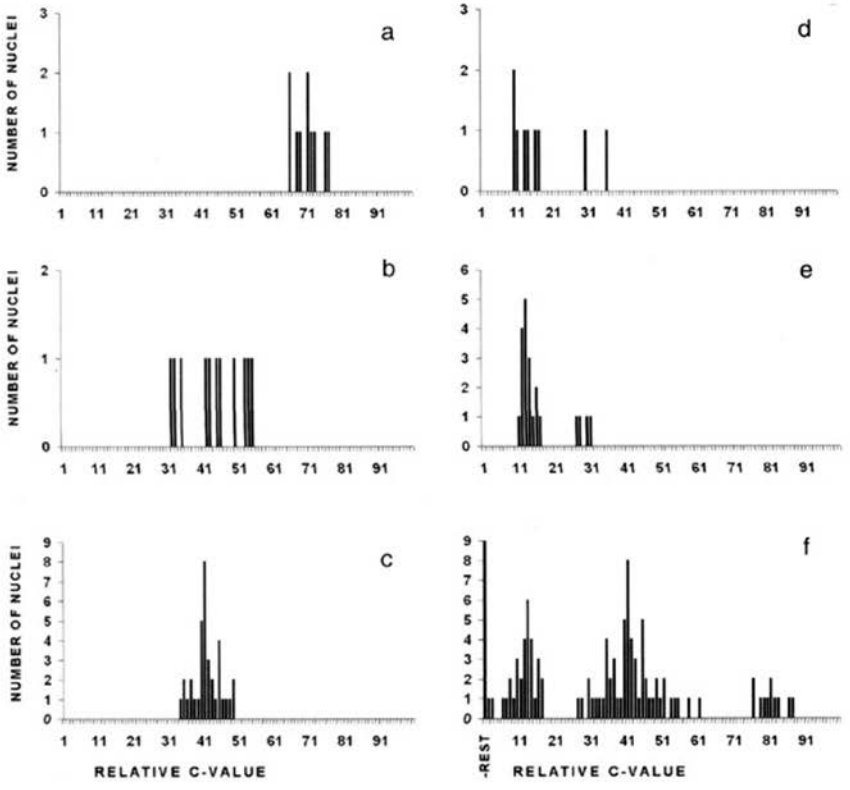

Fig. 6. Histograms of the relative C-values of nuclei in different stages in life cycle of *N. vivida*. a. Postfusion zygote nuclei in young asci (4C); b. DNA synthesis in ascus nuclei after the second meiotic division (nuclei up to 2C); c. endoreduplication in spores (nuclei up to 2C); d. nuclei in a hypha in cell cycle phase G0/G1 = 1C and G2M = 2C; e. nuclei in a paraphysis in cell cycle phase G0/G2 = 1C and G2M = 2C; f. nuclei in a fruit-body (all measurements on histograms) and noise (additional light including autofluorescence of cells, i.e. the first maximum).

& Parish, 1997), for *Epichloë festucae* Leuchtm., Schardl & M.R. Siegel 29 Mb, for *Epichloë* (Fr.) Tul. & C. Tul. anamorphic hybrids *Neotyphoidium lolii* Latch, M.Chr. & Samuels × *E. typhina* (Pers.) Tul. & C. Tul. and *N. coenophialum* (Morgan-Jones & W. Gams) Glenn, C.W. Bacon & Hanlin 55 Mb and 57 Mb, respectively (Kuldau et al., 1999). The last two values represent the largest genome sizes reported so far for filamentous fungi.

Ploidy levels and speciation

When among ascomycetes the ploidy level of N. *rutilans* is approximately 50 (Weber, 1992), then, using genome sizes, the ploidy level of *N. vivida* was calculated

to be 70. The two species are very similar and can be distinguished only by their spores, which possess an incomplete reticulum in *N. rutilans* and delicate regular warts in *N. vivida*. Heteroploid spores of *N. rutilans* have a high variability of spore ornamentation. Some spores have more restricted warts which are not completely connected to form a reticulate ornament. According to Galitski et al. (1999) (see also Hieter & Griffiths, 1999), cells of the ascomycetous yeast *Saccharomyces cerevisiae*, differing only in their ploidy, are identical in terms of DNA sequence information and relative gene dosage, but show different patterns of gene expression. In *N. vivida* and *N. rutilans*, the differences in spore ornamentation may be the result of different gene expressions regulated by a ploidy-dependent gene.

As the spores of *N. rutilans* are heteroploid, some spores of *N. rutilans* and *N. vivida* have the same DNA content. There is as yet no evidence of haploidization of these spore nuclei at germination. It is also known that two closely related species of Leotiales, *'Hymenoscyphus' equisetinus* (Velen.) Dennis and *'H.'rhodoleucus* (Fr.) Z.S. Bi, having the same genome size, differ only in the relative DNA content of their uninucleate spores (1C and 2C, respectively) and in spore width (Weber, 1992). It can be speculated that in such cases polyploidy will repeatedly confirm taxonomically described speciation, as suggested by Bresinsky & Wittmann-Bresinsky (1995) for Boletales.

CONCLUSIONS

Within the true fungi, species of *Neottiella* serve as excellent objects for cytogenetic investigations due to their extraordinarily large nuclear DNA content and low cell autofluorescence. *Neottiella vivida* and *N. rutilans* were found to have genomes of approximately 750 Mb and 530 Mb, respectively.

Neottiella rutilans is the first ascomycete in which heteroploidy of spores has been discovered. Probably different levels of endopolyploidy in its spores account for the large variability of spore ornamentation within one specimen.

Giant mitochondria were found in the ascus, indicating intensive aerobic respiration and energy generation for metabolic activity associated with meiospore formation. It is demonstrated in flowering plants that the number of plastids ultimately produced per cell is a function of the level of endopolyploidy (Butterfass, 1967, 1973). The converse idea is that nuclear DNA replication is regulated by plastids, as appears to be the case with *Chlamydomonas* Ehrenberg (Blamire et al., 1974). This problem needs further research in fungi.

The *Neotiella*-type pattern of karyogamy is in principle maximally economical. All nuclei of ascogenous hyphae, except for the nuclei in the initial, i.e. penultimate cells, have the potential to be used in karyogamy for production of zygotes. In this case, all replicated DNA in ascogenous hyphae can eventually be used for spore production. However, there are two alternatives allowing regulation of spore production: formation of asci one after another, or formation of new croziers, i.e. new branches (instead of asci), for simultaneous production of a large number of asci. It can be speculated that the first alternative is more frequent in species with small primitive ascomata, while the second alternative occurs in species with large, more differentiated ascomata. However, this argument requires further study.

ACKNOWLEDGEMENTS

The research was supported partly by the DFG (Deutsche Forschungsgemeinschaft) and by grants Nos. 3580 and 4989 of the Estonian Science Foundation. I thank Prof. A. Bresinsky for useful consultations and all-round help. I thank Dr. M. Rahi and Dr. A. Raitviir for critical comments on the manuscript. Sincere thanks are due to Mrs. E. Jaigma for revising the English text of the manuscript.

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PERSOONIA
Volume 18, Part 1, 115–122 (2002)

A RECONNAISSANCE OF THE GENUS PSEUDOBAEOSPORA IN EUROPE I

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About 40 collections of *Pseudobaeospora* species from all over Europe have been studied. A key is presented to the 13 species recognised and two provisionally defined ones. Latin diagnoses of six new species, one new variety and one new forma are given.

Part one of this paper contains an introduction, a key to the taxa studied and Latin diagnoses of the new taxa. Part two will contain the description of the genus, full descriptions and figures of all taxa treated, and discussions.

After the surprising discovery (Bas, 1995) that the only two collections of *Pseudobaeospora* Singer available from the Netherlands differed considerably from each other and from the only two species of *Pseudobaeospora* known from Europe at that time, viz. *P. pillodii* (Quél.) Wasser and *P. oligophylla* (Singer) Singer, it became a matter of great interest to discover the real identity of *Pseudobaeospora* collections recorded in the literature. Requests to a number of colleagues for material resulted in a set of about 40 collections, mostly filed as *P. pillodii*, sometimes as *P. oligophylla*, *Pseudobaeospora* spec. or *Collybia* spec. All these collections have been thoroughly analysed and the outcome of these studies was rather surprising. It appeared to be possible to distinguish in Europe 13 to 15 different species. A number of characters that were rather neglected hitherto, such as structure of the pileipellis, colour reactions in KOH and the presence of very distinct cheilocystidia in several species, turned out to be a great help in clearing up the taxonomic situation in the genus.

NOTES ON SOME CHARACTERS

Macroscopic characters

As only two collections of European *Pseudobaeospora* species could be studied in fresh condition, nearly all the descriptions of macroscopic characters of the taxa in this paper are based on field notes (often incomplete) by the collectors, colour slides if available, and drawings. In some cases the size of the basidiocarps had to be estimated from the size of dried specimens. Defining the colours is a special problem, since hardly any references to colour codes are available, and notations like purplish, violaceous, and lilacinous seem to have been used rather indiscriminately. More precise colour notations are badly needed.

Spores

It is a generic character of *Pseudobaeospora* that the spores become thick-walled and dextrinoid. But it is insufficiently stressed in literature that this thickening of the spore wall takes place after the spores have been shed. This is the reason why one usually finds only a very limited amount of thick-walled spores among the thin-walled spores on a fragment of a lamella, often not more than 1–10% (although occasionally much higher). However, on the apex of the stipe and on the pileipellis only thick-walled spores are found. The author considers only these spores fully mature. Therefore the spore sizes given in this paper always refer to the thick-walled spores only. Notations like [40/4] indicate the number of spores measured and the number of collections from which these were taken.

Sclerified basidia

Thick-walled brownish basidia occur frequently, but in strongly varying numbers. Their absence or frequency seems to have little or no differentiating value.

Pileipellis structure

The pileipellis is usually a cutis. But often its cells are so strongly inflated that the pileipellis seems to be pseudoparenchymatic. Careful examination of radial sections and 'scalps' shows that in these cases the inflated cells are arranged in radial or, more rarely, irregularly disposed chains. In the newly described species *P. celluloderma*, however, the pileipellis consists of erect inflated cells, forming a somewhat irregular hymeniderm, which looks strictly round-celled when seen from above.

Sometimes the pileipellis is made up of two layers: the upper layer, the suprapellis, composed of relatively narrow hyphae; the lower layer, the subpellis, composed of chains of inflated cells. In some cases the suprapellis is very thin.

Caulocystidia

At least at the apex of the stipe, caulocystidia are always present, varying in shape from filiform to broadly clavate. They seem to have little diagnostic value.

KOH reactions

There is in *Pseudobaeospora* a surprising range of colour reactions when fragments are placed in a drop of 5% KOH. It has to be stressed here that except in *P. pyrifera*, only fragments of dried material have been tested. This means that in fresh material the colour change may be different. In fresh material of *P. pyrifera* the reaction was merely stronger (L. Krieglsteiner, in litt.).

Because of the small basidiocarps and the often scanty collections, the KOH-test has usually been tried only on the pileipellis, although there are indications that the reaction may be different in other parts of the basidiocarps, as for example in the context of the stipe in *P. pyrifera* and *P. jamonii*. Fragments placed in KOH should be studied immediately, because in one species, *P. dichroa*, a deep red pigment in the pileipellis very soon starts to disappear in small clouds, after which the cells of the pileipellis become green.

Clamp-connections

Most species of *Pseudobaeospora* possess clamp-connections, which are usually easy to find in the various tissues. When they seem to be absent, it is necessary to check the base of the basidia, as in *P. frieslandica* Bas they appear to be restricted to the base of the basidia and the subhymenium.

KEY TO THE SPECIES OF PSEUDOBAEOSPORA IN EUROPE

Spore sizes refer to thick-walled spores only. KOH reactions have been tested on dried material.

1. Pileus whitish to greyish-whitish, pale buff or pale yellowish buff. (When pileus pale silvery brownish grey, see also *P. argentea* at 14.)
   2. Basidiocarps very small (pileus 2–8 mm; stipe 14–30 × 0.1–0.6(–1.0) mm. Pileipellis consisting of loosely arranged radial chains of (5–)10–32(–37) µm wide cells; suprapellis lacking ..... *P. albidula* Bas, spec. nov.
   2. Basidiocarps usually somewhat larger and more sturdy (pileus 7–15 mm; stipe 0.5–2 mm wide). Pileipellis with a distinct suprapellis of narrower hyphae or pileus context with a transparent layer of narrow hyphae.
      3. Lamellae crowded (L = ± 30), strongly intervenose and frequently anastomosing. Base of stipe with orange-yellow rhizoids. Lower part of pileus context transparent, made up of 2.5–6.0 µm wide, agglutinate hyphae. Suprapellis not or hardly differentiated ..... *P. bavariae*, nom. prov.
      3. Lamellae moderately crowded (L = 19–24), not or weakly intervenose. Base of stipe with whitish rhizoids or merely whitish tomentose. No transparent layer in pileus context present. Suprapellis thin but distinct, consisting of 3.0–7.0 µm wide hyphae, over a subpellis of broader-celled hyphae up to 15(–18) µm wide ..... *P. paulochroma* Bas, spec. nov.
1. Pileus purple-blue, violaceous, lilacinous, or brown, grey-brown or grey with or without such tinges.
   4. Pileipellis discolouring red, blue, green or yellow-green in 5% KOH.
      5. Pileipellis with a very conspicuous, rapidly dissolving, red pigment in KOH (at first forming clouds) and afterwards with yellow-green cell walls.
         6. Cheilocystidia absent or very rare
            P. dichroa Bas, spec. nov., forma *dichroa*
         6. Cheilocystidia present and abundant
            P. dichroa forma *cystidiata* Bas, f. nov.
      5. Pileipellis in KOH not emitting a deep red pigment.
         7. Pileipellis turning greenish blue in KOH. Cheilocystidia absent. Spores 4.4–6.4 × 3.3–4.4 µm ..... *P. pallidifolia* Bas, Gennari & Robich
         7. Pileipellis turning blue-green to brownish green in KOH. Cheilocystidia abundant, predominantly broadly clavate. Spores 2.8–3.7 × 2.6–3.5 µm
            P. pyrifera Bas & L.G. Krieglst.
   4. Pileipellis not discolouring or becoming pale yellowish, yellowish-brownish, reddish-brownish or greyish-greenish in KOH.

8. Cheilocystidia conspicuous and abundant.
    9. Lamellae cream to pale brownish. Cheilocystidia mainly narrowly lageniform. Slender pileocystidia scattered to abundant, particularly at centre of pileus. In KOH with small reddish bodies on caulocystidia, often also on pileipellis.
        10. Pileipellis with a thin suprapellis of 1.5–7.0(–10) µm wide hyphae
            P. laguncularis Bas, spec. nov., var. *laguncularis*
        10. Pileipellis without a suprapellis
            P. laguncularis var. *denudata* Bas, var. nov.
    9. Lamellae violaceous to lilacinous, later brownish pink. Cheilocystidia usually clavate. Slender pileocystidia absent, but sometimes suprapellis with some terminal clavate cells. In KOH no reddish bodies on caulocystidia.
        11. Cheilocystidia mainly broadly clavate, 10–30 × 4.0–13 µm. Pileipellis made up of loosely arranged chains of inflated cells, 10–35 × 6.0–17 µm. Context of stipe in KOH reddish brown with greenish yellowish tinge ..... *P. pyrifera* Bas & L.G. Krieglst.
        11. Cheilocystidia mainly slenderly clavate, but also broadly cylindrical and versiform, 15–43 × 4.0–9.5 µm. Pileipellis consisting of a suprapellis of 5.0–7.5 µm wide hyphae with some terminal clavate cells and a broad-celled subpellis with chains of up to 22 µm wide cells. Context of stipe green in KOH
            P. jamonii Bas, Lalli & Lonati
8. Cheilocystidia absent or rare and inconspicuous.
    12. Pileipellis intermediate between a hymeniderm and an irregular epithelium, strictly round-celled when seen from above. Basidiocarps very small; pileus 1–4.5 mm, purple to greyish-vinaceous
        P. celluloderma Bas, spec. nov.
    12. Pileipellis not a hymeniderm, nor an epithelium; if composed of inflated cells, then these in radial chains or irregularly disposed.
        13. Clamp-connections present, but sometimes only at basidia and in subhymenium.
            14. Pileipellis consisting of rather broad, more or less cylindrical hyphae of 5.5–12.5(–15) µm wide. Spores subglobose, 3.5–4.8 × 3.1–4.5 µm, average Q = 1.10–1.15 ..... *P. argentea* Bas
            14. Pileipellis made up of broad-celled, 4.0–20 µm wide hyphae or of a suprapellis of narrow hyphae over a broad-celled subpellis.
                15. Spores globose to subglobose, 3.6–4.5 × 3.2–4.3 µm, Q = 1.00–1.15, average Q = 1.10. Basidiocarps very small; pileus 2–8 mm in diameter, rather pale, lilacinous or pinkish grey
                    P. subglobispora, nom. prov.
                15. Spores broadly ellipsoid to ellipsoid, average Q = 1.25–1.40. Basidiocarps less small; pileus 8–16(–20) mm in diameter and usually darker violaceous to dark violaceous grey or violaceous brown.

16. Spores 3.5–3.9 × 2.6–3.2 µm, Q = 1.20–1.40, average Q = 1.30. Pileipellis consisting of a thin suprapellis of 2.0–4.5(–6.0) µm wide hyphae over a broad-celled subpellis. Lamellae crowded (L = 26–32), dark violaceous grey
P. frieslandica Bas

16. Spores up to 5 or 6.5 µm long. Pileipellis without a suprapellis of narrower hyphae. Lamellae less crowded (L = 8–22), violet or whitish to cream.
17. Lamellae violet. Spores 3.6–4.9(–6.2) × 2.6–3.8 µm; average Q = 1.25–1.30
P. ellipticospora Bas, spec. nov.
17. Lamellae whitish to pinkish cream. Spores 4.4–6.4 × 3.3–4.4 µm; average Q = 1.30–1.40
P. pallidifolia Bas, Gennari & Robich

13. Clamp-connections absent, also from basidia. Basidiocarps very small to small, very slender. Pileus purple or violaceous grey to lilac-brown, with usually broad paler to whitish margin. Lamellae and stipe ± concolorous. Spores 3.4–4.5 × 2.8–3.5 µm, average Q = 1.15–1.30.
18. Pileipellis with abundant, cystidioid, repent to ascending, terminal elements ..... *P. oligophylla* Singer
18. Pileipellis without abundant, cystidioid, repent to ascending, terminal elements ..... *P. pillodii* (Quél.) Wasser

LATIN DESCRIPTIONS

Pseudobaeospora albidula Bas, *spec. nov.*

Pileus 2–8 mm latus, initio hemisphericus, demum conico-convexus vel obtuse conicus, postremo expansus, albus vel griseo-albidus vel pallide bubalinus, centro aliquante fuscans, (sub) coactatus. Lamellae subdistantes (L = 11–17; l = 0–1), adnatae vel valde emarginatae, initio cremeo-albidus, postea pallide bubalinae vel pallide flavidae. Stipes 14–30 × 0.1–0.6(–1.0) mm, initio albidus vel griseo-albidus, postea pallide ochraceo-bubalinus, flocculosus vel sericeus, apice granulo-flocculosus, basi demum brunneolus, sparse lanoso-substrigosus.

Sporae [60/6] 3.4–4.3(–4.5) × (2.6–)2.9–3.5(–3.7) µm, Q = 1.05–1.35, medium Q = 1.15–1.20, subglobosae vel ellipsoideae, initio tenuiter tunicatae et inamyloideae, demum crasse tunicatae et dextrinoideae. Basidia 4-sporigera. Cheilocystidia nulla. Pileipellis ope KOH 5% incolorata, ex catenis cellularum 10–65(–90) × (5–)10–32(–37) µm, radialibus composita, interdum cum cellulis apicalibus cystidioideis, attenuatis vel subutriformibus vel lageniformibus. Fibulae praesentes.

Holotypus hic designatus: 'England, Surrey, Mickleham Downs, 30.VII.1988, A. *Henrici* (K(M) 1031) (K).'

Etymology: albidulus = whitish.

Additional collections examined: England (3), Germany (1), The Netherlands (1).

Pseudobaeospora celluloderma Bas, *spec. nov.*

Pileus 1–4.5 mm latus, primo convexus vel conico-convexus, demum plano-convexus, purpureus vel rubro-violaceus, interdum griseo-vinaceus, translucido-striatus, pallescens. Lamellae (sub)dis-

tantes (L = 7–9(–11); l = 0–1(–3)), adnatae vel emarginatae, concoloratae. Stipes 11–35 × 0.1–0.8 mm, concolorus, apice albo-flocculosus, basi coactatus vel sublanatus.

Sporae [64/6] (3.0–)3.5–4.4 × 2.6–3.5 µm, Q = (1.10–)1.15–1.40(–1.55), medium Q = (1.20–)1.25–1.35, subglobosae vel ellipsoideae, initio tenuiter tunicatae et inamyloideae, demum crasse tunicatae et dextrinoideae. Basidia 4-sporigera. Cheilocystidia nulla. Pileipellis hymenidermoidea, ex cellulis erectis, (6–)10–38 × 6–29 µm, (late) clavatis vel subglobosis constans, ope KOH 5% pallide brunnea vel pallide grisea. Fibulae praesentes.

Holotypus hic designatus: 'England, Surrey, Mickleham Downs, 19.VI.1991, *A. Henrici* (K(M) 17188) (K).'

Etymology: cellula = small cell; derma = skin.

Additional collections examined: England (2), Finland (1), Germany (2), Sweden (1).

Pseudobaeospora dichroa Bas, *spec. nov.*, forma **dichroa**

Pileus 10–30 mm latus, plano-conicus vel plano-convexus, interdum subumbonatus, purpureo-brunneus vel violaceo-tinctus griseo-brunneus, margine opacus vel leviter striatus, siccus, glabellus vel scabrosulus. Lamellae aliquantum confertae vel subdistantes (L = 18–30), adanatae vel fere liberae, purpureo-brunneae vel violaceae. Stipes 20–40 × (0.8–)1.5–2.0 mm, concoloratus, apice albo- vel brunneolo-flocculosus, basi albo-coactatus.

Sporae [45/4] 3.0–3.9(–4.3) × 2.7–3.5 µm, Q = 1.05–1.30(–1.55), medium Q = 1.1YH1.20 (–1.25), subglobosae vel late ellipsoideae, raro ellipsoideae, initio tenuiter tunicatae et inamyloideae, demum crasse tunicatae et dextrinoideae. Basidia 4-sporigera. Cheilocystidia nulla vel infrequentia. 10–45 × 3.5–9.0 µm, anguste clavata (margo lamellarum omnino vel largiter fertilis). Pileipellis ope KOH 5% primo rubra, mox viridis, ex catenis cellularum 34–80 × 18–48 µm, elongatarum, ellipsoidearum, vel globosarum, irregulariter dispositis composita; suprapellis tenuis, ex hyphis angustis interdum presens. Fibulae praesentes.

Holotypus hic designatus: 'England, Hampshire, Butser Hill, Queen Elizabeth Country Park, 27.IX.1992, *T. Læssøe 2906* (K(M)20450) (K).'

Etymology: di = two; -chrous = coloured (referring to the remarkable colour change of the pileipellis in KOH).

Additional collection examined: England (1).

Pseudobaeospora dichroa forma **cystidiata** Bas, *forma nov.*

A typo differens cheilocystidiis 14–45 × 4–10(–17) µm, versiformibus, abundantibus.

Holotypus hic designatus: 'England, Lancashire, Silverdale, Waterslack Wood, 20.X.1984, *L. Livermore 19/84K*, (K(M) 8105) (K).'

Additional collection examined: England (1).

Pseudobaeospora ellipticospora Bas, *spec. nov.*

Pileus plus minusve 8–15 mm latus, obtuse conicus vel plano-conicus, demum plano-concavus et umbonatus, non-striatus, violaceus vel lilacinus, siccus, adpresso-coactus. Lamellae emarginatae vel liberae, distantes vel aliquante confertae, (L = (6–)8–17(–19); l = 0–3), concoloratae. Stipes plus minusve 32–42 × 0.6–1.0 mm, frequenter deorsum attenuatus, concoloratus, sed apice minute albido-flocculosus.

Sporae [38/2] 3.6–4.9(–6.2) × 2.6–3.8(–4.1) µm, Q = (1.10–)1.15–1.50(–1.70), medium Q 1.25–1.30, late ellipsoideae vel ellipsoideae, initio tenuiter tunicatae et inamyloideae, demum crasse tunicatae et dextrinoideae. Basidia 4-sporigera. Cheilocystidia nulla. Pileipellis ope KOH 5% pallide sordideque flava, ex catenis cellularum 14–87(–200) × (4–)18–34(–45) µm composita; suprapellis tenuis, inconspicua, ex hyphis angustis sparsis praesens vel absens. Fibulae praesentes.

Holotypus hic designatus: 'Switzerland, Engadin, Schuls, Pradella, 30.VIII.1986, *E. Horak 3341* (ZT).'

Etymology: ellipticus = ellipsoid; *spora* = spore (in contrast to the closely related *P. subglobispora* ined.).

Additional collection examined: Denmark (1).

Pseudobaeospora laguncularis Bas, *spec. nov.*, var. **laguncularis**

Pileus 3.5–8 mm latus, primo convexus vel late conicus, demum plano-convexus vel plano-conicus, interdum (sub)umbonatus, purpureo-brunneus vel lilacino-argillaceus vel argillaceus. Lamellae aliquantum confertae (L = 20–25; l = 1–3(–7)),valde emarginatae vel liberae, sordide cremeae vel pallide brunneae. Stipes 12–25 × 0.4–1.6 mm, pallide brunneus vel lilacino-griseo-brunneus, subfibrillosus, apice albido-focculosus vel pruinosus.

Sporae [40/4] (3.1–)3.3–4.0(–4.4) × 2.9–3.6(–4.3) µm, Q = 1.05–1.25(–1.30), medium Q = 1.10–1.15, subglobosae vel late ellipsoideae, initio tenuiter tunicatae et inamyloideae, demum crasse tunicatae et dextrinoideae. Basidia 4-sporigera. Cheilocystidia (12–)19–49 × 2.5–8 µm, vulgo anguste lageniformia, minus frequenter filiformia, subcylindracea vel versiformia. Pileipellis ope KOH 5% pallida, virido-brunnea vel flavo-brunna, raro flavo tincta rubro-brunnea; suprapellis tenuis, ex hyphis 1.5–7(–10) latis, repentibus constituta, cum pileocystidiis infrequentibus vel abundantibus, anguste lageniformibus vel subcylindricis; subpellis ex catenis cellularum 12–55 × 8–30 µm composita. Fibulae praesentes.

Holotypus hic designatus: 'England, Lancashire, Silverdale, Gait Barrows, 8.X.1991, *J.C. Leedal* (K(M)8107) (K).'

Etymology: laguncula = small bottle; -aris = provided with.

Additional collections examined: Germany (2), France (1), England (1).

Pseudobaeospora laguncularis var. **denudata** Bas, *var. nov.*

A typo differens suprapellis distituta.

Holotypus hic designatus: 'France, Billième, Savoie, 25.X.1998, *P.A. Moreau* (herb. Moreau, PAM 98102501).'

Known only from the type locality in France.

Pseudobaeospora paulochroma Bas, *spec. nov.*

Pileus 6–10 mm latus, convexus vel conico-convexus, albidus, centro pallide bubalinus, sub lente leviter coactatus. Lamellae aliquante confertae (L = 19–24; l = 1–3), valde emarginatae vel liberae, cremeae, demum subventricosae. Stipes 11–15 × 0.7–1 mm, pallide brunneo-bubalinus, apice subflocculosus, basi coactatus.

Sporae [20/1] 3.8–4.5 × 2.9–3.5(–3.8) µm, Q = (1.10–)1.20–1.35, medium Q = 1.25, late ellipsoideae vel ellipsoideae, initio tenuiter tunicatae et inamyloideae, demum crasse tunicatae et dextrinoideae. Basidia 4-sporigera. Cheilocystidia nulla. Pileipellis ope KOH 5% pallide flavo-brunnea: suprapellis tenuis ex hyphis 3–7 µm latis constitua; subpellis ex cellulis catenulatis ad 15(–18) µm latis constans. Fibulae praesentes.

Holotypus hic designatus: 'Denmark, Jutland, Molsberg, 23.IX.1979, *C. Bas 7516* (L).'

Etymology: paulo = somewhat; -chromus = coloured.

Known only from the type locality in Denmark.

INSUFFICIENTLY KNOWN TAXA

Pseudobaeospora bavariae, *nom. prov.*
Based on one single basidiocarp with intervenose, anastomosing lamellae and a yellow base of the stipe. It may be abnormal.

Pseudobaeospora subglobispora, *nom. prov.*
Three collections, two from Germany and one from England key out here, but there is insufficient and somewhat conflicting information, particularly about the colours of the basidiocarps.

REFERENCES TO ORIGINAL DESCRIPTIONS OF EUROPEAN TAXA OF PSEUDOBAEOSPORA PUBLISHED ELSEWHERE

Pseudobaeospora argentea Bas, Fl. agar. neerl. 3 (1995) 133, fig.134 (inval.); ex Bas, Persoonia 16 (1996) 255.

Pseudobaeospora frieslandica Bas, Fl. agar. neerl. 3 (1995) 134, fig. 135 (inval.); Persoonia 16 (1996) 225 (inval.); ex Bas, Persoonia 17 (1998) 140.

Pseudobaeospora jamonii Bas, Lalli & Lonati, Micol. Vegetat. Mediter. 17 (2002) (in print).

Pseudobaeospora oligophylla[1] (Singer) Singer, Lilloa 22 ('1949') (1951) 438 ; *Baeospora oligophylla* Singer, Rev. Mycol. 3 (1938) 194.

Pseudobaeospora pallidifolia Bas, Gennari & Robich, Riv. Micol. 40 (3) (1997) 196, col. pl., figs.

Pseudobaeospora pillodii[2] (Quél.) Wasser, Fl. Fung. RSS Ucrainicae, Bas. Agar. (1980) 220. *Collybia pillodii* Quél., C. R. Ass. Franc. Av. Sci. (Champ. Jura Vosges, suppl. 17) 18 (1890) 509.

Pseudobaeospora pyrifera Bas & L.G. Krieglst., Z. Mykol. 64 (1998) 204, figs. 1–5.

ACKNOWLEDGEMENTS

The author is very grateful to Dr. R.A. Maas Geesteranus for correcting the Latin descriptions and to Else Vellinga and John Lennie for critical comments on the manuscript.

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Kühner, R. & H. Romagnesi. 1954. Compléments à la 'Flore analytique' III. Bull. Soc. nat. Oyonnax 8: 73–131. (Biblthеca mycol. 56: 109–167).

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1) Type not seen. Interpretation in key based on Singer's diagnosis, in particular on his description of the pileipellis. (One collection from Switzerland analysed.)

2) Type probably not existing. The concept in the key is based on that of several European authors, e.g. Horak (1968) and Kühner in Kühner & Romagnesi (1954). (Material analysed from Germany, Russia (Siberia), and Switzerland.)

PERSOONIA
Volume 18, Part 1, 123–127 (2002)

STUDIES ON FOLIICOLOUS FUNGI VI

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An account is given of three foliicolous fungi from India. Two new species, viz. *Clasterosporium cyperacearum* and *Questieriella grewiae* are described. *Dysrhynchis uncinata* forms a new generic and specific record to India and is reported on an endemic host.

1. **Clasterosporium cyperacearum** Hosag., *spec. nov.* — Fig. 1

Coloniae hypophyllae, densae, anthracinae, ad 10 mm diam., confluentes, portionio supra correspondionis pallide. Hyphae rectae vel anfractuae, cinnamomeae, irregulariter ramosae, cellulae, 5–7 µm crassae. Appressoria lateralia, irregulariter dispersa, ovata, globosa, unicellula, stipitata vel sessilia, irregulariter sublobata vel lobata, 16–20 × 8–16 µm. Setae myceliales numerosae, dense dispersae, simplices, rectae vel curvulae, obtusae vel acutae ad apicem, pallid brunneae vel brunneae, ad 400 µm longae. Conidiophora lateralis oriunda, ascendora, integra, unicellula, fusca, 19–32 × 4–7 µm. Conidia terminalia, simplices, solitaria, recta, obclavata, attenuata ad superne et late rotundata ad apicem, truncata ad basim, 115–164 µm longa; 4–6 µm crassa ad apicem, 13–16 µm crassa ad subbasim, 5–8 µm crassa ad basim, ad 8-septatae, raro leniter constrictae ad septae, tunica glabra. Ad folia *Scleria* sp. (Cyperaceae).

Holotypus: India, Kerala, Kombe, Peppara and Neyyar Wildlife Sanctuaries, Thiruvananthapuram, 19 Feb. 1977, *V.B. Hosagoudar* (HCIO 43980; TBGT 4691, isotype).

Colonies hypophyllous, dense, carbonaceous black, up to 10 mm in diam., confluent, inducing yellowing of the corresponding upper surface of the leaf. Hyphae straight to crooked, cinnamon brown, irregularly branched, cells 5–7 µm wide. Appressoria lateral, irregularly scattered, ovate, globose, unicellular, stipitate to sessile, irregularly sublobate to lobate, 16–20 × 8–16 µm. Mycelial setae numerous, densely scattered, simple, straight to curved, obtuse to acute, pale brown to brown, up to 400 µm long. Conidiophores borne laterally, ascending, entire, unicellular, dark brown, 19–32 × 4–7 µm. Conidia borne as blown-out ends, terminal, simple, solitary, straight, obclavate, tapering towards apex and broadly rounded at the tip, truncate at the base, 115–164 µm long; 4–6 µm broad at the tip, 13–16 µm broad at the broadest part, 5–8 µm broad at the base, up to 8-septate, rarely constricted at the septa, wall smooth.

Clasterosporium cyperacearum is similar to *C. caricinum* Schw. and *C. flagellatum* Syd. in having smooth walled conidia (Ellis, 1958, 1971). The new species differs from *C. caricinum* Schw. in having unicellular conidiophores. It also differs from *C. flagellatum* Syd. in having sublobate to deeply lobate appressoria and smaller conidia.

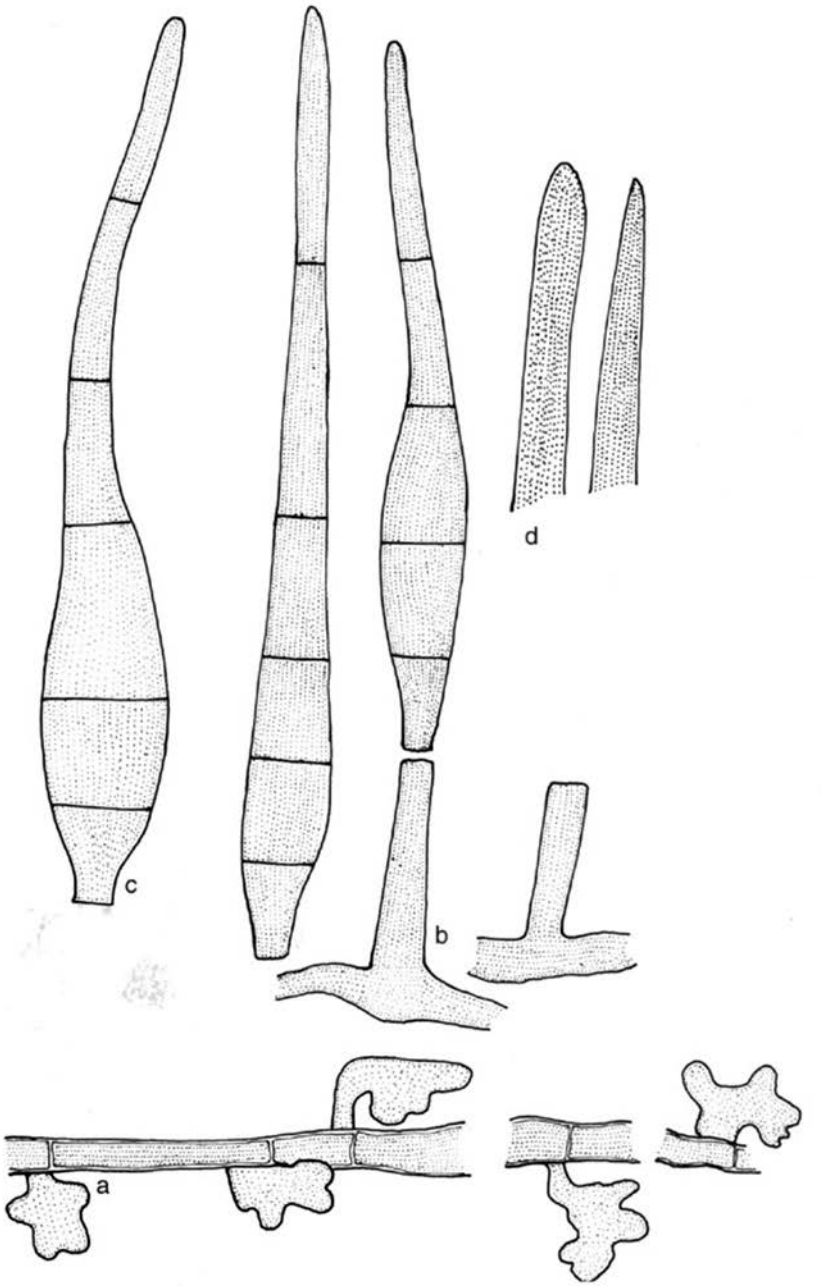

Fig. 1. *Clasterosporium cyperacearum*. a. Appressorium; b. conidiophores; c. conidia; d. setae.

2. **Dysrhynchis uncinata** (Syd.) Arx in E. Müller & Arx

Dysrhynchis uncinata (Syd.) Arx in E. Muller & Arx, Beitr. Kryptogamenflora der Schweiz 2 (1962) 191.
Balladyna uncinata Syd., Ann. Mycol. 12 (1914) 546.
Meliolinella uncinata (Syd.) Hansf., Sydowia 9 (1955) 85.
Kusanobotrys bambusae Hino & Katum., Bull. Yamaguti Univ. 5 (1954) 218.
Neoballadyna butleri Boedijn, Persoonia 1 (1961) 398.

Colonies hypophyllous, dense, running parallel along the veins, up to 3 mm long and 1 mm broad, confluent and covering larger leaf areas. Hyphae straight to crooked, branching irregular at acute angles, loosely to closely reticulate, cells 11–15 × 4–7 µm. Appressoria absent. Mycelial setae numerous, carbonaceous black, septa not visible, simple, straight, flexuous, uncinate to arcuate, obtuse to broadly rounded at the apex, up to 140 µm long. Perithecia slightly stipitate, globose, ovate, ostiolate, 32–44 µm in diam.; asci visible in mature perithecia, 1 or 2 in numbers, ovate to globose, octosporous, 35–45 µm in diam.; ascospores conglobate, oblong, brown, 1-septate, constricted at the septum, broadly rounded at both ends, 25–28 × 11–13 µm, wall smooth in young ascospores but distinctly echinulate in germinating ascospores, germinate by producing germ tube.

Material examined. INDIA: Attayar, Peppara and Neyyar Wildlife Sanctuary, Thiruvananthapuram, Kerala, 20 March 1997, on leaves of *Ochlandra travancorica* Benth. ex Gamble (Poaceae), *V.B. Hosagoudar* (HCIO 43966, TBGT 470).

The present collection differs slightly from earlier records by having shorter mycelial setae and echinulate germinating ascospores. So far *Dysrhynchis uncinata* (Syd.) Arx was known from the Philippines, occurring on *Schizostachyum* sp., *Bambusa* sp., and *Gigantochloa* sp. (Muller & Arx, 1962). A new generic and specific record for India is therefore described here, occurring on an endemic plant (compare Bilgrami et al., 1991).

3. **Questieriella grewiae** Hosag. & C.K. Biju, *spec. nov.* — Fig 2

Coloniae amphigenae, formans surroundibus insulae, nigrae, densae, ad 5 mm diam., raro confluentes. Hyphae rectae, subrectae, flexuosae vel anfractuae, alternate vel opposite acuteque ramosae, laxe reticulatae, cellulae 25–32 × 4–7 µm. Appressoria alternata, unilateralia, dispersa, hemispherica, integra, 9–12 × 9–10 µm. Conidiophora producentis lateralis, macronemata, mononemata, simplices vel raro ramosa, 0–1-septata, 16–32 × 4–7 µm; cellulae conidiogenae terminaliae, cylindraceae, pallid luteae, 15–17 × 4–7 µm. Conidia ellipsoidea, falcata, 3-septata, leniter constricta, cellulae terminalis acutae et late rotundatae, pallidae, cellulae centralis dense brunneae, conidia 40–48 × 11–13 µm. Ad folia *Grewia* sp.(Tilaceae).

Holotypus: India, Mannavan Shola, near Munnar, Idukki, Kerala,11 May 1999, *C.K. Biju*, (HCIO 43972; TBGT 482, isotypus).

Colonies amphigenous, often forming round, isolated patches, up to 5 mm in diam., rarely confluent. Hyphae straight, substraight, flexuous to crooked, branching alternate to opposite at acute angles, loosely reticulate, cells 25–32 × 4–7 µm. Appressoria alternate to unilateral, scattered, hemispherical, entire, 9–12 × 9–10 µm. Conidiophores produced lateral to the hyphae, macronematous, mononematous, simple to rarely branched, 0- or 1-septate, 16–32 × 4–7 µm; conidiogenous cells terminal, cylindrical,

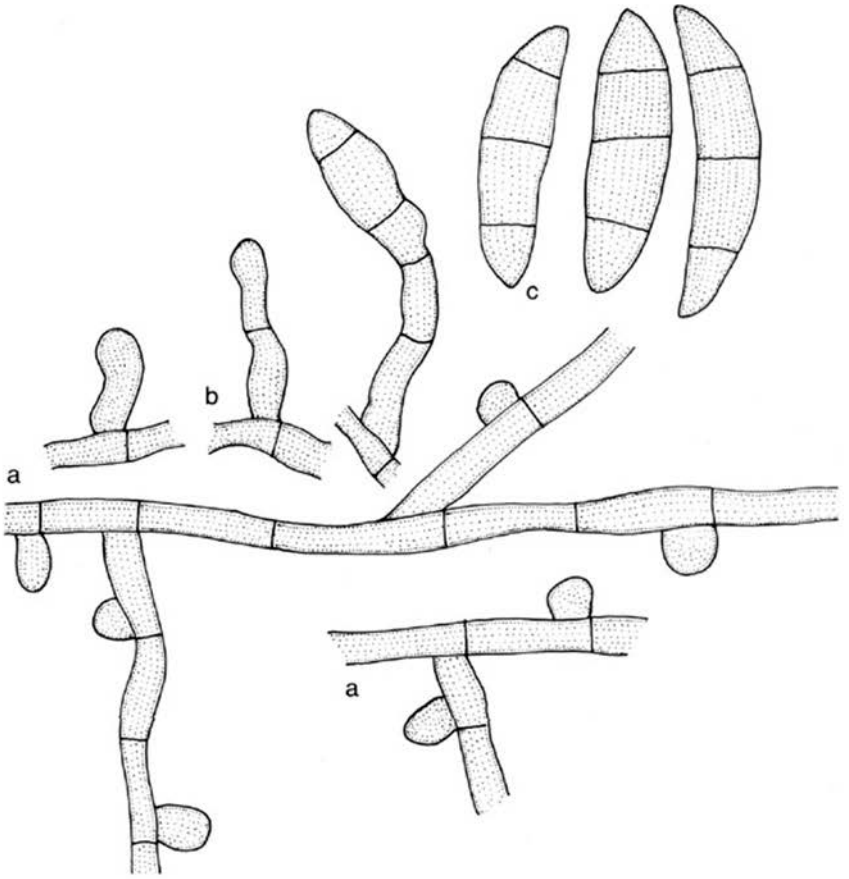

Fig. 2. *Questieriella grewiae*. a. Appressoriate mycelium; b. conidiophores; c. conidia.

pale yellow, 15–17 × 4–7 µm. Conidia ellipsoidal, falcate, 3-septate, slightly constricted at the septa, terminal cells acute and broadly rounded, pale, middle cells deep brown, conidia 40–48 × 11–13 µm.

This is the first record of the genus *Questieriella* on members of the family Tiliaceae (Hughes, 1987).

ACKNOWLEDGEMENT

Thanks are due to Dr. T.K. Abraham, Deputy Director, TBGRI, Palode for encouragement.

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BOOK REVIEWS

P.M. Kirk, P.F. Cannon, J.C. David & J.A. Stalpers (eds.). *Ainsworth and Bisby's Dictionary of the Fungi, 9th Edition.* (CABI Publishing, Wallingford, Oxon OX10 8DE, United Kingdom. 2001.) Pp. 624, 41 text-figs. Price: £ 49.95.

The ninth edition of this world-famous mycologist's handbook is substantially expanded when compared with the former editions. The current edition comprises more than 20,000 entries of generic names, mycological terms, mycotoxins and metabolites, as well as diagnoses of families, orders and higher categories of fungi. The list of generic names and terms used in mycological literature is very extensive and (almost) complete. For each genus the author is cited, followed by data of publication, current status, systematic position, estimated number of species, and references to literature. Mycological terms are explained, when necessary with a figure. Bibliographic data are given for many famous mycologists. New in this edition is a refined and up-to-date classification of fungi, reflecting new insights generated by molecular research. Anamorphic taxa are now fully integrated in this system. The synopsis greatly facilitates the user to find the exact taxonomic position of the groups he is interested in. This impressive piece of work, the result of a long-lasting cooperation of many specialists, is firmly bound in hard cover. It should not be missed on any mycologist's bookshelf.

S.H.J.J. Louwhoff & J.A. Elix. *Hypotrachyna (Parmeliaceae) and allied genera in Papua New Guinea.* (Bibliotheca Lichenologica 81. J. Cramer in der Gebrüder Borntraeger Verlagsbuchhandlung, Johannesstr. 3A, D-70176 Stuttgart. 2002). Pp. 149, numerous black-and-white photographs and distributions maps. Price: unknown.

This books gives an account of the lichen genus *Hypotrachyna* (Ascomycetes, Parmeliaceae) in Papua New Guinea. This genus, which has a pan-tropical montane distribution, with emphasis on South America, counts after revision 39 species in the area concerned. Five species are described as new, and six species represent new records for Papua New Guinea. After a short introduction, a survey is given of the morphology and interspecific variation within the genus, including also chemical characters. The taxonomic part comprises a key to the species and full descriptions of the accepted species, inclusive nomenclator and data on ecology and distribution. Often black-and-white photographs and/or distribution maps are provided. The book concludes with an extensive list of references. This monograph adds substantially to the knowledge of the lichen flora of this remote part of the world.

PERSOONIA
Volume 18, Part 1, 129–133 (2002)

LACTARIUS IGNIFLUUS (RUSSULACEAE), A NEW SPECIES FROM INDIA

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Lactarius ignifluus, a new species in the Russulaceae is described and illustrated from Kerala. The combination of lignicolous habitat, bright scarlet, veined basidiomes, unchanging scarlet red latex and lack of sphaerocytes in the hymenophoral and pileal trama characterize this new species.

During a survey of the agaric flora of Western Ghats, we collected a striking agaric with an unusually bright cap growing on the living dicotyledonous herbs and shrubs in one of the sacred groves of Kerala. Part of the material was subsequently sent to Kew for identification, where Dr. D.N. Pegler determined it as a species of *Lactarius* close to *L. adhaerens* Heim, originally described from Madagascar. Since the material has shown to differ from the latter in several features, notably with regard to colour of latex, it is described below as a new species. The observations are based on fresh specimens collected by the authors. Colours in descriptions are based on Kornerup & Wanscher (1967). Microscopical observations are made from sections mounted in 5% KOH and in Melzer's reagent. The specimens are deposited at the Mycological Herbarium of the Microbiology Division, TBGRI (TBGT) and part at the Royal Botanic Gardens, Kew (K).

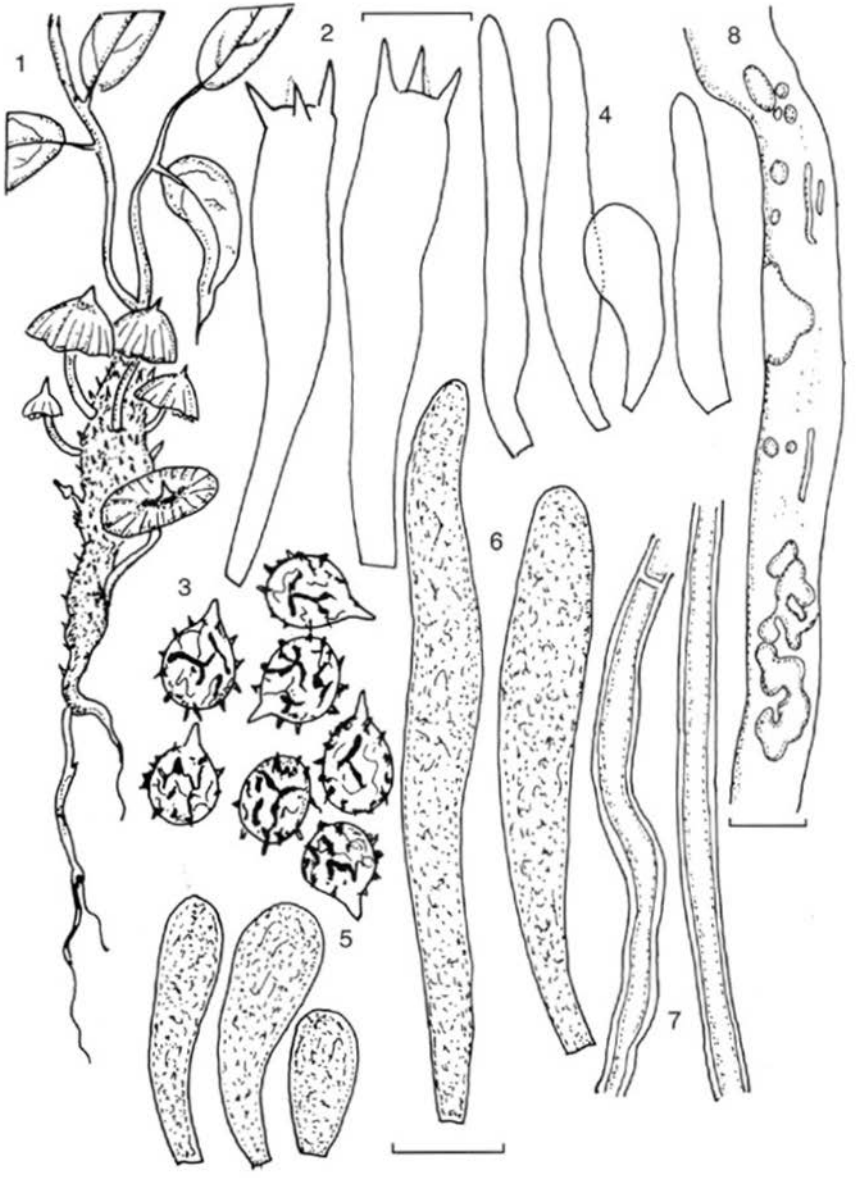
Lactarius ignifluus Vrinda & C.K. Pradeep, *spec. nov.* — Figs. 1–11

Pileus 5–30 mm latus, conico-convexus, expansus, papillatus dein applanatus vel depressus, scarletinus. Lamellae decurrentes, subdistantes, salmoneae. Latex scarletinus, immutabilis. Stipes 1.5–3 cm longus, 1–3 mm crassus, glaber, mycelio albido basale praeditus.

Sporae 6–7.5 × 6–7.5 µm, globosae ad subglobosae, amyloideae, verrucis et cristis ornate, reticulatae. Acies lamellarum sterilis. Cystidia 27–49.5 × 3–6 µm, hyalina, tenuitunicata. Pseudocystidia 33–144 × 6–10.5 µm, clavata vel fusiformia. Trama hymenophoralis subregularis. Cellulae cuticulae pilei globosae vel subglobosae.

Holotypus: India, Kerala state, Iringole sacred grove, 1 Oct. 1996, *Vrinda 3624* (TBGT, isotypus K).

Pileus 5–30 mm diam., convex, becoming applanate, always with an acute papillate umbo; surface 'scarlet' (9A8), fading to 'pastel red' or 'greyish red' (7A5-8B6) when exposed to rain, immediately turning bright scarlet when cut or bruised, dry, non-viscid, veined, with a non-separable cuticle; margin entire. Lamellae decurrent, 'salmon' (6A4), 2–3 mm wide, ventricose, subdistant with lamellulae of 3 lengths, immediately turning bright scarlet when cut; edge concolorous with the sides, entire. Stipe 15–30 × 1–3 mm, central, cylindrical, equal, fistulose; surface concolorous with pileus, whitish below, hirsute at the base, with abundant aborted basidiomata arising from an extensive



Figs 1–8. *Lactarius ignifluus*. — 1. Habit × 1; 2. basidia; 3. spores; 4. cheilocystidia; 5. cheilomacrocystidia; 6. pleuromacrocystidia; 7. hyphae of the stipe hairs; 8. laticiferous hypha. Bar = 10 µm.

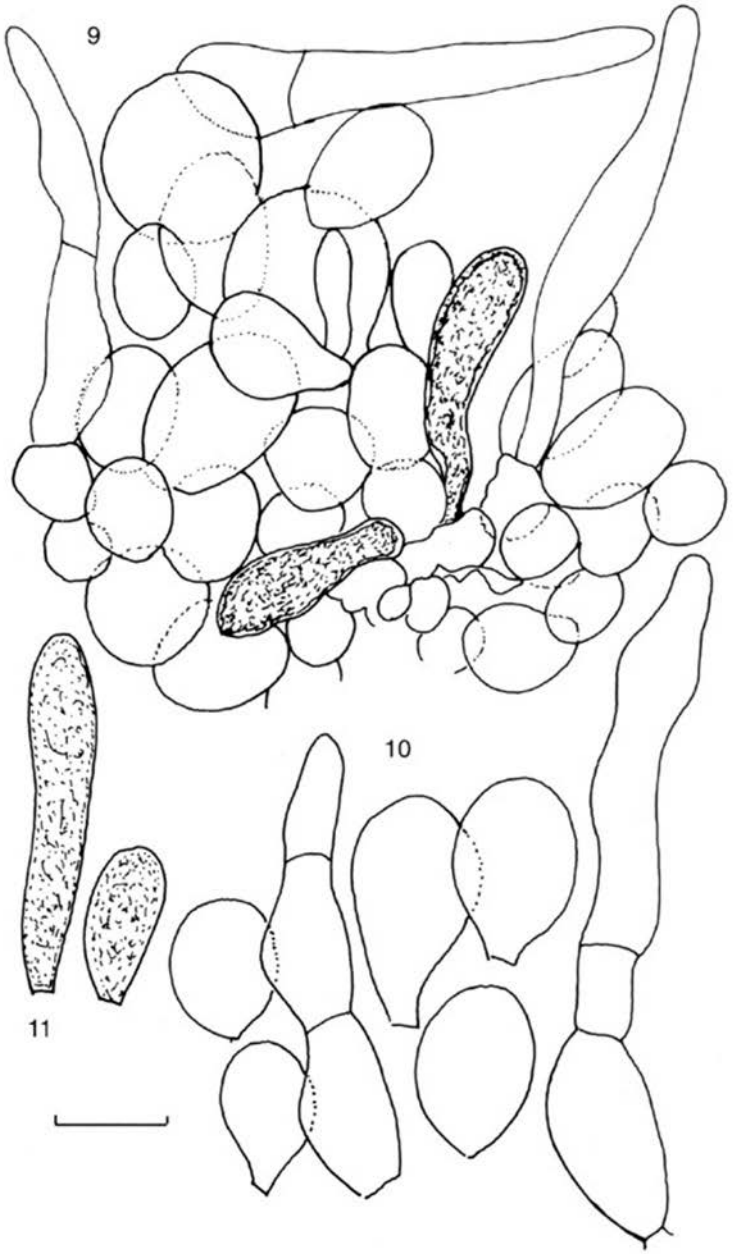
thick, white mycelial mat covering the woody substrate on which it grows. Annulus none. Odour pleasant. Latex 'scarlet' (9A8) from the beginning, unchanging, watery, acrid to taste, very irritating to the tongue. Context thin, up to 0.5 mm at centre, concolorous with pileus. Spore print white.

Spores 6–7.5 × 6–7.5 µm, globose to subglobose (Q = 1.03; n = 50) hyaline, with a strongly amyloid ornamentation composed of ridges, fine lines and verrucae forming a subcomplete reticulum; hilar appendix 1.3–2.4 × 1.2–1.8 µm, hyaline. Basidia 30–52.5 × 7.5–18 µm, clavate, 4-spored. Lamella edge sterile, marginal cells 27–49.5 × 3–6 µm, versiform, mostly narrowly fusoid to lageniform, thin-walled, hyaline. Cheilomacrocystidia subclavate, 20–25 × 7–9 µm, thin-walled, with dense granular content. Pleuromacrocystidia fairly abundant, 33–144 × 6–10.5 µm, clavate to fusiform with granular amorphous contents. Hymenophoral trama subregular with thin-walled subparallel hyphae, 3–12 µm diam., non-gelatinized, lacking any sphaerocytes. Subhymenium well-developed, composed of short, cylindrical, multiseptate elements. Pileipellis an epithelium to palisade, 25–50 µm thick, composed of isodiametric to irregular cells of 9–21 × 7.5–15 µm, which are densely packed; terminal cylindrical elements scarse, thin-walled, 16.5–56 × 3–6 µm, intermixed with scattered dermatomacrocystidia 13.5–30 × 4.5–7.5 µm. Context composed of radially arranged, interwoven, hyaline, thin-walled hyphae of 1.5–16.5 µm diam., lacking sphaerocytes. Trama of stipe composed of densely packed, thin-walled, parallel hyphae, hyaline and non-gelatinized, occasionally septate. Basal mycelial mat, stipe hairs and the aborted basidiomata are made up of compactly arranged, thick-walled, hyaline, non-septate, unbranched, parallel hyphae, 1.5–3 µm diam. Caulocystidia absent. Lactiferous hyphae rather common. All hyphae lacking clamp-connections.

Habitat — Growing on living, standing stems of dicotyledonous herbs and shrubs (members of Annonaceae and Piperaceae), in groups occasionally scattered on soil at the base of these plants.

Specimens examined. INDIA: Kerala state, Iringole sacred grove, 1 Oct. 1996, *Vrinda 3624* (holotype, TBGT; isotype K (M) 47290); 16 Aug. 1994, *Pradeep 1377*; 15 Aug. 1995, *Pradeep 2441*; 23 Aug. 1997, *Sibi 4080*; 30 July 1999, *Pradeep 4793*; 9 Oct. 2000, *Pradeep 5213*.

Lactarius ignifluus is characterized by a distinctive combination of features such as the small, acutely umbonate, reddish, centrally stipitate basidiomes arising from an extensive thick mycelium, covering the woody substrate on which it grows, globose to subglobose spores with a strongly amyloid, almost reticulate ornamentation, sterile lamella edge, abundant pleuromacrocystidia and the total absence of sphaerocytes in the trama and context. Another characteristic feature of the present taxon is its pileipellis, which is an epithelium to palisade (Verbeken, 1998). Its tropical origin, lignicolous habitat, the presence of thin-walled elements in the epicutis, the filamentous hymenophoral trama lacking sphaerocytes, the nearly globose spores and the presence of pseudocystidia on the sides of the lamellae are indicative of section *Venolactarius* (R. Heim) Sing. *Lactarius adhaerens* R. Heim from Madagascar (Heim, 1938) seems to be related to *L. ignifluus* in the hirsute nature of the stipe base, subglobose spores and the epithelial pileipellis. *Lactarius ignifluus*, however, differs from *L. adhaerens* in the size, colour, and shape of the basidiomes, colour and taste of the exudation, size of the spores and the nature of basidia and cystidia. The lignicolous basidiomes invite



Figs. 9–11. *Lactarius ignifluus*. — 9. Surface view of the pileipellis; 10. epithelial elements; 11. dermatomacrocystidia. Scale bar = 10 µm.

comparison with the section *Panuoidei* (Singer, 1984), but apart from the habitat, there are no other significant similarities between them. The most important macroscopic features distinguishing *L. ignifluus* are the bright scarlet, acutely umbonate pileus and its latex that is invariably bright scarlet.

ACKNOWLEDGEMENTS

The authors are thankful to Dr. D.N. Pegler for providing valuable literature and suggestions on *L. adhaerens* and express their deep sense of gratitude to Dr. A. Verbeken for the critical review, advice and useful correspondence.

Two of us (CKP & SM) acknowledge financial assistance from CSIR, New Delhi.

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BOOK REVIEWS

D. Moore, M.M. Nauta, S.E. Evans & M. Rotheroe (eds.). *Fungal conservation, Issues and solutions*. (Cambridge University Press, The Edinburgh building, Cambridge CB2 2RU, UK. 2001.) ISBN 0-521-80363-2. Pp. 262, several text-figs. Price: £ 65.–.

Since mycologists have become aware of a significant decline of (macro)fungi in the last century due to environmental pollution and habitat destruction, conservation of fungi has become an important issue. It is not clear, however, whether conservation should be focused on the fungi themselves, the sites, the habitats or the host. This book deals with the various aspects of fungal conservation in different parts of the world. It has its origin in a Symposium organised by the British Mycological Society, complemented by some invited papers to enhance the geographic coverage of the book. In 20 chapters several subjects are dealt with, varying from microfungus diversity in Kenya to management of forest fungi in the USA, from the effects of nature management on grassland fungi in the Netherlands to biodiversity action plans in the UK, from the threats of mushroom cultivation to biodiversity in China to strategies for conservation of fungi in Sicily. A general introduction and a discussion complete the book. The book does not provide ready-made solutions for the conservation of fungi, but it does give useful suggestions about how fungi can be included in conservation projects in a range of circumstances. As such, the book is unique and recommended for all interested in fungal conservation.

R. Watling, J.C. Frankland, A.M. Ainsworth, & S. Isaac. *Tropical Mycology, vol. 1, Macromycetes*. (CABI Publishing, Wallingford, Oxon OX10 8DE, United Kingdom. 2002.) Pp. 191, with black-and-white photographs and line-drawings. Price: £ 40.

In the past decades the interest in tropical mycology has greatly increased, in part as a result of extensive biodiversity assessment and conservation programs. The current book is produced from papers presented at the British Mycological Society's symposium held in Liverpool in April 2000. It deals with contributions on taxonomy, ecology, biology, and economic potential of tropical Macromycetes. Contributed papers deal with various topics, such as ectomycorrhizal macromycetes in neotropical oakwoods, rainforest in Africa and Asia; basidiomycetes of the Greater Antilles Project; brown- and black-spored agarics of tropical Mexico with particular reference to *Gymnopilus*; taxonomy, ecology and biology of polypores in Indonesia and Taiwan; production of lignolytic enzymes by tropical higher fungi from Ecuador; laboratory studies with *Leucoagaricus* and attine ants; conservation of mycodiversity in India; mushroom collecting in Tanzania and Hunan (Southern China) in connection with inherited wisdom and folklore of two different cultures, and finally the developmental, physiological and environmental aspects of commercially grown mushrooms in the tropics. This collection of papers reflects up-to-date knowledge of this very important group of organisms in endangered habitats.

PERSOONIA
Volume 18, Part 1, 135–138 (2002)

HYGROCYBE MONTEVERDAE
A new species of subgenus Cuphophyllus (Agaricales) from the Canary Islands (Spain)

Á. BAÑARES[1] & E. ARNOLDS[2]

Hygrocybe monteverdae, collected in monte-verde forest in the Canary Islands, is proposed as a new species belonging to subgenus *Cuphophyllus*. Its most remarkable character is the blackening lamellae after drying, being the sole species with this feature in the subgenus.

The 'monte-verde' (*Pruno-Lauretalia azoricae* Oberd. ex Rivas Mart. et al.) of the Macaronesian Archipelago (Açores, Madeira and Canary Islands) is traditionally misnamed '*laurisilva*' (Rivas-Martínez et al., 1993) because of its similarity with the tropical montane lauroid and subtropical-temperate forest. It is a mediterranean hard-leaved forest with a great floristic diversity and predominance of trees, belonging to different plant families, with perennial, coriaceous and bright leaves similar to the leaves of laurel (*Laurus*). Its origin has been founded by the temperate-subtropical paleoflora extant at the end of the Tertiary at Mediterranean riversides which disappeared in the course of the pleistocene glaciations. This community survived on the islands as a plant relict of extraordinary singularity worldwide.

Its pluviometric regime is concentrated mainly in the coldest seasons, autumn and winter; the summer is more of arid character. The annual average precipitation is 600–1,000 mm. Its establishment between 300 and 1,000 m altitude at the northern slopes of the islands is caused by the incidence of the humid Atlantic winds, 'alisios', that support a pluviometric increase along the year by the horizontal precipitation phenomenon.

In Europe most species of *Hygrocybe* are found outside forests in old, poor grasslands, some in heathland and peat bogs (Arnolds, 1990). Some of these species are also occasionally and locally found in deciduous forests on moist, rather fertile and humous soils. In North-America most species of *Hygrocybe*, many of them conspecific with European species, are widespread in a variety of forest types (Hesler & Smith, 1963). This ecological differentiation is not yet well-understood. On the Canary Islands permanent, old pastures are almost absent. The 'monte-verde' constitutes the exclusive habitat for *Hygrocybe* species in the Canary Islands. All 19 cited taxa for the Canary Islands have been collected as terrestrial saprotrophic elements in the 'monte-verde' as well as in mixed 'monte-verde'-pine forests (Beltrán, 1980; Bañares et al., 1980, 1991, 1992, 1994; Bañares & Beltrán, 1982; Beltrán et al., 1987, 1989; Bañares, 1988; Dähncke, 1998). Consequently, the ecological preferences of this genus show more affinity to North-America than to Europe.

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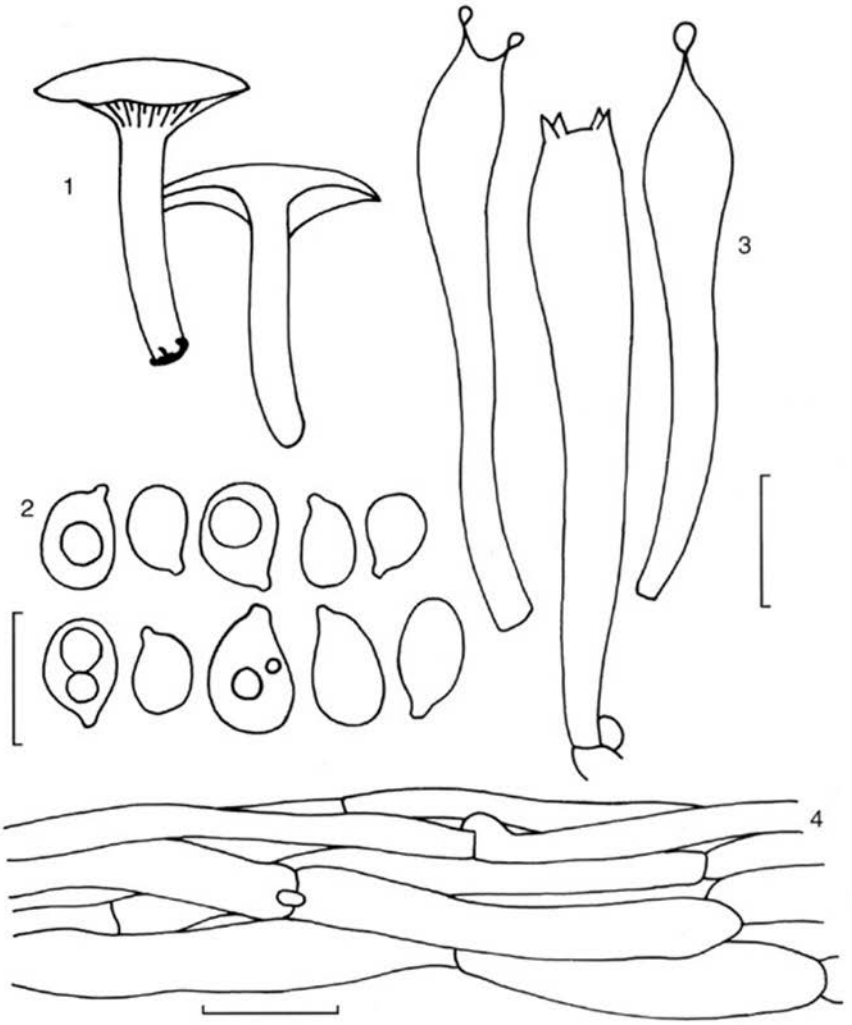

Figs. 1–4. *Hygrocybe monteverdae* (holotype). 1. Habitus × 1; 2. spores; 3. basidia; 4. pileipellis. Scale bar = 10 µm.

The present taxon was previously reported by Bañares et al. (1994) for the island of La Palma, where it was collected in humid sites of the 'monte-verde'. On that occasion, it was named *Hygrocybe pratensis* (Pers.: Fr.) Murril aff. var. *pallida* (Cooke) Arnolds because of its similarity to this taxon in habit, colours and microscopical details. It was noticed that the sporocarps were considerably smaller, and blackening

on drying. The latter feature was initially regarded as a possible anomality. However, a second collection from the same locality shared the same characteristics. Therefore we decided to describe our collections as a new species in the subgenus *Cuphophyllus* Donk.

Hygrocybe monteverdae Bañares & Arnolds, *spec. nov.* — Figs. 1–4

Pileus 10–40 mm latus, plano-convexus, albus, centro ochraceus, haud hygrophanus, siccus. Lamellae decurrentes, distantes, albidae, in exsiccata nigrescentes. Stipes 35–70 × 4–7 mm, aequalis, albus, deorsum attenuatus, pallide roseus. Caro concolor. Odor et sapor nulli. Sporae (5.5–)6–9 (–9.5) × 3.5–5 µm, Q = 1.4–1.9(–2.0), ellipsoideae, ellipsoideae-oblongae, ovoideae vel lacrimiformae. Basidia 39–53 × 5.5–6.5 µm, Q = 6.3–8.0 clavata, 4- et 2- (1-) sporigera intermixta. Lamellarum acies fertilis. Lamellarum trama irregularis, cellulis 32–103 × 3.5–12 µm. Pileipellis cutiformis, hyphis 2–4 µm latis. Fibulae frequentes. In monte-verde ad terram.

Holotypus: 'La Palma, MAB Reserve El Canal y Los Tilos (Puente-Nuevo), 1 Febr. 1991, *Á. Bañares 6456*' (TFC; isotypus in L).

Pileus 10–40 mm wide, plano-convex, not hygrophanous, white, to the centre ochraceous, slightly greyish brown when drying, rather thin-fleshy, not striate, not glutinous. Lamellae slightly decurrent, white but entirely blackening when drying, thickish and distant. Stipe 35–70 × 4–7 mm, slender, cylindrical, slightly tapering to the base, white, pale-pinkish to the base, brown-ochraceous at apex when drying. Context concolorous; taste and smell indistinctive. Spores (5.5–)6–9(–9.5) × 3.5–5 µm, Q = 1.4–1.9(–2.0), very variable, ellipsoid to ellipsoid-oblong or ovoid, often tapering to apiculus and more or less lacrimiform. Basidia 39–53 × 5.5–6.5 µm, Q = 6.3–8.0, slenderly clavate, 4- and 2-spored intermixed, some 1-spored. Cystidia absent. Hymenophoral trama on section distinctly irregular; elements 32–103 × 3.5–12 µm. Pileipellis a dry, poorly differentiated cutis of compact, repent hyphae, 2–4 µm wide, with ochre-yellowish intracellular pigment. Clamp-connections present.

Terrestrial, rare, among leaves in humid site of monte-verde forest, 800 m s.m., under *Laurus azorica* (Seub.) Franco, *Persea indica* (L.) K. Spreng, *Ilex canariensis* Poir. and *Dryopteris oligodonta* (Desv.) Pic.-Serm.

Collections examined. SPAIN: Canary Islands, La Palma, MAB Reserve El Canal y Los Tiles (Puente Nuevo), 1 Feb. 1991, *Á. Bañares 6456* (holotype TFC; isotype in L); 10 Dec. 1998, *Á. Bañares 8295* (TFC).

Hygrocybe monteverdae is a typical representative of subgenus *Cuphophyllus*. It is rather similar to *H. pratensis* (Pers.: Fr.) Murrill var. *pallida* (Cooke) Arnolds (= *H. berkeleyi* (P.D. Orton) P.D. Orton & Watling), but it differs in its smaller and more slender sporocarps, blackening lamellae and darker brown pilei when drying. In addition, *H. monteverdae* has a more compact pileipellis, without erect hyphae, and slightly larger spores. It differs from *H. virginea* (Wulf.: Fr.) P.D. Orton & Watling and allied species, except for the blackening lamellae, in the not hygrophanous, not striate pileus.

ACKNOWLEDGEMENT

One of the authors (A.B.) likes to acknowledge the support given by DGCYT (PB-87/1.004) leaded by Dr. Esperanza Beltrán.

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PERSOONIA
Volume 18, Part 1, 139–142 (2002)

ERYSIPHE HELLEBORI, A NEW AGENT OF POWDERY MILDEW IN YUGOSLAVIA

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A new agent of powdery mildew in Yugoslavia, *Erysiphe hellebori* spec. nov., which parasitizes *Helleborus odoratus* L., is described and illustrated.

Fungi of the family Erysiphaceae are obligate parasites that infect a large number of plants, on which they cause diseases known as powdery mildew. The flora of Spermatophyta in Yugoslavia is rich due to favourable climatic conditions, and an analogously rich amount of parasitic fungi may be expected. However, the number of records of powdery mildews in Yugoslavia is small and mainly confined to species on cultivated plants (Marić & Kovačević, 1946; Arsić, 1961; Spasić, 1961; Mijušković, 1963; Perišić, 1970; Ristić, 1985). The composition of species, their taxonomic characteristics, and the spectrum of host plants of these fungi have been studied in a series of papers (Ranković, 1988,1999; Ranković & Čomić, 1996, 1997).

In the present paper a new agent of powdery mildew in Yugoslavia, viz. *Erysiphe hellebori,* which parasitizes *Helleborus odoratus*, is described.

MATERIAL AND METHODS

The following taxonomic characteristics of *Erysiphe hellebori* have been examined: appearance and distribution of mycelium on the surface of the infected host plant organs, diameter, shape and size of ascomata; number, size and structure of appendages; number, shape and size of ascospores. The values obtained for these characteristics are based in each case on the microscopic examination or measurement of 100 microstructures of the particular structures.

Material of the collections examined has been deposited at the Mycological Herbarium of the Institute of Biology, Kragujevac (MHIB).

Plants of the species *Helleborus odoratus* L. and *Vicia cassubica* L. were artificially inoculated with a suspension of spores of the fungus *E. hellebori,* as well as with a suspension of spores of the fungus *Erysiphe baeumleri* (Magnus) U. Braun & S. Takam. The experiment was performed in threefold repetition.

RESULTS

Erysiphe hellebori Ranković, *spec. nov.*

Differt a *Erysiphe baeumleri* appendicibus plus increbre et ornate tumosis et specifice distinctis.

Mycelia in folias, ex superficie amphilateralia, effusa vel in fragmentis griseolis (Forma 1). Hyphae vegetativae 3.5–6 µm, crassae, irregulares. Conidia non observata. Ascomata inspresa vel subgregaria, in strato myceliale immersa, globosa ad subglobosa, fusca (100–)107–124 (–130) µm

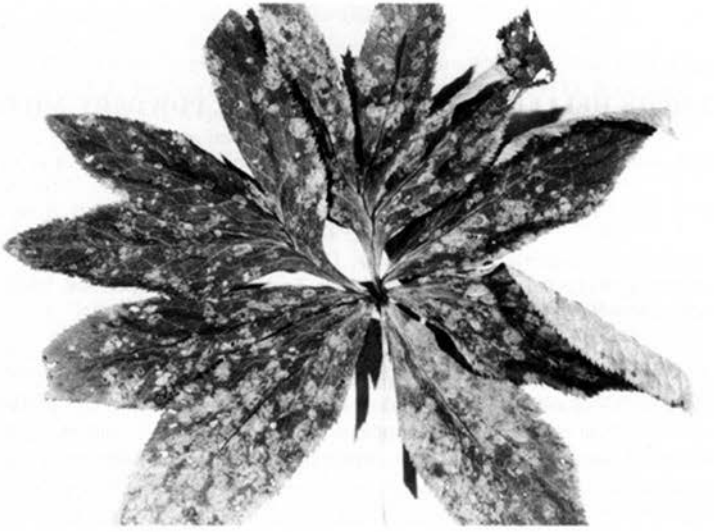

Fig. 1. Leaf of *Helleborus odorus* L. with *Erysiphe hellebori*.

diameter. Peridium pluristratosum. Cellulae polygoniae, 12–28 µm. Appendiculae 8–20 per ascoma, enatae equatorialiter ad subequatorialiter, 5–10 longiores quam ascomatis diameter, flexuosae, cum propensione curvandi in directionem unam, luteae ad basim, ad apicem hyalineae, 0–1(–2) septate, apicibus simplicibus 1–2 ramosis, apicibus non recurvis (Forma 2). Asci 5–10(–14) per ascoma, sessiles ad breve stipitati (60–)65–72(–80) × (30–)33–39(–42) µm. Ascospores (2–)4–5, ellipsoideae ad ovoideae, (18–)20–23(–24) × 10–12(–13.5) µm.

Holotypus: In foliis vivis *Hellebori odorati*, Yugoslavia, prope Knić, Sept. 1988, *B. Ranković, 2231* (MHIB).

Mycelium on both sides of the leaves superficial, effused or in gray patches, evanescent (Fig. 1). Vegetative hyphae 3.5–6 µm wide, irregular. Conidia not observed. Ascomata scattered or subgregarious, immersed in the dense mycelial layer, globose to subglobose, brown, (100–)107–124(–130) µm in diameter. Peridium multilayered, composed of polygonal cells of 12–28 µm in diameter. Appendages 8–20 per ascoma, arising equatorially to subequatorially, 5–10 times as long as the ascomatal diameter, flexuous, with a tendency to turn towards one direction, yellowish at the base, hyaline at the apex, 0–1(–2) septate, apex simple to 1–2 times dichotomously branched, tips not recurved (Fig. 2). Asci 5–10(–14) per ascoma, sessile to short-stalked (60–)65–72(–80) × (30–)33–39(–42) µm. Ascospores (2–)4–5, ellipsoid to ovoid, (18–)20–23(–24) × 10–12(–13.5) µm.

Habitat & distribution — Found on *Helleborus odoratus* L. in the vicinity of Knić and Ćačak, Sept. 1988, and Jastrebac, Sept. 1997; rare.

Ranković (1999) recorded *Microsphaera* spec. on *Helleborus odoratus* from Yugoslavia. *Erysiphe hellebori* resembles *E. baeumleri*, from which it differs in the more frequently and regularly branched appendages. Furthermore, *E. hellebori* and *E. baeumleri* are biologically distinct.

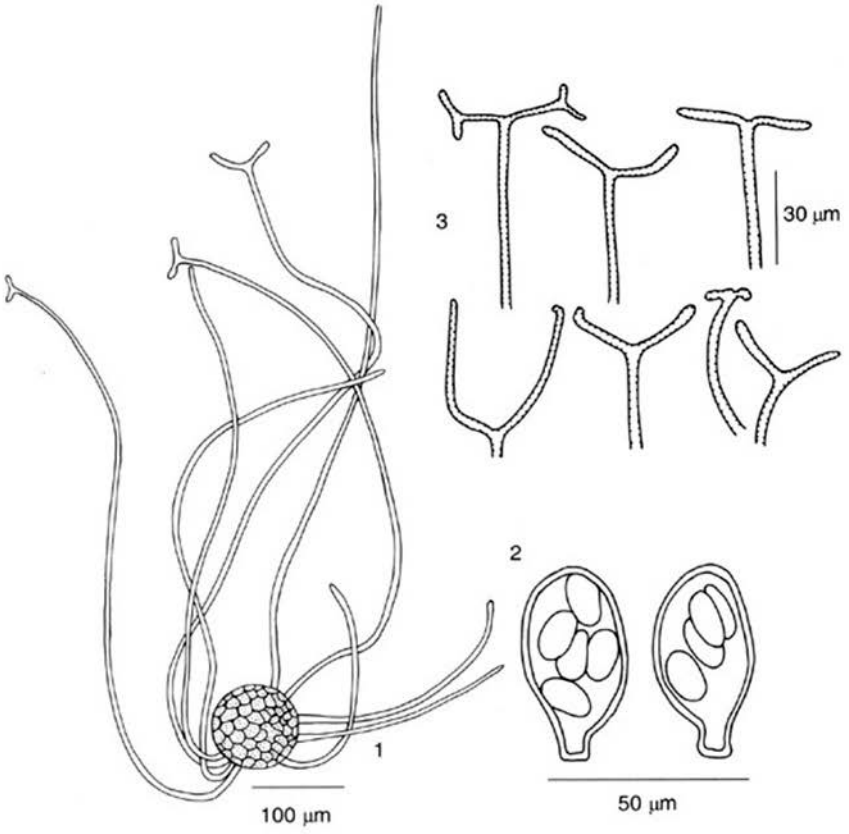

Fig. 2. *Erysiphye hellebori* spec. nov. 1. Ascomata; 2. asci with ascospores; 3. appendages.

Artificial inoculation of *H. odorus* plants with spores of *E. hellebori* gave positive results, whereas results of inoculating *Vicia cassubica* plants with spores of this fungus were negative in all variants. In contrast to this, artificial inoculation with spores of *E. baeumleri* gave negative results on *H. odoratus*, but positive results on *V. cassubica*. It can be concluded that *E. hellebori* and *E. baeumleri*, in addition to morphological differences, also differ with regard to their biological specialization, i.e. they parasitize different plant species belonging to different families.

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PERSOONIA
Volume 18, Part 1, 143–145 (2002)

A NEW SPECIES IN COPRINUS SUBSECTION SETULOSI

C. B. ULJÉ[1] & A. VERBEKEN[2]

Coprinus canistri spec. nov. is proposed. It belongs to the subsection *Setulosi* because of the presence of pileo- and caulocystidia. A comparison is given with *C. subimpatiens* and *C. congregatus*, on account of similar microscopical characters.

During the studies in the genus *Coprinus* by the first author several taxa have been provisionally described without a formal name in earlier papers, awaiting more material to establish their specific status. A recent *Coprinus* find from Belgium supplied by the second author made it possible to evaluate the differences of collection *Uljé 877* with similar species and to describe this taxon formally as a new species.

In the following description the notation [100, 5, 2] stands for '100 spores from 5 basidiocarps in 2 collections'. L × B × W means: length × breadth in frontal view × width in side view. QB stands for 'length divided by breadth' (B), QW for 'length divided by width' (W).

Coprinus canistri Uljé & Verbeken, *spec. nov.* — Fig. 1

Pileus primo 3.5–7 × 3–5 mm, expansus ad 16 mm latus, cremeus ad pallide ochraceobrunneus, in centro ochraceobrunneus, marginem versus pallidior, primo pruinosus, tum laevis. Lamellae anguste adnatae ad subliberae, ex albo nigricantes. Stipes 20–30 × 0.5–1.5 mm, albidus, ab setulis pubescens, basin versus leviter clavatus, usque ad 2 mm crassus.

Sporae 9.3–13.6 × 6.2–8.3 × 6.0–6.8 µm, ellipsoideae ad ovoideae, poro germinativo eccentrico, 1.8 µm lato. Basidia 14–28 × 8.5–10.5 µm, 4-sporigera. Pseudoparaphyses 4–6(–7). Cheilocystidia 30–70 × 17–42 µm, subglobosa ad globosa, ellipsoidea, oblonga vel leviter utriformia. Pleurocystidia 50–110 × 27–45 µm, ellipsoidea, oblonga ad leviter utriformia. Pileocystidia 60–90 × 11–20 µm, lageniformia, interdum fusiformia, apice attenuato, 4–7.5 µm diam. Sclerocystidia absentia. Caulocystidia 60–95(–110) × 14–21 µm, lageniformia vel fusiformia, apice attenuato, 4–8 µm diam. Fibulae absentes.

Holotypus: Belgium, Wingene, VII.2000, *R. Walleyn 1831* (GENT; isotype: L).

Etymology: canistrum = small woven basket.

Closed pileus up to 3.5–7 × 3–5 mm, up to 16 mm in diam. when expanded, cream to pale ochre-brown to ochre-brown at centre (Mu. 7.5 YR 4/6, 10 YR 4–5/4, 6/5), paler towards margin (10 YR 4–5/3, 6/6, 7/2), when young entirely pruinose, becoming smooth on age. Lamellae, L = 16–24, l = 1–3, narrowly adnate to almost free, white to blackish. Stipe 20–30 × 0.5–1.5 mm, whitish, pubescent from numerous setulae, base slightly clavate, up to 2 mm.

Spores [100, 5, 2] 9.3–13.6 × 6.2–8.3 × 6.0–6.8 µm, av. L = 11.8–12.7 µm, av. B = 6.5–7.7 µm, av. W = c. 6.2–6.7 µm, QB = 1.50–1.90, av. QB = 1.60–1.75, QW = 1.85–2.05, av. QW = 1.85–1.95, ellipsoid to ovoid; germ pore eccentric, c. 1.8 µm

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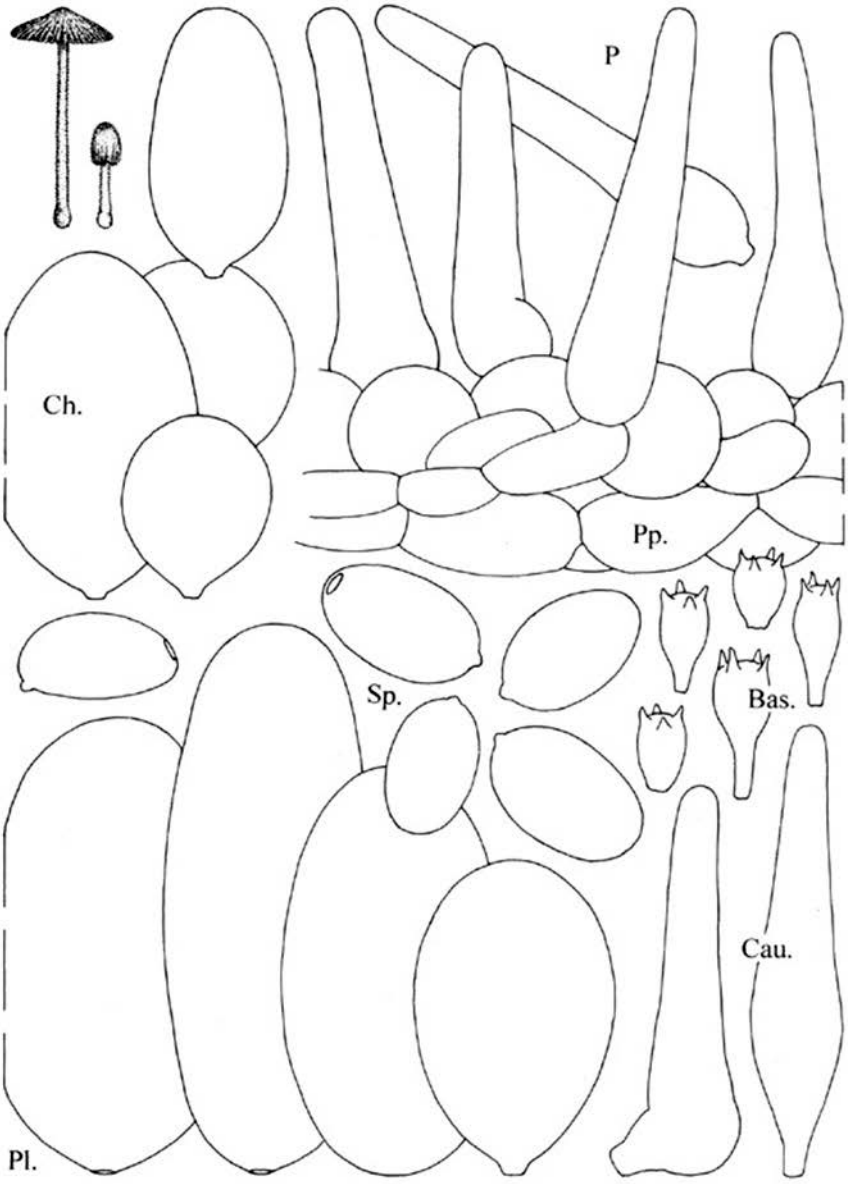

Fig. 1. *Coprinus canistri*. Sp. = spores, × 2000; Bas. = basidia; Cau. = caulocystidia; Ch. = cheilocystidia; P. = pileocystidia; Pl. = pleurocystidia; Pp. = pileipellis (Bas., Cau., Ch., P., Pl. and Pp., × 800).

wide. Basidia 14–28 × 8.5–10.5 µm, 4-spored. Pseudoparaphyses 4–6(–7) per basidium. Cheilocystidia 30–70 × 17–42 µm (sub)globose, ellipsoid, oblong, a few slightly broadly utriform. Pleurocystidia 50–110 × 27–45 µm, ellipsoid, oblong to slightly utriform. Pileocystidia 60–90 × 11–20 µm, lageniform, less frequent (sub)fusiform, with tapering neck, 4–7.5 µm wide at apex. Sclerocystidia absent. Caulocystidia 60–95 (–110) × 14–21, lageniform or fusiform, with tapering neck, 4–8 µm wide at apex. Clamp-connections absent.

Habitat — Growing fasciculate; the holotype found on a woven reed basket, the Dutch collection under shrubs, on branches embedded in mud taken from ditch.

Collections examined. BELGIUM: Wingene, VII.2000, *R. Walleyn 1831* (holotype, GENT). — THE NETHERLANDS: prov. Zuid-Holland, Oegstgeest, Laan v. Poelgeest, 26.VII.1987, *Uljé 877*.

The most closely related species is *Coprinus subimpatiens* M. Lange & A.H. Sm. This species also has pleurocystidia, but grows terrestrial and has usually larger basidiocarps. The pileocystidia in *C. subimpatiens* are larger, up to c. 140 µm long with (sub)cylindric neck, slightly broadened at apex in majority. The (sub)globose to ellipsoid or vesiculose cheilocystidia are mixed with lageniform ones. *Coprinus canistri* also reminds of *C. congregatus* (Bull.) Fr. in both macro- and microscopical characters, but differs in the habitat preference because *C. congregatus* is a (strictly) coprophilous species. Furthermore, *C. canistri* has smaller fruit-bodies, smaller and less narrow spores (av. $Q \geq 1.70$ in *C. congregatus*; av. $Q < 1.70$ in *C. canistri*), shorter pileocystidia and smaller cheilo- and pleurocystidia. The quotient of the spores in all strains (11) of *C. congregatus* studied by M. Lange (1953: 149) also exceeds 1.70 (1.75–1.95).

In a previous description of this species (as *Coprinus* sp.) (Uljé & Bas, 1991: 307) the presence of clamp-connections was mentioned, but careful re-examination of collection *Uljé 877* showed no clamp-connections and revealed only spores of more than 6 µm broad (the earlier mentioned minimum-length of 5.8 µm could not been traced again).

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BOOK REVIEWS

E. Ludwig. *Pilzkompendium, Band I. Die kleineren Gattungen der Makromyzeten mit lamelligem Hymenophor aus den Ordnungen Agaricales, Boletales und Polyporales.* (IHW Verlag, Eching, Germany, 2000 ('2001'). ISBN 3-930167-42-5 (plates), ISBN 3-930167-43-3 (text). Pp. 758, 188 colour plates, with numerous line-drawings. In German. Price: approximately € 178.–.

It took a long time to produce, but eventually early in 2001 the first part of this extensive compendium of macromycetes appeared. It is the result of decades of work by the author, who is known as a passionate mushroom collector and painter. Ludwig has the special gift that he is able to record the beauty and diagnostic characters of a mushroom in an unique way. The first volume consists of a large-sized part, 34 × 24 cm, with the icons, and a normal sized text volume.

The iconography contains 188 plates with a rather randomly obtained selection of the so-called 'smaller' genera of Agaricales, Boletales, and Polyporales, viz.: *Agrocybe, Armillaria, Arrhenia, Baeospora, Bolbitius, Callistosporium, Calocybe, Campanella, Catathelasma, Chaetocalathus, Chamaemyces, Cheimenophyllum, Clitocybula, Clitopilus, Crepidotus, Crinipellis, Cystoderma, Cystolepiota, Delicatula, Dennisiomyces, Dermoloma, Faerberia, Fayodia, Flammulaster, Flammulina, Galeropsis, Gamundia, Gastrocybe, Gomphidius, Gymnopilus, Hohenbuehelia, Hydropus, Hygrophoropsis, Hypholoma, Laccaria, Lentinellus, Lentinula, Lentinus, Lepista, Leucopaxillus, Limacella, Lyophyllum* (incl. *Tephrocybe*), *Macrocystidia, Marasmiellus, Marasmius, Melanomphalia, Melanophyllum, Mycenella, Mythiomyces, Myxomphalia, Naucoria, Nyctalis, Omphalina, Omphalotus, Oudemansiella, Ossicaulis, Panaeolus, Panellus, Paxillus, Phaeocollybia, Phaeolepiota, Phaeomarasmius, Pholiota, Phyllotopsis, Pleurocybella, Pleuroflammula, Pleurotus, Pseudobaeospora, Pseudoclitocybe, Psilocybe, Resupinatus, Rhodocybe, Rhodotus, Rickenella, Ripartites, Rozites, Schizophyllum, Simocybe, Squamanita, Stagnicola, Strobilurus, Stropharia, Tricholomopsis, Tubaria, Volvariella, Xeromphalina*, and *Xerula*. Ludwig depicted almost all known European species of each genus, which makes this compendium remarkably complete. In addition many species have been depicted several times from various localities, in order to get a good impression of infraspecific variability. This alone makes this a unique publication. A few examples are (number of collections depicted in brackets) *Agrocybe praecox* (4), *Cystolepiota hetieri* (3), *Gymnopilus penetrans* (6), *Laccaria proxima* (5), *Lepista panaeolus* (4), *Lyophyllum tylicolor* (5), *Naucoria melinoides*, (4), *Omphalina obscurata* (4) and finally *Panaeolus olivaceus* (8!).

The text volume contains information on all genera, with diagnostic characters, literature references, and notes on species not included in the book. Every species is presented with the correct name, current synonymy, etymology, selected literature and iconography, ecology and distribution, as well as a concise but accurate description of macroscopical and microscopical characters, usually based on the authors own observations. References are given to the material studied, which is conserved in the authors private herbarium. A few critical remarks concern the fact that Ludwig in some cases included species which he did not see fresh himself. Some obscure species from literature, such as *Delicatula cuspidata* and the *Lyophyllum* species described

(invalidly) by Métrod are examples of doubtful taxa, which may not exist in reality. The lack of keys hampers identification, and makes it sometimes difficult to understand the status of some newly described taxa. The publisher took a great financial risk in producing this work, which probably is the reason for choosing the rather light and cheap quality of the paper used in printing the plates, and the binding of the book, which is a pity. The text volume is more robust, well-bound and easy to use.

In conclusion, however, one must state that this first volume of a total of five is very promising. When finished, this compendium will be without any doubt the most important publication on European macromycetes of the twenty-first century. It is to be hoped that the second volume will follow soon: we look forward to it, and recommend this publication warmly to all mushroom lovers.

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