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Identification key for European strand-forming house-rot fungi

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ABSTRACT

Keywords:

Asterostroma
Antrodia
Coniophora
Daedalea
Diplomitoporus
Donkioporia
Dry rot fungi
Gloeophyllum
Lentinus
Leucogyrophana
Oligoporus
Paxillus
Phellinus
Serpula
Trechispora

An identification key for 20 common strand-forming indoor wood decay fungi is given. The key is based on observations of material from affected buildings and on wood samples that have been incubated in the laboratory. The key is with macro- and microscopic photographs.

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One classical identification key for wood decay fungi in buildings based on their strands exists (Falck 1912; modification by Bavendamm 1936). The recent key by Bravery *et al.* (2003) comprises only a limited number of species. Other keys also available are based upon mycelial agar cultures grown under defined conditions (Davidson, Campbell & Vaughn 1942; Nobles 1965; Stalpers 1978; v.Arxa 1981; Lombard & Chamuris 1990). However, their characteristics under these conditions may differ from those of naturally grown mycelia. Furthermore, strand formation has less significance for the identification of fungi in culture as strands often appear only in ageing cultures.

The following key goes back to Falck (1912), but is basically revised and illustrated and contains additionally white rot fungi and species unknown at that time. The key is based on

mycelia collected from affected buildings which have been identified by traditional methods, and from pure cultures which have been verified by rDNA-ITS sequencing (Schmidt & Moreth 2002, 2003a) and then grown on wood samples (Huckfeldt 2003). To date, about 60 indoor wood decay fungi have been described in the literature (Huckfeldt & Schmidt 2005). The key presented comprises 20 of the most common species that form strands or strand-like structures (Guillitte 1992; Koch 1985; Huckfeldt 2003; Schmidt 2006).

Strands are defined as distinct longitudinal aggregations of hyphae which may consist of three hyphal types: a) vegetative hyphae, b) thin fibre (skeletal) hyphae with thick walls for strengthening, and c) broad vessel hyphae for nutrient and water transport. Strands are typically less organized than

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Table 1 – House-rot fungi dealt with in the key and isolates used for pure cultures

Species	Reference isolate coding
<i>Armillaria</i> spp.	
<i>Asterostroma cervicolor</i> (Berk. & Curtis) Massee	
<i>Asterostroma laxum</i> Bres.	
<i>Antrodia serialis</i> (Fr.) Donk	
<i>Antrodia sinuosa</i> (Fr.: Fr.) P. Karsten	115
<i>Antrodia vaillantii</i> (DC: Fr.) Ryv.	123
<i>Antrodia xantha</i> (Fr.: Fr.) Ryv.	289
<i>Coniophora marmorata</i> Desm.	307
<i>Coniophora puteana</i> (Schum.: Fr.) P. Karsten	169
<i>Coprinus</i> spp.	Cd
<i>Daedalea quercina</i> (L.) Fr.	
<i>Diplomitoporus lindbladii</i> (Berk.) Gilb. & Ryv.	Dl
<i>Donkioporia expansa</i> (Desm.) Kotl. & Pouzar	188
<i>Gloeophyllum abietinum</i> (Bull.: Fr.) P. Karsten	197
<i>Gloeophyllum sepiarium</i> (Wulfen: Fr.) P. Karsten	201
<i>Gloeophyllum trabeum</i> (Pers.: Fr.) Murr.	183
<i>Lentinus adhaerens</i> (Alb. & Schw.: Fr.) Fr.	
<i>Lentinus lepideus</i> (Fr.: Fr.) Fr.	184
<i>Leucogyrophana mollusca</i> (Fr.: Fr.) Pouzar	264
<i>Leucogyrophana pinastri</i> (Fr.: Fr.)	273
GINNS & Weresub	
<i>Leucogyrophana pulverulenta</i> (Sow: Fr.) Ginns	
<i>Oligoporus placenta</i> (Fr.) Gilb. & Ryv.	121
<i>Paxillus panuoides</i> (Fr.: Fr.) Fr.	
<i>Phellinus contiguus</i> (Pers.: Fr.) Pat.	BFH 7
<i>Phellinus ferreus</i> (Pers.) Bourdot & Galzin	
<i>Phellinus nigrolimitatus</i> (Rom.) Bourdot & Galzin	
<i>Phellinus pini</i> (Fr.: Fr.) A. Ames	
<i>Phellinus robustus</i> (P. Karsten) Bourdot & Galzin	
<i>Resinicium bicolor</i> (Alb. & Schw.: Fr.) Parm.	
<i>Serpula himantoides</i> (Fr.: Fr.) P. Karsten	99
<i>Serpula lacrymans</i> (Wulfen: Fr.) Schroeter	S7, S10, S11, S16, 2 monokaryons
<i>Trechispora farinacea</i> (Pers.: Fr.) Liberta	
<i>Trechispora mollusca</i> (Pers.: Fr.) Liberta	

the tissue-like structure of rhizomorphs (Moore 1998), their hyphae also show apical growth but they develop behind the mycelial growth front.

In some cases, differentiation by the key is only possible to the genus level, e.g., for species from the genera *Antrodia*, *Coniophora* and *Lentinus* (cf. Stalpers 1978). These are perhaps best differentiated by their ITS sequences, namely *Antrodia* (Schmidt & Moreth 2003b), *Coniophora* (Schmidt et al. 2002a) and *Leucogyrophana* (Schmidt 2003). In some cases, closely related species may also be differentiated by physiological characteristics, with the key containing data on growth rate and dependence on temperature. Some accompanying fungi, such as slime fungi, *Peziza* spp. and *Coprinus* spp., are also mentioned in the key.

1. Material and methods

About 400 fungal samples were collected from affected buildings in North Germany, identified by traditional methods (microscopy, culture studies) and were macroscopically and

microscopically compared with pure reference cultures (Huckfeldt 2003). The isolates for the reference studies (Table 1) were derived from the strain collection of the Wood Biology Division, University of Hamburg and can be obtained on request. Most isolates had been previously verified by sequencing their rDNA-ITS region (Schmidt & Moreth 2002, 2003a). Reference isolates were cultured on sapwood samples of *Pinus sylvestris* L. Autoclaved sticks (2 × 2 × 25 cm) were transferred into autoclaved 5l Erlenmeyer flasks containing 1.5 % malt extract agar (pH 5), and isolates were inoculated onto the agar adjacent to the wood sample and incubated at 20 °C and 70 % RH for up to three years to allow the fungi time to develop mature morphological structures (fruit bodies, strands, discolourations) on the wood samples. In similar fashion, sterile wooden boards (20 × 20 × 0.5 cm) were also transferred to sterile plastic tissue dishes (24.5 × 24.5 × 2.5 cm) containing malt agar, and also inoculated adjacent to the wood and incubated as above. Both techniques allowed the continuous macroscopical and photographic evaluation of growth rate, strand and fruit body development without the need to open the culture vessel. The methods used for growth rate, temperature and microscopic studies are described by Huckfeldt (2003), Schmidt (2003), Schmidt and Moreth (2003b), Schmidt et al. (2002a,b).

2. Key and growth studies

The key derived from collected material and growth studies is given in Table 2. Growth rates and temperature responses of the cultures studied are shown in Table 3. The key is dichotomous. Each numbered couplet (number on the left side, with and without*) is made up of a pair of contrasting characters. Read the first couplet and make a choice. The chosen paragraph is followed by a number (on the right side) indicating the next couplet and so on. The identification finishes at the species or the genus.

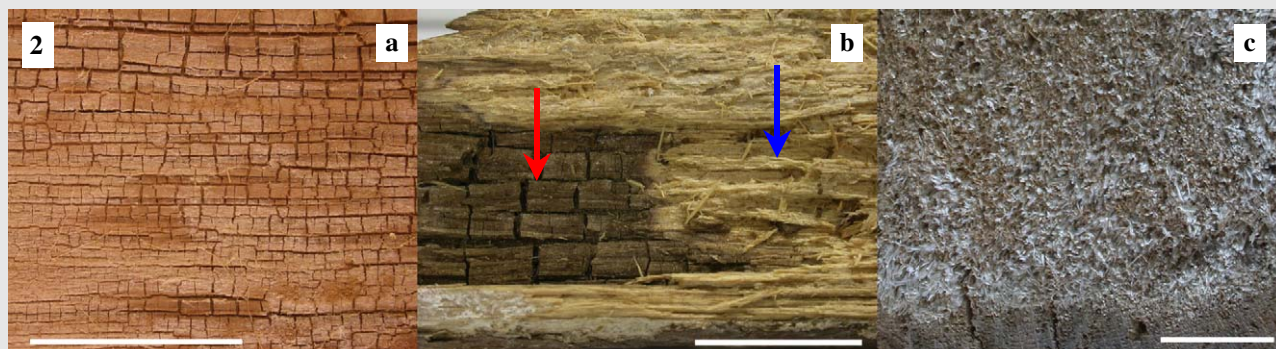
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Table 2 – Key

All key points must be considered before a decision. Small numbers in parentheses refer to the preceding key point;
 Scale: broken bar = 5 mm/5 μ m; solid bar = 50 mm/25 μ m. Latter dimensions refer to micrographs

- | | |
|--|----|
| 1 fungus causes (intensive) rot | 2 |
| 1* fungus does not cause (intensive) rot – possible error: rotten wood is overgrown or infection is in initial stage; no vessel hyphae (if vessels then usually within strands, forward to 3) | 34 |
| 2 ⁽¹⁾ brown-cubical rot (2a–b, red arrow); no setae; spores always even (also under oil-immersion) | 3 |
| 2* white rot (2b–c, blue arrow); vessels always less than 15 μ m diam | 24 |



- | | |
|--|----|
| 3 ⁽²⁾ strands clearly recognizable, but often overgrown by mycelium | 4 |
| 3* strands indistinct (3a–c; microscopic investigation necessary; start at (4) if vessels are present) | 16 |



- | | |
|--|-------------------------|
| 4 ⁽³⁾ vessels over 40 μ m diam or strands over 4 mm diam, removable from the substrate, frequently surrounded by thick mycelium or hidden in masonry, wood etc. (4a–c); dry strands break with clearly audible cracking ; fibre (skeletal) hyphae refractive; vessels with internal wall thickenings (bars), to 60 μ m diam; generative hyphae with clamps | see (12) <i>Serpula</i> |
|--|-------------------------|



- | | |
|---|---|
| 4* strands under 4 mm diam or firmly attached to the substrate | 5 |
| 5 ^(4,16) strands hair-like (5a–c), often branched and clearly defined (with 'bark'), below 0.5 mm diam and often below mycelium, removable; no fibres ; - or strands/mycelium with sclerotia | 6 |

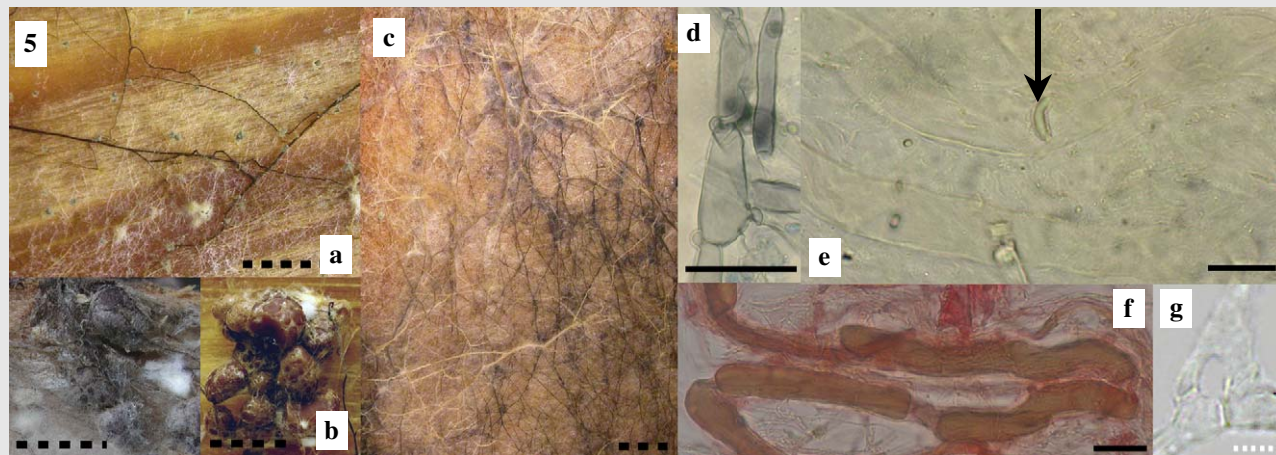


Table 2 (continued)

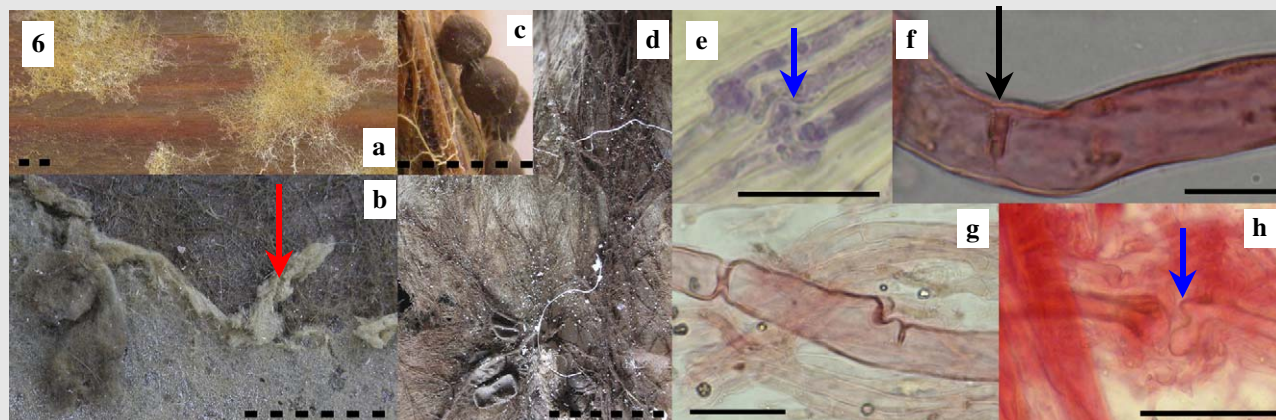
5* strands **not** hair-like, not clearly defined (without bark); no sclerotia; fibres present or absent

7

6(5) sclerotia large, to 6 mm diam, round, often somewhat irregular (6b), sometimes absent; strands hair-like, with bark, cream to yellow, red-brown to black when old (6a, c), under 0.5 mm diam, somewhat flexible when dry; no fibres; vessels to 25 µm diam, numerous, in groups, with bars (arrow), cell wall to 1 µm thick (6e–f); some generative hyphae bubble-like swollen (6d) and according literature with medallion clamps (6g), always with clamps; strands also in masonry; only on softwoods

Leucogyrophana mollusca

6* sclerotia small and oblong, to 2.5 mm long, brown to grey (6*b–c), sometimes absent; strands hair-like, with bark, yellowish, grey to brown (6*a–d), probably darker when old, covered by lighter mycelium (6*b red arrow) or exposed, under 0.5 mm diam, somewhat flexible when dry; no fibres; vessels to 25 µm diam, but often partly thickened, numerous, in bundles, with bars (6*f–g, black arrow); generative hyphae with clamps (6*e, h blue arrow) 2.5–4.5 µm diam; strands also in masonry; probably only on softwoods

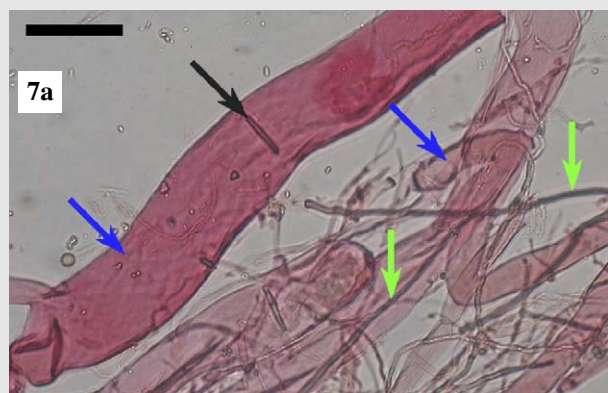
Leucogyrophana pinastri

7(5) strands with vessels (7a blue arrow, bar black arrow), (sometimes rare; search; wood fibres may be mistaken for vessels)

8

7* strands **without** vessels

9



8(7) strands **without** fibres, however usually with vessels and generative hyphae with clamps

10

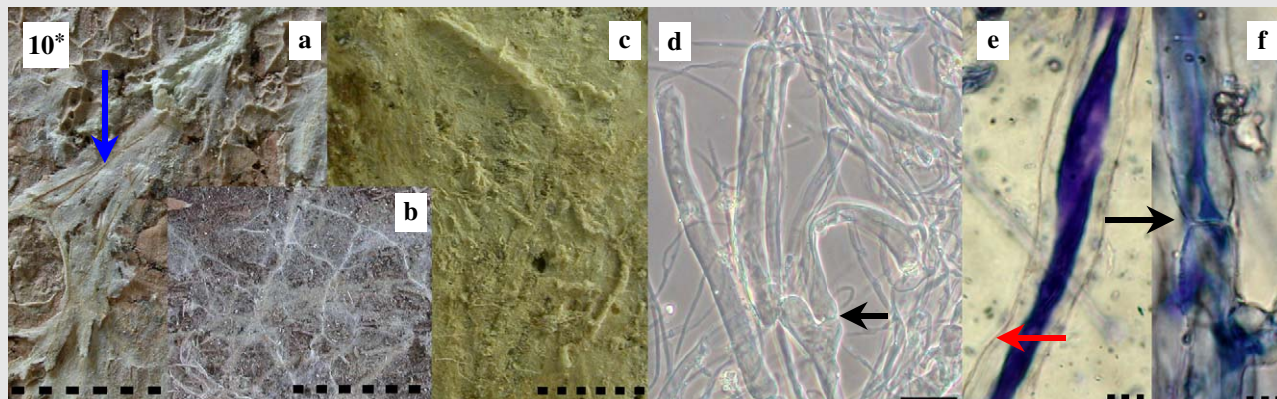
8* strands **with** fibres (7a green arrow), generative hyphae with clamps

11

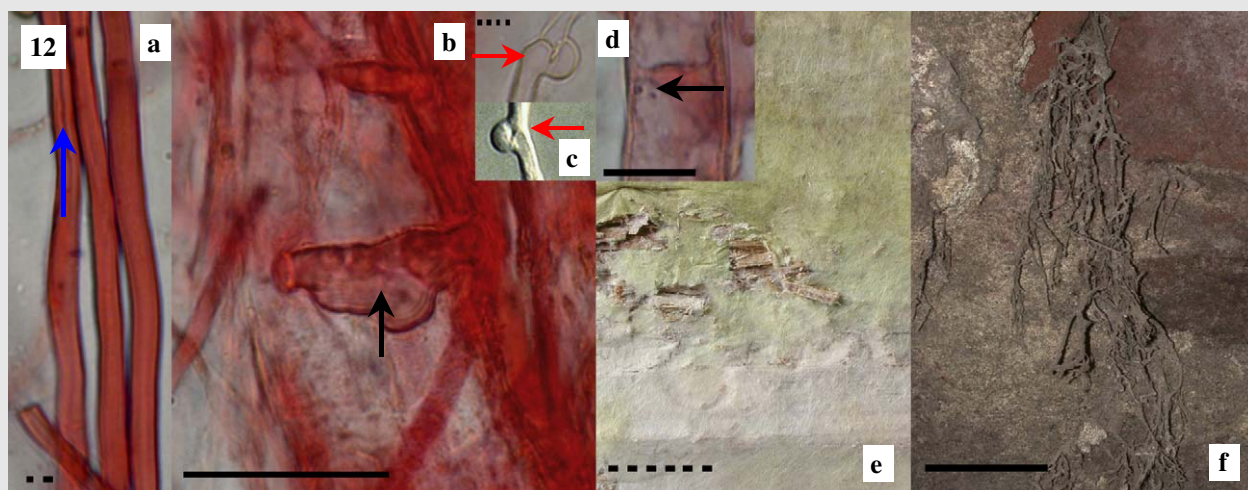
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Table 2 (continued)

9(7) strands with fibres and generative hyphae	16
9* juvenile strands only with generative hyphae (old strands sometimes with vessels und fibres)	22
10(8) vessels rare, often narrowed at the septa; fibres absent or indistinct; generative hyphae with clamps	15
10* vessels numerous, to 20 µm diam, often in bundles, bars indistinct or absent, but with septa (10*d, f black arrow), cell wall to 1 µm thick (10*d-f red arrow); no fibres; generative hyphae with clamps, 2-4 µm diam; strands indistinct, just as embedded (blue arrow) as those of <i>S. lacrymans</i> , somewhat flexible when dry, white, creme-yellow to grey (10*a-c), always brittle, to 2 mm diam, also in masonry	
<i>Leucogyrophana pulverulenta</i>	



11(8) vessels with bars (sometimes absent in very young strands), to 60 µm diam, fibres straight-lined, not flexible (with aqueous or ethanol preparation, may be flexible in KOH)	12
11* vessels without bars, but with clearly defined septa, not over 30 µm diam; mycelium not silver grey (if moulds absent), fibres flexible or not	13
12(11) fibres refractive, (2-) 3-5 (-6) µm diam, straight-lined, septa not visible, no clamps, thick-walled, lumina often visible (12a blue arrow); vessels at least partly numerous (in groups), 5-60 µm diam, not or rarely branched; with bars (black arrow), these up to 13 µm high (12b, d); generative hyphae hyaline, partly yellowish, brown when old, with large clamps (red arrow), 2-4 µm diam (12c); strands white, silver-grey , grey to brown (12f), to 3 cm diam, usually with flabby mycelium in between, dry strands breaking with clearly audible cracking (strands that are contaminated with moulds often not cracking any more); aerial mycelium cotton-woolly, soft, white, light-grey to silver-grey, with yellow (12e), orange or violet spots ('inhibition colour'), often several square metres on walls, ceilings and floors, in the draught collapsing fast; on hardwoods and softwoods; strands often in masonry; (<i>S. himantoides</i> can be excluded, if strands thicker than 2 mm and fibres 2,5-4 µm diam)	
<i>Serpula lacrymans</i>	

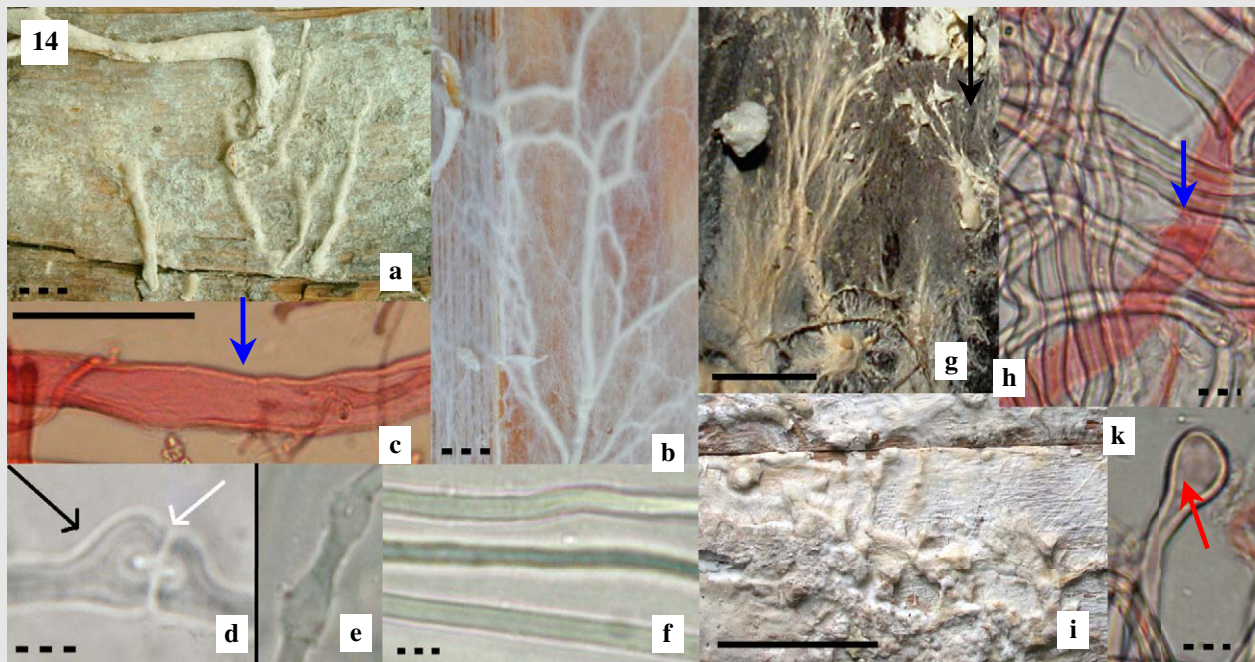


12* see before, but fibres (1,5-) 2-3,5 (-4) µm (sometimes not clearly distinguishable from <i>Serpula lacrymans</i>); strands to 2 mm diam, root-like branched and not as surrounded by thick mycelium as <i>Serpula lacrymans</i> ; sporophore to 2 mm thick	<i>Serpula himantoides</i>
13(11) generative hyphae partly swelling up to 5-10 (-20) µm, fibres up to 2,5 (-3) µm, vessels up to 40 µm; mycelium white, sometimes going yellow (if vessels swelling up: see 15)	22
13* generative hyphae not swelling, ±regular diam, at septa sometimes smaller; strands and aerial mycelium predominantly consisting of fibres, these bright to brown; vessels solitary; generative hyphae present, however partly rare (search)	14

14⁽¹³⁾ fibres light to dark-brown, flexible or not, older strands not snow-white; on hardwoods and softwoods.

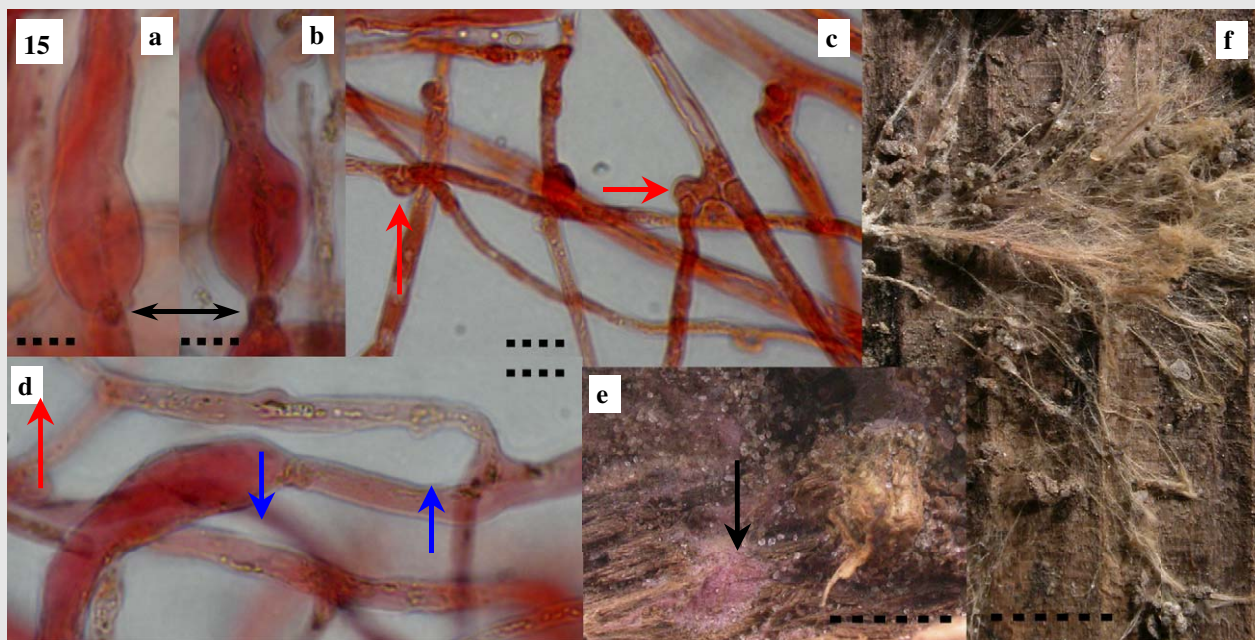
14* fibres hyaline or pale yellow, flexible; strands white to cream (14a-b), partly somewhat yellowing or rarely infected by moulds, also ice flower-like, flexible when dry, up to 7 mm diam; fibres numerous, 2-4 µm diam [in *Antrodia xantha* (14g-k) partly somewhat yellowish (14h), hyphal tips with tapering ending cell walls, 14k red arrow]], narrow lumina, straight-lined, mostly unbranched (14f), insoluble in KOH, [if dissolving, see *Diplomitoporus lindbladii* (31), check rot type, if fibres missing!], but in KOH swelling, sometimes with 'blown up' hyphal segments (14e); vessels rare and in old strands difficult to isolate, up to 25 µm diam, thick-walled with middle lumen, without bars (14c, h blue arrow); generative hyphae with few clamps (black arrow), 2-4 (-7) µm diam, sometimes medallion clamps, often somewhat thick-walled (14d); surface mycelium white to cream, thin, aerial mycelium in no-draught or under-floor areas partly some square metres large, white to cream, later also stalactite-like growth from above; strands also in masonry (?); probably only on softwoods; genus *Antrodia* (species not surely distinguishable on the basis of their strands/mycelia)

Antrodia vaillantii, *A. serialis*, *A. sinuosa*, *A. xantha*



15^(10,14) generative hyphae with clamps (15c-d red arrow); strands first cream to loam yellow, then brownish to ochre, up to 3 mm diam, root-like branches, similar to those of *Coniophora puteana*, however not becoming black (15f); surface mycelium first dirty-white to yellowish, then loam-yellow, brownish to ochre, partly violet (15e black arrow); generative hyphae refractive, (1,5-) 2,5-3-5 (-5) µm diam, partly thickened; fibres indistinct, 1,5-5 µm diam [often only in darker strands]; vessels hyaline, sometimes with 'blown up' hyphal segments (15a-b), up to 20 (-25) µm diam, without bars, but with septa (15a-b, black arrow), with clamps; on and within masonry and wood, often in damp cellars; brown rot

Paxillus panuoides

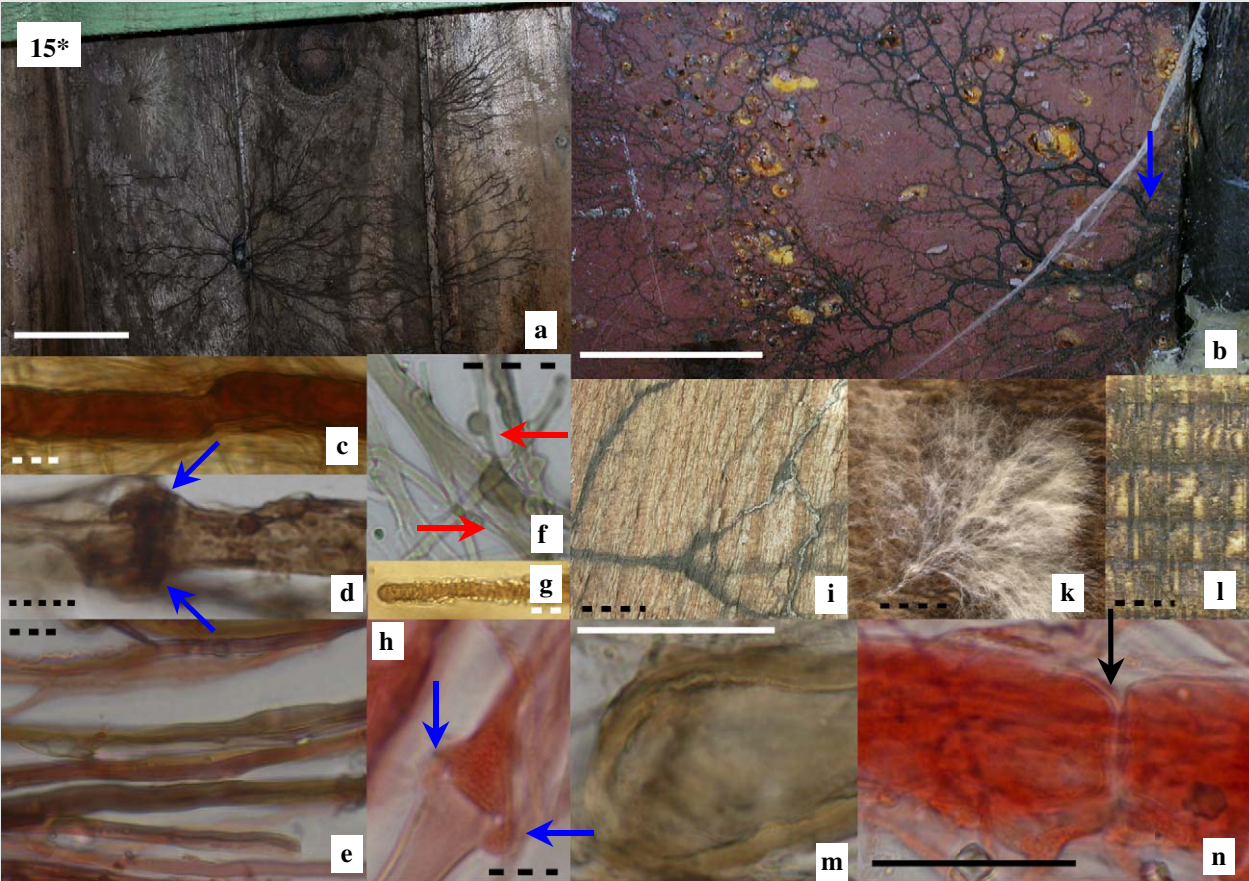


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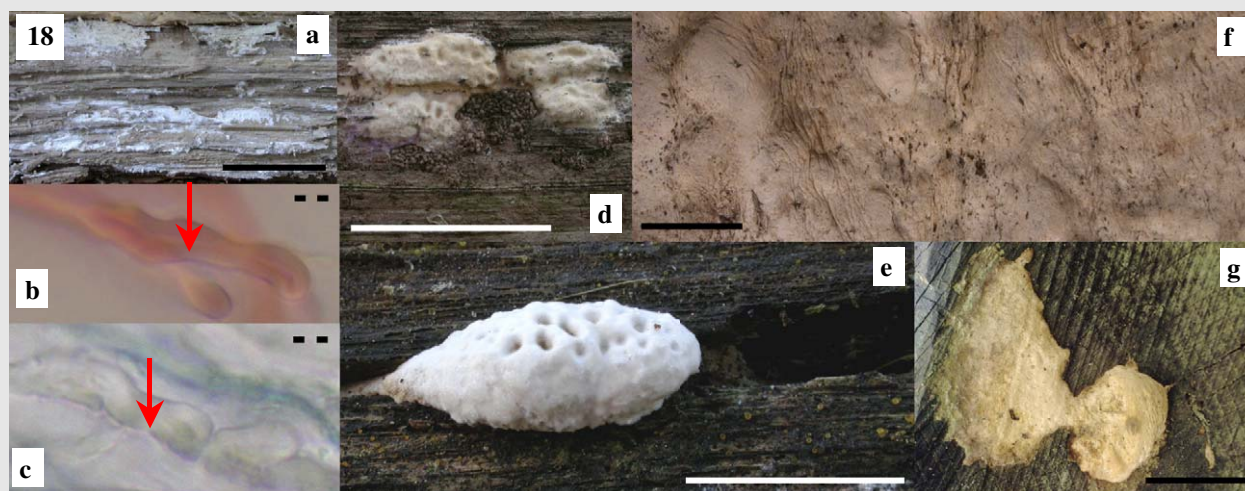
15* generative hyphae without or rarely with clamps, rarely multiple clamps (more often at margin of sporophore, often indistinct, since branched (15*d, h)), 2-9 µm diam; strands first bright (15*h), then brown to black, up to 3 mm wide, to 1, 5 mm thick, root-like (15*a-b) hardly removable (not so with *C. marmorata*), when removed usually fragile, partly with brighter centre (15*i), underlying wood becoming black (15*i, l); fibres pale to dark brown, 2-4 (-5) µm diam, somewhat thick-walled, however with relatively broad, usually visible lumen, also branched, to be confused with generative hyphae (15*e); vessels in strands surrounded and interwoven by fine hyphae (0.5-1.5 µm diam), therefore preparation with H₂SO₄ and KOH solution; drop-shaped, hyaline to brownish secretions (1-5 µm diam) often to be found on hyphae (15*f red arrow); vessels due to preparation irregularly formed or distorted, up to 30 µm diam, thin-walled [or slightly thick-walled with *C. marmorata* (15*m)], without bars, but with septa (15*n black arrow); often also in masonry etc.; genus *Coniophora* (species not surely distinguishable on the basis of their strands/mycelia)

e.g. *Coniophora puteana*, *C. marmorata*



16 ^(3,9) mycelium on masonry, concrete etc.; if applicable vessels possibly not visible or missing, untypical or small; if star-shaped asterosetae present see (25)	5
16* mycelium not on or in masonry	17
17 ⁽¹⁶⁾ fibres present; vessels absent; generative hyphae with clamps (in older parts rare); mycelium and strands only on wood	18
17* fibres missing or very rare; generative hyphae present (see (5) if vessels present – search for vessels, being rare in young strands)	22
18 ⁽¹⁷⁾ fibres partly with swelling and partly with regular diam. (18b–c, red arrow), 2,5-4,5 µm diam. (in sporophores sometimes larger), <u>flexible</u> , lumina small, often visible, sometimes punctually larger; generative hyphae thin-walled, 1-2 (-2,5) µm, with clamps, but no medallions; cystidia possible; mycelium cream to corky (18a, f), firm and tough, often in cavities and shakes in wood below sporophores (18d–f); on oak, half-timbering (18g); brown rot	
<i>Daedalea quercina</i>	

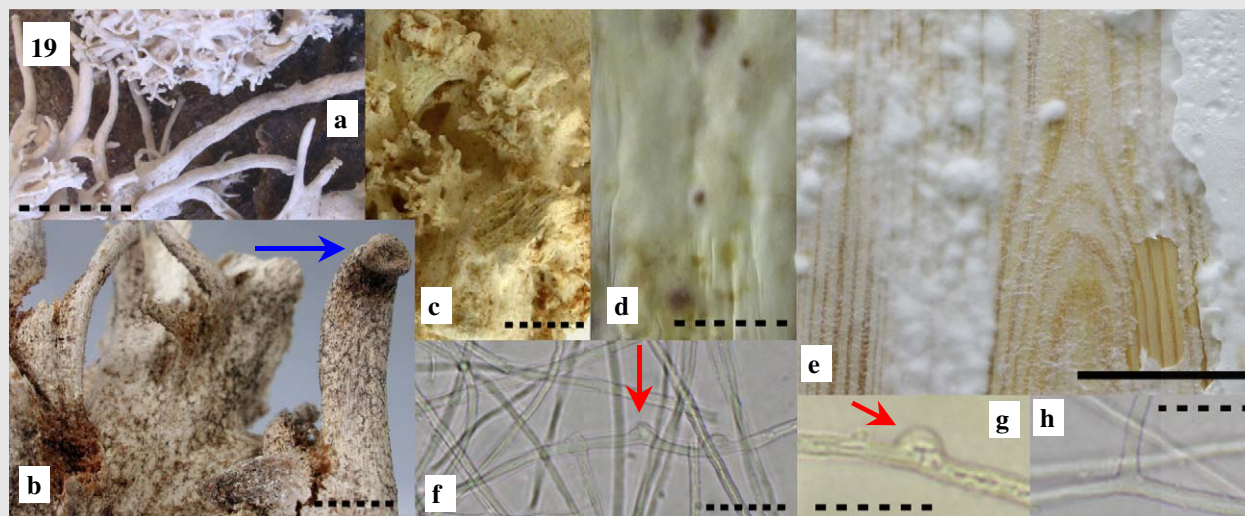
Table 2 (continued)



18* fibres not swelling, \pm regular diam; hyphae in wood usually possess clamps of medallion type

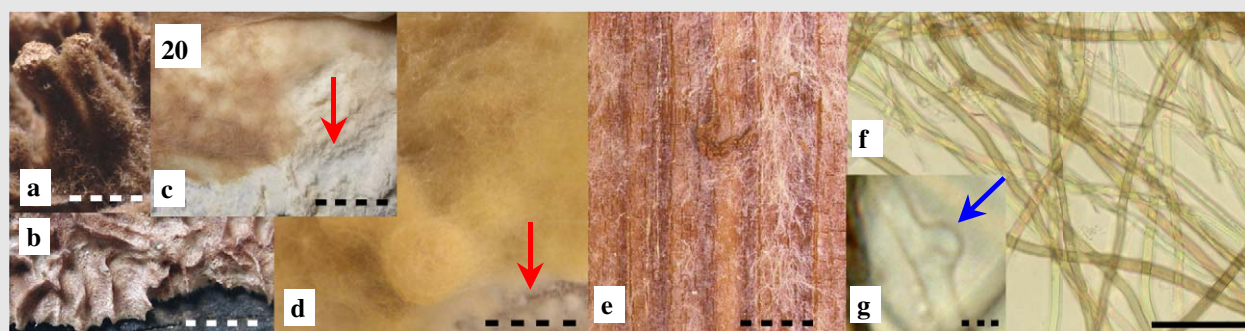
19⁽¹⁸⁾ mycelium rough-velvet; usually two-layered, at least two-coloured: white mycelium close to wood and covered by yellow, reddish to brown aerial mycelium; fibres 2-5 μ m diam, discoloured at darker mycelial areas; generative hyphae with clamps; grey mycelia cannot be differentiated; often on windows

19* mycelium fine-velvet to silky; not distinctly two-layered (19d-e); fibres 1.5-2.5 μ m diam, hyaline, straight, rarely branched (19f, h); generative hyphae always with clamps, 1.5-2 μ m diam (19f-g, red arrow); if hyphae wider see (14); mycelium firm and tough, first white, then with yellow, ochre to violet spots (19d); covering cavities and shakes in wood, easy to remove; mycelia and strands so far only proven for wood; monstrous 'dark fruit bodies' (19a-c), sometimes with little caps (19b blue arrow); usually on softwoods; brown rot; genus *Lentinus* e.g. *Lentinus lepideus*, *L. adhaerens*



20⁽¹⁹⁾ fibres up to dark-brown (examine dark areas); aerial mycelium cream, ochre to dark-brown, underneath white to cream mycelium (not always clearly visible – use pocket-lens; 20c-d, red arrow); fibres 1.5-3 (-4.5) μ m diam (20f); generative hyphae 2-4.5 μ m diam, with clamps 20g blue arrow); strands rare, then forming structures of a few centimetres, these first bright, reddish, then red-brown to grey (20e); in cavities dark, monstrous tap-, pin-, antlers- or cloud-like 'dark fruit bodies' (20a-b); only on softwoods

Gloeophyllum abietinum



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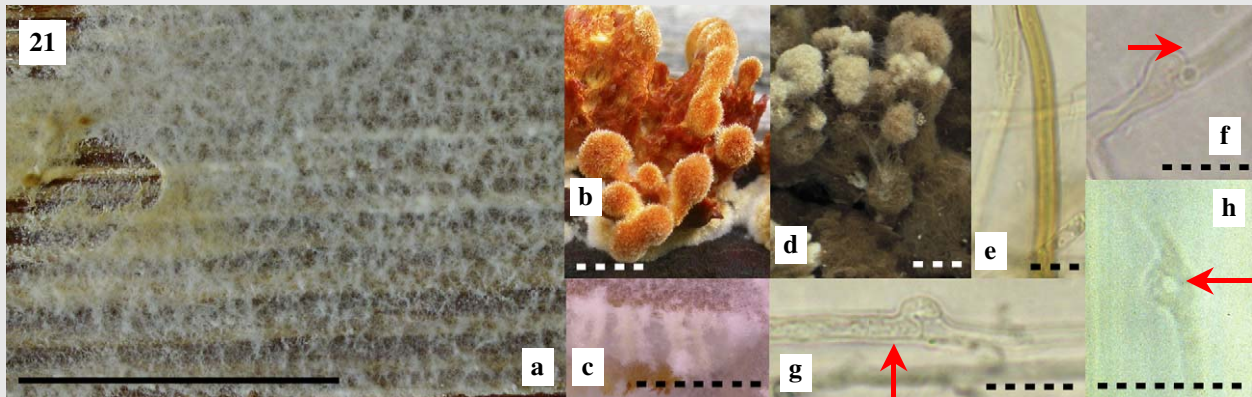
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20* fibres and surface mycelia not so dark, 2-5 µm diam; sometimes also 'dark fruit bodies'

21

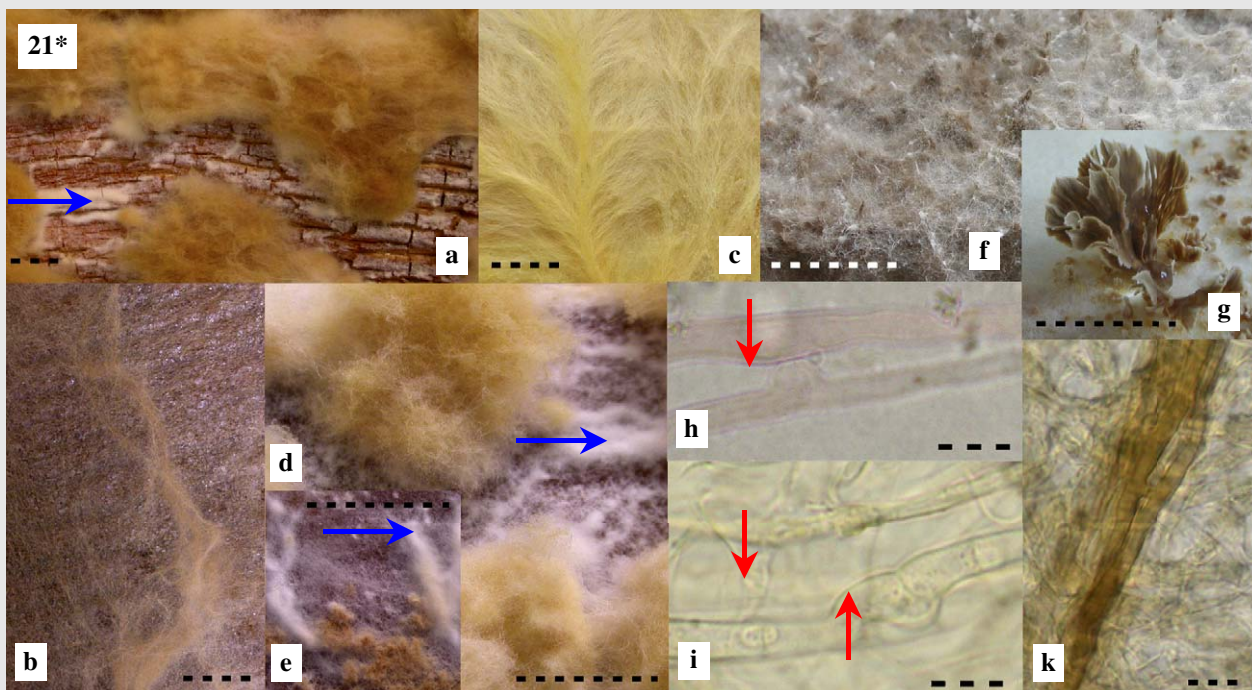
21⁽²⁰⁾ mycelium white, cream to light brown (21a-b); rarely short strands of few centimetres of length, these first bright, then yellowish to ochre-brown and usually covered by mycelium; fibres light to dark yellow, light-brown to brown, 2-4.5 µm diam (partly broader); generative hyphae hyaline, 2-4 µm diam, with clamps (21f-h red arrow); arthrospores rare, 3-4 × 10-15 µm, cylindrical; often in shakes; tap-, pin-, antlers- or cloud-like 'dark fruit bodies' (21b, d); only on softwoods

Gloeophyllum sepiarium



21* mycelium white, beige, yellow-orange to light grey-brown (21*a-f); strands under 1 mm diam and not clearly defined; surface mycelium white-yellow to grey and usually covered by mycelium (21*a, d-e); fibres very light yellow, gold-yellow to light-brown, 1-4 µm diam, septa clearly recognizable (21*k); generative hyphae hyaline, 2-4 µm diam, thin-walled, with clamps (21*h-i); 'dark fruit bodies' also antlers-shaped, often with brighter tips (21*g); often in shakes; only on wood (softwoods and hardwoods)

Gloeophyllum trabeum

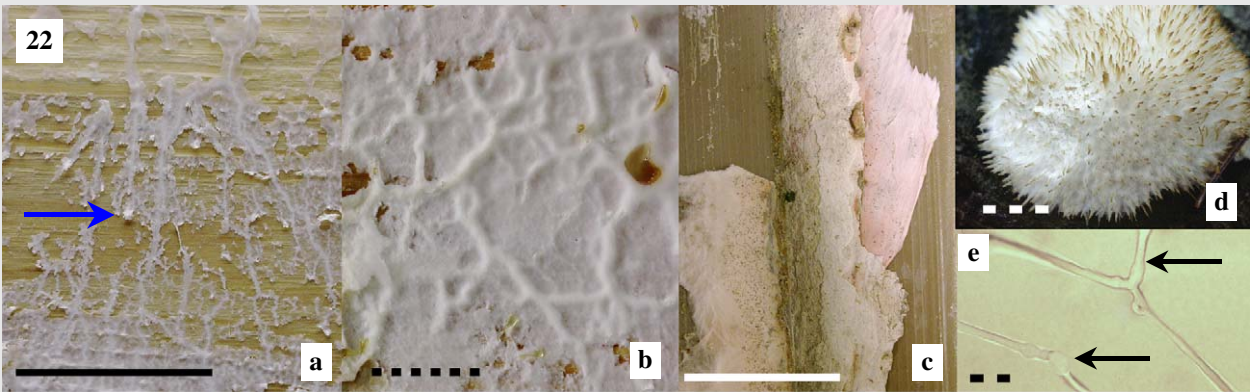


22^(9,13,17) generative hyphae **without** clamps

23

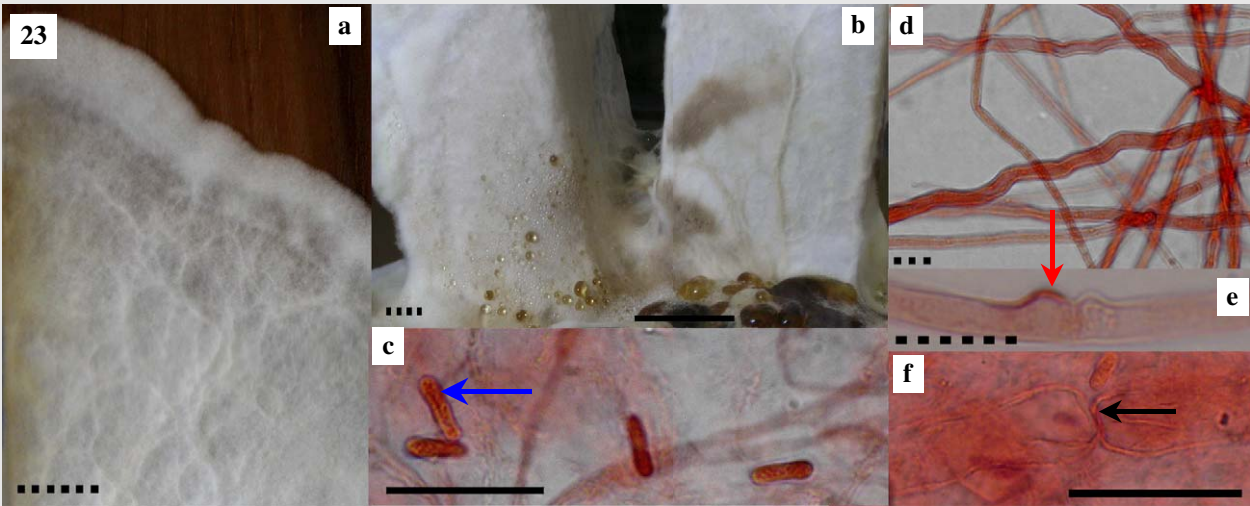
22* generative hyphae with clamps, partly with swellings (22e black arrow), 1-2 µm diam; fibres and vessels only in older strands; fibres 0.5-2 (-3) µm, hyaline, straight-lined, thick-walled, septa not visible, no clamps, no reaction in KOH; vessels 6-35 µm, thin-walled or slightly thick-walled, hyaline, vessels in strands surrounded and interwoven by fine hyphae (0.5-1.5 µm diam); mycelium pure white or pink (22a-c), if being undisturbed lasting so, easily removable, but sensitive (22a blue arrow); strands often sunk in mycelium; on softwoods, rarely on hardwoods; brown rot; genus *Oligoporus* and similar fungi (22d; species indistinguishable by strands and mycelia) e.g. *Oligoporus placenta*

Table 2 (continued)

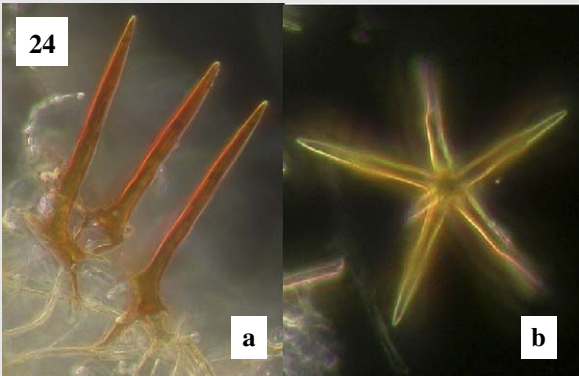


23 ⁽²²⁾ thin-walled, cylindrical arthrospores 1,5-2,5 × 5-12 μm (23c blue arrow); generative hyphae hyaline, thin-walled or slightly thick-walled (23d), 2-3 (-4) μm diam, without clamps, but with primordial clamps (23e red arrow); vessels indifferent, septa present, thin-walled, to 12 μm diam (23f black arrow); in older parts sometimes small fibres (compare with 12); mycelium white to yellow (23a-c), easily removable, but sensitive; strands often sunk in mycelium (23b)

Monokaryon of *Serpula lacrymans*



23* arthrospores absent or different 34
White rot fungi
24 ⁽²⁾ setae present, simple setae (24a) or star-shaped asteroetae (24b), within white to cream mycelium, partly only very small nests of setae (search) 25

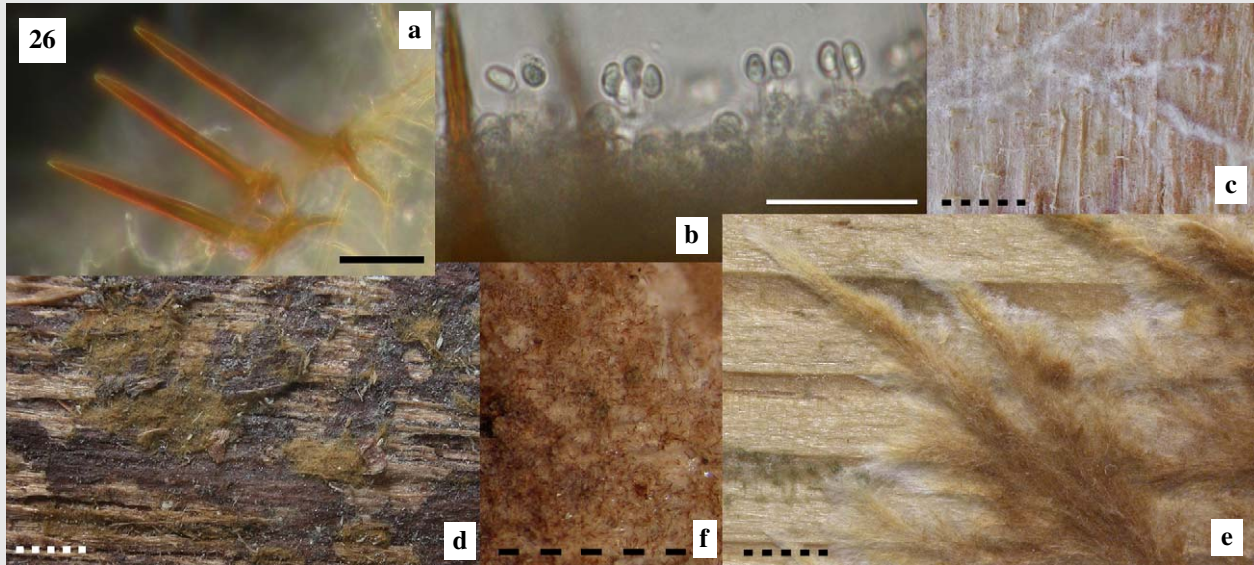


24* setae absent 28
25 ⁽²⁴⁾ asteroetae present (24b); generative hyphae without clamps 27
25* setae not clearly star-shaped or simply branched, partly rooted (24a) 26

(continued on next page)

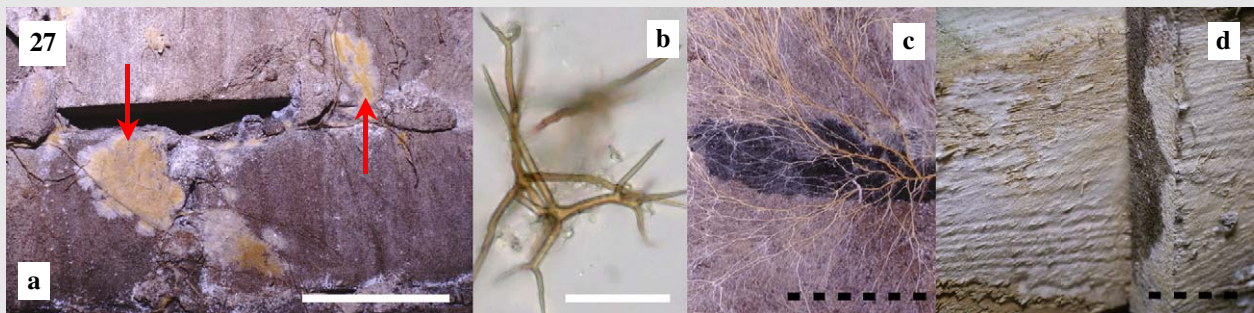
Table 2 (continued)

26⁽²⁵⁾ simple, dark-brown, to 170 µm long setae within mycelium, strands and sporophores (26a–b); fibres pale yellow, thin-walled, 2–3 µm diam, rarely branched; generative hyphae hyaline; mycelium downy, loam-yellow to brown (26d–e), also white when young (26c); cord-like structures up to 4 mm wide and 0.5 mm thick, firmly attached, often finger-shaped branched; usually on hardwoods (often on framework), very rare on softwoods; so far proven for oak, ash, false acacia, elm, beech, fir and spruce; white rot *Phellinus contiguus*



26* simple, dark-brown setae in fruit bodies and mycelium, under 100 µm; other species of the genus *Phellinus* known for buildings (species not surely distinguishable on the basis of strands/mycelia) *Phellinus ferreus*, *Ph. nigrolimitatus*, *Ph. pini*, *Ph. robustus*

27⁽²⁵⁾ asterosetae dichotomously branched, to 90 µm diam, in sporophores, mycelium and strands, partly rare (27b); generative hyphae with simple septa, 2–4 µm diam; strands cream to red-brown, fibrous surface (27a, c–d); partly embedded in white mycelium (27d) or in sporophores (red arrow); spores subglobose, smooth; strands on and in masonry; white rot *Asterostroma laxum*



27* asterosetae only rarely branched, up to 190 µm diam, in sporophores, mycelium and strands (27*b–c); generative hyphae with simple septa, 1.5–3 µm diam; strands cream-brown, up to 1 mm diam; surface mycelium first white, then brown, partly small mycelial plugs (27*a); spores subglobose, tuberculate; strands on and in masonry (27*d); white rot *Asterostroma cervicolor*

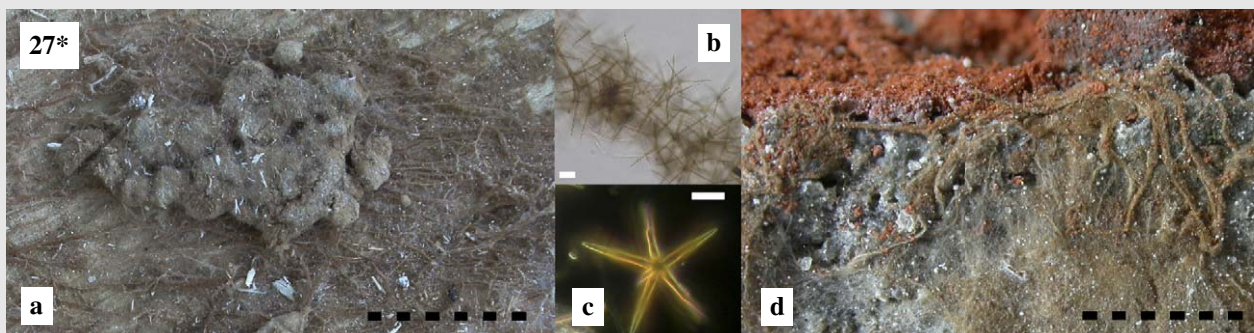


Table 2 (continued)

28⁽²⁴⁾ fibres absent (also in aqueous preparation); sometimes strands with vessels

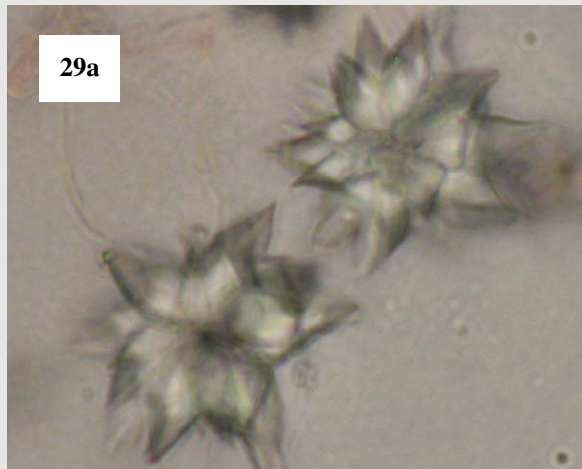
29

28* fibres present; strands without vessels; mycelium sometimes with vessel-like hyphae

31

29⁽²⁸⁾ crystalline astercystidia in sporophores and strands, up to 20 µm diam (29a), cystidia stipe to 11 µm long, 2 µm diam; generative hyphae with clamps, 1.5-3 µm; vessels thin-walled, to 15 µm diam, without bars, but with septa; no fibres; strands snow-white to cream, 0.2-1 mm diam (?), mostly short und near of sporophores; sporophores smooth; to date only found on softwoods; white rot

Resinicium bicolor

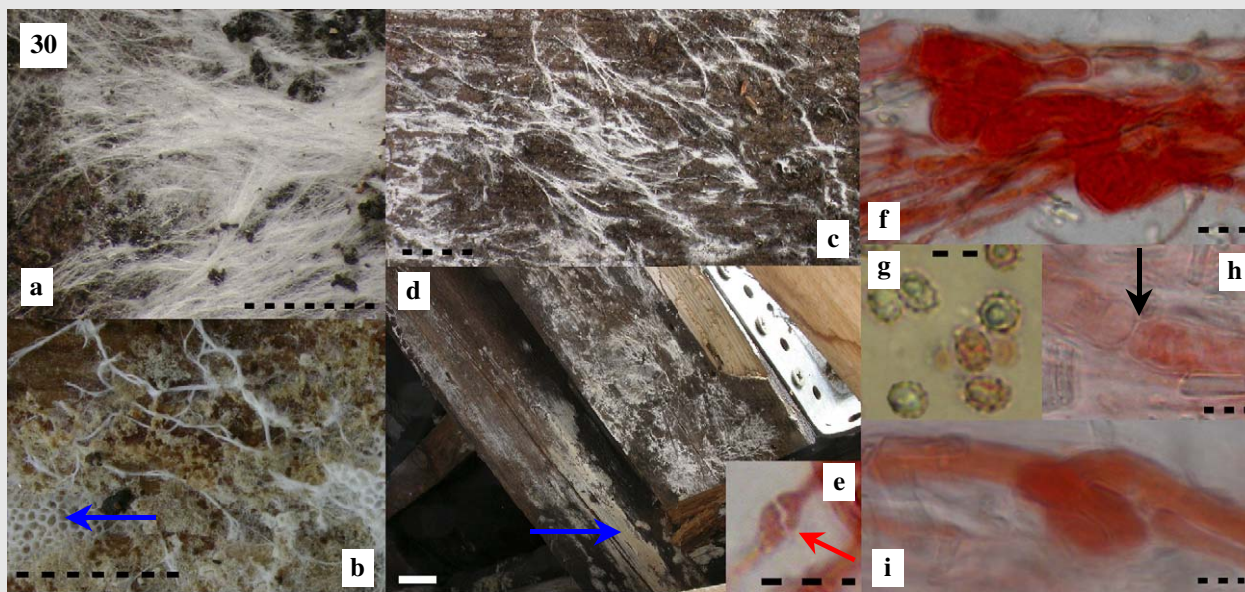


29* without astercystidia

30

30⁽²⁹⁾ generative hyphae with clamps (30e), partly with bubble-like swellings, 1-2 (-4) µm; no fibres (if fibres present, see 31); sometimes with vessels (then no swellings), small clamps, 4-9 (?) µm diam (30f, h-i); strands snow-white to cream, 0.2-1 mm diam, fragile (30a,d), often only short and near sporophores (30b, d blue arrow); fruit bodies resupinate, thin, poroid, grandinoid or smooth, fragile; spores warty, translucent and small, 4-5.5 × 3-4.5 µm (30g); so far only found directly on damp wood; white rot; genus *Trechispora* (species not distinguishable on the basis of strands/mycelia; in buildings *T. farinacea* and *T. mollusca*)

Trechispora spp.

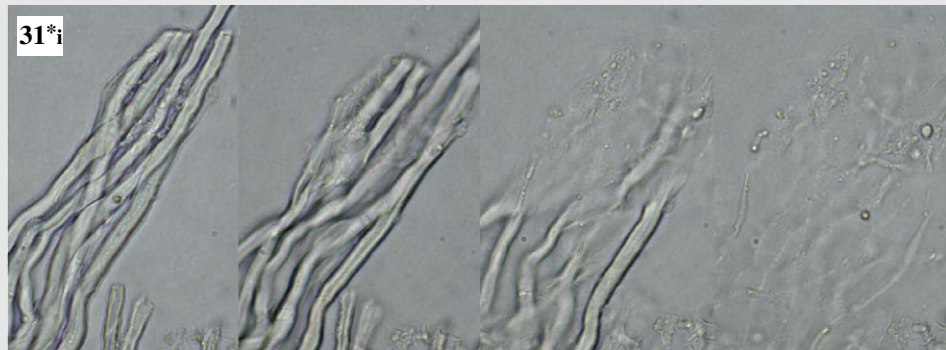


30* other characteristics

34

31⁽²⁸⁾ fibres insoluble in 5 % KOH, sometimes slightly swelling, partly under 3 µm diam; mycelium partly with brown crust

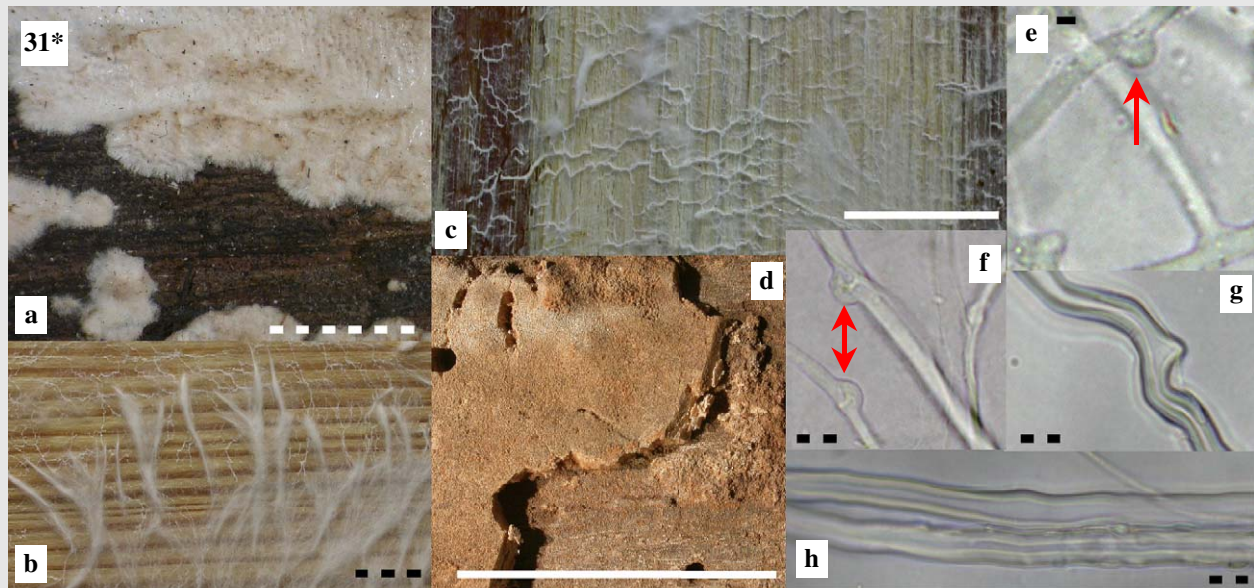
32



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Table 2 (continued)

31* fibres completely soluble in 5 % KOH, 2-4,5 (-8?) μm diam (31*i), thick-walled to solid ('filled'; 31*g-h), similar to *A. vaillantii* (14); no vessels; generative hyphae with few clamps (31*e-f red arrow), 1-2,5 μm diam; surface mycelium **without** crusts; usually meagre, partly forming compact plates (31*d), white to light-brown; strands white (31*b-c), partly somewhat yellowing (31*a), root-like, richly branched, radiate or ice flower-like, fibrous, up to 2 mm diam; mycelium so far only proven on wood; white rot *Diplomitoporus lindbladii*



32⁽³¹⁾ often lemon-shaped, hyaline, thick-walled arthroconidia, 5-7 \times 7-12 (-?) μm , in surface mycelium, which lies close to the wood, and in substrate mycelium (32a); fibres hyaline to brown (32e-f), to 2 μm diam, not very thick-walled and hardly separable from generative hyphae; generative hyphae hyaline, with clamps, these often difficult to find, 1-2 μm diam (32g, graphic); vessels not proven; strands usually absent or short and under mycelium (32k; laboratory culture); mycelium first white to cream, then yellowish, grey to brown (32d, i), when old often luxuriant, firm and tough, frequently with paper-like, firm, brown crust, predominantly in shakes and cavities, usually with amber guttation drops (32c blue arrow) or with brown to black spots (remainders of dried guttation; 32d black arrow), in constructions white to crème (32b); surface mycelium partly with distinct margin; sometimes with poroid fruit bodies within surface mycelium (1-90 mm thick), then also wider hyphae (32g); white rot, preferential sapwood decay, hardwoods and softwoods, no or only few growth on masonry *Donkioporia expansa*

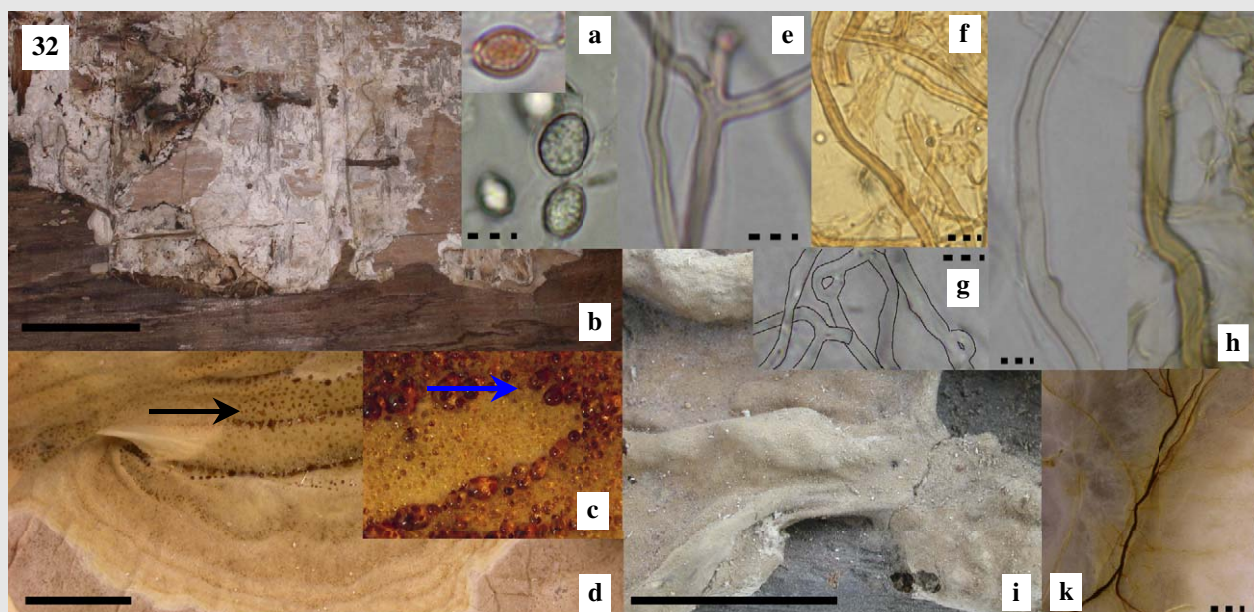


Table 2 (continued)

32* arthroconidia, strands or mycelia different

33

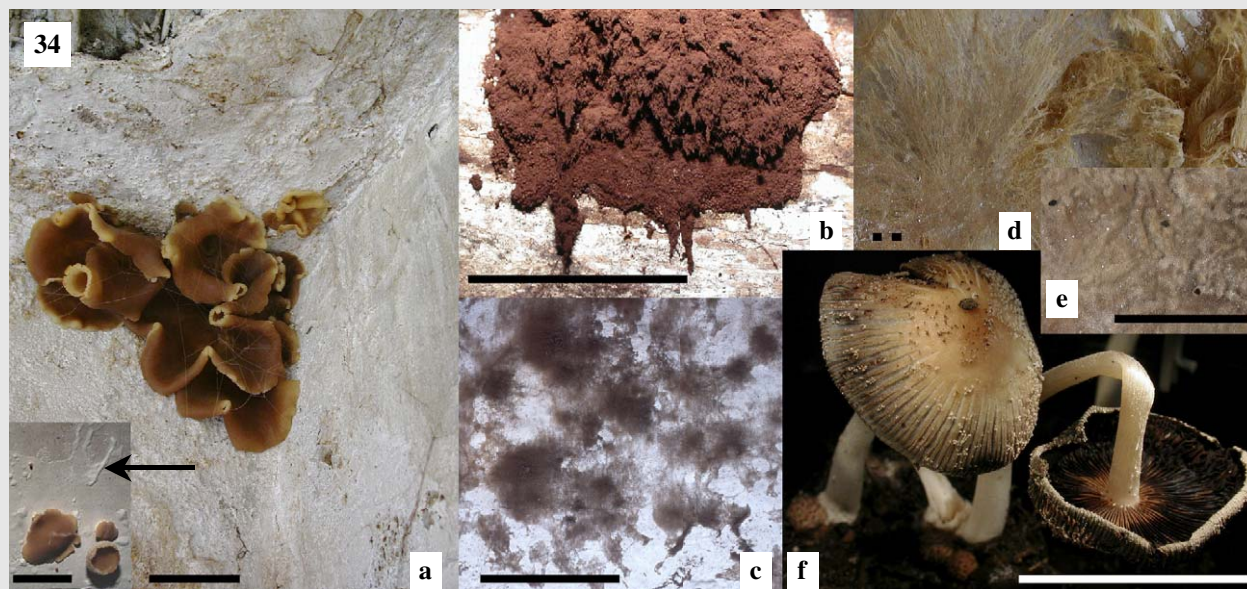
33⁽³²⁾ strands black, very clear, with separate crust layer, often also hollow when old (33), clearly thicker than 1 mm, only on wood with bark rests or in wood in the area of in-growing roots, examine for in-growing roots; hardwoods and softwoods; white rot rhizomorphs of *Armillaria* spp.

33* strands or mycelia different

34



34^(1,23,30,33) on masonry, rough-casting etc.; without or with only some wood decay: *Corpinus* spp. (34 d–g), *Peziza* spp. (34a, white strands black arrow), *Scutellinia* spp., *Pyronema* spp., moulds (e.g. *Cladosporium* spp. 34c) and slime fungi (*Reticularia lycoperdon* Bull. (34b, *Fuligo* spp., *Trichia* spp.)



34* on wood: further species, which so far were found rarely in buildings (e.g. *Daldinia* spp., *Fomitopsis* spp., *Phanerochaete* spp., *Pleurotus* spp., *Hyphodontia* spp., *Phlebiopsis* spp., *Polygaster* spp., *Trametes* spp.); rot nevertheless possible

Table 3 – Growth rate and reaction on temperature of some house-rot fungi (summarized from Huckfeldt 2003, Schmidt & Moreth 2003b, Schmidt et al. 2002a, b)

Group	Species	Number of investigated isolates	Growth rate on agar mm/day	Temperature °C				
				optimum on agar mm/day	maximum on agar in 2 weeks incubation °C	maximum on agar in short test °C (hours)	lethal on agar in 2 weeks incubation °C	lethal in 4 hours in slowly dried wood °C
Dry rot fungi	<i>Serpula lacrymans</i>	2	4.0–5.1	20.0	25.0	55 (1)	30.0	<50–70
	<i>Serpula Monokaryon</i>	4	2.1–2.2	19.0–20.0	28.0			
	<i>S. himantoides</i>	2	7.0–11.0	25.0–27.5	32.5		>35.0	65
	<i>Leucogyrophana mollusca</i>	6	1.0–3.3	25.0–27.5	32.5		30.0–>35.0	75
	<i>L. pinastri</i>	4	2.4–4.2	20.0–27.5	32.5		>35.0	
Cellar fungi	<i>Coniophora puteana</i>	27	2.5–11.3	22.5–25.0	27.5–>37.5	55 (3)	32.5–>37.5	70–75
	<i>C. marmorata</i>	2	9.7–12.3	20.0–27.5	25.0–>37.5		35.0–>37.5	
	<i>C. arida</i>	1	4.7	25.0	27.5		35.0	
	<i>C. olivacea</i>	5	3.7–9.0	22.5–25.0	32.5–35.0		35.0–>37.5	
		12	4.3–7.7	27.5–31.0	35.0	65 (3)	37.0–40.0	>80
House polypores	<i>Antrodia vaillantii</i>	4	4.0–8.0	25.0–30.0	35.0	65 (3)	37.0–42.5	
	<i>A. xantha</i>	3	5.5–8.2	27.5–30.0	35.0		40.0–42.5	
	<i>A. serialis</i>	3	3.5–3.9	22.5–25.0	32.5–35.0		37.5–42.5	
	<i>Oligoporus placenta</i>	4	4.2–9.8	25.0	35.0	65 (3)	40.0–45.0	>80
		5	3.8–5.5	25.0–27.5	37.5–42.5		40.0–42.5	>95
Gill polypores	<i>Gleophyllum abietinum</i>	4	6.8–8.3	27.5–32.5	≥45.0	60 (3)	≥45.0	>95
	<i>G. sepiarium</i>	5	7.1–9.1	30.0–37.5	≥45.0	80 (1)	≥45.0	>95
	<i>G. trabeum</i>	1	5.1	28.0	34.0		>40.0	>95
Oak polypore	<i>Donkioporia expansa</i>							

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