

Additional reports on coprophilous *Lasiosphaeriaceae* from tropical climates

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Abstract: Following a recent work on coprophilous *Cercophora* species from tropical climates, this paper deals with more species of *Lasiosphaeriaceae* from the same climates. Coprophilous *Lasiosphaeriaceae* are divided into groups according to their regularity of growing on dung. Three additional *Cercophora* species and two *Podospora*, some of which are very rare or even never recorded since the original finding, are described in detail and compared with similar taxa. A key is provided to the complex of *Cercophora* species with a palisade or tufts of swollen and agglutinated neck hairs.

Keywords: Ascomycota, *Cercophora brevifila*, *C. mirabilis*, *C. samala*, morphology, *Podospora hyalopilosa*, *P. inquinata*.

Introduction

Deal with coprophilous ascomycetes, continuously for more than thirty years, inevitably implies to meet with many representatives of *Lasiosphaeriaceae* Nannf. (*Sordariales* Chadef. ex Hawksw. & O.E. Erikss.), a family encompassing 35 genera (MAHARACHCHIKUMBURA *et al.*, 2015), most (24) growing on dung.

Coprophilous *Lasiosphaeriaceae* can be subdivided, in my view, into four groups:

1) The first and largest group, consists of genera that we can call "obligatory fimicolous" since, to the best of my knowledge, they have been recorded only from dung. In this group are placed *Anopodium* N. Lundq., *Apodospora* Cain & J.H. Mirza, *Arniella* Jeng & J.C. Krug, *Bombardioidea* C. Moreau ex N. Lundq., *Emblemospora* Jeng & J.C. Krug, *Fimetariella* N. Lundq., *Periamphispora* J.C. Krug, *Tripterosporella* Subram. & Lodha, *Zygopleurage* Boedijn, and *Zygospermella* Cain.

2) In the second group we find genera that, although distinctly coprophilic (*Arnium* Nitschke ex G. Winter, *Camptosphaeria* Fuckel, *Podospora* Ces., *Schizothecium* Corda and *Strattonia* Cif.), also include a minority of species occasionally or consistently recorded (MIRZA & CAIN, 1969; LUNDQVIST, 1972) from other substrates (soil, wood, etc.).

3) Each genus of the third group consists of two main clusters of species recognizable by their exclusive substrate choice:

a) groupings of *Apiosordaria* Arx & W. Gams spp., as well as of *Lacunospora* Cailleux [regarded by KIRK *et al.* (2008) as a synonym of *Apiosordaria*], are respectively known from soil (GUARRO *et al.*, 2012) and dung (CAIN & FARROW, 1956; CAILLEUX, 1970; VALLDOSERA & GUARRO, 1994);

b) *Cercophora* Fuckel spp. were monographed according to their fimicolous (LUNDQVIST, 1972) or lignicolous (HILBER & HILBER, 1979; BELL & MAHONEY, 2016) habitat. Likewise, *Apodus* Malloch & Cain and *Echria* (N. Lundq.) Krus *et al.* comprise two species each. Species of *Apodus* are from dung (MALLOCH & CAIN, 1971) and stems (ARX, 1975) while species of *Echria* are from dung (LUNDQVIST, 1972; KRUS *et al.*, 2015) and wood (RAJA & SHEARER, 2006; KRUS *et al.*, 2015).

4) The fourth group includes genera [*Cladorrhinum* Sacc. & Marchal (hyphomycete), *Melanocarpus* Arx (not placed in the *Lasiosphaeriaceae* by STCHIGEL *et al.*, 2002) and *Triangularia* Boedijn] with a very low rate of coprophilous species (VALLDOSERA & GUARRO, 1992; KHAN & KRUG, 1989; MOUCHACCA & GAMS, 1993).

LUNDQVIST (1972) drew a world-map of coprophilous ascomycetes and recognized two main patterns of latitudinal distribution, a "north-temperate" and a "tropical-subtropical" group, also supposing the existence of a "south-temperate" group. Several *Lasiosphaeriaceae* have been recorded from tropical climates and some of them are known from the tropics only (HENNING, 1895; PETCH, 1925; CAILLEUX, 1969; LUNDQVIST, 1972), e.g. *Cercophora caerulea* (Petch)

N. Lundq., *C. elephantina* (Henn.) N. Lundq., *Lacunospora stercoraria* Cailleux and *Podospora bicolor* Cailleux.

I recently described *Cercophora elephantina* from an Indian tropical area (DOVERI, 2016), together with two other *Cercophora* spp., one of which was a new taxon. The current publication, which describes two *Podospora* spp. and three *Cercophora* spp. from an Indonesian tropical area, should be seen as an ideal continuation of my previous work.

Materials and methods

A sample of wild water buffalo dung was collected in Rinca island (Indonesia) and a few days later brought to Italy where, after a first observation, was placed in a non-sterilised damp chamber, following the methods suggested by DOVERI (2004). Cultured material, incubated at room temperature (18–25°C) under natural light, but not exposed to direct sunlight, was examined on alternate days under a stereomicroscope. Microscopic examinations were carried out on specimens removed from the damp chamber dung and mounted in water and Congo red, sometimes in cotton blue in lactic acid. Spore size was measured in water. Perithecial height is recorded inclusive of the neck.

Abbreviations: CLSM = author's personal herbarium.

Taxonomy

Cercophora brevifila N. Lundq. & Fakirova, *Dokl. Bŭlgarska Akademiyana Naukita*, 26: 1395 (1973). **Plates 1-5**

Perithecia semi-immersed to superficial, 370–530 × 250–400 µm, obpyriform, sometimes conical, non-stromatic, dark brown at transmitted light, pale brown at reflected light, membranous, covered with numerous hyphoid hairs. Neck conical-papillate or cylindrical, 100–120 × 80–120 µm, straight or curved, somewhat darker than the venter, rough, ungrooved, covered with a palisade of short, agglutinated hairs. **Perithecial contents** hyaline. **Peridium** semi-transparent, three-layered, pseudoparenchymatous: exostratum a *textura angularis*, *epidermoidea* at short intervals, of brown, fairly thick-walled, polygonal or irregular cells, 6–12 × 6–8 µm, sometimes disposed in a petaloid pattern around the bases of hyphoid hairs; mesostratum of paler, elongated, parallel, cylindrical cells; endostratum a *textura angularis* of pale, thin-walled, polygonal cells, up to 12 × 10 µm. **Neck hairs** 7–14 × 4–7 µm, straight or somewhat curved, brown, thick-walled, 0–2-septate, roundish or swollen at the apex. **Peridial hairs** hyphoid, numerous, sometimes crowded and ramified, flexuous, brown, septate, fairly thick-walled, 2–2.5 µm diam., 4–7 µm at the base. **Paraphyses** mixed with the asci and exceeding them, cylindrical-moniliform, sometimes branched at the base, septate,

often narrowing at the septa, 5–10 µm diam., tapering upwards, containing many hyaline vacuoles. **Asci** 195–255 × 15–18 µm, unilocular, non-amyloid, 8-spored, cylindrical at first, cylindrical-clavate later, slightly flattened or roundish at the apex, with a quite long, lobate stalk, a simple apical ring and a rough, subspherical, often deformed subapical plasma globulus, 5–6 µm diam. **Ascospores** bi-triseriate inside the ascus: at first one-celled, hyaline, cylindrical, bent below or sigmoidal, 45–50 × 4.5–5 µm, containing 10–12 droplets, with two central, solid, lash-shaped gelatinous caudae, one at each end, roughly equal in length, the basal one sometimes slightly

wider, 27–30 × 2–3 µm; swelling later at one end and becoming clavate-sigmoidal or clavate with a bent lower end; finally two-celled as divided by a transverse septum into an upper head and a lower pedicel. Spore head becoming dark pigmented, (18–) 18.5–22 × (9.5–) 10–11.5 (–12.5) µm, ellipsoidal or narrowly ellipsoidal (Q = 1.56–2.21; average Q = 1.87), equilateral, sometimes transversely septate, tapering at the apex, often umbonate, flattened at the base. Germ pore eccentric. Pedicel 30–38 × 4–5.5 µm, hyaline, bent at the lower end or sometimes geniculate, soon collapsing. **Asexual morph** not seen.

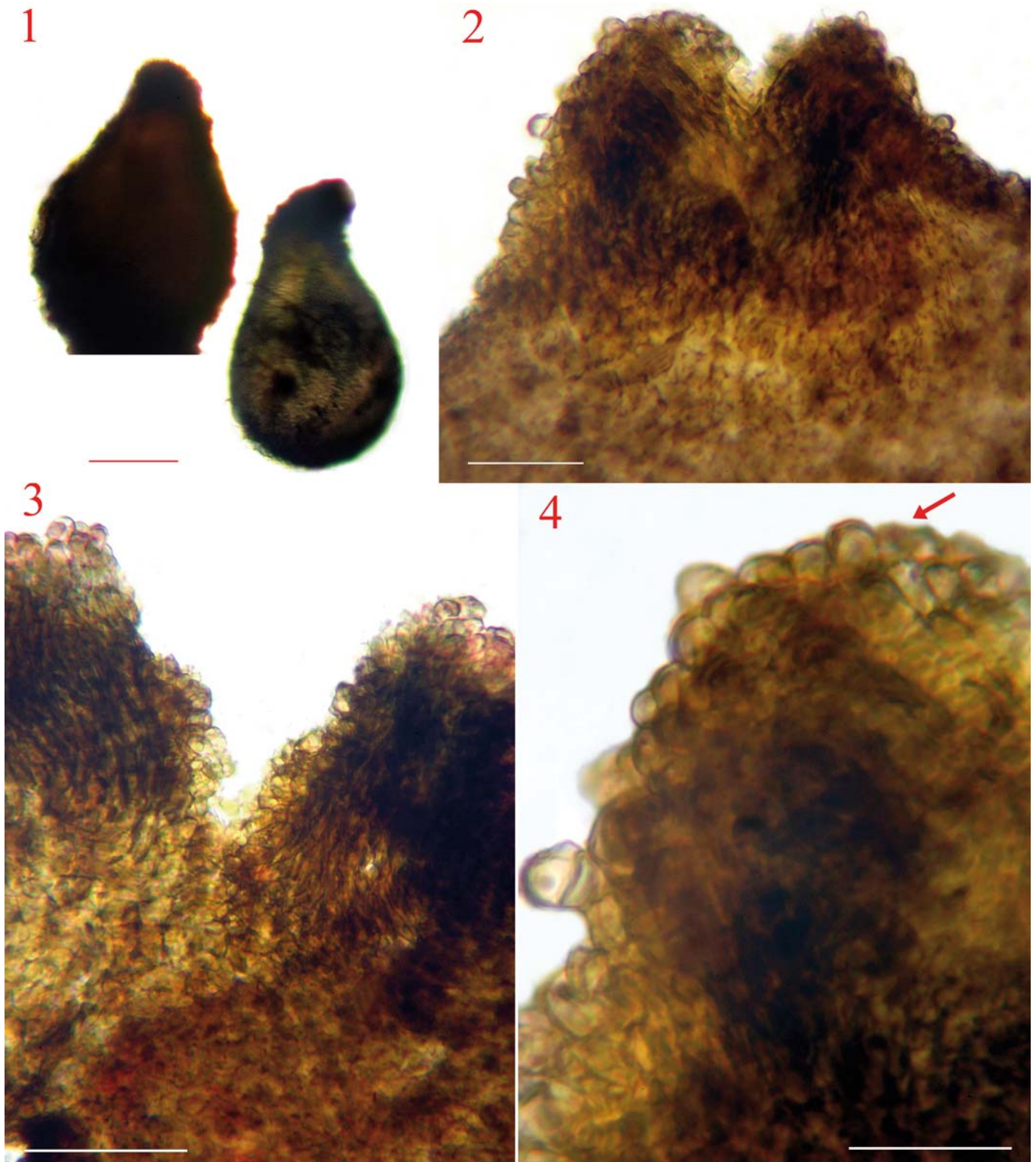


Plate 1 – *Cercophora brevifila*

1. Perithecia in water. 2. Perithecial neck. 3. Detail of the neck. 4. Palisade of neck hairs (arrow). Scale bars: 1 = 150 µm; 2–3 = 30 µm; 4 = 20 µm.

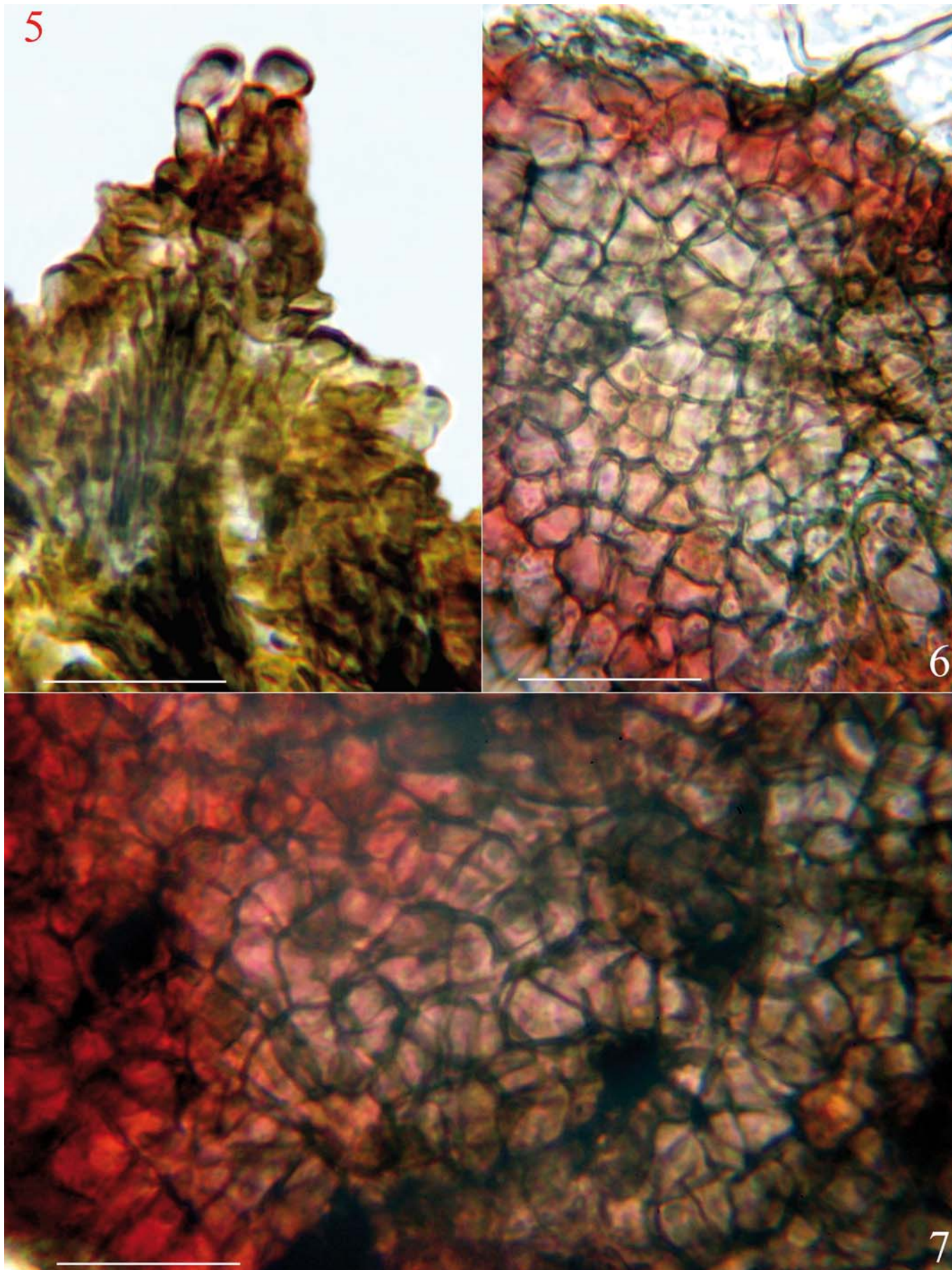


Plate 2 – *Cercophora brevifila*

5. Neck hairs. 6. Exoperidial *textura angularis*. 7. Detail of exoperidial petaloid pattern. Scale bars: 5–7 = 20 μ m.

Material examined: INDONESIA, Rinca island, 8° 43' 58" S 119° 39' 41" E, 0 m a.s.l., about twenty scattered or gregarious specimens on wild water buffalo (*Bubalus arnee*) dung in a damp chamber culture, leg. M.T. Seu, 20.08.2016, CLSM 009.16.

Cercophora mirabilis Fuckel, *Jb. nassau. Ver. Naturk.*, 23-24: 245 (1870).

Plates 6-11

≡ *Podospora mirabilis* (Fuckel) Gola, *Atti Accad. Sci. Veneto-Trentino-Istriana.*, 21 Suppl. 1(1-16): 213 (1930).

≡ *Lasiosphaeria mirabilis* (Fuckel) J.C. Krug & R.S. Khan, in Khan & Krug, *Proc. Thirteenth Plenary Meeting of AETFAT, Zomba, Malawi*, 2-11 April 1991, Vol. 1 (Malawi): 761 (1994).

Perithecia immersed at first with only the upper part of the neck emerging, slightly erumpent later (only the upper one third visible), 600–650 × 300–350 μm, obpyriform, non-stromatic, very pale brown or almost hyaline, membranous, semitransparent, sparsely covered with hyphoid hairs. Neck cylindrical, 120–180 × 70–90 μm, straight or somewhat curved, blackish, ungrooved, covered with a palisade of short, agglutinated hairs. **Perithecial contents** hyaline. **Peridium** three-layered, pseudoparenchymatous: exostratum a *textura angularis* of pale coloured, fairly thick-walled, polygonal cells, 6–10 × 5–8 μm; mesostratum of pale, parallel, elongated cells; endostratum a

textura angularis of pale, thin-walled, polygonal cells, 12–18 × 10–17 μm. **Neck hairs** 20–30 × 4–7 μm, straight or somewhat curved, blackish, thick-walled, 1–3-septate, roundish but not swollen at the apex. **Peridial hairs** scarce, hyphoid, flexuous, hyaline, septate, thin-walled, 2–2.5 μm diam. **Paraphyses** mixed with the asci and exceeding them, cylindric-moniliform, sometimes branched at the base, septate, often narrowing at the septa, 7–10 μm diam., tapering upwards, containing many hyaline vacuoles. **Asci** 220–270 × 12–16 μm, unitunicate, non-amyloid, 8-spored, cylindrical at first, cylindric-clavate later, slightly flattened or roundish or even slightly pointed at the apex, moderately short-stalked, with a simple apical ring and a rough, spherical, subapical plasma globulus, 5–7 μm diam. **Ascospores** bi-triseriate inside the ascus: at first one-celled, hyaline, straight-cylindrical, or bent at one end, or sigmoidal, 50–60 × 5–5.5 μm, containing 15–20 droplets, with two central, solid, lash-shaped gelatinous caudae, one at each end, roughly equal in size, 35–60 × 3–3.5 μm (very short, 14–16 μm long, in a single ascospore); swelling later at one end and becoming clavate-sigmoidal or clavate with a bent lower end; finally two-celled as divided by a transverse septum into an upper head and a lower pedicel. Spore head late becoming dark pigmented, 18–21 × (8–) 9 (–10) μm, narrowly ellipsoidal (Q = 1.80–2.62; average Q = 2.17), equilateral or sometimes slightly inequilateral, often transversely septate in the middle, then constricted at the septum, tapering at the apex but sometimes umbonate, flat-

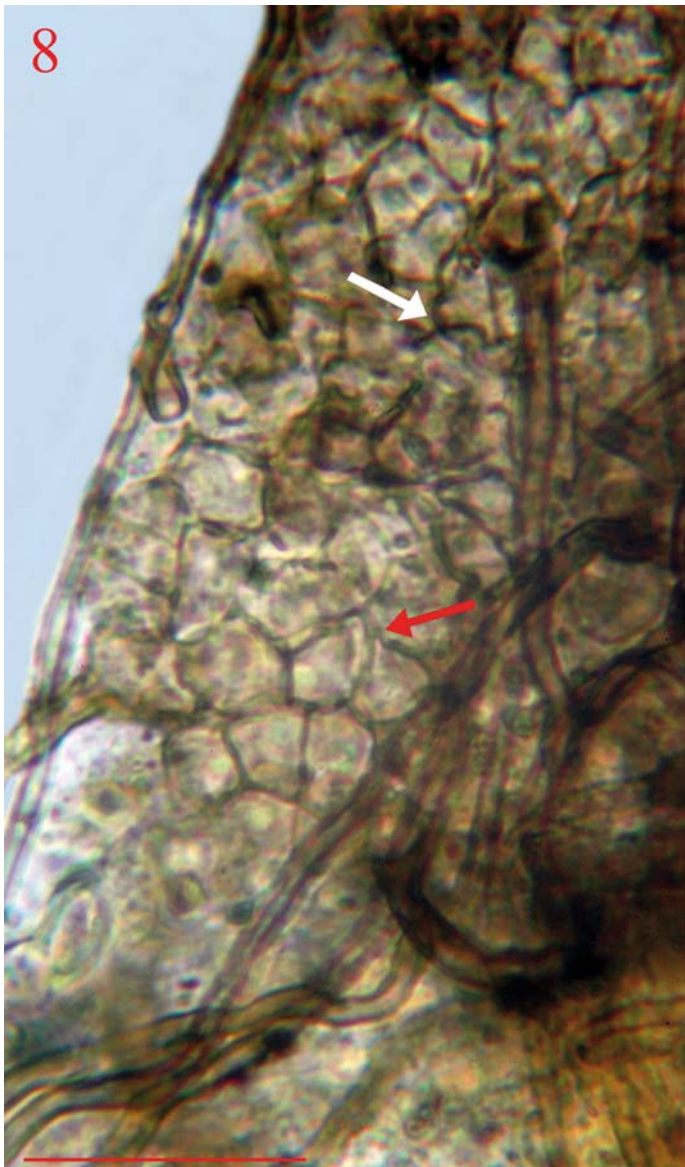


Plate 3 – *Cercophora brevifila*

8. Exoperidial *textura angularis* (red arrow) and *epidermoidea* (white arrow). 9. Paraphyses. Scale bars: 8 = 30 μm; 9 = 40 μm.

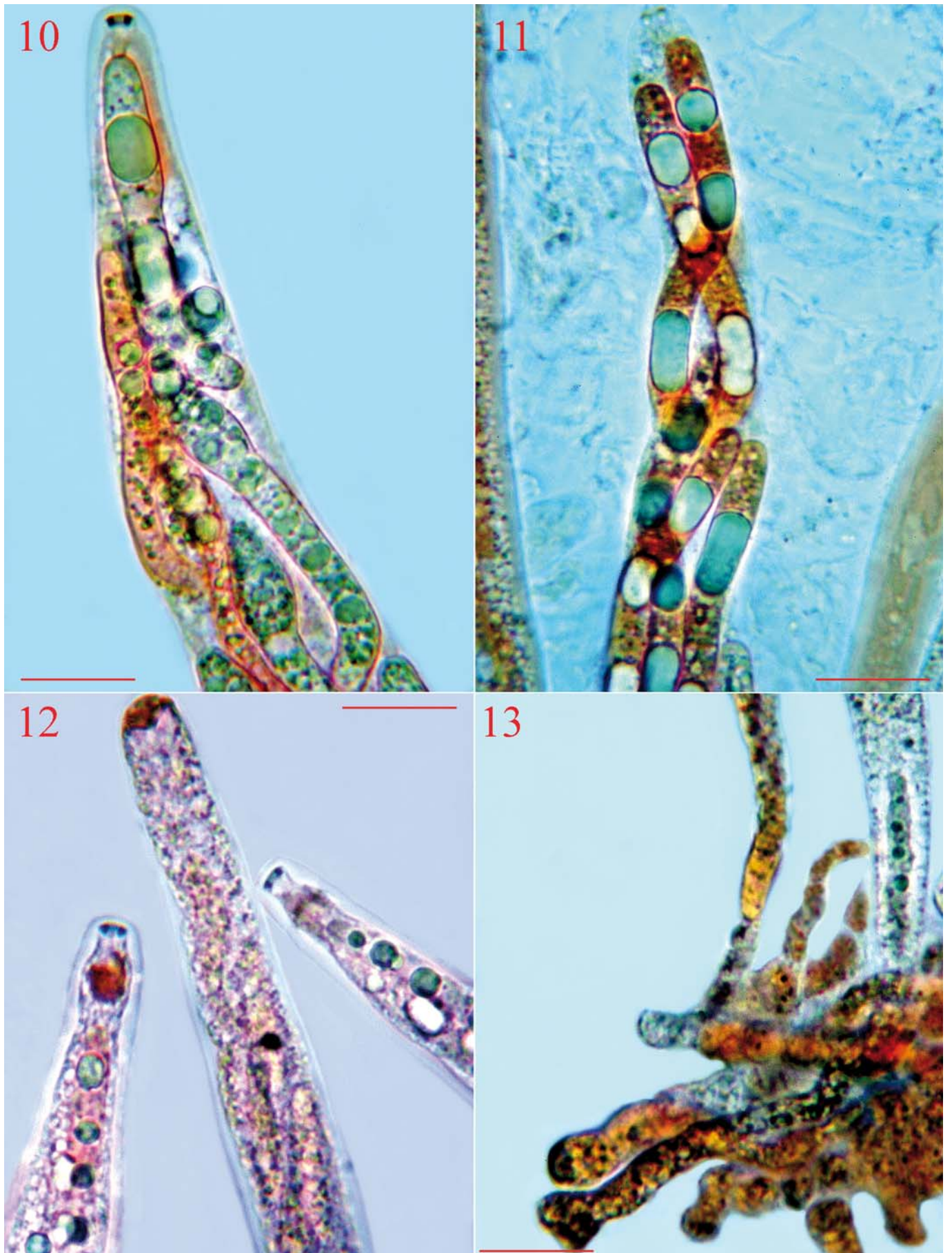


Plate 4 – *Cercophora brevifila*
 10–13. Different portions of 8-spored asci in different stages. Scale bars: 10 μ m.

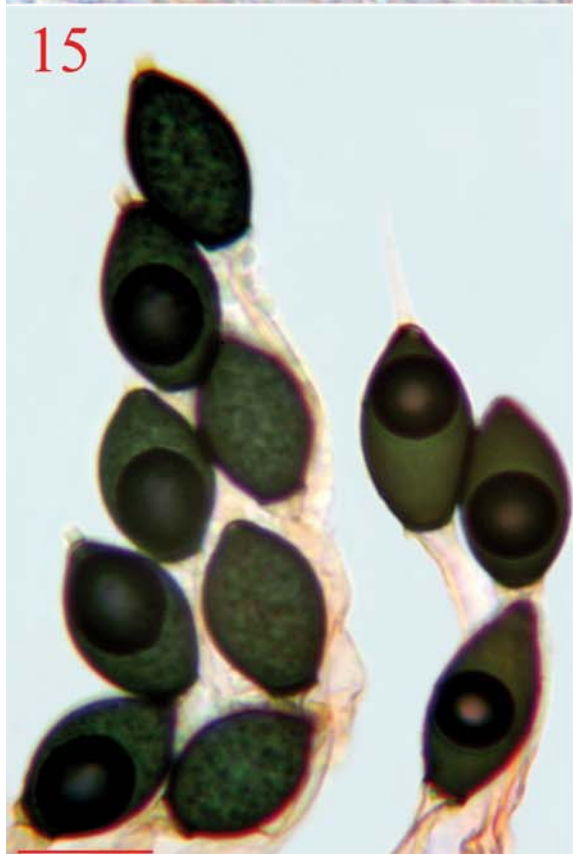


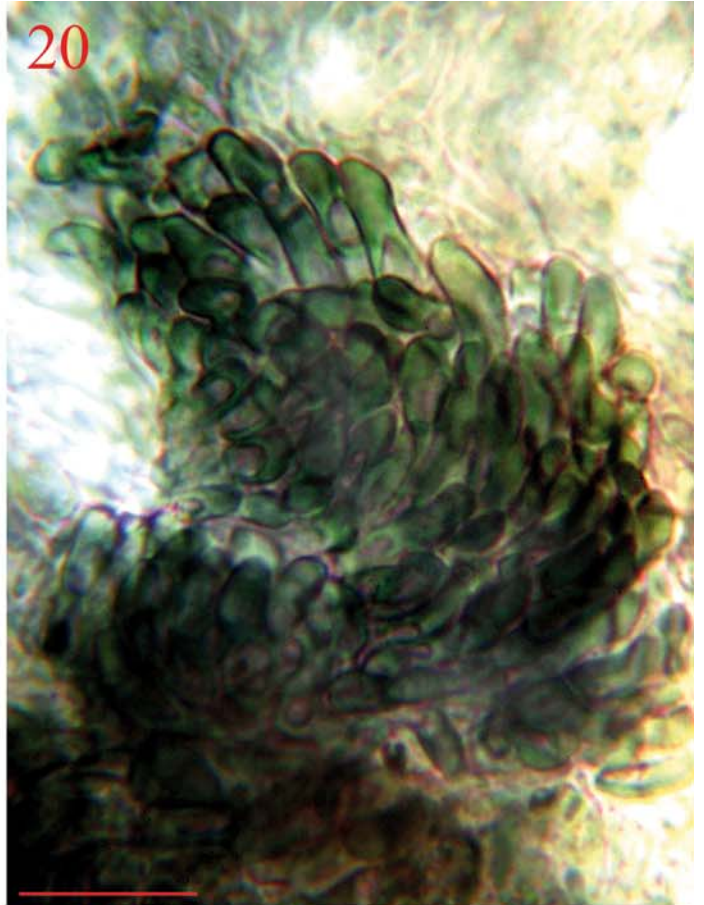
Plate 5 – *Cercophora brevifila*

14–15. Ascospores in a late stage. 16. Swelling hyaline ascospores and dark pigmented spore heads. 17–18. Ascospores in early stages. Scale bars: 14–16, 18 = 12 μm; 17 = 15 μm.

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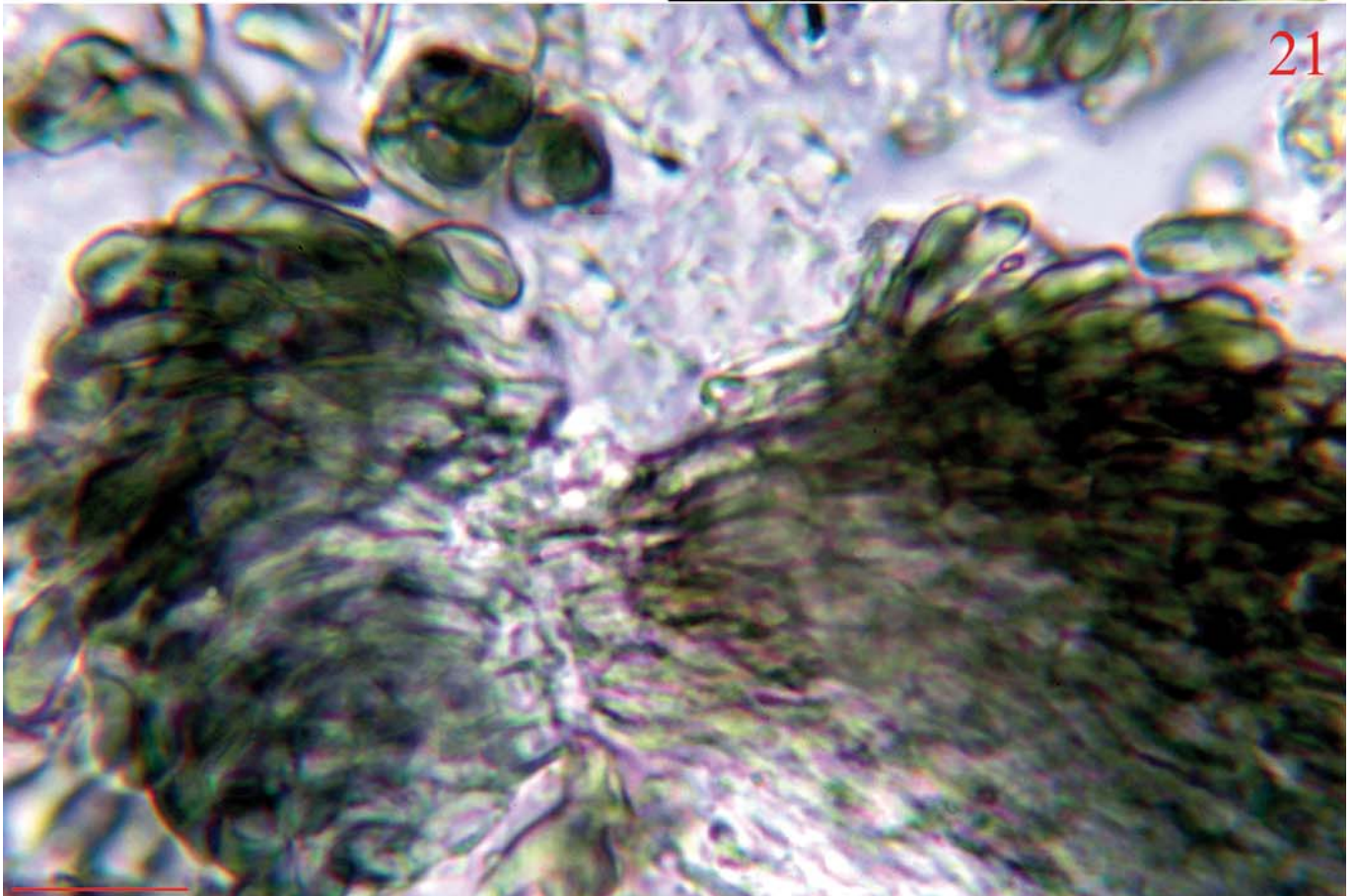


Plate 6 – *Cercophora mirabilis*

19. Ascoma in water. 20. Tuft of neck hairs. 21. Palisade of neck hairs. Scale bars: 19 = 150 μ m; 20–21 = 20 μ m.

tened at the base. Germ pore eccentric. Pedicel 35–42 × 5–6 μm, hyaline, almost straight or bent at the lower end, sometimes geniculate, often 1–3 transversely septate, then with swollen (up to 10 μm diam.) segments narrowing at the septa. **Asexual morph** not seen.

Material examined: INDONESIA, Rinca island, 8° 43' 58" S 119° 39' 41" E, 0 m a.s.l., about twenty scattered or gregarious specimens on wild water buffalo (*Bubalus arnee*) dung in a damp chamber culture, leg. M.T. Seu, 20.08.2016, CLSM 028.94 penta.

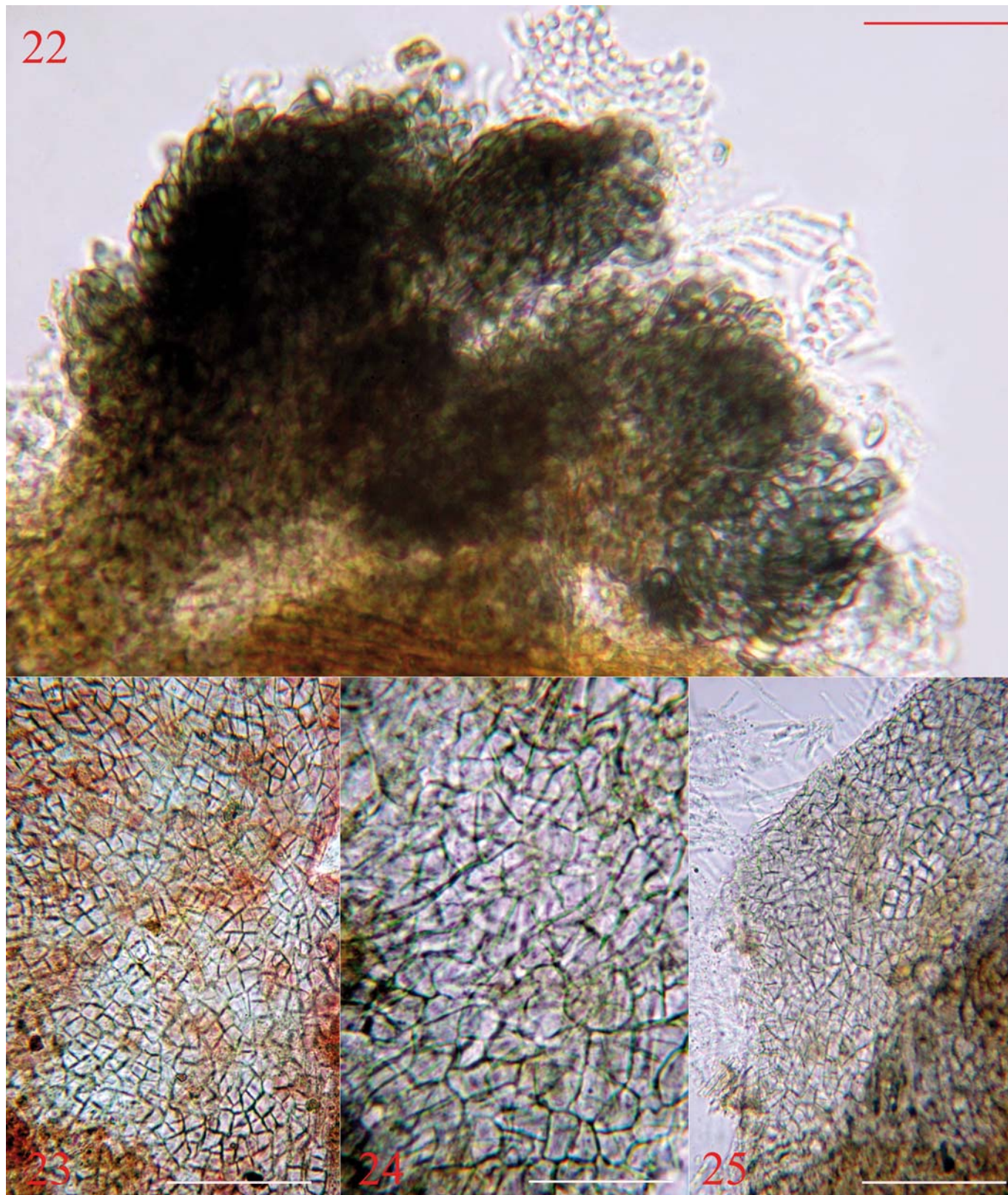


Plate 7 – *Cercophora mirabilis*

22. Detail of a squashed neck. 23–25. Details of exoperidial *textura angularis*. Scale bars: 22–23 = 40 μm; 24 = 25 μm; 25 = 50 μm.

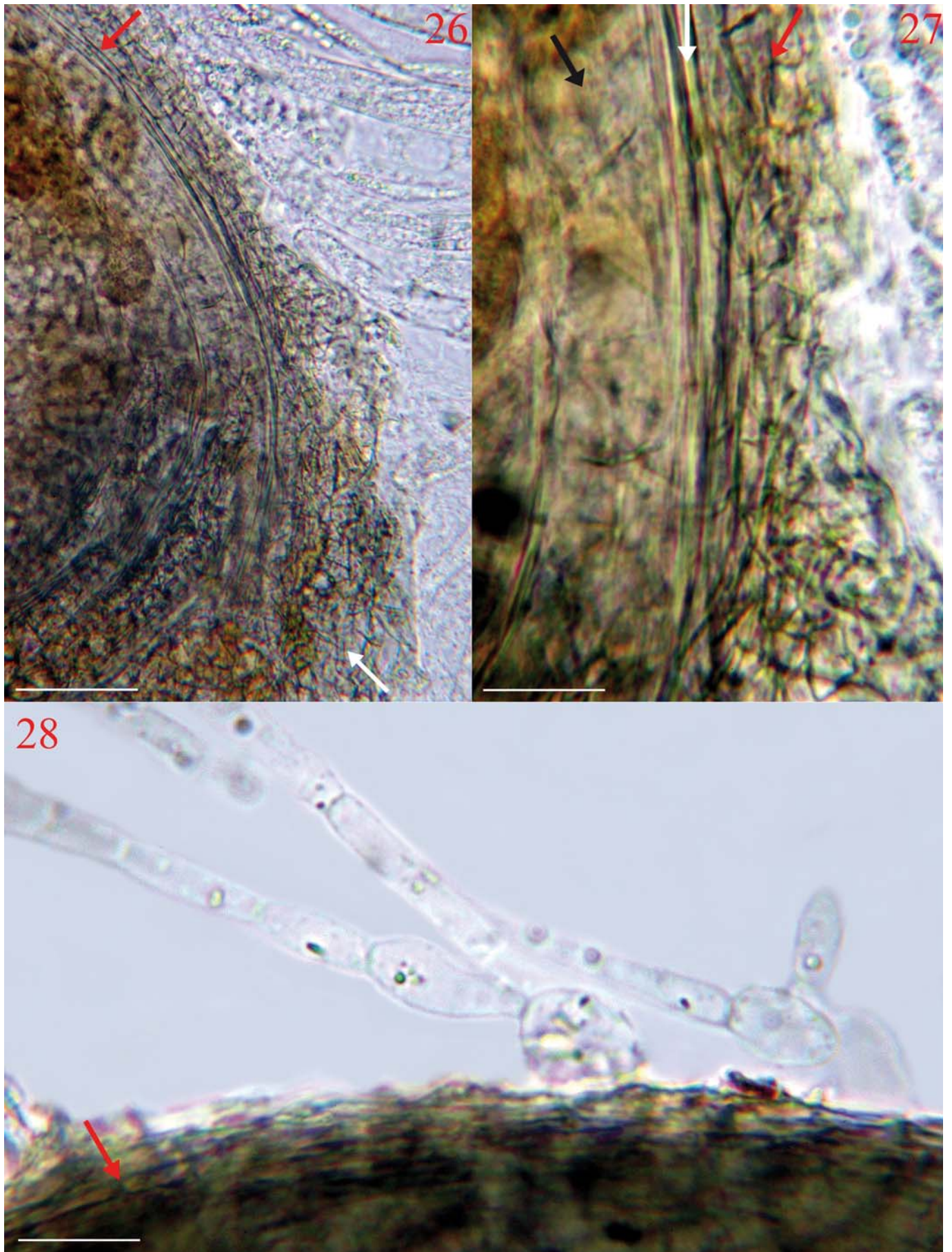


Plate 8 – *Cercophora mirabilis*

26. Mesostratum (red arrow) and exostratum (white arrow) in longitudinal section. 27. Three-layered peridium (exostratum = red arrow; mesostratum = white arrow; endostratum = black arrow). 28. Mesostratum (arrow) and paraphyses in foreground. Scale bars: 26 = 40 μm ; 27 = 15 μm ; 28 = 12 μm .

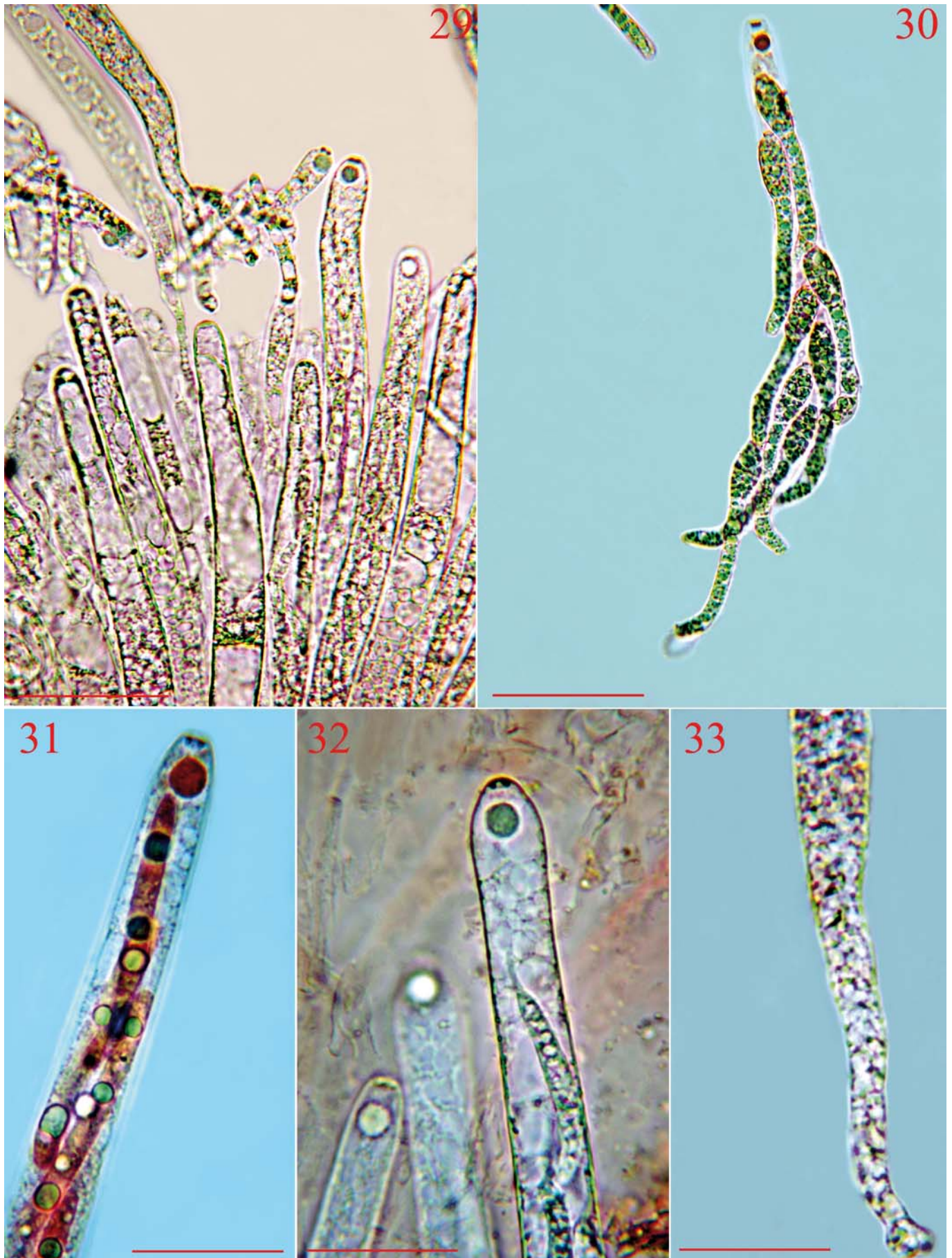


Plate 9 – *Cercophora mirabilis*

29. Detail of centrum in an early stage. 30. 8-spored ascus. 31–33. Different portions of asci. Scale bars: 29 = 30 μm ; 30 = 40 μm ; 31–33 = 25 μm .

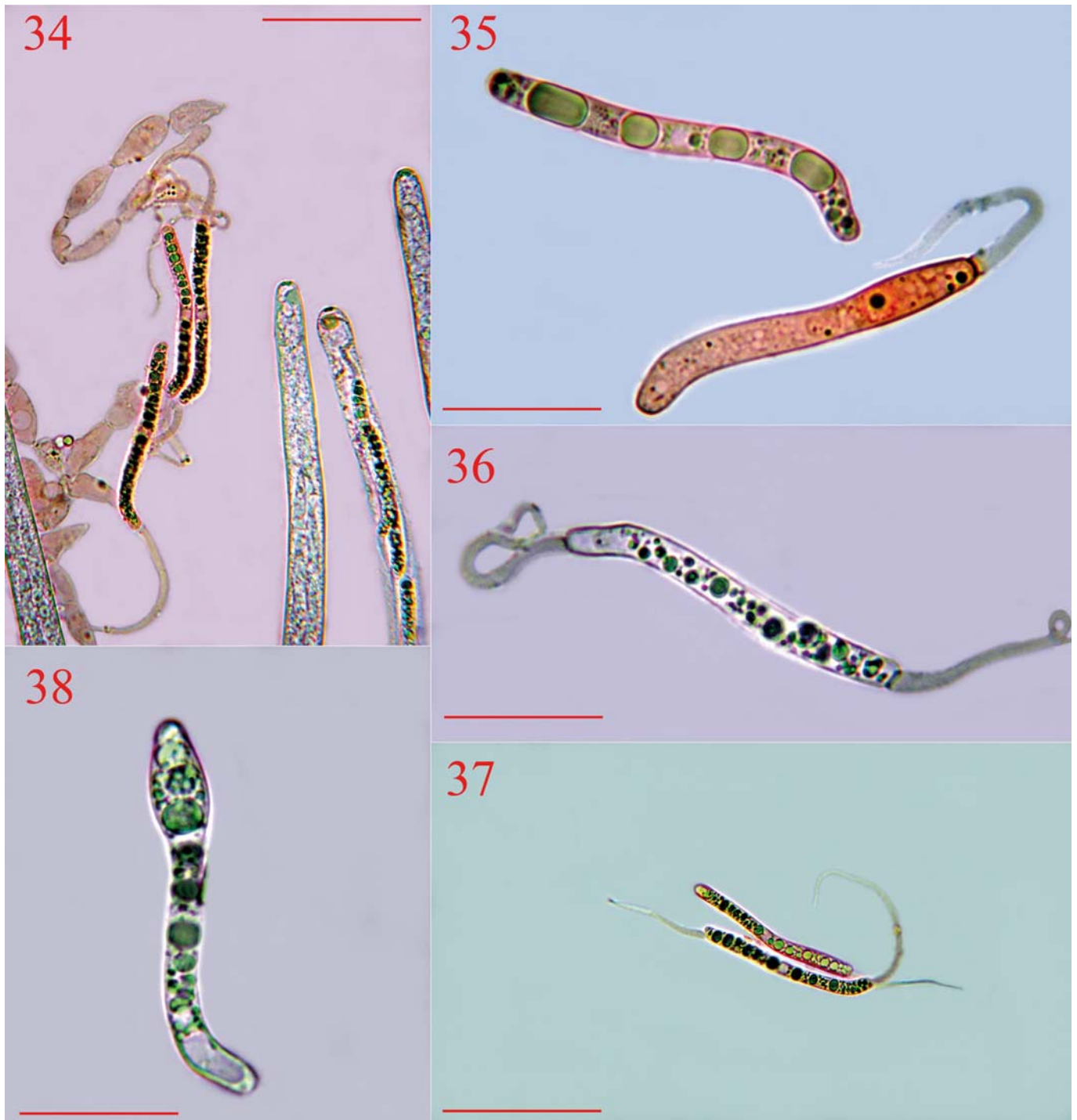


Plate 10 – *Cercophora mirabilis*

34. Young components of centrum. 35–37. Ascospores in an early stage. 38. Hyaline ascospore swelling above. Scale bars: 34, 37 = 50 μm ; 35–36, 38 = 25 μm .

Cercophora samala Udagawa & T. Muroi, *Trans. Mycol. Soc. Japan*, 20: 454 (1979). **Plates 12-16**

Perithecium 420 \times 220 μm , obpyriform, non-stromatic, dark olive brown, coriaceous, opaque, densely hairy. Neck hairy, cylindric, 180 \times 120 μm , somewhat curved, blackish, carbonaceous, vaguely grooved. **Perithecial contents** very pale cream. **Peridium** four-layered: first outer layer of seemingly carbonaceous, elongated cells, 8–25 \times 1.5–2 μm , rounded and possibly raised at the ends, sparsely disposed on the lower two thirds of perithecium, much more dense on the upper third and at the neck base, forming a uniform layer on the remaining neck; second layer a predominant *textura epidermoidea* with small intervals of *textura angularis*, formed of pale brown,

fairly thick-walled, irregular or polygonal cells, 4–10 \times 3–7 μm , prevalently polygonal, much darker and with thicker walls at the neck base, roundish papillate at the ostiole; third layer of pale, parallel, thin-walled, elongated cells; fourth layer a *textura angularis* of pale, thin-walled, polygonal, sometimes irregular cells, 10–14 \times 7–8 μm . **Neck hairs** arising from the base, scattered or fasciculate, superficial, 28–90 \times 3.5–4 μm , rigid, straight or slightly flexuous, dark brown, paler at the apex, thick-walled, septate, with a slightly enlarged, polymorphous base, tapering upwards with a pointed or somewhat roundish tip. **Peridial hairs** abundant, hyphoid, flexuous, sometimes ramified, hyaline, septate, thin-walled, 1–2.5 μm diam., often more than 100 μm long, with a slightly enlarged or sometimes bulbous base. **Paraphyses** mixed with the asci and exceeding them, fi-

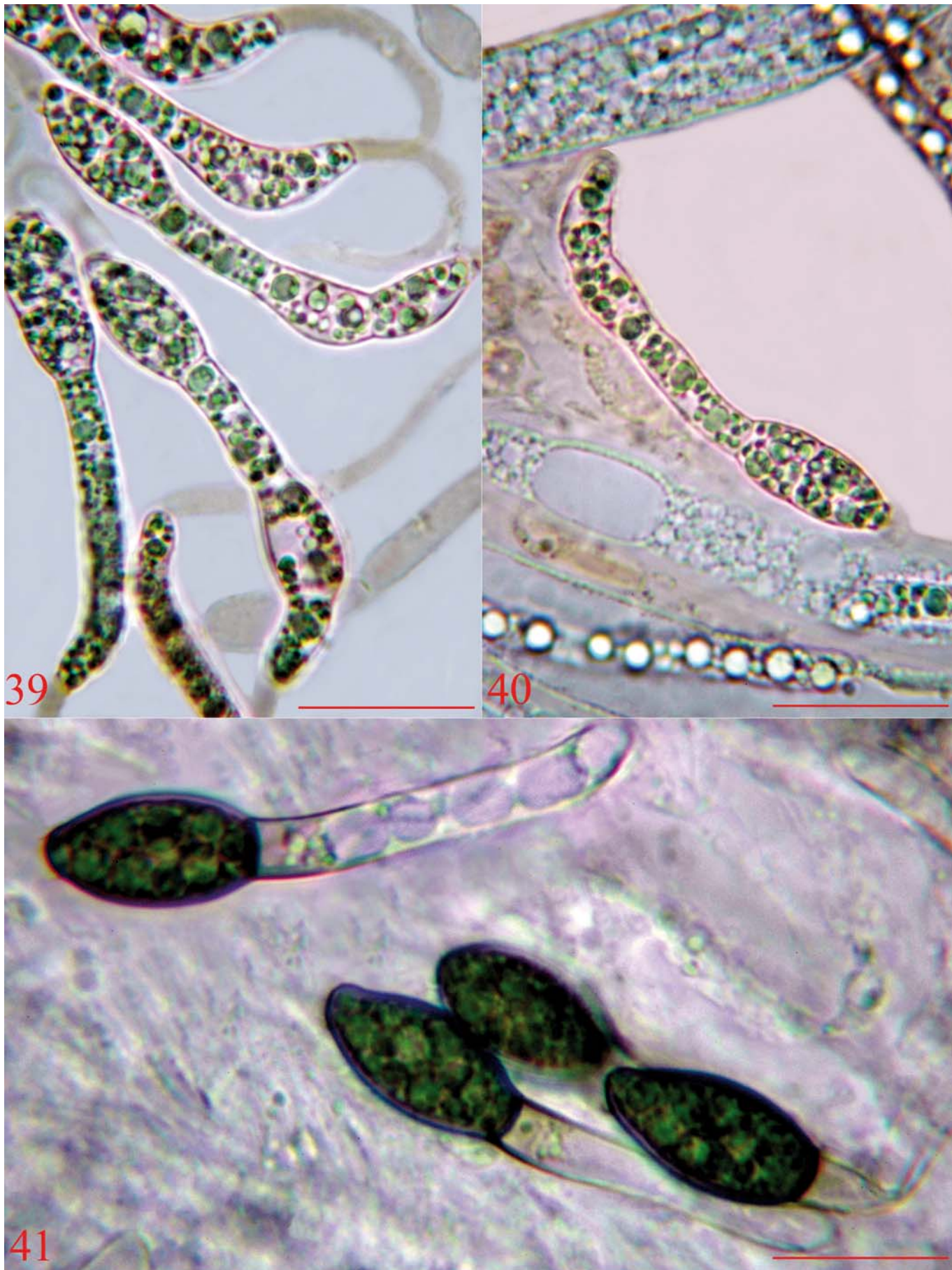


Plate 11 – *Cercophora mirabilis*

39–40. Transversely poly-septate ascospores with swollen segments. 41. Pigmented ascospores in a late stage. Scale bars: 39–40 = 20 μm ; 41 = 15 μm .

liform, septate, 3–4 μm diam., tapering upwards, containing many hyaline vacuoles. **Asci** 195–215 \times 12–15 μm , unitunicate, non-amyloid, 8-spored, cylindrical at first, cylindric-clavate later, slightly flattened or roundish at the apex, long-stalked, without a plasma globulus, with a simple apical ring. **Ascospores** bi-triseriate inside the ascus: at first one-celled, hyaline, straight-cylindrical or bent at one end, or sigmoidal, 45–55 \times 4–5 μm , containing about ten droplets, with two central, solid, lash-shaped gelatinous caudae, one at

each end, roughly equal in size, 40–50 \times 2.5 μm , stretching after compression; swelling later at one end and becoming clavate-sigmoidal or clavate with a somewhat curved lower end; finally two-celled as divided by a transverse septum into an upper head and a lower pedicel. Spore head hyaline, not becoming dark pigmented, 16–17 \times 9–11 μm , broadly ellipsoidal to ellipsoidal ($Q = 1.45\text{--}1.88$; average $Q = 1.66$), equilateral, slightly pointed at the apex, flattened at the base. Germ pore not seen. Pedicel 30–38 \times 4.5–5 μm , hyaline,

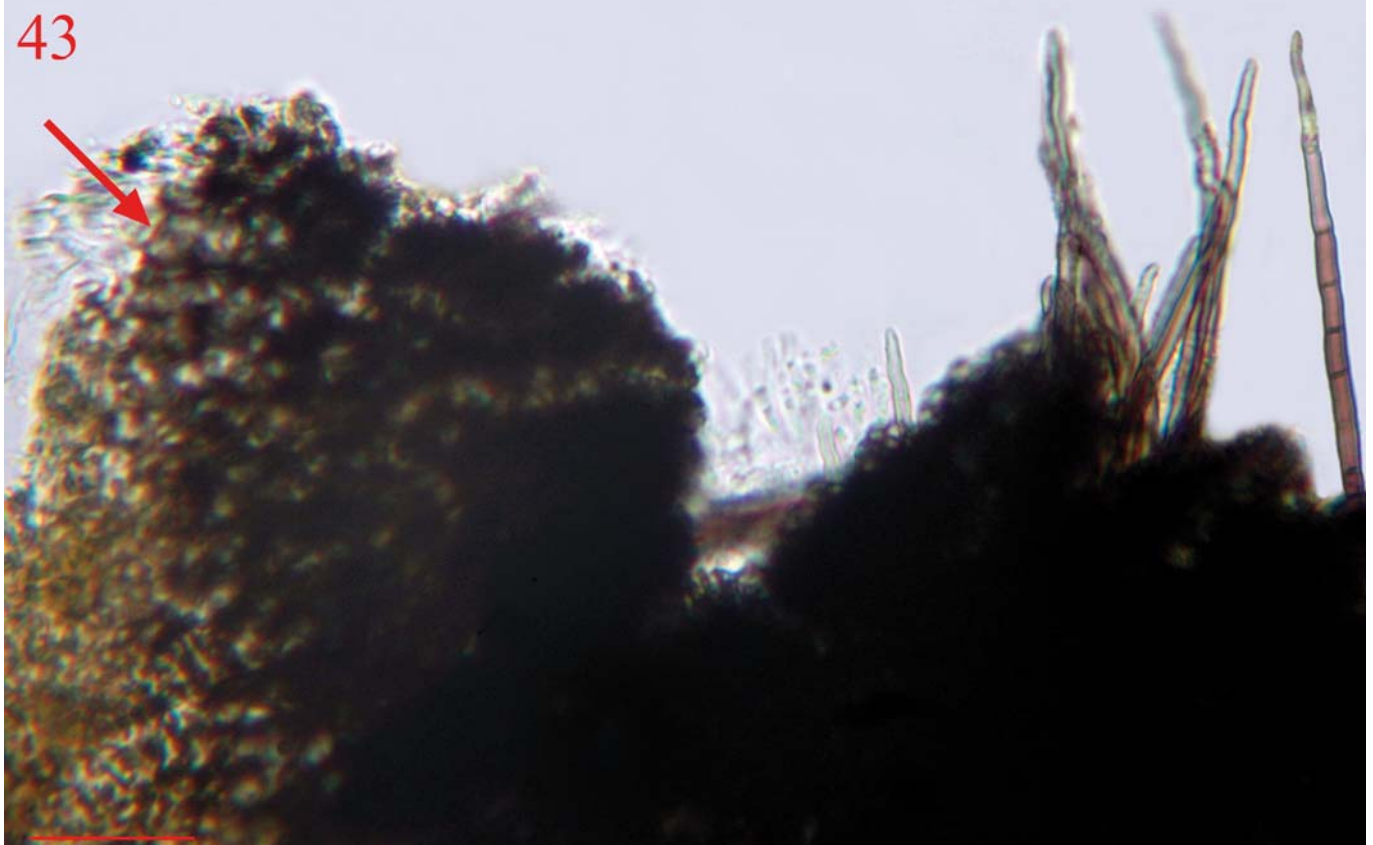
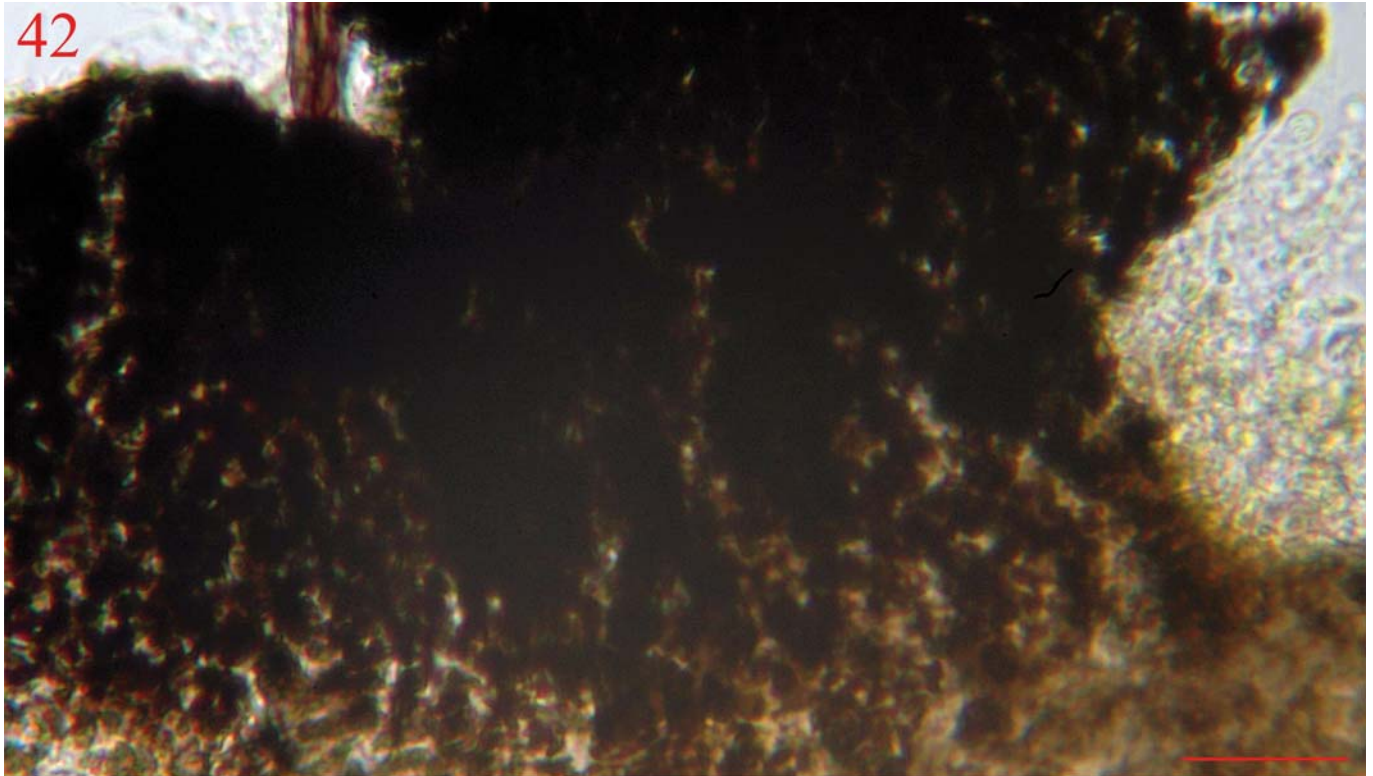


Plate 12 – *Cercophora samala*

42. Neck base. 43. Detail of a squashed neck with hairs and thick-walled cells of the base (arrow). Scale bars: 42 = 20 μm ; 43 = 25 μm .

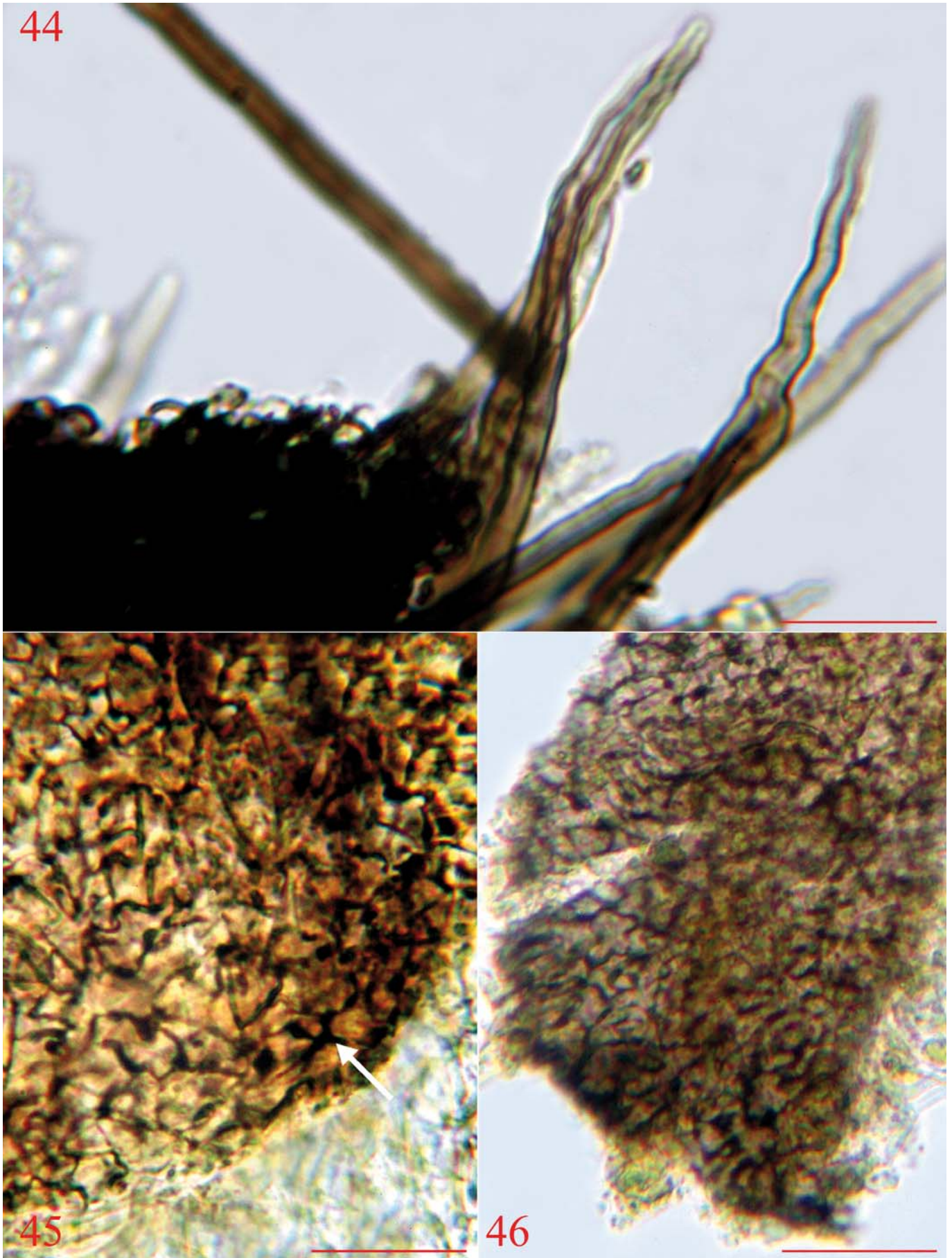


Plate 13 – *Cercophora samala*

44. Neck hairs. 45–46. *Textura epidermoidea* of the second peridial layer from outside and blackish, elongated cells of the first layer (arrow).
Scale bars: 44–45 = 20 μm ; 46 = 25 μm .

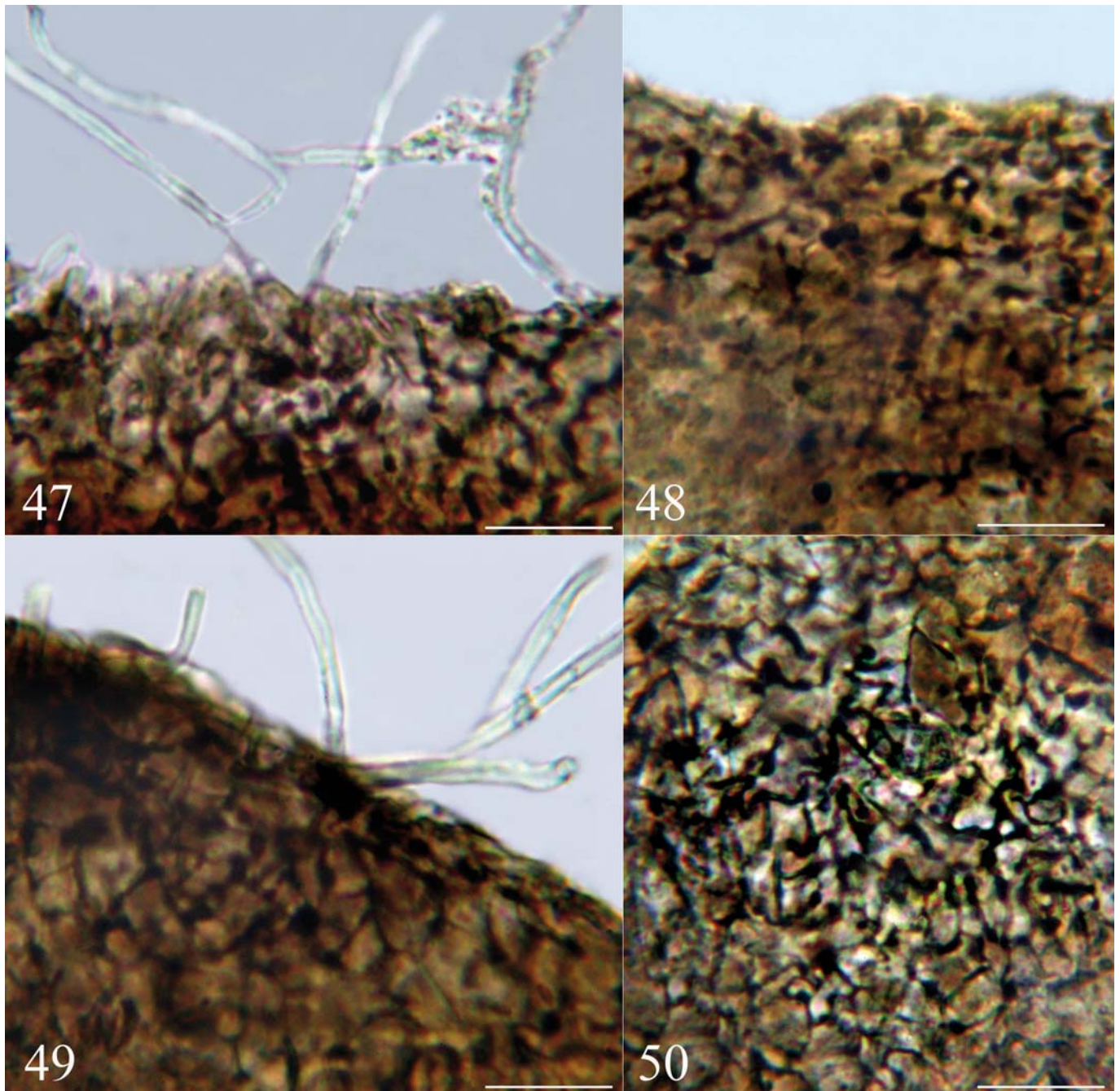


Plate 14 – *Cercophora samala*

47, 49. Hyphoid hairs. 48. Blackish cells of the outer peridial layer. 50. Detail of *textura epidermoidea*. Scale bars: 47–48, 50 = 15 μm ; 49 = 10 μm .

sigmoidal or bent below, sometimes transversely septate. **Asexual morph** not seen.

Material examined: INDONESIA, Rinca island, 8° 43' 58" S 119° 39' 41" E, 0 m a.s.l., about twenty scattered or gregarious specimens on wild water buffalo (*Bubalus arnee*) dung in a damp chamber culture, leg. M.T. Seu, 20.08.2016, CLSM 008.16.

Podospora hyalopilosa (R. Stratton) Cain, *Can. J. Bot.*, 40: 460 (1962). **Plates 17-20**

≡ *Pleurance hyalopilosa* R. Stratton, *Ohio St. Univ. Bull.*, 26: 92 (1921) (basionym).

≡ *Sordaria hyalopilosa* (R. Stratton) Cain, *Univ. Toronto Stud. Mycol. Ser.*, 38: 45 (1934).

Perithecia immersed at first, with only the neck emerging, semi-immersed later, 400–600 × 280–500 μm , subglobose to obpyriform, pale brown, semitransparent, membranous, the exposed part of the venter covered with hyphoid hairs. Neck hairy, blackish, carbonaceous, hemispherical or subcylindrical, often curved, usually somewhat wider than high, 80–130 × 100–140 (–170) μm . **Peridium** pseudoparenchymatous, 3-layered: exostratum a *textura mixta, angularis* and *epidermoidea* of pale brown, fairly thin-walled, polygonal or irregular, undulating cells, 5–8 × 3–5 μm , supporting numerous thin-walled, hyaline, septate, often encrusted, hyphoid hairs, 1–1.5 μm diam., very dense at intervals and interwoven to form a net. Exoperidial cells blackish at the neck, thick-walled, elongated-rectangular towards the ostiole, 3–4 μm diam., with rounded or somewhat pointed ends; mesostratum formed of pale, parallel, cylindrical cells; endostratum a *textura globulosa-angularis* of pale, thin-walled, roundish to polygonal cells, 10–17 μm diam. **Neck hairs**

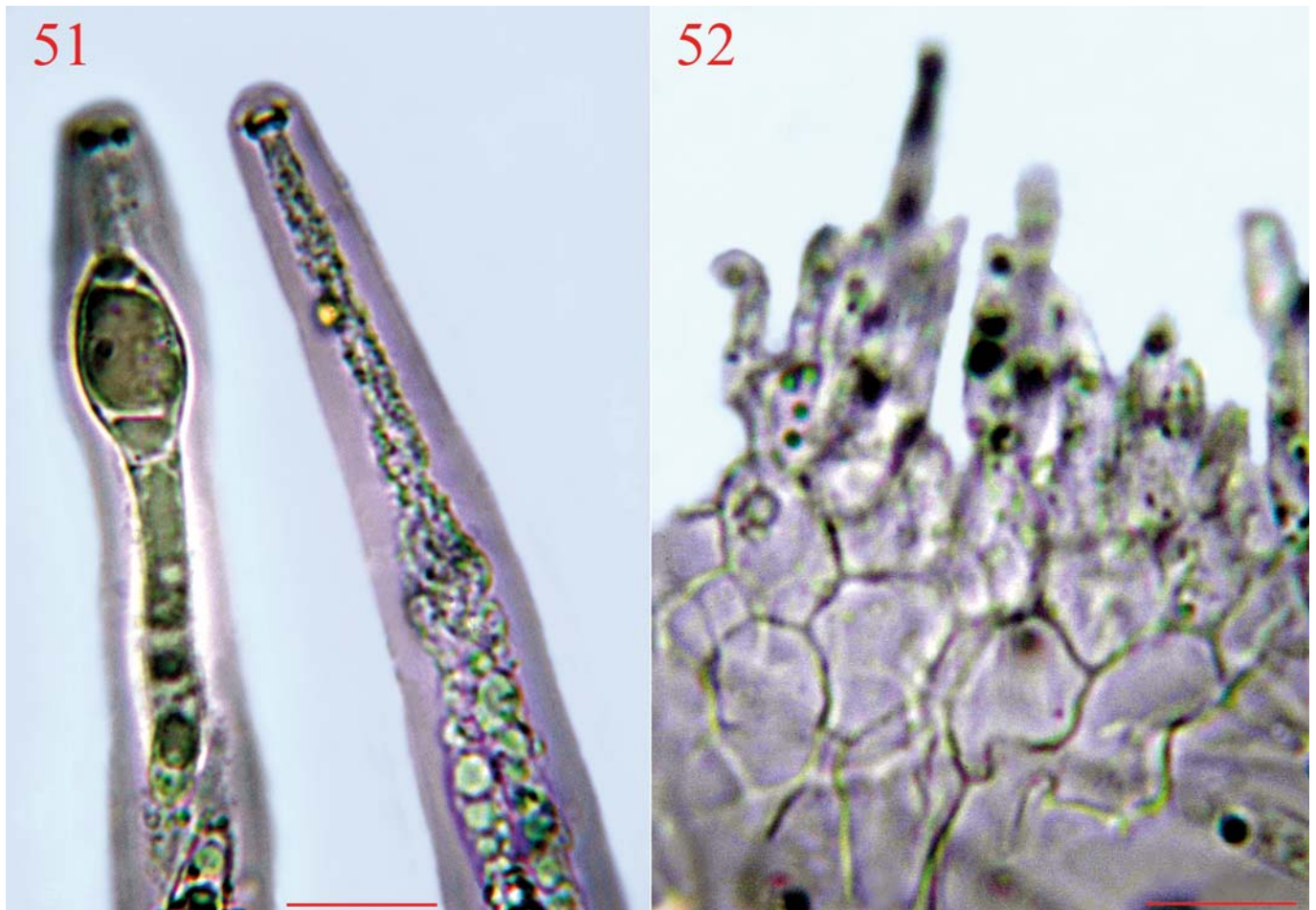


Plate 15 – *Cercophora samala*

51. Upper portion of young asci. 52. Periphyses arising from endoperidial cells of the ostiolar channel. Scale bars: 51 = 12 μm ; 52 = 10 μm .

Key to *Cercophora* spp. with swollen, agglutinated neck hairs

- 1 Neck hairs less than 15 μm long. Hyaline ascospores 45–60 \times 4.5–5 μm , with 9–12 oil drops. Spore head 18–22 \times 10–13 μm . Pedicel 30–46 \times 5.5–6.5 μm . Gelatinous caudae less than 15 μm long (up to 30 μm in my Indonesian collection).
On dung ***C. brevifila***
- 1* Neck hairs up to 40 μm long. Hyaline ascospores with a higher number of drops (number not specified in *C. ignis*) **2**
- 2 Spore head 20–24 \times 8–10 μm , strongly tapering upwards. Pedicel 35–40 \times 5–7 μm . Caudae very small, triangular.
On burnt ground ***C. ignis***
- 2* Spore head not strongly tapering, sometimes umbonate. Caudae lash-shaped. Habitat different **3**
- 3 Neck not ridged. Asci with a simple apical ring. Ascospores 48–73 \times 4–6.5 μm . Spore head 15–25 \times 9–13.5 μm .
Pedicel 26–50 \times 4–6.5 μm . Caudae 30–100 \times 2.5–3.5 μm . On dung ***C. mirabilis***
- 3* Neck longitudinally ridged. Asci with a simple or double apical ring **4**
- 4 Apical ring simple. Gelatinous caudae unequal in size, apical cauda 12–30 \times 1.5–2.5 μm , basal cauda 25–50 \times 1.5–3.5 μm .
Hyaline ascospores 45–58 \times 4–5 μm . Spore head 14.5–19 \times 6.5–8 μm . Pedicel 25–35 \times 3.5–5 μm . On dung ***C. anisura***
- 4* Apical ring double. Gelatinous caudae roughly equal in size. On wood **5**
- 5 Gelatinous caudae up to 55 μm long. Ascospores 45–50 \times 6–7 μm . Spore head 15–19 \times 8–10 μm .
Pedicel 30–40 \times 4–6.5 μm ***C. natalitia***
- 5* Caudae significantly shorter, 5–15 μm . Ascospores 42–67 \times 3–7 μm . Spore head 15–25 \times 8–12 μm .
Pedicel 22–37 \times 4–6 μm ***C. caudata***

53



54

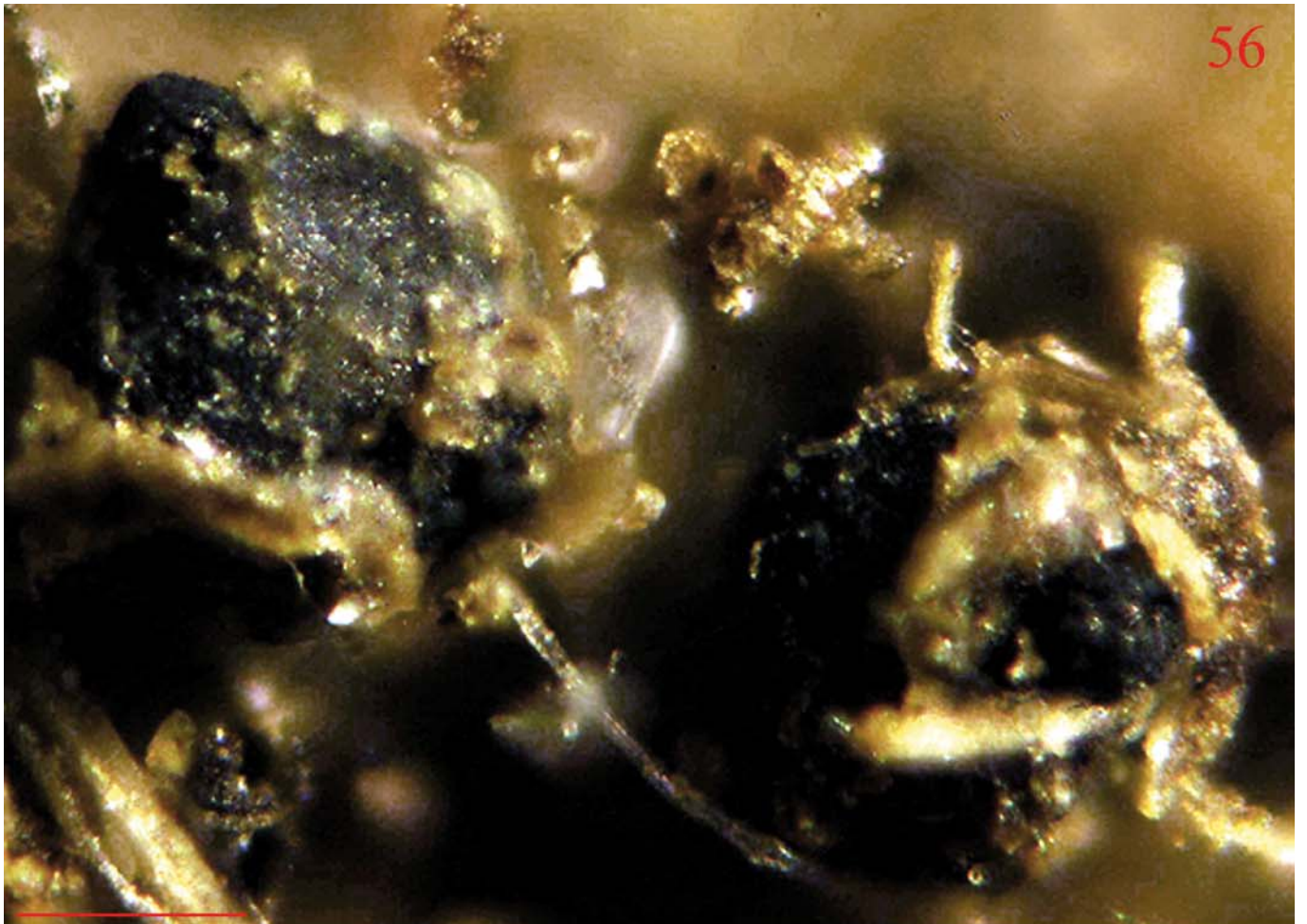


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Plate 16 – *Cercophora samala*

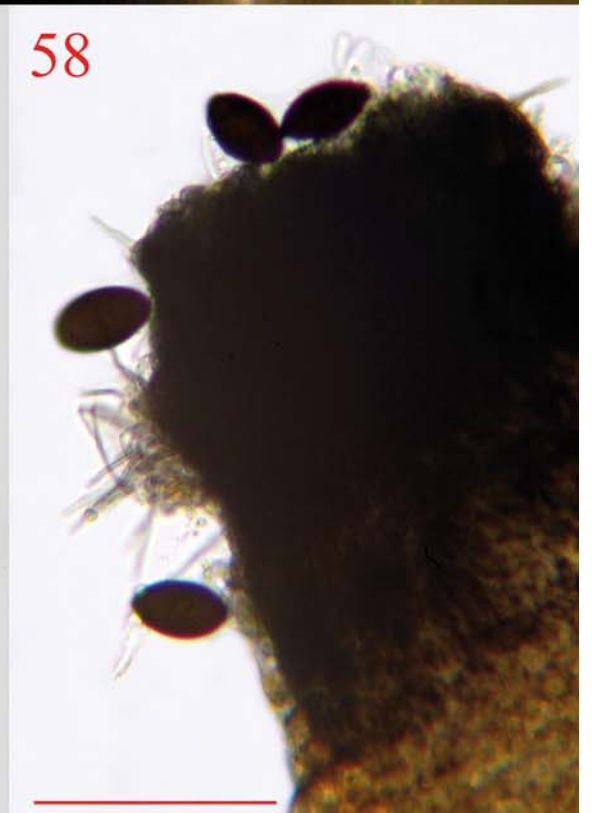
53–55. Ascospores in different stages. Scale bars: 53 = 20 μ m; 54–55 = 25 μ m.



56



57



58

Plate 17 – *Podospora hyalopilosa*

56. Ascomata on dung. 57. Ascoma in water. 58. Perithecial neck and free ascospores. Scale bars: 56 = 300 μ m; 57 = 150 μ m; 58 = 70 μ m.

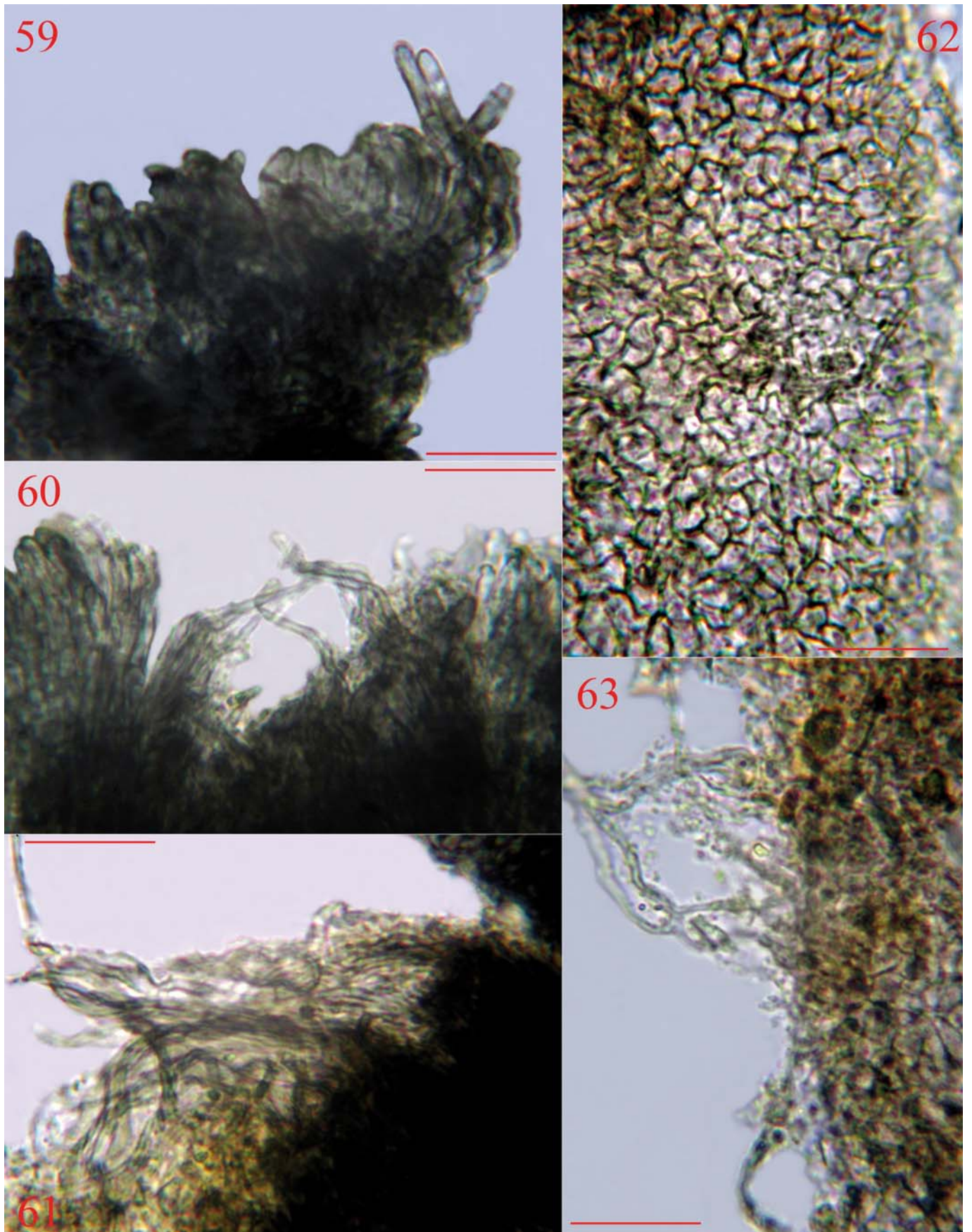


Plate 18 – *Podospora hyalopilosa*

59. Periostiolar cells of the neck. 60. Detail of the neck. 61. Fasciculate neck hairs. 62. Exoperidial *textura mixta*, *angularis* and *epidermoidea*. 63. Hyphoid hairs of perithecial venter. Scale bars: 59, 62–63 = 20 µm; 60–61 = 25 µm.

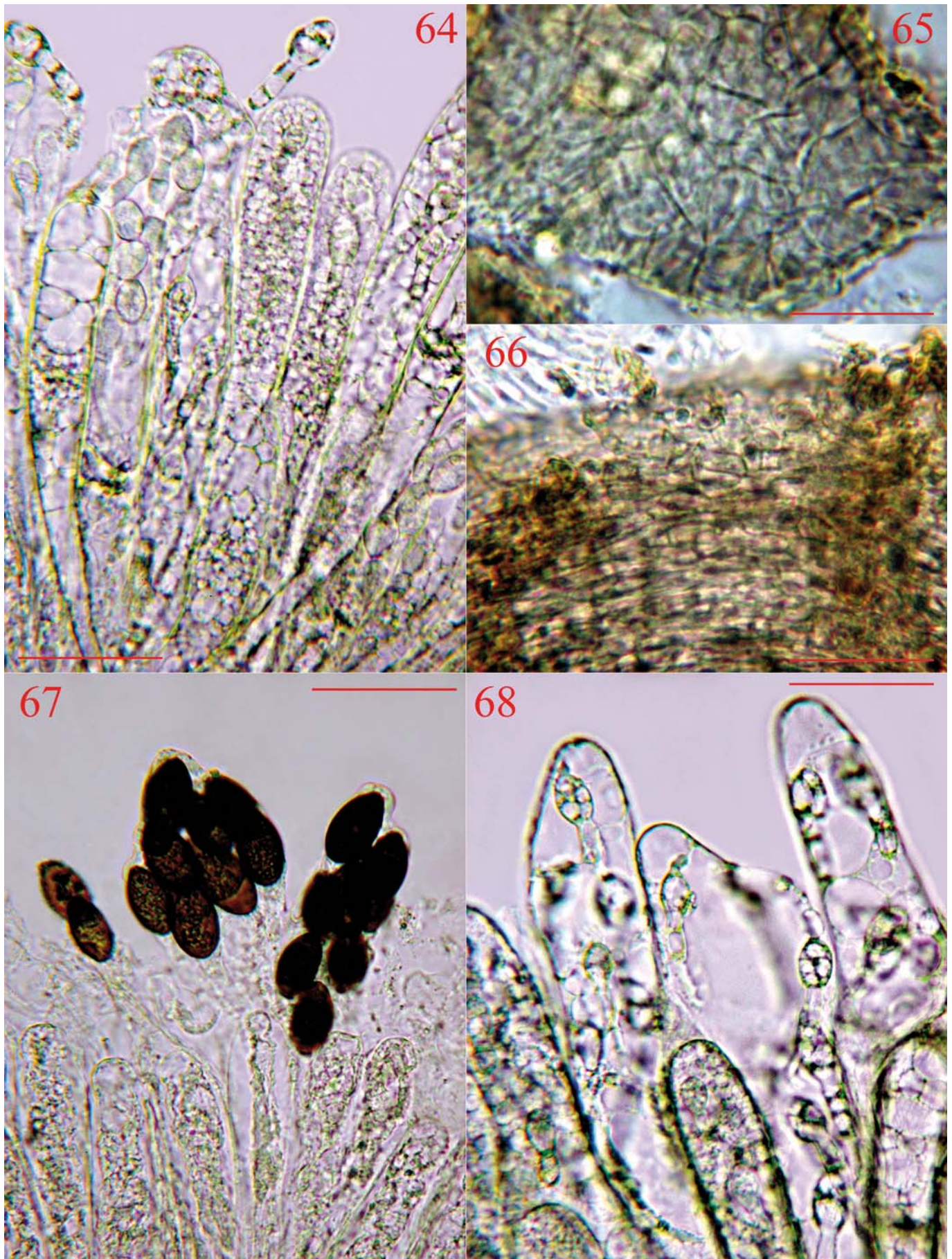


Plate 19 – *Podospora hyalopilosa*

64. Young, long-stalked asci and free immature ascospores. 65. Cells of endostratum. 66. Detail of mesostratum. 67. Detail of centrum with dark pigmented ascospores inside the asci. 68. Asci containing immature, spoon-shaped ascospores. Scale bars: 64, 67 = 40 μm ; 65 = 25 μm ; 66 = 50 μm ; 68 = 30 μm .

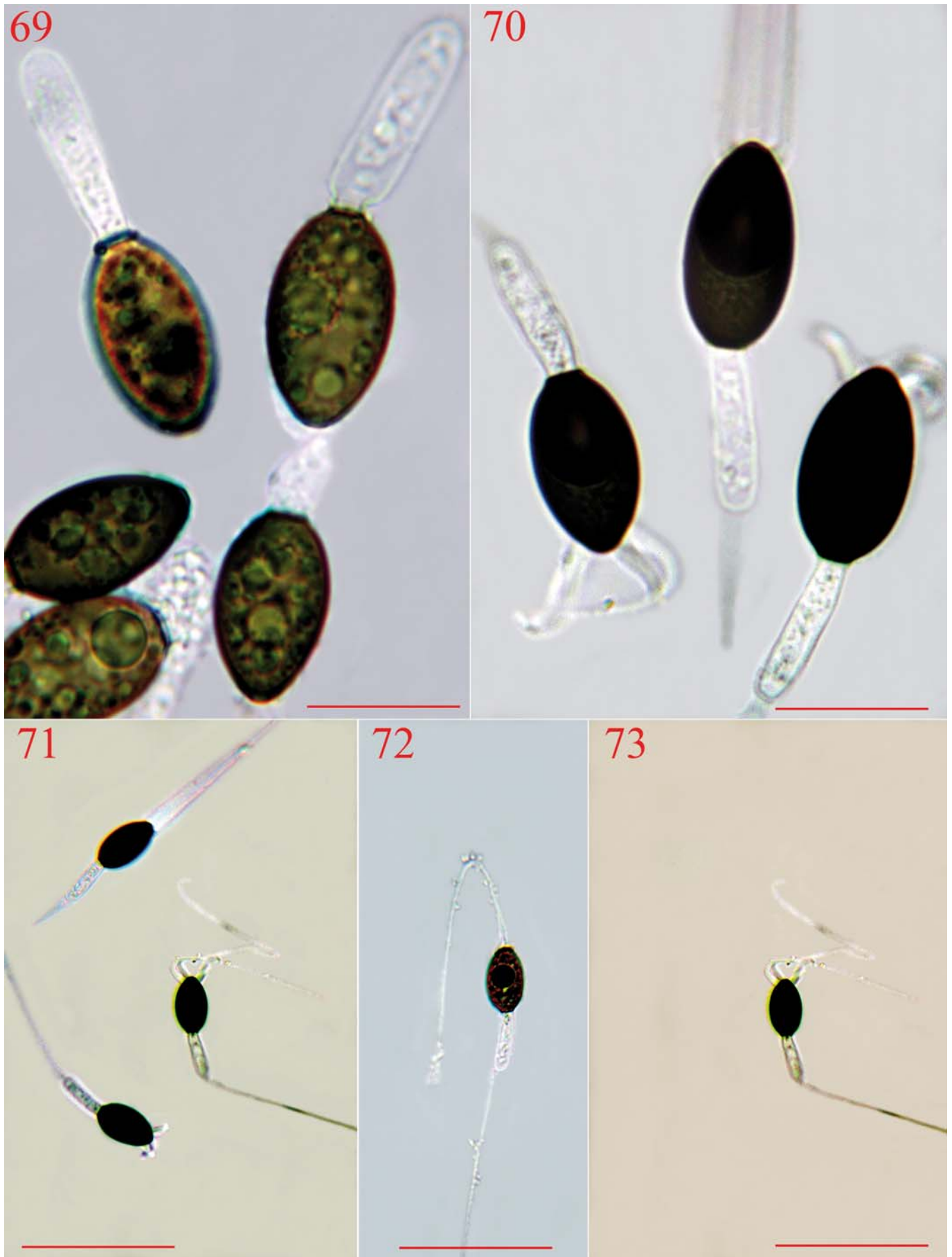


Plate 20 – *Podospora hyalopilosa*

69–73. Ascospores in different stages. Scale bars: 69 = 16 μ m; 70 = 20 μ m; 71–73 = 50 μ m.

20–100 × 1.5–2.5 µm, numerous, hyphoid, scattered and hyaline all over the neck or fasciculate and pale grey at its base, septate, thin-walled, straight or somewhat curved, often flexuous at the base, usually roundish at the apex. **Paraphyses** soon reduced to a shapeless mass. **Asci** 8-spored, unitunicate, non-amyloid, cylindrical-claviform at first, with a roundish or somewhat flattened apex, swelling soon and becoming clavate-sacciform, 170–250 × 30–40 µm, long-stalked, slightly narrowing at the apex, with an indistinct apical apparatus. **Ascospores** biseriate but soon clustered in the upper part of asci, one-celled, spoon-shaped and hyaline in the early stages, yellowish later, transversely septate at maturity, with a dark brown spore head and a hyaline pedicel. Spore head quite variable in size even in the same ascus, (18–) 21–26 (–27) × 12–15 (–15.5) µm, ellipsoidal, rarely narrowly ellipsoidal (Q= 1.50–1.92; average Q= 1.73), equilateral, smooth, thick-walled, flattened at the base, with a central germ pore and a de Bary bubble in aqueous media. Pedicel often plasma filled, usually clavate (narrowing at its base), rarely cylindrical, sometimes transversely septate, 11–25 × 6–8 µm. Gelatinous equipment of easily stretching, solid caudae: a single basal cauda arising from the pedicel apex, 45–55 × 4 µm, four apical caudae tentacle-shaped, possibly furrowed, arising near the apex of the spore head but not hiding the germ pore, 10–15 × 3 µm.

Material examined: INDONESIA, Rinca island, 8° 43' 58" S 119° 39' 41" E, 0 m a.s.l., about twenty scattered or gregarious specimens on wild water buffalo (*Bubalus arnee*) dung in a damp chamber culture, leg. M.T. Seu, 20.08.2016, CLSM 006.16.

Podospora inquinata Udagawa & S. Ueda, *Mycotaxon*, 22: 400 (1985). **Plates 21–23**

Perithecium superficial, 450 × 300 µm, obpyriform, pale brown, semitransparent, membranous, the venter covered with numerous hyphoid hairs. Neck glabrous, blackish, carbonaceous, cylindrical, often curved, wider than high, 100 × 150 µm. **Peridium** pseudoparenchymatous, 3-layered: exostratum a *textura angularis* of pale brown, fairly thin-walled, polygonal cells, 4–11 × 4–6 µm, blackish and with thicker walls at the neck, increasingly elongated upwards, papillate around the ostiole; mesostratum formed of pale, parallel, cylindrical cells; endostratum a *textura angularis* of pale, thin-walled, polygonal cells, 10–20 × 10–15 µm diam. **Hyphoid hairs** isolated or tufted, pale brown, darker near the neck base, thin-walled, septate, flexuous, sometimes branched, rounded at the apex, 1–1.5 µm diam. (4–5 µm at the base), even more than 250 µm long. **Paraphyses** cylindrical-moniliform (narrowing at the septa), tapering upwards, 8–20 µm diam., reduced soon to a shapeless mass. **Asci** 8-spored, unitunicate, non-amyloid, cylindrical at first and somewhat flattened at the apex, becoming clavate with an obtuse-conical apex, 205–220 × 35–45 µm, quite long-stalked, lacking an apical apparatus. **Ascospores** irregularly biseriate, one-celled, spoon-shaped and hyaline in the early stages, yellowish later, transversely septate at maturity, with a dark brown spore head and a hyaline pedicel. Spore head 25–27.5 × 15–17.5 µm, broadly ellipsoidal to ellipsoidal (Q= 1.47–1.71; average Q= 1.61), sometimes slightly inequilateral, smooth, thick-walled, rarely transversely septate, barely umbonate, usually concave at the base, with an indistinct germ pore and a de Bary bubble in aqueous media. Pedicel often plasma filled, broadly cylindrical and wider at its attachment to the spore head, 17–22 × 7–8 µm. Gelatinous equipment formed of two usually loop-shaped caudae: the basal cauda arising from the pedicel apex, imperceptibly longitudinally striate, 15–27 × 5–7 µm, the apical cauda arising from the apex of the spore head but slightly eccentric, appearing hollow, 27–30 × 3–5 µm.

Material examined: INDONESIA, Rinca island, 8° 43' 58" S 119° 39' 41" E, 0 m a.s.l., about twenty scattered or gregarious specimens on

wild water buffalo (*Bubalus arnee*) dung in a damp chamber culture, leg. M.T. Seu, 20.08.2016, CLSM 007.16.

Discussion

About *Cercophora mirabilis*, *C. brevifila* and their relatives

According to LUNDQVIST & FAKIROVA (1973) *Cercophora mirabilis* belongs to a complex of species characterised by a palisade or tufts of agglutinated, swollen, obtuse neck hairs, asci with a subapical plasma globulus and usually a simple apical ring, and ascospores with an eccentric germ pore. I also add that all the species of the group have brown, membranous peridia and perithecial venters covered with brown hyphoid hairs. One species (*Cercophora ignis* A. Bell & Mahoney) is carbonicolous, two [*C. caudata* (Curr.) N. Lundq.; *C. natalitia* (Speg.) N. Lundq.] lignicolous, the others (*C. anisura* N. Lundq., *C. brevifila* N. Lundq. & Fakirova, *C. mirabilis*) coprophilous, although *C. mirabilis* was also isolated from straw (LUNDQVIST, 1972).

Cercophora mirabilis differs from *C. anisura* in that it has larger perithecia, without a longitudinally ridged neck, and somewhat larger ascospores with gelatinous caudae equal in length (LUNDQVIST, 1972). It is distinguishable from *C. brevifila* by having longer neck hairs, and ascospores with a larger number of oil drops (LUNDQVIST & FAKIROVA, 1973) and longer caudae.

Following a procedure I have introduced in a recent paper (DOVERI, 2016), I usually start from morphological features, rather than from the habitat (LUNDQVIST, 1972; HILBER & HILBER, 1979), to primarily subdivide groups of *Cercophora* spp. This allows me to compare with each others also species recorded from different substrates, in this case *C. mirabilis* with *C. caudata*, *C. natalitia* and *C. ignis*, whose main differential characteristics are shown in the key below.

My Indonesian collection of *Cercophora mirabilis* differs from those I described in Italy (DOVERI, 2004) in that it has slightly smaller perithecia with a paler peridium, scarce, very pale hyphoid hairs, smaller ascospores and asci. Its spore heads and pedicels, however, like those of the Italian collections, develop a transverse septation, which elsewhere was described only in Australian specimens (BELL, 2005). Besides, the ascospores of the Indonesian collection have a strange feature never mentioned before, i.e. frequently transversely septate pedicels and/or spore heads with inflated segments. I do not think that we must assign an infraspecific taxonomic value to this phenomenon, I suppose, instead, that swellings are caused by a thermal rise within perithecia growing completely immersed, with only the upper part of the neck emerging. The immersed growth pattern of *Cercophora mirabilis* is exceptional, so much so that most other collections worldwide of this species were described with semi-immersed perithecia (LUNDQVIST, 1972; UDAGAWA & MUROI, 1979; WANG, 1994; MOYNE & PETIT, 2007). Very pale perithecial venters and few and pale hyphoid hairs of my collection could also be ascribed to this unusual growth.

The Indonesian collection of *C. brevifila* matches that described from Bulgaria (LUNDQVIST & FAKIROVA, 1973) with the exception of somewhat smaller ascospores and longer gelatinous caudae. I do not think that such differences might suggest two distinct taxa, although the epithet "*brevifila*" was originally assigned to this species precisely for its very short caudae. We should be very cautious in attributing a primary importance to the length of the lash-shaped caudae, as it is known (LUNDQVIST, 1972) that they easily stretch even at the lowest pressures on slide coverslips.

Cercophora mirabilis is a quite common species, recorded from all climates (BELL, 1983, 2005; KHAN & KRUG, 1994; MELO *et al.*, 2012; LÉCURU, 2013; RUBIO *et al.*, 2013), particularly from cattle dung (FUCKEL, 1870; LUNDQVIST, 1972, 1981; UDAGAWA & MUROI, 1979; BARRASA & MORENO, 1984; CHANG & WANG, 2005; WELT & HEINE, 2006; RICHARDSON, 2008). As for the other coprophilous species of the group, *C. anisura* was recorded twice from cattle dung (LUNDQVIST, 1972, 1981), once from horse (DOVERI, 2004), whereas we cannot establish a real subs-

trate preference of *C. brevifila*, as it had been recorded only once from horse dung (LUNDOVIST & FAKIROVA, 1973).

About *Cercophora samala* and its protologue

Cercophora samala is characterised by rigid, often fasciculate, brown neck hairs, a coriaceous peridium, asci lacking a subapical plasma globulus, and growth on dung. Unfortunately I could study only one specimen, which differs from the *typus* (UDAGAWA & MUROI, 1979) in a few negligible details, i.e. somewhat shorter asci and

slightly shorter ascospores with a just smaller and not yet pigmented head.

Despite the scarce material at my disposal, I am still able to make some clarifications about the peridial frame. In the original diagnosis in Latin the “*strato externo*” is called “*textura intricata* of dense, elongated, brown cells” (UDAGAWA & MUROI, 1979). The dark, star-shaped cells drawn in the protologue look like what I describe in my specimen as elongated, carbonaceous cells of the outermost peridial layer. According to UDAGAWA & MUROI (1979), and also in my opinion,

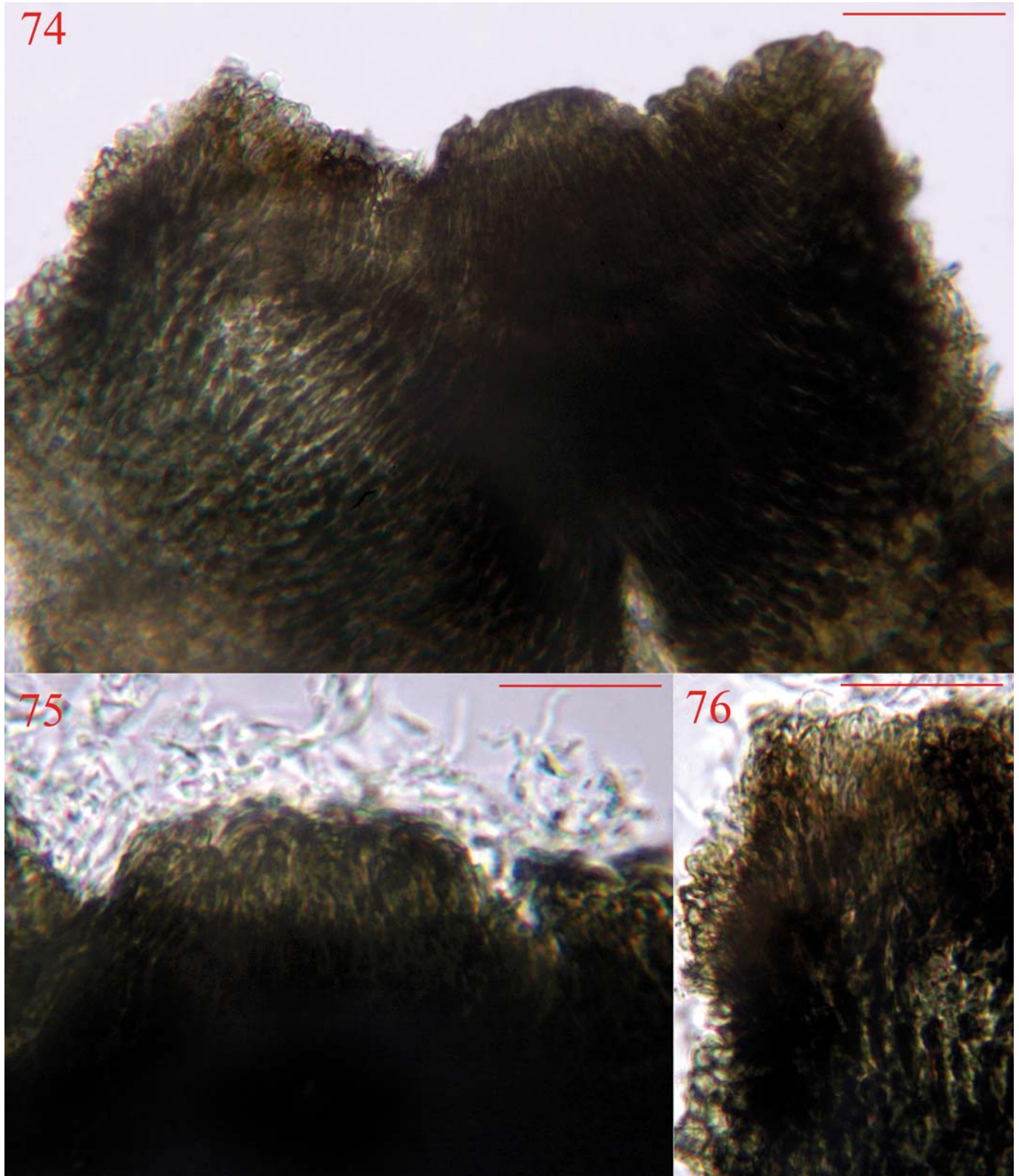


Plate 21 – *Podospora inquinata*

74. Perithecial neck. 75. Upper portion of the neck. 76. Upper two thirds of the neck. Scale bars: 74 = 25 µm; 75 = 15 µm; 76 = 20 µm.

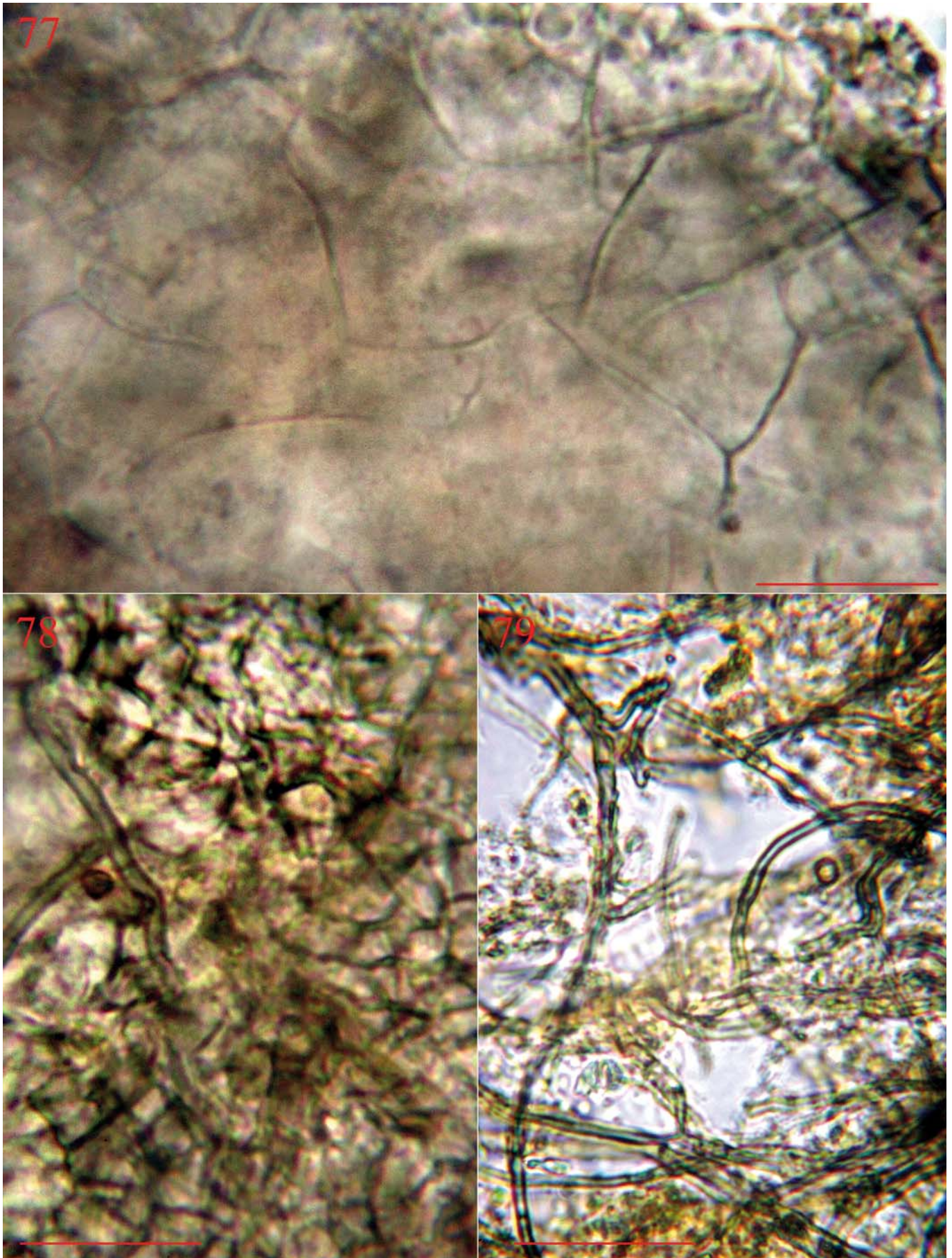


Plate 22 – *Podospora inquinata*

77. Detail of peridial endostratum. 78. Detail of exostratum. 79. Hyphoid hairs. Scale bars: 77 = 10 μm ; 78 = 30 μm ; 79 = 20 μm .

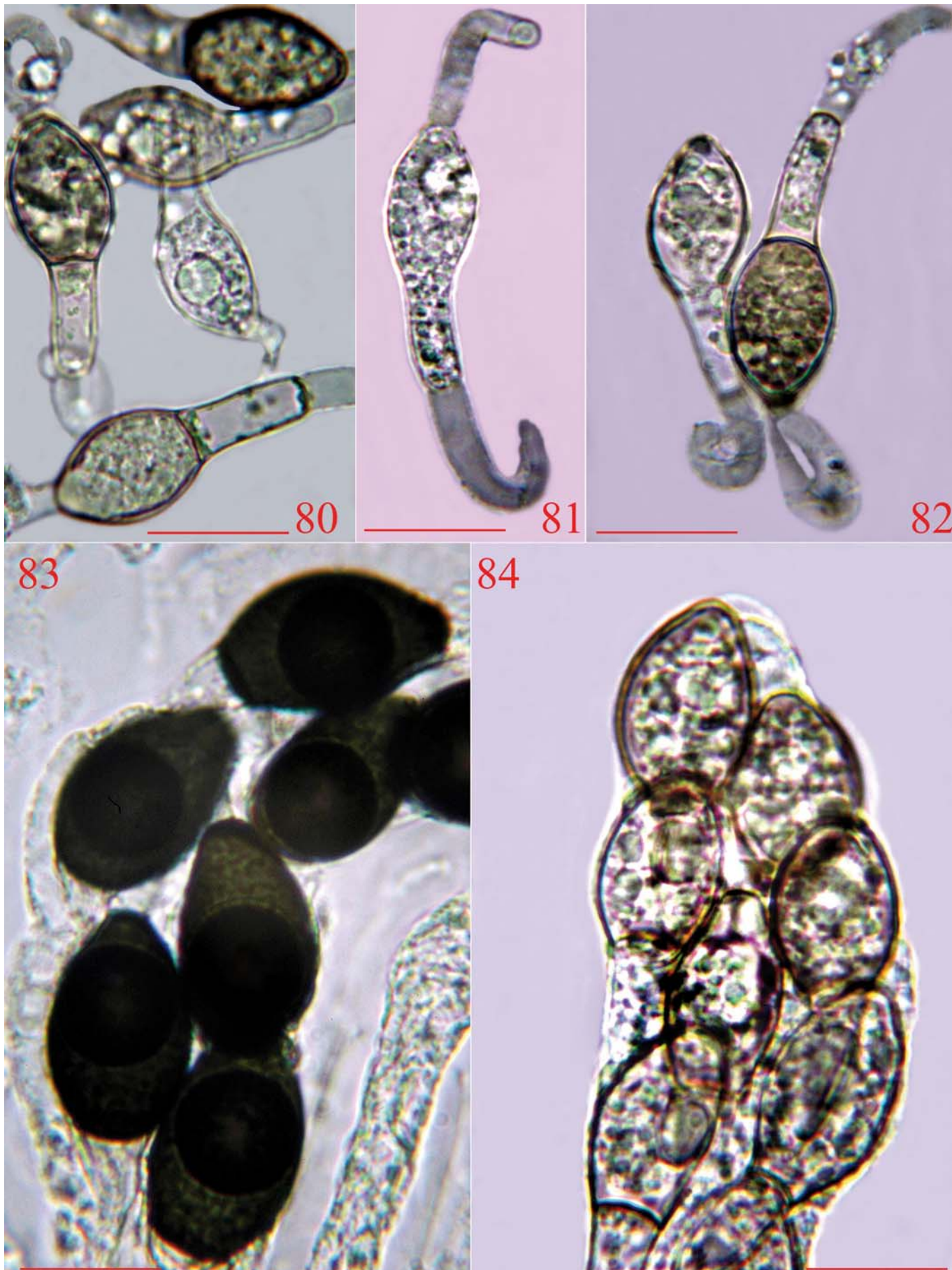


Plate 23 – *Podospora inquinata*

80–82. Ascospores in different stages. 83–84. 8-spored asci. Scale bars: 80–82 = 20 μ m; 83–84 = 15 μ m.

they are real cells with defined outlines, which cannot be mistaken for shapeless carbonaceous deposits. Based on their typical shape and the sparse arrangement in several peridial parts, “*textura intricata*” seems an inappropriate description of the outer peridial layer.

The second layer from outside, whose frame is called “*textura angularis*” in the protologue, has, in my specimen, a predominant *textura epidermoidea* of irregular cells with wavy outlines, and only few intervals of polygonal cells (*textura angularis*). Due to a wider cell contact surface, an epidermoid frame provides, in my opinion, a tougher consistency than an angular frame... and a tough peridium was precisely described in the protologue.

The original diagnosis also shows other inaccuracies, mainly a discrepancy between drawing and description of the hair shape and arrangement. Nevertheless the original picture of the hairs fully matches mine.

Cercophora samala was compared at first (UDAGAWA & MUROI, 1979) with *C. scortea* (Cain) N. Lundq., as the two species share a coriaceous peridium and rigid, brown hairs fading upwards. The comparison seems somewhat forced, as in *C. scortea* the hairs are scattered and do not cover the neck, the asci have a subapical globulus, and the “pseudo-bombardioid” peridium (LUNDQVIST, 1972) owes its toughness to a layer of gelatinised cells (MILLER, 2003).

Bahupaathra samala Subram. & Lodha [= *Cladorrhinum samala* (Subram. & Lodha) W. Gams & Mouch.] was originally regarded (UDAGAWA & MUROI, 1979) as the asexual morph of *Cercophora samala*, but subsequent mating studies (MOUCHACCA & GAMS, 1993) proved their incompatibility and assigned a different *Cladorrhinum* sp. to *Cercophora samala*.

After the first Japanese findings on cow dung, *Cercophora samala* has not been recorded worldwide.

About *Podospora hyalopilosa* and similar species

Podospora hyalopilosa belongs to sect. *Malinvernia* (Rabenh.) N. Lundq., which encompasses species characterized by a membranous peridium, 4- to poly-spored asci, dumb-bell shaped or clavate to spoon-shaped young ascospores with a variety of gelatinous equipment at maturity (LUNDQVIST, 1972). It was often compared (CAIN, 1934; MIRZA & CAIN, 1969; DOVERI, 2004; MUNGAI *et al.*, 2011) with *P. communis* (Speg.) Niessl, also in this section, which differs in having a cylindrical pedicel with four basal caudae and somewhat larger spore heads.

Podospora hyalopilosa was so named (STRATTON, 1921) because of its hyaline hairs on the perithecial neck, a feature that could further distinguish it from *P. communis* (neck glabrous), but that is not constant (KRUG & KHAN, 1989) and often disappears with age (CAIN, 1934).

KHAN & CAIN (1972) also compared *Podospora hyalopilosa* with *P. multispora* R.S. Khan & Cain and *P. deropodalis* R.S. Khan & Cain, as the three species have similar ascospores with some apical caudae and a single basal cauda. *P. multispora* clearly belongs, like *P. hyalopilosa*, to sect. *Malinvernia* and can be easily distinguished by its poly-spored asci and smaller ascospores. Conversely it is difficult to accommodate *P. deropodalis* in any of the sections established by LUNDQVIST (1972), as it has, in my opinion, an intermediate position between sect. *Rhyphophila* N. Lundq. (cylindrical young ascospores, pedicel longer than the spore head, black spinules at the neck base) and sect. *Malinvernia* (asci with an apical apparatus and ascospores with solid gelatinous caudae). The black spinules and the very long pedicel easily distinguish *P. deropodalis* from *P. hyalopilosa*.

Podospora hyalopilosa is a fairly common species, recorded from all over the world except from Europe and the poles. About 50% of records are from tropical climates (ASAD & AHMAD, 1968; MIRZA & CAIN, 1969; GARCÍA-ZORRÓN, 1973; KRUG & KHAN, 1989; WANG, 2000; BELL, 2005; MUNGAI *et al.*, 2011) and more than 50% from cattle dung (STRATTON, 1921; CAIN, 1934; GARCÍA-ZORRÓN, 1973; KRUG & KHAN, 1989; WANG, 2000; MUNGAI *et al.*, 2011).

About *Podospora inquinata* and its substrate tolerance

Podospora inquinata (sect. *Malinvernia*) is characterised by hairy perithecia with a glabrous neck, long-stalked, clavate asci lacking an apical ring, ascospores with a cylindrical-conical pedicel and two loop-shaped gelatinous caudae. It was originally compared (UDAGAWA & UEDA, 1985) with *P. macropodalis* Mirza & Cain, the latter having a similar perithecial morphology and sharing clavate asci and broadly ellipsoidal ascospores with two gelatinous caudae. *P. macropodalis* is still distinguishable for having very short-stalked asci with an apical ring, somewhat smaller spore heads, a slender, cylindrical pedicel, and lash-shaped caudae (MIRZA & CAIN, 1969; UDAGAWA & UEDA, 1985).

The very similar *P. pseudoinquinata* S.I. Ahmed & Masood, isolated from camel dung in tropical climates, differs from *P. inquinata* in that it has wider asci, larger spore heads (40–55 × 30–40 µm) and pedicels, and lash-shaped caudae (AHMED & MASOOD, 1993).

My single Indonesian specimen of *P. inquinata* differs from the *typus* in some negligible details, i.e. somewhat narrower spore heads, and basal caudae usually wider than the apical.

Podospora inquinata was originally isolated from marine sediments in a polluted area (*inde nomen*) and subjected to growth tests in culture with increasing saline concentrations (UDAGAWA & UEDA, 1985): the spore germination, progressively inhibited with the increase of salinity, but the vegetative growth, better developing at high salinities, suggesting that *P. inquinata* could be only an occasional inhabitant of marine environments.

A second record (AL-SAADON, 2000) of *Podospora inquinata* was from an unidentified wood submerged in freshwater (Euphrates river, Iraq).

Mine is the third record worldwide, the first from dung, a finding suggesting that this species also, like the vast majority of *Podospora* spp. (KIRK *et al.*, 2008), is coprophilous. Other *Podospora* species usually growing on dung were also recorded from different substrates (LUNDQVIST, 1972). In this respect *P. inquinata* also could belong to a group of species with a wide substrate “tolerance” (LUNDQVIST, 1972).

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