**Cortinarius hildegardiae** and *C. mariekristinae* spp. nov., two new species in the phlegmacioid clade Humolentes (sect. *Calochroi* s. l.)

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*Cortinarius hildegardiae* and *C. mariekristinae* are described as new to science. They are phlegmacioid species with more or less yellow pilei, yellow lamellae, and extractable, greenish yellow antraquinonic pigments. They belong to the Humolentes s. l. clade. *Cortinarius hildegardiae* resembles *C. humolens* and *C. osloensis*, but differs from the former in the more vivid greenish yellow pileus margin and veil remnants on bulb margin when young. It differs from its phylogenetic sister species *C. osloensis* by smaller spores and different habitat and distribution. *Cortinarius mariekristinae* occupies a sister position to *C. humolens*, but differs from this and the often co-occurring *C. osloensis* e.g. by the larger spores. Species descriptions are provided, with emphasis on micromorphological characters. Their phylogenies based on nrDNA ITS sequences are presented.

**Keywords**: taxonomy, species descriptions, European distribution, ITS phylogeny, spore morphology, 2 new taxa.

The present paper treats two new phlegmacioid species of *Cortinarius* (Pers.) Gray in the Calochroi clade with yellow antraquinonic pigments. The phlegmacioid species containing such pigments have traditionally been classified in sect. *Fulvi* M.M. Moser (see e.g. Brandrud et al. 1989–2018), here termed fulvoid species. However, according to phylogenetic studies (see e.g. Frøslev et al. 2007, Garnica et al. 2016), the fulvoid species do not form a monophyletic group, but are in a number of sub-clades intermixed within the large Calochroi clade, referable to section *Calochroi* M.M. Moser & Horak sensu Frøslev et al. (2005, 2007). This wide concept of sect. *Calochroi* is now applied by most authors (see e.g. Bellanger 2015, Garnica et al. 2016). The two new species treated here belong to the Humolentes (sub)clade, which is composed of both of fulvoid and non-fulvoid species.

The section *Calochroi* s. l. is a very large, but morphologically well delineated and phylogenetically distinct clade among the phlegmacioid taxa (see Garnica et al. 2003, 2005, 2009, 2016; Peintner et al. 2004; Frøslev et al. 2005, 2007). The species in sect. *Calochroi* s. l. (sensu Frøslev et al. 2005, 2007) can be distinguished from those in related groups by the combination of (i) basidiomata with abruptly bulbous stipes, (ii) simplex pileipellis consisting of a thick, strongly gelatinous, easily separable epicutis and (iii) amygdaloid–citriform spores with coarse, crust-like, almost net-like ornamentations (cf. Brandrud et al. 1989–2018). The Humolentes clade falls within this morphological framework, and with species that often have yellow-(ochre) colours, including pale (greenish) yellow to wax-yellow lamellae, a large marginated bulb, usually whitish context, often saffron-coloured spots following insect damages, negative microchemical KOH-reactions, and comparatively large spores, >10 µm long. Parts of the Humolentes clade as here applied were formerly referred to as Pseudoglaucopodes clade (Garnica et al. 2009, 2016).

**Material and methods**

**Morphological study**

A total of 24 collections of the two new species were examined in both fresh and dried condition, as well as a number of collections of the most similar and most closely related taxa of the Humolentes clade, e.g. *C. humolens*, *C. osloensis*, and *C. lavandu-
*Lochlochaenaceae*. Collections made by the first author (abbreviated TEB in the text) are deposited in the Botanical Museum of the University of Oslo (O). Materials collected by the second and third authors (abbreviated SSt and DB) are deposited in the Botanische Staatssammlung München (M) and in the Eötvös Loránd University, Budapest, Hungary (ELTE), respectively. Herbarium abbreviations follow Index Herbariorum (Thiers [continuously updated]).

The taxonomic descriptions are based on the material studied by the authors. The measurements of macromorphological characters are based on expanded, but never old (and then often aberrant) basidiomata. Macrochemical reagents applied were 2% and 40% KOH. The terminology of characters follows Brandrud et al. (1990, 2018a).

Microscopical structures were observed partly from fresh material mounted in H₂O, often with a drop of 40% KOH subsequently added, and partly from dried material mounted in H₂O and then KOH. Measurements and photographs of basidiospores were made in L4 solution according to Clémençon (Clémençon 1972, Erb & Matheis 1983). When impossible to obtain a sufficient quantity of spores from the stipe, the cortina or spore deposits on microscope slides, a spore preparation from the lamellae was examined. Since the deviations of values between these methods within the same collection were found to be insignificant, all measurements of each collection were combined.

Basidiospore measurements were made at 1000× magnification with a calibrated optical micrometer or on a flat screen with the program ProgRes CapturePro from Jenoptik. The measurements are based on at least 30 spores from each collection; numbers in square brackets refer (in this order) to the number of collections they originate from, the number of basidiomata and the number of spores measured, respectively. Spore measurements are given as follows: length range × width range. Q values were calculated as follows: Q = length divided by width. To exclude aberrant spores the given values in the text are based only on spores within the 95% confidence interval (Tab. 1).

The photo micrographs of the spores are created with the method of “focus-stacking” (Schmidt-Stohn 2011). About twenty to thirty shots with the Jenoptik ProgRes® C10 plus digital camera, each with different focus (each step ca. 0.2 µm), are combined to the final picture with the Helicon Focus 6.5 program. For the correction and the final arrangement of the spores on the plates Adobe Photoshop CS5 was used. In these pictures, each spore can reliably be identified with its individual pattern of ornamentation.

**Phylogenetic study**

DNA extraction, polymerase chain reaction (PCR) and sequencing procedures followed Brandrud et al. (2018b) and Holec et al. (2018). Primers ITS1F and ITS4 (White et al. 1990, Gardes & Bruns 1993) were used to amplify the ITS region of the ribosomal RNA gene. Newly generated sequences were combined with data from Freslev et al. (2007), Garnica et al. (2016) and other published sequences from GenBank, focusing on the Humolentes s.l. lineage within sect. *Calochroi* (Tab. 2). Sequences were aligned with the online version of MAFFT v. 7 using the E-INS-i algorithm (Katoh & Standley 2013). Alignment was checked and edited with SeaView 4 (Gouy et al. 2010). The phylogenetically informative indels of the ITS region were coded with FastGap 1.2 (Borchsenius 2009) following the simple indel coding algorithm (Simmons et al. 2001). The D1/D2 part of the LSU region was kept for those GenBank sequences, where it was available in order to improve the robustness of our phylogenetic analysis.

The final ITS+LSU comprised 34 samples of 1261 characters including gaps. Indels were coded as presence/absence data and used as separate partition (34 additional binary characters) in the phylogenetic analyses resulting in a final dataset of 1295 characters. The concatenated ITS+LSU+binary data set was subjected to Maximum Likelihood phylogenetic analyses in the raxmlGUI (Silvestro & Michalak 2012) implementation of RAXML (Stamatakis 2014) using the GTR+GAMMA substitution model for the nucleotide partitions and the default setting for binary (indel) data. Rapid bootstrap analysis with 2,000 replicates was applied for testing branch support. Bayesian inference (BI) analysis was performed with MrBayes 3.1.2 (Ronquist & Huelsenbeck 2003). The alignment was partitioned and the GTR + G model of evolution was applied for the ITS+LSU and the two-state Markov model for the indel characters. Four Markov chains and two independent runs were performed for 10,000,000 generations, sampling every 1,000 steps. Burn-in was set to 30%. From the post burn-in trees, 50% majority rule consensus tree and posterior probabilities (PP) were calculated. Tree topologies of both ML (Fig. 1) and BI analyses were checked visually and no incongruence was observed. Phylogenetic trees were edited in MEGA7 (Kumar et al. 2016) and Adobe Illustrator CS4.
Tab. 1. Spore dimensions of *Cortinarius hildegardiae* and *C. mariekristinae*.

<table>
<thead>
<tr>
<th>Species</th>
<th>n coll.</th>
<th>n spec.</th>
<th>n spores</th>
<th>LxW (all) + MV; µm</th>
<th>LxW 95 %-variation w/ MV; µm</th>
<th>Q L/W (all) + MV</th>
<th>Q L/W 95%-var. w/ MV</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>C. hildegardiae</em> SS14-207 (holotype)</td>
<td>1</td>
<td>1</td>
<td>55</td>
<td>9.5–10.6–12.2 × 5.3–5.8–6.5</td>
<td>9.6–10.6–11.7 × 5.3–5.8–6.3</td>
<td>1.65–1.84–2.10</td>
<td>1.65–1.84–2.06</td>
</tr>
<tr>
<td><em>C. hildegardiae</em> SS13-128</td>
<td>1</td>
<td>3</td>
<td>129</td>
<td>9.4–10.7–11.7 × 5.1–6.0–6.7</td>
<td>9.7–10.7–11.7 × 5.4–6.0–6.6</td>
<td>1.62–1.80–2.01</td>
<td>1.62–1.80–1.98</td>
</tr>
<tr>
<td><em>C. hildegardiae</em> SS13-218 / TEB932-13</td>
<td>1</td>
<td>1</td>
<td>50</td>
<td>9.6–10.4–11.1 × 4.9–5.4–5.9</td>
<td>9.6–10.4–11.1 × 5.0–5.4–5.8</td>
<td>1.69–1.93–2.12</td>
<td>1.72–1.93–2.12</td>
</tr>
<tr>
<td><em>C. hildegardiae</em> TEB743-12 / DB4804</td>
<td>1</td>
<td>2</td>
<td>41</td>
<td>10.3–11.2–12.4 × 6.0–6.6–7.1</td>
<td>10.2–11.2–12.2 × 6.2–6.6–7.0</td>
<td>1.49–1.70–1.87</td>
<td>1.54–1.70–1.86</td>
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<tr>
<td><em>C. hildegardiae</em> TEB929-17</td>
<td>1</td>
<td>2</td>
<td>64</td>
<td>8.1–10.0–11.1 × 5.4–6.0–6.7</td>
<td>8.9–10.0–11.1 × 5.5–6.0–6.7</td>
<td>1.40–1.66–1.89</td>
<td>1.44–1.66–1.88</td>
</tr>
<tr>
<td><em>C. hildegardiae</em> DB5620</td>
<td>1</td>
<td>2</td>
<td>71</td>
<td>8.4–9.7–10.6 × 5.0–5.8–6.5</td>
<td>8.7–9.7–10.7 × 5.2–5.8–6.4</td>
<td>1.42–1.66–1.88</td>
<td>1.44–1.66–1.88</td>
</tr>
<tr>
<td><em>C. hildegardiae</em> DB5996 / TEB751-15</td>
<td>1</td>
<td>1</td>
<td>31</td>
<td>9.8–10.7–11.6 × 5.8–6.2–6.9</td>
<td>9.8–10.7–11.5 × 5.7–6.2–6.8</td>
<td>1.54–1.71–1.87</td>
<td>1.54–1.71–1.89</td>
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<tr>
<td><em>C. hildegardiae</em> DB6615</td>
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<td>1</td>
<td>62</td>
<td>9.9–11.0–12.1 × 5.8–6.5–7.2</td>
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<td>1.51–1.70–1.93</td>
<td>1.52–1.70–1.88</td>
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<tr>
<td><em>C. hildegardiae</em> CR5822-2017</td>
<td>1</td>
<td>2</td>
<td>78</td>
<td>9.2–10.6–11.9 × 5.6–6.4–7.2</td>
<td>9.6–10.6–11.6 × 5.8–6.4–7.0</td>
<td>1.47–1.66–1.97</td>
<td>1.48–1.66–1.84</td>
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<tr>
<td></td>
<td>8</td>
<td>15</td>
<td>581</td>
<td>10.5 × 6.1</td>
<td>10.5–10.5–11.9 × 5.3–6.1–6.9</td>
<td>1.40–1.74–2.12</td>
<td>1.48–1.74–2.00</td>
</tr>
<tr>
<td><em>C. mariekristinae</em> TEB413-14 (holotype)</td>
<td>1</td>
<td>1</td>
<td>49</td>
<td>11.6–12.5–13.9 × 6.8–7.4–8.0</td>
<td>11.3–12.5–13.6 × 6.8–7.4–8.0</td>
<td>1.50–1.68–1.86</td>
<td>1.50–1.68–1.86</td>
</tr>
<tr>
<td><em>C. mariekristinae</em> TEB261-14 / DB5377</td>
<td>1</td>
<td>1</td>
<td>30</td>
<td>11.8–12.8–14.0 × 7.0–7.7–8.6</td>
<td>11.6–12.8–14.0 × 6.9–7.7–8.4</td>
<td>1.56–1.67–1.76</td>
<td>1.55–1.67–1.79</td>
</tr>
<tr>
<td><em>C. mariekristinae</em> TEB379-15 / DB5771</td>
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<td>1</td>
<td>30</td>
<td>11.3–12.5–13.3 × 7.0–7.5–7.9</td>
<td>11.7–12.5–13.4 × 7.1–7.5–7.9</td>
<td>1.52–1.68–1.82</td>
<td>1.54–1.68–1.82</td>
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<tr>
<td><em>C. mariekristinae</em> TEB539-15</td>
<td>1</td>
<td>1</td>
<td>50</td>
<td>11.6–12.6–13.5 × 6.9–7.6–8.0</td>
<td>11.7–12.6–13.6 × 7.1–7.6–8.0</td>
<td>1.50–1.67–1.83</td>
<td>1.53–1.67–1.81</td>
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<tr>
<td><em>C. mariekristinae</em> TEB347-17</td>
<td>1</td>
<td>1</td>
<td>38</td>
<td>11.2–12.7–13.8 × 7.0–7.5–8.5</td>
<td>11.5–12.7–13.9 × 6.9–7.5–8.2</td>
<td>1.44–1.69–1.93</td>
<td>1.50–1.69–1.88</td>
</tr>
<tr>
<td><em>C. mariekristinae</em> TEB439-17</td>
<td>1</td>
<td>1</td>
<td>40</td>
<td>11.5–13.0–14.0 × 6.8–7.5–8.3</td>
<td>11.7–13.0–14.3 × 6.6–7.5–8.4</td>
<td>1.50–1.73–1.97</td>
<td>1.47–1.73–2.00</td>
</tr>
<tr>
<td><em>C. mariekristinae</em> TEB502-17</td>
<td>1</td>
<td>1</td>
<td>31</td>
<td>10.8–12.0–13.2 × 7.2–7.7–8.3</td>
<td>10.9–12.0–13.1 × 7.1–7.7–8.2</td>
<td>1.43–1.55–1.72</td>
<td>1.41–1.55–1.69</td>
</tr>
<tr>
<td><em>C. mariekristinae</em> GS19-10-2012</td>
<td>1</td>
<td>3</td>
<td>96</td>
<td>11.3–12.9–15.6 × 6.6–7.5–8.4</td>
<td>11.5–12.9–14.3 × 6.9–7.5–8.1</td>
<td>1.55–1.73–1.93</td>
<td>1.57–1.73–1.89</td>
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<tr>
<td></td>
<td>8</td>
<td>10</td>
<td>364</td>
<td>12.7 × 7.5</td>
<td>10.8–12.7–15.6 × 6.6–7.5–8.6</td>
<td>11.5–12.7–13.9 × 6.9–7.5–8.1</td>
<td>1.43–1.69–1.97</td>
</tr>
</tbody>
</table>

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Results and discussion

Phylogeny

Both ML and BI analyses, applying ITS and LSU as molecular markers, recovered the two new species with maximum support (100/1.00) within the Humolentes s.l. clade. The intraspecific variability in the ITS region is low in *C. hildegardiae* (maximum of 2 nucleotides), and zero in *C. mariekristinae*. Both new species have a clear bar-coding gap (ca. 3% dissimilarity) towards the closest species in our phylogeny. *Cortinarius hildegardiae* is a well-supported (96/1.00) sister species to *C. osloensis*, while *C. mariekristinae* is sister to...
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Fig. 1. Phylogenetic relationship of the *Humolentes* s.l. clade based on maximum likelihood analysis of nrDNA ITS and LSU sequences with coded gaps as additional source of information. Maximum likelihood bootstrap support values and Bayesian posterior probabilities given at branches. GenBank numbers given only for sequences taken from public databases. For newly generated sequences specimen vouchers given. Holotype sequences of the two new species highlighted in boldface. Bar indicating 0.01 expected change per site per branch.

*C. humolens* but the relationship was weakly supported (57/0.75).

The *Humolentes* clade (*Humolentes* s.l.) as here applied, consists of three well-supported lineages; the *C. humolens* lineage (incl. *C. mariekristinae*), the *C. osloensis* lineage (incl. *C. hildegardiae*) and the *C. saporatus-C. caroviolaceus* lineage. The two former lineages consist of morphologically very similar, mainly fulvoid taxa, but according to present molecular data do not form a monophyletic group. The *C. humolens* lineage/subclade was formerly named as Pseudoglaucopus clade by Garnica et al. (2009, 2016). However, since most of the species in this lineage/subclade as well as the three lineages taken together (clade *Humolentes* s. l.) possess yellow colours and anthraquinonic pigments, we find the name ‘*Humolentes* clade’ more informative, referring to a representative and rather frequent, yellow species with anthraquinonic pigments (*C. pseudoglaucopus* lacks these yellow pigments).

**Taxonomy**

*Cortinarius hildegardiae* Schmidt-Stohn, Brandrud & Dima, spec. nov. – Figs. 2–5, 10

MycoBank no.: MB 830268

Etymology. – In honour of Hildegard Badekow-Schmidt-Stohn, the wife of the second author of the paper.

**Description.** – *Pileus* 4–12 cm, (hemi-) spherical, then plano-convex, glutinous, glabrous; incurved margin with small drop-like spots or not; sometimes innately fibrillose from darker, radial fibrils, sometimes also with dark brown stripes due to apressed grass/moss remnants; margin or sometimes entire pileus when young pale ochre yellow with an initial distinct greenish yellow-lemon yellow tinge, centre becoming (spotwise) discoloured ochre brown or more reddish brown with age due to oxidation (resembling *C. sulfurinus*, *C. quercilicis*), often distinctly bicoloured, sometimes persistently uni-coloured ochre yellow, when sheltered under leaves or a moss carpet; becoming more or less saffron brown tinged where eaten by snails. Universal veil remnants indistinct to rather abundant, and then leaving whitish, large patches at pileus centre. – *Lamellae* crowded (*L* = 70–100), 4–10 mm broad, pale greenish (-greyish) yellow, straw yellow to wax yellow; then ochraceous brown with an olivaceous tinge; edge often slightly to distinctly crenulate. – *Stipe* 4–8 x 1–2(2.5) cm, with an often large, marginate bulb (up to 4 cm wide), greyish white (to yellowish white) when young, then whitish, with age tinged ochre yellow from base upwards. Universal veil on the bulb when young distinct to abundant and volva-like, slightly viscid, distinctly greenish yellowish (contrasting with the whitish stipe above and the pure white mycelium below), with age slightly brownish. Cortina fairly abundant, whitish. Basal mycelium white, with whitish to yellow mycelial strands. – Context whitish, when young with watery greyish or yellowish grey tinged hygrophanous spots in stipe apex, rarely faintly bluish tinged. Outside and inside of bulb sometimes becoming saffron yellow spotted (especially where eaten), sometimes more brown-spotted. Smell weak, indistinct when cut, but distinctly earthy or dust-like on the lamellae. – Macromorphological reactions 2 % and 40 % KOH negative (pale brownish) in context. – Exsiccata ochre brown. – Extractable pigments not studied, but pigment topology, colours and oxidation behaviour clearly indicate presence of the same pigment as in the sister species *C. osloensis*; the greenish yellow flavomannin-6,6',8-trimethylether (FTM).

**Basidiospores** [9, 15, 58], 9.1–11.9 x 5.3–6.9 µm (*MV* = 10.5 x 6.1 µm), *Q* = 1.48–2.00 (*MV* = 1.74), amygdaloid-citiform, more or less strongly and coarsely net-like verrucose, warts more or less prominent, distinctly to hardly visible in the outline of the spores, suprahilar plaque more or less distinct, apiculus rather smooth. – *Basidia* 9–11 µm wide, 4-spored, some with yellowish content. – Lamella edge more or less fertile. – Lamella trama of 4–20 µm wide, mainly hyaline hyphae. – Universal veil out of 3–8(10) µm wide hyphae, mainly hyaline, some with intracellular, yellow (brown) granules or lumps. – Pileipellis simplex, a cutis of 2–5 µm wide, loosely erect-entangled hyphae, gelatinous at surface, mainly hyaline, the basal part of cutis out of 4–7(9) µm wide hyphae, partly in subparallel, interconnected bundles; pigment mainly intracellular, initially pale (greenish) yellow, then yellow brown, granular, with KOH oleiferous; pigment from exsiccata usually yellowish brown with KOH. – Trama beneath pileipellis hyaline.

**Habitat.** – In calcareous or base-rich frondose forests, mainly associated with *Quercus* spp.; in *Q. ilex* forests, *Q. pubescens-Q. cerris* forests, mixed *Q. robur-Fagus sylvatica* forest (the type locality being a park) but also more or less calcareous *F. sylvatica* forests, once also in a *Tilia platyphyllos* stand with *Q. pyrenaica* along river. Also recorded in montane conifer forests under *Abies alba* in shallow, strict calcareous soil on mossy ground; found mainly in *Phlegmacium*-rich sites.

**Distribution.** – Widespread in European Mediterranean-nemoral-montane regions, but extremely rare. So far only known from two sites in Germany, Italy, Hungary, France and one site in Switzerland and Spain. Present records are restricted to SW, W and C European regions with calcareous *Quercus-Fagus* and *Abies* forests, but the species probably follows such habitats also further east, e.g. in the little investigated Carpathians-Balkan mountains and the Caucasus.

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such as mellae that can be confused with young. Usually has some lilac tinges on lamellae when vandulochlorus of these are easily separated by the much larger spores tinges or spots on pileus apex. Microscopically, Furthermore, the latter has more frequently bluish becomes more brownish oxidized (often bicoloured). greenish yellow on pileus (margin) when young, and cally, but the former is on average slightly more nae bulb margin. There is an earthy-raphanoid smell, and a negative KOH-reaction. Phylogenetically, the species comes it has an earthy-raphanoid smell, and a negative KOH-reaction. Phylogenetically, the species comes very close to C. osloensis, but differs (i) in more vivid greenish yellow tinges on pileus margin and veil at bulb margin when young, (ii) darker brown discoulouration of pileus with age and exposure (iii) smaller spores and (iv) habitat (C. osloensis is only found in calcareous Tilia cordata forests). Although more distant phylogenetically (see Fig. 1), the species might also look very similar to C. humolens Brandrud, which has very similar spores, and may co-occur in the same habitat. However, when young, C. hildegardiae is distinguished by the pure greenish yellow to lemon yellow tinges on the pileus and bulb margin. Cortinarius humolens has a more greyish-green to greyish-olivaceous tinge when young. Cortinarius hildegardiae and C. mariekristinae are often difficult to distinguish macroscopically, but the former is on average slightly more greenish yellow on pileus (margin) when young, and becomes more brownish oxidized (often bicoloured). Furthermore, the latter has more frequently bluish tinges or spots on pileus apex. Microscopically, these are easily separated by the much larger spores of C. mariekristinae (see below). The related C. lavandulochlorus Eyssart. may also resemble it, but usually has some lilac tinges on lamellae when young.

There are a number of fulvoid species with greenish yellow colours on the pileus, veil and lamellae that can be confused with C. hildegardiae; such as C. citrinus J.E. Lange ex P.D. Orton and C. splendens Rob. Henry, or the taxa in the Elegantiores and Sulfurini clades. However, these species are normally more vividly coloured, with yellow pigments also in (parts of) the context, and usually some reddish KOH reaction in coloured parts of the basidiomes or on basal mycelium (in the Sulfurini clade).

The greenish yellow pigment found in C. hildegardiae is extractable, and according to microtopology and oxidation behaviour (hardly changing colour with age or with KOH), this is very probably the same, anthraquinonoid pigment (flavomannin-trimethyl ether) as found in other, yellow-gilled taxa in Humolentes. This is the most highly methylated, most stable, non-oxidized, flavomannin-pigment found in phlegmacioi cortinarii. Cortinarius hildegardiae seems to occupy mainly two kinds of habitats; thermophilous, calcareous Mediterranean to southern hemispheral Quercus-Fagus forests, and montane, strongly calcareous Abies forests. The Abies-associated variant seems to have slightly larger spores than the thermophilous Quercus-Fagus forest variant. The four measured collections of the Abies variant has an average spore size of 10.9 × 6.6 µm, whereas the specimens from the Quercus variant have MV = 10.3 × 6.0 µm. The Abies-associated variant apparently also shows a subtle differentiation in ITS-phylogeny (one nucleotide; Fig. 1). More material is needed to see if this morphological and phylogenetic differentiation is constant. A similar kind of habitat differentiation is seen in other phlegmacioi taxa, such as C. dibaphus and C. olidoamarus. Also C. subgracilis has a similar kind of habitat preferences, and in this case, a morphological difference between Abies and southern Quercus variants is noted (Brandrud et al. 2018a).

Cortinarius mariekristinae Brandrud & Dima, spec. nov. – Figs. 6–9, 11

Etymology. – Dedicated to Marie Kristine Brandrud, the daughter of the first author of the paper.


Description. – Pileus 4–9 cm, (hemispherical), then plano-convex, glutinous, glabrous, incurved margin with or without small drop-like spots; outer half pale ochre yellow with an initial distinct greenish yellow-lemon yellow tinge (at least margin), central pale ochre brown, with age pale ochre yellow with ochraceous brown cen-
Fig. 10. Basidiospores of *Cortinarius hildegardiae*. Voucher numbers of the examined collections indicated below each series of photos.
tre; becoming more or less saffron brown tinged where snail eaten. Universal veil remnants sparse and indistinct or sometimes leaving pale ochraceous appressed scales at pileus centre. – Lamellae crowded (L = 60–90), 3–8 mm broad, pale (greenish/greyish) yellow, straw yellow to wax yellow, soon ochraceous brown with an olivaceous tinge; edge crenulate. – Stipe 4–7 × 0.8–1.5 cm, with a marginate bulb (up to 3.5 cm wide), bulb often rather sharply margined, flattened; often greyish white when young, faintly to distinctly greyish blue (-lilac) at apex, soon entire greyish white, but sometimes with persistent lilac blue spots. Universal veil on the bulb margin sparse to distinct, slightly viscid, when young distinctly greenish yellowish (contrasting the whitish stipe above and the pure white mycelium below), with age more indistinctly whitish to pale ochraceous brown. Cortina fairly abundant, whitish. Basal mycelium white, a few pale greenish yellow mycelial strands observed. – Context whitish, when young with watery greyish hygrophanous spots in stipe (apex), apex also with lilac bluish spots. Bulb inside and outside often with pronounced saffron yellow spots, especially where eaten. Smell distinctly to strongly earthy, raphanoid, especially from the spots, especially where eaten. Smell distinctly to strongly earthy, raphanoid, especially from the spots, especially where eaten.

Habitat. – In calcareous Tilia cordata (–Corylus avellana) forests, mainly in thin soil on limestone benches or in gravelly scree soil.

Distribution. – Mainly known from SE Norway from the Oslofjord region (7 localities) and from one locality in Germany, Rhein valley (see Gminder & Saar 2013 and Saar & Schmidt Stohn 2018).


Comments. – All ITS sequences are identical, no intraspecific variability was detected. The closest relative of C. mariekristinae is C. humolens differing by 13–18 substitution and indel positions (97.86–97.04 % similarity).

Cortinarius mariekristinae is characterized by the combination of initially greenish yellow pileus (margin), lamellae and veil, lilac bluish spots at stipe apex and remarkably large spores. The large spores distinguish it from all similar taxa. The species is macromorphologically very similar to the co-occurring C. osloensis, but can be distinguished by the more vivid greenish yellow veil and pileus margin when young and the often lilac bluish tinges at stipe apex, apart from the larger spores. The very dark spore powder sticking to the abundant cortina remnants on stipe surface gives this a superficial resemblance to the also co-occurring C. caesiocortinatus. However, the latter has more or less subglobose spores and never yellowish tinges on the lamellae.

Phylogenetically, C. mariekristinae is the sister species of C. humolens, but differs from it in the initially pure greenish yellow veil and pileus margin, the (much) larger spores and a different habitat. Macroscopically, this in fact looks most similar to C. hildegardeae, but has on average a paler, less oxi-

Brandrud et al.: Cortinarius hildegardiae and C. mariekristinae, spp. nov.
Fig. 11. Basidiospores of *Cortinarius mariekristinae*. Voucher numbers of the examined collections indicated below each series of photos.
dized pileus centre when mature, and furthermore, *C. hildegardeiae* only exceptionally shows bluish tinges on the stipe.

*Cortinarius mariekristinae* is apparently a very rare species, with its major populations in the calcareous *Tilia* forests of the Oslofjord-Mjøsa region of SE Norway. Even though we have been studying the Humolentes group in many parts of Europe including extensive sequencing, we have only been able to document this one from a single site outside SE Norway; at the foothills of the Rhein valley (Gminder & Saar 2013, as *C. osloensis*, Saar & Schmidt-Stohn 2018, as *C. sp.*). The species shares this mainly Oslofjord *Tilia cordata* forest distribution with the related *C. osloensis*. Based on a recent finding, *C. osloensis* is now also confirmed from a single site outside SE Norway (calcareous *Tilia cordata* forest in Hungary, see Fig. 1, Tab. 2). Other species such as *C. tiliae* are also mainly confined to the old, relicual *Tilia* forests of SE Norway. We believe that these more or less *Tilia*-associated calciphilous taxa formerly had a much wider distribution in Europe when *Tilia* forests were abundant after the ice-age. In conjunction with the subsequent decline of these *Tilia* forests and expansion of other forest-forming trees on limestone, such as *Fagus sylvatica* and *Carpinus betulus*, these *Tilia* associated species apparently have disappeared from most areas, and are now confined to smaller, calcareous relics. Some of these relics are present mainly in SE Norway but also elsewhere, e.g. in the Czech Republic (Chytrý & Sádlo 1997), and both *C. mariekristinae* and *C. osloensis* should be searched for there.

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