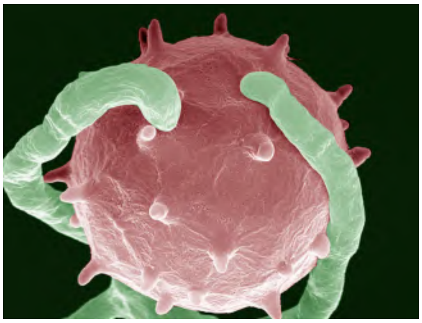
AGARICA

Mykologisk tidsskrift utgitt av Norges sopp- og nyttevekstforbund

2015 vol. 36



AGARICA

Mykologisk tidskrift utgitt av Norges sopp- og nyttevekstforbund.
A mycological journal published by Agariplantus norvegicus.

Tidsskriftet AGARICA publiserer originalartikler med hovedfokus på mykofloristikk og taksonomi og tar dessuten sikte på å formidle god populærvitenskap. Ulike typer manuskript mottas, herunder regulære artikler, mindre kommentarer (notes), oversiktsartikler (reviews) eller populariserte utgaver av mer omfattende forskningsartikler. AGARICA publiserer norsk-, svensk-, dansk-, og engelskspråklige bidrag. Tidsskriftet har fagfellevurdering og artiklenes endelige utforming gjøres i samarbeid mellom forfatter og redaksjonen. I utgangspunktet utkommer et årlig nummer av AGARICA (men ved større tilstrømming av artikler utkommer to).

Ønsker du å abonnere på AGARICA gå til hjemmesiden til Norges sopp- og nyttevekstforbund eller direkte til http//www.Agarica.no.

Norges sopp- og nyttvekstforbund
Fredrik A. Dahls vei 20, 1430 Ås
www.soppognyttevekster.no
E-post: post@soppognyttevekster.no

Forsidebilde: For fotokreditt se figur i artikkelen til Brandrud et al.

I venstre kolonne denne siden fra toppen:

An ornamented oogonium of *Pythium anandrum.* Photo: N. E. Nagy and I. Børja.

Entoloma fulvoviolaceum. Photos: J. Vauras.

Ascosporer av *Vialea insculpta*. Photo: B. Nordén.

Ramaria rubripermanens. Photo: K. Bendiksen.

Kjære leser

Vi i redaksjonen i Agarica er glade fordi det er så mange som bidrar med manus. I denne utgaven av Agarica kan man stifte nærmere bekjentskap med *Pythium*, nærmere bestemt sykdomstilfeller i granplanter som er forårsaket av *Pythium undulatum* og patogenitet *in vitro* til norske isolater av *P. undulatum* og *P. anandrum.* Vi er også stolte over å kunne presentere en artikkel med tre slørsopparter nye for vitenskapen. I tillegg har vi en imponerende mengde med arter nye for Norge. Grupper som får spesiell fokus i denne utgaven av Agarica er Ramaria-komplekset, Callistosporium, telamonioide Cortinarius ophiostomatoide sopper og Sordariomycetes. Sistnevnte kommer også med en omfattende sjekkliste. I tillegg til fagartiklene har vi en bokanmeldelse av en finsk bok 'Sopp og naturverdier i ulike skogbiotoper'.

Artikkelen med nybeskrivelser av de telamonioide Cortinarius-artene, og sjekklisten over norske Sordariomycetes legges på Agarica sin nettside parallelt med at papirutgaven trykkes.

Siden Agarica startet opp igjen i 2006 har Gro Gulden vært et viktig medlem av redaksjonen. Hun har også vært redaktør. Å ha Gro med på laget er en stor styrke for redaksjonen fordi hun er svært kunnskapsrik, effektiv og strukturert. Hun er alltid positiv og villig til å stille opp og det er en stor glede å få samarbeide med henne. I dette nummeret av Agarica gir Klaus Høiland sin personlige gjennomgang av noen høydepunkter gjennom Gro's innholdsrike mykologiske karriere.

Anders K. Wollan og Gry Alfredsen

Redaktører

Dear reader

The editorial board of Agarica are happy due to the fact that so many authors contribute with manuscripts to this journal. In this volume of Agarica you will learn to know more about *Pythium,* more specifically about disease in Norway spruce (*Picea abies*) seedlings caused by *Pythium undulatum*, and pathogenicity *in vitro* of Norwegian isolates of *P. undulatum* and *P. anandrum*. We are also proud to present a paper with three *Cortinarius* species new to science. In addition we have an impressive contribution of species new for Norway. Taxonomical groups that get special focus in this volume of Agarica are; the *Ramaria* complex, Callistosporium, the telamonioid *Cortinarius* taxa, ophiostomatoid fungi, and Sordariomycetes. The latter also include a comprehensive check list. In addition to the scientific papers we present a review of a Finish book about fungi and nature qualities in different forest habitats.

The paper with description of new telamonioid *Cortinarius* species, and the check list of Norwegian Sordariomycetes will be made available on the Agarica web page parallel with printing of Agarica volume 36.

Since 2006 Gro Gulden has been an important member of the editorial board of Agarica, and she has also been the editor. To have Gro on our team in the editorial board is a great advantage because she is very knowledgeable, efficient and organised. Gro is always positive and willing to help out, and it is a great pleasure to work with her. In this volume Klaus Høiland gives his personal review of some of the highlights in Gro's comprehensive mycological career.

Anders K. Wollan og Gry Alfredsen

Editors

Gro Gulden 75 år

Et våkent øye for soppene og soppsaken, skrev jeg den gang Gro fylte 60. Det kan vi fortsatt trygt skrive. I fjor (2014) sto hun på barrikadene for soppkontrollen. Poenget er at Staten har sluttet å gi økonomisk støtte til offentlige soppkontroller. Etter å ha holdt det gående på frivillig basis, sa Norges sopp- og nyttevekstforbund stopp! Forbundets soppkontroller opphørte i 2015. Gro skrev flere lesverdige kronikker og innlegg i avisene, f.eks. i Dagsavisen. Det er å håpe at de bevilgende myndigheter leser disse. Det står jo faktisk om liv og død!

Gro ved statuen av Anne Stine og Helge Ingstad, L'Ance aux Meadows, Newfoundland Foto: J.-O. Aarnæs.

Det var med musseronger at Gro startet sin vitenskapelige karriere. Hennes hovedfagsoppgave til cand. real. handlet om musseronger i videste forstand. Veileder var professor Finn-Egil Eckblad. Oppgaven omfattet ikke bare de «ekte» mykorrhizadannende musserongene *Tricholoma*, men også alle de saprotrofe slektene som tidligere ble regnet inn i slekta: ridderhatter *Lepista*, fagerhatter *Calocybe*, stubbemusseronger *Tricholomopsis*, munkehatter *Melanoleuca* osv. Kort sagt «musseronger» slik de framsto i Bøhmes gamle soppbøker. Oppgaven som ble belønnet med «blank stolpe» (karakteren 1,0) resulterte i «Musserongflora» utgitt på Universitetsforlaget. Ei bok jeg tok med meg i skog og mark, og som nå bærer preg av akkurat dette.

I 1967 ble hun ansatt som konservator for Soppherbariet ved Botanisk museum (nå del av Naturhistorisk museum). I 2001 ble hun utnevnt som professor. Gro gikk av i 2006 og er nå professor emeritus. Hennes innsats i Soppherbariet har satt spor etter seg! Hun var selv en flittig samler, særlig av hattsopper, men mye av arbeidet besto i å ta seg av alle soppene som studenter, amatører og andre soppinteresserte hadde samlet i felt. Disse måtte jo kontrollbestemmes, og det lille kontoret hennes fløt nær sagt over av bestemmelseslitteratur når det var som mest hektisk. Mang en gang satt hun med et par sopper på bordet, den ene hånda i telefonrøret, den andre på ei bok og med hodet plantet i mikroskopet. Da var det bare å smøre seg med tålmodighet. Som deltaker i ulike komiteer for mykologiske kongresser, symposier og kurs er hun uunnværlig, ikke minst fordi hun også har god praktisk teft, f.eks. hvor vi skal ha ekskursjonene og løsninger på diverse logistiske utfordringer. Hennes store kunnskaper om sopp har dessuten vært til nytte da hun var med på å initiere de omfattende verkene «Nordic Macromycetes» og oppfølgeren «Funga Nordica» (to utgaver) i samarbeid med andre ledende nordiske mykologer. Hun har også skrevet noen av nøklene som eneforfatter eller sammen med andre, f.eks. *Strobilurus* og *Lepista*. Disse verkene er et «must» for alle som jobber med mykologi enten det er i felt eller ved skrivebordet.

Gros interesser omfatter mange soppgrupper, f.eks. konglehatter *Strobilurus*, topphatter *Phaeocollybia*, klokkehatter *Galerina*, piggsopper. Men vel så mye dreier forskningen hennes seg om tematiske ting innen soppverdenen: sopp i fjellet og i Arktis, fylogeni hos brunsporete slekter ved hjelp av DNA, og undersøkelser av sopp og forsuring.

Hennes innsats for arktisk-alpine sopp er velkjent, ikke minst internasjonalt. Hun er spesielt aktiv i ISAM (International Symposium on Arctic and Alpine Mycology), som omfatter mykologer fra hele verden. I 2005 ledet hun ISAM-symposiet på Finse alpine forskningssenter. Hun har vært drivkraften i utgivelsen av serien «Arctic and Alpine Fungi», et standardverk som brukes når vi skal arbeide med sopp i fjellet og Arktis. Svalbard har mer og mer blitt hennes «jaktmark», og her har hun studert sopp siden begynnelsen av 80-åra og helt til i år (2015). Et av resultatene er «Svalbards sopper», ei populærbok over de viktigste artene vi kan finne på denne øygruppa. Jeg glemmer aldri da Gro og jeg, sammen med et par andre gode kollegaer, reiste til Longyearbyen vinteren 2011 for å skrive denne boka. Det ble en minneverdig og effektiv arbeidsøkt i polarmørket.

Gro har også engasjert seg i problemstillingen omkring mykorrhiza, og sopp og forsuring. På 80-tallet var hun med på et fellesprosjekt med norske og tyske mykologer i undersøkelsesområder i Schwarzwald, Aust-Agder og Nord-Trøndelag. Vi fant forskjeller i forekomstene av sopp, men om disse kan tilskrives forurensningene får bli ettertidas dom.

For soppsaken er, som nevnt, Gros innsats fantastisk. Nå er hun engasjert i soppkontrollens skjebne og utdanningen av soppkontrollører. Hun deltar, sammen med bl.a. meg, i «Fagmykologisk råd» under Norges sopp- og nyttevekstforbund. Men hennes innsats strekker seg helt tilbake til starten med hovedoppgaven om musserongene. Hun har skrevet og oversatt flere soppbøker, og til og med laget ei morsom soppbok for barn. Som soppentusiast har hun den gode egenskapen at hun kan fordype seg i både strengt vitenskapelige problemstillinger og svare på de mest trivielle spørsmål fra publikum. Typisk situasjon fra kontoret til Gro: Midt under en dypsindig diskusjon med meg om de cystidekarakterene som atskiller *Galerina marginata* fra *G. stylifera* ringte telefonen der hun villig svarte fru Hvermannsen at vi må skjære av alt som er mørkt på matblekksoppen før den tilberedes. Gro er befriende ujålet samtidig som hun kan sitt fag på topp-nivå og klart sier i fra om noen forsøker å ta vitenskapelige snarveier. Sammen med Trond Schumacher skrev hun i 1977«Giftsopper og soppforgiftninger» på Universitetsforlaget. Et populærvitenskapelig nybrottsarbeid på norsk – utsolgt i dag, men meget etterspurt fremdeles.

I begynnelsen av 70-åra fikk jeg Gro som veileder på oppgaven «Storsopper på maritime sanddyner på Lista, Vest-Agder». Sopp på sanddyner sto oppført i en oversikt over mulige hovedfagsoppgaver. Denne fristet meg, særlig fordi jeg ferierte på Lista og kjente sanddynelandskapet godt. Dette ble en i høy grad minnerik tid. Både feltarbeidet på sanddynene og alle de merkelige og spesialtilpassete soppene var så fascinerende at oppgaven svulmet opp til to bindsterke verk med diverse tillegg (som sikkert burde ha vært kortet til under halvparten). Diverse verk om trevlesopper, reddiksopper og slørsopper på fransk og tysk ble lest under Gros kyndige veiledning. Ja, selv avhandlinger på klingende polsk og tsjekkisk ble studert. Og seinere har jeg aldri sluppet tak i sanddynesoppene på Lista. Deres liv som mykorrhizapartnere eller hekseringdannere har jeg fortsatt å studere ved bruk av ulike molekylære metoder. Og dette takket være at Gro er en så inspirerende og oppmuntrende veileder og kollega!

Ikke å forglemme alle de flotte turene, feltkursene, utstillingene og kontrollene jeg har hatt og har sammen med Gro. Den beste måten å lære sopp på er å se soppene ute, eller i det minste friske på utstilling. Gros pedagogiske evne til å påpeke viktige kjennetegn og økologiske sammenhenger har inspirert mang en vordende mykolog. Vi har ikke tall på alle de publikumsaktivitetene Gro har deltatt på: turer, kontroller, foredrag, kurs. Alltid like entusiastisk, uansett hvor mange slitte kremler og anonyme slørsopper folk kommer trekkende med.

Gro er fra Drammen, og de siste åra har vi hatt som tradisjon å gå tur om våren i Bragernesåsen, med lunsj i Åspaviljongen og middag i hennes hyggelige leilighet på toppen av en av blokkene på Strøtvedt. Den artsrike floraen blir grundig studert på turene, ofte sammen med lokale botanikere. Min mor (Randi), som også var drammenser, og jeg hadde opprinnelig denne tradisjonen, men da Gro flyttet tilbake til Drammen rundt 2000, ble hun med på turene våre. Mor syntes dette var veldig hyggelig og så fram til drammensturene med Gro.

På en av Gros tidligere åremålsdager, det må ha vært i 1974, reiste professor Rolf Nordhagen seg ved lunsjbordet («Te-bordet») i Botanisk museum og holdt en improvisert tale til Gro. Talen var flott, men det eneste jeg husker fra den er: «I am here for the pleasure» (mulig et sitat fra Samuel Johnson, som Nordhagen var begeistret for). En storslagen hilsen fra en botanikkprofessor, som etter sigende ikke kunne fordra sopp. Ja, det er alltid en glede å ha med Gro å gjøre, og for Gro er soppene en like stor glede!

Gratulerer med dine 75 år!

Klaus Høiland

Pathogenicity of Norwegian isolates of *Pythium undulatum* and *Pythium anandrum* on Norway spruce seedlings

Isabella Børja, Nina Elisabeth Nagy, May Bente Brurberg,
Leif Sundheim, Maria-Luz Herrero

Norwegian Institute of Bioeconomy Research (NIBIO), P.O. Box 115,
NO - 1431 Ås

Corresponding author:
isabella.borja@nibio.no

Norsk tittel: Patogenitet hos norske isolater av *Pythium undulatum* og *Pythium anandrum* i granplanter.

Børja I, Nagy NE, Brurberg MB, Sundheim L, Herrero M-L, 2015. Pathogenicity of Norwegian isolates of *Pythium undulatum* and *Pythium anandrum* on Norway spruce seedlings. Agarica 2015 vol. 36: 5-10.

KEYWORDS
Disease, forest nurseries, *Pythium* spp., roots, Scanning electron microscopy (SEM)

NØKKELORD
Sykdom, skogplanteskoler, *Pythium* spp., røtter, skanning elektron mikroskopi (SEM)

SAMMENDRAG

Pythium arter er organismer spredt over hele verden. De fleste lever som saprofytter, men noen av dem er patogene. Her beskriver vi sykdomstilfeller i granplanter (*Picea abies*) som er forårsaket av *Pythium undulatum* og patogenitet *in vitro* til norske isolater av *P. undulatum* og *P. anandrum*.

ABSTRACT

Pythium species are fungal-like organisms distributed all over the world. Most *Pythium* spp. live as saprophytes, but some of them are pathogenic. Here we report on disease incidence in Norway spruce (*Picea abies*) seedlings caused by *Pythium undulatum*, and pathogenicity *in vitro* of Norwegian isolates of *P. undulatum and P. anandrum.*

INTRODUCTION

Pythium species (class Oomycota) are fungal-like eukaryotic microorganisms inhabiting a wide range of environments worldwide and commonly referred to as water molds. Because their morphology is superficially similar to that of true Fungi (Eumycota), they used to be included in the kingdom Eumycota. However, recently discovered major structural distinctions between Oomycota and Eumycota indicate that Oomycota are more related to Stramenophila, a lineage including photosynthetic brown algae, and therefore phylogenetically very distant from the kingdom Eumycota. Many oomycetes are saprobic, but some are pathogens of plants and animals. The high growth and spread rate of *Pythium* spp. makes rapid detection and identification crucial for development of control strategies.

In Norway a serious root dieback of Norway spruce (*Picea abies* (L.) H. Karst) seedlings in forest nurseries in the 1980s was caused mostly by Pythiaceous organisms (Venn 1985). Similar "dying off" symptoms in Noble fir (*Abies procera* Rehder) were observed during the early 1980s in the USA (Chastagner et al. 1995) and in the mid 1980s in Ireland (Ward 1994, Shafizadeh and Kavanagh 2005). Losses were estimated to 30% - 50% of the seedlings in the USA (Chastagner et al. 1995). In Norway, the source of inoculum turned out to be the sand layer under the nursery containers, which hosted the propagules of pathogenic organisms. This led to changes of growing routines in order to prevent contact between the containers and the underlying sand layer (Kohmann and Børja 2002, Lilja et al. 2010).

An extensive mapping of Oomycota in Norway was carried out in the period 2012-2014. We isolated, among other oomycetes and fungi, two potentially pathogenic Pythium spp, *Pythium undulatum* H. E. Petersen and *P. anandrum* Drechsler. Wardlaw and Palzer (1985) showed that *P. anandrum* caused stem rot in nursery grown *Eucalyptus* spp. in Tasmania. In Turkey, Balci and Halmschlager (2003) recovered *P. anandrum* from 70% of sites with oak decline ascribed to *Phytophthora*-infection, but they never tested the pathogenicity of the *P. anandrum* isolates. Later, Akilli et al. (2013) reported that *P. anandrum* was the cause of oak decline in Turkey. However, there is little information on pathogenicity of *Pythium* spp. in North European tree species.

The aims of our study were (i) to assess the pathogenicity of *P. undulatum* on Norway spruce seedlings in forest nursery conditions and (ii) to compare the *in vitro* pathogenicity of Norwegian isolates of *P. anandrum* and *P. undulatum* on roots of Norway spruce seedlings.

MATERIALS AND METHODS

Pathogenicity testing in nursery conditions

Parallel inoculating experiments were set up in three forest nurseries (A, B, C), all located in south-east Norway. In each nursery, Norway spruce seedlings grown in 18 multipot containers with 96 cavities in each were inoculated about 60 days after seed germination. Each container was divided into two equal zones, one half was inoculated with *P. undulatum* (isolate 83-100/Øa from culture collection of Norwegian Institute of Bioeconomy, NIBIO), and the other half was inoculated with malt agar only. Inoculum was prepared by growing *P. undulatum* mycelium in petri dishes on a thin layer of medium containing 1.25% (w/v) malt extract and 0.7% agar (w/v). The *Pythium*-colonized medium was emptied into a narrow-mouth bottle and homogenized with Ultra Turrax T25. Mycelial fragments in the homogenate were adjusted to concentration 0.015 g dry weight per ml homogenate which equals approximately to $3x10^3$ colony forming units. A surgical syringe (Gillette, 50 ml, with 2.0 x 80 mm needle) was filled with the homogenate, and 1 ml was injected into each container pot. The inoculum was injected along the wall of each pot to prevent root injuries. Seedlings were sampled and evaluated about 70 days after inoculation. Shoot length of the seedling was measured and shoot viability was classified in three groups: healthy, symptomatic and dead. For root viability evaluation, the whole root systems were washed and visually assigned into one of three groups: 0-5%, 5-50% and 50-100% root damage.

Pathogenicity testing of *P. undulatum* and *P. anandrum in vitro*

Isolates of *P. undulatum* and *P. anandrum* were mostly recovered from water and soil samples collected in different ecological sites (Table 1). Isolates from water were obtained by baiting *in situ* with plant material for 3-5 days. Semi-selective media for *Pythium*, P_{10}ARP (Kannwischer and Mitchell 1978) or P_5ARP (Jeffers and Martin 1986) were used for isolation. Two *P. undulatum* isolates, designated as 231598 and 11405, were obtained on P_5ARP amended with hymexazol (25µg/ml). Identification of isolates was made by sequencing the Internal Transcribed Spacer (ITS) region of the ribosomal DNA using ITS1 and ITS4 primers (White et al. 1990). The sequences were used to support identification of the isolates based on searches in public databases (GenBank and Phytophthora Database). All isolates we used are deposited in culture collection of NIBIO.

Seeds of Norway spruce were surface steri-

Table 1. Geographic origin of *P. anandrum* (Pa) and *P. undulatum* (Pu), isolates.

Isolate	Isolated from	Locality
P.a. 231071 (CBS139433)	Soil (baiting with pepper seeds)	Mixed forest in Vestby, Akershus
P.a. 231207	Water (baiting *in situ* with Rhododendron leaves)	Fut river, Breiva, Bodø, Nordland
P.a. 231603	Soil	Arboretum, Milde, Bergen, Hordaland
P.u. 231080	Brackish water (baiting *in situ* with grass)	Shoreline, Askvika, Hjelmeland, Rogaland
P.u. 231391	Brackish water (baiting *in situ* with Rhododendron leaves)	Shoreline, Askvika, Hjelmeland, Rogaland
P.u. 231595	Water (baiting *in situ* with alder seeds)	Langfjord lake, Sør-Varanger, Finnmark
P.u. 231598	Water (baiting *in situ* with Rhododendron leaves)	Langfjord lake, Sør-Varanger, Finnmark
P.u. 231606	Water (baiting *in situ* with Rhododendron leaves)	Loken lake, Sør-Varanger, Finnmark
P.u. 231617	*Potamogeton* sp. (aquatic plant)	Loken lake, Sør-Varanger, Finnmark

lized in sodium hypochlorite (4.5%, v/v) and germinated on malt agar medium (1.25% malt, w/v and 2% agar w/v) in petri dishes. After the disinfected roots had germinated to about 2 cm length, six seedlings were placed in a circle around the front line of growing mycelia of either *P. undulatum* or *P. anandrum* on malt agar medium. Viability of each root was evaluated daily as a percentage of damaged tissue.

RESULTS AND DISCUSSION

Pythium undulatum caused stunted growth and mortality of shoots and roots in nurseries

Seedlings inoculated with *P. undulatum* were shorter, with mean shoot length of 98 mm, while shoots in control seedlings had mean shoot length of 158 mm. Also, shoot mortality was highest in seedlings inoculated with *P. undulatum*, causing 12-18% dieback in nurseries A and B, while more than half of the inoculated seedlings died in nursery C (Table 2).

Root system evaluation of seedlings inoculated with *Pythium* (n=108) showed that 28% of the seedlings had healthy roots (0-5% damage), 33 % of seedling had roots with

Table 2. Shoot viability in seedlings inoculated with *P. undulatum*.

	Nursery A (n=776)		**Nursery B (n=763)**		**Nursery C (n=871)**	**Nursery C (n=871)**
Treatment	Symptomatic (%)	Dead (%)	Symptomatic (%)	Dead (%)	Symptomatic (%)	Dead (%)
Pythium-inoculated	9	18	18	12	6	52
Control	0	0	2	0	0	0

moderate dieback (6-50% damage) and 39% of seedlings had roots with extensive dieback (51-100% damage). In control seedlings 93% had healthy roots, 6% had moderate dieback, and one percent had extensive dieback.

Pathogenicity of *P undulatum* and *P. anandrum* isolates *in vitro*

All isolates tested showed a high level of pathogenicity, except the *P. undulatum* isolate nr. 231598, which did not cause much tissue damage (Fig.1). Fifty percent of the fine roots of Norway spruce were damaged 2-3 days after infection with two *P. anandrum* (no. 231071 and 231207, see Fig. 1). Similar rapid damage was detected for two isolates of *P. undulatum* (nr. 231080 and 231391, see Fig. 1). All the other *P. undulatum* isolates and one *P. anandrum* isolate were slower to cause damage, causing about 20-30% tissue damage after 2-3 days. However, after 6 days all the pathogenic isolates caused almost complete tissue damage (Fig. 1), whereas control tissues were healthy.

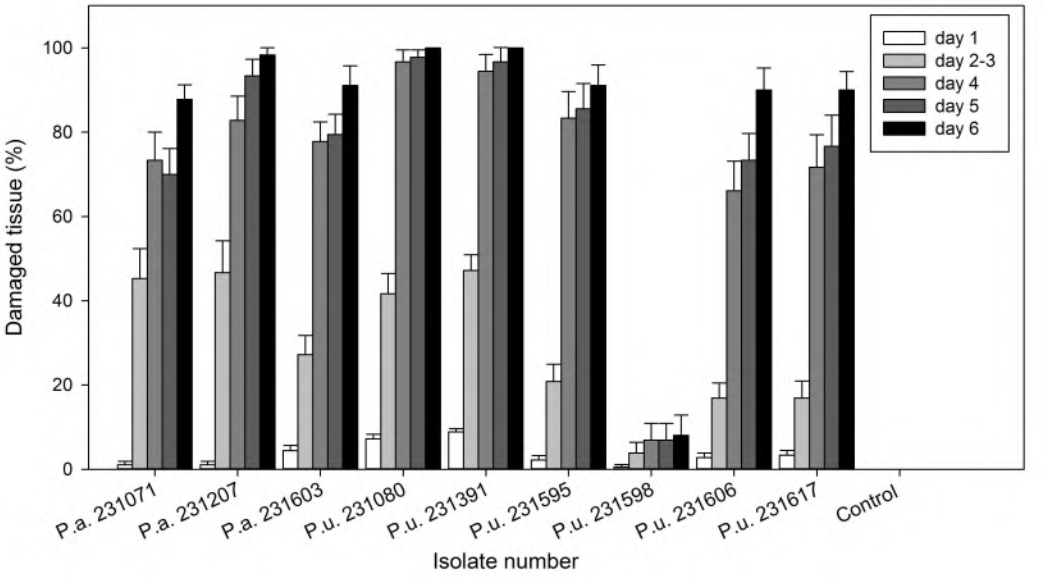


Figure 1. Pathogenicity test showing percentage of damaged tissue in Norway spruce seedlings inoculated with *Pythium anandrum* (Pa) and *P. undulatum* (Pu), and assessed daily for health condition up to six days after infection.

Conclusions

In a phylogenetic analysis of 116 *Pythium* species, based on the ITS region of the nuclear ribosomal DNA, *P. anandrum* and *P. undulatum* cluster in the same group, clade H (Levesque and De Cock 2004). Species in this clade are characterized by very large sporangia, and ornamented oogonia (Fig. 2A, *P. anandrum*). We show here that *P. undulatum* (Fig. 2B) and *P. anandrum* are pathogenic on young plant tissues, as they cause damage both on Norway spruce seedlings inoculated in nurseries, but also on plant tissues *in vitro*.

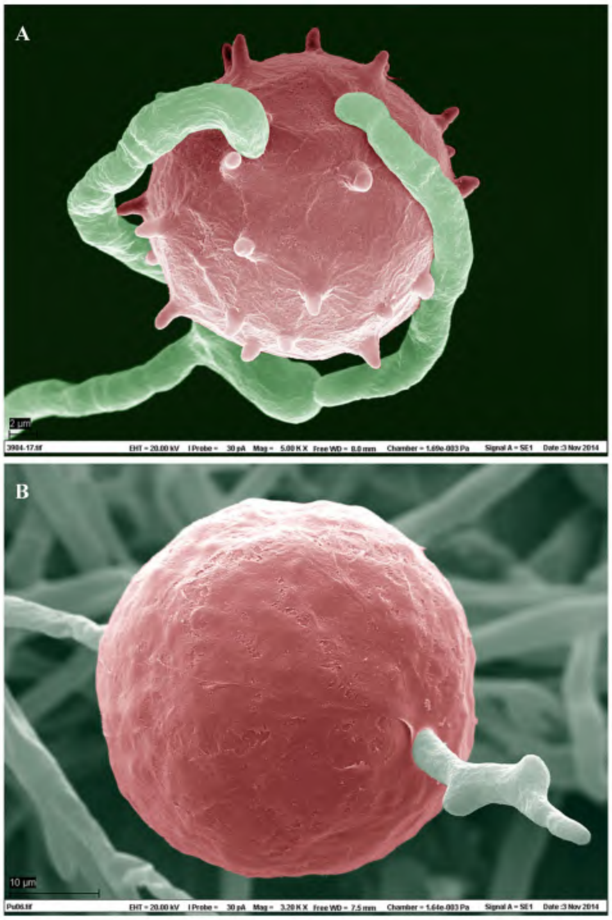


Figure 2. Morphology of *Pythium* structures. **A** Ornamented oogonium of *P. anandrum* and **B** Chlamydospore of *P. undulatum*. Both images are photographed in a scanning electron microscope, and artificially colored in Photoshop to enhance the structures. Photo: N. E. Nagy and I. Børja, coloration F. N. Kidder.

ACKNOWLEDGEMENTS

We thank Jan Světlík and Halvor Solheim for sampling and The Norwegian Biodiversity Information Centre (Artsdatabanken), project Nr. 70184222, for financial support.

REFERENCES

Akilli S, Serce CU, Katircioglu YZ, Maden S, 2013. Does *Pythium anandrum* contribute to the dieback of sessile oak (*Quercus petraea*) in Turkey? Forest Pathology 43: 505-508.

Balci Y, Halmschlager E, 2003. *Phytophthora* species in oak ecosystems in Turkey and their association with declining oak trees. Plant Pathology 52: 694-702.

Chastagner GA, Hamm PB, Riley KL, 1995. Symptoms and *Phytophthora* spp. associated with root rot and stem canker of Noble fir Christmas trees in the Pacific Northwest. Plant Disease 79: 290-293.

Jeffers SN, Martin SB, 1986. Comparison of two media selective for *Phytophthora* and *Pythium* species. Plant Disease Reporter 70: 1038-10.

Kannwischer ME, Mitchell DJ, 1978. The influence of a fungicide on the epidemiology of black shank of tobacco. Phytopathology 68: 1760-1765.

Kohmann K, Børja I. 2002. Hot-water Treatment for Sanitizing Forest Nursery Containers: Effects on Container Microflora and Seedling Growth. Scandinavian Journal of Forest Research 17:111-117.

Levesque CA, De Cock A, 2004. Molecular phylogeny and taxonomy of the genus *Pythium*. Mycological Research 108: 1363-1383.

Lilja A, Poteri M, Petaisto R-L, Rikala R, Kurkela T, Kasanen R, 2010. Fungal Diseases in Forest Nurseries in Finland. Silva Fennica 44: 525-545.

Shafizadeh S, Kavanagh JA, 2005. Pathogenicity of *Phytophthora* species and *Pythium undulatum* isolated from *Abies procera* Christmas trees in Ireland. Forest Pathology 35: 444-450.

Venn K, 1985. Rotavdøing hos bartreplanter i skogplanteskoler (Summary: Root dieback of coniferous seedlings in forest nurseries). Rapport fra Norsk Institutt for Skogforskning 3/85: 1-11.

Ward D, 1994. Death of Noble fir Christmas Trees at Kilmacthomas, Comeragh Forest. Co. Waterford Ireland: Research Coillte, Forest Protection.

Wardlaw T J, Palzer C, 1985. Stem diseases in nursery saplings caused by *Phytophthora cactorum, P. citricola* and *Pythium anandrum*. Australas. Plant Pathology 14: 57-59.

White T, Burns T, Lee S, Taylor J. 1990. Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. In: Innis M A, Gelfand D H, Sninsky J J, White T J, editors. PCR protocols: A guide to methods and applications. Academic Press, New York, USA, pp. 315–322.

Some new and little known telamonioid *Cortinarius* species from Norway

Tor Erik Brandrud[1], Egil Bendiksen[1], Bálint Dima[1,2,3]

[1]Norwegian Institute for Nature Research (NINA),
Gaustadalléen 21, NO-0349 Oslo
[2]Department of Biosciences, Plant Biology, P.O. Box 65, FI-00014,
University of Helsinki, Finland
[3]Department of Plant Anatomy, Institute of Biology, Faculty of Science, Eötvös
Loránd University, Pázmány Péter s. 1/c, H-1117 Budapest, Hungary

Corresponding author: tor.brandrud@nina.no

Norsk tittel: Noen nye og lite kjente telamonioide slørsopper (*Cortinarius*) i Norge

Brandrud TE, Bendiksen E, Dima B, 2015. Some new and little known telamonioid *Cortinarius* species from Norway. Agarica vol. 36: 11-42.

KEYWORDS
Cortinarius, *Telamonia*, new species, ITS-sequences, morphology

NØKKELORD
Cortinarius, *Telamonia*, nye arter, ITS-sekvensering, morfologi

SAMMENDRAG
Noen lite kjente telamonioide slørsopper (*Cortinarius*) er studert morfologisk og fylogenetisk, inkludert tre nye arter for vitenskapen og åtte nye for Norge. Følgende nye arter er beskrevet:
C. puellaris (knyttet til lind, hassel og eik), *C. annae-maritae* (bjørk, bøk) og *C. subtilis* (lind, hassel, bøk, edelgran). *Cortinarius puellaris* er kjent fra 12 genetisk verifiserte kollekter, og tilhører artskomplekset rundt *C.* cf. *cristatosporus*. Denne arten er fylogenetisk velavgrenset, men har overlappende morfologiske karakterer med søsterarter, og kan således betraktes som en semi-kryptisk art. Beskrivelsene av de to sistnevnte artene er basert på én kollekt av hver. Disse to synes begge å være relativt isolert både fylogenetisk og morfologisk, men mer material er nødvendig for å kunne fastslå graden av morfologisk differensiering. *Cortinarius subtilis* er kjent fra ulike deler av Europa, i form av sekvenserte mykorrhiza-prøver, men er kjent med fruktlegemer kun fra typematerialet fra SØ Norge.

Mer enn 70 telamonioide slørsopparter er funnet nye for Norge de siste fem årene. Av disse er følgende, karakteristiske arter nærmere presentert her: *C. conterminus*, *C. fuscoumbrinus*, *C. fuscescens*, *C. impennoides*, *C. microglobisporus*, *C. niveotraganus*, *C. pseudofallax* og *C. salicticolus*.

ABSTRACT
Some little known telamonioid *Cortinarius* taxa are studied morphologically and phylogenetically, including three new species and eight new to Norway. The following new species are described; *C. puellaris* (*Tilia-Corylus-Quercus* associate), *C. annae-maritae* (*Betula-Fagus*) and *C. subtilis* (*Tilia-Corylus-Fagus-Abies*). *Cortinarius puellaris* is known from 12 genetically verified collections, and belongs to a complex around *C.* cf. *cristatosporus*. This is well-supported phylogenetically, but has overlapping morphological characters with sister taxa, and can be regarded as a semi-cryptic species. The descriptions of the two latter species are based on one collection

of each. These two seem both to be rather isolated species phylogenetically and morphologically, but more material is needed to confirm their degree of morphological differentiation. *Cortinarius subtilis* is known from various parts of Europe, from sequences based on mycorrhizae samples, but is known with basidiocarps only from the type collection from SE Norway.

More than 70 telamonioid species are found new to Norway the last five years. Of these, the following species are treated here: *C. conterminus*, *C. fuscescens*, *C. fuscoumbrinus*, *C. impennoides*, *C. microglobisporus*, *C. niveotraganus*, *C. pseudofallax* and *C. salicticolus*.

INTRODUCTION

Telamonioid cortinarii into the DNA-era

Cortinarius is the largest genus among the agaricoid fungi, assuming to include at least 900 species only in the Nordic countries (Knudsen and Vesterholt 2012). Based on morphological features, five to eight subgenera have usually been distinguished, of which subgenus *Telamonia* (including *Sericeocybe*) and *Phlegmacium* are the largest, housing more than two-thirds of the species (see e.g. Brandrud et al. 1990–2013, Knudsen and Vesterholt 2012). Molecular data have indicated that these subgenera as traditionally circumscribed, are not monophyletic (e.g. Peintner et al. 2004, Stensrud et al. 2014, Garnica et al. 2015). The *Telamonia* species together with species from subgenus *Dermocybe* form a “super-clade” from which a number of more or less supported clades can be distinguished, including *Telamonia* s. str., the telamonioid *Obtusi* and *Anomali* as well as several dermocyboid groups (Stensrud et al. 2014). However, more evidence from multi-gene studies are needed to find a well-supported phylogeny at the subgenus-sectional level in *Cortinarius*. Until the phylogenetic relationships at these levels are more settled, we propose to use morph-based expressions such as telamonioid and phlegmacioid *Cortinarius* species for our taxa.

The telamonioid cortinarii have always been poorer understood than other kinds of *Cortinarius* species. These “anonymous brown ones” often have few microscopical distinguishing features and are regularly underrepresented in fungas and at fungus exhibitions, even though a vast number of species has been described (cfr. the numerous studies of Henry, e.g. Henry 1935, and the Atlas des Cortinaires, e.g. Bidaud et al. 2000, 2003 from France). However, due to variability, overlap in most morphological characters, combined with the rarity of many taxa, species delimitations have often been vague, based on very little material and taxonomic not very relevant variation. As a result, a great many *Telamonia* names are hardly possible to interpret based on morphology and are not in common use use among cortinariologists. Even the best cortinariologists have to admit that there are a lot of telamonioid species out there that remain unrecognized morphologically.

On this background, the introduction of genetic methods has been a revolution in taxonomy of the telamonioid species. Without barcoding, using ITS sequences it would probably not have been possible to sort out the most critical groups. With the aid of extensive ITS sequencing, combined with detailed morphological studies, a new and quite more complete taxonomy is now established in critical groups such as sect./clade *Brunnei*, *Armillati* as well as the coniferous forest species of *Bovini* (Niskanen et al. 2009, 2011, 2013a), whereas the critical *Hinnulei-Safranopedes* and the *Duracini* are still unresolved.

However, these phylogenetic-morphological studies have also shown that not all genetically differentiated taxa are morphologically distinguishable, and for many of the rarest taxa, we have simply not sufficient data to state whether these are morphologically well differentiated or not. Some genetically well supported *Bovini* species, apparently have overlapping morphological features (Niskanen et al. 2013a), and seem in some cases to be very difficult to distinguish morphologically. In the case of the six species of the recently treated *Disjungendi*, the degree of morphological differentiation is hardly known at present, and the members could be termed cryptic or semi-cryptic species (Liimatainen et al. 2015). However, true cryptic species, well-supported genotypes without any morphological differentiation at all, seems to be rare: The more accurately the critical genotypes are studied, the more morphological differentiations are found. The *C. bovinus*-complex, formerly regarded as one morphospecies, now including 7 species with some morphological differentiation, is one example (Niskanen et al. 2013a).

During the last 5 years, more than 250 specimens of critical telamonioid *Cortinarius* species have been ITS-sequenced in connection with projects at Norwegian Institute for Nature Research (NINA), including a *Cortinarius* Species project 2010–2012 under The Norwegian Biodiversity Information Centre ("Artsdatabanken"). Here, some of the results from these studies are presented, including descriptions of three new species which are of conservation biology interest, as well as the presentation of some characteristic and well-identifiable new species to Norway.

MATERIALS AND METHODS

Morphological methods

Altogether 38 collections of the 11 taxa presented were examined. Only specimens with both morphological and phylogenetic data were included in the study. Most specimens were collected by the authors from Norwegian sites.

Spores and other microscopic features were studied and measured with a 100 × oil immersion lens (achromatic Zeiss and Leiz equipments), with mounts in 2% KOH and Melzer's reagent. From each basidiocarp, a random selection of ten to twenty mature spores obtained from cortina remnants/stipe surface were measured excluding apiculus and ornamentation. Mean values (MV) of spore length and width as well as Q-values (length/width ratio) were then calculated for each specimen. For type collections of new species, up to five different specimens were measured per. collection. The pileipellis and lamellae tissue were studied in 2% KOH.

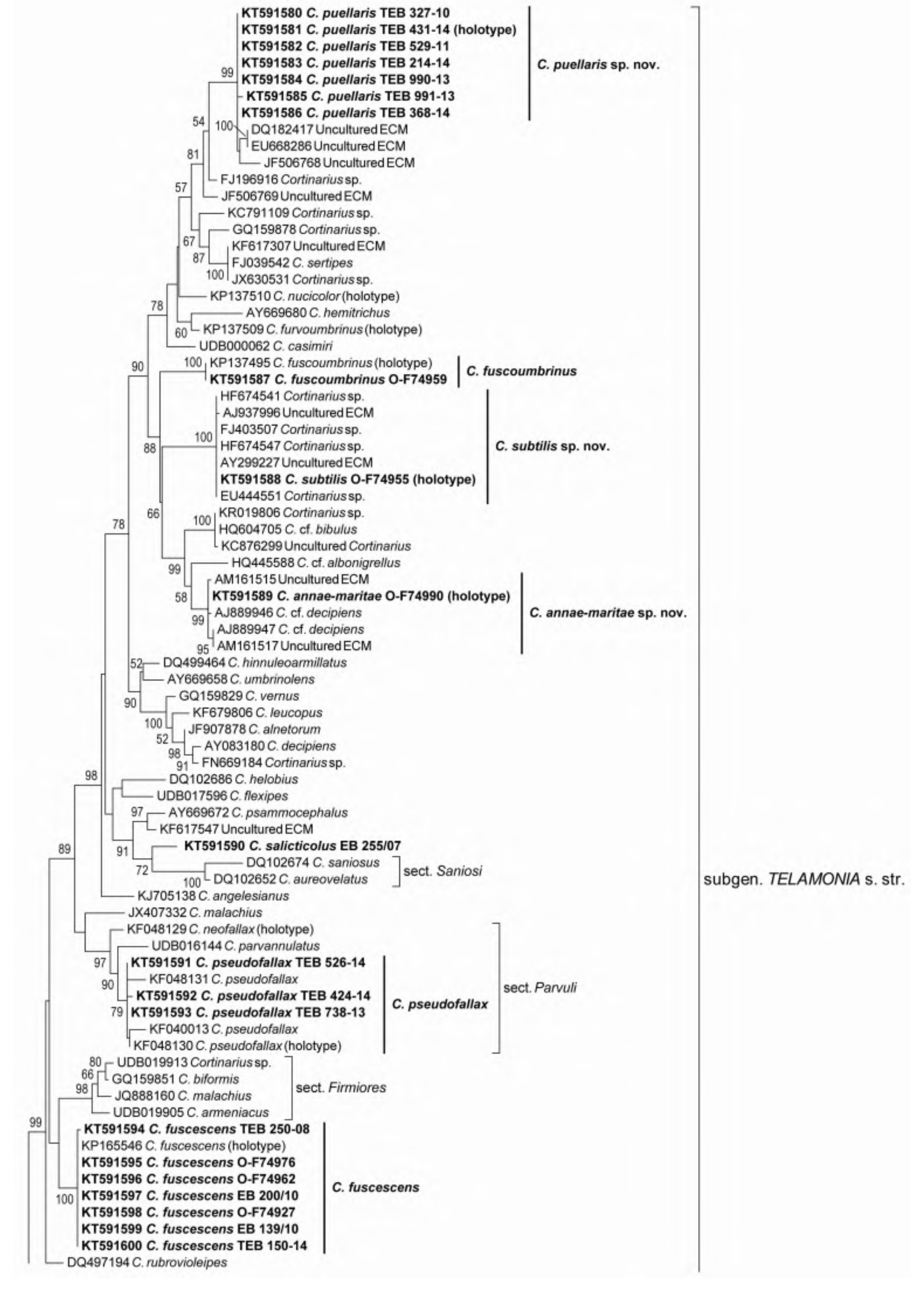
The colour standards used are those of Kornerup and Wanscher (1978; abbr. KOR) and Cailleux (1981; abbr. CAI). Norwegian red list categories referred for species and habitat types are those given by Henriksen et al. (2015) and Lindgaard and Henriksen (2011), respectively. The collections made by the authors are deposited in the herbarium of the University of Oslo (O), or as otherwise cited.

Molecular methods

For the DNA extraction and PCR reactions mainly the Phire® Plant Direct PCR Kit (Thermo Scientific, USA) was used following the recommendations of the manufacturer, but also other DNA extraction kits were applied (Frøslev et al. 2005, 2007).

The ITS region of the nrDNA was amplified with the primer pairs ITS1F/ITS4 or ITS1F/ITS4B (White et al. 1990, Gardes and Bruns 1993). Majority of the amplicons were sequenced at LGC Genomics (Berlin, Germany) with the same primers used in PCR reactions. The electropherograms were checked, assembled and edited with the CodonCodeAligner 4.1. (CodonCode Corporation, Centerville, MA, USA).

Some sequences were produced at the University of Oslo and University of Copenhagen, using similar methods. Some were generated in collaboration with the Norwegian Barcode of Life Network (NorBOL)


KT591580 C. puellaris TEB 327-10
KT591581 C. puellaris TEB 431-14 (holotype)
KT591582 C. puellaris TEB 529-11
KT591583 C. puellaris TEB 214-14
KT591584 C. puellaris TEB 990-13
KT591585 C. puellaris TEB 991-13
KT591586 C. puellaris TEB 368-14
C. puellaris sp. nov.
99
54
100
DQ182417 Uncultured ECM
EU668286 Uncultured ECM
JF506768 Uncultured ECM
81
FJ196916 Cortinarius sp.
57
JF506769 Uncultured ECM
KC791109 Cortinarius sp.
GQ159878 Cortinarius sp.
67
KF617307 Uncultured ECM
87
FJ039542 C. sertipes
100
JX630531 Cortinarius sp.
KP137510 C. nucicolor (holotype)
78
AY669680 C. hemitrichus
60
KP137509 C. furvoumbrinus (holotype)
UDB000062 C. casimiri
90
100
KP137495 C. fuscoumbrinus (holotype)
KT591587 C. fuscoumbrinus O-F74959
C. fuscoumbrinus
HF674541 Cortinarius sp.
AJ937996 Uncultured ECM
FJ403507 Cortinarius sp.
100
HF674547 Cortinarius sp.
88
AY299227 Uncultured ECM
KT591588 C. subtilis O-F74955 (holotype)
EU444551 Cortinarius sp.
C. subtilis sp. nov.
78
66
100
KR019806 Cortinarius sp.
HQ604705 C. cf. bibulus
KC876299 Uncultured Cortinarius
HQ445588 C. cf. albonigrellus
99
AM161515 Uncultured ECM
58
KT591589 C. annae-maritae O-F74990 (holotype)
AJ889946 C. cf. decipiens
99
AJ889947 C. cf. decipiens
95
AM161517 Uncultured ECM
C. annae-maritae sp. nov.
52
DQ499464 C. hinnuleoarmillatus
AY669658 C. umbrinolens
GQ159829 C. vernus
90
KF679806 C. leucopus
100
JF907878 C. alnetorum
52
98
AY083180 C. decipiens
91
FN669184 Cortinarius sp.
98
DQ102686 C. helobius
UDB017596 C. flexipes
97
AY669672 C. psammocephalus
KF617547 Uncultured ECM
89
91
KT591590 C. salicticolus EB 255/07
72
DQ102674 C. saniosus
100
DQ102652 C. aureovelatus
sect. Saniosi
KJ705138 C. angelesianus
subgen. TELAMONIA s. str.
JX407332 C. malachius
KF048129 C. neofallax (holotype)
UDB016144 C. parvannulatus
97
KT591591 C. pseudofallax TEB 526-14
90
KF048131 C. pseudofallax
KT591592 C. pseudofallax TEB 424-14
79
KT591593 C. pseudofallax TEB 738-13
KF040013 C. pseudofallax
KF048130 C. pseudofallax (holotype)
C. pseudofallax
sect. Parvuli
80
UDB019913 Cortinarius sp.
66
GQ159851 C. biformis
98
JQ888160 C. malachius
UDB019905 C. armeniacus
sect. Firmiores
99
KT591594 C. fuscescens TEB 250-08
KP165546 C. fuscescens (holotype)
KT591595 C. fuscescens O-F74976
KT591596 C. fuscescens O-F74962
100
KT591597 C. fuscescens EB 200/10
KT591598 C. fuscescens O-F74927
KT591599 C. fuscescens EB 139/10
KT591600 C. fuscescens TEB 150-14
C. fuscescens
DQ497194 C. rubrovioleipes

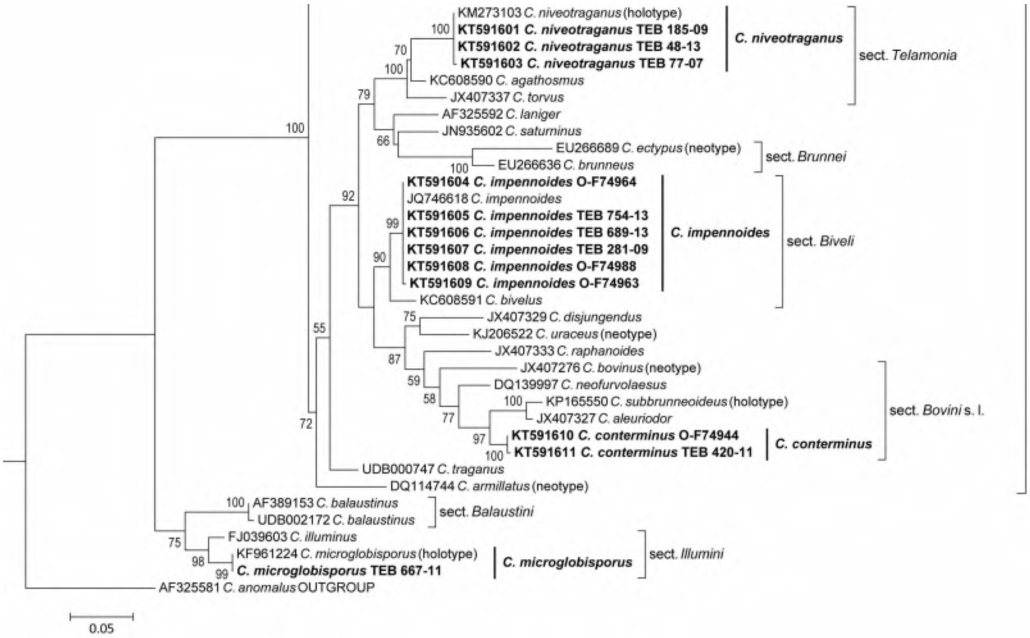


Figure 1. Phylogenetic tree inferred from nrDNA ITS sequences using RAxML. BS values > 50% are indicated at branches. Species treated in the paper are marked with bold as well as the sequences generated for this study. Scale bar indicates 0.05 expected change per site per branch.

as part of BOLD. For BOLD methods, see Ratnasingham and Hebert (2007, 2013).

Multiple sequence alignment was done by PRANK (Löytynoja and Goldman 2005) as implemented in its graphical interface (PRANKSTER) under default settings. After its manual adjustment in SeaView (Gouy et al. 2010), the alignment comprised 844 characters. The phylogenetically informative indels were coded following the simple indel coding algorithm (Simmons et al. 2001) with the program FastGap 1.2 (Borchsenius 2009). Adding indel characters to the nucleotide alignment of ITS sequences increases the robustness of the phylogenetic analyses (Nagy et al. 2012). The final matrix including nucleotide + binary data was 1150 characters long. Maximum Likelihood analysis was carried out using RAxML (Stamatakis 2014) in raxmlGUI (Silvestro and Michalak 2012). To test branch support, rapid bootstrap analysis and 1,000 replicates under the GTRGAMMA substitution model was used for the partitioned alignment (ITS + indels). *Cortinarius anomalus* (AF325581) was selected as outgroup.

Altogether 110 sequences (+ 1 outgroup) were included in our phylogenetic analysis of which 33 were newly generated in this study (Fig. 1, Table 1). For the rest, we sampled sequences of morphospecies similar to the Norwegian species and published in relevant literatures (e.g. Niskanen 2014, Niskanen et al. 2009, 2011). Furthermore we used BLAST (Altschul et al. 1990) for searching the most similar sequences to ours. Some sequences had insufficient length or quality, and these are excluded from the analysis (Fig. 1), and not submitted to GenBank. Nevertheless, these sequences could be used for identification using BLAST against public databases (e.g. GenBank, UNITE).

All ITS sequenced collections were also examined morphologically by us, and are listed under each species description. Sequences have been deposited in GenBank and accession numbers are given in Table 1.

RESULTS AND DISCUSSION

Taxonomy

Below, three telamonoid taxa are described as new species and eight other rare or little known species are presented and discussed.

New species: The three new species are genetically well supported, and apparently also morphologically well distinguished, but their morphological differentiations towards related species are still poorly known, due to little material. However, since these are apparently rare species, in rare habitats, with a limited probability for more finds, we have decided to describe these as new, based mainly on their status as well-differentiated genetically (> 1% difference from sister species in ITS), combined with some morphological differentiation. The species are found in more or less threatened habitats, and two of them are therefore included in the 2015 red list (Henriksen et al. 2015), and hence they need new names.

Among the three new species, *C. puellaris* is known and studied from 12 collections (10 from SE Norway), whereas the two others are studied only from one collection each. The two latter are, however, also known from more ITS sequences, from mycorrhizal (soil) samples. Whereas *C. puellaris* apparently belongs to a well-supported clade, the two others (*C. annae-maritae* and *C. subtilis*), seem to be more isolated, with > (15–)20 nucleotide and indel differences to the nearest, known sister species, and with no clear affinity to larger clades. The latter ones also seem to have no or very little morphological overlap with phylogenetically related taxa, and according to present knowledge they appear to be well-defined taxa with clear diagnostic features. With a low ITS similarity towards sister taxa (approx. 97%), these are really well-supported phylogenetic species by all ITS barcoding threshold levels applied in *Cortinarius* (Garnica et al. in prep.).

Cortinarius puellaris belongs to a species complex of small, galerinoid species with remarkable strongly verrucose-spiny spores (here called the *C. cristatosporus*-*C. puellaris* group/complex). In SE Norway, we regularly find two taxa; *C. puellaris* and another one with larger spores here identified to *C. cf. cristatosporus* Reumaux. The two sister taxa are well-defined phylogenetically (>1% ITS differences, and a clear barcoding gap). They differ also in spore characters, but have slightly overlapping values. Macromorphologically, these are apparently indistinguishable. Since not always distinguishable by morphology, *C. puellaris* should probably be regarded as semi-cryptic species.

The new species thus falls into two major categories:

(i) *C. annae-maritae* and *C. subtilis*: Phylogenetically rather isolated and well supported lineages. Apparently also well distinguished from related taxa morphologically, but material too little to judge the morphological variation (only one collection studied of each).

(ii) *C. puellaris*; belongs to the *C.* cf. *cristatosporus*-*C. puellaris* complex, with phylogenetically well-supported, but morphologically weakly differentiated taxa (12 different collections studied of *C. puellaris*). This should be regarded as a semi-cryptic species.

Species new to Norway

In the period 2010–2012 a *Cortinarius* study was performed in the Species Project under the Biodiversity Information Centre ("Artsdatabanken"). Combining a morphological study with extensive barcoding (ITS sequencing) we have been able to document more than 80 new *Cortinarius* species to Norway, including at least 71 telamonioid ones (Table 2). An element of these does not match existing, sequenced species, and are probably new to science. A couple of these are included in the red list 2015, and are published here, whereas others will be published later. Many of the taxa in Table 2 are reported as new to Norway in the present paper, others in some recent publications Niskanen et al. (2013a) for some *Bovini* species, Brandrud and Bendiksen 2014a,b for some sandy pine forest species and Evju et al. 2014 for a number of calcareous *Tilia-Corylus* forest species (Table 2).

Some of the new-to-Norway species are characteristic and rather easy recognizable based on morphology and habitat, and these are treated in the present paper.

General remarks

Among the approx. 250 Norwegian telamonioid *Cortinarius* specimens sequence-studied by the present authors in the last 5 years, almost one-third appears to belong to new species to Norway. This indicates the still limited knowledge on the biodiversity of the genus in the region, in spite of long ongoing studies on the genus in Norway. Furthermore, a considerable number of well-supported genotypes of the telamonioid taxa have no sequence match in public databases, or match only with sequences from environmental samples (soil samples) with no names or notes on basidiome morphology. Some of these sequenced taxa without proper names appears to be differentiated morphologically from known taxa when studied closely (as shown above), whereas the morphological differentiation of others are hardly known at the moment.

Our data is one of more recent examples that show the lack of basic knowledge about species numbers of telamonioid cortinarii (see also e.g. Liimatainen 2014, Liimatainen et al. 2015, Niskanen et al. 2013). There is now a need to speed up the description of new species in such groups, and make genetic barcode data available for reference to ecologists and other workers directly reliant on taxonomic work. In this situation, it seems better to describe new species on scanty material, based mainly on phylogenetic evidence, supported by the available morphological evidence, rather than wait for years for better and more complete taxonomical data. Parallel with that, there is a need to refine a modern phylogenetic-morphological species concept for such critical groups, including taxonomic group studies on barcoding gaps and optimal dissimilarity threshold levels (Garnica et al. in prep.).

Descriptive part

New species:

Cortinarius annae-maritae Bendiksen & Brandrud sp. nov.

Fig. 2a, 3a
MycoBank: MB814274

Type
Norway, Finnmark, Alta, Storelvdalen, Vatnheim E, Nature-type locality BN 00062755 Tvestraumen, UTM EC 58 32, 30 m a.s.l., middle boreal zone, sandy pine forest with *Pinus sylvestris* and *Betula pubescens*, heath type, 17 Aug. 2013, leg. A.-M. & E. Bendiksen, EB108/13 (holotype, O-F74990, herb. O). GenBank KT591589.
Etymology: Named after the daughter of E. Bendiksen, co-finder of the fungus at the type locality.

Pileus 2,5–3 cm, obtusely conical-campanulate, regular, later expanded and umbonate, when young with fibrillose whitish veil remnants in a broad margin zone; hygrophanous; redbrown, on drying first becoming bicoloured and vividly ochraceous brown from centre, finally entire pileus surface pale ochraceous brown. Lamellae rather crowded, vividly

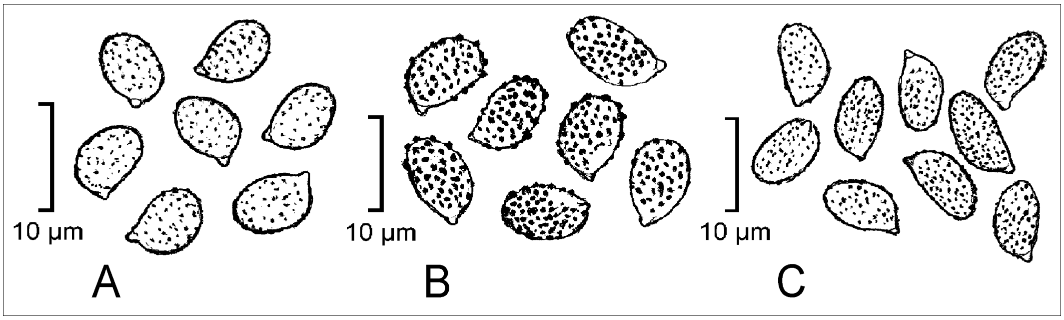


Figure 2. Spore sketches. a: *Cortinarius annae-maritae*. EB 108/13 b: *C. puellaris*. TEB 431-14 c: *C. subtilis*. EB 726/11 (all from holotypes). Drawings: K. Bendiksen.

ochraceous-fulvous brown when young, later darker, reddish brown. Stipe 6–9 × 0.4–0.55 cm at apex, cylindrical or faintly thinner towards base; when young with distinct white veil remnants, partly somewhat patchy in the lower part; silvery fibrillose, pale, upper part initially with a distinct violet tinge, lower part with age and touch becoming somewhat fleshy brown. Context with bluish violet tinges in stipe apex; smell insignificant.

Spores (6.5–)7–7.5(–8) × 5–5.5(–6) µm, MV = 7.18 × 5.33 µm, Q = 1.35; broadly ellipsoid to almost subglobose, rather weakly and densely verrucose. Basidia more or less hyaline, with some granulate content; lamellae edge more or less sterile, with short, clavate, hyaline elements (mainly 7–8 µm wide, up to 10 µm); lamellae trama of narrow, up to 10(–15) µm wide hyphae, weakly pigmented, with faintly thickened yellow walls, no encrustrations seen. Pileipellis duplex; epicutis thin, of approx. 3–5 layers, of 3–10 µm wide, distinctly yellowbrown, zebra-striped(-verrucose) encrusted pigmented; subcutis (hypodermium) subcellular of inflated elements up to 25(–30) µm wide, pigment yellow, parietal, forming an amber-like embedment, pigment encrusted in transition layers to epicutis. Brown, oleiferous hyphae not seen.

DNA (ITS) sequence

The type sequence (from present study) and sequences of ectomycorrhizal/basidiocarp samples from Denmark are almost identical. Differences observed are 1 or 2 indel positions, and in the case of AM161517 one nucleotide difference exists.

Habitat and distribution

Known from one site (the type site) in N Norway, and one from Denmark (Zealand). The Norwegian find was from a sandy pine forest, with the typical north Fennoscandian mixture of *Pinus sylvestris* and some *Betula pubescens*, and with ericaceous vascular plants and moss (*Pleurozium*). The Danish finds were from a mycorrhizal project in a *Fagus sylvatica* forest. The species is documented as a mycorrhizal partner of *Fagus sylvatica* in Denmark (R. Kjøller, pers. comm.), and *Betula* is the most probable host in N Norway.

Investigated material

Norway: Finnmark, Alta, Storelvdalen, Vatnheim E, Tvestraumen (Nature-type locality BN 00062755), 30 m a.s.l., middle boreal zone, sandy pine forest with *Pinus sylvestris* and *Betula pubescens*, heath type, 17. Aug. 2013, A-M. & E. Bendiksen, EB108/13 (holotype, O-F74990). Denmark: Zealand, Ringsted NW, Lille Bøgeskov, 12. Sept. 2001, M. Christensen, MC01-515 (herb. C, sub nom. *C. decipiens*, C-F-84760).

Comments

The type *Cortinarius annae-maritae* is characterized by its red brownish pileus and violaceous blue tinge on stipe apex, contrasting the (red)brownish lamellae (without any bluish tinge). Microscopically, the broadly ellipsoid-subglobose, small spores are remarkable. According to notes on the Danish collection, the pileus here was violaceous brown (very young material). Unfortunately, no spores were found in the Danish material (too young).

The species resembles some small, slender telamonias in the *Hydrocybe* group/section with a distinct bluish stipe apex such as *C. decipiens*, *C. bibulus* coll., *C. praestigiosus* coll., *C.* cf. *subcastaneus* and possibly also *C. casimiri* coll. However, these can be distinguished by the following features; darker, more grey brownish, fibrillose pileus and association mainly with *Salix* (*C. decipiens*); smaller basidiocarps, with stronger bluish colour, and an association with *Alnus* (*C. bibulus* coll.); veil/basalmycelium turning reddish (*C. praestigiosus* coll.); with more grey brownish-dark brownish pileus, small, strongly verrucose spores and an association with *Corylus-Tilia* (*C.* cf. *subcastaneus*); or having larger spores, more fibrillose veil and a pinkish tinge on the base of stipe (*C. casimiri*) (see Lindström 2012). All of these species also have more narrow, ellipsoid spores, except *C.* cf. *subcastaneus*, as here interpreted (Table 2), but the latter has more strongly verrucose spores. With its small, broadly ellipsoid spores, the species might also resemble some taxa in the *C. flexipes*-group, such as *C. inolens* and *C. comptulus*, but these have more grey brown-olive brown colours, without a bluish stipe apex. Microscopically the species also resembles *C. vernus*, e.g. with sterile lamellae edge, and broad spores, but this has much more strongly ornamented spores.

Phylogenetically, *C. annae-maritae* is not nested in the same clade as *C. decipiens*, but comes close to some other taxa in the *Hydrocybe* group with good support (Fig 1.), such as *C. bibulus* coll. and a *C.* cf. *albonigrellus* collection from Svalbard (Bjorbækmo et al. 2010). *Cortinarius annae-maritae* is well-supported genetically, and differs by 15 nucleotide and indel positions from the known closest relative (KC876299, a mycorrhizal sample of unknown morphology) (Fig. 1).

Small, slender telamonias with a brown cap and stem with violet tinge (often associated with the name *C. decipiens*) have always been difficult to identify by morphological characters, and the species may have been overlooked. The present species probably has a rather wide distribution and habitat range, from north Scandinavia in middle boreal *Betula-Pinus* forests to south Scandinavia in nemoral *Fagus* forests. A mycorrhizal association with *Fagus sylvatica* is documented in the Denmark site (R. Kjøller, pers. comm.; see GenBank sequences), and *Betula pubescens* is the most probable host in N Norway. Possibly, this species has a similar habitat and distributional range as some (other) *Fagus-Betula* associates, such as *C. balaustinus* and *C. talus*.

***Cortinarius puellaris* Brandrud, Bendiksen & Dima, sp. nov.**

Fig. 2b, 3b, 4
MycoBank: MB814275

Type:

Norway, Akershus, Asker, Sjøstrand S, calcareous lime forest under *Tilia cordata* and *Corylus avellana*, 10 Sept. 2014, leg. T.E. Brandrud & B. Dima, TEB 431-14 (holotype, herb. O), DB5474 (isotype, herb. BP). GenBank KT591581.

Etymology: from latin *puella*; young girl, referring to its small, tender and gracile habit.

Pileus 0.5–3 cm, acutely conical to campanulate, later (acutely) umbonate, strongly hygrophanous and distinctly translucently striate;

Figure 3. a: *Cortinarius annae-maritae*. EB 108/13 (holotype). Alta, Vatnheim. b: *Cortinarius puellaris*. TEB 820b-11. Røyken, Tåje. Photos: a: E. Bendiksen; b: K.H. Brandrud.

glabrous with no traces of veil remnants, except when very young sometimes faintly silvery of fine veil treads; ochraceous brown to darker (red)brown-umber brown, margin initially whitish; ochraceous white when dry. Lamellae crowded, adnate, edge even to finely fimbriate-serrulate, initially rather pale ochraceous yellowbrown to fulvous brown, later rather pale brownish to darker (chocolate) brown, edge pale, sometimes whitish. Stipe 3–6 × 0.2–0.4 cm, with clavate-cylindrical (-tapering) base, firm, slightly cartilaginous; fibrillose of few, whitish veil remnants when young, then glossy without visible veil remnants; initially ochraceous white in upper part, soon ochraceous grey brown, and developing a dark clay brown colour from the base and when bruised, some become slightly more olivaceous ochre (like in *C. flexipes*-group). Context watery grey brown-ochraceous brown when moist, darker brown in pileus, often darker brown in the lower half of the stipe; smell insignificant.

Spores 8–9(–9.5) × 5.5–6(–6.5) µm, MV = 8.75 × 5.87 µm, Q = 1.49; broadly ellipsoid-ovoid, densely and very strongly verrucose, warts often prominent spiny-dentate, especially distally (up to approx. 1.5(–2) µm long “teeth”); some spores (in spore deposits) only moderately verrucose, rarely the majority of deposited spores moderately verrucose. Basidia hyaline with refractive granules; lamellae edge more or less sterile, with short, clavate, hyaline elements (up to 10 µm wide); lamellae trama with distinct, yellow brown pigment; pigment parietal to distinctly encrusted, with pale, irregular small crusts or more zebra-striped pattern. Pileipellis duplex; epicutis thin, of 3–8(–10) µm wide hyphae, at surface hyaline or with pale yellowish, membranal pigment, and at least basally with distinct, zebra-striped, yellowbrown, encrusted pigment (like in lamellae trama); subcutis (hypodermium) subcellular of inflated elements up to 25 µm wide, pigment yellow, parietal, amber-like, cementing the elements, encrusted in transition layers to epicutis. A few, narrow, brown hyphae with oleiferous necropigment seen.

DNA (ITS) sequence

12 collections have been sequenced. The species shows a minor infraspecific variation of 1–2 nucleotides.

Figure 4. *Cortinarius puellaris*. TEB 431-14 (holotype). Asker, Sjøstrand S. Photo: B. Dima.

Habitat and distribution

In SE Norway occurring in a number of calcareous lime forests under *Tilia cordata* and *Corylus avellana*. Also found in calcareous *Quercus ilex* forests in S France. The species is probably widely distributed calcareous *Quercus-Carpinus-Tilia*(-*Fagus*?) forests throughout temperate-boreonemoral parts of Europe. The species is redlisted as VU (vulnerable) in Norway due to its association with calcareous lime forests which is a threatened habitat.

Investigated material

Norway, Oslo, Bygdøy, T.E. Brandrud & B. Dima, TEB 214-14; Akershus, Bærum, Dælivann, T.E. Brandrud & B. Dima, TEB 368-14, Asker, Sjøstrandvegen, TEB 529-11, Sjøstrand S, T.E. Brandrud & B. Dima, TEB 431-14, DB5474 (holotype), Elnestangen SW, T.E. Brandrud & B. Dima, TEB 441-14; Buskerud, Hole, Bråtafjellet, TEB 699-11, TEB 719-11, TEB 790-11, Røyken, Tåje, TEB 820b-11; Telemark, Bamble, Langesundtangen nature reserve, TEB 327-10.

France: Languedoc-Roussilon, Hérault, Bédarieux, TEB 990-13, TEB 991-13.

Comments

Cortinarius puellaris is a very small, tiny, galerinoid cortinarii with ochre brown-redbrown striate pileus with a more greyish brown, darkening stipe. The very strongly verrucose-spiny, broadly ellipsoid spores are furthermore a remarkable feature. *Cortinarius puellaris* is found in several localities in calcareous *Tilia-Corylus* forests in SE Norway. Here it co-occurs with a closely related taxon with slightly larger, strongly verrucose-spiny spores. The latter taxon corresponds well with *C. cristatosporus* Reumaux and to some degree also to *C. russulaespermus* Carteret (with more amygdaloid spores) described from France in Atlas des Cortinaires (Bidaud et al. 2003), and we preliminary name this *C.* cf. *cristatosporus*. Also the present species is found in France (collected by us in Bédarieux; see list of investigated material), and it is likely to be included among the many small ochre-redbrown species in deciduous forests of Atlas des Cortinaires. However, no species is described with this small cristate-spiny spores in the Atlas, and according to an ongoing type study in Helsinki, the present one has no match with the types of these French taxa (K. Liimatainen, T. Niskanen, pers. comm.), so we therefore describes this as new.

Cortinarius puellaris and *C.* cf. *cristatosporus* is very similar macroscopically (based on >10 collections seen of each), and like some other small, galerinoid cortinarii, these seem difficult/impossible to distinguish by macroscopical features alone. However, the species are clearly differentiated on the spore size and partly the shape, – at least when the rather uniform spores from spore deposits on the stipe are compared. *Cortinarius puellaris* has a spore average of 8.75 × 5.87 µm, whereas the spores of *C.* cf. *cristatosporus* is larger, with MV = 9.5 × 5.92 µm. Normally, the two species can be distinguished on average spore size <9.0 µm and >9.0 µm, respectively. Furthermore, the spores of *C. puellaris* are more broadly ellipsoid (Q = 1.49), whereas those of *C.* cf. *cristatosporus* are more ellipsoid-drop-shaped (Q = 1.60). Based on the material seen so far, less than approx. 20% of the collections show overlap in spore size and shape, and for these, an ITS-sequence will be needed to confirm identity.

Phylogenetically, *C. puellaris* differs by 10 nucleotide and indel positions, from our *C.* cf. *cristatosporus* found in calcareous *Tilia* forests. Two mycorrhizal sample sequences, with no data on morphology, differ in only 5 nucleotide and indel positions (Fig. 1). The taxonomic position of this needs further study. *Cortinarius puellaris* and related taxa constitute a sister clade to the *Safranopedes* group, but the former is distinguished on i) smaller, more tiny, galerinoid basidiomes, ii) hardly any saffron yellow tinges on the stipe, and iii) larger and more spiny verrucose spores. The very thin-fleshed taxa of the *C. puellaris*-*C. cristatosporus* group are very easily dried out in their often fairly open and dry deciduous forest habitats, and might be easily overlooked or misidentified.

Cortinarius subtilis **Bendiksen & Brandrud, sp. nov.**

Fig. 2c, 5
MycoBank: MB814276

Type
Norway, Akershus, Asker, Løkenes, Spireodden Nature Reserve, calcareous lime forest under *Tilia cordata* and *Corylus avellana*, 8 Sept. 2011, E. Bendiksen, EB 726/11 (holotype, O-F74955, herb. O). GenBank KT591588
Etymology: from latin *subtilis*, fine, delicate.

Pileus 1–3 cm, obtusely to sometimes acutely conical, then (sharply) umbonate, very fine remnants of fibrillose veil when (very) young, soon glabrous, hygrophanous, sometimes faintly translucently striate with age; centre dark reddish brown (KOR 8-9F6-7), slightly paler towards margin (KOR 7F6-7); drying out diffusely, in longitudal strikes or first from centre (bicoloured), often rather vividly ochre brown near centre on drying (KOR 6C7-6–5A5-4), later the whole cap pale ochraceous (-ochraceous white). Lamellae moderately crowded, emarginate, edge even, (pale) ochraceous brown, later darker, rusty brown. Stipe 3–6.5 × 0.2–0.5 cm, cylindric, often with an attenuate base, often bent or tortuose, with a sparse cover of whitish to whitish ochre/ochraceous white fibrillose veil remnants, partly faintly girdled; initially ochraceous white, then pale brownish with a fleshy tinge, finally more redbrown, at least when handled; a thin, white mycelial felt

Figure 5. *Cortinarius subtilis*. EB 726/11 (holotype). Asker, Løkeneshalvøya, Spireodden. Photo: K. Bendiksen.

often rather pronounced on the lower part. Context pale, with a fleshy brownish tinge; smell insignificant.

Spores 7–8.5 × 4–5 µm, MV = 7.79 × 4.50 µm, Q = 1.73, subamygdaloid (-ellipsoid), weakly and densely verrucose, rather weakly dextrinoid. Basidia hyaline, often with some granulate content, some with more or less brownish, amorphous necropigment; lamellae edge more or less fertile; lamellae trama of more or less narrow hyphae, on mature specimens also with some inflated elements up to 25 µm wide, trama distinctly pigmented, with thickened yellow walls, in some specimens also with distinct yellow brown, zebra-striped encrustrations on narrow elements and thick yellow walls on wider ones, with brown pigment lumps in the corners. Pileipellis duplex; epicutis thin, of approx. 3–5 layers, of 3–10 µm wide and long hyphae, pigmentation variable, hyphae distinctly yellow brown zebra-striped encrusted to almost smooth, with yellow walls; subcutis (hypodermium) more or less subcellular (elements often twice as long as wide) of inflated elements up to 25 µm wide, pigment distinct to strong, mainly yellow(brown) parietal, forming an amber-like embedment. Brown, oleiferous hyphae not seen.

DNA (ITS) sequence

Six sequences from mycorrhizal samples are deposited in GenBank (Fig. 1). No infraspecific variation found. The species is phylogenetically well-supported and rather isolated, distinguished from the closest relatives in ITS region by more than 20 nucleotide and indel differences.

Habitat and distribution

The type was found in the boreonemoral zone of SE Norway, in calcareous lime forests under *Tilia cordata* and *Corylus avellana*. These tree species are the most probable mycorrhizal associates, but also other possible hosts were observed at the site (*Quercus* at 6–7 m distance, tall *Betula* 5 m). The basidiocarps (about 20 specimens) were growing in leaf litter, in vegetation of *Convallaria majalis*, *Hepatica nobilis*, *Lonicera xylosteum*, *Dryopteris filix-mas* and seedlings of *Fraxinus excelsior.*

Elsewhere in Europe, the species has been recorded in more or less calcareous beech or beech-fir forests, as mycorrhiza samples (verified by 100% match with ITS sequences in GenBank), from the following sites: Slovenia, Dinaric Alps, Rajenavski Rog Nature reserve, calcareous virgin beech-fir forest, ectomycorrhizae with *Abies alba* (see Grebenc et al. 2009); Slovenia, Istria peninsula, calcareous *Fagus* forests, *Fagus* ectomycorrhizae; Italy, Trento region calcareous *Fagus* forest on dolomite and limestone, *Fagus* ectomycorrhizae (cfr. Di Marino 2008); France, Claye-Souilly NE of Paris, *Fagus* forests on (lime-rich) clayey soil, *Fagus* ectomycorrhizae (see Buée et al. 2005).

Investigated material
Norway, Akershus, Asker, Løkenes, Spireodden Nature Reserve, 8 Sept. 2011, leg. E. Bendiksen, EB 726/11 (holotype, O-F74955).

Comments
Cortinarius subtilis is a quite anonymous, small species, characterized by tiny, redbrownish basidiocarps, stipe with attenuate base, small, subamygdaloid, finely verrucose spores and the habitat in calcareous *Tilia-Corylus-Quercus* forest. Although small and anonymous, the combination of tiny, galerinoid, redbrown basidiocarps, weakly ornamented, subamygdaloid, small spores, no distinct smell and habitat in calcareous, thermophilous deciduous forests seems rather unique, and should make this recognizable. With the attenuate base, the species may resemble co-occurring deciduous forest taxa in the *C. safranopes* group, but these are normally larger, more ochraceous yellow or olive, and they usually have a vivid saffron ochre colour on some parts of the stipe. Furthermore, these have more strongly (-spiny) ornamented, broadly ellipsoid spores. *Cortinarius subtilis* might also recall a small sized species in the *Hinnulei*-group. However, these also have much more ornamented spores, more ochre yellow colours, and a distinct earth-like smell. Finally, the species resembles *C. puellaris* and other related obtusoid-galerinoid, small taxa in the *C. cristatosporus* group. However, these taxa have extremely ornamented (spiny) spores, and also a more darkening stipe.

Phylogenetically, *C. subtilis* seems to be rather isolated with no clear affinity to any known group/clade. There is no clear indications of our species in mycological literature, and according to the large, ongoing type study in Helsinki, the species has no match among the numerous telamonioid *Cortinarius* types from relevant habitats described by Henry, Bidaud and other French mycologists (K. Liimatainen, T. Niskanen, pers. comm.), indicating that this must be rare. However, a remarkable series of mycorrhizal samples matches in the GenBank, showing that this is well-documented associate of *Fagus* (-*Abies*) in different parts or Europe, from the lowlands of NE France, to the eastern Prealps in N Italy and Slovenia, – and north to *Tilia-Corylus* forests in SE Norway. These evidences from below-ground samples indicate that this species is widely distributed and probably not infrequent in European nemoral-boreonemoral-montane deciduous forests. The untypical proportion between below-ground and above-ground sequence matches indicates that this is relatively more frequent below-ground, rarely producing basidiocarps. But it cannot be ruled out that this tiny species really has a normal fruiting frequency, but might have been notoriously overlooked.

Some species new to Norway since 2009

Cortinarius conterminus Bidaud & Carteret 2014

Fig. 6a

Pileus 3–6 cm, convex to faintly umbonate, very finely silvery-silky fibrillose of veil when young, soon glabrous, hygrophanous, more or less bicoloured when slightly dry; dark purplish brown, chocolate brown to more red-brown, margin paler grey brown to whitish from fibrillose veil when (very) young; more ochraceous grey brown (but not very pale) when dry. Lamellae crowded, emarginate, edge even, initially rather pale greyish brown with a violaceous/-purplish brown tinge, later dark redbrown-chocolate brown. Stipe 3–6 × 0.8–1.5 cm, with clavate-bulbous base, bulb up to 2.2 cm wide, fibrillose to faintly girdled of rather thin silvery whitish veil remnants; initially greyish white with a bluish tinge at apex, soon darkening to greyish(-blackish) brown from base. Context (purplish) brown marbled, with a distinct bluish tinge in apex when (very) young, soon darkening to chocolate brown in the base of bulb, otherwise slightly darkening with age; smell weak, somewhat of radish/earth/raw latex (like many *Bovini* spp.).

Spores 7.5–9 × 4.5–5.5 µm, ellipsoid, rather strongly and densely verrucose.

DNA (ITS) sequence

Two collections sequenced from SE Norway. The species is well-supported phylogenetically, distinguished from related taxa by more than 20 ITS differences. The species is nested in the *Bovini* s. l. clade, related to species such as *C. aleuriodor*, *C. anisatus*, *C. sordidemaculatus* and *C. neofurvolaesus*.

Habitat and distribution

In calcareous *Picea abies* forests, on marble/limestone ridges in shallow, mossy soil (probably 3 finds), also one find from more intermediate rich (less calcareous) low-herb spruce forest. Hitherto known only from SE Norway, and from France (Bidaud et al. 2014). The species is categorized as DD (data deficient) on the Norwegian redlist.

Investigated material

NNorway, Oslo, Grorud, Røverkollen, T.E. Brandrud 4 Sept. 2011 O-F74944); Oppland, Lunner, Omdalsvannet SW, T.E. Brandrud, TEB 420-11.

Comments

Cortinarius conterminus is a medium(-small) sized species with features of the *Bovini* group. That is, rather dark greybrown-chocolate brown colours, and stipe/context that darkens from the base. The species differs from other *Bovini* species by its (bluish-) purplish brown tinges when young, as well as the small spores. *Cortinarius sordidemaculatus* is genetically rather close, but differs in the lack of purplish brown tinges, and slightly larger spores. Another close species, *C. anisatus* is more greybrown and has a smell of aniseed, whereas *C. neofurvolaesus* is more red brownish. The locality at Lunner is characterized by rock outcrops of marble, whereas the collection from medium base-rich rocks near Oslo, indicates that this is not a strictly calciphilous species. The comparison of our sequences with the unpublished type sequence of *C. conterminus* from France was kindly made available by Jean-Michel Bellanger.

Cortinarius fuscescens Kytöv., Niskanen & Liimat. 2014

Fig. 6b

Pileus 2.5–5 cm, obtusely conical to broadly convex, often irregular, later flattened with or without an umbo, when young with fibrillose whitish-pale brownish veil remnants in margin, soon glabrous; hygrophanous, often with a faintly striate margin when expanded; dark (red)brown-umber brown-chocolate brown, (KOR 7E(-F)6-7, R-S27), centre sometimes blackish brown, drying in striae, becoming paler brownish (via KOR 6D7-8/5C7-8) and at last pale ochraceous brown (KOR 5B5-4, A4). Lamellae 2–5 mm, moderately crowded

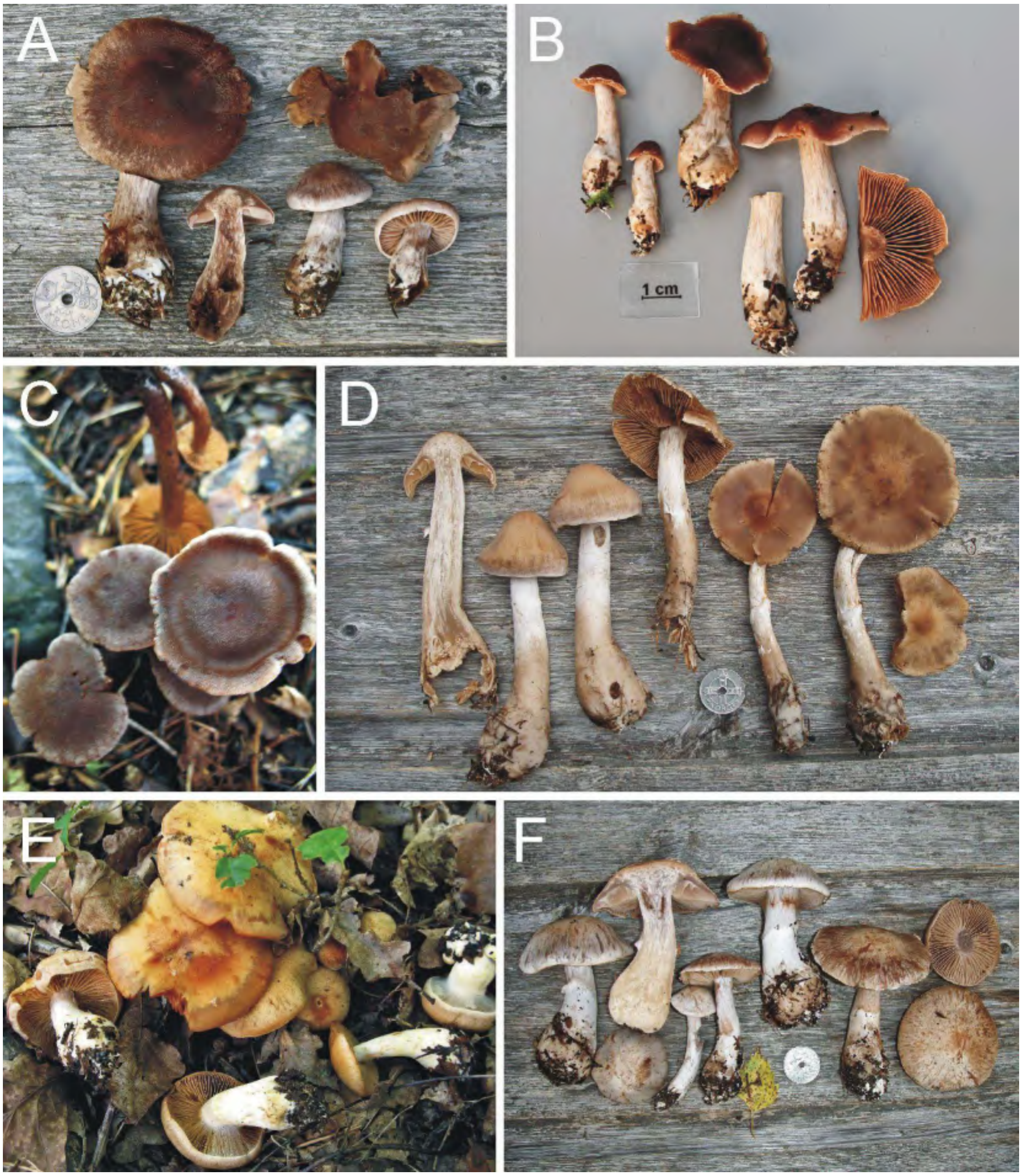


Figure 6. **A:** *Cortinarius conterminus*. TEB 420-11. Lunner, Omdalsvannet SW. **B:** *Cortinarius fuscescens*. TEB 150-14. Lunner, S. Oppdalen. **C:** *Cortinarius fuscoumbrinus*. EB 709/11. Asker, Vettre E. **D:** *Cortinarius impennoides*. TEB 689-13, Jevnaker, Mosmoen **E:** *Cortinarius microglobisporus*. KB&EB 119/11. Drangedal, Henneseidfjellet NR. **F:** *Cortinarius niveotraganus*. TEB 48-13. Ringerike, Viul. Photos: a,b,d.f: K. H. Brandrud; c,e: E. Bendiksen.

to slightly distant, pale brown as young, later rusty brown to reddish brown. Stipe 3.5–6 × 0.4–1 cm at apex, cylindrical to often irregularly clavate (bulb up to 1.5 cm), sometimes with tapering base; silvery fibrillose, pale greyish with sparse veil, then brownish grey. Context when young pale brownish, becoming slightly darker brown with age (but never dark brown in base of stipe), smell insignificant.

Spores (6.5–)7–8.5 × (4–)4.5–5 µm, subamygdaloid (-ellipsoid) weakly (finely) and densely verrucose.

DNA (ITS) sequence
7 collections sequenced here (+ 4 in GenBank, from Finland). No infraspecific variation seen. Distinguished from related species by > 11 nucleotide and indel positions in the ITS region (Niskanen 2014).

Habitat and distribution
Locally common in moderately rich (mesotrophic) to calcareous, young low herb spruce forests (planted after clear cutting) in southern-middle boreal zones in SE Norway, also observed in older forests. Only found under *Picea abies*. The most typical habitat is dense, young forests with a needle bed and only sparse cover of bryophytes, grasses and herbs. Widely distributed in S Norway from central eastern parts (Oppland) to the southernmost parts (Aust-Agder). Otherwise the species is up to now only known from different parts of S Finland (Niskanen 2014).

Investigated material
Norway, Akershus, Nittedal, Slattum, Haugersetra, needle bed in approx. 45 years old, planted low herb spruce forest, E. Bendiksen, EB 139/10. Oppland, Lunner, S. Oppdalen, Amundrud NE, 465 m a.s.l., low herb spruce forest, E. Bendiksen, EB 200/10; EB 617/11 (O-F74976); T.E. Brandrud, TEB 150-14; Karussputten S, UTM NM 85 85, 400 m a.s.l., south boreal zone, calcareous, moss-rich spruce forest, E. Bendiksen, K. Bendiksen 3 Sept. 2011, (O-F74927); S. Oppdalen, Storhaugen S, T.E. & K.H. Brandrud, TEB 101-12; Gran, Svartbråtåberget, UTM NM NM 9012 9192, young, low herb spruce forest, T.E. Brandrud, E. Bendiksen, 9 Aug. 2012 (O-F74962). Aust-Agder, Froland, Jurdalsknuten Nature Reserve, mossy, young, *Picea* plantation, T.E. Brandrud, TEB 250-08.

Comments
Cortinarius fuscescens is a small, but rather stout species usually with an umbonate, brown pileus and sparse veil. The species is very anonymous and is perhaps best characterized by the lack of any remarkable, diagnostic features. However, the small, subamygdaloid spores (recalling those in the *Duracini* group) should be noted. The species has some resemblances to small, dark brownish telamonias such as *C. decipiens* and *C. depressus*, but is slightly warmer redbrown in colours, lack any bluish-pinkish tinges, is more fleshy, and the spores are different. It might also resemble species in the *C. biformis*-group, but is smaller, has smaller spores, and has more uniform, brown colours.

The species has been recorded regularly by one of us (EB) under the working name "*C. pseudodecipiens*" in a *Picea* plantation (from approx. 1960) with permanent plots for a forest succession study of macromycetes from 1978 (Bendiksen 1980), and it still fruits most years in several plots there (Lunner, Oppland). The species exemplifies a typical, anonymous and variable, small, telamonioid species which was evaluated to be difficult to describe as a new species on morphological characters alone because of many similarly looking, hardly interpretable species already described.

The species is probably common at least in the cambrosilurian districts in SE Norway. A find from the very south of Norway, and some probable, but genetically non-verified collections also from other parts of Norway, and a number of finds from Finland (Niskanen 2014), indicate that this might be widely distributed, and much overlooked in Fennoscandia. It is remarkable that this is not among the many hundred small telamonias described from France, and it must be very rare in C–W Europe.

Cortinarius fuscoumbrinus **Liimat., Niskanen & Kytöv. 2014**

Fig. 6c

Pileus 1.5–5 cm, obtusely conical to broadly convex with a slight umbo, later flattened to slightly umbilicate-umbonate; when young with fibrillose whitish to pale brownish veil remnants at margin, soon glabrous or minutely scaly, hygrophanous, some with a very slightly translucently striate margin with age; dark redbrown-umber brown, (KOR 7(-8)F6), on drying bicoloured and also drying in striae, becoming paler via ochraceous brown and finally paler ochraceous. Lamellae 2–6 mm, distant, pale ochraceous yellow brown when young. Stipe 3–8 × 0.4–0.9(–1.2) cm, mostly cylindrical, but some slightly clavate, base tapering; silvery fibrillose, veil sparse as scattered threads, whitish; rather dark brownish grey with a red brown tinge, (KOR ca. 7F5-4); dark brown towards the base, darkening with age. Context pale brownish pale, darker towards the surface, a few turning strongly reddish-purplish in stipe base and basal mycelia by cutting (KOR 9-10C-D6); smell insignificant.

Spores 7.5–9 × 5.5–6(–6.5) µm, broadly ellipsoid to ovoid, strongly and rather densely verrucose, often very strongly verrucose distally.

DNA (ITS) sequence

The one collection sequenced from Norway is 100% identical with the two collections including type from Sweden. Distinguished by >25 ITS differences from related taxa.

Habitat and distribution

The Norwegian find is from a mixed calcareous forest dominated by *Corylus* with some *Pinus*. In Sweden the species is found in dry, calcareous *Quercus*-*Corylus* woodland (Liimatainen 2014). Hitherto, it is redlisted as DD (data deficient) in Norway.

Investigated material

Norway, Akershus, Asker, Vettre E, UTM NM 82561 33538, mixed calcareous forest, dominated by hazel coppices (*Corylus avellana*). Large *Pinus* 3 m and large *Betula* 3 m away, boreonemoral zone, 8 Sept. 2011, E. Bendiksen, EB 709/11.

Comments

Cortinarius fuscoumbrinus is a rather small/medium-sized and rather fleshy species characterized by the dark umber brown pileus, darkening stipe and the small, broadly ellipsoid, strongly verrucose spores. The rather vivid ochraceous brown colour of young lamellae seems also characterizing. It looks mainly like a small species of the *C. bovini*-group, but it has no phylogenetic affinity to the *Bovini* clade(s). The species resembles e.g., the medium large to rather small bovinoid *C.* aff. *rubricosus*, which occurs in calcareous *Corylus-Tilia* forests of the same Oslofjord region, but this has darker lamellae and more pronounced darkening tissue, and is quite dissimilar in ITS sequence. It might also remind medium-sized taxa in the *C. phaeosmus* group, but these differ in a pronounced smell, and more greybrownish colours. Phylogenetically, *C. fuscoumbrinus* is a well-supported and rather isolated lineage in all analyses, with > 25 ITS differences to all related taxa, and seems to be a very distinct species. Apparently, this comes closest to some small to very small species of the *Hydrocybe* group, like *C. casimiri* and *C. bibulus*, as well as the here described *C. annae-maritae* (Fig. 1), which are morphologically quite different species (with greybrownish and bluish tinges).

Cortinarius fuscoumbrinus is apparently a south-southeastern species in Scandinavia, and up to now it has been recorded only in three places worldwide; two in Sweden (Västergötland, Kinnekulle and in Öland) (Liimatainen 2014) and this find from Norway. All of the localities are rich calcareous *Corylus* or *Corylus-Quercus* forests, and well-known mycological hot-spots for rare and threatened species.

***Cortinarius impennoides* Bidaud, Moënne-Locc. & Reumaux 2000**

Fig. 6d

Pileus 2.5–7 cm, hemispherical-campanulate, then plano-convex with or without a broad umbo, margin rather persistently down-curved, often irregular; silky-silvery shiny fibrillose and a broad margin zone with white veil remnants, sometimes rather persistent, with age glabrous, hygrophanous, or bicoloured, with only centre hygrophanous, not translucently striate; somewhat chestnut-redbrown at centre, more greyish brown-clay brown towards margin (KOR 7(-9) F-E6-7, 8-7D7, 6AB5-6), on drying paler in outer part (sometimes drying in radial striae), often starting in a concentric zone near centre, becoming paler greyish brown (KOR 6D4-7 and paler). Lamellae 4–10 mm, moderately crowded, pale brown-clay brown or tinged ochraceous greybrown when young, later darker chestnut brown. Stipe 6–12 × 0.7–1.5 cm, more or less clavate to bulbose, with swollen base up to 4 cm broad; with rather abundant white veil forming one or two irregular girdles, otherwise fibrillose, initially almost whitish, more greyish brown – clay brown – ochraceous greybrown tinged with age and when bruised, apex with a silvery greyish and sometimes a faint bluish tinge when young. Context when young pale whitish grey – greyish brown, in stem apex watery greyish, also sometimes with a faint violet tinge, discolouring dark brown where damaged by insect larvae; smell insignificant or sometimes a distinct raw (somewhat earthy-raphanoid) smell when cut (rapidly disappearing).

Spores (7.5–)8–9 × 5–6 µm, (broadly) ellipsoid, weakly/distinctly and densely verrucose.

DNA (ITS) sequence

6 collections sequenced here (four from Norway). No infraspecific variation seen.

Habitat and distribution

Mainly in dry, sandy pine forests, but also in calcareous pine-spruce forests, and probably also in mesotrophic/semi-rich low-herb spruce forests. The holotype from France is from oligotrophic spruce forest (Bidaud et al. 2000). Probably the species has a wide distribution, confirmed up to now from E France (Isère/Grenoble region), Finland, Sweden and Norway, and it also grows in North America, where it has been identified (DNA) from British Columbia, Canada (Niskanen et al. 2013b). In Finland, it is reported as a common species in boreonemoral to boreal zone (von Bonsdorff et al. 2012).

Investigated material

Norway, Akershus, Bærum, Dælivann, T.E. Brandrud, TEB 754-13; Hedmark: Åmot, Rød, 13 Sept. 2012, K. Bendiksen (O-F74988); Oppland, Jevnaker, Mosmoen, T.E. Brandrud, TEB 689-13; Nord-Trøndelag, Stjørdal, Beistadvollen, T.E. Brandrud, TEB 281-09.
FINLAND: Oulun Pohjanmaa, Oulu, Ritaharju, 26 Aug. 2012, K. Bendiksen & E. Bendiksen, O-F74964, Kaijonharju, Kuivasjärvi S, 24 Aug. 2012, E. Bendiksen, O-F74963.

Comments

Cortinarius impennoides is characterized by the rather large, slender basidocarps with rather "cold" colours, ranging from greybrown/ clay brown to slightly more redbrown (pileus centre). According to Niskanen and Kytövuori (2012), this is a rather frequent and macroscopically variable species. Material seen so far by the present authors was, however, fairly homogeneous, but the species is surely anonymous, and has been remarkable overlooked, until recent documentations by molecular methods. The species resembles some taxa in the *C. biformis* group, but these are either more vividly coloured, with distinct ochraceous yellow and/or distinct bluish tinges (*C. biformis*), or has smaller, more broadly ellipsoid spores (*C. turgidoides*). The species may also recall *C. malachius*, but this has a more fibrillose pileus when young. Furthermore, the species has been mixed with taxa in the *Bovini* group with rather "cold", clay brown colours such as *C. sordidemaculatus*, but *C. impennoides* never darkens in the same manner as the *Bovini* taxa. *Cortinarius impennoides* becomes slightly greyish brown to ochraceous grey brown in the lower half of stipe with age/when bruised, but never dark brown, not even in the base of stipe which becomes regularly dark brown in the *Bovini* taxa. Phylogenetically, *C. impennoides* is not joining the *C. biformis*-*C. malachius*-*C. armeniacus* branch, but comes out as a sister species to *C. bivelus* (Fig. 1), a deciduous forest species with thicker veil, less hygrophanous and more vividly coloured pileus.

Our studied, and phylogenetically confirmed material is from i) dry, sandy pine forests (four collections) and ii) calcareous forests, including dry, karstic calcareous spruce forest (one collection) and dry calcareous mixed forest (probably under *Picea*; one coll.). Since the calcareous (coniferous) forests are more intensively mapped/surveyed for cortinarii in Norway than the sandy pine forests, it seems likely that the latter habitat is the major one for *C. impennoides*, at least for Norway, and the species can probably be added to the long list of Norwegian, preferential sandy pine forest fungi (Brandrud and Bendiksen 2014a,b). This habitat combination of mineral-rich, sandy pine forests and calcareous spruce(-pine) forests is not untypical for a number of species in sandy pine forests such as *C. phrygianus* (Brandrud and Bendiksen 2014). However, according to Niskanen and Kytövuori (2012) and von Bonsdorff et al. (2014), in Finland the species has a wider ecology, including more mesotrophic-oligotrophic coniferous forests.

Cortinarius microglobisporus **Borghi, Bellù & Peintner 2014**

Fig. 6e

Pileus 3–7 cm, convex to plano-convex, pileus margin for a long time curved downward, slightly undulate; when young white fibrillose from veil at margin, sometimes finely, silvery innately fibrillose by pale veil threads elsewhere; more or less hygrophanous, often with characteristic darker hygrophanous veins and spots on paler ground, and a darker, hygrophanous marginal zone, sometimes entire pileus hygrophanous; centre dark ochraceous brown when moist (KOR 6 D-E7-8), in some basidiocarps with a very faint tinge of olivaceous (KOR 5 E8), outer part paler, fleshy brown to somewhat vividly ochraceous brown; normally bicoloured with pale ochraceous yellow brown centre, also with a flesh coloured tinge (KOR 5A4) and a dark brown marginal zone; pale ochraceous yellow brown when entire pileus is dry, (CAI M65) and margin pale brownish (KOR K90/CAI M65). Lamellae 3–5 mm broad, rather dense, even, emarginated with finely fimbriate edge, with a rather vividly ochraceous yellow brown colour as young, later brownish. Stipe 3.0–6.0 × 1.0–1.6 (base up to 2.5) cm, from almost even to clavate and bulbous, and then with a more or less tapered base, on a fibrillose, pale ground covered by a distinctly yellowish veil (KOR 3A4-5) ending upwards in a faint, thread ring zone, lower part may get ochraceous brownish spots by age or touch. Context pale, ochraceous yellowish; smell none or weak.

Spores 5–6.5 × 4–5 µm, globose to subglobose, distinctly/medium strongly and densely verrucose.

DNA (ITS) sequence

The sequence from the Norwegian collection and the sequence from the Italian type appear identical (but the Norwegian sequence is not complete).

Habitat and distribution

Known from one locality in N Europe; boreonemoral zone in SE Norway; in intermediate (mesotrophic) low herb oak forest in dense oak leaf litter, (a 2 m tall *Picea* 2m away), *Juniperus communis*, field layer vegetation sparse, with *Avenella* (*Deschampsia*) *flexuosa*, *Calluna vulgaris*, *Carex digitata*, *Melampyrum pratense*, and *Vaccinium myrtillus*. The species is new to Norway and is earlier only known from the type locality in a submediterranean habitat in Italy (Apeninnes; Parma, Borgo Val di Taro, 700 m a.s.l.) (Peintner et al. 2014), where it was found about three weeks later than the Norwegian find, in 2011. There it occurred in a mesotrophic *Quercus cerris* forest, under *Quercus cerris* and some scattered *Castanea sativa*.

The species is redlisted as VU (vulnerable) in Norway 2015 due to the assumption that this characteristic species is very rare and its association with low-herb oak woodland which is a red-listed habitat.

Investigated material

Norway, Telemark, Drangedal, Henneseidfjellet Nature Reserve, intermediate low herb oak forest, 1. Sept. 2011, K. Bendiksen, T.E. Brandrud, I. Kytövuori, E. Bendiksen, KB&EB 119/11, TEB 667-11.

Comments

Cortinarius microglobisporus is a rather stout species, characterized by the often pale and pseudohygrophanous pileus, with a fine, silvery, innately fibrillose structure, and often a dark, hygrophanous marginal zone, resembling certain phlegmacioid species such as *C. herpeticus* and *C. talus*. Furthermore, the species is characterized by the very small, (sub)globose spores (hence the name *C. microglobisporus*), and its habitat in mesotrophic oak forests. We have also noted an ochraceous yellow tinge on the veil girdles, which is not mentioned in the description of the type. The species resembles *C. balaustinus*, which also may have a pseudohygrophanous, finely innately fibrillose structure of pileus, and has small, subglobose spores. However, this is associated mainly with *Betula* in northern areas, and with *Fagus*. Phylogenetically, they are quite dissimilar. The species is so far only found once in S Norway and once in C Italy (Peintner et al. 2014).

Based on phylogenetic analyses by Peintner et al. (2014) *C. microglobisporus* constitutes a sister to a clade formed by collections of *C. illuminus*, a common species in Fennoscandia growing in oligotrophic *Picea* forest. *Cortinarius illuminus* differs from the present species in the strongly hygrophanous, redbrown pileus with a slightly translucently margin, a brownish discolouring stipe (apex), as well as the habitat. We have not obtained a complete ITS sequence of the Norwegian collection, but the intact part was identical with the sequence of the type, and there is no doubt about the conspecificity of this characteristic species.

Mesotrophic-oligotrophic oak forests have a distinct *Cortinarius* element differing from that of calcareous oak forests. This element, with characteristic species such as *C. subcompar*, *C. cagei* and *C. chromataphilus* (= *C. sabuletorum*) is quite similar both in S Scandinavia and C Europe (see Brandrud et al. 2012), and *C. microglobisporus* seems to belong to this element. However, with its striking characters, this must be a very rare species.

Cortinarius niveotraganus Kytöv., Niskanen & Liimat. 2014

Fig. 6f

Pileus 3–7 cm, convex to often slightly, broadly umbonate, distinctly viscid when very young and fresh, white silky fibrillose when young, later often with darker brown, hygrophanous spots, often bicoloured, with pale fulvous-ochre brown centre, and darker fulvous brown hygrophanous streaks, spots or zones in the outer part. Lamellae with even to serrulate gill edge, pale ochraceous grey at first, then turning pale ochre to rusty brown. Stipe 4–8 × 1–2 cm, with a clavate-bulbose base (up to 3 cm wide), initially with a distinct white girdle from rather thick veil; below girdle whitish fibrillose, above initially greyish white to greyish blue tinged at apex (contrasting the greybrownish lamellae). Context with hygrophanous streaks (marbled), pale ochraceous grey in bulb, initially with a bluish tinge in stipe apex (at least towards the sides), and greyish white in pileus. Smell on surfaces (especially the lamellae) sweetish, fruity, like fruit-esters, resembling that of *C. traganus*, *C. agathosmus*, *C. torvus* or *C. ionosmus*, but sometimes faint to absent, when cut faintly of radish/earth-like.

Spores 9–10.5 × 5–6 µm, ellipsoid (-subamygdaloid), strongly and rather densely verrucose.

DNA (ITS) sequence

Three collections sequenced here (and two in GenBank). No infraspecific variation in ITS seen.

Habitat and distribution

Apparently widely distributed in Norway and the rest of Fennoscandia. In Norway occurring in hemiboreal to northern boreal (subalpine) regions, associated mainly or only with *Betula pubescens* and *B. pendula*, in rich low-herb to calcareous birch forests or mixed forests. In the lowland occurring early in the season (June) together with other late spring-early summer species such as *C. colymbadinus*. Some finds are from sandy, steep slopes, some from formerly cattle-grazed, open woodland or forests rims. It is reported from Sweden and Finland by Niskanen et al. (2008) and Niskanen (2014). The north boreal/subalpine birch forests seem to be the major habitat in Fennoscandia as a whole, and here it occurs in July-August.

Investigated material

Norway, Buskerud, Ringerike, Viul, TEB 48-13. Oppland, Lom, Visdalen, TEB 185-09; Sør-Fron, Augla Nature Reserve, Tåkåstad, TEB 77-07.

Comments

Cortinarius niveotraganus is a characteristic species with its early fruiting from June, initially almost whitish basidiocarps with bluish stipe apex and a sweetish smell upon the lamellae. However, the sweetish smell is not always easy to sense, and the species has apparently been much overlooked, and has been a well-kept secret until quite recently. The species was first introduced in Funga Nordica in 2008 (Niskanen et al. 2008), and then formally described in Niskanen (2014), and is here reported new to Norway. The species can be confused with the whitish deciduous forest taxa *C. alboglobosus* (*Betula*) and *C. niveoglobosus* (*Populus*) which also might come early in the season, but these have smaller spores, lack a distinct sweetish smell and bluish tinges. *Cortinarius alboglobosus* is known at least from one site in Norway (at Voss, Hordaland TEB 144-07, verified with ITS sequence), whereas *C. niveoglobosus* is not found with certainty in

Norway. *Cortinarius niveotraganus* also resembles *C. quarciticus*, but has thicker veil, less bluish tinges, a sweetish smell and larger spores. *Cortinarius quarciticus* occurs in dry (sandy) pine forests. In fact, three of the five known sites of *C. niveotraganus* in Norway are also sandy forests, but on slopes with mixed *Picea* forest with *Betula*, and fruiting quite earlier than *C. quarciticus*. Phylogenetically, *C. niveotraganus* is nested in the section *Telamonia*, apparently most closely related to *C. agathosmus* (19 ITS differences) (see Niskanen 2014, Fig. 1) of which it shares the same smell. However, in other characters these are not similar, for instance, *C. agathosmus* has a thick, membranaceous, ring-like veil on the stipe and different colours. *Cortinarius niveotraganus* is hitherto known almost only from Fennoscandia, but it is very likely to occur also in northern/middle boreal areas of Russia. Like some other *Betula* associates, this seems to be very rare in C. Europe (so far known from one collection in N Germany; leg. G. Schmidt-Stohn).

Cortinarius pseudofallax **Carteret 2004**

Fig. 7a

Pileus 0.5–2(–2.5) cm, campanulate, later more or less umbonate (to plano-convex), strongly hygrophanous; when young silky-fibrillose from veil remnants at margin, or with thicker veil patches, rarely entire pileus finely fibrillose when young, but soon glabrous and glossy; uniformly ochraceous yellow brown (-fulvous) to fudge brown (resembling *C. hinnuleus*), initially with white margin (from veil), paler ochraceous yellow when dry, even whitish when veil fibers still persist. Lamellae crowded, adnate, edge even, initially rather vividly yellow brown to fulvous-fudge brown (like pileus), later slightly darker fulvous. Stipe 2.5–8 × 0.25–0.4 cm, with clavate-cylindric base; veil thick, usually prominent, leaving 1–2 girdles or with a distinct annulated zone (like in *C. parvannulatus*); veil remnants persistently white; stipe apex initially pale to strongly and then persistently violaceous blue, contrasting yellow brown lamellae colour (sometimes whitish grey with a faint bluish tinge), often tinged blue also in the base of stipe; stipe otherwise often with an ochraceous yellow tinge in central part, sometimes becoming darker ochre brown at base. Context ochre brown in pileus, paler ochre greyish in stipe, usually distinctly lilac bluish in stipe apex. Smell faint, possibly somewhat cedar/pencil-like.

Spores 6.5–8 × 4–5 µm, ellipsoid, densely and (medium) strongly verrucose. Pileipellis duplex; epicutis of thin hyaline to basally also slightly brown encrusted hyphae; subcutis (hypodermium) subcellular, elements embedded (cemented) in an amber-like, golden yellow brown parietal pigment, but also more narrow, zebra-encrusted elements occur.

DNA (ITS) sequence

The species shows a small, apparently infraspecific variation. Our 3 sequenced collections from Norway are identical in ITS (except for one length polymorphism), and identical with GenBank sequences from Finland and Sweden. However, these have 1 ITS difference from the type collection from France, as well as from collections from Estonia and Spain. Altogether 10 collections have been sequenced from Europe.

Habitat and distribution

The Norwegian habitat is boreonemoral, dry, calcareous *Tilia* forests under *Tilia cordata* and *Corylus avellana and Salix caprea* (3 collections). Hitherto found in a small area of the inner Oslofjord (Oslo-Asker-Røyken). Outside Norway found mainly in moister habitats under *Salix* spp. and *Populus tremula*, but also in a drier mixed *Quercus*-*Populus* site (Finland). The species is hitherto known from Norway (present study), Sweden, Finland, Estonia, France and Spain, as well as N America (Esteve-Raventós et al. 2013). The species is redlisted as NT (nearly threatened) in Norway due to its rareness and apparent affinity mainly to rare and threatened habitats.

Investigated material
Norway, Oslo, Bygdøy, Hengsåsen, T.E. Brandrud & B. Dima, TEB 526-14; Akershus, Asker, Elnestangen N, T.E. Brandrud & B. Dima, TEB 424-14; Buskerud, Røyken, Bøsnipa, T.E. Brandrud & B. Dima, TEB 738-13.

Comments
Cortinarius pseudofallax is characterized by the following features; an ochre yellow brown, "hinnuleus-coloured" pileus, a thick, often membranaceous-annulate veil on the stipe, and a more or less intensely violaceous blue tinged stipe apex. The species belongs to a complex group of small thick-veiled telamonias, where its close relatives are distinguished e.g. on lack of bluish tinges and darker, more redbrown-umber to brown colours. Formerly, only one species was usually recognized in this group, *C. parvannulatus* (Brandrud et al. 1990–2012, Lindström 2012), and this has probably often been treated collectively. Taken in strict sense, *C. parvannulatus* is apparently distinguished on the complete lack of bluish tinges, and more redbrown colours, apparently also with a more constantly, annulated veil girdle (Esteve-Raventós et al. 2013). The smell seems to be rather similar in the species of the group, but this is perceived differently by different persons; according to Lindström (2012) being distinctly cedar/pencil-like, according to Esteve-Raventós et al. (2013) more sweetly. The sect. *Parvuli* was emended as a name for this group/clade by Esteve-Raventós et al. (2013).

Cortinarius pseudofallax is in Norway hitherto found only in calcareous *Tilia-Corylus* forests of the innermost Oslofjord (Oslo-Asker-Røyken). This seems to be a deviating habitat for the species and the group as a whole. Moist *Salix* swamp forests and rich *Populus tremula-Salix caprea* forests seem to be the main habitats for the species elsewhere in the Nordic countries and in other regions of Europe and North America, as well (Esteve-Raventós et al. 2013). However, the species is from Finland also reported from a rich *Quercus robur-Corylus avellana-Populus tremula* forest, resembling more the Norwegian sites. Furthermore, a rather similar habitat preference, combining rich *Salix* and *Tilia-Corylus* habitats has also been observed for some other species, such as *C. saturninus*. In one case, *Salix caprea* was also present at the site for two of the Norwegian finds.

***Cortinarius salicticolus* Volders & Gelderblom 2013**

Fig. 7b

Pileus 1.5–3.5(–5) cm, irregularly convex to obtusely conical, then plano-convex, often with a low umbo, when young with fibrillose, pale veil remnants in the marginal zone, some with brownish patches near margin, later glabrous; hygrophanous; very dark red brown-umber brown with almost blackish centre, (KOR 7(-8)F8), on drying paler brown (CAI S29-27), drying out concentrically. Lamellae 2–5 mm broad, moderately crowded to somewhat distant, emarginate to rather broadly adnate with a small, decurrent tooth, edge even, initially pale ochre to greyish brown, later darker (P47, 6C6-D7), edge concolorous. Stipe 2.5–4.5(–7) × 0.2–0.5(–0.8) cm, cylindric, often somewhat tortuous, fibrillose, when young faintly girdled from rather thin, whitish to pale brownish veil remnants, becoming brownish like stipe surface; initially silvery pale with a distinct flesh coloured tinge, later more brownish, darker reddish brown on handling. Context at first pale fleshy brown, soon darkening; smell insignificant.

Spores 8.5–10 × 4.5–5.5 µm, MV = 9.38 × 5.00 µm, Q = 1.88; subamygdaloid(-ellipsoid), weakly and densely verrucose, rather weakly dextrinoid. Basidia often filled with golden brown, amorphous necropigment; lamellae edge more or less fertile; lamellae trama of up to 15(–20) µm wide hyphae, weakly pigmented, with faintly thickened yellow walls. Pileipellis duplex; epicutis thin, of approx. 3–5 layers, of 3–10(–12) µm wide and long, distinctly yellow(-brown), verrucose-zebra-striped encrusted pigmented; subcutis (hypodermium) subcellular of inflated elements up to 25(–30) µm wide, pigment strong, mainly yellow parietal, forming an amber-like embedment, sometimes also with yellow brownish crusts, and sometimes with narrow, zebra-striped encrusted hyphae intermixed.

DNA (ITS) sequence

One collection sequenced by us, three sequenced in Gent, Belgium (Delgat 2015), all being identical. The species is well-supported phylogenetically, distinguished in the ITS region from nearest neighbours by more than 20 nucleotide and indel differences.

Habitat and distribution

Found once in SE Norway in boreonemoral zone, under shrubs of *Salix cinerea* near eutrophic lake. There was also a young (3–4 m tall) birch tree 4 m away from the basidiocarps, but *Salix* is the most probable mycorrhizal host. Other vascular plants present were a.o. *Filipendula ulmaria*, *Lysimachia vulgaris*, and *Calamagrostis phragmitoides*. Among fungi, *Entoloma politum* was abundant in the locality. The species is also found in the Antwerpen-Limburg districts of Belgium, on moist ground under *Salix alba*, *S. cinerea* and other willow species (Haan et al. 2013a,b). The species is now redlisted as DD (data deficient) in Norway.

Investigated material

Norway, Akershus, Ås, Østensjøvannet, 28 Sept. 2007, EB 255/07.

Comments

Cortinarius salicticolus is a rather small-sized, but stout species, reminding in habitus of an *Inocybe*. The dark umber brown pileus, the darkening basidocarps and the subamygdaloid, finely verrucose spores are characteristic, as well as the moist habitat under *Salix*. The morphological features and habitat of the Norwegian material conform rather well with those of the protologue of *C. salicticolus* (De Haan et al. 2013a), except that the spores in the protologue are described as slightly smaller than the spores of our material (MV = 8.4 × 4.7 µm versus 9.38 × 5.00 µm). According to Lynn Delgat (pers. comm), however, our sequence has a complete match

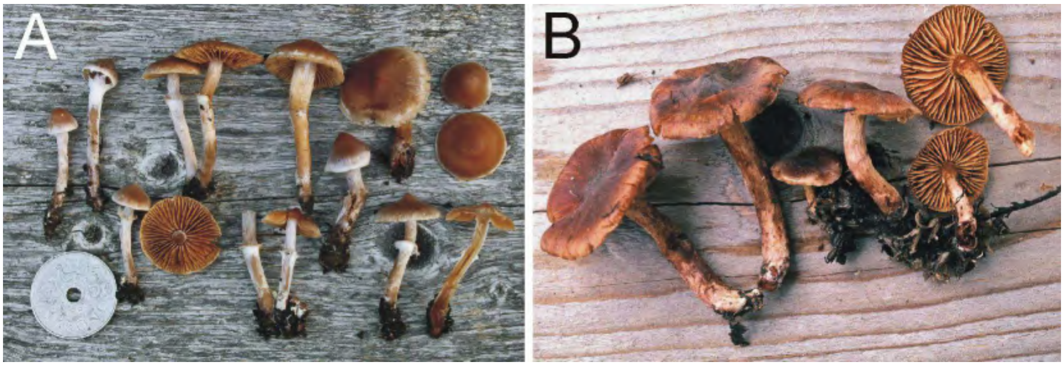


Figure 7. **A:** *Cortinarius pseudofallax*. TEB 424-14. Asker, Elnestangen N. **B:** *Cortinarius salicticolus*. EB 255-07. Ås, Østensjøvannet. Photos: a: B. Dima; b: E. Bendiksen.

with the type sequence of *C. salicticolus* (Delgat 2015). Also *C. cavipes* J. Favre sensu De Haan et al. (2013b) appears to represent the same species, with identical ITS (one collection sequenced by Delgat 2015). This, however, deviates somewhat from our material by the more (pale) yellowish ochre lamellae, and a more or less reddening of basalmycelia, but on the other hand has more similar spore-size (MV = 9.0 × 5.0 µm). Our species, although very little known, seems not to be rare in the Antwerpen-Limburg districts of Belgium, (including *C. cavipes* sensu De Haan et al. 2013a,b).

Cortinarius salicticolus resembles *Cortinarius umbrinolens* (*C. rigidus* s. J.E. Lange) in habit and colours, but lacks the characteristic earth-like smell of the latter one and has more amygdaloid spores. A weak pelargonium smell was noted by De Haan et al. (2013a,b), but such a smell was not found on the Norwegian material of *C. salicticolus*. The weakly ornamented, subamygdaloid and rather narrow spores resembles those of e.g. *C. lux-nymphae*, but this has a thicker veil, fibrillose pileus and a quite different habitat (dry pine(-spruce) forests). Also *C. fuscescens* has resembling spores, but this is a larger, spruce forest species.

Phylogenetically, *C. salicticolus* is well distinguished, in fact, at the moment we do not know of any species with less than 20 ITS differences from this one. *Cortinarius salicticolus* appears in a low-supported basal clade (together with e.g. *C. psammocephalus*) of lineages with *Incrustrati-Saniosi-Paleaci* species such as *C. angelesianus* and *C. flexipes*, and it is distant from the apparently morphologically most similar *C. umbrinolens* (Fig. 1).

A lacustrine-riparian habitat, among the moist *Salix* thickets along lake shores or river banks is unusual for cortinarii, but species such as *C. cinnamomeoluteus*, *C. uliginosus*, *C. helobius* s. lat. and *C. lacustris* are typical in such sites. Also species in the section/clade *Parvuli*, such as *C. pseudofallax* treated here, occur in moist *Salix* habitats.

ACKNOWLEDGEMENTS

We thank Kare Liimatainen, Tuula Niskanen, University of Helsinki for information on lack of type sequence matches regarding our new species, Ilkka Kytövuori, Univ. Helsinki for extensive field work co-operation 2010–2011, Jean-Michel Bellanger, French Institute of Health and Medical Research as well as Lynn Delgat and Annemieke Verbeken, University of Gent, for confirming the identity of type sequences of *C. conterminus* and *C. salicticolus*, resp. and Rasmus Kjøller, Univ. Copenhagen for information on sequenced mycorrhizal samples. Håkan Lindström, Kälarne and Jacques Melot, Reykjavik are thanked for taxonomic and nomenclatural advices, respectively. Furthermore, we thank Mika Bendiksby, Marit M. Bjorbækmo, Ingeborg Bjorvand Engh, Univ. Oslo and Tobias G. Frøslev, Univ. Copenhagen for sequencing and analyses of ITS sequences of parts the present material. Some DNA barcode data in this publication was generated in collaboration with the Norwegian Barcode of Life Network (NorBOL) funded by the Research Council of Norway and the Norwegian Biodiversity Information Centre, and we thank Gunnhild Marthinsen and Katriina Bendiksen, University of Oslo for their help and co-operation with these samples. Katriina Bendiksen is also thanked for making spore-drawings, and Kristin H. Brandrud for photos.

Much of the data presented here are results of a Species Project on *Cortinarius* 2010–2012, funded by The Norwegian Biodiversity Information Centre (“Artsdatabanken”). Some recent data are also obtained through a monitoring program for calcareous *Tilia* forests, as part of a national program for mapping and monitoring red listed species (the ARKO project), funded through the Norwegian Environment Agency.

REFERENCES

Altschul, SF, Gish W, Miller, W, Myers EW, Lipman DJ, 1990. Basic local alignment search tool. Journal of Molecular Biology 215: 403–410.

Bendiksen E, 1980. *Cortinarius*, underslekter *Leprocybe*, *Sericeocybe*, *Myxacium* og *Telamonia* i forskjellige suksesjonsstadier av granskogssamfunn i Lunner, Oppland. – Cand. scient. thesis, Univ. Oslo, 81 p.

Bidaud A, Moënne-Loccoz P, Reumaux P, 2000. Atlas des Cortinaires. Pars IX. S.A.R.L. Editions fédérations mycologique Dauphiné-Savoie. Marlioz.

Bidaud A, Carteret X, Eyssartier G, Moënne-Loccoz P, Reumaux P, 2003. Atlas des Cortinaires. Pars XIII. S.A.R.L. Editions fédérations mycologique Dauphiné-Savoie. Marlioz.

Bidaud A, Carteret X, Reumaux P, 2014. Atlas des Cortinaires. Pars XXIII. S.A.R.L. Editions fédérations mycologique Dauphiné-Savoie. Marlioz.

Bjorbækmo MFM, Carlsen T, Brysting A, Vrålstad T, Høiland H, Ugland KI, Geml J, Schumacher T, Kauserud H, 2010. High diversity of root associated fungi in both alpine and arctic *Dryas octopetala*. BMC Plant Biology 10: 244.

von Bonsdorff T, Niskanen T, Kytövuori I, Liimatainen K, Vauras J, Kokkonen K, Huhtinen S, Puolasmaa A, Kosonen L, 2012. New national and regional biological records for Finland 1. Contributions to agaricoid and ascomycetoid taxa of fungi. Memoranda Societatis pro Fauna et Flora Fennica 88: 53–60.

Borchsenius F, 2009. FastGap 1.2. – http://www.aubot.dk/FastGap_home.htm, Department of Bio-sciences, Aarhus University, Denmark.

Brandrud TE, Bendiksen E, 2014a. Fungi of sandy pine forests in Norway, and a comparison of this threatened element elsewhere in Europe (-Asia). Agarica 35: 67-87.

Brandrud TE, Bendiksen E, 2014b. Sandfuruskog og sandfuruskogsopper. Viktige områder for biologisk mangfold. NINA Rapport 1042. 74 p.

Brandrud TE, Dima B, Schmidt-Stohn G, 2012. *Cortinarius* species in acidophilous-eutrophic (but not calciphilous) oak forests of S Norway and Hungary. Journal des J.E.C. 14: 7–26. (English version)

Brandrud TE, Lindström H, Marklund H, Melot J, Muskos S, 1990–2012. Cortinarius, Flora Photographica. Vol. 1–5. Härnösand.

Buée M, Vairelles D, Garbaye J, 2005. Year-round monitoring of diversity and potential metabolic activity of the ectomycorrhizal community in a beech (*Fagus sylvatica*) forest subjected to two thinning regimes. Mycorrhiza 15(4): 235–245.

Cailleux A, 1981. Code des couleurs des sols. Boubée, Paris.

De Haan A, Volders J, Gelderblom J, Verstraeten P, Van de Kerckhove O, 2013a. Bijdrage tot de kennis van het subgenus *Telamonia* (*Cortinarius*) in België: 18de verslag van de werkgroep Cortinarius. Sterbeeckia. 32: 11-29.

De Haan A, Volders J, Gelderblom J, Verstraeten P, Van de Kerckhove O, 2013b. *Cortinarius* subg. *Telamonia* in Vlaanderen. Sterbeeckia. 32, Bijlage.

Delgat L, 2015. The giant genus Cortinarius: C. subgen. Telamonia in Flanders. Master Thesis. University of Gent.

De Marino E, 2008. The ectomycorrhizal community structure in beech coppices of different age. Thesis. University Padova & Munich.

Esteve-Raventós F, Niskanen T, Platas G, Liimatainen K, Ortega A, 2014. *Cortinarius pseudofallax* (Cortinariaceae, Agaricales), the first records from the Iberian Peninsula and Fennoscandia, and taxonomic notes on the *C. parvannulatus*/*cedriolens* group. Mycological Progress 13: 393–398.

Evju M,, Bakkestuen V, Blom HH, Brandrud TE, Bratli H, Nordén B, Sverdrup-Thygeson A, Ødegaard F, Åström J, 2014. Kartlegging og overvåking av rødlistearter: Framdriftsrapport for ARKO-prosjektet i 2014. NINA Minirapport 525.

Frøslev TG, Matheny PB, Hibbett DS, 2005. Lower level relationships in the mushroom genus *Cortinarius* (Basidiomycota, Agaricales): A comparison of RBP1, RBP2, and ITS phylogenies. Molecular Phylogenetics and Evolution 37: 602−618.

Frøslev TG, Jeppesen TS, Laessøe T, Kjøller R, 2007. Molecular phylogenetics and delimitations of species in *Cortinarius* section *Calochroi* (Basidiomycota, Agaricales) in Europe. Molecular Phylogenetics and Evolution 44: 217–227.

Gardes M, Bruns TD, 1993. ITS primers with enhanced specifity for basidiomycetes, application to the identification of mycorrhizae and rusts. Mol Ecol 2:113–118.

Garnica S, Schön ME, Abarenkov K, Riess K, Liimatainen K, Niskanen T, Dima B, Soop K, Frøslev TG, Jeppesen TS, Peintner U, Kuhnert-Finkernagel R, Brandrud TE, Saar G, Oertel B, Ammirati JF, in prep. Determining threshold values for barcoding fungi: lessons from *Cortinarius* (Basidiomycota), a highly diverse and widespread ectomycorrhizal genus.

Gouy M, Guindon S, Gascuel O, 2010. SeaView version 4: a multiplatform graphical user interface for sequence alignment and phylogenetic tree building. Molecular Biology & Evolution 27(2): 221–224.

Grebenc T, Christensen M, Vilhar U, Čater M, Martin MP, Simomčič P, Kraigher H, 2009. Response of ectomycorrhizal community structure to gap opening in natural and managed temperate beech-dominated forests. Canadian Journal of Forest Research 39: 1375–1386.

Henriksen S, Hilmo O, Kålås, JA, 2015. The 2015 Norwegian red list for species. Norwegian Biodiversity Information Centre, Trondheim. (in print).

Henry R, 1935. Etude de quelques Cortinaires. Bulletin Société mycologique de France 51: 215–241.

Knudsen H, Vesterholt J, 2012. Funga Nordica. Agaricoid, boletoid, clavarioid, cyphelloid and gastroid genera. Nordsvamp, Copenhagen.

Kornerup A, Wanscher JH, 1978. Methuen handbook of colour, ed. 3. Eyre Methuen, London.

Liimatainen K, 2014. Nomenclatural novelties. Index Fungorum no. 198.

Liimatainen K, Niskanen T, Ammirati JF, Kytövuori I, Dima B, 2015. *Cortinarius*, subgenus *Telamonia*, section *Disjungendi*, cryptic species in North America and Europe. Mycological Progress 12: 1016.

Lindgaard A, Henriksen S, 2011. The 2011 Norwegian red list for Ecosystems and habitat types. Norwegian Biodiversity Information Centre, Trondheim.

Lindström H, 2012. Key P: Subgen. *Telamonia* sect. *Hydrocybe* (Fr.) Nezdojm. In: Knudsen H, Vesterholt J, (eds.), Funga Nordica, 2nd edn. Nordsvamp, Copenhagen, pp 878–882.

Löytynoja A, Goldman N, 2005. An algorithm for progressive multiple alignment of sequences with insertions. – Proceedings of the National Academy of Sciences of the United States of America (PNAS) 102(30): 10557–10562.

Nagy LG, Kocsubé S, Csanádi Z, Kovács GM, Petkovits T, Vágvölgyi C, Papp T, 2012. Remind the gap! Insertion – deletion data reveal neglected phylogenetic potential of the nuclear ribosomal internal transcribed spacer (ITS) of fungi. PLoS ONE 7 e49794.

Niskanen T, 2014. Nomenclatural novelties. – Index Fungorum no. 201.

Niskanen T, Kytövuori I, 2012. Key, in: Subgen. *Telamonia* sects. Balaustini Moënne-Locc. and Remaux, *Lanigeri* Melot and Niveoglobosi Kytöv., Liimat. and Niskaen. In: Knudsen H, Vesterholt J. (eds.) Funga Nordica, 2nd edn. Nordsvamp, Copenhagen, pp 860–862.

Niskanen T, Kytövuori I, Liimatainen K, 2009. Cortinarius sect. *Brunnei* (Basidiomycota, Agaricales) in northern Europe. Mycological Research 113: 182–206.

Niskanen T, Kytövuori I, Liimatainen K, 2011a. *Cortinarius* sect. *Armillati* in North Europe. Mycologia 103: 1080–1101.

Niskanen T, Kytövuori I, Liimatainen K, Lindström H, 2013a. The species of *Cortinarius*, section *Bovini*, associated with conifers in Northern Europe. Mycologia 105: 977–993.

Niskanen T, Liimatainen K, Kytövuori I, Lindström H, 2008. Subgen. Telamonia (Fr.) Trog. In: Knudsen H, Vesterholt J, (eds) Funga Nordica, 1. edn. Nordsvamp, Copenhagen, pp 721–777.

Niskanen T, Liimatainen K, Ammirati JF, 2013b. Five new *Telamonia* species (*Cortinarius*, Agaricales) from western North America. Botany 91: 478–485.

Peintner U, Dresch P, Bellù F, Borghi E, 2014. *Cortinarius microglobisporus* (Basidiomycota), a new species with roundish spores related to *C. illuminus*. Mycological Progress 13: 899–904.

Peintner U, Moncalvo J-M, Vilgalys R, 2004. Toward a better understanding of the infrageneric relationships in *Cortinarius* (Agaricales, Basidiomycota). Mycologia 96: 1042–1058.

Ratnasingham S, Hebert PDN, 2007. BOLD: The Barcode of Life Data System (www.barcodinglife.org). Molecular Ecology Notes 7, 355-364.

Ratnasingham S, Hebert PDN, 2013. A DNA-Based Registry for All Animal Species: The Barcode Index Number (BIN) System. PLoS ONE 8(8): e66213.

Silvestro D, Michalak I, 2012. raxmlGUI: a graphical front-end for RAxML. Organisms Diversity & Evolution 12: 335–337.

Simmons MP, Ochoterena H, Carr TG, 2001. Incorporation, relative homoplasy, and effect of gap characters in sequence-based phylogenetic analysis. Systematic Biology 50(3): 454–462.

Stamatakis A, 2014. RAxML version 8: a tool phylogenetic analysis and post-analysis of large phylogenies. Bioinformatics 30: 1312–1313.

Stensrud Ø, Orr RJS, Reier-Røberg K, Schumacher T, Høiland K, 2014. Phylogenetic relationships in *Cortinarius* with focus on North European species. Karstenia 54: 57–71.

White TJ, Bruns T, Lee S, Taylor J, 1990. Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. In: Innis MA, Gelfand DH, Sninsky JJ, White TJ (eds.), PCR protocols: a guide to methods and amplifications. Academic, New York, pp 315–322.

APPENDIX

Table 1. *Cortinarius* sequences produced in this study. *Cortinarius microglobisporus* (TEB667-11) are included in the phylogeny but not listed here, since only part of the ITS1 region was amplified successfully, therefore it is excluded from the GenBank submission. (N= Norway, SF=Finland, F=France)

Species	Voucher	Locality	GenBank accessions
C. annae-maritae sp. nov.	O-F74990 (holotype)	N, Finnmark	KT591589
C. conterminus	TEB 420-11	N, Oppland	KT591611
C. conterminus	O-F74944	N, Oslo	KT591610
C. fuscescens	EB 139/10	N, Akershus	KT591599
C. fuscescens	TEB 250-08	N, Aust-Agder	KT591594
C. fuscescens	EB 200/10	N, Oppland	KT591597
C. fuscescens	O-F74976 (EB 617/11)	N, Oppland	KT591595
C. fuscescens	O-F74927	N, Oppland	KT591598
C. fuscescens	O-F74962	N, Oppland	KT591596
C. fuscescens	TEB 150-14	N, Oppland	KT591600
C. fuscoumbrinus	O-F74959	N, Akershus	KT591587
C. impennoides	TEB 754-13	N, Akershus	KT591605
C. impennoides	O-F74988	N, Hedmark	KT591608

C. impennoides	TEB 281-09	N, N-Trøndelag	KT591607
C. impennoides	TEB 689-13	N, Oppland	KT591606
C. impennoides	O-F74963	SF, Oulu	KT591609
C. impennoides	O-F74964	SF, Oulu	KT591604
C. niveotraganus	TEB 048-13	N, Buskerud	KT591602
C. niveotraganus	TEB 77-07	N, Oppland	KT591603
C. niveotraganus	TEB 185-09	N, Oppland	KT591601
C. pseudofallax	TEB 424-14	N, Akershus	KT591592
C. pseudofallax	TEB 738-13	N, Buskerud	KT591593
C. pseudofallax	TEB 526-14	N, Oslo	KT591591
C. puellaris sp. nov.	TEB 431-14 (holotype)	N, Akershus	KT591581
C. puellaris	TEB 529-11	N, Akershus	KT591582
C. puellaris	TEB 368-14	N, Akershus	KT591586
C. puellaris	TEB 214-14	N, Oslo	KT591583
C. puellaris	TEB 327-10	N, Telemark	KT591580
C. puellaris	TEB 990-13	F, Hérault	KT591584
C. puellaris	TEB 991-13	F, Hérault	KT591585
C. salicticolus	EB 255/07	N, Akershus	KT591590
C. subtilis sp. nov.	O-F74955 (holotype)	N, Akershus	KT591588

Table 2. Telamonioid *Cortinarius* species new to Norway (2009-)2010-2014, verified with ITS sequences. Complex = species complexes that have been splitted in two or more taxa.

Species	Status	Finds sequenced 2010-2014	1. publiced NO
A calcareous Tilia-Corylus forests			
C. cf. *cristatosporus*	complex	Oslo, Bærum, Røyken, Gran	Evju et al. 2014
C. ferrugineovelatus	complex	Bærum	here
C. fuscoumbrinus		Asker	here
C. hillieri	complex	Oslo, Asker, Lunner	Brandrud 2011
C. aff. *milvinicolor*	complex	Asker, Porsgrunn, Froland	Evju et al. 2014
C. aff. *milvinicolor* II	complex	Lunner, Gran	here
C. aff. *phaeosmus*	complex	Hole	Brandrud 2011
C. nodosisporus	complex	Oslo	here
C. pseudofallax	complex	Oslo, Bærum, Asker, Røyken	Evju et al. 2014
C. aff. *pseudosafranopes*	complex	Oslo, Hole, Larvik, Tokke	Evju et al. 2014
C. puellaris sp. nov.	complex	Oslo, Bærum, Asker, Røyken, Hole, Bamble	here
C. aff. *rubricosus*	complex	Hole, Porsgrunn	Evju et al. 2014
C. aff. *safranopes*	complex	Oslo	here
C. saturninus II	complex	Oslo, Bærum, Røyken	here
C. aff. *sordescentipes*	complex	Oslo, Bærum, Asker, Lunner, Froland	Evju et al. 2014
C. cf. *strenuisporus*	complex	Oslo, Bærum, Asker, Røyken, Hole	Evju et al. 2014

C. cf. *subcastaneus*		Røyken, Porsgrunn.	here
C. subexitiosus	complex	Bamble	here
C. subtilis sp. nov.		Asker	here
C. umbrinobellus	complex	Gjøvik	here
C. aff. *valgus*		Porsgrunn	here
B rich Quercus-Tilia forest			
C. claroplaniusculus	complex	Drangedal, Evje & Hornnes	here
C. heterocyclus II	complex	Bygland	here
C. leiocastaneus	complex	Larvik	here
C. microglobisporus		Drangedal	here
C. olididisjungendus	complex	Luster, Oppdal	here
C. subbalaustinus II	complex	Lunner, Røyken, Porsgrunn	here
C. subcompar		Arendal	Brandrud et al. 2012
C calcareous Picea-Pinus forests			
C. anisatus	complex	Vestre Slidre	Kålås et al. 2010
C. anisochrous	complex	Hamar, Gran	Niskanen et al. 2013a
C. badiolaevis	complex	Bærum	here
C. aff. *brunneocalcareus*	complex	Lunner	here
C. conterminus	complex	Lunner	here
C. coracis (*C. crassifolius* ss. auct.)	complex	Lunner, Steinkjer	Brandrud et al. 2009
C. ferruginipes coll.	complex	Lunner, Porsgrunn , Bamble	here
C. fuscobovinaster	complex	Steinkjer, Gran, Lunner, Oslo	Niskanen et al. 2013a
C. fuscobovinus	complex	Steinkjer, Gran	Niskanen et al. 2013a
C. aff. *irregularis*	complex	Øystre Slidre, Øyer	here
C. oulankaënsis	complex	Steinkjer, Gran, Lunner	Brandrud et al. 2009
C. orasericeus	complex	Lunner	here
C. piceidisjungendus	complex	Åmot, Volda, Namskogan	here
D sandy pine forests			
C. adustorimosus (*C. pseudorubricosus*)		Søndre Land, Karasjok	Kålås et al. 2010
C. anomalellus		Elverum, Oslo, Stokke	Brandrud & Bendiksen 2014 a, b
C. bayeri		Elverum	Brandrud & Bendiksen 2014 a, b
C. carabus		Elverum, Åmot	Brandrud & Bendiksen 2014 a, b
C. coleoptera		Elverum	Niskanen et al. 2009
C. flexipes II	complex	Elverum	here
C. flos-paludis II	complex	Elverum, Lunner	here
C. fusisporus	complex	Elverum, Nannestad, Ringerike, Drangedal	Brandrud & Bendiksen 2014 a, b

C. impennoides		Jevnaker, Bærum, Åmot, Stjørdal	Funga Nordica 2012
C. melitosarx	complex	Oslo, Åmot, Grong	Brandrud et al. 2009
C. neofurvolaesus		Sel	Brandrud & Bendiksen 2014 a, b
C. pinigaudis	complex	Elverum	Niskanen et al. 2011
C. violilamellatus	complex	Nannestad	Brandrud & Bendiksen 2014 a, b
E Rich subalpine birch forests			
C. annae-maritae sp. nov.		Alta	here
C. aff. *craticius*	complex	Vågå	here
C. heterocyclus	complex	Vågå, Oppdal	here
C. niveotraganus		Ringerike, Lom, Sør-Fron	here
C. roseoarmillatus	complex	Søndre land	here
F other (coniferous) forest types			
C. caesioarmeniacus	complex	Voss	here
C. caesiobrunneus	complex	Vestre Slidre, Øyer	Niskanen et al. 2009
C. carneinatus II	complex	Lunner, Ulvik, Røyrvik	here
C. fuscescens	complex	Lunner, Gran, Nittedal, Froland	here
C. aff. *helvolus*		Lunner, Gran, Steinkjer	here
C. hinnuleus II	complex	Steinkjer, Levanger	here
C. imbutus II	complex	Åmot	here
C. piceidisjungendus	complex	Åmot, Volda, Namsskogan	here
C. privignipallens	complex	Oslo, Åmot, Grong	here
C. salicticolus		Ås	here
C. turgidoides	complex	Namsskogan	here
C. suboenochaelis	complex	Øyer, Elverum	Funga Nordica 2012
C. uraceisporus	complex	Lunner	here

Forty pyrenomycetous fungi belonging to Class Sordariomycetes new to Norway

Björn Nordén[1], Thomas Læssøe[2], John Bjarne Jordal[3], Jens H Petersen[4],
Hermann Voglmayr[5], Walter Jaklitsch[6]

[1]Norwegian Institute for Nature Research (NINA),
Gaustadalleen 21, NO-0349 Oslo, Norway
[2]Department of Biology/Natural History Museum of Denmark, University of Copenhagen, Universitetsparken 15, 2100, Copenhagen Ø, Denmark
[3]Auragata 3, 6600 Sunndalsøra, Norway
[4]Nøruplundvej 2, Tirstrup. DK-8400 Ebeltoft, Denmark
[5]Division of Systematic and Evolutionary Botany, Department of Botany and Biodiversity Research, University of Vienna,
Rennweg 14, A-1030 Vienna, Austria.
[6]Institute of Forest Entomology, Forest Pathology and Forest Protection (IFFF), Department of Forest- and Soil Sciences, University of Natural Resources and Life Sciences, Hasenauerstraße 38, A-1190 Vienna, Austria

Corresponding author: Bjorn.Norden@nina.no

Norsk tittel: 40 kjernesopper nye for Norge

Nordén B, Læssøe T, Jordal JB, Petersen JH, Voglmayr H, Jaklitsch W, 2015. Forty pyrenomycetous fungi belonging to Class Sordariomycetes new to Norway. Agarica 2015 vol. 36: 43-54.

KEYWORDS
Ascomycetes, wood-living fungi, bark-living fungi, pyrenomycetes

NØKKELORD
Sekksporesopp, vedboende sopp, barkboende sopp, pyrenomyceter

SAMMENDRAG

40 arter av kjernesopper (pyrenomyceter) tilhørende klassen Sordariomycetes presenteres som nye for Norge. Artene ble samlet i edellauvskog i Sør-Norge som del av et prosjekt finansiert av den norske Artsdatabanken. Artene er hovedsakelig vedboende, men noen arter som vokser på bark, lav, moser, møkk og sopp er også inkludert.

ABSTRACT

Forty species of ascomycetes belonging to class Sordariomycetes are presented as new to Norway. The species were collected in temperate deciduous forest in South Norway as part of a project financed by the Norwegian Biodiversity Information Centre. The species are mainly wood-inhabiting, but a few species on bark, bryophytes, fungi, lichens or dung are also included.

INTRODUCTION

Ascomycetes come in a bewildering array of shapes and forms, and in exceedingly great numbers. However, despite their outstanding importance for biodiversity, especially the non-lichenized members remain little studied and poorly known. This is certainly true for pyrenomycetous fungi, i.e. fungi with perithecia, or with ascomata resembling perithecia. Before the era of modern and molecular systematics, such fungi were collectively referred to as Pyrenomycetes, but belong to several only distantly related clades or lineages. One of the largest of these groups is class Sordariomycetes, which encompasses for example the well-known genera *Sordaria*, *Trichoderma* and *Xylaria*. Sordariomycetes are found on many different substrates of which dead wood of deciduous trees is one of the most species rich. Few mycologists study these fungi in Norway, but an active research group exists at the arctic university in Tromsø. In a project financed by the Norwegian Biodiversity Information Centre (Artsdatabanken), pyrenomycetous fungi were surveyed in the temperate deciduous forests of southern and western Norway. In this paper we concentrate on species belonging to class Sordariomycetes and report 40 species as new to Norway. In addition, finds of five rarely collected species are reported. The reported species are predominantly associated with dead wood or bark, but some were collected from bryophytes, fungal fruit-bodies, lichen thalli, or droppings. Short comments on the distribution, ecology and taxonomy of the species are provided.

MATERIALS AND METHODS

Most of the reported species were collected in the field by us, but a few of the species were instead encountered during a revision of the mycological collections in Norwegian herbaria. All collections were made in temperate deciduous forests in southern and western Norway, north to Steinkjer in Nord-Trøndelag. The species were determined by studying the sexual morph (teleomorph) under the microscope unless otherwise stated. Experts in various groups were consulted for determination or verification of several species, and an international expert workshop was arranged in Arendal in October 2014. Another workshop for amateur mycologists from Norway was arranged in Tønsberg in October 2013. A species was considered as new to Norway unless it appeared in Aarnæs (2002) or in either The Norwegian Mycological Database (NSD 2015) or Norwegian Biodiversity Information Centre (Artsdatabanken 2015). Only selected finds are presented and more material may exist. Positions are given as latitude/longitude with decimal degrees. All collections will subsequently be placed in Herb. O. Collectors and identifiers are: BN= Björn Nordén, CL=Cristian Lechat, EJ=Edvin Johannesen, HG=Helge Gundersen, HV= Hermann Voglmayr, JBJ=John Bjarne Jordal, JF=Jacques Fournier, JHP=Jens H. Petersen, JS=Jogeir Stokland, PC=Paul Cannon, TL= Thomas Læssøe, WJ=Walter Jaklitsch. Data on distribution in Sweden and Denmark are cited from Eriksson (2014) and Dansk Svampeatlas (2015), respectively if not otherwise stated.

RESULTS

***Albertiniella polyporicola* (Jacz.) Malloch & Cain.** Fig. 1.

This species is relatively common in Sweden and has 21 records in Denmark.

Material: Oslo, 200 m SE of Skullerudstua, near Østmarka (Ljanselva), 59.8626 / 10.7880,

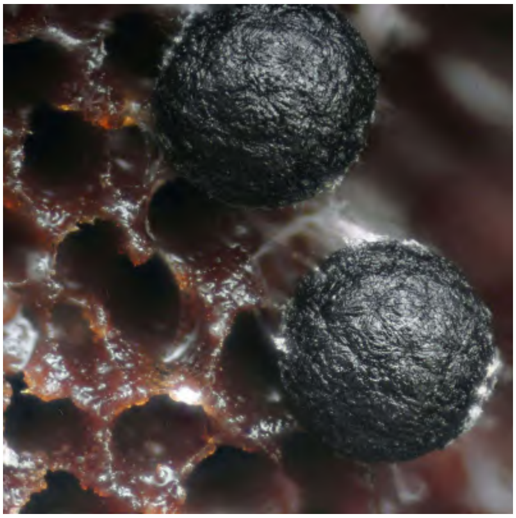


Figure 1. *Albertiniella polyporicola* growing on the hymenium of *Ganoderma applanatum*. Photo: H. Gundersen.

on dead *Ganoderma applanatum* basidiome, May 2, 2013, leg. EJ, HG, det. BN.

Amphiporthe hranicensis **(Petr.) Petr.**
An easily recognizable species that may be common on its host in south Norway. It was found in Skåne in Sweden and has 11 records in Denmark.
Material: Oslo, Vålerenga church, 59.9068 / 10.7880, on attached corticated, *Tilia* branch 1 cm thick, May 29, 2013, leg. & det. TL.

Amphiporthe leiphaemia **(Fr.: Fr.) Butin**
The species is known to be a common endophyte in *Quercus* twigs (Ragazzi et al. 2003). In Sweden it is known from Skåne to Uppland, and it has been found 5 times in Denmark. Material: Vestfold, Tønsberg, Søndre Berg, 59.3005 / 10.4035, on cut corticated *Quercus* branch, Aug. 15, 2012, leg. & det. BN. A previous find was reported by Aarnæs (2002).

Amphisphaeria bufonia **(Berk. & Broome) Ces. & De Not.** Fig. 2, 3.
This species grows according to the literature on *Quercus*, while the type species of the genus, *Amphisphaeria umbrina* (Fr.) De Not. occurs on *Ulmus* (Eriksson 2014). Although our material was found on *Ulmus* it fits better with *A. bufonia* as described by Barr (1994) than with the description of *A. umbrina* in Kang et al. (1999). The spores are verrucose, 1(-3)-septate and about 21 µm long. Both species are known from Sweden, but not from Denmark.
Material: Møre og Romsdal, Nesset, Eikesdalen, Stakkengfonna Nature Reserve, 62.4508 / 8.2772, on bark of living *Ulmus* in deciduous forest, May 14, 2012, leg. BN, JBJ, det. BN, TL.


Figure 2. *Amphisphaeria bufonia* on *Ulmus* bark. Photo: J. B. Jordal.


Fig. 3. One of the *Ulmus* trees on which *Amphisphaeria bufonia* was found (Møre og Romsdal: Nesset: Eikesdalen). Photo: J. B. Jordal.

Bryocentria metzgeriae **(Ade & Höhn.) Döbbeler.** Fig. 4.
This species is most probably overlooked due to the very small ascomata, but it can be spotted by looking for dead, white patches on the common liverwort *Metzgeria furcata.* It is


Figure 4. *Bryocentria metzgeriae* on the thallus of *Metzgeria furcata.* Photo: C. Reisborg.

known from Skåne and Uppland in Sweden, but not from Denmark. A related species, *B. hypothallina* is published separately from Norway as new to science (Nordén et al. 2015).
Material: Vestfold, Tønsberg, Søndre Berg, 59.3005 / 10.4035, on *Metzgeria furcata* on bark of *Quercus*, Aug. 15, 2012, leg. BN, det. BN, TL.

Camarops lutea **(Alb. & Schwein.) Shear**
In Sweden it is known from Skåne to Uppland, and it is rather common in Denmark with a wide host range. Based on its fairly conspicuous stromata it is not expected to be overlooked and may be uncommon in Norway.
Material: Vestfold, Tønsberg, Gullkronene Nature Reserve, Lille Gullkrona, 59.2853 / 10.3826, on fallen *Fagus* trunk, Oct. 25, 2013, leg. & det. TL.

Camarops pugillus **(Schwein.) Shear**
The species appears to be rare in the Nordic countries and usually occurs on deciduous wood, e.g. *Corylus* and *Alnus*, and this appears to be the first published report from coniferous wood *Camarops pugillus* is sometimes difficult to separate from *C. lutea* as intermediate specimens occur. This rare species has been described and illustrated in detail from Sweden and Denmark (Lundqvist 1987, Læssøe and Hansson 2008).
Material: Telemark, Porsgrunn, Bakke, 59.17 / 9.84, *Picea abies* log in temperate deciduous forest, Sept. 4, 1996, leg. JS, det. BN.

Ceratosphaeria lampadophora **(Berk. & Broome) Niessl**
The species is probably not rare on dead wood of deciduous trees but is easily overlooked and clearly less common than species of *Lentomitella* that macroscopically are very similar. It has been collected in Skåne and Västerbotten in Sweden but can probably be found all over the country. In Denmark it was found 3 times.
Material: Hordaland, Etne, Bjelland, 59.8218 / 6.2042, on *Fraxinus* wood, May 10, 2013, leg. & det. BN, TL.

Ceratosphaeria rhenana **(Auersw.) Berl. & Voglino (s. Munk 1957, Cannon 2015)**
The species is probably not rare on dead wood of deciduous trees but is easily overlooked. It is found in Sweden from Skåne to Uppland and was found 4 times in Denmark. It is in need of both taxonomic and phylogenetic assessment.
Material: Akershus, Nesodden, Røer, 59.81 / 10.68, on *Quercus* wood, decorticated attached branch, Feb. 2, 2013, leg. & det. TL.

Ceriospora ribis **Henn. & Plöttn.**
The species is new to Scandinavia.
Material: Vestfold, Horten, Fjugstad, 59.3611 / 10.4637, on wood of *Ribes nigrum* in deciduous forest, Oct. 24, 2013, leg. & det. BN.

Chaetosphaeria tortuosa **Réblová, Seifert & G.P. White**
This species is new to Scandinavia.
Material: Vest-Agder, Kristiansand, Nedre Timenes, on dead fallen *Tilia cordata* twig, Oct. 5, 2014, 58.1649 / 8.1096, leg. & det. PC.

Diatrype decorticata **(Pers.) Rappaz.** Fig. 5.
This species was reported from *Fagus sylvatica* and *Corylus avellana* in Sweden (Eriksson 2014). According to our observations (Nordén unpublished) it probably occurs regularly on *Quercus*. It is found in south Sweden and is reported as common in Denmark.
Material: Akershus, Nesodden, Røer, 59.81 / 10.68, on *Quercus* branch, Feb. 2, 2013, leg. TL, det. BN. A previous find was reported by Aarnæs (2002).

Figure 5. *Diatrype decorticata* on a *Fagus* branch. Photo: C. Reisborg.

***Diatrype stigmaoides* Kauffman.** Fig. 6.
This species was described from North-America and is distinguished by e.g. a prominently undulating stromatal surface, a prominent white endostroma, and preference for *Quercus*. It was previously collected in continental Europe but is new to Scandinavia (Fournier unpublished).
Material: Aust-Agder, Froland, Ytre Lauvrak, 58.5882 / 8.3255, on *Quercus petraea* in temperate deciduous forest, Sept. 26, 2014, leg. BN, det. JF.

***Endothia gyrosa* (Schwein: Fr.) Fr.**
The pinkish conidial mass of the asexual morph occurring in combination with the sexual morph is diagnostic in the field. The species is probably rare and appears to be new to Scandinavia. Apparently it is also rare in the rest of Europe, and it has been found on *Castanea* in Austria by WJ.
Material: Aust-Agder, Froland, Ytre Lauvrak, 58.5882 / 8.3255, on *Quercus petraea* branch, Oct. 10, 2014, leg. & det. WJ.

***Eutypa leioplaca* (Fr.) Cooke**
This species is probably not rare on *Acer* branches in Norway. It is known from the south to the middle parts of Sweden (Eriksson 2014), and was collected twice in Denmark.
Material: Aust-Agder, Arendal, Langevoll, Nedenes, 58.4217 / 8.6990, on *Acer pseudoplatanus* wood in temperate deciduous forest, Oct. 4, 2014, leg. BN, det. JF.

Figure 6. *Diatrype stigmaoides* on *Quercus*. Photo: B. Nordén.

***Hapalocystis bicaudata* Fuckel**
The Swedish mycologist Lennart Holm made several collections of this species in South Sweden during the nineteen fifties – seventies. It will probably prove to have a wide distribution in Norway as more collectors become aware of the species. It is known from Denmark, but may have declined there due to the Dutch elm disease.
Material: Aust-Agder, Froland, Ytre Lauvrak, 58.5882 / 8.3255, on *Ulmus glabra* branches, Oct. 3, 2014, leg. & det. HV.

***Helminthosphaeria pilifera* Réblová**

This species is probably myco-parasitic but nothing is known about host range. Some seemingly closely related species parasitize various corticioid fungi and *Clavulina coralloides*. It was described from *Fagus* wood in the Czech Republic (Réblová 1999) based on a single collection. It was found once in southern Sweden, but is not known from Denmark.

Material: Aust-Agder, Arendal, Songeskogen, Stea, 58.4942 / 8.8049, on *Populus tremula* wood in temperate deciduous forest, Oct. 4, 2014, leg. & det. JF.

***Hypoxylon fuscoides* J. Fourn., P. Leroy, M. Stadler & Roy Anderson**

This species is very similar in appearance to the very common species *H. fuscum* but differs in the purple reaction in KOH solution. It is not with certainty known from Sweden but most probably occurs there, and it is known from 9 collections in Denmark.

Material: Akershus, Nesodden, Røer, ca. 59.81 / 10.68 on *Alnus glutinosa* branch in deciduous forest, Feb. 2, 2013, leg. & det. TL.

***Immersiella caudata* (Curr.) A.N. Mill. & Huhndorf**

The perithecia are immersed in soft and decayed wood and are not easy to spot. It was found a few times in South Sweden and from 5 collections in Denmark.

Material: Vestfold, Tønsberg, Gullkronene Nature Reserve, Lille Gullkronen, 59.2853 / 10.3826, on *Quercus* wood in deciduous forest, Oct. 25, 2013, leg. & det. TL, JHP.

***Lasiosphaeria sorbina* (Nyl.) P. Karst**

This appears to be a rare species and was found only once in Sweden, and likewise in Denmark (Munk 1957).

Material: Hordaland, Bømlo, Spyssøya, Stølsvika South, 59.7253 / 5.3692, on attached, corticated *Tilia* twigs, May 11, 2013, leg. & det. TL. A previous find was reported by Aarnæs (Mathiassen & Granmo (2012).

***Lentomitella crinigera* (Cooke) Réblová**

Lentomitella crinigera belongs to a group of species with immersed perithecia with long protruding necks that often occur on decayed wood of deciduous trees. This species was found in Skåne in Sweden, and once in Denmark.

Material: Norway, [undatet], Anonymous, Herb. O 184457, as *Endoxyla rostrata*, rev. BN, TL 2013.

***Lopadostoma dryophilum* (G.H. Otth) Jaklitsch, J. Fourn. & Voglmayr**

This is a rarely collected species. It appears to be confined to *Quercus* spp. (Jaklitsch et al. 2015). It is not known from Sweden and has only two recent Danish records.

Material: Akershus, Nesodden, Røer, ca. 59.81 / 10.68, on corticated *Quercus* branch in association with *Vuilleminia comedens* and *Ascodichaena rugosa*, Apr. 26, 2013, leg. & det. TL.

***Melanconiella flavovirens* (G.H. Otth) Voglmayr & Jaklitsch**

Voglmayr et al. (2012) gave a monographic account on the genus *Melanconiella* and demonstrated high host specificity of its members, *M. flavovirens* being confined to *Corylus*. Based on our own field experience, we confirm host specificity on *Corylus* and conclude that it may be rare in Scandinavia. It was found in Västergötland and Uppland in Sweden but is not known from Denmark.

Material: Vest-Agder, Kristiansand, Nedre Timenes, 58.1649 /8.1096, on dead attached *Corylus avellana* twig, Oct. 5, 2014, leg. & det. PC.

***Natantiella ligneola* (Berk. & Broome) Réblová**

Natantiella ligneola belongs to a group of species with immersed perithecia with long

protruding necks that often occur on decayed wood of deciduous trees. It was found in Uppland in Sweden and was collected on nine occasions in Denmark.
Material: Møre og Romsdal, Tingvoll, ca. 63.00 / 8.00, on deciduous wood, Aug. 17, 1981, as *Endoxyla rostrata*, Herb. O 184465, leg. Geir Hungnes, rev. BN, TL 2013.

***Nectria nigrescens* Cooke**
This species reminds of *Nectria cinnabarina* but has up to 3-septate ascospores and short to long stipitate sporodochia (Hirooka et al. 2012), which darken and eventually become black in the field, and are then easily recognized. It is new to Scandinavia.
Material: Aust-Agder, Froland, Ytre Lauvrak, 58.5882 / 8.3255, on *Rhamnus frangula,* Oct. 3, 2014, leg. & det. WJ.

***Nemania maritima* Y.M. Ju & J.D. Rogers.** Fig. 7.
Nemania maritima has a wide distribution along warmer coasts where it grows on various kinds of wood (Ju and Rogers 2002), always in contact with sea water. It is not yet known from Sweden, but occurs in Denmark (Læssøe 2003).
Material: Hordaland, Bømlo, Spyssøya, Stølsvika South, 59.7262 / 5.3689, deciduous wood on the beach, May 11, 2013, leg. & det. TL.

Figure 7. *Nemania maritima* on submerged wood by the sea shore. Photo: J. H. Petersen.

***Neobarya parasitica* (Fuckel) Lowen**
This is the only fairly well known member of this myco-parasitic genus (Candoussau et al. 2007). It was found from Skåne to Medelpad in Sweden and was found 11 times in Denmark.
Material: Østfold, Rygge, Kajalunden nature reserve, 59.3644 / 10.6778, on *Bertia moriformis* ascomata on *Fagus* log in deciduous forest, Apr. 23, 2013, leg. & det. BN, TL. A previous find was reported by Aarnæs (2002).

***Phomatospora helvetica* H. Wegelin**
Many aquatic pyrenomycetous fungi can be expected to occur in Norway, but this remains to be studied. The species appears to be new to Scandinavia.
Material: Aust-Agder, Arendal, Langevoll, Nedenes, 58.4217 / 8.6990, on submerged wood in small stream in temperate deciduous forest, Oct. 4, 2014, leg. & det. JF.

***Podospora setosa* (G. Winter) Niessl**
A species growing on dung of various animals and with several finds in Sweden, but has not been found in Denmark.
Material: Aust-Agder, Froland, Ytre Lauvrak, 58.5882 / 8.3255, on roe deer dung in temperate deciduous forest, Oct. 3, 2014, leg. JF, det. Michel Delpont, after incubation in moist chamber. A previous find was reported by Aarnæs (2002).

***Protocrea pallida* (Ellis & Everh.) Jaklitsch, K. Põldmaa & Samuels**
This species is easily identified by its host choice and by a fairly bright orange stromatal colour (Læssøe 1994, Jaklitsch 2011). It has for a long time been known as *Hypocrea pallida*, but Jaklitsch et al. (2008) showed that phylogenetically it clearly belongs to *Protocrea*. This species is known from Skåne in Sweden, and is a rather common species in Denmark.
Material: Akershus, Nesodden, Røer, 59.81 / 10.68, on *Tyromyces basidiomata* on *Betula*, Feb. 2, 2013, leg. & det. TL.

Pseudovalsa umbonata **(Tul. & C. Tul.) Sacc**

Pseudovalsa umbonata is known from six provinces in South Sweden, and may occur in much of the range of *Quercus* also in Norway. It is not known from Denmark.

Material: Aust-Agder, Froland, Ytre Lauvrak, on *Quercus petraea*, 58.5882 / 8.3255, Oct. 3, 2014, leg. & det. HV, WJ.

Quaternaria dissepta **(Fr.) Tul. & C. Tul.**

This species is not rare in Sweden and known from Skåne to Uppland. It was recorded seven times in Denmark. This *Ulmus* specific species may follow the distribution of *Ulmus* in Norway, but probably face decline due to the Dutch elm disease.

Material: Akershus, Fet, Fetsund, 59.9331 / 11.1618, on dead *Ulmus* branch in deciduous forest, May 5, 2013, leg. & det., TL, BN.

Rosellinia helvetica **L.E. Petrini, Petrini & S.M. Francis**

Rosellinia helvetica was found in Skåne to Västergötland in Sweden and three times in Denmark.

Material: Vestfold, Larvik, ca. 59.05 / 10.02, Sept. 2 1879, Herb. O 212179 as *Rosellinia thelena*, Rev. TL, BN. Nord-Trøndelag, Steinkjer, Byahalla NR, 64.0508 / 11.5717, on *Ulmus* twigs on the ground in temperate deciduous forest, May 9, 2014, leg. BN, JBJ, det. BN.

Rosellinia marcucciana **Ces.** Fig. 8.

A synonyme of this species is *R. britannica* L.E. Petrini, Petrini & S.M. Francis (Petrini 2013). Previously, most material referable to this species (and several others) was identified and filed as *R. mammaeformis,* but *R. marcucciana* is a far more common species. *Rosellinia. marcucciana* has larger ascospores and ascus apical plugs than *R. mammaeformis*. It is known from Skåne in Sweden and from 31 Danish collections on a whole range of hardwood hosts.

Material: Vestfold, Nøtterøy, Landsrød, 10.3810 / 59.1788, on *Tilia* wood in temperate deciduous forest, Oct. 27, 2013, leg. & det. BN.

Figure 8. *Rosellinia marcucciana* on fallen branch of a deciduous tree. Photo: C. Reisborg.

Sphaerostilbella berkeleyana **(Plowr. & Cooke) Samuels & Cand.** Fig. 9.

This species has a single record from Sweden (Skåne) and 8 records from Denmark. Its host *Stereum hirsutum* is a common species and more finds of *S. berkeleyana* may turn up if the species is sought for.

Material: Aust-Agder, Arendal, Stea, 58.4930 / 8.8033, in mixed forest, on *Stereum hirsutum* basidiomata, Oct. 4, 2014, leg. & det. TL, Conf. CL.

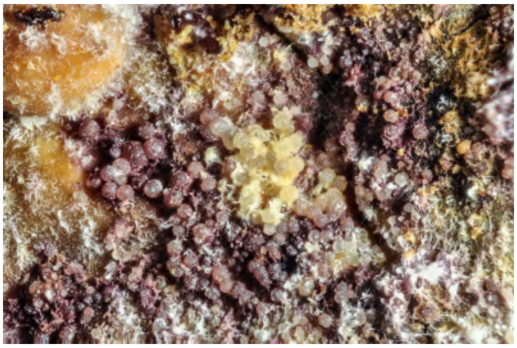


Figure 9. *Sphaerostilbella berkeleyana* on the hymenium of *Stereum hirsutum.* Photo: J. H. Petersen.

Stegonsporium pyriforme (Hoffm.) Corda

The ascospores of *S. pyriforme* are similar to those of *S. acerophilum*, but differ by spore septation and the size of spore appendages (Voglmayr and Jaklitsch 2008), and their hosts (*Acer pseudoplatanus* vs. *A. saccharum*). Jaklitsch and Voglmayr (2014) described two similar species, *S. protopyriforme* and *S. pseudopyriforme*, which also occur on *A. pseudoplatanus* and which can be reliably distinguished from *S. pyriforme* only by molecular data. *Stegonsporium pyriforme* sensu stricto is not with certainty known from Sweden but is known from Denmark (Voglmayr and Jaklitsch 2014).

Material: Aust-Agder, Arendal, Langevoll, Nedenes, 58.4217 / 8.6990, on *Acer pseudoplatanus* twig, Oct. 4, 2014, leg. & det. HV.

Thelonectria discophora (Mont.) P. Chaverri & C. Salgado

A plurivorous species, known from *Salix* in Småland in Sweden, but not from Denmark.

Material: Norway, Aust-Agder, Arendal, Stea, Songeskogen, 58.4942 / 8.8049, on *Quercus* bark, Oct. 4, 2014, leg. CL.

Trichoderma europaeum Jaklitsch & Voglmayr

The ascomata of *Trichoderma* species (formerly classified as *Hypocrea*) are only in good condition for a short period, and many require cultivation and sequencing for reliable determination. They can therefore be difficult to study, and many species are certainly undiscovered in Norway. Until recently, *T. europaeum* has been classified as *T. minutisporum* but Jaklitsch and Voglmayr (2015) demonstrated that *T. minutisporum* sensu stricto is confined to North-America, and described *T. europaeum* and *T. mediterraneum* for European collections. Most previous records of *T. minutisporum* from Europe represent *T. europaeum*, which is the most common species in the genus in Europe (Jaklitsch 2011, Jaklitsch and Voglmayr 2015) including Sweden and Denmark.

Material: Vestfold, Gullkronene Nature Reserve, Lille Gullkrona, 59.2861 / 10.3814, on *Fagus* wood in deciduous forest, Oct. 25, 2013, leg. & det. TL, JHP.

Trichoderma moravicum Jaklitsch

The stromata typically form on decayed wood in moist forest (Jaklitsch 2011). The species appears to be new to Scandinavia.

Material: Vest-Agder, Kristiansand, Nedre Timenes, 58.1642 / 8.1092, on leaf debris in temperate deciduous forest, Oct. 5, 2014, leg. & det. TL.

Trichoderma silvae-virgineae Jaklitsch. Fig. 10.

Stromata of *T. silvae-virgineae* may resemble for instance immature stromata of the common but green-spored *T. strictipile*, but is white-spored and has prominent perithecial contours. It was found once in Skåne in Sweden and also once in Denmark.

Material: Vestfold, Horten, Fjugstad, 59.3611 / 10.4637, on *Fagus* wood in temperate deciduous forest, Oct. 24, 2013, leg. & det. TL & JHP.

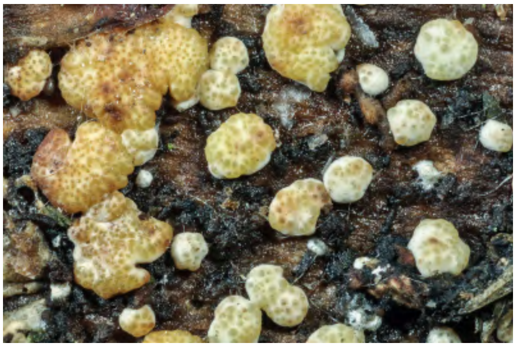


Figure 10. *Trichoderma silvae-virgineae* on *Fagus* log. Photo: J. H. Petersen.

Trichoderma strictipile Bissett

There are many Norwegian collections determined as *Hypocrea gelatinosa*. The majority of these probably represent *Trichoderma strictipile*, a much more common species in

most of Europe (Jaklitsch 2009, Jaklitsch and Voglmayr 2015). The thirteen collections labeled *H. gelatinosa* in Herb. O were all revised as *H. strictipilosa* by BN and TL in 2013. It occurs north to Uppland in Sweden and has 21 Danish records.
Material: Vestfold, Gullkronene Nature Reserve, Lille Gullkrona, 59.2862 / 10.3832, on decorticated *Quercus* wood in temperate deciduous forest, Oct. 25, 2013, leg. & det. TL, JHP.

***Trichonectria rubefaciens* (Ellis & Everh.) Diederich & Schroers.** Fig. 11.
It is known from the lichen *Pleurosticta acetabulum* in Östergötland and Närke in Sweden (Nordin et al. 2015), but has not been found in Denmark.
Material: Hordaland, Etne, Tungesvikstranda, 59.7338 / 5.9724, parasitic on the thallus of *Lobaria virens* on *Fraxinus excelsior* in a steep slope, May 12, 2013, leg. & det. BN.

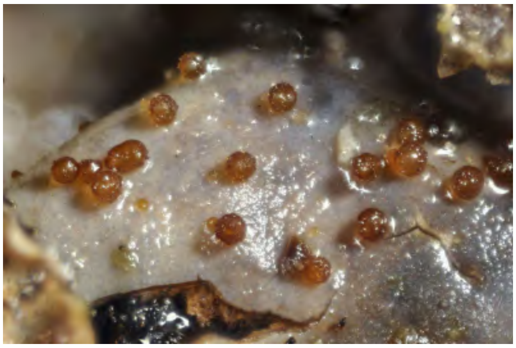


Figure 11. *Trichonectria rubefaciens* on the thallus of *Parmelia sulcata.* Photo: J. H. Petersen.

***Trichosphaerella decipiens* E. Bommer, M. Rousseau & Sacc.**
The species is known from Sweden (Skåne, Öland) and has 17 records in Denmark.
Material: Vestfold, Tønsberg, Gullkronene Nature reserve, Lille Gullkrona, 59.2853 / 10.3826, on the hymenium of *Peniophora limitata* on branch of deciduous tree, Oct. 25, 2013. leg. JBJ, det. TL.

***Vialaea insculpta* (Fr.) Sacc.** Fig. 12.
The species is probably quite common on both wild and planted *Ilex aquifolium* bushes. It is new to Scandinavia.
Material: Aust-Agder, Grimstad, Dømmesmoen Park, 58.3562 / 8.5775, on *Ilex aquifolium* twigs, Oct. 4, 2014, leg. & det. BN.

Figure 12. *Vialaea insculpta* ascospores. Photo: B. Nordén.

***Xylomelasma sordida* Réblová**
Xylomelasma sordida belongs to a group of species with immersed perithecia with long protruding necks that often occur on decayed wood of deciduous trees. It was found in Skåne in Sweden and on three occasions in Denmark.
Material: Nord-Trøndelag, Steinkjer, Byahalla NR, 64.0508 / 11.5717, on dead part of coppiced *Ulmus* in deciduous forest, May 9, 2014, leg. BN, JBJ, det. BN.

DISCUSSION

Our survey shows that pyrenomycetous fungi in temperate deciduous forests have been poorly studied in Norway. The low interest in these fungi by both professional and amateur mycologists is striking, for example in comparison with the interest in small and obscure lichenized fungi. The reasons are probably a paucity of academic traditions with few available experts, and the lack of comprehensive and updated determination keys and check-lists. A first critical check-list of Norwegian Sordariomycetes produced as part of the project (Nordén et al. 2015).

In addition the 40 Sordariomycete species reported here, three species were described as new to science within the project period, *Chlorostroma vestlandicum* (Nordén et al. 2014a), *Bryocentria hypothallina* (Nordén et al. 2015b) and *Stylonectria norvegica* (Lechat et al. 2015), and two were reported as new to Norway in Nordén (2014).

During our intensive search for fungi belonging to class Sordariomycetes in temperate deciduous forests, we also identified several pyrenomycetous fungi new to Norway belonging to other taxonomic groups. The most numerous were species belonging to class Dothideomycetes and to the Chaetothyriomycetidae in Eurotiomycetes, and these findings will be reported elsewhere. Our results highlight the importance of temperate deciduous forests for the diversity of Sordariomycetes and other pyrenomycetous fungi. It is also clear that much work is needed before the wood-inhabiting pyrenomycetous fungi in Norway are satisfactorily known. Further, several species found by us are undescribed and taxonomic work should be intensified.

ACKNOWLEDGMENTS

We owe special gratitude to several experts (credited under each respective species above) who helped with determinations, especially during and after our workshop in Arendal in 2014. The Norwegian Environment Agency enabled the fieldwork, and the Norwegian Biodiversity Information Centre (Artsdatabanken) financed the taxonomic work including the two workshops. The photos by Christopher Reisborg were produced during the work with the Encyclopedia of the Swedish Flora and Fauna at the Swedish University of Agricultural Sciences.

REFERENCES

Aarnæs J-O, 2002. Catalogue over macro- and micromycetes recorded for Norway and Svalbard. Fungiflora A/S Oslo, 412 pp.

Artskart 2015. Norwegian Biodiversity Information Centre Species Map Service. http://artskart.artsdatabanken.no/FaneArtSok.aspx. Accessed 1st May 2015.

Barr ME, 1994. Notes on the Amphisphaeriaceae and related families. Mycotaxon 51: 191-224.

Candoussau F, Boqueras M, Gómez-Bolea A, Læssøe T, Lowen R, Rogers JD, Rossman AY, Samuels GJ, 2007. Observations on *Neobarya*, including new species and new combinations. Sydowia 59: 179-215.

Cannon P, 2015. http://fungi.myspecies.info/all-fungi/ceratosphaeria-rhenana. Accessed 1st May 2015.

Dansk Svampeatlas, 2015. http://www.svampe.dk/soeg/indholdsfortegnelse.php. Accessed 1st May 2015.

Eriksson OE, 2014. Checklist of the non-lichenized ascomycetes of Sweden. Acta Universitatis Upsaliensis. Symbolae botanicae Upsalienses 36: 1-499.

Hirooka Y, Rossman AY, Samuels GJ, Lechat C, Chaverri P, 2012. A monograph of *Allantonectria*, *Nectria*, and *Pleonectria* (Nectriaceae, Hypocreales, Ascomycota) and their pycnidial, sporodochial, and synnematous anamorphs. Studies in Mycology 71: 1-210.

Jaklitsch M, 2009. European species of *Hypocrea* part I. The green-spored species. - Studies in Mycology 63: 1-91.

Jaklitsch WM, 2011. European species of *Hypocrea* part II: species with hyaline ascospores. Fungal Diversity 48: 1-250.

Jaklitsch WM, Põldmaa K, Samuels GJ, 2008. Reconsideration of *Protocrea* (Hypocreales, Hypocreaceae). Mycologia 100: 962-984.

Jaklitsch WM, Fournier J, Rogers JD, Voglmayr H, 2014. Phylogenetic and taxonomic revision of *Lopadostoma*. Persoonia 32: 52-82.

Jaklitsch WM, Voglmayr H, 2015. Biodiversity of *Trichoderma* (Hypocreaceae) in Southern Europe and Macaronesia. Studies in Mycology

80: 1-87.

Ju YM, Rogers JD 2002. The genus *Nemania*. Nova Hedwigia 74: 75-120.

Kang JC, Hyde KD, Kong RY, 1999. Studies on Amphisphaeriales: The Amphisphaeriaceae (sensu stricto). Mycological Research 103: 53-64.

Lechat C, Fournier J, Nordén B, 2015. *Stylonectria norvegica* (Nectriaceae), a new species from Norway. Ascomycete.org 7: 220-224.

Læssøe T, 1994. Tre svampeboende arter af kødkernesvamp (*Hypocrea*) - danske kødkernesvampe 2. Svampe 30: 6-10.

Læssøe T, 2003. Endnu en *Nemania* fundet i Danmark – *Nemania maritima*, in: Vesterholt, J. (ed.). Usædvanlige danske svampefund. Svampe 47: 48-49.

Læssøe T, Hansson S-Å, 2008. Finger-Kulsnegl (*Camarops pugillus*) fundet i Danmark og Skåne. Svampe 57: 30-31, 37.

Lundqvist N, 1987. Pyrenomyceten *Camarops pugillus* funnen i Sverige. Svensk Mykologisk Tidskrift 81: 65-69.

Mathiassen GH, Granmo A, 2012. Sluttrapport for artsprosjektet sekksporesopper i Finnmark 2011-2012. Tromsø.

Munk, A. 1957. Danish pyrenomycetes: a preliminary flora. Dansk Botanisk Arkiv 17: 1-491.

Nordén N, 2014. *Annulohypoxylon minutellum* and *Obolarina dryophila* (Xylariales), two stromatic pyrenomycetes on oak new to Norway. Agarica 35: 25-28.

Nordén B, Læssøe T, Jordal JB, 2014. *Chlorostroma vestlandicum* sp. nov., a host-specific mycoparasite on *Hypoxylon vogesiacum* from western Norway. Karstenia 54: 9-14.

Nordén B, Gardiennet, A, Priou, JP, Döbbeler, P, 2015. *Bryocentria hypothallina* (Hypocreales) – a new species on *Metzgeria furcata*. Ascomycete.org 7: 121-124.

Nordin A, Moberg R, Tønsberg T, Vitikainen O, Dalsätt Å, Myrdal M, Snitting D, Ekman S, 2015. Santesson's Checklist of Fennoscandian Lichen-forming and Lichenicolous Fungi. http://130.238.83.220/santesson/home.php?-link=Home). Accessed 31st March 2015.

NSD, 2015. Norsk Soppdatabase, Naturhistorisk museum, Universitetet i Oslo, http://www.nhm.uio.no/botanisk/sopp/. Accessed 15th March 2015.

Petrini LE, 2013. *Rosellinia*: A world monograph. Bibliotheca Mycologica 205. J. Cramer. 410 pp.

Ragazzi A, Moricca S, Capretti P, Dellavalle I, Turco E, 2003. Differences in composition of endophytic mycobiota in twigs and leaves of healthy and declining *Quercus* species in Italy. Forest Pathology 33: 31-38.

Réblová M, 1999. Teleomorph-anamorph connections in ascomycetes 3. Three new lignicolous species of *Helminthosphaeria*. Sydowia 51: 223-244.

Voglmayr H, Jaklitsch WM, 2008. *Prosthecium* species with *Stegonsporium* anamorphs on *Acer*. Mycological Research 112: 885-905.

Voglmayr H, Jaklitsch WM, 2014. Stilbosporaceae resurrected: generic reclassification and speciation. Persoonia 33: 61-82.

Voglmayr H, Rossman AY, Castlebury LA, Jaklitsch W, 2012. Multigene phylogeny and taxonomy of the genus *Melanconiella* (Diaporthales). Fungal Diversity 57: 1-44.

A checklist of Norwegian Sordariomycetes

Björn Nordén[1], John Bjarne Jordal[2]

[1]Norwegian Institute for Nature Research (NINA),
Gaustadalleen 21, NO-0349 Oslo, Norway
[2]Auragata 3, 6600 Sunndalsøra, Norway

Corresponding author: Bjorn.Norden@nina.no

Norsk tittel: En sjekkliste over kjernesopper i Norge

Nordén B, Jordal JB, 2015. A checklist of Norwegian Sordariomycetes. Agarica 2015 vol. 36: 55-73.

KEYWORDS
Ascomycetes, wood-living fungi, wood-decaying fungi, corticolous fungi, pyrenomycetes, temperate deciduous forest

NØKKELORD
Sekksporesopp, vedboende sopp, barkboende sopp, pyrenomyceter, edelløvskog

SAMMENDRAG
Sjekklista omfatter alle kjernesopper (pyrenomyceter) tilhørende klassen Sordariomycetes som er kjent fra Norge og inkluderer 590 arter. Lista er basert på gjennomgang av herbariemateriale, litteratur og egne undersøkelser 2011-2015.

ABSTRACT
A checklist is presented of ascomycetes belonging to class Sordariomycetes in Norway. It encompasses 590 species. The list is based on material from Norwegian herbaria, literature and our own investigations 2011-2015.

INTRODUCTION

This is the first critical checklist of Sordariomycetes in Norway. Aarnæs (2002) provided a list of 623 names of sordariomycetes, but mentioned that 'To decide what the correct epithet and author citation for a species should be, is the work of a specialist'. The present list attempts to provide updated information on new finds and nomenclature. Specific data on the ecology and distribution of the species in Norway can be gathered from the cited data sources, while more general data on for example substrate relations can be found in Eriksson (2014) and at http://www8.umu.se/myconet/asco/vasc/index.html.

MATERIALS AND METHODS

The list is based on data from Aarnæs (2002), Norsk Soppdatabase (NSD, 2015), the Norwegian Biodiversity Information Centre ("Artsdatabanken" & GBIF Norway (2015), also called "Artskart"), other relevant literature, and the study of own material and material from public herbaria in Norway. In the list, NSD (2015) is not cited separately, since it was merged with Artskart. However, NSD should be consulted if information is not found in Artskart since some of the information may not yet have been implemented in Artskart.

Digitized data on Norwegian herbarium specimens of Sordariomycetes were downloaded 01.11.2015 from Artsdatabanken & GBIF Norway and valid names were extracted and compiled. All names of Ascomycetes mentioned from Norway by Aarnæs (2002) were compiled, in total 3150 names. The identity of all names was controlled by comparing to Eriksson (2014), Index Fungorum (http://www.indexfungorum.org/names/names.asp) and the Norwegian Species Names

Database (Artsdatabanken 2015). Their identity was investigated in the same way as other names. The systematic belonging of the valid names (family, order, class) was added as given in Index Fungorum and Lumbsch and Huhndorf (2010).

Species reported from Norway by reference only to the asexual stage were not listed. Only species with a voucher are listed. We did not include species identified from an environmental DNA sequence. Species in need of cultivation for secure determination but for which this was not performed were excluded. For some old names, usually from the 1800s, we haven't been able to figure out what they would stand for and such names were excluded. Further, entries in Artskart for which no identifier were given were excluded. Among synonyms, mainly those facilitating to find species in Artskart are listed.

RESULTS

The check-list encompasses 590 species, with the largest orders being Xylariales with 145 species, Diaporthales with 122, Hypocreales with 111, and Sordariales with 77 species. After each name, and in some cases synonyms, family and order is followed by Norwegian vernacular name when applicable, and thereafter by source.

The checklist is also available online at Agarica.no.

Acanthonitschkea peltigericola (Alstrup & Olech) O.E. Erikss. & R. Sant., Nitschkiaceae, Coronophorales, source: Aarnæs (2002)

Acanthonitschkea tristis (Pers.: Fr.) Nannf., Nitschkiaceae, Coronophorales, source: Artskart (2015), Aarnæs (2002)

Albertiniella polyporicola (Jacz.) Malloch & Cain, Cephalothecaceae, Sordariales, source: Nordén et al. (2015b)

Allantoporthe decedens (Fr.: Fr.) M.E. Barr, Melanconidaceae, Diaporthales, source: Artskart (2015), Aarnæs (2002)

Allantoporthe tessella (Pers.: Fr.) Petr., Melanconidaceae, Diaporthales, source: Artskart (2015), Aarnæs (2002)

Amphiporthe hranicensis (Petr.) Petr., Valsaceae, Diaporthales, source: Nordén et al. (2015b)

Amphiporthe leiphaemia (Fr.: Fr.) Butin, Valsaceae, Diaporthales, source: Artskart (2015), Aarnæs (2002)

Amphisphaerella dispersella (Nyl.) O.E. Erikss., Amphisphaeriaceae, Xylariales, source: Artskart (2015), Aarnæs (2002)

Amphisphaerella erikssonii Math., Amphisphaeriaceae, Xylariales, source: Artskart (2015), Aarnæs (2002)

Amphisphaerella xylostei (Pers.: Fr.) Raulamort, Amphisphaeriaceae, Xylariales, source: Artskart (2015), Aarnæs (2002)

Amphisphaeria bufonia (Berk. & Broome) Ces. & De Not., Amphisphaeriaceae, Xylariales, source: Nordén et al. (2015b)

Amphisphaeria umbrina (Fr.) De Not., Amphisphaeriaceae, Xylariales, source: Artskart (2015), Aarnæs (2002)

Anisogramma virgultorum (Fr.: Fr.) Theiss. & Syd., Valsaceae, Diaporthales, source: Artskart (2015), Aarnæs (2002)

Annulohypoxylon cohaerens (Pers.: Fr.) Y.M. Ju, J.D. Rogers & H.M. Hsieh, Xylariaceae, Xylariales, source: Artskart (2015), Aarnæs (2002)

Annulohypoxylon minutellum (Syd. & P. Syd.) Y.M. Ju, J.D. Rogers & H.M. Hsieh, Xylariaceae, Xylariales, source: Nordén (2014)

Annulohypoxylon multiforme (Fr.: Fr.) Y.M. Ju, J.D. Rogers & H.M. Hsieh, Xylariaceae, Xylariales, Norwegian name: bjørkekullsopp, source: Artskart (2015)

Annulusmagnus triseptatus (S.W. Wong, K.D. Hyde & E.B.G. Jones) J. Campb. & Shearer, Annulatascaceae, Incertae sedis, source: Artskart (2015)

Anopodium ampullaceum N. Lundq., Lasiosphaeriaceae, Sordariales, source: Aarnæs (2002)

Anthostoma polare K. Holm & L. Holm, Diatrypaceae, Xylariales, source: Aarnæs (2002)

Anthostomella arenaria O.E. Erikss., Xylariaceae, Xylariales, source: Aarnæs (2002)

Anthostomella lugubris (Roberge ex Desm.) Sacc., Xylariaceae, Xylariales, source: Aarnæs (2002)

Anthostomella phaeosticta (Berk.) Sacc., Xylariaceae, Xylariales, source: Aarnæs (2002)

Apiognomonia alniella (P. Karst.) Höhn., Valsaceae, Diaporthales, source: Artskart (2015), Aarnæs (2002)

Apiognomonia borealis (J. Schröt.) M. Monod, Valsaceae, Diaporthales, source: Sogonov et al. (2008)

Apiognomonia erythrostoma (Pers.: Fr.) Höhn., Valsaceae, Diaporthales, source: Artskart (2015), Aarnæs (2002)

Apiothyrium arcticum Petr., Hyponectriaceae, Xylariales, source: Aarnæs (2002)

Apodospora simulans Cain & Mirza, Lasiosphaeriaceae, Sordariales, source: Artskart (2015), Aarnæs (2002)

Aporhytisma urticae (Fr.: Fr.) Höhn., Valsaceae, Diaporthales, source: Aarnæs (2002)

Arnium hirtum (E.C. Hansen) N. Lundq. & J.C. Krug, Lasiosphaeriaceae, Sordariales, source: Artskart (2015), Aarnæs (2002)

Arnium imitans N. Lundq., Lasiosphaeriaceae, Sordariales, source: Artskart (2015), Aarnæs (2002)

Arnium leporinum (Cain) N. Lundq. & J.C. Krug, Lasiosphaeriaceae, Sordariales, source: Aarnæs (2002)

Arnium olerum (Fr.) N. Lundq. & J.C. Krug, Lasiosphaeriaceae, Sordariales, source: Aarnæs (2002)

Arwidssonia empetri (Rehm.) B. Erikss., Hyponectriaceae, Xylariales, source: Artskart (2015), Aarnæs (2002)

Arwidssonia loiseleuriae B. Erikss., Hyponectriaceae, Xylariales, source: Aarnæs (2002)

Barbatosphaeria barbirostris (Dufour: Fr.) Réblová, Incertae sedis, Sordariales, source: Artskart (2015)

Barrmaelia macrospora (Nitschke) Rappaz, Xylariaceae, Xylariales, source: Mathiassen & Granmo (2012)

Barrmaelia oxyacanthae (Mont.) Rappaz, Xylariaceae, Xylariales, source: Artskart (2015), Aarnæs (2002)

Barrmaelia pseudobombarda (Sacc.) Rappaz, Xylariaceae, Xylariales, source: Mathiassen et al. (2015)

Bertia moriformis (Tode: Fr.) De Not., Nitschkiaceae, Coronophorales, Norwegian name: morbærkjernesopp, source: Artskart (2015), Aarnæs (2002)

Bertia moriformis var. *latispora* Corlett & J.C. Krug, Nitschkiaceae, Coronophorales, source: Artskart (2015)

Biscogniauxia cinereolilacina (J.H. Mill.) Pouzar, Xylariaceae, Xylariales, Norwegian name: lindekullsopp, source: Artskart (2015), Aarnæs (2002)

Biscogniauxia granmoi Lar. N. Vassiljeva, Xylariaceae, Xylariales, source: Artskart (2015), Aarnæs (2002)

Biscogniauxia marginata (Fr.) Pouzar, Xylariaceae, Xylariales, Norwegian name: vrangkullsopp, source: Artskart (2015), Aarnæs (2002)

Biscogniauxia nummularia (Bull.: Fr.) Kuntze, Xylariaceae, Xylariales, Norwegian name: heggekullsopp, source: Aarnæs (2002)

Biscogniauxia repanda (Fr.: Fr.) Kuntze, Xylariaceae, Xylariales, Norwegian name: rognekullsopp, source: Artskart (2015), Aarnæs (2002)

Bombardia bombarda (Batsch: Fr.) J. Schröt., Lasiosphaeriaceae, Sordariales, source: Artskart (2015), Aarnæs (2002)

Bombardioidea bombardioides (Auersw. ex Niessl) C. Moreau ex N. Lundq., Lasiosphaeriaceae, Sordariales, source: Artskart (2015)

Bryocentria hypothallina B. Nordén, Gardiennet, Priou & Döbbeler, Bionectriaceae, Hypocreales, source: Nordén et al. (2015a)

Bryocentria metzgeriae (Ade & Höhn.) Döbbeler, Bionectriaceae, Hypocreales, source: Nordén et al. (2015b)

Bryonectria hylocomii (Döbbeler) Döbbeler, Bionectriaceae, Hypocreales, source: Aarnæs (2002)

Buergenerula biseptata (Rostr.) Syd., Magnaporthaceae, Incertae sedis, source: Artskart (2015), Aarnæs (2002)

Cainiella borealis M.E. Barr, Hyponectriaceae, Xylariales, source: Artskart (2015), Aarnæs (2002)

Cainiella johansonii (Rehm) E. Müll., Hyponectriaceae, Xylariales, source: Artskart (2015), Aarnæs (2002)

Calosphaeria cf. *cryptospora* Munk, Calosphaeriaceae, Calosphaeriales, source: Mathiassen & Granmo (2012)

Calosphaeria ciliatula (Fr.: Fr.) P. Karst., Calosphaeriaceae, Calosphaeriales, source: Artskart (2015)

Calosphaeria dryina (Curr.) Nitschke, Calosphaeriaceae, Calosphaeriales, source: Artskart (2015), Aarnæs (2002)

Calosphaeria pulchella (Pers.: Fr.) J. Schröt., Calosphaeriaceae, Calosphaeriales, source: Artskart (2015), Aarnæs (2002)

Calosphaeria wahlenbergii Nitschke, Calosphaeriaceae, Calosphaeriales, source: Artskart (2015), Aarnæs (2002)

Camarops lutea (Alb. & Schwein.: Fr.) Shear, Syn. Camaropella lutea (Alb. & Schwein.) Lar.N. Vassiljeva, Boliniaceae, Boliniales, source: Nordén et al. (2015b)

Camarops microspora (P. Karst.) Shear, Boliniaceae, Boliniales, Norwegian name: orekullskorpe, source: Artskart (2015), Aarnæs (2002)

Camarops polysperma (Mont.) J.H. Miller, Boliniaceae, Boliniales, source: Artskart (2015)

Camarops pugillus (Schwein.: Fr.) Shear, Syn. Camaropella pugillus (Schwein. Fr.) Lar.N. Vassiljeva, Boliniaceae, Boliniales, source: Nordén et al. (2015b)

Camarops tubulina (Alb. & Schwein.: Fr.) Shear, Boliniaceae, Boliniales, Norwegian name: grankullskorpe, source: Artskart (2015)

Caudospora taleola (Fr.: Fr.) Starbäck, Incertae sedis, Diaporthales, source: Artskart (2015), Aarnæs (2002)

Ceratocystiopsis minuta (Siemaszko) H.P. Upadhyay & W.B. Kendr., Ophiostomataceae, Ophiostomatales, source: Artskart (2015)

Ceratocystis coerulescens (Münch) B.K. Bakshi, Incertae sedis, Microascales, source: Artskart (2015), Aarnæs (2002)

Ceratocystis pilifera (Fr.) C. Moreau, Incertae sedis, Microascales, source: Artskart (2015), Aarnæs (2002)

Ceratosphaeria lampadophora (Berk. & Broome) Niessl, Incertae sedis, Incertae sedis, source: Nordén et al. (2015b)

Ceratosphaeria ordinata (Fr.) Kirschst., Incertae sedis, Incertae sedis, source: Artskart (2015), Aarnæs (2002)

Ceratosphaeria rhenana (Auersw.) G. Winter, Incertae sedis, Incertae sedis, source: Nordén et al. (2015b)

Ceratostoma haematorhynchum (Sommerf.) Fr., Ceratostomataceae, Hypocreales, source: Artskart (2015), Aarnæs (2002)

Ceratostomella cuspidata (Fr.: Fr.) Réblová, Annulatascaceae, Incertae sedis, source: Aarnæs (2002)

Ceratostomella rostrata (Tode: Fr.) Sacc., Annulatascaceae, Incertae sedis, source: Artskart (2015), Aarnæs (2002)

Cercophora coprophila (Fr.) N. Lundq., Lasiosphaeriaceae, Sordariales, source: Artskart (2015), Aarnæs (2002)

Cercophora gossypina N. Lundq., Lasiosphaeriaceae, Sordariales, source: Artskart (2015)

Cercophora mirabilis Fuckel, Lasiosphaeriaceae, Sordariales, source: Artskart (2015), Aarnæs (2002)

Ceriospora ribis Henn. & Plöttn. 1900, Syn. Neokeissleria ribis (Henn. & Plöttn.) Petr., Melanconidaceae, Diaporthales, source: Artskart (2015)

Ceriosporopsis circumvestita (Kohlm.) Kohlm, Halosphaeriaceae, Microascales, source: Rämä et al. (2014)

Ceriosporopsis halima Linder, Halosphaeriaceae, Microascales, source: Rämä et al. (2014)

Chaetomium cochliodes Palliser, Chaetomiaceae, Sordariales, source: Artskart (2015)

Chaetomium crispatum (Fuckel) Fuckel, Chaetomiaceae, Sordariales, source: Aarnæs (2002)

Chaetomium elatum Kunze, Syn. Chaetomium comatum (Tode: Fr.) Fr., Chaetomiaceae, Sordariales, source: Artskart (2015), Aarnæs (2002)

Chaetomium globosum Kunze: Fr., Chaetomiaceae, Sordariales, Norwegian name: raggråtemugg, source: Artskart (2015), Aarnæs (2002)

Chaetomium indicum Corda, Chaetomiaceae, Sordariales, source: Artskart (2015)

Chaetomium spirale Zopf, Chaetomiaceae, Sordariales, source: Artskart (2015)

Chaetomium tomentosum Preuss, Chaetomiaceae, Sordariales, source: Aarnæs (2002)

Chaetosphaerella phaeostroma (Dur. & Mont.) E. Müll. & C. Booth, Chaetosphaerellaceae, Coronophorales, source: Artskart (2015)

Chaetosphaeria myriocarpa (Fr.: Fr.) Booth, Chaetosphaeriaceae, Chaetosphaeriales, source: Artskart (2015), Aarnæs (2002)

Chaetosphaeria ovoidea (Fr.: Fr.) Constant., K. Holm & L. Holm, Chaetosphaeriaceae, Chaetosphaeriales, source: Artskart (2015), Aarnæs (2002)

Chaetosphaeria potentillae Rostr., Chaetosphaeriaceae, Chaetosphaeriales, source: Aarnæs (2002)

Chaetosphaeria pulviscula (Curr.) C. Booth, Chaetosphaeriaceae, Chaetosphaeriales, source: Artskart (2015), Aarnæs (2002)

Chaetosphaeria tortuosa Réblová, Seifert & G.P. White, Chaetosphaeriaceae, Chaetosphaeriales, source: Nordén et al. (2015b)

Chamaeascus arcticus L. Holm, K. Holm & M.E. Barr, Hyponectriaceae, Xylariales, source: Artskart (2015), Aarnæs (2002)

Chlorostroma vestlandicum Nordén & Læssøe, Xylariaceae, Xylariales, source: Nordén et al. (2014a)

Claviceps nigricans Tul., Clavicipitaceae, Hypocreales, Norwegian name: sivaksmeldrøye, source: Artskart (2015), Aarnæs (2002)

Claviceps purpurea (Fr.) Tul. s.lat., Clavicipitaceae, Hypocreales, Norwegian name: meldrøye, source: Artskart (2015), Aarnæs (2002)

Clypeosphaeria asparagi (Fuckel) G. Winter, Clypeosphaeriaceae, Xylariales, source: Artskart (2015), Aarnæs (2002)

Clypeosphaeria mamillana (Fr.: Fr.) Lambotte, Clypeosphaeriaceae, Xylariales, source: Aarnæs (2002)

Coelosphaeria acervata P. Karst., Nitschkiaceae, Coronophorales, source: Aarnæs (2002)

Colletotrichum salicis (Auersw. ex Fuckel) Damm, P.F. Cannon & Crous, Syn. Plectosphaera salicis (Auersw. ex Fuckel) Arx & E. Müll., Phyllachoraceae, Phyllachorales, source: Aarnæs (2002)

Coniochaeta leucoplaca (Berk. & Ravenel) Cain, Coniochaetaceae, Coniochaetales, source: Artskart (2015), Aarnæs (2002)

Coniochaeta ligniaria (Grev.) Cooke, Coniochaetaceae, Coniochaetales, source: Artskart (2015), Aarnæs (2002)

Coniochaeta malacotricha (Auersw. ex Niessl) Traverso, Coniochaetaceae, Coniochaetales, source: Mathiassen & Granmo (2012)

Coniochaeta ovata Matsush., Coniochaetaceae, Coniochaetales, source: Artskart (2015)

Coniochaeta pulveracea (Ehrh.: Fr.) Munk, Coniochaetaceae, Coniochaetales, source: Artskart (2015), Aarnæs (2002)

Coniochaeta scatigena (Berk. & Broome) Cain, Coniochaetaceae, Coniochaetales, source: Artskart (2015), Aarnæs (2002)

Coniochaeta sordaria (Fr.: Fr.) Petr., Coniochaetaceae, Coniochaetales, source: Aarnæs (2002)

Coniochaeta subcorticalis (Fuckel) Munk, Coniochaetaceae, Coniochaetales, source: Artskart (2015), Aarnæs (2002)

Coniochaeta vagans (Carestia & De Not.) N. Lundq., Coniochaetaceae, Coniochaetales, source: Artskart (2015), Aarnæs (2002)

Coniochaeta velutina (Fuckel) Cooke, Coniochaetaceae, Coniochaetales, source: Artskart (2015), Aarnæs (2002)

Cordyceps bifusispora O.E. Erikss., Cordycipitaceae, Hypocreales, Norwegian name: hvit åmeklubbe, source: Artskart (2015), Aarnæs (2002)

Cordyceps militaris (L.: Fr.) Link, Cordycipitaceae, Hypocreales, Norwegian name: rød åmeklubbe, source: Artskart (2015), Aarnæs (2002)

Corollospora comata (Kohlm.) Kohlm, Halosphaeriaceae, Microascales, source: Rämä et al. (2014)

Corollospora luteola Nakagiri & Tubaki, Halosphaeriaceae, Microascales, source: Rämä et al. (2014)

Corollospora maritima Werderm., Halosphaeriaceae, Microascales, source: Rämä et al. (2014)

Coronophora annexa (Nitschke) Fuckel, Nitschkiaceae, Coronophorales, source: Artskart (2015)

Coronophora gregaria Fuckel, Nitschkiaceae, Coronophorales, source: Artskart (2015), Aarnæs (2002)

Coronophora ovipara Munk, Nitschkiaceae, Coronophorales, source: Artskart (2015), Aarnæs (2002)

Cosmospora coccinea Rabenh., Nectriaceae, Hypocreales, source: Artskart (2015)

Cosmospora episphaeria (Tode: Fr.) Rossman & Samuels, Nectriaceae, Hypocreales, source: Artskart (2015), Aarnæs (2002)

Cosmospora flavoviridis (Fuckel) Rossman & Samuels, Nectriaceae, Hypocreales, source: Artskart (2015)

Cosmospora magnusiana (Rehm) Rossman & Samuels, Nectriaceae, Hypocreales, source: Artskart (2015)

Cryptodiaporthe apiculata (Wallr.) Petr., Gnomoniaceae, Diaporthales, source: Artskart (2015)

Cryptodiaporthe aubertii (Westend.) Wehm., Gnomoniaceae, Diaporthales, source: Aarnæs (2002)

Cryptodiaporthe populea (Sacc.) Butin ex Butin, Gnomoniaceae, Diaporthales, source: Aarnæs (2002)

Cryptodiaporthe pyrrhocystis (Berk. & Broome) Wehm., Gnomoniaceae, Diaporthales, source: Aarnæs (2002)

Cryptodiaporthe salicella (Fr.: Fr.) Petr., Gnomoniaceae, Diaporthales, source: Artskart (2015), Aarnæs (2002)

Cryptomycina pteridis (Rebent.: Fr.) Höhn., Incertae sedis, Incertae sedis, Norwegian name: einstapeskorpe, source: Aarnæs (2002)

Cryptosphaeria eunomia (Fr.) Fuckel, Diatrypaceae, Xylariales, source: Artskart (2015), Aarnæs (2002)

Cryptosphaeria ligniota (Fr.) Auersw., Diatrypaceae, Xylariales, source: Artskart (2015), Aarnæs (2002)

Cryptosphaeria subcutanea (Wahlenb.: Fr.) Rappaz, Diatrypaceae, Xylariales, source: Artskart (2015), Aarnæs (2002)

Cryptosporella suffusa (Fr.: Fr.) L.C. Mejía & Castl., Valsaceae, Diaporthales, source: Artskart (2015), Aarnæs (2002)

Cryptovalsa protracta (Pers.: Fr.) Ces. & De Not. ex Fuckel, Incertae sedis, Incertae sedis, source: Aarnæs (2002)

Cyanophomella acervalis (Sacc.) Höhn., Nectriaceae, Hypocreales, source: Artskart (2015)

Daldinia loculata (Lev.) Sacc., Xylariaceae, Xylariales, Norwegian name: beltekullsopp, source: Artskart (2015)

Daldinia petriniae Y.M. Ju, J.D. Rogers & San Martín, Xylariaceae, Xylariales, source: Artskart (2015)

Daldinia vernicosa Ces. & De Not., Syn. Daldinia fissa Lloyd, Xylariaceae, Xylariales, source: Artskart (2015)

Diaporthe arctii (Lasch) Nitschke, Diaporthaceae, Diaporthales, source: Aarnæs (2002)

Diaporthe beckhausii Nitschke, Diaporthaceae, Diaporthales, source: Artskart (2015), Aarnæs (2002)

Diaporthe decorticans (Lib.) Sacc. & Roum., Diaporthaceae, Diaporthales, source: Aarnæs (2002)

Diaporthe detrusa (Fr.: Fr.) Fuckel, Diaporthaceae, Diaporthales, source: Artskart (2015), Aarnæs (2002)

Diaporthe eres Nitschke, Diaporthaceae, Diaporthales, source: Artskart (2015), Aarnæs (2002)

Diaporthe fibrosa (Pers.: Fr.) Nitschke, Diaporthaceae, Diaporthales, source: Aarnæs (2002)

Diaporthe forabilis Nitschke, Diaporthaceae, Diaporthales, source: Aarnæs (2002)

Diaporthe impulsa (Cooke & Peck) Sacc., Diaporthaceae, Diaporthales, source: Artskart (2015)

Diaporthe incarcerata (Berk. & Broome) Nitschke, Diaporthaceae, Diaporthales, source: Aarnæs (2002)

Diaporthe minuscula Sacc. & Speg., Diaporthaceae, Diaporthales, source: Aarnæs (2002)

Diaporthe otthii Nitschke, Diaporthaceae, Diaporthales, source: Artskart (2015)

Diaporthe padi G.H. Otth, Diaporthaceae, Diaporthales, source: Artskart (2015)

Diaporthe radula Nitschke, Diaporthaceae, Diaporthales, source: Artskart (2015)

Diaporthe strumella (Fr.: Fr.) Fuckel, Diaporthaceae, Diaporthales, source: Artskart (2015), Aarnæs (2002)

Diaporthe transversalis P. Karst., Diaporthaceae, Diaporthales, source: Aarnæs (2002)

Diaporthe tulasnei Nitschke, Diaporthaceae, Diaporthales, source: Aarnæs (2002)

Diaporthella aristata (Fr.: Fr.) Petr., Valsaceae, Diaporthales, Norwegian name: bjørketaggvorte, source: Artskart (2015), Aarnæs (2002)

Diatrype bullata (Hoffm.: Fr) Fr., Diatrypaceae, Xylariales, Norwegian name: seljerundskorpe, source: Artskart (2015), Aarnæs (2002)

Diatrype decorticata (Pers.: Fr.) Rappaz, Diatrypaceae, Xylariales, source: Artskart (2015), Aarnæs (2002)

Diatrype disciformis (Hoffm.: Fr.) Fr., Diatrypaceae, Xylariales, Norwegian name: bøkerundskorpe, source: Artskart (2015), Aarnæs (2002)

Diatrype flavovirens (Pers.: Fr.) Fr., Diatrypaceae, Xylariales, Norwegian name: grønnskorpe, source: Artskart (2015), Aarnæs (2002)

Diatrype quercina (Pers.: Fr.) Fr., Syn. Diatrypella quercina (Pers.: Fr.) Cooke, Diatrypaceae, Xylariales, source: Artskart (2015)

Diatrype spilomea Syd., Diatrypaceae, Xylariales, source: Artskart (2015)

Diatrype stigma (Hoffm.: Fr.) Fr., Diatrypaceae, Xylariales, Norwegian name: svartskorpe, source: Artskart (2015), Aarnæs (2002)

Diatrype stigmaoides Kauffman, Diatrypaceae, Xylariales, source: Nordén et al. (2015b)

Diatrype undulata (Pers.: Fr.) Fr., Diatrypaceae, Xylariales, source: Artskart (2015)

Diatrypella favacea (Fr.: Fr.) Ces. & De Not., Diatrypaceae, Xylariales, source: Artskart (2015), Aarnæs (2002)

Diatrypella verruciformis (Ehrh.: Fr.) Nitschke, Diatrypaceae, Xylariales, source: Artskart (2015), Aarnæs (2002)

Discosphaerina sorbi L.Holm, K.Holm & M.E.Barr, Hyponectriaceae, Xylariales, source: Mathiassen & Granmo (2012)

Discostroma corticola (Fuckel) Brockmann, Amphisphaeriaceae, Xylariales, source: Artskart (2015), Aarnæs (2002)

Discostroma fuscellum (Berk. & Broome) Huhndorf, Amphisphaeriaceae, Xylariales, source: Artskart (2015), Aarnæs (2002)

Discostroma hyperboreum (P. Karst.) O.E. Erikss., Amphisphaeriaceae, Xylariales, source: Artskart (2015), Aarnæs (2002)

Discostroma propendulum (P Karst.) Brockmann, Amphisphaeriaceae, Xylariales, source: Artskart (2015)

Ditopella ditopa (Fr.: Fr.) J. Schröt., Gnomoniaceae, Diaporthales, source: Artskart (2015)

Dyrithium lividum (Pers.: Fr.) M.E. Barr, Amphisphaeriaceae, Xylariales, source: Artskart (2015), Aarnæs (2002)

Echinosphaeria canescens (Pers.: Fr.) A.N. Mill. & Huhndorf, Helminthosphaeriaceae, Sordariales, source: Artskart (2015), Aarnæs (2002)

Echinosphaeria strigosa (Alb. & Schwein.: Fr.) Sacc., Syn. Lasiosphaeria strigosa (Alb. & Schwein.: Fr.) Sacc., Lasiosphaeriaceae, Sordariales, source: Aarnæs (2002)

Elaphocordyceps capitata (Holmsk.: Fr.) G.H. Sung, J.M. Sung & Spatafora, Ophiocordycipitaceae, Hypocreales, Norwegian name: stor soppklubbe, source: Artskart (2015), Aarnæs (2002)

Elaphocordyceps longisegmentis (Ginns) G.H. Sung, J.M. Sung & Spatafora, Ophiocordycipitaceae, Hypocreales, Norwegian name: vrangsoppklubbe, source: Artskart (2015), Aarnæs (2002)

Elaphocordyceps ophioglossoides (Ehrh.: Fr.) G.H. Sung, J.M. Sung & Spatafora, Ophiocordycipitaceae, Hypocreales, Norwegian name: smal soppklubbe, source: Artskart (2015), Aarnæs (2002)

Elaphocordyceps rouxii (Cand.) G.H. Sung, J.M. Sung & Spatafora, Ophiocordycipitaceae, Hypocreales, Norwegian name: narresoppklubbe, source: Artskart (2015)

Emericellopsis terricola J.F.H. Beyma, Incertae sedis, Hypocreales, source: Aarnæs (2002)

Enchnoa infernalis (Kunze: Fr.) Sacc., Nitschkiaceae, Coronophorales, source: Artskart (2015), Aarnæs (2002)

Enchnoa lanata (Fr.: Fr.) Fr., Nitschkiaceae, Coronophorales, source: Artskart (2015)

Endothia gyrosa (Schwein.: Fr.) Fr., Valsaceae, Diaporthales, source: Nordén et al. (2015b)

Endoxyla operculata (Alb. & Schwein.: Fr.) Sacc., Boliniaceae, Boliniales, source: Aarnæs (2002)

Endoxylina pini Sivan., Diatrypaceae, Xylariales, source: Mathiassen & Granmo (2012)

Entoleuca mammata (Wahlenb.) J.D. Rogers & Y.M. Ju, Xylariaceae, Xylariales, Norwegian name: vierkullsopp, source: Artskart (2015), Aarnæs (2002)

Epichloë typhina (Pers.: Fr.) Tul. & C. Tul., Clavicipitaceae, Hypocreales, Norwegian name: kjevlesopp, source: Artskart (2015), Aarnæs (2002)

Euepixylon udum (Pers.) Læssøe & Spooner, Xylariaceae, Xylariales, source: Artskart (2015), Aarnæs (2002)

Eutypa astroidea Rappaz, Diatrypaceae, Xylariales, source: Aarnæs (2002)

Eutypa lata (Pers.: Fr.) Tul. & C. Tul., Diatrypaceae, Xylariales, source: Artskart (2015), Aarnæs (2002)

Eutypa leioplaca (Fr.: Fr.) Cooke, Diatrypaceae, Xylariales, source: Nordén et al. (2015b)

Eutypa maura (Fr.: Fr.) Fuckel, Diatrypaceae, Xylariales, source: Artskart (2015), Aarnæs (2002)

Eutypa petrakii Rappaz, Diatrypaceae, Xylariales, source: Artskart (2015), Aarnæs (2002)

Eutypa polycocca (Fr.) P. Karst., Diatrypaceae, Xylariales, source: Artskart (2015), Aarnæs (2002)

Eutypa sparsa Romell, Diatrypaceae, Xylariales, source: Artskart (2015), Aarnæs (2002)

Eutypa spinosa (Pers.: Fr.) Tul. & C. Tul., Diatrypaceae, Xylariales, source: Artskart (2015), Aarnæs (2002)

Eutypella cerviculata (Fr.: Fr.) Sacc., Diatrypaceae, Xylariales, source: Artskart (2015), Aarnæs (2002)

Eutypella grandis (Nitschke) Sacc., Diatrypaceae, Xylariales, source: Artskart (2015), Aarnæs (2002)

Eutypella padina (Nitschke) Nannf., Diatrypaceae, Xylariales, source: Artskart (2015), Aarnæs (2002)

Eutypella prunastri (Pers.: Fr.) Sacc., Diatrypaceae, Xylariales, source: Artskart (2015), Aarnæs (2002)

Eutypella sorbi (Alb. & Schwein.: Fr.) Sacc., Diatrypaceae, Xylariales, Norwegian name: rogneknapp, source: Artskart (2015), Aarnæs (2002)

Eutypella stellulata (Fr.) Sacc., Diatrypaceae, Xylariales, source: Artskart (2015), Aarnæs (2002)

Exarmidium excellens (Rehm ex Sacc.) Aptroot, Hyponectriaceae, Xylariales, source: Aarnæs (2002)

Exarmidium hemisphaericum (Fr.: Fr.) Aptroot, Hyponectriaceae, Xylariales, source: Aarnæs (2002)

Exarmidium inclusum (Pers.: Fr.) Aptroot, Hyponectriaceae, Xylariales, source: Aarnæs (2002)

Gaeumannomyces graminis (Sacc.) Arx & D.L. Olivier, Magnaporthaceae, Incertae sedis, source: Artskart (2015), Aarnæs (2002)

Gelasinospora tetrasperma Dowding, Sordariaceae, Sordariales, source: Artskart (2015), Aarnæs (2002)

Gibberella flacca (Wallr.) Sacc., Nectriaceae, Hypocreales, source: Artskart (2015), Aarnæs (2002)

Gibberella pulicaris (Fr.: Fr.) Sacc., Nectriaceae, Hypocreales, source: Artskart (2015), Aarnæs (2002)

Gibberella zeae (Schwein.) Petch, Nectriaceae, Hypocreales, source: Artskart (2015), Aarnæs (2002)

Glomerella amenti (Rostr.) E. Müll. & Arx, Glomerellaceae, Incertae sedis, source: Artskart (2015), Aarnæs (2002)

Glomerella graminicola D.J. Politis, Glomerellaceae, Incertae sedis, source: Artskart (2015)

Gnomonia cerastis (Riess) Ces. & De Not., Gnomoniaceae, Diaporthales, source: Artskart (2015), Aarnæs (2002)

Gnomonia dryadis Auersw., Gnomoniaceae, Diaporthales, source: Artskart (2015), Aarnæs (2002)

Gnomonia fimbriata (Pers.: Fr.) Fuckel, Gnomoniaceae, Diaporthales, source: Aarnæs (2002)

Gnomonia gnomon (Tode: Fr.) J. Schröt., Gnomoniaceae, Diaporthales, source: Artskart (2015)

Gnomonia hyparctica Lind, Gnomoniaceae, Diaporthales, source: Artskart (2015), Aarnæs (2002)

Gnomonia norvegica, Gnomoniaceae, Diaporthales, source: Aarnæs (2002)

Gnomonia rostellata (Fr.: Fr.) Wehm., Gnomoniaceae, Diaporthales, source: Artskart (2015)

Gnomonia rubi (Rehm) G. Winter, Gnomoniaceae, Diaporthales, source: Nordskog et al 2003

Gnomonia skiftei M. Monod, Gnomoniaceae, Diaporthales, source: Aarnæs (2002)

Gnomoniella albomaculans Neger, Valsaceae, Diaporthales, source: Artskart (2015)

Gnomoniella tubaeformis (Tode: Fr.) Sacc., Valsaceae, Diaporthales, source: Artskart (2015), Aarnæs (2002)

Gnomoniella vagans Johanson, Gnomoniaceae, Diaporthales, source: Artskart (2015), Aarnæs (2002)

Gnomoniopsis idaeicola (P. Karst.) D.M. Walker, Syn. Diaporthe idaeicola (P. Karst.), Valsaceae, Diaporthales, source: Aarnæs (2002)

Grosmannia cucullata (H. Solheim) Zipfel, Z.W. de Beer & M.J. Wingf., Ophiostomataceae, Ophiostomatales, source: Aarnæs (2002)

Halosphaeria pileata (Kohlm.) Kohlm, Halosphaeriaceae, Microascales, source: Rämä et al. (2014)

Halosphaeria quadri-remis (Höhnk) Kohlm., Halosphaeriaceae, Microascales, source: Rämä et al. (2014)

Halosphaeria tubulifera Kohlm., Halosphaeriaceae, Microascales, source: Rämä et al. (2014)

Hapalocystis bicaudata Fuckel, Melanconidaceae, Diaporthales, source: Nordén et al. (2015b)

Havispora longyearbyenensis K.L. Pang & Vrijmoed, Halosphaeriaceae, Microascales, source: Rämä et al. (2014)

Helminthosphaeria clavariarum (Desm.) Sacc., Helminthosphaeriaceae, Sordariales, source: Artskart (2015)

Helminthosphaeria corticiorum Höhn., Helminthosphaeriaceae, Sordariales, source: Jordal & Læssøe (2009)

Helminthosphaeria pilifera Réblová, Helminthosphaeriaceae, Sordariales, source: Nordén et al. (2015b)

Hercospora tiliae (Pers.: Fr.) Tul. & C. Tul., Melanconidaceae, Diaporthales, source: Artskart (2015)

Hilberina caudata (Fuckel) Huhndorf & A.N. Mill, Incertae sedis, Incertae sedis, source: Artskart

(2015), Aarnæs (2002)

Humicola alopallonella Meyers & R.T. Moore, Chaetomiaceae, Sordariales, source: Rämä et al. (2014)

Hydropisphaera arenula (Berk. & Broome) Rossman & Samuels, Syn. Nectria arenula (Berk. & Broome) Berk., Bionectriaceae, Hypocreales, source: Aarnæs (2002)

Hydropisphaera peziza (Tode: Fr.) Dumort., Syn. Nectria peziza (Tode: Fr.) Fr., Bionectriaceae, Hypocreales, source: Artskart (2015)

Hypocopra aviaria P. Karst., Xylariaceae, Xylariales, source: Aarnæs (2002)

Hypocopra equorum (Fuckel) G. Winter, Xylariaceae, Xylariales, source: Artskart (2015)

Hypocopra leporina (Niessl ex Rehm) J.C. Krug & N. Lundq. ex Doveri, Xylariaceae, Xylariales, source: Artskart (2015)

Hypocopra ornithophila Speg., Xylariaceae, Xylariales, source: Artskart (2015)

Hypocreopsis riccioidea (Bolt.: Fr.) P. Karst., Hypocreaceae, Hypocreales, Norwegian name: seljepute, source: Artskart (2015), Aarnæs (2002)

Hypomyces armeniacus Tul. & C. Tul., Hypocreaceae, Hypocreales, source: Aarnæs (2002)

Hypomyces aurantius (Pers.: Fr.) Tul. & C. Tul., Hypocreaceae, Hypocreales, Norwegian name: oransje kjukesnylter, source: Artskart (2015), Aarnæs (2002)

Hypomyces chrysospermus Tul. & C. Tul., Hypocreaceae, Hypocreales, Norwegian name: rørsoppsnylter, source: Artskart (2015), Aarnæs (2002)

Hypomyces lateritius (Fr.: Fr.) Tul. & C. Tul., Hypocreaceae, Hypocreales, Norwegian name: blek riskesnylter, source: Artskart (2015), Aarnæs (2002)

Hypomyces luteovirens (Fr.: Fr.) Tul. & C. Tul., Hypocreaceae, Hypocreales, Norwegian name: grønn kremlesnylter, source: Artskart (2015), Aarnæs (2002)

Hypomyces microspermus Rogerson & Samuels, Hypocreaceae, Hypocreales, source: Aarnæs (2002)

Hypomyces ochraceus (Pers.) Tul. & C. Tul., Hypocreaceae, Hypocreales, source: Artskart (2015), Aarnæs (2002)

Hypomyces papulasporae Rogerson & Samuels, Hypocreaceae, Hypocreales, source: Artskart (2015), Aarnæs (2002)

Hypomyces polyporinus Peck, Hypocreaceae, Hypocreales, source: Artskart (2015)

Hypomyces porphyreus Rogerson & Mazzer, Hypocreaceae, Hypocreales, Norwegian name: rødsporesoppsnylter, source: Artskart (2015), Aarnæs (2002)

Hypomyces rosellus (Alb. & Schwein.: Fr.) Tul. & C. Tul., Hypocreaceae, Hypocreales, Norwegian name: sjampinjongsnylter, source: Artskart (2015), Aarnæs (2002)

Hypomyces semitranslucens G.R.W. Arnold, Hypocreaceae, Hypocreales, source: Aarnæs (2002)

Hypomyces spadiceus Fr. ex Th. Fr., Hypocreaceae, Hypocreales, source: Artskart (2015), Aarnæs (2002)

Hypomyces stephanomatis Rogerson & Samuels, Hypocreaceae, Hypocreales, source: Artskart (2015)

Hypospilina bifrons (DC.: Fr.) Traverso, Valsaceae, Diaporthales, source: Aarnæs (2002)

Hypospilina pustula (Pers.: Fr.) M. Monod, Valsaceae, Diaporthales, source: Artskart (2015), Aarnæs (2002)

Hypoxylon fragiforme (Pers.: Fr.) J. Kickx f., Xylariaceae, Xylariales, Norwegian name: bøkekullsopp, source: Artskart (2015), Aarnæs (2002)

Hypoxylon fuscoides J. Fourn., P. Leroy, M. Stadler & Roy Anderson, Xylariaceae, Xylariales, source: Nordén et al. (2015b)

Hypoxylon fuscopurpureum (Schwein.: Fr.) M.A. Curtis, Xylariaceae, Xylariales, source: Artskart (2015)

Hypoxylon fuscum (Pers.: Fr.) Fr., Xylariaceae, Xylariales, Norwegian name: hasselkullsopp, source: Artskart (2015), Aarnæs (2002)

Hypoxylon howeanum Peck, Xylariaceae, Xylariales, Norwegian name: lundkullsopp, source: Artskart (2015), Aarnæs (2002)

Hypoxylon laschii Nitschke, Xylariaceae, Xylariales, source: Artskart (2015), Aarnæs (2002)

Hypoxylon liviae Granmo, Xylariaceae, Xylariales, source: Artskart (2015)

Hypoxylon macrocarpum Pouzar, Xylariaceae, Xylariales, source: Artskart (2015)

Hypoxylon macrosporum P. Karst., Xylariaceae, Xylariales, Norwegian name: stripekullsopp, source: Artskart (2015), Aarnæs (2002)

Hypoxylon petriniae M. Stadler & J. Fourn., Xylariaceae, Xylariales, source: Artskart (2015)

Hypoxylon porphyreum Granmo, Xylariaceae, Xylariales, source: Artskart (2015), Aarnæs (2002)

Hypoxylon rubiginosum (Pers.: Fr.) Fr., Xylariaceae, Xylariales, Norwegian name: kopperkullsopp, source: Artskart (2015), Aarnæs (2002)

Hypoxylon salicicola Granmo, Xylariaceae, Xylariales, source: Artskart (2015)

Hypoxylon vogesiacum (Curr.) Sacc., Xylariaceae, Xylariales, Norwegian name: almekullsopp, source: Artskart (2015), Aarnæs (2002)

Immersiella caudata (Curr.) A.N. Mill. & Huhndorf, Lasiosphaeriaceae, Sordariales, source: Nordén et al. (2015b)

Immersiella immersa (P. Karst.) A.N. Mill. & Huhndorf, Lasiosphaeriaceae, Sordariales, source: Mathiassen & Granmo (2012)

Isothea rhytismoides (Bab. ex Berk.) Fr., Phyllachoraceae, Phyllachorales, source: Artskart (2015), Aarnæs (2002)

Jattaea discreta (Berl.) Réblová, Calosphaeriaceae, Calosphaeriales, source: Mathiassen & Granmo (2012)

Klasterskya acuum (Mouton) Petr., Ophiostomataceae, Ophiostomatales, source: Artskart (2015), Aarnæs (2002)

Kretzschmaria deusta (Hoffm.: Fr.) P.M.D. Martin, Xylariaceae, Xylariales, Norwegian name: kullskorpe, source: Artskart (2015), Aarnæs (2002)

Laestadia palustris Fr., Valsaceae, Diaporthales, source: Artskart (2015)

Lasiosphaeria glabrata (Fr.) Munk, Lasiosphaeriaceae, Sordariales, source: Artskart (2015)

Lasiosphaeria lanuginosa (P. Crouan & H. Crouan) A.N. Mill. & Huhndorf, Lasiosphaeriaceae, Sordariales, source: Artskart (2015)

Lasiosphaeria libertiana Speg. & Roum., Lasiosphaeriaceae, Sordariales, source: Aarnæs (2002)

Lasiosphaeria muscicola De Not., Lasiosphaeriaceae, Sordariales, source: Artskart (2015)

Lasiosphaeria mycophila (G. Winter) Carroll & Munk, Lasiosphaeriaceae, Sordariales, source: Aarnæs (2002)

Lasiosphaeria ovina (Pers.: Fr.) Ces. & De Not., Lasiosphaeriaceae, Sordariales, source: Artskart (2015), Aarnæs (2002)

Lasiosphaeria punctata Munk, Lasiosphaeriaceae, Sordariales, source: Artskart (2015)

Lasiosphaeria rhacodium (Pers.: Fr.) Ces. & De Not., Lasiosphaeriaceae, Sordariales, source: Artskart (2015)

Lasiosphaeria sorbina (Nyl.) P. Karst., Lasiosphaeriaceae, Sordariales, source: Mathiassen & Granmo (2012)

Lasiosphaeria tephrotricha (Fr.) Sacc., Lasiosphaeriaceae, Sordariales, source: Aarnæs (2002)

Lasiosphaeriopsis christiansenii Alstrup & D. Hawksw., Nitschkiaceae, Coronophorales, source: Aarnæs (2002)

Lasiosphaeriopsis stereocaulicola (Linds.) O. E. Erikss. & R. Sant., Nitschkiaceae, Coronophorales, source: Aarnæs (2002)

Lasiosphaeris hirsuta (Alb. & Schwein.: Fr.) A.N. Mill. & Huhndorf, Lasiosphaeriaceae, Sordariales, source: Artskart (2015), Aarnæs (2002)

Lasiosphaeris hispida (Tode: Fr.) Clem., Lasiosphaeriaceae, Sordariales, source: Artskart (2015)

Lentomita hirsutula Bres., Chaetosphaeriaceae, Chaetosphaeriales, source: Mathiassen & Granmo (2012)

Lentomitella cirrhosa (Pers.: Fr.) Réblová, Boliniaceae, Boliniales, source: Artskart (2015), Aarnæs (2002)

Lentomitella crinigera (Cooke) Réblová, Boliniaceae, Boliniales, source: Nordén et al. (2015b)

Leucostoma cinctum (Fr.) Höhn., Valsaceae, Diaporthales, source: Artskart (2015)

Leucostoma persoonii (Nitschke) Höhn., Syn. Valsa persoonii Nitschke, Valsaceae, Diaporthales, source: Aarnæs (2002)

Leucostoma translucens (De Not.) Höhn., Valsaceae, Diaporthales, source: Artskart (2015)

Lichenochora constrictella (Müll.Arg.) Hafellner, Incertae sedis, Phyllachorales, source: Aarnæs (2002)

Lindra inflata I.M. Wilson, Lulworthiaceae, Lulworthiales, source: Rämä et al. (2014)

Linospora arctica P. Karst., Valsaceae, Diaporthales, source: Artskart (2015), Aarnæs (2002)

Linospora capreae (DC.: Fr.) Fuckel, Valsaceae, Diaporthales, source: Artskart (2015), Aarnæs (2002)

Linospora ceuthocarpa (Fr.) Lind, Valsaceae, Diaporthales, source: Artskart (2015), Aarnæs (2002)

Linospora salicis-helveticae M. Monod, Valsaceae, Diaporthales, source: Mathiassen & Granmo (2012)

Linospora salicis-reticulatae M. Monod, Valsaceae, Diaporthales, source: Aarnæs (2002)

Linospora sibbaldiae Rostr., Valsaceae, Diaporthales, source: Artskart (2015), Aarnæs (2002)

Lopadostoma dryophilum (Nitschke ex G.H. Otth) Jaklitsch, J. Fourn. & Voglmayr, Xylariaceae, Xylariales, source: Nordén et al. (2015b)

Lopadostoma gastrinum (Fr.) Traverso, Xylariaceae, Xylariales, source: Artskart (2015), Aarnæs (2002)

Lopadostoma pouzarii Granmo & L.E. Petrini, Xylariaceae, Xylariales, source: Artskart (2015)

Lopadostoma turgidum (Pers.: Fr.) Traverso, Xylariaceae, Xylariales, source: Artskart (2015), Aarnæs (2002)

Lulwoana uniseptata (Nakagiri) Kohlm., Volkm.-Kohlm., J. Campb., Spatafora & Gräfenhan, Lulworthiaceae, Lulworthiales, source: Rämä et al. (2014)

Lulworthia floridana Meyers, Lulworthiaceae, Lulworthiales, source: Rämä et al. (2014)

Lulworthia halima (Diehl & Mounce) Cribb & J.W. Cribb, Lulworthiaceae, Lulworthiales, source: Rämä et al. (2014)

Lulworthia maritima (Sacc.) Cribb & J.W. Cribb, Lulworthiaceae, Lulworthiales, source: Aarnæs (2002)

Lulworthia purpurea (I.M. Wilson) T.W. Johnson, Lulworthiaceae, Lulworthiales, source: Rämä et al. (2014)

Mamianiella coryli (Batsch: Fr.) Höhn., Valsaceae, Diaporthales, source: Artskart (2015), Aarnæs (2002)

Mazzantia galii (Guep.: Fr.) Mont., Valsaceae, Diaporthales, source: Artskart (2015), Aarnæs (2002)

Melanamphora spinifera (Walr.) Lafl., Syn. Melanamphora spiniferum (Walr.) Lafl., Melanconidaceae, Diaporthales, source: Aarnæs (2002)

Melanconiella flavovirens (G.H. Otth) Voglmayr & Jaklitsch, Melanconidaceae, Diaporthales, source: Nordén et al. (2015b)

Melanconis alni Tul. & C. Tul., Melanconidaceae, Diaporthales, source: Artskart (2015)

Melanconis fennica P. Karst., Melanconidaceae, Diaporthales, source: Artskart (2015), Aarnæs (2002)

Melanconis stilbostoma (Fr.: Fr.) Tul. & C. Tul., Melanconidaceae, Diaporthales, source: Artskart (2015), Aarnæs (2002)

Melanconium betulinum Schumach. & Kunze, Melanconidaceae, Diaporthales, source: Artskart (2015)

Melanopsamma pomiformis (Pers.: Fr.) Sacc., Niessliaceae, Hypocreales, source: Artskart (2015), Aarnæs (2002)

Melanospora aculeata Ë.C. Hansen, Ceratostomataceae, Hypocreales, source: Artskart (2015), Aarnæs (2002)

Melanospora brevirostris (Fuckel) Höhn., Ceratostomataceae, Hypocreales, Norwegian name: sandbegersnylter, source: Artskart (2015), Aarnæs (2002)

Melanospora chionea (Fr.: Fr.) Corda, Ceratostomataceae, Hypocreales, source: Artskart (2015), Aarnæs (2002)

Melanospora lagenaria (Pers.: Fr.) Fuckel, Ceratostomataceae, Hypocreales, source: Artskart (2015), Aarnæs (2002)

Melanospora leucotricha Corda, Ceratostomataceae, Hypocreales, source: Artskart (2015)

Melanospora phaseoli Roll-Hansen, Ceratostomataceae, Hypocreales, source: Artskart (2015), Aarnæs (2002)

Melanospora zamiae Corda, Ceratostomataceae, Hypocreales, source: Artskart (2015)

Melogramma aesculinum G.H. Otth., Melanconidaceae, Diaporthales, source: Artskart (2015), Aarnæs (2002)

Melomastia mastoidea (Fr.: Fr.) J. Schröt., Incertae sedis, Xylariales, source: Artskart (2015), Aarnæs (2002)

Microascus trigonosporus C.W. Emmons & B.O. Dodge, Microascaceae, Microascales, source: Artskart (2015)

Monographella nivalis (Schaffnit) E. Müll., Amphisphaeriaceae, Xylariales, source: Artskart (2015), Aarnæs (2002)

Mycogone rosea Link, Hypocreaceae, Hypocreales, source: Artskart (2015)

Naïs inornata Kohlm., Halosphaeriaceae, Microascales, source: Rämä et al. (2014)

Natantiella ligneola (Berk. & Broome) Réblová, Calosphaeriaceae, Calosphaeriales, source: Nordén et al. (2015b)

Nectria aurantiaca (Tul. & C. Tul.) Jacz., Nectriaceae, Hypocreales, source: Artskart (2015)

Nectria cinnabarina (Tode: Fr.) Fr., Nectriaceae, Hypocreales, Norwegian name: rødvorte, source: Artskart (2015), Aarnæs (2002)

Nectria citrina Fr., Nectriaceae, Hypocreales, source: Aarnæs (2002)

Nectria coryli Fuckel, Nectriaceae, Hypocreales, source: Artskart (2015), Aarnæs (2002)

Nectria cucurbitula (Tode: Fr.) Fr., Nectriaceae, Hypocreales, source: Artskart (2015), Aarnæs (2002)

Nectria dematiosa (Schwein.) Berk., Nectriaceae, Hypocreales, source: Artskart (2015)

Nectria lamyi (Desm.) De Not., Nectriaceae, Hypocreales, source: Aarnæs (2002)

Nectria modesta Höhn., Nectriaceae, Hypocreales, source: Artskart (2015)

Nectria nigrescens Cooke, Nectriaceae, Hypocreales, source: Nordén et al. (2015b)

Nectriella chrysites (Westend.) Sacc., Bionectriaceae, Hypocreales, source: Artskart (2015), Aarnæs (2002)

Nectriella laminariae O.E. Erikss., Bionectriaceae, Hypocreales, source: Artskart (2015), Aarnæs (2002)

Nectriella silenes-acaulis Nograsek, Bionectriaceae, Hypocreales, source: Aarnæs (2002)

Nectriopsis lecanodes (Ces.) Diederich & Schroers, Bionectriaceae, Hypocreales, source: Artskart (2015)

Nectriopsis mindoënsis (Petr.) Samuels, Bionectriaceae, Hypocreales, source: Aarnæs (2002)

Nectriopsis violacea (J.C. Schmidt: Fr.) Maire, Bionectriaceae, Hypocreales, source: Aarnæs (2002)

Nemania aenea (Nitschke) Pouzar, Xylariaceae, Xylariales, source: Artskart (2015)

Nemania atropurpurea (Fr.: Fr.) Pouzar, Xylariaceae, Xylariales, source: Artskart (2015), Aarnæs (2002)

Nemania aureolutea (L.E. Petrini & J.D. Rogers) Granmo, Xylariaceae, Xylariales, source: Artskart (2015)

Nemania colliculosa (Schwein.: Fr.) Granmo, Xylariaceae, Xylariales, source: Artskart (2015)

Nemania confluens (Tode: Fr.) Laessøe & Spooner, Xylariaceae, Xylariales, Norwegian name: eikekullsopp, source: Artskart (2015), Aarnæs (2002)

Nemania effusa (Nitschke) Pouzar, Xylariaceae, Xylariales, source: Artskart (2015), Aarnæs (2002)

Nemania maritima Y.M. Ju & J.D. Rogers, Xylariaceae, Xylariales, source: Nordén et al. (2015b)

Nemania prava Granmo, Læssøe & T. Schumach., Xylariaceae, Xylariales, source: Artskart (2015)

Nemania reticulata (P. Karst.) Granmo, Xylariaceae, Xylariales, source: Artskart (2015), Aarnæs (2002)

Nemania serpens (Pers.: Fr.) Gray, Xylariaceae, Xylariales, Norwegian name: ospekullsopp, source: Artskart (2015), Aarnæs (2002)

Neobarya parasitica (Fuckel) Lowen, Clavicipitaceae, Hypocreales, source: Artskart (2015), Aarnæs (2002)

Neonectria coccinea (Pers.: Fr.) Rossman & Samuels, Nectriaceae, Hypocreales, Norwegian name: falsk løvtrekreft, source: Artskart (2015), Aarnæs (2002)

Neonectria ditissima (Tul. & C. Tul.) Samuels & Rossman, Syn. Nectria ditissima Tul. & C. Tul., Nectriaceae, Hypocreales, Norwegian name: rakletrekreft, source: Artskart (2015)

Neonectria fuckeliana (C. Booth) Castl. & Rossman, Nectriaceae, Hypocreales, Norwegian name: rød bartrekreft, source: Artskart (2015)

Neonectria galligena (Bres.) Rossman & Samuels, Nectriaceae, Hypocreales, Norwegian name: frukttrekreft, source: Artskart (2015)

Neonectria neomacrospora (C. Booth & Samuels) Mantiri & Samuels, Syn. Nectria neomacrospora C.Booth & Samuels, Nectriaceae, Hypocreales, source: Aarnæs (2002)

Neonectria punicea (J.C. Schmidt) Castl. & Rossman, Syn. Nectria punicea (J.C. Schmidt: Fr.) Fr., Nectriaceae, Hypocreales, source: Artskart (2015)

Niesslia exilis (Alb. & Schwein.: Fr.) G. Winter, Niessliaceae, Hypocreales, source: Artskart (2015)

Niesslia exosporioides (Desm.) G. Winter, Niessliaceae, Hypocreales, source: Artskart (2015), Aarnæs (2002)

Niesslia haglundii Starbäck, Niessliaceae, Hypocreales, source: Aarnæs (2002)

Nitschkia brevispina (Munk) Nannf., Nitschkiaceae, Coronophorales, source: Artskart (2015), Aarnæs (2002)

Nitschkia collapsa (Romell) Chenant., Nitschkiaceae, Coronophorales, source: Artskart (2015)

Nitschkia cupularis (Pers.: Fr.) P. Karst., Nitschkiaceae, Coronophorales, source: Aarnæs (2002)

Nitschkia grevillei (Rehm) Nannf., Nitschkiaceae, Coronophorales, source: Artskart (2015), Aarnæs (2002)

Nitschkia parasitans (Schwein.) Nannf., Nitschkiaceae, Coronophorales, source: Artskart (2015), Aarnæs (2002)

Obolarina dryophila (Tul. & C. Tul.) Pouzar, Xylariaceae, Xylariales, source: Nordén (2014)

Ophiocordyceps entomorrhiza (Dicks.) G.H. Sung, J.M. Sung, Hywel-Jones & Spatafora, Ophiocordycipitaceae, Hypocreales, Norwegian name: grå åmeklubbe, source: Artskart (2015)

Ophiocordyceps gracilis (Grev.) G.H. Sung, J.M. Sung, Hywel-Jones & Spatafora, Ophiocordycipitaceae, Hypocreales, Norwegian name: våråmeklubbe, source: Artskart (2015)

Ophiocordyceps myrmecophila (Ces.) G.H. Sung, J.M. Sung, Hywel-Jones & Spatafora, Ophiocordycipitaceae, Hypocreales, Norwegian name: maurklubbe, source: Artskart (2015), Aarnæs (2002)

Ophiognomonia alni-viridis (Podl. & Svrcek) Sogonov, Syn. Gnomonia alni-viridis Podl. & Svrcek, Gnomoniaceae, Diaporthales, source: Artskart (2015)

Ophiognomonia padicola (Lib.) M. Monod, Syn. Gnomonia padicola (Lib.) Kleb., Valsaceae, Diaporthales, source: Artskart (2015)

Ophiognomonia rosae (Fuckel) Kirschst., Valsaceae, Diaporthales, source: Mathiassen & Granmo (2012)

Ophiognomonia setacea (Pers.: Fr.) Sogonov, Valsaceae, Diaporthales, source: Artskart (2015), Aarnæs (2002)

Ophiostoma ainoae H. Solheim, Ophiostomataceae, Ophiostomatales, source: Aarnæs (2002)

Ophiostoma bicolor R.W. Davidson & D.E. Wells, Ophiostomataceae, Ophiostomatales, source: Artskart (2015)

Ophiostoma canum (Münch) Syd. & P. Syd., Ophiostomataceae, Ophiostomatales, source: Artskart (2015)

Ophiostoma clavatum Mathiesen, Ophiostomataceae, Ophiostomatales, source: Artskart (2015)

Ophiostoma flexuosum H. Solheim, Ophiostomataceae, Ophiostomatales, source: Aarnæs (2002)

Ophiostoma ips (Rumbold) Nannf., Ophiostomataceae, Ophiostomatales, source: Artskart (2015)

Ophiostoma minus (Hedgc.) Syd. & P. Syd., Ophiostomataceae, Ophiostomatales, source: Artskart (2015)

Ophiostoma novo-ulmi Brasier, Ophiostomataceae, Ophiostomatales, Norwegian name: almesykesopp, source: Aarnæs (2002)

Ophiostoma penicillatum, Ophiostomataceae, Ophiostomatales, source: Artskart (2015)

Ophiostoma piceae (Münch) Syd. & P. Syd., Ophiostomataceae, Ophiostomatales, source: Artskart (2015), Aarnæs (2002)

Ophiostoma polonicum Siemaszko, Syn. Ceratocystis polonica (Siemaszko) C. Moreau, Ophiostomataceae, Ophiostomatales, source: Artskart (2015)

Ophiostoma polyporicola Constant. & Ryman, Ophiostomataceae, Ophiostomatales, source: Artskart (2015)

Ophiostoma stenoceras (Robak) Nannf., Ophiostomataceae, Ophiostomatales, source: Aarnæs (2002)

Ophiostoma tetropii Mathiesen, Ophiostomataceae, Ophiostomatales, source: Aarnæs (2002)

Ophiostoma ulmi (Buisman) Nannf., Ophiostomataceae, Ophiostomatales, source: Artskart (2015), Aarnæs (2002)

Orphnodactylis wittrockii (Erikss.) Malloch & Mallik, Syn. Phylleutypa wittrockii (J.Erikss.) Petr., Phyllachoraceae, Phyllachorales, source: Aarnæs (2002)

Paranectria affinis (Grev.) Sacc., Bionectriaceae, Hypocreales, source: Aarnæs (2002)

Peristomialis marchantiae (Sommerf.) Boud., Bionectriaceae, Hypocreales, source: Aarnæs (2002)

Peroneutypa corniculata (Ehrh.) Berl., Diatrypaceae, Xylariales, source: Artskart (2015), Aarnæs (2002)

Peroneutypa scoparia (Schwein.: Fr.) Carmarán & A.I. Romero, Diatrypaceae, Xylariales, source: Artskart (2015)

Phomatospora arenaria Sacc. & E. Bommer, Incertae sedis, M. Rousseau, Xylariales, source: Aarnæs (2002)

Phomatospora berkeleyi Sacc., Incertae sedis, Xylariales, source: Artskart (2015), Aarnæs (2002)

Phomatospora dinemasporium J. Webster, Incertae sedis, Xylariales, source: Artskart (2015), Aarnæs (2002)

Phomatospora helvetica H. Wegelin, Incertae sedis, Xylariales, source: Nordén et al. (2015b)

Phomatospora hyalina (Griffiths) Cain, Incertae sedis, Xylariales, source: Artskart (2015)

Phycomelaina laminariae (Rostr.) Kohlm., Phyllachoraceae, Phyllachorales, source: Rämä et al. (2014)

Phyllachora angelicae (Fr.) Fuckel, Phyllachoraceae, Phyllachorales, source: Artskart (2015), Aarnæs (2002)

Phyllachora bromi Fuckel, Phyllachoraceae, Phyllachorales, source: Aarnæs (2002)

Phyllachora graminis (Pers.: Fr.) Nitschke, Phyllachoraceae, Phyllachorales, source: Artskart (2015), Aarnæs (2002)

Phyllachora junci (Alb. & Schwein.: Fr.) Fuckel, Phyllachoraceae, Phyllachorales, source: Artskart (2015), Aarnæs (2002)

Phyllachora lineola (Schwein.) Sacc., Phyllachoraceae, Phyllachorales, source: Aarnæs (2002)

Phyllachora sylvatica Sacc. & Speg., Phyllachoraceae, Phyllachorales, source: Artskart (2015), Aarnæs (2002)

Physalospora alpestris Niessl, Hyponectriaceae, Xylariales, source: Artskart (2015), Aarnæs (2002)

Physalospora arctostaphyli B. Erikss., Hyponectriaceae, Xylariales, source: Aarnæs (2002)

Physalospora empetri Rostr., Hyponectriaceae, Xylariales, source: Artskart (2015), Aarnæs (2002)

Physalospora galii Rostr., Hyponectriaceae, Xylariales, source: Artskart (2015), Aarnæs (2002)

Physalospora hyperborea Bäumler, Hyponectriaceae, Xylariales, source: Artskart (2015), Aarnæs (2002)

Plagiosphaera immersa (Trail) Petr., Incertae sedis, Sordariales, source: Aarnæs (2002)

Plagiostoma campylostyla (Auersw.) M.E. Barr, Syn. Gnomonia campylostyla Auersw., Valsaceae, Diaporthales, source: Artskart (2015)

Pleonectria ribis (Niessl) P. Karst., Nectriaceae, Hypocreales, source: Artskart (2015), Aarnæs (2002)

Pleuroceras helveticum (Rehm) M.E. Barr, Valsaceae, Diaporthales, source: Artskart (2015), Aarnæs (2002)

Pleuroceras insulare Johanson, Valsaceae, Diaporthales, source: Aarnæs (2002)

Pleuroceras pleurostylum (Auersw.) M.E. Barr, Valsaceae, Diaporthales, source: Aarnæs (2002)

Podospora appendiculata (Auersw. ex Niessl) Niessl, Lasiosphaeriaceae, Sordariales, source: Artskart (2015), Aarnæs (2002)

Podospora communis (Speg.) Niessl, Lasiosphaeriaceae, Sordariales, source: Artskart (2015), Aarnæs (2002)

Podospora curvicolla (G. Winter) Niessl, Lasiosphaeriaceae, Sordariales, source: Artskart (2015)

Podospora decipiens (G. Winter ex Fuckel) Niessl, Lasiosphaeriaceae, Sordariales, source: Artskart (2015), Aarnæs (2002)

Podospora fimicola Ces. ex Mussat, Lasiosphaeriaceae, Sordariales, source: Artskart (2015), Aarnæs (2002)

Podospora kansensis (Griffiths) Cain, Lasiosphaeriaceae, Sordariales, source: Artskart (2015)

Podospora myriospora (P. Crouan & H. Crouan) Niessl, Lasiosphaeriaceae, Sordariales, source: Artskart (2015), Aarnæs (2002)

Podospora pauciseta (Ces.) Traverso, Lasiosphaeriaceae, Sordariales, source: Aarnæs (2002)

Podospora perplexans (Cain) Cain, Lasiosphaeriaceae, Sordariales, source: Artskart (2015)

Podospora pleiospora (G. Winter) Niessl, Lasiosphaeriaceae, Sordariales, source: Artskart (2015)

Podospora pyriformis (A. Bayer) Cain, Lasiosphaeriaceae, Sordariales, source: Artskart (2015), Aarnæs (2002)

Podospora setosa (G. Winter) Niessl, Lasiosphaeriaceae, Sordariales, source: Aarnæs (2002)

Polystigma fulvum DC.: Fr., Phyllachoraceae, Phyllachorales, source: Artskart (2015), Aarnæs (2002)

Polystigma rubrum (Pers.: Fr.) DC., Phyllachoraceae, Phyllachorales, source: Artskart (2015), Aarnæs (2002)

Poronia punctata (L.: Fr.) Fr., Xylariaceae, Xylariales, Norwegian name: knappsopp, source: Artskart (2015), Aarnæs (2002)

Pronectria ornamentata (D. Hawksw.) Lowen, Bionectriaceae, Hypocreales, source: Aarnæs (2002)

Pronectria robergei (Mont. & Desm.) Lowen, Bionectriaceae, Hypocreales, source: Aarnæs (2002)

Prosthecium appendiculatum (G.H. Otth) M.E. Barr, Incertae sedis, Diaporthales, source: Aarnæs (2002)

Prosthecium auctum (Berk. & Broome) Petr., Incertae sedis, Diaporthales, source: Artskart (2015), Aarnæs (2002)

Protocrea delicatula (Tul. & C. Tul.) Petch, Hypocreaceae, Hypocreales, source: Artskart (2015), Aarnæs (2002)

Protocrea farinosa (Berk. & Broome) Petch, Hypocreaceae, Hypocreales, source: Artskart (2015)

Protocrea pallida (Ellis & Everh.) Jaklitsch, K. Põldmaa & Samuels, Hypocreaceae, Hypocreales, source: Nordén et al. (2015b)

Pseudallescheria boydii (Shear) McGinnis, A.A. Padhye & Ajello, Microascaceae, Microascales, source: Aarnæs (2002)

Pseudomassaria inconspicua (Johanson) M.E. Barr, Hyponectriaceae, Xylariales, source: Artskart (2015), Aarnæs (2002)

Pseudomassaria islandica (Johanson) M.E. Barr, Hyponectriaceae, Xylariales, source: Aarnæs (2002)

Pseudomassaria lycopodina (P. Karst.) Arx, Hyponectriaceae, Xylariales, source: Artskart (2015)

Pseudomassaria minor (M.E. Barr) M.E. Barr, Hyponectriaceae, Xylariales, source: Aarnæs (2002)

Pseudomassaria vaccinii Dennis, Hyponectriaceae, Xylariales, source: Mathiassen & Granmo (2012)

Pseudonectria buxi Seifert, Gräfenhan & Schroers, Syn. Pseudonectria rousseliana (Mont.) Wollenw., Nectriaceae, Hypocreales, source: Aarnæs (2002)

Pseudovalsa lanciformis (Fr.: Fr.) Ces. & De Not., Pseudovalsaceae, Diaporthales, source: Artskart (2015), Aarnæs (2002)

Pseudovalsa umbonata (Tul. & C. Tul.) Sacc., Pseudovalsaceae, Diaporthales, source: Nordén et al. (*2015b)*

Pseudovalsaria ferruginea (Nitschke) Rappaz, Clypeosphaeriaceae, Xylariales, source: Artskart (2015), Aarnæs (2002)

Pseudovalsella thelebola (Fr.: Fr.) Sacc., Melanconidaceae, Diaporthales, source: Artskart (2015), Aarnæs (2002)

Quaternaria dissepta (Fr.: Fr.) Tul. & C. Tul., Syn. Eutypella dissepta (Fr.: Fr.) Rappaz, Diatrypaceae, Xylariales, source: Nordén et al. (2015b)

Quaternaria quaternata (Pers.: Fr.) J. Schröt., Diatrypaceae, Xylariales, source: Artskart (2015), Aarnæs (2002)

Reconditella physconiarum Matzer & Hafellner, Incertae sedis, Sordariales, source: Aarnæs (2002)

Remispora maritima Linder, Halosphaeriaceae, Microascales, source: Rämä et al. (2014)

Remispora spitsbergensis K.L. Pang & Vrijmoed, Halosphaeriaceae, Microascales, source: Rämä et al. (2014)

Remispora stellata Kohlm., Halosphaeriaceae, Microascales, source: Rämä et al. (2014)

Rhagadostoma lichenicola (De Not.) Keissl., Nitschkiaceae, Coronophorales, source: Aarnæs (2002)

Rhamphoria pyriformis (Pers.: Fr.) Höhn., Annulatascaceae, Incertae sedis, source: Artskart (2015)

Rosellinia abscondita Rehm, Xylariaceae, Xylariales, source: Artskart (2015), Aarnæs (2002)

Rosellinia aquila (Fr.: Fr.) De Not., Xylariaceae, Xylariales, source: Artskart (2015), Aarnæs (2002)

Rosellinia britannica L.E. Petrini, Petrini & S.M. Francis, Xylariaceae, Xylariales, source: Artskart (2015)

Rosellinia helvetica L.E. Petrini, Petrini & S.M. Francis, Xylariaceae, Xylariales, source: Nordén et al. (2015b)

Rosellinia mammiformis (Pers.: Fr.) Ces. & De Not., Xylariaceae, Xylariales, source: Artskart (2015), Aarnæs (2002)

Rosellinia marcucciana Ces., Xylariaceae, Xylariales, source: Nordén et al. (2015b)

Rosellinia mycophila (Fr.: Fr.) Sacc., Xylariaceae, Xylariales, source: Artskart (2015), Aarnæs (2002)

Rosellinia nectrioides Rehm, Xylariaceae, Xylariales, source: Artskart (2015), Aarnæs (2002)

Rosellinia subsimilis P. Karst. & Starbäck, Xylariaceae, Xylariales, source: Artskart (2015), Aarnæs (2002)

Rosellinia thelena (Fr.: Fr.) Rabenh., Xylariaceae, Xylariales, source: Artskart (2015), Aarnæs (2002)

Roselliniopsis groedensis (Zopf) Matzer & Hafellner, Incertae sedis, Sordariales, source: Aarnæs (2002)

Ruzenia spermoides (Hoffm.: Fr.) O. Hilber ex A.N. Mill. & Huhndorf, Lasiosphaeriaceae, Sordariales, source: Artskart (2015)

Sablicola chinensis E.B.G. Jones, K.L. Pang & Vrijmoed, Halosphaeriaceae, Microascales, source: Rämä et al. (2014)

Saccardoëlla kanderana Math., Incertae sedis, Incertae sedis, source: Mathiassen (1993)

Schizothecium aloides (Fuckel) N. Lundq., Lasiosphaeriaceae, Sordariales, source: Artskart (2015)

Schizothecium conicum (Fuckel) N. Lundq., Lasiosphaeriaceae, Sordariales, source: Artskart (2015), Aarnæs (2002)

Schizothecium dakotense (Griffiths) N. Lundq., Lasiosphaeriaceae, Sordariales, source: Aarnæs (2002)

Schizothecium dubium (E.C. Hansen) N. Lundq., Lasiosphaeriaceae, Sordariales, source: Aarnæs (2002)

Schizothecium fimicola Corda, Lasiosphaeriaceae, Sordariales, source: Artskart (2015), Aarnæs (2002)

Schizothecium hispidulum (Speg.) N. Lundq., Lasiosphaeriaceae, Sordariales, source: Artskart (2015)

Schizothecium miniglutinans (J.H. Mirza & Cain) N. Lundq., Lasiosphaeriaceae, Sordariales, source: Aarnæs (2002)

Schizothecium pilosum (Mouton) N. Lundq., Lasiosphaeriaceae, Sordariales, source: Artskart (2015), Aarnæs (2002)

Schizothecium tetrasporum (G. Winter) N. Lundq., Lasiosphaeriaceae, Sordariales, source: Artskart (2015), Aarnæs (2002)

Schizothecium vesticola (Berk. & Broome) N. Lundq., Lasiosphaeriaceae, Sordariales, source: Artskart (2015), Aarnæs (2002)

Scopinella caulincola (Fuckel) Malloch, Incertae sedis, Sordariales, source: Mathiassen & Granmo (2012)

Sillia ferruginea (Pers.: Fr.) P. Karst., Valsaceae, Diaporthales, source: Artskart (2015), Aarnæs (2002)

Sordaria baltica N. Lundq., Sordariaceae, Sordariales, source: Artskart (2015), Aarnæs (2002)

Sordaria fimicola (Roberge ex Desm.) Ces. & De Not., Sordariaceae, Sordariales, source: Artskart (2015), Aarnæs (2002)

Sordaria humana (Fuckel) G. Winter, Sordariaceae, Sordariales, source: Aarnæs (2002)

Sordaria macrospora Auersw., Sordariaceae, Sordariales, source: Artskart (2015), Aarnæs (2002)

Sordaria superba De Not., Sordariaceae, Sordariales, source: Artskart (2015), Aarnæs (2002)

Sphaerodes fimicola (E.C. Hansen) P.F. Cannon & D. Hawksw., Ceratostomataceae, Hypocreales, source: Artskart (2015)

Sphaeronaemella helvellae (P. Karst.) P. Karst., Incertae sedis, Microascales, source: Aarnæs (2002)

Sphaerostilbella aureonitens (Tul. & C. Tul.) Seifert, Samuels & W. Gams, Hypocreaceae, Hypocreales, source: Artskart (2015)

Sphaerostilbella berkeleyana (Plowr. & Cooke) Samuels & Cand., Hypocreaceae, Hypocreales, source: Nordén et al. (2015b)

Stegonsporium pyriforme (Hoffm.: Fr.) Corda, Syn. Prosthecium pyriforme Jaklitsch & Voglmayr, Incertae sedis, Diaporthales, source: Nordén et al. (2015b)

Stigmatula astragali (Lasch) P.F. Cannon, Phyllachoraceae, Phyllachorales, source: Artskart (2015), Aarnæs (2002)

Strattonia borealis N. Lundq., Lasiosphaeriaceae, Sordariales, source: Aarnæs (2002)

Strattonia carbonaria (W. Phillips & Plowr.) N. Lundq., Lasiosphaeriaceae, Sordariales, source: Artskart (2015)

Stylonectria norvegica Lechat, J. Fourn. & Nordén, Nectriaceae, Hypocreales, source: Lechat et al. (2015)

Stylonectria purtonii (Grev.) Gräfenhan, Syn. Cosmospora purtonii (Grev.) Rossman & Samuels, Nectriaceae, Hypocreales, source: Aarnæs (2002)

Sydowiella ambigua (Mouton) Munk, Melanconidaceae, Diaporthales, source: Artskart (2015)

Sydowiella depressula (P. Karst.) M.E. Barr, Melanconidaceae, Diaporthales, source: Artskart (2015), Aarnæs (2002)

Sydowiella dryadis Lar.N. Vassiljeva, Melanconidaceae, Diaporthales, source: Artskart (2015), Aarnæs (2002)

Sydowiella fenestrans (Duby) Petr., Melanconidaceae, Diaporthales, source: Artskart (2015), Aarnæs (2002)

Telimenella gangraena (Fr.) Petr., Phyllachoraceae, Phyllachorales, source: Artskart (2015), Aarnæs (2002)

Thelonectria discophora (Mont.) P. Chaverri & C. Salgado, Nectriaceae, Hypocreales, source: Nordén et al. (2015b)

Thielavia basicola Zopf, Chaetomiaceae, Sordariales, source: Artskart (2015), Aarnæs (2002)

Thielaviopsis basicola (Berk. & Broome) Ferraris, Ceratocystidaceae, Microascales, source: Artskart (2015)

Thyridium vestitum (Fr.: Fr.) Fuckel, Thyridiaceae, Incertae sedis, source: Artskart (2015)

Thyronectria berolinensis (Sacc.) Seaver, Incertae sedis, Incertae sedis, source: Artskart (2015)

Thyronectria cucurbitula (Tode) Jaklitsch & Voglmayr, Syn. Zythiostroma pinastri (P. Karst.) Höhn., Nectriaceae, Hypocreales, source: Artskart (2015)

Thyronectria lamyi (Desm.) Seeler, Syn. Nectria lamyi (Desm.) De Not., Incertae sedis, Incertae sedis, source: Aarnæs (2002)

Togninia vibratilis (Fr.) Réblová & L. Mostert, Togniniaceae, Diaporthales, source: Aarnæs (2002)

Torpedospora ambispinosa Kohlm., Torpedosporaceae, Incertae sedis, source: Rämä et al. (2014)

Trichoderma aerugineum Jaklitsch, Hypocreaceae, Hypocreales, source: Artskart (2015)

Trichoderma alutaceum Jaklitsch, Syn. Hypocrea alutacea (Pers.: Fr.) Tul. & C. Tul., Hypocreaceae, Hypocreales, Norwegian name: kjerneklubbe, source: Artskart (2015)

Trichoderma citrinoviride Bissett, Hypocreaceae, Hypocreales, source: Rämä et al. (2014)

Trichoderma citrinum (Pers.) Jaklitsch, W. Gams & Voglmayr, Syn. Hypocrea citrina (Pers.: Fr.) Fr., Hypocreaceae, Hypocreales, Norwegian name: gul putesopp, source: Artskart (2015)

Trichoderma crystalligenum Jaklitsch, Syn. Hypocrea crystalligena Jaklitsch, Hypocreaceae, Hypocreales, source: Artskart (2015)

Trichoderma danicum (Jaklitsch) Jaklitsch & Voglmayr, Syn. Hypocrea danica Jaklitsch, Hypocreaceae, Hypocreales, source: Artskart (2015)

Trichoderma europaeum Jaklitsch & Voglmayr, Hypocreaceae, Hypocreales, source: Nordén et al. (2015b)

Trichoderma leucopus Jaklitsch, Syn. Hypocrea leucopus (P. Karst.) H. Chamb., Hypocreaceae, Hypocreales, source: Artskart (2015)

Trichoderma moravicum Jaklitsch, Hypocreaceae, Hypocreales, source: Nordén et al. (2015b)

Trichoderma nybergianum (T. Ulvinen & H. Chamberlain) Jaklitsch & Voglmayr, Syn. Hypocrea nybergiana T. Ulvinen & H. Chamb., Hypocreaceae, Hypocreales, source: Artskart (2015)

Trichoderma pulvinatum (Fuckel) Jaklitsch & Voglmayr, Syn. Hypocrea pulvinata Fuckel, Hypocreaceae, Hypocreales, Norwegian name: kjukeputesopp, source: Artskart (2015)

Trichoderma seppoi Jaklitsch, Syn. Hypocrea seppoi Jaklitsch, Hypocreaceae, Hypocreales, source: Artskart (2015)

Trichoderma silvae-virgineae Jaklitsch, Hypocreaceae, Hypocreales, source: Nordén et al. (2015b)

Trichoderma spinulosum (Fuckel) Jaklitsch & Voglmayr, Mycotaxon 126: 153. 2013., Syn. Creopus spinulosus (Fuckel) Moravec, Hypocreaceae, Hypocreales, source: Artskart (2015)

Trichoderma strictipile Bissett, Hypocreaceae, Hypocreales, source: Nordén et al. (2015b)

Trichoderma viride Pers., Syn. Hypocrea rufa (Pers.: Fr.) Fr., Hypocreaceae, Hypocreales, Norwegian name: brun putesopp, source: Artskart (2015)

Trichonectria rubefaciens (Ellis & Everh.) Diederich & Schroers, Bionectriaceae, Hypocreales, source: Nordén et al. (2015b)

Trichosphaerella decipiens E. Bommer, M. Rousseau & Sacc., Niessliaceae, Hypocreales, source: Nordén et al. (2015b)

Trichosphaeria melanostigmoides (Feltgen) Munk, Trichosphaeriaceae, Trichosphaeriales, source: Artskart (2015)

Trichosphaeria notabilis Mouton, Trichosphaeriaceae, Trichosphaeriales, source: Artskart (2015)

Umbrinosphaeria caesariata (Clinton & Peck) Réblová, Chaetosphaeriaceae, Chaetosphaeriales, source: Artskart (2015)

Valsa abietis (Fr.: Fr.) Fr., Valsaceae, Diaporthales, source: Artskart (2015), Aarnæs (2002)

Valsa ambiens (Pers.: Fr.) Fr., Valsaceae, Diaporthales, source: Artskart (2015), Aarnæs (2002)

Valsa auerswaldii Nitschke, Valsaceae, Diaporthales, source: Artskart (2015), Aarnæs (2002)

Valsa boreella P. Karst., Valsaceae, Diaporthales, source: Aarnæs (2002)

Valsa ceratophora Tul. & C. Tul., Valsaceae, Diaporthales, source: Artskart (2015), Aarnæs (2002)

Valsa ceratosperma (Tode: Fr.) Maire, Valsaceae, Diaporthales, source: Aarnæs (2002)

Valsa coronata (Hoffm.: Fr.) Fr., Syn. Valsa ceratosperma (Tode: Fr.) Maire, Valsaceae, Diaporthales, source: Artskart (2015)

Valsa cristata Nitschke, Valsaceae, Diaporthales, source: Artskart (2015), Aarnæs (2002)

Valsa dolosa (Fr.) Nitschke, Valsaceae, Diaporthales, source: Aarnæs (2002)

Valsa dubyi Nitschke, Valsaceae, Diaporthales, source: Artskart (2015), Aarnæs (2002)

Valsa excipienda P. Karst., Valsaceae, Diaporthales, source: Artskart (2015), Aarnæs (2002)

Valsa germanica Nitschke, Valsaceae, Diaporthales, source: Artskart (2015)

Valsa leucostoma (Pers.: Fr.) Fr., Valsaceae, Diaporthales, source: Artskart (2015), Aarnæs (2002)

Valsa massariana De Not., Valsaceae, Diaporthales, source: Artskart (2015)

Valsa melastoma (Fr.: Fr.) Fr., Valsaceae, Diaporthales, source: Artskart (2015), Aarnæs (2002)

Valsa microstoma (Pers.: Fr.) Fr., Valsaceae, Diaporthales, source: Aarnæs (2002)

Valsa nivea (Hoffm.: Fr.) Fr., Valsaceae, Diaporthales, Norwegian name: barkhvitprikk, source: Artskart (2015), Aarnæs (2002)

Valsa pini (Alb. & Schwein.: Fr.) Fr., Valsaceae, Diaporthales, source: Artskart (2015), Aarnæs (2002)

Valsa rhodophila Berk. & Broome, Valsaceae, Diaporthales, source: Artskart (2015), Aarnæs (2002)

Valsa ribesia P. Karst., Valsaceae, Diaporthales, source: Aarnæs (2002)

Valsa rostrupiana (Munk) Munk, Valsaceae, Diaporthales, source: Mathiassen & Granmo (2012)

Valsa salicina (Pers.: Fr.) Fr., Valsaceae, Diaporthales, source: Artskart (2015), Aarnæs (2002)

Valsa salicis (Fuckel) G. Winter, Valsaceae, Diaporthales, source: Artskart (2015), Aarnæs (2002)

Valsa sordida Nitschke, Valsaceae, Diaporthales, source: Artskart (2015), Aarnæs (2002)

Valsaria anserina (Pers.: Fr.) Sacc., Incertae sedis, Diaporthales, source: Artskart (2015)

Valsaria insitiva (Tode: Fr.) Ces. & De Not., Incertae sedis, Diaporthales, source: Artskart (2015)

Valsella clypeata Fuckel, Valsaceae, Diaporthales, source: Artskart (2015)

Valsella fertilis (Nitschke) Sacc., Valsaceae, Diaporthales, source: Artskart (2015)

Vialaea insculpta (Fr.) Sacc., Vialaeaceae, Diaporthales, source: Nordén et al. (2015b)

Winterina clavata Munk, Nitschkiaceae, Coronophorales, source: Artskart (2015)

Xenonectriella lutescens (Arnold) Weese, Nectriaceae, Hypocreales, source: Aarnæs (2002)

Xenotypa aterrima (Fr.: Fr.) Petr., Valsaceae, Diaporthales, source: Artskart (2015), Aarnæs (2002)

Xylaria arbuscula sensu lato Sacc., Xylariaceae, Xylariales, source: Herbarium O

Xylaria carpophila (Pers.: Fr.) Fr., Xylariaceae, Xylariales, Norwegian name: bøkehamshorn, source: Artskart (2015), Aarnæs (2002)

Xylaria filiformis (Alb. & Schwein.: Fr.) Fr., Xylariaceae, Xylariales, Norwegian name: staudehorn, source: Artskart (2015), Aarnæs (2002)

Xylaria hypoxylon (L.: Fr.) Grev., Xylariaceae, Xylariales, Norwegian name: stubbehorn, source: Artskart (2015), Aarnæs (2002)

Xylaria longipes Nitschke, Xylariaceae, Xylariales, Norwegian name: smalt stubbehorn, source: Artskart (2015), Aarnæs (2002)

Xylaria polymorpha (Pers.: Fr.) Grev., Xylariaceae, Xylariales, Norwegian name: bredt stubbehorn, source: Artskart (2015), Aarnæs (2002)

Xylomelasma sordida Réblová, Incertae sedis, Incertae sedis, source: Nordén et al. (2015b)

Zignoëlla fallax (Sacc.) Sacc., Chaetosphaeriaceae, Chaetosphaeriales, source: Artskart (2015), Aarnæs (2002)

Zignoëlla minutissima P. Karst., Chaetosphaeriaceae, Chaetosphaeriales, source: Aarnæs (2002)

Zygospermella insignis (Mouton) Cain, Lasiosphaeriaceae, Sordariales, source: Aarnæs (2002)

DISCUSSION

The 590 sordariomycetes known from Norway can be compared to the 850 sordariomycetes found in Sweden (based on Eriksson 2014, complemented by a few lichen associated species from Nordin et al. 2015), and indicates that many species may still await discovery in Norway. Assuming that as many species occur in Norway as in Sweden, more than 250 species await to be discovered in Norway. We consider this assumption reasonable despite the lack of some tree species and habitats in Norway, since Norway has a very varied topography and climate with rich deciduous forest and other important habitats. Sweden is of course not fully investigated either and the number of undiscovered species in Norway is therefore probably considerably higher. We hope that the list will contribute to increased interest for sordariomycetes in Norway. Additions and corrections to the list are welcomed.

ACKNOWLEDGEMENTS

The Norwegian Biodiversity Information Centre (Artsdatabanken) financed the project.

REFERENCES

Aarnæs J-O, 2002. Catalogue over macro- and micromycetes recorded for Norway and Svalbard. Fungiflora A/S Oslo, 412 pp.

Artsdatabanken, 2015. Norwegian Species Names Database. http://www2.artsdatabanken.no/artsnavn/Contentpages/Sok.aspx. Accessed 1st November 2015.

Artsdatabanken, GBIF Norway, 2015. Artskart. Norwegian Biodiversity Information Centre Species Map Service. http://artskart.artsdatabanken.no/FaneArtSok.aspx. Accessed 1st November 2015.

Eriksson OE, 2014. Checklist of the non-lichenized ascomycetes of Sweden. Acta Universitatis Upsaliensis. Symbolae botanicae Upsalienses 36: 1-499.

Jordal JB, Læssøe T, 2009. Rapport fra Riskens soppkurs i Eikesdalen 25.-28.09.2008. 52 pp.

Lechat C, Fournier J, Nordén B, 2015. *Stylonectria norvegica* (Nectriaceae), a new species from Norway. Ascomycete.org 7: 220-224.

Lumbsch HT, Huhndorf SM, 2010. Outline of Ascomycota – 2009. Myconet 14: 1-40.

Mathiassen G, 1993. Corticolous and lignicolous pyrenomycetes s. lat. (Ascomycetes) on *Salix* along a mid-Scandinavian transect. - Sommerfeltia 20: 1-180.

Mathiassen G, Granmo A, 2012. Sluttrapport for artsprojektet sekksporresopper i Finnmark. - Tromsø Museum, Universitetsmuseet 2012, 90 pp.

Mathiassen GH, Granmo A, Rämä T, in press. *Barrmaelia pseudobombarda* (Ascomycota), a rare European species with a peculiar disjunct distribution. Österreichische Zeitschrift für Pilzkunde.

Nordén N, 2014. *Annulohypoxylon minutellum* and *Obolarina dryophila* (Xylariales), two stromatic pyrenomycetes on oak new to Norway. Agarica 35: 25-28.

Nordén B, Læssøe T, Jordal JB, 2014. *Chlorostroma vestlandicum* sp. nov., a host-specific mycoparasite on *Hypoxylon vogesiacum* from western Norway. Karstenia 54: 9-14.

Nordén B, Gardiennet A, Priou JP, Döbbeler P, 2015a. *Bryocentria hypothallina* (Hypocreales) – a new species on *Metzgeria furcata*. Ascomycete.org 7: 121-124.

Nordén B, Læssøe T, Jordal JB, Petersen JH, Voglmayr H, Jaklitsch W, 2015b. Forty-five pyrenomycetous fungi belonging to Class Sordariomycetes new to Norway. Agarica 36: 43-54.

Nordin A, Moberg R, Tønsberg T, Vitikainen O, Dalsätt Å, Myrdal M, Snitting D, Ekman S, 2015. Santesson’s Checklist of Fennoscandian Lichen-forming and Lichenicolous Fungi. http://130.238.83.220/santesson/home.php?-link=Home). Accessed 31st March 2015.

Nordskog B., Stensvand A., Heiberg N, 2003. Fungi Occurring on Aerial Constituents of Cultivated Blackberry (*Rubus fruticosus* L.) in Norway. Acta Agriculturae Scandinavica, B 53, 21-28.

NSD, 2015. Norsk Soppdatabase, Naturhistorisk museum, Universitetet i Oslo, http://www.nhm.uio.no/botanisk/sopp/. Accessed November 1st 2015.

Rämä T, Mathiassen GH, Kauserud H, 2014. Marine fungi new to Norway, with an outlook to the overall diversity. Agarica 34: 35-54.

Sogonov MV, Castlebury LA, Rossman AY, Mejía LC, White JF, 2008. Leaf-inhabiting genera of the Gnomoniaceae, Diaporthales. Studies in Mycology 62: 1-79. doi: 10.3114/sim.2008.62.01.

Ophiostomatoid fungi in Norway

Halvor Solheim, Ari M. Hietala

Norwegian Institute of Bioeconomy Research,
P.O. Box 115, NO-1431 Ås, Norway

Corresponding author:
halvor.solheim@nibio.no

Norsk tittel: Ophiostomatoide sopper i Norge

Solheim H, Hietala AM, Ophiostomatoid fungi in Norway. Agarica 2015 vol. 36: 75-88.

KEYWORDS
Bark beetle associated fungi, blue-stain fungi, *Ceratocystis, Endoconidiophora, Grosmannia, Leptographium, Ophiostoma*

NØKKELORD
Barkbilleassosierte sopper, blåvedsopp, *Ceratocystis, Endoconidiophora, Grosmannia, Leptographium, Ophiostoma*

SAMMENDRAG

Sekksporesopp i ordenene Microascales og Ophiotomatales blir vanligvis kalt ophiostomatoide sopper. Disse er tilpasset spredning med insekter og inkluderer flere viktige patogene sopper som infiserer i sår som blir laget av eller besøkt av insektvektorer. De best kjente artene, *Ophiostoma ulmi* og *O. novo-ulmi,* er årsak til almesyke. Foruten patogene sopper er det mange saprofytter som er kjent for å forårsake blåved i tømmer. På grunn av stor morfologisk likhet mellom mange arter har det vært forvirring knyttet til taksonomi både på artsnivå og på høyere systematisk nivå.

Barkbiller er de vanligste vektorene for ophiostomatoide sopper. Bare seks barkbillearter er godt undersøkt med hensyn til ophiostomatoide sopper i Norge, og forekomst av bare 22 arter er publisert herfra. Dette er lite sammenlignet med andre nordiske land, hvor totalt 18 barkbillearter har blitt studert for assosierte sopper. Av ca. 400 beskrevne arter er ialt 52 ophiostomatoide sopper kjent fra de nordiske landene. Formålet med denne artikkelen er å gi en kort oversikt over ophiostomatoide sopper med hovedvekt på norske funn.

ABSTRACT

Ascomycetes in the orders Microascales and Ophiostomatales are generally referred to as the ophiostomatoid fungi. These fungi are adapted to insect transmission and include several important tree pathogens that typically infect wounds visited or created by their insect vectors. The best known represents being the causative agents of Dutch elm disease, *Ophiostoma ulmi* and *O. novo-ulmi*. In addition to pathogens, there are also many saprobic ophiostomatoid species that cause blue-stain in sapwood of timber. Due to great morphological similarities of many species, the taxonomy of ophiostomatoid fungi has been confusing, both at species and at higher systematic levels.

Bark beetles are the most common vectors of ophiostomatoid fungi. In Norway, only six bark beetles have so far been thoroughly studied with respect to ophiostomatoid fungi and the occurrence of only 22 species has so far been published. This is little compared to the other Nordic countries where totally 18 beetle species have been studied for their fungal associates. Altogether 52 ophiostomatoid fungi are known from the Nordic countries among ca 400 described species worldwide. The purpose of this article is to provide a brief review of ophiostomatoid fungi, with focus on species recorded from Norway.

INTRODUCTION

Ascomycetes in the orders Microascales and Ophiostomatales [subclasses *Sordariomycetidae* and *Hypocreomycetidae* of the class *Sordariomycetes* (de Beer et al. 2013a)] are referred to as the ophiostomatoid fungi. These phylogenetically diverse fungi are characterized by morphologically similar structures, resulting from convergent evolution as an adaptation to insect dispersal (Wingfield et al. 1993). Ophiostomatoid fungi include several important tree pathogens, that typically infect wounds visited or created by their insect vectors, the best known representatives being the causative agents of Dutch elm disease, *O. ulmi* (Buisman) Nannf. and *O. novo-ulmi* Brasier. In addition to pathogens, there are also many saprotrophs causing blue-stain of sapwood in timber (Fig. 1). No fungus thriving on phloem or xylem of live trees is considered to be able to penetrate through the lignosuberized outer bark of tree stems, a structure forming an effective constitutive defense. Direct fungal infection of tree stems originates commonly from wounds created by animals, insects, wind damage and human activities such as wounds inflicted upon mechanized thinning operations. The intimate relationship of ophiostomatoid fungi with their insect vectors provide these fungi access to tree energy reserves prior to arrival of wind dispersed fungi. The preferred substrates of ophiostomatoid fungi, easily assimilable non-structural carbohydrates, such as starch and free sugars, are favored substrates for all fungi and the vector-created window for pioneer colonization of phloem and sapwood is presumably crucial for the ecological success of ophiostomatoid fungi.

Ophiostomatoid fungi have more or less spherical ascomata with long beaks where ascospores are being exuded in slimy spore masses, which is an adaption to insect dispersal (Fig. 2). These fungi were conventionally delineated mainly by size and color of ascomata, the form of cilia on the top of the beaks, and ascospore size, shape and the sheath (if present) that often surrounds them. In addition, the asexual features have been used in species identification (Figs. 3-5 show typical asexual


Figure 1. Characteristic bluing in pine after bark beetle attack. Photo: H. Solheim.


Figure 2. A typical ascocarp (ca. 400 μm) of ophiostomatoid fungi (an unscribed *Ceratocystis* species). Photo: H. Solheim.

states of the three most common ophiostomatoid genera). Due to overlap in morphological characters between many species, a lot of confusion has been related to the taxonomy of ophiostomatoid fungi, both at species and at higher systematic level.

Modern molecular techniques have provided further resolution to fungal taxonomy, this resulting in steady increase in the number of ophiostomatoid taxa during the last 20 years. At the moment there are nearly 400 accepted species of ophiostomatoid fungi in 18 accepted genera (de Beer et al. 2013b, 2014). The most common genera are *Ophiostoma* with 134 species and *Leptographium* (including *Grosmannia*) with 94 species (both in the order *Ophiostomatales),* and *Ceratocystis s. lato* (order *Microascales*) with 72 accepted species (de Beer et al. 2013b). Other genera in the order *Ophiostomatales* include *Ceratocystiopsis* with 16, *Fragosphaeria* with 2, *Graphilbum* with 8 and *Raffaelea* s. str. with 15 accepted species (Dreaden et al. 2014).

Additional ophiostomatoid genera within the *Microascales* are *Cornuvesica* with 1, *Custingophora* with 1, *Graphium* with 9, *Knoxdaviesia* with 9 and *Sphaeronaemella* with 7 accepted species (de Beer et al. 2013b). *Ceratocystis s. lato* has recently been redefined and consist at the moment of seven genera, including *Ceratocystis s. str.* (de Beer et al. 2014).

Most ophiostomatoid fungi have been found in association with bark beetles (Kirisits 2004), but they may also be vectored by other insects, such as bark weevils (Viiri 2004, Jankowiak and Bilański 2013a, b), longhorn beetles (Jankowiak 2010, Jankowiak and Kolarik 2010) and other insects visiting fresh wounds of trees (Kamgan et al. 2010). However, most studies have focused on bark beetles, mainly on those colonizing with conifers.

The most devastating disease caused by ophiostomatoid fungi is Dutch elm disease. The disease was first discovered in Europe about hundred years ago, and the first pandemic caused by *O. ulmi* reached a peak in the 1930s (Brasier 1996). The second pandemic caused by the more virulent *O. novo-ulmi* reached a peak during the 1990s (Brasier 1996).

THE HISTORY OF OPHIOSTOMATOID FUNGI IN NORWAY

Among the Nordic countries, Sweden has the longest research history with ophiostomatoid fungi. Already in 1927 Lagerberg et al. (1927) published an extensive work on blue-staining of pine and spruce, and this was followed up by Melin and Nannfeldt (1934), who studied fungi associated with blue-staining in woodpulp. After the Second World War Rennerfelt (1950), Mathiesen (1950, 1951), Mathiesen-Käärik (1953) and Käärik (1980) continued the Swedish tradition. Many ophiostomatoid fungi were described during those two periods.

Figure 3. The asexual state (*Thielaviopsis*-like) of an undescribed *Thielaviopsis* species. The conidia are ca 20 µm long. Photo: H. Solheim.

In Norway, Robak (1932) also studied blueing of wood pulp, and visited Melin's lab in Sweden with isolates of an *Ophiostoma* (*Ceratostomella*) species. After his visit in Sweden, Robak described a new species, *O. stenoceras* (Robak) Nannf. As far as we know this is the first record of an ophiostomatoid fungus in Norway. Later, Finn and Helga Roll-Hansen were isolating ophiostomatoid fungi from artificially wounded Norway spruce [*Picea abies* (L.) Karst.] trees, and exchanged isolates, among others with Aino Käärik. Two ophiostomatoid fungi were found to be common wound colonizers (Roll-Hansen and Roll-Hansen 1980), this being later confirmed by Solheim and Selås (1986).

Figure 4. The asexual state (ca 250 µm) of *Leptographium curvisporum*. Photo: H. Solheim.

In 1974, James Reid from the University of Manitoba, Winnipeg in Canada was visiting the forest pathology group in Norway, led by Finn Roll-Hansen. During the stay, he collected many samples of ophiostomatoid fungi which he brought back to Canada. After retirement, he started to characterize these isolates together with co-workers which has so far lead to the description of two new species from Norway (Hausner et al. 2003, Reid et al. 2010).

In connection with the huge outbreak of the bark beetle *Ips typographus* L. on Norway spruce in the late 1970's, the ophiostomatoid fungi associated with this economically important insect were intensively studied in Norway by fungal isolation from infested wood (Solheim 1986, 1992a, b) and from the bark beetles themselves (Furniss et al. 1990, Solheim 1993; Krokene and Solheim 1996). Solheim (1986) isolated ten different species of which three were new ones. His studies revealed a clear pattern of succession in fungal invasion in sapwood after attack by *I. typographus*. *Endoconidiophora polonica* (Siemaszko) Z.W. de Beer, T.A. Duong & M.J. Wingf. was the primary invader with other ophiostomatoid species trailing some millimeters behind its colony frontier (Solheim 1992a, b).

In the 1990's, further studies of ophiostomatoid fungi were undertaken to examine species associated with four additional bark beetles, *Hylurgops palliates* Gyll., *Ips duplicatus* Sahlb., *Pityogenes chalcographus* L. and *Polygraphus poligraphus* L. (Krokene and Solheim 1996). One novel *Ambrosiella* species was discovered, which still remains to be described at species level since this is a difficult group (Rollins et al. 2001). Recent molecular studies revealed that species formerly designated to *Ambrosiella* are related to different genera (DeBeer et al. 2013a, b).

During the last ten years three different studies have been carried out on ophistomatoid material collected in Norway. Fungal isolations from the birch bark beetle *Scolytus ratzeburgi* and its galleries revealed four novel ophiostomatoid species (Linnakoski et al. 2009); only one of these has so far been described. Likewise, sporadic isolations from the bark beetles *Dryocetes autographus* Ratz. and *Hylastes cunicularius* Er. have revealed two new species of *Leptographium*, (Jacobs et al. 2010). In addition, one new species was described after a survey of wounds of broadleaved trees (Kamgan et al. 2010).

Altogether only 22 ophiostomatoid species are published from Norway. Of these nine were described as new species based on Norwegian material (see below). This diversity is low compared to other Nordic countries, where, at least 52 ophiostomatoid species are currently known, but more studies has been undertaken in both Finland and Sweden (see Linnakoski et al. 2012a and this paper).

BARK BEETLES IN NORWAY STUDIED FOR OPHIOSTOMATOID FUNGI

Nearly 70 different species of bark beetles are recorded from Norway. Of those, only six conifer inhibiting bark beetles have been studied in relation to associated fungi, namely *H. palliatus, I. duplicatus, I. typographus, P. chalcographus, P. poligraphus* and *Scolytus ratzeburgi* Jans. (Solheim 1986, 1992a, b, Krokene and Solheim 1996, Linnakoski et al. 2009). In addition, sporadic sampling has been done from *D. autographus* and *H. cunicularius* (Jacobs et al. 2010). In the other Nordic countries 10 additional bark beetles have been studied (Linnakoski et al. 2012a), while 14 additional bark beetle species also present in Norway have been studied elsewhere in Europe (Kirisits 2004, Jankowiak and Rossa 2008). Nearly all bark beetles studied so far in Norway/the Nordic countries are colonizing conifers. On broadleaved trees the only comprehensively investigated species is *S. ratzeburgi* on birch (*Betula* ssp.) (Linnakoski et al. 2008, 2009). In addition, we know that the two species causing Dutch elm disease, and vectored by *Scolytus* spp., kill elm (*Ulmus* spp.) trees also in Norway (Brasier and Kirk 2001, Solheim et al. 2011). Here it is noteworthy to state that the only elm bark beetle currently present in Norway, *Scolytus laevis* Chap., has never been studied for associated fungi.

KNOWN OPHIOSTOMATOID FUNGI IN NORWAY

Ophiostomatales

Ceratocystiopsis minuta (Siemaszko) H.P. Upadhyay & W.B. Kendr.

This species, described from Poland, is often present in Norway spruce infested by *I. typographus* (Siemaszko 1939, Solheim 1986), and has also been reported from several continents in association with various bark beetle species (de Beer et al. 2013b). In Norway, this species was found associated with *I. typographus* as a tertiary invader of sapwood (Solheim 1992b), while Käärik (1975) found *C. minuta* in a second stage after *I. typographus* attack in Sweden. There is evidence that *C. minuta*as defined morphologically represents a species complex. Plattner et al. (2009) found seven *C. minuta* lineages of which two were of Polish origin. Further studies of this complex are needed, and this work should be facilitated by the recent epitypification of a Polish strain isolated from ascospores taken from perithecia in galleries of *I. typographus* on a spruce stem (Read and Hausner 2010).

Ceratocystiopsis rollhanseniana (J. Reid, Eyjólfsd. & Hausner) Zipfel, Z.W. de Beer & M.J. Wingf.

This species was described by Hausner et al. (2003) based on material isolated from beetle galleries on standing, dead Scots pine

(*Pinus sylvestris* L.) trees. There are only two known isolates of this species, one collected near Kongsvinger and the other near Tangen, Setskog.

Grosmannia cucullata (H. Solheim) Zipfel, Z.W. de Beer & M.J. Wingf.

Grosmannia cucullata was isolated for the first time from five bark beetles (*I. typographus*), which were caught upon their emergence from logs of Norway spruce (Solheim 1986). Later, this species has been found associated with *I. typographus* in other countries as well but also with several other bark beetles in many European countries (Kirisits 2004). The fungus has also been isolated from adult *I. typographus* ssp. *japonica* in Japan (Yamaoka et el. 1997). Linnakoski et al. (2012a) wrote that this species appears to be one of the most common *Grosmannia* species in Fennoscandia. However, it may represent a species complex (Linnakoski 2012b). A revision of the *G. olivacea* complex, of which *G. cucullata* is a part of, is needed.

Grosmannia europhioides (E.F. Wright & Cain) Zipfel

This species was described by Wright and Cain (1961) from various species of *Picea* in North-America. It was later synonymized with *G. piceiperda* (Rumbold) Goid. (Upadhyay 1981). Among several others, Rumbold (1936) did not observe the presence of any sheath surrounding the ascospores of *G. piceiperda* as was described by Wright and Cain (1961) for *G. europhioides*. The taxonomic status of the species in the *G. piceiperda* group is currently unclear, but phylogenetic studies have indicated that *G. piceiperda* and *G. europhioides* represent distinct species (Zipfel et al. 2006). Linnakoski et al. (2012b) showed that the *G. piceiperda* complex consist of four different lineages of which three are from North America. Neither *G. europhiodes* nor *G. piceiperda* have ex-type cultures, but represent probably two of the three lineages from North America. European isolates represent probably an undescribed species (Linnakoski et al. 2012b).

This fungus is commonly associated with I. *typographus* (Solheim 1986, 1992a, 1993), but is also a tertiary invader of sapwood (Solheim 1992b). It has also been found associated with *Ips duplicatus* and *Polygraphus poligraphus* in Norway (Krokene and Solheim 1996). In other parts of Europe, isolates identified as *O. piceiperda* or *G. europhioides* have been collected in association with many different bark beetles in Europe (Kirisits 2004). A revision of this group is ongoing (Yuichi Yamaoka, pers. comm.).

Grosmannia penicillata (Grosmann) Goid.

The asexual state of this species, *Leptographium penicillatum,* was described in 1931 (Grosmann 1931), and the teleomorph state a year later (Grosmann 1932). This species is consistently associated with *I. typographus* in many countries in Europe (see Kirisits 2004 for review), and has also been found together with a few other bark beetle species (Kirisits 2004). The original collection of this species was lost during the war, and Solheim (1986) designated a neotype from Swedish material.

In Norway this species is very commonly associated with *I. typographus* (Furniss et al. 1990; Solheim 1986, 1992b, 1993, Krokene and Solheim 1996), but occurs also together with a few other bark beetles (Krokene and Solheim 1996). This species was among the secondary invaders of Norway spruce sapwood after *I. typographus* attack and trailed in mean 13 mm behind the primary invader *E. polonica* (Solheim 1992a, b).

Leptographium chlamydatum K. Jacobs, M.J. Wingf. & H. Solheim

The fungus was recently described based on Norwegian material and was isolated from the bark beetles *H. cunicularis* and *D. auto-*

graphus (Jacobs et al. 2010). It has later been found also in Finland and Russia in association with 5 different bark beetle species (Linnakoski 2011).

Leptographium curvisporum K. Jacobs, M.J. Wingf. & H. Solheim
This species was also recently described based on Norwegian material. It was isolated from Norway spruce wood adjacent to galleries of the root-feeding bark beetles *D. autographus* and *H. cunicularius* (Jacobs et al. 2010).

Leptographium lundbergii Lagerb. & Melin
This species is the type species of the genus *Leptographium* and was described from Sweden from a wind-felled, strongly blue-stained pine tree (Lagerberg et al. 1927). The status of this species has been problematic as both the specimen the description was based on and a designated neotype have been lost (Jacobs et al. 2005). The culture collection at Norwegian Forest and Landscape Institute hosts an old Swedish strain isolated from pine by Aino Käärik, and an old Norwegian strain from pine. These isolates formed the basis for a taxonomic re-evaluation of *L. lundbergii* and the Swedish isolate was selected as the neotype (Jacobs et al. 2005). The species is probably a common associate of pine and spruce infesting bark beetles (Jacobs et el. 2005). However, its occurrence and ecology have not been thoroughly studied either in Norway or elsewhere.

Ophiostoma ainoae H. Solheim
This species, described by Solheim (1986), is commonly associated with *I. typographus* (Furniss et al. 1990) and also with other bark beetle species (Kirisits 2004, Linnakoski et al. 2010). In the study by Solheim (1992a, b), *O. ainoae* was a secondary invader of sapwood and trailed in mean 14 mm behind *E. polonica*. This species is conspecific with Käärik's (1975) *Ceratocystis* gr. *clavata*.

Ophiostoma bicolor R.W. Davidson & D.E. Wells
This species is one of the most common ophiostomatoid fungi obtained from *Ips*-infested spruce trees in western North America (Davidson et al. 1967), but can also be associated with various bark beetle and tree species both in Europe and North-America (Davidson 1955, Kirisits 2004). In Norwegian studies this species has been one of the most common associates with *I. typographus* (Furniss et al. 1990, Solheim 1992a, b, Solheim 1993, Krokene and Solheim 1996), trailing 5 mm behind the more virulent, primary sapwood invader, *E. polonica* (Solheim 1988, Solheim 1992a). It has also been found in association with other bark beetle species in Norway spruce (Krokene and Solheim 1996).

Ophiostoma borealis Kamgan, H. Solheim & Z.W. de Beer.
During a Norwegian survey of wounds in broadleaves trees this species was found only in Northern Norway, mainly on birch, but once also on European aspen (*Populus tremula* L.) (Kamgan et al. 2010). In addition, this species has been found in galleries of *S. ratzeburgi* on birch in Finland and once in a wounded lime (*Tilia cordata* Mill.) tree in Austria (Kamgan et al. 2010).

Ophiostoma denticiliatum Linnakoski, Z.W. de Beer & M.J. Wingf.
This species was isolated from galleries of *S. ratzeburgi* in birch collected in Norway and described based on those samples (Linnakoski et al. 2009). It has also been found in wounding of birch, once in Norway and once in Sweden (Kamgan et al. 2010).

Ophiostoma flexuosum H. Solheim
This species was isolated from an atypical gallery of *I. typographus* on Norway spruce, next to a shallow, 2-3 mm deep discoloration in sapwood, together with O. *bicolor* and *G.*

penicillata. It has also been isolated in a low frequency in some other studies of *I. typographus* (Harding 1989, Jankowiak 2005) and of other bark beetles (Kirisits 2004).

Ophiostoma karelicum Linnakoski, Z.W. de Beer & M.J. Wingf.
This species has been found to be the most common ophiostomatoid fungus associated with the birch bark beetle *S. ratzeburgi* in Finland and Russian Karelia (Linnakoski et al. 2008) and Norway (Linnakoski et al. 2009). It seems to be a constant associate of the birch bark beetle, but is also found at a low frequencies with some conifer associated bark beetles (Linnakoski et al. 2010).

Ophiostoma novo-ulmi Brasier
This species is the causative agent of the second pandemic of Dutch elm disease Brasier 1991), and is now widespread in Europe, Central Asia and North-America (Basier 1996). It has also been introduced to New Zealand. Currently, *O. novo-ulmi* was separated into two subspecies, ssp. *novo-ulmi* and ssp. *americana* (Brasier and Kirk 2001), which were formerly known as Eurasian and North American races, respectively (Brasier 1979). This species is now well established in the Oslofjord region, but the disease incidence remains relatively low compared to other European countries (Solheim et al. 2011). Both subspecies have been found in Norway, ssp. *americana* was introduced first, in 1981, while ssp. *novo-ulmi* arrived a few years later (Brasier and Kirk 2001).

Ophiostoma piceae (Münch) Syd. & P. Syd.
This species was described already in 1907, and is probably one of the most common ophiostomatoid fungi in conifers. It is frequently associated with a wide variety of conifer infesting bark beetles (Kirisits 2004) and is also common as a wound colonizer in Norway spruce (Roll-Hansen and Roll-Hansen 1980, Solheim and Selås 1986). Earlier studies have been based mainly on morphological species concept, but a recent survey in Finland and Russian Karelia using DNA sequencing showed that isolates considered as *O. piceae* had often been misidentified in the past (Linnakoski et al. 2010). A study of Norwegian isolates designated as *O. piceae* is ongoing.

Ophiostoma quercus (Georgev.) Nannf.
This species was long treated as a synonym of *O. piceae*. However, Brasier and Webber (1990) suggested the separation of the two species, which has been confirmed by several studies (De Beer et al. 2013b). Confusion exists in these publications regarding the correct formulation of the epithet (*'querci'* vs. *'quercus'*). In a detailed argument, De Beer *et al.* (2003) showed why *'quercus'* is the

Figure 5. The asexual state (*Pesotum*-like- ca 600 µm) of *Ophiostoma piceae*. Photo: H. Solheim.

correct derivation. This species is probably rather frequent on broadleaved trees in Norway. It was found infrequently associated with the birch bark beetle *S. ratzeburgi* (Linnakoski et al. 2009), but was the most common species isolated from wounds of broadleaved trees (Kamgan et al. 2010).

Ophiostoma stenoceras (Robak) Melin & Nannf.
This species was described by Robak (1932) based on samples from wood pulp. It was later found by Melin and Nannfeldt (1934) also upon mycological studies on wood pulp, and has also been found in association with some bark beetle species (Mathiese-Käärik 1953). It is probably a rare species.

Ophiostoma tetropii Math.-Käärik
This species was described from Sweden based on isolates obtained from tunnels of *Tetropium* sp. in Norway spruce (Mathiesen 1951). It is commonly associated with *Tetropium* sp. in Poland as well (Jankowiak and Kolarik 2010), while in Norway and Sweden it can also be associated with *I. typographus,* though probably only casually (Käärik 1975, Solheim 1986). In a Norwegian study *O. tetropii* was isolated at the base of trees 75 and 130 weeks after attack by *I. typographus* (Solheim 1992b); it is likely that the galleries of *Tetropium* sp. overlapped spatially with those of *I. typographus* at that time.

Ophiostoma ulmi Buis.
This species was the cause of the first pandemic of Dutch elm disease (Brasier 1996). However, the spread northwards in Europe was rather slow. The origin of this species has been discussed for years. Recently, *O. ulmi* was found in Japan, as was *O. novo-ulmi* ssp. *americana* (Masuya et al. 2010). Possibly, *O. ulmi* is native to Japan, while *O. novo-ulmi* may be a recent invader. The two first Dutch elm disease episodes in Norway, in 1963 and 1972, were most probably caused by *O. ulmi* (Solheim et al. 2011). After the introduction of *O. novo-ulmi* an intensive monitoring was undertaken and of about 600 isolates collected from 1981 to1991 only nine were identified as *O. ulmi* (Solheim et al. 2011).

Microascales
Ceratocystis norvegica J. Reid & Hausner
This species, associated with *I. typographus* on Norway spruce, was recently described based on material the senior author collected during his stay in Norway in 1975 (Reid et al. 2010). Phylogenetically it is distinct from all the other currently recognized conifer-infesting *Ceratocystis s. lato* species. The generic placement of this species is uncertain since isolates were not available during the comprehensive study where *Ceratocystis s. lato* was divided in seven different genera (de Beer et al. 2014).

Endoconidiophora pinicola (T.C. Harr. & M.J. Wingf.) Z.W. de Beer, T.A. Duong & M.J. Wingf.
This species belongs to the *C. coerulescens* complex split up by Harrington and Wingfield (1998). Based on earlier studies in the UK, this taxon was considered to be restricted to pine, but is now also known from spruce, as exemplified by the Norwegian isolate mentioned by Reid et al. (2010).

Endoconidiophora polonica (Siemaszko) Z.W. de Beer, T.A. Duong & M.J. Wingf.
This species was described from Poland as a common associate of *I. typographus* (Siemaszko 1939). It has later been found in most studies on ophiostomatoid fungi associated with this bark beetle (Kirisits 2004, Linnakkoki 2011), and can also occur in association with some other bark beetles (Krokene and Solheim 1996, Kirisits 2004). The frequency of the fungus varies greatly at different locations. The species is common in Norway (particularly

in south-eastern parts of the country), but was rarely detected in Finland, Sweden and Russian Karelia (Linnakoski et al. 2012a). Because of its high virulence, it has been suggested to be essential for *I. typographus* outbreaks, but the results from different studies are conflicting and this view is currently not supported. *Endoconidiophora polonica* is considered the most aggressive ophiostomatoid fungus in conifers in Fennoscandia (Horntvedt et al. 1983, Solheim 1988).

As mentioned above, *E. polonica* is able to penetrate relatively quickly into the wet sapwood of Norway spruce after attack by *I. typographus*, while other ophiostomatoid species are following (Solheim 1992a, b). The ability of *E. polonica* to "lead the way" onto the sapwood is not due to species-specific differences in colonization rate, but due to its ability to grow under low oxygen pressure (Solheim 1991). In inoculation experiments imitating bark beetle attack ("mass inoculations"), *E. polonica* was able to kill Norway spruce trees without the presence of the bark beetle (Horntvedt et al. 1983). Other tested species (*G. penicillata* and *O. bicolor*) were only able to grow in the inner bark (Solheim 1988). *Endoconidiophora polonica* has been used as a model organism in studying tree resistance mechanisms in Norway spruce (Christiansen et al. 1999, Krokene et al. 1999).

Endoconidiophora resinifera (T.C. Harr. & M.J. Wingf.) Z.W. de Beer, T.A. Duong & M.J. Wingf.

This species was separated from *E. coerulescens* by Harrington and Wingfield (1998), partly based on Norwegian material, and a sample from wounded Norway spruce was chosen as the holotype. In Norway, this species is a common colonizer of wounded Norway spruce (Roll-Hansen and Roll-Hansen 1980, Solheim and Selås 1986), and it has also been found on wounded spruce trees elsewhere in Europe and in North-America (Harrington and Wingfield 1998). Its vertical rate of spread within the sapwood may be up to 80 cm per year (Roll-Hansen and Roll-Hansen 1980, Solheim and Selås 1986).

CONCLUSIONS AND FUTURE PROSPECTS

Owing to adaptation to insect transmission, ophiostomatoid fungi have spherical fruit-bodies with long beaks where ascospores exude in slimy spore masses at the top. The considerable overlap in morphological features between different ophiostomatoid species, a result of convergent evolution, makes the systematics of this group very challenging. With the adoption of molecular taxonomy, further revision of the nomenclature and species concepts of these fungi can be expected in the near future.

In Norway only seven bark beetles have so far been thoroughly studied with respect to ophiostomatoid fungi and only 22 ophiostomatoid fungi are currently recorded from Norway. This is little compared to the other Nordic countries where 12 additional beetle species have been studied. Altogether 52 ophiostomatoid fungi are known from the Nordic countries and ca. 400 worldwide. Particularly species associated with bark beetles feeding on broadleaved trees have received little attention; we anticipate that several novel ophiostomatoid species remain to be discovered, both in Norway and worldwide.

ACKNOWLEGDGEMENTS

Thanks to all colleagues in Norway, South Africa, and other countries who has participated in collecting, isolating and preserving ophiostomatoid fungi at Norwegian Forest and Landscape Institute. A special thanks are expressed to Olaug Olsen, who handled most of the isolates, and to two reviewers for valuable contributions. Financial support has been given by the Norwegian Forest and Landscape Institute (now Norwegian Institute of Bioeconomy

Research), Norwegian Biodiversity Information Centre and the Ministry of Agriculture and Food.

REFERENCES

Brasier CM, 1979. Dual origin of recent Dutch elm disease outbreaks in Europe. Nature 281: 78–80.

Brasier CM, 1991. *Ophiostoma novo-ulmi* sp. nov., causative agent of current Dutch elm disease pandemics. Mycopathologia 115: 151–161.

Brasier CM, 1996. New horizons in Dutch elm disease control. Report Forest Research, Edinburgh 1996: 20–28.

Brasier CM, Kirk SA, 2001. Designation of the EAN and WAN races of *Ophiostoma novo-ulmi* as subspecies. Mycological Research 105: 547-554.

Brasier CM, Webber JF, 1990. Status of *Ophiostoma piceae* on hardwoods and conifers. Taxonomy and Biology of the Ophiostomatales, an International Symposium, August 1990. Bad Windsheim, Germany (abstract).

Christiansen E, Krokene P, Berryman AA, Franceschi VR, Krekling T, Lieutier F, Lönneborg A, Solheim H, 1999. Mechanical injury and fungal infection induce acquired resistance in Norway spruce. Tree Physiology 19**:** 399–403.

Davidson RW, 1955. Wood-staining fungi associated with bark beetles in Engelmann Spruce in Colorado. Mycologia 47: 58–67.

Davidson RW, Käärik A, Francke-Grosmann H, 1967. A restudy of *Ceratocystis penicillata* and report of two American species of this genus from Europe. Mycologia 59: 928–932.

De Beer ZW, Glen HF, Wingfield BD, Wingfield MJ, 2003. *Ophiostoma quercus* or *Ophiostoma querci*? Mycotaxon 86: 211–214.

De Beer ZW, Seifert KA, Wingfield MJ, 2013a. The ophiostomatoid fungi: their dual position in the *Sordariomycetes*, in: Seifert KA, de Beer ZW, Wingfield MJ (Eds.), The Ophiostomatoid fungi: expanding frontiers. CBS Biodiversity Series 12. Utrecht: the Netherlands. CBS Press, pp. 1–19.

De Beer ZW, Seifert KA, Wingfield MJ, 2013b. A nomenclator for ophiostomatoid genera and species in the *Ophiostomatales* and *Microascales*, in: Seifert KA, de Beer ZW, Wingfield MJ (eds.), The Ophiostomatoid fungi: expanding frontiers. CBS Biodiversity Series 12. Utrecht: the Netherlands. CBS Press, pp. 243–320.

De Beer ZW, Duong TA, Barnes I, Wingfield BD, Wingfield MJ, 2014. Redefining *Ceratocystis* and allied genera. Studies in Mycology 79: 187-219.

Dreaden TJ, Davis JM, De Beer ZW, Randy C. Ploetz RC, Soltis PS, Wingfield MJ, 2014. Phylogeny of ambrosia beetle symbionts in the genus *Raffaelea*. Fungal Biology 118: 970-978.

Furniss MM, Solheim H, Christiansen E, 1990. Transmission of blue-stain fungi by *Ips typographus* (Coleoptera: Scolytidae) in Norway spruce. Annals of the Entomological Society of America 83(4): 712-716.

Grosmann H, 1931. Beitrage zur Kenntnis der Lebensgemeinschaft zwischen Borkenkäfern und Pilzen. Zeitschrift für Parasitenkunde 3: 56–102.

Grosmann H, 1932. Über die systematischen Bezichungcn der Gattung *Leptographium* Lagerb. ex Melin zur Gattung *Ceratostomella* Sacc. nebst einigen Bemerkungen über *Scopularia venusta* Preuss and *Hantzschia phycomyces* Avd. Hedwigia 72: 180-198.

Harding S, 1989. The Influence of Mutualistic Blue-Stain Fungi on Bark Beetle Population Dynamics. PhD dissertation, Royal Veterinary and Agricultural University Copenhagen, Copenhagen, Denmark.

Harrington TC, Wingfield MJ, 1998. The *Ceratocystis* species on conifers. Canadian Journal of Botany 76: 1446–1457.

Hausner G, Eyjólfsdóttir GG, Reid J, 2003. Three new species of *Ophiostoma* and notes on *Cornuvesica falcata*. Canadian Journal of Botany 81: 40–48.

Horntvedt R, Christiansen E, Solheim H, Wang S, 1983. Artificial inoculation with *Ips typographus*-associated blue-stain fungi can kill healthy Norway spruce trees. Meddelelser fra Norsk institutt for skogforskning 38(4): 1- 20.

Jacobs K, Solheim H, Wingfield BD, Wingfield MJ, 2005. Taxonomic re-evaluation of *Leptographium lundbergii* based on DNA sequence comparisons and morphology. Mycological Research 109: 1149–1161.

Jacobs K, Krokene P, Solheim H, Wingfield M, 2010. Two new species of *Leptographium* from *Dryocoetes autographus* and *Hylastes cunicularius* in Norway. Mycological Progress 9: 69–78.

Jankowiak R, 2005. Fungi associated with *Ips typographus* on *Picea abies* in southern Poland and their succession into the phloem and sapwood of beetle-infested trees and logs. Forest Pathology 35: 37-55.

Jankowiak R, 2010. *Ophiostoma sensu lato* species associated with the cerambycid beetles *Monochamus sutor* (L.) and *Rhagium inquisitor* (L.) in southern Poland. (In Polish with English summary). Sylwan 154: 381−387.

Jankowiak R, Bilański P, 2013a. Association of the pine-infesting *Pissodes* species with ophiostomatoid fungi in Poland. European Journal of Forest Research 132: 523-534.

Jankowiak R, Bilański P, 2013b. Diversity of ophiostomatoid fungi associated with the large pine weevil, *Hylobius abietis* and infested Scots pine seedlings in Poland. Annals of Forest Science 70: 391–402.

Jankowiak R, Kolarík M, 2010. Diversity and pathogenicity of ophiostomatoid fungi associated with *Tetropium* species colonizing *Picea abies* in Poland. Folia Microbiologica 55: 145–154.

Jankowiak R, Rossa R, 2008. Associations between *Pityogenes bidentatus* and fungi in young managed Scots pine stands in Poland. Forest Pathology 38: 169–177.

Kamgan Nkuekam G, Solheim H, De Beer ZW, Grobbelaar JW, Jacobs K, Wingfield MJ, Roux J, 2010. *Ophiostoma* species, including *Ophiostoma borealis* sp. nov., infecting wounds of native broad-leaved trees in Norway. Cryptogamie Mycologie 31: 285–303.

Käärik, A. 1975. Succession of microorganisms during wood dccay. in: Licse W (ed.), Biological transformation of Wood by microorganisms. Proceedings of the Sessions on Wood Products Pathology at the 2nd International Congress of Plant Pathdlogy, September 10-12, 1973, Minneapolis, USA, pp. 39-51.

Käärik A, 1980. Fungi causing sap stain in wood. Rapport nr. *R114.* Institutionen för Virkeslära, Sveriges Lantbruksuniversitet, Uppsala, Sweden. 112 p.

Kirisits T, 2004. Fungal associates of European bark beetles with special emphasis on the ophiostomatoid fungi. In: Bark and Wood Boring Insects in Living Trees in Europe, a Synthesis; Lieutier F, Day KR, Battisti A, Grégoire J-C, Evans H, (eds.), Kluwer Academic, Dortrecht, The Netherlands, pp. 181–235.

Krokene P, Solheim H, 1996. Fungal associates of five bark beetle species colonizing Norway spruce. Canadian Journal of Forest Research 26: 2115-2122.

Krokene P, Christiansen E, Solheim H, Berryman AA, Franceschi VR, 1999. Induced resistance to pathogenic fungi in Norway spruce. Plant Physiology 121: 565–570.

Lagerberg T, Lundberg G, Melin E, 1927. Biological and practical researches into blueing of pine and spruce. Svenska Skogsvårdsföreningens Tidskrift 25: 145-272, 561-739.

Linnakoski R, 2011. Bark beetle-associated fungi in Fennoscandia with special emphasis on species of *Ophiostoma* and *Grosmannia*. Ph.D. Dissertation, The Finnish Society of Forest Science, Joensuu, Finland, 2011.

Linnakoski R, de Beer ZW, Rousi M, Niemelä P, Pappinen A, Wingfield MJ, 2008. Fungi, including *Ophiostoma karelicum* sp. nov., associated with *Scolytus ratzeburgi* infesting birch in Finland and Russia. Mycological Research 112: 1475–1488.

Linnakoski R, De Beer ZW, Rousi M, Solheim H, Wingfield MJ, 2009. *Ophiostoma denticiliatum* sp. nov. and other *Ophiostoma* species associated with the birch bark beetle in southern Norway. Persoonia 23: 9–15.

Linnakoski R, de Beer ZW, Ahtiainen J, Sidorov E, Niemelä P, Pappinen A, Wingfield MJ, 2010. *Ophiostoma* spp. associated with pine- and spruce-infesting bark beetles in Finland and Russia. Persoonia 25: 72–93.

Linnakoski R, de Beer ZW, Niemelä P, Wingfield MJ, 2012a. Associations of conifer-infesting bark beetles and fungi in Fennoscandia. Insects 3: 200-227.

Linnakoski R, de Beer W, Duong TA, Niemilä P, Pappinen A, Wingfield MJ, 2012b. *Grosmannia* and *Leptographium* spp. Associated with conifer-infesting bark beetles in Finland and Russia, including *Leptographium taigense* sp. nov. Antonie van Leeuwenhoek 102: 375–399.

Masuya H, Brasier C, Ichiharac Y, Kubonoa T, Kanzaki N, 2010. First report of the Dutch elm disease pathogens *Ophiostoma ulmi* and *O. novo-ulmi* in Japan. Plant Pathology 59: 805.

Mathiesen A, 1950. Über einige mit Borkenkäfern assoziierte Bläuepilze in Schweden. Oikos 2: 275–308.

Mathiesen A, 1951. Einige neue *Ophiostoma*-Arten in Schweden. Svensk Botanisk Tidskrift 45: 203–232.

Mathiesen-Käärik A, 1953. Eine Übersicht über die gewöhnlichsten mit Borkenkäfern assoziierten Bläuepilze in Schweden und einige für Schweden neue Bläuepilze. Meddelanden Statens Skogsforsknings Institut 43: 1–74.

Melin E, Nannfeldt JA, 1934. Research into the blueing og ground wood-pulp. Svenska Skogsvårdsföreningens Tidskrift 32: 397-616.

Plattner A, Kim JJ, Reid J, Hausner G, Lim YW, Yamaoka Y, Breuil C, 2009. Resolving taxonomic and phylogenetic incongruence within species *Ceratocystiopsis minuta*. Mycologia 101: 878–887.

Reid J, Hausner G, 2010. The epitypification of *Ophiostoma minutum*, now *Ceratocystiopsis minuta.* Mycotaxon 113: 463-474.

Reid J, Iranpour M, Rudski SM, Loewen PC, Hausner G, 2010. A new conifer-inhabiting species of *Ceratocystis* from Norway. Botany 88: 971–983.

Rennerfelt E, 1950. Über den Zusammenhang zwischen dem Verblauen des Holzes und den Insekten. Oikos 2: 120-137.

Robak H, 1932. Investigation regarding fungi on Norwegian ground wood pulp and fungal infection at wood pulp mills. Nyt Magazin for Naturvidenskab Oslo 71: 185-330.

Roll-Hansen F, Roll-Hansen H, 1980. Microorganisms which invade *Picea abies* in seasonal stem wounds. II. Ascomycetes, Fungi imperfecti, and bacteria. General discussion, Hymenomycetes included. European Journal of Forest Pathology 10: 396-410.

Rollins F, Kevin G, Jones KG, Kroken P, Solheim H, Blackwell M, 2001**.** Phylogeny of asexual fungi associated with bark and ambrosia beetles. Mycologia 93: 991-996.

Rumbold CT, 1936. Three blue staining fungi, including two new species associated with bark beetles. Journal of Agricultural Research 52: 419–437.

Siemaszko W, 1939. Fungi associated with bark-beetles in Poland. Planta Polonica 7: 1–54. [In Polish with English summary].

Solheim H, 1986. Species of *Ophiostomataceae* isolated from *Picea abies* infested by the bark beetle *Ips typographus*. Nordic Journal of Botany 6: 199–207.

Solheim H, 1988. Pathogenicity of some *Ips typographus*-associated blue-stain fungi to Norway spruce. Meddelser fra Norsk Institutt for Skogforskning 40: 1–11.

Solheim H, 1991. Oxygen deficiency and spruce resin inhibition of growth of fungi associated with *Ips typographus*. Mycological Research 95: 1387-1392.

Solheim H, 1992a. The early stages of fungal invasion in Norway spruce infested by the bark beetle *Ips typographus*. Canadian Journal of Botany 70: 1-5.

Solheim H, 1992b. Fungal succession in sapwood of Norway spruce infested by the bark beetle *Ips typographus*. European Journal of Forest Pathology 22: 136-148.

Solheim H, 1993. Fungi associated with the spruce bark beetle *Ips typographus* in an endemic area in Norway. Scandinavian Journal of Forest Research 8: 118-122.

Solheim H, Selås P, 1986. Discoloration and microflora in wood of *Picea abies* (L.) Karst. after wounding. I. Spread after 2 years. (In Norwegian with English summary). Rapport Norsk institutt for skogforskning 7/86: 1-16.

Solheim H, Eriksen R, Hietala AM, 2011. Dutch Elm disease is currently not a threat to wych elm in Norway. Forest Pathology 41: 182-188.

Upadhyay HP, 1981. A monograph of *Ceratocystis* and *Ceratocystiopsis.* The University of Georgia Press, Athens. 176 p.

Viiri H, 2004. Fungi associated with *Hylobius abietis* and other weevils, in: Lieutier F, Day KR, Battisti A, Gregoire JC, Evans HF (eds.), Bark and wood boring insects in living trees in Europe, a synthesis. Bark and wood boring insects in living trees in Europe, a Synthesis, Kluwer, Dordrecht, pp. 380–393.

Wingfield MJ, Seifert KA, Webber JF, 1993. *Ceratocystis* and *Ophiostoma*: taxonomy, ecology and pathogenicity. American Phytopathological Society Press, St. Paul, MN, USA.

Wright EF, Cain RF, 1961. New species of the genus *Ceratocystis.* Canadian Journal of Botany 39: 1215-1230.

Yamaoka Y, Wingfield MJ, Takahashi I, Solheim H, 1997. Ophiostomatoid fungi associated with the spruce beetle *Ips typographus* f. *japonicus* in Japan. Mycological Research 101: 1215-1227.

Zipfel RD, de Beer ZW, Jacobs K, Wingfield BD, Wingfield MJ, 2006. Multi-gene phylogenies define *Ceratocystiopsis* and *Grosmannia* distinct from *Ophiostoma*. Studies in Mycology 55: 75–97.

Ectomycorrhizal *Ramaria* species in nutrient-poor Fennoscandian conifer forests including a note on the *Ramaria botrytis* complex

Katriina Bendiksen[1], Ilkka Kytövuori[2], Mika Toivonen[2],
Egil Bendiksen[3], Tor Erik Brandrud[3]

[1]Natural History Museum, University of Oslo,
P.O. Box 1172 Blindern, NO-0318 Oslo, Norway
[2]Finnish Museum of Natural History, Mycology Division,
P.O. Box 7, FI-00014, Helsinki University, Finland
[3]Norwegian Institute for Nature Research (NINA),
Gaustadalleen 21, NO-0349 Oslo, Norway

Corresponding author:
katriina.bendiksen@nhm.uio.no

Norsk tittel: Ektomykorrhizadannende *Ramaria*-arter (korallsopp) i næringsfattig barskog i Fennoskandia, inkludert betraktninger om *Ramaria botrytis*-komplekset

Bendiksen K, Kytövuori I, Toivonen M, Bendiksen E, Brandrud TE, 2015.
Ectomycorrhizal *Ramaria* species in nutrient-poor Fennoscandian conifer forests including a note on the *Ramaria botrytis* complex. Agarica 2015 vol. 36: 89-108.

KEYWORDS
Ramaria, Coral fungi, boreal coniferous forest, ecology, taxonomic revision

NØKKELORD
Ramaria, korallsopp, boreal barskog, økologi, taksonomisk revisjon

SAMMENDRAG

Gjennom herbarierevisjon (2005–2008), og feltarbeid av forfatterne (2009–2011) og en rekke biologer og amatørmykologer (2009–2014) har de ektomykorrhizadannende korallsoppartene (*Ramaria*) blitt studert med hensyn til diversitet, utbredelse og økologi. Det har blitt foretatt morfologisk analyse av mer enn tusen innsamlinger, og ca. 650 representative fennoskandiske kollekter har blitt studert molekylært (nrDNA ITS og deler av LSU). For å stabilisere nomenklaturen har 87 relevante typer av korallsopparter fra Europa og Nord-Amerika blitt undersøkt morfologisk og molekylært. Til nå har 46 forskjellige arter blitt identifisert fra nordisk materiale, og minst førti av dem kan skilles morfologisk. Mer enn tjue av artene vokser i barskog. Mindre enn ti av dem er ikke spesielt næringskrevende, og de er knyttet til boreal, ofte furudominert skog. Denne artikkelen har hovedfokus på sistnevnte gruppe.

Det er gitt beskrivelser av *R. boreimaxima, R. eosanguinea, R. 'neoformosa* sensu Schild'*, R. primulina, R. testaceoflava, R. botrytis, R. 'botrytis coniferous'* og *R. 'rubripermanens* sensu Christan 2008'

For artsgruppen som er presentert viser undersøkelsen at det er behov for en rekke endringer med hensyn til taksonomi og nomenklatur. Bare to av artene som er behandlet, *R. botrytis* og *R. testaceoflava* har beholdt de navnene som tradisjonelt har vært brukt for dem. En av artene er nybeskrevet (*R. boreimaxima,* 2014). I to tilfeller har typestudier med bruk av molekylære metoder bekreftet identitet med taksa med ukjent eller lite kjent navn i Norden (*R. eosanguinea* og *R. primulina*).

For de øvrige artene trengs ytterligere undersøkelser av nomenklaturen, og sannsynligvis er de ubeskrevne.

ABSTRACT

A herbarium revision (2005–2008), and field work by authors (2009–2011) and by several biologists and amateur mycologists (2009–2014) have been performed to record the species diversity, distribution and ecology of ectomycorrhizal *Ramaria*-species in Fennoscandia. Morphological analysis of more than thousand specimens has been carried out, and ca. 650 representative Fennoscandian specimens have been studied molecularly (nrDNA ITS and part of LSU). To stabilize the nomenclature, 87 relevant type specimens of *Ramaria* species from Europe and North America have been examined morphologically and molecularly.

So far, 46 different species have been identified among Nordic material, and at least 40 of them can be identified morphologically. More than twenty of the species grow in coniferous forests. Less than ten of them are not especially nutrient demanding and prefer boreal, often pine dominated forests. This paper has its focus on the latter group.

Descriptions are provided for *R. boreimaxima, R. eosanguinea, R. 'neoformosa* sensu Schild'*, R. primulina, R. testaceoflava, R. botrytis, R. 'botrytis coniferous'* and *R. 'rubripermanens* sensu Christan 2008'

Our study has shown the need for several nomenclatural-taxonomic changes in the group presented here. Only two of the treated species, *R. botrytis* and *R. testaceoflava,* have retained traditionally used names. One of the species has been described as new (*R. boreimaxima,* 2014). In two cases, type studies using molecular methods have confirmed identity with unknown or little used names in the Nordic countries (*R. eosanguinea* and *R. primulina*). The rest of the species need further nomenclatural research and are probably undescribed.

INTRODUCTION

This is the third paper from our Nordic *Ramaria* project, the aim of which has been to research the species diversity, distribution and ecology of mycorrhizal *Ramaria* species and to stabilize their nomenclature.

Preliminary results of the project are reported in Kotiranta et al. (2009), where the first Finnish records are presented, and in two subsequent papers. The first of these (Brandrud et al. 2012) provides descriptions of species connected to boreonemoral broadleaved deciduous forests in Norway. The second one (Bendiksen et al. 2013) has its focus on species in base-rich coniferous forests in Norway (both papers in Norwegian with abstracts in English). The general background for the project is given in these papers.

During 2005–2008, 2010–2011 and 2013–2014 the project was financially supported by taxonomy initiatives in Finland (Forest Biodiversity Programme for Southern Finland), Norway (Norwegian Biodiversity Information Centre) and Sweden (Swedish Biodiversity Information Centre), respectively. The funding from Sweden was granted for molecular studies that will be completed by the end of 2015. The geographical focus of the project has now been widened to the whole of Fennoscandia.

The names and taxonomy of almost all Fennoscandian *Ramaria* species have until recently been adopted from Central and South Europe, and from North America. Comparison of DNA sequences from Nordic material with relevant European and North American type specimens reveal that several Fennoscandian species have a strictly boreal distribution and are probably undescribed.

In the present paper we treat the last, larger ecological group of Fennoscandian ectomycorrhizal *Ramaria* species, the least nutrient-demanding ones, most of which seem to grow with *Pinus* and *Picea*, preferably in dry, sandy, pine dominated forests with only thin organic soil. In addition we present the three known Nordic species in the *Ramaria botrytis* complex, two of which have a clearly deviating ecology, since we have discovered that the earlier concept of *R. botrytis* in Fennoscandia is collective and one of the taxa is a genuinely boreal species.

After completing our molecular studies, the phylogenetic results, taxonomic revisions, descriptions of new species and a key to the Nordic species will be published in separate papers.

MATERIALS AND METHODS

The Fennoscandian *Ramaria* project is based on the following data sources:

1) Revision of *Ramaria* specimens of all available Nordic herbaria (BG, H, LD, O, OULU, S, TRH, TROM, TUR).
2) Specimens collected over a long period of time by I. Kytövuori.
3) Specimens collected by project members during the field work in Norway in 2009–2011, as part of the Norwegian taxonomy project, and the collections sent to us by biologists working with nature surveys and by accomplished amateurs.
4) Recent collections sent to us from Sweden in 2013–2014 by more than ten biologists and amateurs.
5) Molecular analysis of ca. 650 representative specimens from Fennoscandia and ca. 260 specimens with relevant ecology and distribution from Central and Southern Europe, and from North America.
6) Studies of 87 European and North American type specimens. Further, we studied specimens of the mycorrhizal *Ramaria* species introduced in the German monograph of *Ramaria* by Christan (2008) and deposited in his private herbarium.

The Nordic material, more than a thousand morphologically analyzed specimens, covers most of the biogeographic provinces in Fennoscandia: from Agder in the south to Troms in the north in Norway, from Skåne to Lule Lappmark and Norrbotten in Sweden and from Åland and Varsinais-Suomi to Inari Lapland in Finland. The best examined area in Norway is the South Eastern part (Østlandet) and in Sweden the provinces Skåne, Uppland and Dalarna. In Finland the southern part of the country is most thoroughly inventoried.

Microscopic observations were made in Melzer's reagent (MLZ) instead of cotton blue, used by most Ramaria researchers. MLZ, which has been used by three of the authors as standard mountant with agarics, has also worked well when studying Ramaria. The spores were measured without ornamentation and apiculus. Approximately 5% of the measured spores (extremes) were excluded to obtain the given variations of spore lengths and widths, and length/width ratios (Q). All measured spores were included in all given calculated mean values: for average spore lengths, widths and length/width ratios (all boldfaced) and for variations of averages between specimens (av., Q av.).

A representative selection of all morphological Nordic species was examined molecularly. DNA was extracted from small pieces of dried fruit bodies. ITS sequences (including 5.8S) and sequences including a part of LSU of nucleic rDNA were obtained by direct sequencing. Most of the selected Finnish material was sequenced at Helsinki University in 2005–2008. Most of the Norwegian material was sequenced in Guelph, Ontario, Canada, in 2011 and 2014 as a part of the Norwegian Barcode of Life (NorBOL) project. Most of the Swedish and some Norwegian and Finnish material were sequenced at the Natural History Museum of Oslo (NHM) in 2014.

The abbreviation NR in the lists of studied material refers to Nature Reserve. Authors' names as collectors are abbreviated as EB, KB, TEB, IK and MT. Abbreviations of official herbaria are in accordance with Holmgren et

Figure 1. “*Ramaria*-land”. Dry pine forest on sandy soil. Norway, Hedmark, Elverum, Heradsbygd skistadion. Photo: T. E. Brandrud.

al. (1990). Herbarium acronyms followed by accession number refer to databased records.

Nature type codes, given as ecological information for each species (Online material 1), follows the Norwegian system of Nature in Norway (NiN), version 2.0 (Halvorsen et al. 2015).

RESULTS AND DISCUSSION

So far, 46 different species have been identified among Nordic material of mycorrhizal *Ramaria*, based on molecular data. For the moment, it is possible to identify at least 40 of them morphologically. More than twenty species are growing in coniferous forests and less than ten of those belong to the group of least nutrient-demanding ones, treated in this paper. Several of the present species seem to have their optimum in sandy pine forests like in fig. 1 (*R. boreimaxima, R. eosanguinea, R. neoformosa* sensu Schild and *R. primulina*). However, all of these also occur in other forest types, including more mesic spruce forests. An exception from this pattern is *Ramaria testaceoflava*, which has a strong preference for *Picea*.

The present paper also treats the entire *R. botrytis* complex, including *R. botrytis* s. str. and *R. ‘rubripermanens* sensu Christan’ with preference for boreonemoral oak-lime forests and dry pine forests, as well as *R.* ‘*botrytis* coniferous’ found mainly in boreal spruce forests and sandy pine forests.

The taxonomic groups, to which the treated species belong, are briefly introduced, and descriptions of the species are provided below.

Figure 2. *Ramaria boreimaxima* (young and small fruit body). Sweden, Jämtland, Östersund, Blixtbäcksselet NV, KB&EB 83/10. Photo: K. Bendiksen.

RAMARIA BOREIMAXIMA GROUP

The group is characterized by large cauliflower-like fruitbodies, which are apricot coloured or pale orange yellow as young, soon fading to alutaceous, and narrowly cylindrical spores with low ornamentation of small warts in obscure rows.

The group seems to have an isolated position among mycorrhizal *Ramaria.*

Ramaria boreimaxima Kytöv. & Toivonen**.**
Fig. 2.
Misapplied name: *R. magnipes* Marr & D.E. Stuntz (Nitare 2010).

Macromorphology: Fruit bodies large, up to 30 cm high and 25 cm broad, cauliflower-like especially when young, later congested-branched when the branches become longer, apical branches narrow, pointed, pale orange yellow when young, soon discolouring to alutaceous or flesh toned, rarely with salmon pinkish tints, extreme apices pale orange when young. Stipe robust, branching upwards, white. Context white, in apical branches pale orange brown, usually not reddening or darkening when handled or dried. Smell weak. Taste mild, slightly bitter at older apices.

Microscopy: Spores narrowly cylindrical to narrowly dacryoid, 9.7–***10.9*** – 12.2 x 3.9 – ***4.4*** −4.8 µm (av. = 10.9–11.5 x 4.0–4.6 µm), Q = 2.1−***2.47***−2.7 (Q av. = 2.35–2.58), (285 spores, 16 specimens), warts small and low, occasionally a few elongated, mostly in irregular rows. Basidia and hyphae in trama with clamps; hyphae in the basal tomentum of the stipe smooth with neither crystals nor a gelatinous sheath, mostly with clamps.

Habitat and distribution: Especially in dry sandy pine forests, including sites with more coarse, gravelly till, rarely in rocky pine forests on shallow soil, sometimes in mesic spruce dominated coniferous forests. From the northern part of the boreonemoral zone to the northern boreal zone; somewhat rare to occasional. In Norway recorded from southeastern part of the country, from Østfold to Aust-Agder; in Sweden from Dalarna to Lule Lappmark and in Finland from Varsinais-Suomi to Koillismaa.

Notes: *Ramaria boreimaxima* is a newly described, apparently boreal species (Kytövuori and Toivonen 2014). The species is characterized by the large to very large fruit bodies growing preferentially in dry, sandy pine forests. It resembles in appearance other large *Ramaria* species, such as *R. flavescens* and *R. eosanguinea*, both of which are more pure yellow when young. *R. flavescens* has different, strongly verrucose spores and a preference for base-rich habitats, and the most northern records are from the boreonemoral zone (Bendiksen et al. 2013).

R. eosanguinea grows in similar habitats but is usually somewhat smaller, with smaller, more tapering stipe, the base context of which is watery greyish, marbled and becomes brownish upon drying. *R. eosanguinea* has also a characteristic saffron(-iodoform)-like smell. Some of the basal tomentum hyphae of *R. eosanguinea* have a sparse cover of flat crystals. The spores of the latter are oblong-cylindrical, often somewhat sway-backed and have even lower ornamentation than the spores of *R. boreimaxima.* Both *R. boreimaxima* and *R. eosanguinea* have spores with so low warts that a well-adjusted microscope and some experience are needed to be able to see the ornamentation; spores are not smooth as it is often claimed.

The American name, *R. magnipes,* has been applied for this in recent Swedish literature (Nitare 2010, Gärdenfors 2010) but the type specimen of *R. magnipes* is now confirmed to belong to the *R. flava* group.

Fennoscandian material studied and confirmed by DNA:

Norway

Østfold: Aremark, Aug. 16, 1987, Mathisen (O-F121580); Fredrikstad District, Weholt 34/88 (O).

Buskerud: Kongsberg, Kongsbergskogen v/Haurevanna, Aug. 21, 1999, Gulden, Sørensen, Fonneland & Dahl (O-F63166).

Aust-Agder: Vegårdshei, Sundet-Lundhaug, Aug. 14, 2011, Henrichsen & Fonneland, I-FL 2011-147 (O-F294494); Åmli, Baas i Tovdalen, Sept. 19, 2010, Gundersen & Junker (O-F295771).

Sweden

Dalarna: Säter, Gustaf socken, Dammsjön NR, Aug. 21, 2011, Aronsson (S, dupl. O); Söderbärke, Mäsberget, Sept. 24, 2011, Hermansson S2675 (O).

Hälsingland: Voxna, Lobonäs, Sept. 16, 1995, Pirjo Kytövuori & IK 95-1977 (H).

Ångermanland: Junsele, Ysjö, Aug. 30, 1997, IK 97-443 (H).

Jämtland: Rätan, Handsjö, Aug. 31, 2003, IK, Niskanen & Liimatainen (H); Östersund, Blixtbäcksselet NV, Aug. 27, 2010, Petterson (KB&EB 83/10, O-F294273).

Finland

Uusimaa: Espoo, Luukki, Aug. 22, 2000, IK & Course (H).

Etelä-Häme: Lammi, Evo, Pitkäniemenkangas, Aug. 20, 1996, IK 96-525 (HOLOTYPUS, H); Renko, Hiitankangas, Aug. 10, 1997, IK 97-185 (H).

Etelä-Savo: Kerimäki, Louhi, Sept. 8, 1998, IK 98-1749 (H).

Ramaria* aff. *boreimaxima

A few specimens morphologically resembling *R. boreimaxima* have a distinctly deviating ITS sequence while the LSU sequence is identical. We have not yet found morphological characters distinctive enough to distinguish one from another, although some small macroscopic differences e.g. in fruitbody colour and in form of the branch tips can be observed.

We have records of these deviating specimens from both Norway and Sweden, but not from Finland. They seem to have a similar ecology as *R. boreimaxima* but show a more southwestern distribution.

Fennoscandian material studied and confirmed by DNA:

Norway

Buskerud: Sigdal, Høgås S, Jul. 12, 2011, Hofton THH-11219 (O).

Aust-Agder: Arendal, Hisøy, Aug. 28, 2011, Castberg (KB&EB 78/11, O-F294400); Åmli, Baas i Tovdal, Aug. 18, 2010, Gundersen & Fonneland, TEB 413-10 (O-F296370).

Sweden

Upland: Börje, Herrhagen, Aug. 21, 2009, Aronsson (S, dupl. O).

Värmland: Gullspång, Södra Råda, Aug. 19, 2009, Jansson (Herb. Söderberg).

Dalarna: Älvdalen – Bora, Aug. 23, 2009, H. & H. Grünert (Herb. J. Christan).

RAMARIA FLAVA GROUP

The group is characterized by yellow, medium sized to large fruit bodies with tapering glabrous stipe, watery greyish, marbled context with yellow tint, strong saffron- (iodoform-cellar-) like smell, and oblong-cylindrical spores with low ornamentation of more or less elongated warts in obscure rows.

All the three species of the *Ramaria flava* group in Fennoscandia are connected to coniferous forests. *Ramaria safraniolens* Christan and *R. flava* var. *pinicola* Schild are connected to rich spruce dominated forest, whereas *R. eosanguinea* R.H. Petersen prefers dry pine forests on sandy soil. *Ramaria safraniolens* is treated as *R. flava* var. *scandinavica* in Bendiksen et al. (2013). *Ramaria flava* var. *pinicola* is apparently quite rare in the area, with only one confirmed record from Fennoscandia so far (Sweden, Uppland, Häverö, Strid 26179).

Ramaria flava s. str. is a southern broadleaved deciduous forest species so far not found in Fennoscandia. The neotype of *Ramaria flava* (Schaeff.: Fr.) Quél. has been chosen (Schild 1991) from *Fagus* forest from Bayern, Germany, and it has been studied by us (microscopy and DNA).

Ramaria eosanguinea R.H. Petersen. Fig. 3.
Macromorphology: Branches homogeneous and rather strongly yellow, with lemon yellow tinge when young (reminiscent of *R. schildii*), never warm yellow–orange yellow tinted, rarely with salmon pink tinges on uppermost branches; with a strong characteristic saffron-like smell. Otherwise like *R. safraniolens.*

Microscopy: Spores oblong-cylindrical, often somewhat sway-backed, 9.5–***10.6***–11.8 x 3.9–***4.2***–4.5 µm (av. = 10.4–11.2 x 4.1–4.3 µm), Q = 2.25–***2.52***–2.75 (Q av. = 2.43–2.62), (230 spores, 11 specimens), ornamentation very low, consisting of elongated warts in obscure rows in surface view, looking almost smooth in profile view. Basidia and trama hyphae with clamps. Basal tomentum hyphae partly covered by thin crystals, most septa without clamps.

Habitat and distribution: In oligotrophic, dry sandy pine forests, but also in low-herb and calcareous pine forests and in low-herb spruce forests. Widely distributed and occasional, but rare in southernmost parts of Norway and Sweden. In Norway most frequently known from sandy pine forests (Telemark-Buskerud-Oppland-Hedmark), but also low herb pine forests from Telemark to Møre og Romsdal, and from low-herb spruce forests in Oslo and Trøndelag–Nordland. In Sweden and Finland common in a wide range of habitats, from moist, rich spruce dominated forests to dry, oligotrophic pine forests on sandy soil. In Sweden known from Skåne to Lule Lappmark

Figure 3. *Ramaria eosanguinea.* Norway, Oppland, Odnesberga, TEB 174-14. Photo: K. H. Brandrud.

and in Finland from Varsinais-Suomi to Sompio Lapland.

Although described from Switzerland (Petersen 1976), *Ramaria eosanguinea* is not treated by Christan (2008), and the species is apparently quite rare in Central Europe. Its main distribution seems to lie in boreal North Europe.

Notes: The type specimen of *Ramaria eosanguinea* is identical with our species, even though part of the description of the species is deviating, especially the rubescent flesh. However, the watery greyish, marbled flesh in the stipe of our species turns rusty brown when dried.

Ramaria eosanguinea is fairly easily identified as belonging to the *R. flava* group by its smell and its oblong-cylindrical, very weakly ornamented spores. From *R. safraniolens* it is separated by a more northern distribution and a wider ecology. In their sympatric area, in the boreonemoral zone, the identification may be very difficult. As a rule the spores of *R. eosanguinea* are smaller, narrower and more weakly ornamented than those of *R. safraniolens,* and the basal tomentum hyphae have fewer crystals.

Ramaria eosanguinea and *Ramaria safraniolens* are probably the species most often named *R. flava* in earlier Nordic literature.

Fennoscandian material studied and confirmed by DNA:

Norway

Oslo: Lillomarka, Ravnkollen, Aug. 9, 2011,

EB 499/11 (O-F294286).
Oppland: Øystre Slidre, Storefoss ved Heggenes, Sept. 16, 1979, Stordal (O-F8150).
Telemark: Tinn, Midstrondbekken NR, Aug. 9, 2011, TEB 345-11 (O-F294425).
Sogn og Fjordane: Sogndal, Amladalen, Sept. 11, 2010, TEB 257-10 (O-F296336).
Møre og Romsdal: Norddal, Ytreli, Sept. 11, 2010, Holtan, TEB 259-10 (O-F296338); Norddal, Fjørå E, Aug. 31, 2011, Holtan (O-F294430).
Sør-Trøndelag: Oppdal, Ålbu, Sept. 5, 2010, KB&EB 150/10 (O-F294285).
Nord-Trøndelag: Steinkjer, Stod, Sept. 5, 2010, TEB 168-10 & Holien (O-F296318); Steinkjer, Stod, Sept. 5, 2010, Holien HH 132/10 & TEB (O-F293411); Stjørdal, Råenmarka, Aug. 13, 2009 TEB 284-09 (O-F296393).

Sweden

Skåne: V. Sönnarlöv, Klöva hallar, Oct. 16, 2005, Söderberg (Herb. Söderberg).
Öland: Böda, Kronopark, Sept. 14, 1988, Korhonen 8716 (H).
Västergötland: Mariestad, Surö, Aug. 19, 2007, Grundel (Herb. Söderberg).
Uppland: Norrtälje, Kapellskär, Sept. 13, 2012, Strid 26162 (S); Västerlövsta, Stora Runnhällen, Sept. 8, 2012, Aronsson (S, dupl. O).
Dalarna: Grangärde, Gänsberget, Sept. 5, 2009, Hermansson S-2456a (O); Grangärde, Sunnansjö, Sept. 17, 2011, Hermansson (O); Ludvika, Dammsjön, 8 Sept. 2009, Hermansson S-2468 (O); Ludvika, Dammsjöbäcken, Aug. 30, 2011, Hermansson S-2593 (O); Ludvika, Biskopsnäset, Sept. 21, 2009, Hermansson S-2501 (O); Malung, Öjsberget, 2010, Kirppu (O); Mora, Bonäs, Sept. 13, 2007 KB & EB (O-F294341); Norrbärke, Björsjö, Sept. 17, 2011, Hermansson S-2655 (O); Rättvik, Rättviksheden, Sept. 18, 2009, Hermansson & Sören S-2493 (O); Särna, Höstet, Sept. 9, 2011, Hermansson (O); Söderbärke, Sörsnäset, Sept. 21, 2011, Hermansson S-2666 (O); Söderbärke, Blomsteränget – Korsheden, Sept. 21, 2011, Hermansson S-2667 (O).
Lule Lappmark: Jokkmokk, Ekopark Vuollerim, Sept. 30, 2010, Karström 10116 (Herb. Karström).

Finland

Varsinais-Suomi: Lohja, Jalassaari, Tamminiemi, Aug. 27, 2000, IK (H); Vihti, Nuuksio National Park, Sept. 21, 2004, IK (H); Västanfjärd, Lammala, Sept. 25, 2001, IK et al. (H).
Pohjois-Savo, Kerimäki, Louhi, 1 Oct. 1994, IK 94-1231 (H).
Kainuu: Paltamo, Tololanmäki, Sept. 14, 2008, IK 08-1799 (H); Sotkamo, Talvivaara, Sept. 5, 2001, Kosonen (H).
Sompio Lapland: Pelkosenniemi, Suvanto, Kalkkivaara, Aug. 26, 1992, IK 92-1115 (H).

RAMARIA '*NEOFORMOSA* SENSU SCHILD' GROUP

The group is characterized by yellow, medium sized fruit bodies developing saffron yellow to salmon pink colours during maturation, glabrous stipe with white context, rather small (< 10 µm), narrow, weakly verrucose spores and mostly clampless hyphae. Basal tomentum hyphae are thinly covered by gelatinous sheath. In addition some of them are covered by a thick layer of small to large crystals.

Based on the ITS sequences there are three species belonging to the group in Fennoscandia. All of them grow in coniferous forests. Two of them, not treated here, seem to have more southwestern distribution and to prefer nutrient-rich, calcareous habitats. It is very difficult to distinguish the three species morphologically, and further research is needed. None of them have a known proper name. Christan (2008) uses the name *Ramaria fagetorum* Maas Geest. ex Schild for a German species belonging to this group, but this species has so far not been detected from Fennoscandia. The molecular analysis of the type specimen of *Ramaria fagetorum* is not yet completed.

One of the Finnish specimens of the species described below was determined by Schild as

Figure 4. *Ramaria 'neoformosa* sensu Schild'. Norway, Buskerud, Sigdal, Presttjennåsen, Hofton THH-11223. Photo: T. H. Hofton.

Ramaria neoformosa R.H. Petersen (Punkari 1988). The interpretation is underlined by Schild's (1978) comment of *R. neoformosa*, "ähnliche sporen" with *R. fagetorum*. We have thus chosen to apply the provisional name *R. neoformosa* sensu Schild for the species in this paper.

The molecular data and spore characteristics strongly suggest that *R. neoformosa* R.H. Petersen in the original sense and sensu Christan (2008) are, however, *R. formosa* (Pers.) Quél., despite of being clampless. *Ramaria formosa* is not closely related to the group in question here.

Ramaria* '*neoformosa **sensu Schild'.** Fig. 4.
Macromorphology: Fruitbodies with distinct stipe and subparallel to somewhat diverging branches, branch tips warm yellow, branches below pale yellowish to often almost white as young, soon turning saffron yellow to pale salmon pink, with age often uniformly pinkish white. Stipe normally with rounded, rarely tapering base. Stipe context pure white, often with saffron to salmon pink tint in branches. Odour pleasant, corn-like.

Microscopy: Spores narrowly (amygdaloid)-cylindrical to cylindrical, 8.6–***9.8***–11.3 x 3.6–***4.0***–4.5 µm (av. = 9.3–10.3 x 3.8–4.2 µm), Q = 2.10–***2.48***–2.95 (Q av. = 2.39–2.58), (220 spores, 11 specimens), weakly verrucose, with elongated, low warts in obscure rows. Hyphae mostly without clamps, some clamped basidia may be present. Basal tomentum hyphae clampless, thinly slime-covered, some with a thick crystal cover.

Habitat and distribution: In coniferous forests, from rich spruce forests to oligotrophic, dry pine forests on sandy soil. In Norway rare, found twice in dryish spruce dominated localities, once in low herb spruce forest and once in calcareous pine forest, in Østfold and Buskerud. In Sweden from Dalarna to Lule Lappmark, rare to occasional, more common in sandy pine forests in the northern part of the country. In Finland occasional; from south coast to Sompio Lapland. The species seems to be somewhat continental, with distinctly eastern distribution in Fennoscandia. It is associated with both spruce and pine.

Notes: *Ramaria neoformosa* sensu Schild resembles *R. safraniolens* and *R. eosanguinea*, but has wider stipe, pure white stipe flesh, different smell, smaller spores, clampless septa and different basal tomentum. It is also more salmon tinted than *R. eosanguinea.* From *R. lutea* and *R. primulina* the present species differs by its stronger colours, stouter branches with non-gelatinized flesh, larger stipe, narrower spores and some crystal-covered basal tomentum hyphae.

Fennoscandian material studied and confirmed by DNA:

Norway

Østfold: Borge, Aug. 21, 1988, Weholt ØW 30/88 (Herb. Weholt).

Buskerud: Hole, Vik, Sept. 2, 1969, Gulden (O-F74943); Nes, Flatdalsåsen, Oct. 6, 2007, Hofton (O-F287577); Sigdal, Presttjennåsen, Jul. 12 2011, Hofton THH-11223 (O).

Sweden

Dalarna: Bonäsheden, Sept. 13, 2007, MT & IK 07-1321 (H).

Jämtland: Bräcke, Ammerberget, Aug. 26, 2010, Pettersson (KB & EB 52/10) (O-F294252).

Lule Lappmark: Jokkmokk, Piatis, Aug. 31, 2011, Wiking (Herb. Karström).

Finland

Varsinais-Suomi: Kemiö, Pederså, Sept. 21, 1990, IK 90-1841 (H); Parainen, Granvik, Sept. 30, 1989, Heinonen (TUR); Vihti, Salmenkartano, Aug. 30, 2004, IK (H).

Etelä-Häme: Kuru, Seitseminen National Park, July. 28, 2000, P. Kytövuori & IK (H); Vesilahti, ca. 1979, Punkari (H).

Etelä-Savo: Kerimäki, Louhi, Sept. 9, 1998, IK 98-1803 (H).

Pohjois-Savo: Kuopio, Riistavesi, Aug. 28, 1987, IK 87832 (H).

Kainuu: Puolanka, Paljakka, Aug. 16, 2002, IK (H).

Sompion Lapland: Pelkosenniemi, Suvanto, Aug. 26, 1992, IK 92-1117 (H).

RAMARIA LUTEA – R. FLAVOIDES **GROUP**

The group is characterized by vivid to pale yellow, medium sized fruit bodies, sticky-viscid context, short stipe which is covered by rudimentary branches and raphanoid smell. Spores are rather small to medium sized, ellipsoid and distinctly verrucose, with low warts not in rows. Basal tomentum hyphae are covered by gelatinous sheath.

Three Fennoscandian species, so far possible to identify morphologically, belong to the group, *Ramaria lutea* (Vitt.) Schild (treated in Brandrud et al. 2012), *R. flavoides* agg. (Bendiksen et al. 2013) and *R. primulina* R.H. Petersen.

Ramaria primulina R.H. Petersen**.** Fig. 5.
Ramaria aff. *flavigelatinosa* Marr & D.E. Stuntz in Kotiranta et al. (2009)

Macromorphology: Fruit bodies medium-sized, densely branched, branches somewhat flexuous to curly towards the top, pale citrine yellow, almost white when dried, with gelatinizing context, stipe small.

Microscopy: Spores obovoid-cylindrical to (strongly) lacrimoid to almost obliquely pyriform, 8.8–***10.1***–11.6 x 4.3–***4.8***–5.4 µm (av. = 9.7–10.4 x 4.6–5.0 µm), Q = 1.75–***2.12***–2.40 (Q av. = 2.04–2.13), (210 spores, 10 specimens), fairly strongly, coarsely ver-

Figure 5. *Ramaria primulina.* Norway, Buskerud, Krødsherad, Fyranflaget N, Hofton THH-11297. Photo: T. H. Hofton.

rucose, warts wide but fairly low, not in rows. In the Nordic material the spores are in size intermediate between *R. lutea* and *R.* cf. *subtilis*. Basidia and trama hyphae are mostly without clamps. Branch trama mostly with olive yellowish to greenish granules or oil guttules. Basal tomentum hyphae clampless, covered by a fairly thin gelatinous sheath.

Habitat and distribution: Mostly in calcareous to oligotrophic dry pine forests on sandy soil, but has also been found in mesic spruce forests. In Norway there are only few records; from dry, calcareous pine dominated forests in the south-eastern part of the country. In Sweden the species is known from Uppland to Lule Lappmark, as rare to occasional. In Finland it is fairly rare to occasional and is known from the southern coast to Perä-Pohjanmaa and Koillismaa. The lack of more Norwegian findings might indicate that *R. primulina* is a continental species with a (south-) eastern distribution in Fennoscandia.

Notes: Ramaria primulina differs from most of the other Fennoscandian *Ramaria* species by its pale yellow colour, fairly thin, dense and curly branches, small stipe, gelatinous context and lacrimoid, verrucose spores with low warts not in rows. *Ramaria lutea* (Vitt.) Schild is fairly similar, but it is often somewhat smaller, less curly, its spores are smaller and it grows mostly with nemoral broad-leaved deciduous trees. Species in *R. flavoides* complex are more vivid, yolk yellow, have bigger spores than *R. primulina* and grow in nutrient-rich spruce forests.

When studying molecularly North American type specimens, *R. primulina* R.H. Petersen from Nova Scotia, Canada, proved to be identical with our species. The type and the description are consistent with our material, except for the fact that the Nova Scotian type specimen is clamped (Petersen 1986). Fennoscandian material is mostly clampless, however, few clamps have been found in some of the examined specimens. More material from eastern North America is needed to get knowledge of the whole morphological variation of the species.

Fennoscandian material studied and confirmed by DNA:

Norway

Akershus: Nannestad, Tømte Sept. 2, 1972, Høiland (O-F121667).
Hedmark: Løten, Sept. 22, 2000, Fonneland (O-F63955).
Buskerud: Krødsherad, Aug. 30, 2011, Hofton THH-11297 (O).

Sweden

Östergötland: Ljungsbro, Sept. 11, 2005, Söderberg (Herb. Söderberg).
Uppland, Fasterna: Aug. 29, 1984, Anderberg (SF42835).
Dalarna: Söderbärke, Uvberget, Sept. 24, 2011, Hermansson S-2672.

Finland

Satakunta: Alastaro, Virttaankangas, Oct. 7, 1990, IK 90-2442 (H).
Etelä-Häme: Vesilahti, ca. 1979, Punkari (H).
Etelä-Savo: Kerimäki, Louhi, Sept. 8, 1998, IK 98-1775 (H).
Pohjois-Karjala: Rautavaara, Pumpulikirkko, Sept. 26, 2004, Kokkonen (H)

RAMARIA TESTACEOFLAVA GROUP

The group is characterized by the dark staining of the context and surfaces and abundant basal tomentum at the stipe base with much litter and mosses attached.

This is an isolated, small group among mycorrhizal *Ramaria,* including also *Ramaria bataillei*, a rare nemoral–boreonemoral deciduous forest species in Fennoscandia, treated in Brandrud et al. (2012).

Ramaria testaceoflava (Bres.) Corner**.** Fig. 6.
Macromorphology: Branches initially yellow, soon bicoloured, with ochre yellow tips and smoke grey brown tinges subapically. Staining dark lilac grey to vinaceous brown when handled or cut. Taste bitter.

Microscopy: Spores cylindrical, sometimes sway-backed, 10.2–***11.5***–13.4 x 4.5–***4.9***–5.4 µm (av. = 11.2–12.0 x 4.7–5.1 µm), Q = 2.05–***2.36***–2.75 (Q av. = 2.22–2.46), (160 spores, 8 specimens), moderately verrucose, warts narrow but fairly high, not in rows. Both basidia and spores have yellowish granulose contents in MLZ. Basidia and tramal hyphae with clamps. Basal tomentum hyphae at the very base covered by needle-shaped crystals, with clamps.

Habitat and distribution: Rather frequent − occasional and widely distributed in low-herb spruce forest (incl. younger plantations), rare in low-herb pine forests. The species may grow even in the most nutrient-poor low herb spruce forests dominated by *Vaccinium myrtillus.* In Norway recorded north to Troms, in Sweden to Norrbotten and in Finland to Inari Lapland.

Notes: *Ramaria testaceoflava* is the most common, widespread and well known mycorrhizal *Ramaria* species in Fennoscandia. It is easily distinguished among the conifer forest species by its colours, strongly lilac grey-brownish staining of the context, peculiar spores and abundant needle-shaped crystals on basal tomentum hyphae.

Fennoscandian material studied and confirmed by DNA:

Norway

Oppland: Nordre Land, Dokka, Sept. 12, 2000, IK (H); Gran, Skjervumsbråtan, TEB 39-10.
Nord-Trøndelag: Lierne KB, EB & TEB 22-10 (O-F296242); Overhalla, Aug. 17, 1968,

Figure 6. *Ramaria testaceoflava.* Norway, Nordland, Grane, Fagerlia, KB&EB Sept. 1, 2010. Photo: K. Bendiksen.

Stordal (O-F74991).

Sweden

Hälsingland: Los, Karlsberg, Sept. 16, 1995, IK 95-1455 (H).

Jämtland: Oviken, Björn, Aug. 29, 2003, IK & Niskanen & Liimatainen (H).

Norrbotten: Junosuando, Karhakkavuoma, Aug. 15, 1998,IK 98-894 (H).

Finland

Pohjois-Karjala: Lieksa, Kylyvaara, Sept. 5, 1980, IK 80697 (H).

Perä-Pohjanmaa: Ylitornio, Kuusikkorompaat, Sept. 6, 1992, IK 92-1895 (H).

RAMARIA BOTRYTIS GROUP

The group is characterized by pale greyish white fruitbodies with purplish red to lilac pink branch tips when young, often with purplish spots also elsewhere, and striate spores with longitudinal, helical ribs and elongated warts.

Note: The yellow brownish spore mass that covers older fruit bodies of all *Ramaria* species makes especially whitish species, such as *R. botrytis* group, hard to identify and distinguish from yellow species macroscopically.

Ramaria botrytis group in Fennoscandia comprises species connected to both deciduous and coniferous forests. At least three species exist in Fennoscandia. Of these, *R. botrytis* (Pers.: Fr.) Bourdot (= *R. botrytis* s. str.) and *R. 'rubripermanens* sensu Christan (2008)' are typical species of boreonemoral, broad-leaved deciduous forests (Brandrud et al. 2012). However, both of the species can grow with *Pinus* too, and *R. rubripermanens*

Figure 7. *Ramaria botrytis.* Norway, Møre og Romsdal, Norddal, Ytreli, Holtan Sept. 11, 2010, TEB 260-10. Photo: K. H. Brandrud.

sensu Christan probably also with *Picea*. A third species, presented here as *R. 'botrytis* coniferous', is strictly connected to conifers (mainly spruce). The names *Ramaria rubrievanescens* Marr & D.E. Stuntz and *R. rubripermanens* Marr & D.E. Stuntz have been used for European species of *R. botrytis* group (e.g. Christan 2008), but we have no records of those species from Fennoscandia.

Ramaria botrytis (Pers.: Fr.) Bourdot**.** Fig. 7.
Macromorphology: Fruit bodies medium-sized to large, when (very) young with purplish red to lilac-pink branch tips, but usually soon fading, entire fruit bodies becoming pale greyish white, sometimes with vinaceous red spots. Old fruit bodies get a beige ochre shade from ripe spore mass covering the branches.

Microscopy: Spores boletoid, with a prominent suprahilar depression, 12.2–***14.5***–17.2 x 4.5–***5.5***–6.3 µm (av. = 13.6–15.8 x 5.3–5.9 µm), Q = 2.30–***2.65***–3.20 (Q av. = 2.48–2.84), (210 spores, 10 specimens), strongly striate with longitudinal, helical ribs. Basidia and trama hyphae with clamps. Basal tomentum hyphae smooth, with clamps.

Habitat and distribution: *Ramaria botrytis* is one of the characteristic species in nemoral and boreonemoral broad-leaved deciduous forests, but it occurs also in warm boreonemoral pine forests. Records from Norway are from *Quercus-Tilia-* (and *Fagus*) forests in coastal regions from Akershus to Sogn og Fjordane and from dry, warm low-herb *Pinus* forests, mainly in fjord areas in Møre og Romsdal. The distribution is similar in Sweden, where it is occasional from Skåne to Dalsland and Uppland. In Finland the species is very rare, with only a couple of records from Åland and Varsinais-Suomi. The distribution and ecology resembles that of *R. flavescens,* which is a more common species.

Notes: *Ramaria botrytis* differs from the other species of the group by its large and very strongly striate spores with distinctly tapering apex. *Ramaria 'botrytis* coniferous' has somewhat smaller spores with rounded apex and with narrower, denser and more helical ridges.

It has also a more northern-continental distribution and is restricted to spruce-pine forests. *R. 'rubripermanens* sensu Christan' has much narrower and smaller spores than both of the other two species in the group.

Fennoscandian material studied and confirmed by DNA:

Norway

Aust-Agder: Evje og Hornnes, Dåvassdalen, Sept. 2, 2000, TEB 251-00 (O-F168954); Froland, Mykland, Aug. 19, 2009, TEB 307-09 (O-F 296396).

Akershus: Asker, Løkenesskogen, Sept. 8, 2011, IK (O-F294434).

Vestfold: Larvik, Kattestranda, Aug. 31, 2009, Hansen (dupl. H).

Hordaland: Ulvik, Timbergilet, Aug. 23, 2003, Flatabø (O-F65967).

Sogn og Fjordane: Leikanger, Kvinnefossen, Sept. 9, 2000, Gaarder & Abel (O-F146157); Luster, Solvorn, Sept. 9, 2000, Fadnes (O-F73234); Luster, Solvorn, Grytøyr (O-F146090); Sogndal, Stedjeberga, Sept. 11, 2010, TEB 264-10 (O-F296343).

Møre og Romsdal: Norddal, Steiggjelet, Sept. 11, 2010, Jenssen, TEB 262-10 (O-F296341).

Sweden

Skåne: Kristianstad, Degeberga, Sept. 22, 2005, Söderberg (Herb. Söderberg); Höganäs, Kullaberg, Aug. 22, 1998, Söderberg (Herb. Söderberg); Höör, Rövarekulan, Oct. 5, 2006, Söderberg (Herb. Söderberg).

Öland: Högsrum, Halltorps hage, Sept. 10, 2003, IK & Niskanen (H); Norra Möckleby, Sept. 20, 2013, Knutsson (Herb. Knutsson).

Västergötland: Mariestad, Surö, Aug. 19, 2007, Grundel (Herb. Söderberg).

Dalsland: Mellerud, Skållerud etc., Sept. 17, 2014, Stridvall, Johansson & Carlsson14-074 (GB).

Södermanland: Salem, no date, Jaederfeldt (S-F13934).

Uppland: Arnö, Hälsingbo, Oct. 8, 2010, Aronsson (S).

Finland

Varsinais-Suomi: Lohja, Huhtasaari, Sept. 18, 1991, IK (H).

Ramaria 'botrytis coniferous**'.** Fig. 8.
Misapplied name: *Ramaria botrytis* (Pers.: Fr.) Bourdot (Kotiranta et al. 2009).

Macromorphology: Fruit bodies large, with thick, robust stipe, when young with bright, deep purplish red-vinaceous branch tips, red colours fading with age, and entire fruit bodies become pale greyish white, sometimes with more persistent vinaceous spots where damaged.

Microscopy: Spores boletoid, with a prominent suprahilar depression, typically with rounded apex, 12.0–***13.8***–15.9 x 5.0–***5.6***–6.3 µm (av. 13.3–14.5 x 5.4–6.1 µm), Q = 2.15–***2.46***–2.75 (Q av. = 2.39–2.52), (200 spores, 10 specimens), fairly strongly striate with longitudinal, helical ribs and elongated warts. The ornamentation distinctly less strong and more helical than that of *R. botrytis*. Basidia and trama hyphae with clamps. Basal tomentum hyphae coated with thin gelatinous sheath, with clamps.

Habitat and distribution: Records from Norway are mainly from calcareous spruce-dominated forests, from Southeast and Central Norway north to Nordland. The species is apparently most frequent in Trøndelag–Nordland. The species has a continental distribution in Fennoscandia. It is more common in Sweden and Finland and has a wider range of habitats there, from moist, rich, spruce dominated sites to dry pine forests on sandy soil. In Sweden it is known from Västergötland and Värmland to Lule Lappmark and Norrbotten, and in Finland from Varsinais-Suomi to Koillismaa.

Figure 8. *Ramaria 'botrytis* coniferous' Norway, Nord-Trøndelag, Steinkjer, Skrattåsen, Sept. 5, 2009 TEB (O-F289570). Photo: T. E. Brandrud.

Notes: From *Ramaria botrytis* s. str. this species is recognized by its habitat, strictly in coniferous forests, and a more northeastern, continental distribution. Morphologically, the species is distinguished by spores that are somewhat wider and shorter, and more rounded at apex, less strongly and more helically striate than in *R. botrytis*. The ridges are lower, narrower and denser. *Ramaria 'rubripermanens* sensu Christan' differs by its much narrower and smaller spores.

Fennoscandian material studied and confirmed by DNA:

Norway

Hedmark: Eidskog, Magnor, Sept. 1977, Kjær (O-F84679); Folldal, Dalholen, Aug. 6, 1980, EB 527/80 (O-F370150).

Oppland: Nordre Land, Odnesberga, Sept. 1, 1998, Gaarder & G. Høitomt 1295 (O-F94022); Vestre Toten, Kauserudtjern – Slomma, Aug. 14, 2010, TEB 104-10 (O-F296289).

Telemark: Kviteseid, Bandak, Aug. 25, 2009, Hofton THH-09342 (O).

Nord-Trøndelag: Lierne, Sørli, Aug. 28, 2010, KB-EB-TEB 21-10 (O-F296241); Steinkjer, Kvam, Sept. 9, 2013, Holien 169/13, Bratli & Jordal (TRH, dupl. O-F74942); Steinkjer, Langvatnet N, Aug. 25, 2013, Holien 124/13 (TRH, dupl. O-F74941).

Sweden

Västergötland: Gullspång, Amnhärad, Sept. 7, 2005, Grundel (O-F74993).

Värmland: Gullspång, Södra Råda, Sept. 12, 2009, Söderberg (Herb. Söderberg).

Dalarna: Gustafs, Mossby, Sept. 18, 2011, Hermansson (S-2658, O); Ludvika, Ställviksberget, Sept. 2, 2010, Hermansson (S-2546); Norrbärke, Limnäsudden, Sept. 2,

2009, Hermansson (S-2445, O).
Lule Lappmark: Jokkmokk, Ekopark Vuollerim, Sept. 12, 2008, Karström 0849 (Herb. Karström).
Norrbotten: Kalix, Siksundsjöberget, Sept. 21, 2011, Westerberg 4808-5 (Herb. Westerberg).

Finland

Kainuu: Paltamo, Likolampi, Aug. 29, 1981, IK 81908 (H).
Oulun Pohjanmaa: Kiiminki, Lamminselkä, Sept. 2, 2004, Rahko (OULU).

Ramaria* '*rubripermanens sensu Christan (2008)'**.** Fig. 9.
Misapplied name: *Ramaria rubripermanens* Marr & D.E. Stuntz (Christan 2008)

Macromorphology: Fruit bodies medium-sized to large, often with pointed base, when young branch tips and often outer branches bright purplish red – vinaceous red, same tinge often occurs also in context of outer branches, red colours fading with age, entire fruitbodies becoming pale greyish white, sometimes with more persistent vinaceous spots where damaged.

Microscopy: Spores narrowly boletoid to fusiform, with a shallow suprahilar depression, 10.0–***11.3***–12.9 x 3.9–***4.3***–4.8 µm (av. = 10.9–11.7 x 4.2–4.4 µm), Q = 2.35–***2.63***–2.90 (Q av. = 2.54–2.69), (210 spores, 10 specimens), striate with longitudinal helical ribs and elongated warts. Basidia and trama hyphae with clamps. Basal tomentum hyphae coated with a distinct gelatinous sheath, with clamps.

Habitat and distribution: Records from Norway are mainly from dry, slightly richer *Quercus* forests on shallow soil, also from dry *Fagus* forest, some finds in dry, rich *Pinus* forests; thermophilous and coastal, most observations from Akershus to Aust-Agder, but occurring north to Møre og Romsdal as a rare species. In Sweden the species is recorded from beech forests in Skåne to dry calcareous and greenstone pine forests in Dalarna, as occasional to rare. In Finland it is known from Varsinais-Suomi to Koillismaa, as fairly rare. Most finds are from spruce dominated nutrient-rich forests mixed with deciduous trees.

Notes: In Fennoscandia *Ramaria 'rubripermanens* sensu Christan' is easily recognized by the combination of purplish reddish colours and narrow, distinctly striate spores. The reddish colours are somewhat stronger and less fading than those of *R. botrytis*. The two other species of the group, *R. botrytis* and *R. 'botrytis* coniferous', have much wider spores. According to our ongoing type studies, the American name *R. rubripermanens* is not applicable to our North European species which is identical with Christan's material from Germany.

Fennoscandian material studied and confirmed by DNA:

Norway

Aust-Agder: Arendal, Hisøy, Aug. 22, 2009, B. Larsen, I-LF09-077 (O-F290871.
Akershus: Nesodden, Gaupemyrdammen, Aug. 21, 2011, Wollan (O-F294387).
Telemark: Drangedal, Eikelundsheia, Sept. 1, 2011, IK, KB&EB 139/11 (O-F294407).
Møre og Romsdal: Norddal, Vika/Ytterli, Aug. 30, 2011, Holtan (O-F294426).

Sweden

Skåne: V. Sönnarlöv, Klöva hallar, Sept. 17, 2010, Söderberg (Herb. Söderberg).
Halland: Varberg, Hiaklitten, Aug. 31, 2010, Fritz (Herb Fritz).
Västmanland: Nora, Viker, Sept. 25, 2010, Söderberg (Herb. Söderberg).
Hälsingland: Bollnäs, Glössbo, 2011, Pallin (Herb. Söderberg).
Dalarna: Ludvika, Ställviksberget, Oct. 2, 2010, Hermansson (S-2544); Smedjebacken, Björsjö, Oct. 16, 2006, Söderberg (Herb.

Figure 9. *Ramaria 'rubripermanens* sensu Christan (2008)'. Norway, Telemark, Drangedal, Eikelundheia, KB&EB 139/11. Photo: K. Bendiksen.

Söderberg).

Finland

Varsinais-Suomi: Lohja, Hermala, Sept. 25, 1991, IK (H).

Uusimaa: Espoo, Pirttimäki, Aug. 31, 1991, IK (H).

Etelä-Häme: Korpilahti, Oittila, Vaarunvuori, Sept. 5, 1984, IK 84394 (H).

Pohjois-Savo: Kangaslampi, Rauhamäki, Sept. 14, 1985, Haikonen 6513 (H).

AKNOWLEDGEMENTS

This study has got financial support from Forest Biodiversity Programme for Southern Finland (2006–2008), Norwegian Biodiversity Information Centre (2010–2011) and Swedish Biodiversity Information Centre (2013–2015). We wish to thank our Swedish coordinator, Johan Nitare from Swedish Forest Agency and all those many persons who have collected interesting material for the project. Especially Lennart Söderberg and Janolof Hermansson have sent us a great number of specimens from Sweden. We owe a great thank to Josef Christan for valuable loans from his private herbarium and to curators of herbaria L, WTU and ZT, and Ronald H. Petersen, TENN, for loan of type specimens and other relevant material. Audun Schrøder-Nielsen is thanked for molecular analysis carried out at the Natural History Museum of Oslo and Tom Hellik Hofton and Kristin H. Brandrud for loan of photos. Karl-Henrik Larsson and Josef Christan are acknowledged for their comments and proposals.

REFERENCES

Bendiksen E, Bendiksen K, Brandrud TE, Kytövuori I, Toivonen M, 2013. Ektomykorrhizadannende korallsopper (Ramaria p.p.) i rik barskog i Norge. Agarica 33: 3–26.

Brandrud TE, Bendiksen E, Bendiksen K, Kytövuori I, Toivonen M, 2012. Ektomykorrhizadannende korallsopper (Ramaria p.p.) i eikeskog og annen edellauvskog i Norge. Agarica 32: 5–19.

Christan J, 2008. Die Gattung Ramaria in Deutschland. Monographie zur Gattung Ramaria in Deutschland, mit Bestimmungsschlüssel zu den europäischen Arten. IHW Verlag, Eching, 352 p.

Gärdenfors, U, 2010. Rödlistade arter i Sverige 2010. The 2010 Red List of Swedish Species. ArtDatabanken, SLU, Uppsala, 592 p.

Halvorsen R, Bryn A, Erikstad L, Lindgaard A, 2015. Natur i Norge - NiN. Versjon 2.0.0. Artsdatabanken, Trondheim, http://www.artsdatabanken.no/nin.

Holmgren PH, Holmgren NH, Barnett LC, 1990. Index Herbariorum. Part I. The Herbaria of the World. – New York Botanical Garden.

Kotiranta H, Saarenoksa R, Kytövuori I, 2009. Aphyllophoroid fungi of Finland. A checklist with ecology, distribution and threat categories. Norrlinia 19: 1–223.

Kytövuori I, Toivonen M, 2014. Ramaria boreimaxima Kytöv. & Toivonen, sp. nova, in: von Bonsdorff T, Kytövuori I, Vauras J, Huhtinen S, Halme P, Rämä T, Kosonen L, Jakobsson S. Sienet ja metsien luontoarvot (Indicator fungi). Norrlinia 27: 239–240.

Nitare J, 2010. Signalarter. Indikatorer på skyddsvärd skog. Flora över kryptogamer. Skogsstyrelsens förlag, Jönköping, 4. ed. 392 p.

Petersen RH, 1976. Contribution toward a monograph of Ramaria III. *R. sanguinea*, *R. formosa*, and two new species from Europe. American Journal of Botany 63(3): 309–316.

Petersen RH, 1986. Some Ramaria taxa from Nova Scotia. Canadian Journal of Botany, 64(8): 1786–1811.

Punkari A, 1988: Ramaria-sienisuku (haarakkaat) Suomessa. – Pro gradu. Helsingin Yliopisto. Kasvitieteen Laitos [*Genus Ramaria (Coral fungi) in Finland.* – Master thesis. Helsinki University, Institution of Botany]

Schild E, 1978. Was ist *Ramaria aurea* und *Ramaria flava*? Zeitschrift für Mykologie 44(2): 171–178.

Schild E, 1991. Zur Typisierung von *Ramaria flava* (Schaeff.) Quélet und *Ramaria sanguinea* (Pers.) Quélet. Zeitschrift für Mykologie 57(2): 229–248.

Callistosporium Singer, en ny slekt av små hattsopper i Norge

Gro Gulden[1], Inger-Lise Fonneland[2]

[1]Naturhistorisk museum, Universitetet i Oslo, postboks 1172 Blindern,
NO-0318, Oslo
[2]Mellomveien 11, NO-4870, Fevik

Kontakt: gro.gulden@nhm.uio.no

English title: *Callistosporium* Singer, a genus of small agarics new to Norway

Gulden G, Fonneland I-L, 2015. *Callistosporium* Singer, en ny slekt av små hattsopper i Norge. Agarica 2015 vol. 36: 109-115.

NØKKELORD
Antrakinoner, *Callistosporium pinicola,* nekropigment, Tricholomataceae

KEYWORDS
Anthraquinons, *Callistosporium pinicola,* necropigment, Tricholomataceae

ABSTRACT

In 2014, a small, more or less olive brown agaric, *Callistosporium pinicola*, growing inside a heavily decayed spruce log, was found in South Norway, in the county of Telemark. This is the first record of the species as well as the genus in Norway. Yellow gills, spores with crystalline yellow content, and a purplish KOH reaction are characteristic features of the genus which belongs in the family Tricholomataceae. The species *C. pinicola* is recognized by its very small spores. We assume that the yellow and brown colours of *Callistosporium* fruitbodies are due to the presence of unstable, dimeric anthraquinonoid pigments and that the colour shifts (darkening) that occur in living and dead fruitbodies are due to oxidation of these. That spore prints are white and stay white while pigment is observed in preparations of spores in dead tissues is considered a result of processes occurring upon spore maturation; wall thickening, for instance, can hide the relatively pale pigment inside. A thicker, or otherwise altered wall can also explain why a spore print remained white when basic solutions were applied, and did not show the purplish discoloration seen in spores in preparations of the gills.

SAMMENDRAG

Et funn fra Telemark i 2014 av den lille hattsoppen *Callistosporium pinicola* er omtalt og likeledes slekten som ikke var kjent i Norge tidligere. *Callistosporium*-artene er mer eller mindre olivenbrune med gule skiver, og er kjent for å inneholde et gult krystallinsk pigment i sporene. Slekten tilhører familien Tricholomataceae og arten *C. pinicola* skiller seg fra nærstående arter ved å ha svært små sporer. Pigmentet både i sporene og i fruktlegemene mørkner etter hvert, og alle deler farges purpur i basiske løsninger. Alt tyder på at fargene og fargeforandringene hos artene i slekten skyldes ustabile, dimere antrakinonpigmenter og oksydasjon av disse. At sporepulveret er hvitt, og uforanderlig hvitt, til tross for at pigment kan ses i sporer i mikroskopipreparater fra tørkete fruktlegemer, antar vi er et resultat av sporemodningen; en tykkere sporevegg kan skjule et relativt svakt farget innhold og sporene vil derved fremstå som fargeløse og danne et hvitt sporepulver. En fortykket eller på annet vis endret sporevegg kan også forklare hvorfor basiske løsninger som ble tilført et sporepulver ikke

forårsaket purpur misfarging slik som ellers ses i sporer fra skivepreparater.

INNLEDNING

Avisen Varden kunne 22. september 2014 fortelle at den lille hattsoppen *Callistosporium pinicola* – en ny art for Norge – var blitt funnet i Telemark i løpet av et kartleggingskurs som foregikk i Skienstraktene. Soppen er temmelig uanselig, men en olivenbrun hattfarge og mer eller mindre gule skiver gjør den litt spesiell. Det er lett å tro det er en brunsporing, kanskje en olivenhatt (*Simocybe*) eller en bittersopp (*Gymnopilus*), for den smaker også litt bittert, men så snart man ser at den er hvitsporet kan tankene gå mot en flathatt (*Gymnopus*) eller kanskje en liten fagerhatt (*Rugosomyces*). Men flathattene har gjerne ikke utrandete skiver, og fagerhattene har cellulær hatthud. Det kan nevnes flere forskjeller, men det mest karakteristiske med artene i slekten *Callistosporium* er pigmentene, hvor særlig et gult til olivenbrunt pigment som ses i sporene hos tørkete fruktlegemer har fått mye oppmerksomhet. Selve navnet *Callistosporium,* som kan utlegges som ″vakreste sporer″, vitner om det. Pigmentet omtales gjerne som nekropigment fordi det bare ses i tørkete/døde sopper (eksikkater), jfr. Singer (1975), Ludwig (2001), Vesterholt og Holec (2012), Arnolds (2006), med fler. Fruktlegemene hos *Callistosporium*-artene er mer eller mindre brune og skivene mer eller mindre gule; gulfargen er mest utpreget hos unge individer og brunfargen mest hos eldre. Det fins også former med mer rødlige til purpurbrune farger. Alle mørkner til svartbrune i eksikkater. Pigmentene det er snakk om er av antrakinonnatur (Kühner 1980, Moser 1984), og friske sopper som påføres basiske løsninger (KOH, NH_3) på hatt eller skiver farges straks rosa til dypt vinrøde. Den samme reaksjonen foregår i eksikkatmateriale, og i mikroskopiske preparater ses da elementene (sporer, basidier, hyfer) med gråfiolette til purpur farger; dessuten ses purpurfargete korn og også rødning av selve væsken.

Callistosporium pinicola er hittil den eneste kjente representanten for slekten i Norge. I denne artikkelen omtaler vi slekten *Callistosporium*, ‘vår art’ og hvordan den skiller seg fra nærmeste slektninger. Videre diskuteres farger og fargeendringene vi observerer og det tilsynelatende paradoksale forholdet at sporene, som jo inneholder nekropigment, danner et stabilt hvitt sporepulver.

Slekten *Callistosporium* Singer

Tradisjonelt er slekten plassert i den store hvitsporete familien Tricholomataceae med musseronger, traktsopper, flathatter osv., og vi gjenfinner slekten i den tricholomatoide kladen i den fylogenetiske oversikten til Matheny et al. (2006) hvor fylogenien er basert på analyse av seks genregioner. Pigmentene er som nevnt sentral for slektsdefinisjonen, og forhold som at alle hyfer mangler bøyler og at basidiene ikke er siderofile/karminofile (som f. eks. hos fagerhatter *Rugosomyces*) skiller slekten ytterligere fra nærstående slekter.

Slekten er liten med kanskje 8-10 kjente arter globalt, hvorav 4-5 arter opptrer i Europa og bare to arter hittil er kjent i Norden. Tallene er avhengige av hvor bred artsoppfatning som legges til grunn, og hvordan man oppfatter varieteter i forhold til arter. I Europa er *C. luteo-olivaceum* den vanligste arten, med relativt mange funnsteder i tempererte områder helt nord til Syd-Sverige og Syd-Finland. Vår art, *C. pinicola,* ble først omtalt i 1991 fra Frankrike (Bon 1991), og da som en form *minor* av *C. xanthophyllum* [= *C. luteo-olivaceum,* se Redhead 1982)]. Utførlig beskrivelse av den nye formen ble først gitt av Ludwig (2001), og den fikk artsnavnet *C. pinicola* i forbindelse med funn i Nederland (Arnolds 2006). *Callistosporium-a*rtene er vanligere i sydlige deler av Europa enn i nord - unntaket er kanskje *C. pinicola* - og noen taksa har forekomst bare i Middelhavsområdet. Artene i slekten synes generelt å være sjeldne, men vidt utbredte,

Figur 1. *Callistosporium pinicola* (I-LF 2014-43) på voksestedet, inni sterkt nedbrutt granlåg. Callistosporium pinicola *growing inside a heavily decayed spruce log. Photo: I-L Fonneland.*

noen på flere kontinenter (Redhead 1982). De fleste er saprotrofer på ved, men noen kan også opptre på strø og jord.

Callistosporium pinicola **Arnolds**

Fig. 1, 2

Beskrivelse av det norske materialet. Mikroskopiske data fra tørket materiale observert i H_2O, KOH 5 %, NH_3 10 %, Melzers reagens og blå melkesyre. Fargeangivelser: Kornerup og Wanscher (1962).

Hatt 1,5-4 cm bred, hvelvet men snart litt nedsunket i sentrum, tynnkjøttet, matt til blank, hygrofan, som frisk olivenbrun (ca 6F6,) til noe rødbrun, tørker opp til beigebrun (6D6, 6D5), som eksikkat mørkt rødbrun-svartbrun. Skiver utrandete, tette, mer eller mindre gule til gulbrune, olivenbrune, mørkt brune som eksikkat. Stilk tynn, 20-35 x 1,5-4 mm, glatt, helt nedentil svakt hvitlodden, brun som hatten. Kjøtt ganske sprøtt (farge ikke notert). Smak svakt bitter, ingen tydelig lukt. Sporepulver hvitt.

Sporer små, (3-) 3,5-4 x 2-2,5(-3) µm, bredt ellipsoide til subglobose, med tydelig apikulus, sporevegg hyalin, inamyloid, acyanofil, med krystallinsk, lysbrytende, uregelmessig, hyalint til gult og gulbrunt innhold i H_2O; i KOH og NH_3 ses oljedråpe og plasma som varierer fra nesten hyalint over svakt til temmelig sterkt purpur og vinrødt, ofte også med små korn. Basidier 17-22 x 4-5 µm, (2-)4-sporete, uten siderofil granulasjon, i H_2O med gulbrunt, uregelmessig til småkornet innhold, i KOH og NH_3 ses innholdet som mer eller mindre sterkt purpur til vinrødt. Ingen cystider. Preparat av skiver viser regulært trama oppbygget av 4-20 µm brede, ganske tett septerte

Figur 2. Sporer av *Callistosporium pinicola* (I-LF 2014-43) i NH3 10 %.
Spores of Callistosporium pinicola *in NH3 10%. Photo: I-L Fonneland.*

hyfer som er lyst og jevnt olivenbrune av membranpigment (i H_2O), temmelig mørkt olivenbrunt i hymenieregionen pga. brunt innhold i basidier, sporer, og rikelig med små, uregelmessige pigmentkorn; i KOH og NH_3 er tramahyfer, hymenielementer og korn mer eller mindre purpur til vinrødt fargete. Hatthuden er en kutis av radiære, relativt tett septerte, 3-10 µm brede, jevnt olivenfargete hyfer uten inkrusteringer; ofte ses sporeansamlinger på hatthuden som partier av dypere olivenbrun farge (i H_2O); i basiske løsninger er hyfene svakere eller sterkere purpurfargete og det ses tilsvarende sterkt rødlige partier av sammenpakkete sporer. Ingen pileocystider. Stilkhuden er oppbygget av tilsvarende hyfer som i hatthuden; ingen caulocystider. Bøyler mangler.

I mikroskopiske preparater i vann (av eksikkatmateriale) går altså fargeskalaen i gult og brunt mens elementene får en rosa, gråfiolett til purpur farge i basiske løsninger. Det fins også mye små korn i preparatene som er olivenbrune i vann og farges sterkt purpur i basiske løsninger. Da vi mikroskoperte friskt materiale (i 5 % KOH) ble ikke noe pigment i sporene sett, selv om det var forventet siden vi antok det var en *Callistosporium* vi hadde funnet.

Funnsted: Telemark: Skien, Jarseng, bekkedal med edelløvskog med innslag av gran, UTM WGS84 (MGRS) 32V NL 4143 5976; 10 fruktlegemer – ingen unge – vokste tett sammen inne i sterkt forråtnet granlåg; funnet 19. september 2014, leg. Inger-Lise Fonneland, I-LF 2014-43, det. Gro Gulden (O-F75900).

Kommentarer

Sporene er små og ganske markert mindre hos *C. pinicola* enn hos de andre artene i slekten hvor sporene varierer i lengde fra (5-)6-7 µm og helt opp til 11-13 µm. Vesterholt og Holec (2012, i Funga Nordica) angir en sporelengde på (2,5-)3-4(-4,5) µm for *C. pinicola,* og 4-7 µm for den andre arten i Norden, *C. luteo-olivaceum.* Også bredden på sporene er svært liten hos *C. pinicola,* angitt som 2-3(-3,5) µm i Funga Nordica (Vesterholt and Holec 2012) mens den er angitt som 3-4,5 µm for *C. luteo-olivaceum*. Andre arter i slekten har sporebredder på 5-7 µm (Moser 1984, Bon 1991).

Ellers er det vanskelig å peke på distinkte kjennetegn for C. *pinicola* i forhold til *C. luteo-olivaceum*. Sistnevnte er beskrevet og avbildet fra Värmland i Sverige (Stålberg 1987). Den store fargevariasjonen på hatt og skiver hos *C. pinicola* går tydelig fram av fotografiene hos Antonín et al. (2009) og av bilder på internett. Ganske unge fruktlegemer er nesten helt gule, noe som er utmerket dokumentert i figur 1 hos Verbeken og Walleyn (2003). Arnolds (2006) angir at hatten vanligvis er livlig gulbrun, oransjebrun, rustbrun til rødbrun og bare unntaksvis har oliven tone nær midten, og han skriver videre at den ikke er, eller bare er svakt hygrofan. Andre forfattere fremhever olivenfarven på både hatt og skiver og angir mer eller mindre hygrofanitet

(Ludwig 2001, Antonín et al. 2009, Vesteholt og Holec 2012). Skivene hos begge de nordiske artene er gule, helt gule som unge og brunere med alderen, og ender opp som mørkebrune i eksikkater. Stilken blir hul med alderen, og Ludwig (2000 og 2001) avbilder og angir at den kan ha hvite rhizoider ved basis. (Han tilføyer pussig nok også at eksikkatmateriale av vår småsporete art ikke mørkner, men dette beror trolig på en feilskrift). Smaken hos *C. pinicola* angis varierende som mild eller bitter og lukten fremheves av noen som melaktig (Ludwig 2001, Arnolds 2006). I skillet mellom de enkelte artene i slekten er det lagt vekt på at våre to nordiske arter har tette skiver, mens arter som fins lenger sør i Europa, som *C. olivascens* og *C. elaeodes,* har fjernere og tykkere skiver (Bon 1991). Den førstnevnte er markant forskjellig fra alle ved å ha ekstracellulært og inkrustrerende pigment som farges spektakulært blått i basiske løsninger (Bon 1991), mens *C. elaeodes* av mange oppfattes som en form av, eller identisk med *C. luteo-olivaceum*. Av de to nordiske artene kan kanskje *C. luteo-olivaceum* være noe større enn *C. pinicola* og ha en tendens til å være knippevoksende, men dette er ikke lett å bedømme.

Callistosporium pinicola er rapportert fra en rekke land i Europa, fra Frankrike i vest til Ukraina i øst, Italia i syd til Sverige i nord (Halama og Rutkowski 2014). I Sverige er den kjent fra Jämtland. Den er oftest samlet på sterkt nedbrutt barved, også i hulrom i veden slik som vårt funn. Verbeken og Walleyn (2003) rapporterer gjentatte funn på en meget gammel og råtten bøkestamme i et naturreservat i Belgia, likeledes angir Antonín et al. (2009) funn på løvved i Tsjekkia, tilsynelatende bøk. I følge Ludwig (2001) og flere andre forfattere synes råtnende barved å være hovedsubstrat for arten. I Tsjekkia og Ukraina er gammelskog-naturskog av bartrær, vesentlig i kalde og relativt fuktig områder som i montane og submontane strøk typiske voksesteder, men også elvedaler og kløfter med ravineskog dominert av løvtrær, samt bøkeskoger på kalk er kjente voksesteder. I Frankrike er arten påvist i blandingsskog med eik, bøk, agnbøk og furu i høyereliggende strøk (Halama og Rutkowski 2014). Forekomst av arten i naturskog i Polen, både i furu-bøkeskog og eike-agnbøkskog med mye død ved (Halama og Rutkowski 2014) bekrefter inntrykket av at gamle naturskoger kan være artens rette element i Mellom-Europa. Men i Nederland, hvor gran- og furuskog er plantet, er funn gjort i første generasjons plantasjer. Antonín et al. (2009) mener at arten kan egne seg som indikatorart for fuktig gammelskog med bartrær, og de polske forfatterne foreslår at arten innlemmes i den polske rødlisten. På den annen side påpeker både de tsjekkiske og polske forfatterne at arten av en eller annen grunn tilsynelatende er i spredning.

Alle omtaler av slekten *Callistosporium* viser til pigmenter, først og fremst et gult krystallinsk pigment i sporene og basidiene, og dessuten nevnes gjerne i artsomtaler at fruktlegemene mørkner i eksikkat (bl.a. Arnolds 2006, Antonín et al. 2009, Halama og Rutkowski 2014). Singer (1975) skriver i slektsdiagnosen at i det minste en viss prosent av sporene er «usually partly bright colored (the interior of the spores) in dried specimens, or rarely with a hyaline pigment body». I slektsbeskrivelsen omtaler Singer (1975) pigment i hymenoforet (skivene) – spesielt i sporene – som er fargeløst i friskt materiale, men utfelles (precipitates) ved dehydrering. I nøkkelen (s. 229) omtales disse som nekropigmenter. Også Ludwig (2001) og Vesterholt og Holec (2012), begrenser omtalen av nekropigmenter til slike som ses i mikroskopiske preparater av skivene fra eksikkatmateriale. Omtalen av nekropigmenter synes alltid å være begrenset til sporer og andre elementer i hymenoforet, mens den gradvise mørkningen av selve fruktlegemene fra gult til brunt og til slutt svartningen i eksikkater ikke settes i direkte sammenheng med hymenoforpigmentene. På bakgrunn av at alle deler av fruktlegemene, fra sporer til hatthud og kjøtt, farges purpur med basiske løsninger, mener vi det er grunn til å anta at visse pigmenter (antrakinoner) fins i hele fruktlegemet, og at mørkningen vi observerer skyldes oksydasjon av disse. Lys kan være en initieringsagens, basiske forbindelser en annen.

Allerede Kühner (1980) antok at pigmentene hos *Callistosporium* var av antrakinonnatur, i likhet med de gule pigmentene i svovelmusserong (*Tricholoma sulphureum*) og riddermusserong (*T. equestre*).[1] Disse musserongene mørkner også i eksikkat, og gule til brune pigmenter kan da ses som korn i sporer og vev (Kühner 1980, egne observasjoner). Senere påviste Moser (1984) de antrakinonoide, dimere pigmentene skyrin (oransje) og hypericin (lilla-purpur) i *C. luteo-olivaceum* og fant dessuten en rekke sterkt fluoriserende, gule, oransje, grønne og blågrønne substanser (trolig beslektede antrakinoner) hos andre arter i slekten. Det er grunn til å anta at det er dette purpurfargete pigmentet hypericin vi ser i *C. pinicola* ved tørking og ved reaksjon med baser som KOH, og kanskje er det gule pigmentet i unge fruktlegemer, basidier og sporer skyrin, eller beslektede, dimere antrakinonpigmenter.

Antrakinoner er ikke vanlige pigmenter i skivesopper, men vel kjent hos en del slørsopper, spesielt i underslekten *Dermocybe,* hvor de bl.a. kommer til anvendelse ved soppfarging av animalske fibre som ull og silke (Høiland 1984). Atrakinoner fins også i de to slørsoppene *Cortinarius atrovirens* og *C. odoratus* i underslekten *Phlegmacium* (jfr. Steglich and Oertel 1985, Brandrud 1998). Disse soppene er sterkt grønnfarget av pigmentet atrovirin, og hypericin opptrer bare som et lilla-purpur oksydasjonsprodukt/nekropigment ved reaksjon med baser som KOH på tørket materiale, dvs. en lignende opptreden som hos *C. pinicola*. Hypericin er ellers mest kjent som den kraftige purpurrøde fargen som framkommer fra blomsterknoppene hos arter av slekten perikum (*Hypericum* spp.) når disse gnis mot hendene eller legges på sprit for å lage perikumsnaps.

Alle litteraturbeskrivelser fremholder sporepulveret hos *Callistosporium* som hvitt; Singer (1975) føyer riktignok til «when fresh» og Ludwig (2001) skriver at det er hvitt til lyst kremfarget (mørknende). At sporepulveret er hvitt, og vedvarende hvitt, er bemerkelsesverdig siden sporene i mikroskopiske preparater ses med gult- til brunfarget innhold. De farges også mer eller mindre purpur med KOH/NH_3. Av ren nysgjerrighet tilsatte vi dråper av KOH og NH_3 til sporepulveret og hadde egentlig forventet en umiddelbar rødfarging slik vi hadde funnet i eksikkatmateriale ved tilsetting av baser - men reaksjonen uteble. Sporepulveret forble hvitt, muligens meget svakt rosa. Siden sporene i et sporepulver er helt modne mens de i preparater fra skivene hovedsakelig er umodne (da de modne sporene allerede er frigjort og forsvunnet fra skivene) mener vi forklaringen på den manglende reaksjonen kan skyldes at sporeveggen under modningen endres, trolig tykner. En tykk sporevegg vil kunne skjule de innvendige og relativt lyse pigmentene, og sporene vil derved fremstå som fargeløse og danne et hvitt sporepulver. En slik vegg kan også hindre basene i å trenge inn og oksydere antrakinonene, slik de ellers gjør i de umodne sporene.

Da det passende norske navnet olivenhatter allerede er i bruk - for slekten *Simocybe* – foreslår vi «antrakinonhatter» som norsk slektsnavn og «småsporet antrakinonhatt» som norsk navn for arten *C. pinicola.*

TAKK

Tilslutt en takk til Tor Erik Brandrud og Klaus

---

[1] Kühner bruker dette også som et argument for å innlemme *Callistosporium* i slekten *Tricholoma* (i gammel og vid forstand). Arten *C. elaeodes* ble opprinnelig beskrevet i slekten *Tricholoma*.

Høyland som har bidratt med verdifulle kommentarer til teksten vedrørende antrakinoner.

ETTERSKRIFT

I tidsskriftet Svampe vol. 72, 2015: 44-52 rapporterer T.Læssøe et første funn av *C. pinicola* i Danmark, gjort allerede i 2013.

REDAKSJONELL KOMMENTAR:

Callistosporium pinicola har fått navnet atrakinonhatt i den norske rødlista av 2015.

REFERANSER

Antonín V, Beran M, Borovička J, Dvořák D, Holec J, 2009. First records of *Callistosporium pinicola* in the Czech Republic and new findings of its ecology. Czech Mycol. 61: 1-12.

Arnolds E. 2006. A confusing duo: *Calocybe cerina* and *Callistosporium pinicola* (Agaricales). Acta Mycologica, Warszawa 41(1): 29-40.

Bon M, 1991. Les Tricholomes. Flore Mycologique d'Europe 2. Documentes mycologiques, Mémoire hors série no. 2.

Brandrud TE, 1998. *Cortinarius* subgen. *Phlegmacium* sect. *Fulvi* – chemotaxonomy versus morphological taxonomy. Journal des Journées Européennes Cortinaire 0: 4-9.

Halama M, Rutkowski R, 2014. *Callistosporium pinicola* (Basidiomycota), a fungus species new to Poland. Acta Mycologica 49(2): 189-197.

Høiland K, 1984. *Cortinarius* subgenus *Dermocybe* with special regard to the species in the Nordic countries. Opera Botanica 71: 1-113.

Kornerup A, Wanscher JH, 1962. Farver i farver. København, 248.

Kühner R, 1980. Les Hyménomycètes agaricoïdes. Bulletin de la Société Linnéenne de Lyon, numéro spécial, 49 Année.

Ludwig E, 2000. Pilzkompendium Bd. 1. Abbildungen. IHW Verlag, Eching, 188 fargeplansjer.

Ludwig E, 2001. Pilzkompendium Bd. 1. Beschreibungen. IHW Verlag, Eching, 758 sider.

Matheny PB, Curtis JM, Hofstetter V, Aime MC, Moncalvo J-M, et al. 2006. Major clades of Agaricales: a multilocus phylogenetic overview. Mycologia 98(6): 982-995.

Moser M, 1984. Notes on the genus *Callistosporium*. La famiglia delle Tricholomataceae. Centro studi per la flora mediterranea, Borgo vald ei Taro, Italy: 145-159.

Redhead SA, 1982. The systematics of *Callistosporium luteo-olivaceum.* Sydowia 35: 223-235.

Singer R, 1975. The Agaricales in modern taxonomy. J. Cramer 1975, 912 sider + 84 plansjer.

Steglich W, Oertel B, 1985. Untersuchungen zur Konstitution und Verbreitung der Farbstoffe von *Cortinarius*, Untergattung *Phlegmacium* (Agaricales). Sydowia ('1984') 38: 284–295.

Stålberg J, 1987. Ett interessant Värmlandsfund – *Callistosporium olivascens* (Berk. & Curt.) Singer. Jordstjärnan 8: 43-44.

Verbeken A, Walleyn R, 2003. Validations de *Callistosporium luteo-olivaceum* f. *minor* et de *Xerula radicata* f. *arrhiza*. Documents mycologiques , vol. 32, fasc. 127-128: 3-7.

Vesterholt J, Holec J, 2012. *Callistosporium* Singer. i Knudsen H, Vesterholt J (red.): Funga Nordica: 449-450, Nordsvamp, København, s. 449-450.

Entoloma fulvoviolaceum Noordel. & Vauras - not previously reported from Norway

Øyvind Weholt, Siw Elin Eidissen, Jostein Lorås

Høgskolen i Nesna, NO-8700 Nesna, Norway

Corresponding author:
oyvind.weholt@fredfiber.net

Norsk tittel: *Entoloma fulvoviolaceum* Noordel. & Vauras – ikke tidligere rapportert fra Norge

Weholt Ø, Eidissen SE, Lorås J, 2015. *Entoloma fulvoviolaceum* Noordel. & Vauras − not previously reported from Norway. Agarica 2015, vol. 36: 117-123.

KEYWORDS
Entoloma fulvoviolaceum, Agaricales, Holmvassdalen Nature Reserve, Norway, calcareous soils

NØKKELORD
Entoloma fulvoviolaceum, Agaricales, Holmvassdalen naturreservat, Norge, kalkgrunn

SAMMENDRAG

I Norge er *Entoloma fulvoviolaceum* funnet på minst fem ulike lokaliteter i Holmvassdalen naturreservat i Nordland i perioden 2009-2014. Denne rødsporen ble først beskrevet fra Finland i 2003. Sikre funn av arten fra andre land er ikke påvist. Artikkelen beskriver de norske funnene og gjør rede for artens økologi.

ABSTRACT

In the period 2009-2014 *Entoloma fulvoviolaceum* was found in at least five different locations in Holmvassdalen Nature Reserve in North Norway. The species was first described from Finland in 2003, and so far Holmvassdalen is the only place where it with certainty has been reported outside the type locality. Details of macro- and microscopical features and ecology are presented in the article.

INTRODUCTION

In the period 2007-2014 hundreds of specimens of the genus *Entoloma* were collected in Holmvassdalen Nature Reserve, in the county of Nordland, mainly by Siw Elin Eidissen and Jostein Lorås. The first author, who provided microscopy of a high number of dried *Entoloma* specimens, by this effort discerned nine collections of *Entoloma fulvoviolaceum*. Two of the specimens were compared with a paratype material from the Finnish type locality. Specimens from three of the Norwegian localities were sequenced and confirmed to match *Entoloma fulvoviolaceum* Noordel. & Vauras.

The size of the forest reserve is approximately 6000 hectares and was established in 2008 by the Norwegian Ministry of Environment. The spruce forest in Holmvassdalen Nature Reserve is old with a long continuity, as it has never been clearcut (Lorås and Eidissen 2012). So far 130 red-listed species of fungi are recorded in the area following the Norwegian Red List (Brandrud et al. 2010), of which 40 belong in *Entoloma*. A mix of different habitats exists in the area, among others rich fens and wooden grassland, mostly surrounded by calciphilous spruce woodlands (*Picea abies*). The localities where the finds were done share ecological features like calcareous bedrocks, humidity and vegetation. A river, Holmvasselv, flows through the bottom of the valley and keeps the moisture in the air relatively constant. In addition,


07/09/2014

Figure 1. *Entoloma fulvoviolaceum* is recognized by the brown, faintly to distinctly translucently striate and pronouncedly squamulose pileus, denser towards the darker center (JL 109-2014). Photo: J. Lorås.

calcareous water from the hillsides fertilizes the soil continuously. This process is by all accounts essential to the occurrence and distribution of most *Entoloma* species in the nature reserve (Lorås and Eidissen 2011).

DESCRIPTION OF THE NORWEGIAN MATERIAL

The first specimens assumed to be *E. fulvoviolaceum* were found in 2009. Both macroscopy and microscopy tallied well with the original description, except the colour of the stipe which was more blue than violaceous. Since this was the first find of the species in Norway, we contacted Jukka Vauras in order to have his opinion. He kindly sent an isoparatype and pictures, so we could make a microscopical comparison with our material. This examination showed good compliance, hence, we felt comfortable that our material from Holmvassdalen really was *E. fulvoviolaceum*. In 2010 a new find was made having the same characters and accordingly it was concluded that this one also was *E. fulvoviolaceum*. Later on, the isoparatype of *E. fulvoviolaceum* received from Jukka Vauras was sequenced. The result showed a perfect match with our specimens from Holmvassdalen.

Since 2010, several other finds made us suspect we had more specimens of *E. fulvoviolaceum*. In 2014 the ITS region of seven of these collections were sequenced by Pablo Alvarado Garcia at ALVALAB. Four of them failed in obtaining


07/09/2014

Figure 2. *Entoloma fulvoviolaceum* with a pale brown pileus and some darker center (JL 103-2014). Photo: J. Lorås.

good sequences, whilst sequences from three collections, one from 2011 and two from 2014, were analysed by Bálint Dima who found them to match with a sequence of *E. fulvoviolaceum* from Finland deposited in BOLD database. This Finnish specimen is the isotype of *E. fulvoviolaceum* sequenced in the framework of the Finnish Barcode of Life project (B. Dima, pers. comm.). Thus our identification based on morphological characters is supported by the ITS sequence data too, and we think it is a valid conclusion that we at least have five finds of *E. fulvoviolaceum* from Holmvassdalen.

Figure 3. Lamellae of *Entoloma fulvoviolaceum* are pale, cream-colored, and with concolorous edge (JL 103-2014). Photo: J. Lorås.

Entoloma fulvoviolaceum is a species in subgenus *Leptonia* and belongs to the section *Cyanulum and stirpe Asprellum* (Noordeloos, 2004). The stirpe is featured by brown pileus colours and blue polished stipes. Macroscopically *E. fulvoviolaceum* is recognized by the brown, faintly to distinctly translucently striate and pronouncedly squamulose pileus, denser towards the darker disc (Figs. 1 and 2). The lamellae are pale, cream-coloured, and with concolorous edge (Fig. 3).

The stipe is originally described with a “delicately violaceous” stipe, “pallescent with age” (Noordeloos 2004). No developmental stages of carpophors from Holmvassdalen demonstrated violaceous colours. According to Vauras the violaceous stipe colour shown in Noordeloos (2004) is too strong (pers. comm.). This is also seen in the received pictures (Figs. 4 and 5). The stipe colour in our finds varied from dark to light blue, independent of age (Figs. 6 and 7). The pileus is originally described as “deep orange brown with darker reddish brown centre”, while our finds showed variation from reddish brown to more pure brown colours, scarcely to be perceived as orange brown.

Apart from the discrepancies in colour shades, the specimens from Holmvassdalen comply macroscopically well with the pictures of *E. fulvoviolaceum* from Finland.

Microscopically the species is recognized by lack of clamps and numerous, predominantly clavate cheilocystidia, smaller than or scarcely protruding the basidia, less than 40 µm long. The pileipellis was originally described with brown intracellular pigment and made up of “broadly clavate to subglobose terminal elements”. This agrees well with our material, but the terminal cells were in some specimens slightly longer than the size given in the original description, see Fig. 8.

Entoloma fulvoviolaceum keys out close to *E. sodale* and *E. poliopus* (Noordeloos 2004). According to the key it differs from those by pileus and stipe colours As discussed above, based on the material from Holmvassdalen, the colours can not be found valid as an unambiguous separating character. However,

Figure 4 and 5. The stipe is originally described with a “delicately violaceous” stipe, “pallescent with age”. Photos showing clearly conifer needles in the habitat. Photos: J. Vauras.

our experience is that *E. fulvoviolaceum* could better be recognized by the typical, nicely squamulose pileus, combined with a blue, polished stipe. *Entoloma poliopus* could be discerned by a different squamulose pattern, and *E. sodale* by a more distinctly translucent striate pileus. Microscopically *E. sodale* and *E. poliopus* both differ by longer and differently shaped cystidia, broadly clavate in *E. sodale* and cylindrical to clavate in *E. poliopus*. *Entoloma asprellum* in the same stirpe differs by lack of cystidia and the less and differently squamulose pileus pattern.

Originally, the spore size of *E. fulvoviolaceum* is reported as 8.5-11.0(-11.5) x 6.0-8.0 (-8.5) µm, with Qav = 1.3-1.6. Table 1 indicates that it is a larger size variation than given, and we also found that the paratype we received from Vauras had larger spores than given in the original description. In Table 1 our measurements are given and it is seen that spores reaching 12-13 µm are not unusual. Both the size given for the typus and the paratypus are within the variation of the finds from Holmvassdalen.

Figure 6. In spite of the original descriptions of *Entoloma fulvoviolaceum* saying "delicately violaceous" stipe color, our finds varied from dark to light blue (JL 109-2014). Photo: J. Lorås.

Material studied

UTM coordinates refers to UTM (WGS84) zone 33W

Norway: Nordland: Grane: Holmvassdalen, det. Ø. Weholt

a) UTM 7244846, 420877, Aug. 11, 2009, leg. M. Eidissen 7571-7573;

b) UTM7243802, 420766, Sept. 7, 2010, leg. J. Lorås 1275-1281;

c) UTM 7246395, 421935, 3 Sept. 2011, leg. J. Lorås JL178-2011;

d) UTM 7246494, 421771, Sept. 7, 2014, leg. J. Lorås and S. E. Eidissen JL103-2014

Figure 7. This specimen of *Entoloma fulvoviolaceum* has a light blue stipe, rather different from a violaceous color (JL 103-2014). Photo: J. Lorås.

e) UTM 7246485, 421736, Sept. 7, 2014, leg. J. Lorås and S. E. Eidissen JL109-2014

DISTRIBUTION AND ECOLOGY

Coll. a) Found in rich calcareous meadow of low-herbs, among others with *Parnassia palustris*
Coll. b) Found in a calcareous mixed forest, dominated by spruce
Coll. c) Found in a meadow of tall-herbs, dominated by *Aconitum lycoctonum ssp. septentrionale*
Coll. d) Found in an old spruce forest on bare soil in a humid area
Coll. e) Found in moss in a meadow of low-herbs, surrounded by old calcareous spruce forest

Although calcareous influence is mentioned for only three of the finds, we can be sure that the soil also is calcareous for the two others since belts of limestone are cutting through the whole nature reserve. The old spruce forest stands and the rich meadows in the area are typical habitats for the *Entoloma* species found in the area. These vegetation types also provide conditions for a number of other very rare species, among them *Entoloma holmvassdalenense* and *E. sublaevisporum* (Weholt et al. 2014), and *E. gomerense* (Lorås et al. 2014).

The type locality of *E. fulvoviolaceum* is in a southern region of Finland and consequently the localities in Holmvassdalen are the northernmost. The habitat in Finland is described briefly as "*in mixed deciduous forest on calcareous soil*" (Noordeloos 2004:1083). It is also said to grow in groups (Noordeloos 2012).

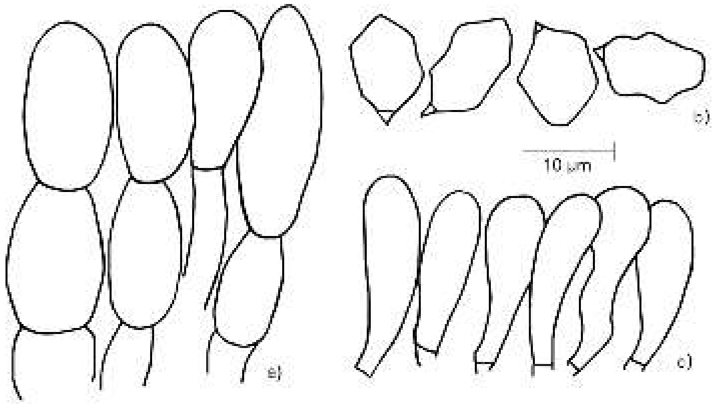


Figure 8. Pileipellis (a), spores (b) and cheilocystidia (c) elements of *Entoloma fulvoviolaceum*.

However, two photos show clearly conifer needles in the habitat (Fig. 4 and 5), while the text exclusively mentions mixed deciduous forest. (Noordeloos 2004:1328). Conifers therefore very probably have been present very close to the fungi. In Holmvassdalen Nature Reserve conifers are present at all five sites, which clearly shows that *E. fulvoviolaceum* also occurs in spruce forest. In fact, our finds indicate that this is the normal preference in Holmvassdalen. Normally the number of specimens for each find is one, sometimes two, which diverges from previous indications.

Common for all finds, including the Finnish one, is the presence of calcareous soils. *Entoloma fulvoviolaceum* seems therefore to be a species requiring lime. The species grows in meadows of both low-herbs and tall-herbs, often with a field layer of moss that retains moisture. When moss is lacking, it seems to be able to live on bare, moist soil.

The finds of *Entoloma fulvoviolaceum* in Holmvassdalen are concentrated to the northern and lowest part of the valley.

Overall, our knowledge of the variability and distribution pattern is rather incomplete of *E. fulvoviolaceum*. This applies both to colour variations of cap and stipe as to the

Table 1. Spore measurements of *E. fulvoviolaceum* from Holmvassdalen. 10-15 spores are measured for each collection. Letters a-e designate the different collections as specified in Materials studied below.

Isoparatypus, JV 20117 Finland, 22.08.2007	9.1-13 x 7.0-8,1 µ, Qav = 1.4
a) 7571-7573	9.2-13.0 x 8.0 -8.2 µ, Qav = 1.35
b) 1275-1281	9.8-12.2 x 7.2-8.3 µ, Qav = 1.3
c) JL178-2011 (sequenced material)	10.0-13.2 (-15) x 7.2-9,4(-10.1) µ, Qav = 1.5
d) JL103-2014 (sequenced material)	10.0-13.2 (-14) x 7.0-8.0 µ, Qav =1.6
e) JL109-2014 (sequenced material)	9.2-10.5(-12) x 7.0-8.2 µ, Qav = 1.4

habitats of the species. The old spruce forest constitutes the very foundation of this species' distribution in the area.

ACKNOWLEDGMENTS

We would like to thank Balint Dima, Hungary for the kind help in interpretation of the sequences of *E. fulvoviolaceum* and to Pablo Alvarado Garcia at the ALVALAB, Spain for the sequence work. And also thanks to Jukka Vauras for sending us an isoparatypus of *Entoloma fulvoviolacum* and for allowing us to use some of his pictures.

REFERENCES

Brandrud TE, Bendiksen E, Hofton TH, Høiland K, Jordal JB, 2010. Sopp. Fungi, in: Kålås JA, Viken Å, Henriksen S, Skjelseth S (Eds.), The 2010 Norwegian red list for species. Artsdatabanken, The Norwegian biodiversity information centre, Trondheim, pp. 87-123.

Lorås J, Eidissen SE, 2011. Rødlistede beitemarksopp i kalkgranskog - arter, økologi og habitatpåvirkning i Holmvassdalen naturreservat. Agarica 31: 45-56.

Lorås J, Eidissen, SE, 2012. Holmvassdalen naturreservat – botanisk mangfold og kontinuitet i granskog. Blyttia 70: 73-88.

Lorås J, Weholt Ø, Eidissen SE, 2014. *Entoloma gomerense* Wölfel & Noordel. – a new species to Northern Europe. Agarica 35: 19-24.

Noordeloos ME, 2004. *Entoloma* s. l. Fungi Europaei 5A. Candusso, Alassio.

Noordeloos ME, 2012. *Entoloma* (Fr.) P. Kumm., in: Knudsen H, Vesterholt J (Eds.). Funga Nordica. Nordsvamp, Copenhagen, pp. 517-576.

Weholt Ø, Lorås J, Eidissen SE, 2014. One new and one rare species of *Entoloma* from the Norwegian nature reserve Holmvassdalen. Österreichische Zeitschrift für Pilzkunde 23: 55-60.

Spooneromyces velenovskyi (Vacek ex Svrček) van Vooren, første funn i Norge

Roy Kristiansen

Pb. 32, NO-1650 Sellebakk

Kontakt: mykosof@online.no

English title: First record of *Spooneromyces velenovskyi* (Vacek ex Svrček) van Vooren in Norway

Kristiansen R, 2015. *Spooneromyces velenovskyi* (Vacek ex Svrček) van Vooren, første funn i Norge. Agarica 2015 vol. 36: 125-129.

NØKKELORD
Ascomycotina, Pezizales, Pyronemataceae, *Spooneromyces velenovskyi,* ny for Norge

KEYWORDS
Ascomycota, Pezizales, Pyronemataceae, *Spooneromyces velenovskyi*, new to Norway

ABSTRACT

The discomycete *Spooneromyces velenovskyi* (Vacek) van Vooren is described from the riverbank of the Upper Forra nature reserve in Levanger, Nord-Trøndelag. The ascocarps are 1-5 mm broad and associated with *Spooneromyces laeticolor* (P. Karst.) T. Schumach. & J. Moravec. This is the first record of *S. velenovskyi* in Norway.

SAMMENDRAG

Discomyceten *Spooneromyces velenovskyi* (Vacek) van Vooren beskrives fra Øvre Forra naturreservat i Levanger kommune, Nord-Trøndelag. Soppen opptrer som 1-5 mm store apothecier sammen med *Spooneromyces laeticolor* (P. Karst.) T. Schumach. & J. Moravec. Dette er første funn av arten i Norge.

INNLEDNING

Under et kartleggingsprosjekt i Øvre Forra naturreservat i Levanger kommune i Nord-Trøndelag i august 1998 ble det funnet flere interessante discomyceter. Rundt Roknesvollen fant vi bl.a. *Lamprospora dicranellae* Benkert (Kristiansen 1998), *Scutellinia macrospora* (Svrček) Le Gal, *Scutellinia cejpii* (Velen.) Svrček, *Ramsbottomia asperior* (Nyl.) Benkert & T. Schumach., *Neottiella aphanodyction* (Kobayasi) Dissing, Korf & Sivertsen, *Octospora splachnophila* Benkert & Kristiansen (Benkert og Kristiansen 2008, Kristiansen 2013) på knappmøkkmose (*Splachnum vasculosum*), flere koprofile arter, som *Ascobolus immersus* Pers., *Lasiobolus cuniculi* Velen., *Saccobolus depauperatus* (Berk. & Broome) E. C. Hansen, *Cheilymenia coprinaria* (Cooke) Boud*.,* foruten de to jordboende *Spooneromyces*-artene *S. laeticolor* (P. Karst.) T. Schumach. & J. Moravec (Kristiansen 2014) og *S. velenovskyi* (Vacek ex Svrček) van Vooren. Sistnevnte er foranledningen til den påfølgende beskrivelse av denne arten.

Spooneromyces-slekten ble opprettet av Schumacher & Moravec (1989). Slekten omfatter fire arter, *S. laeticolor* (P. Karst.) T. Schumach. & J. Moravec, *S. helveticus* J. Breitenb. & F. Kränzl, *S. daliensis* (W. Y. Zhuang) W. Y. Zhuang og *S. microsporus* Jamoni (Jamoni 2008).

På basis av de molekylær-fylogenetiske undersøkelsene gjort i familien Pyronemataceae utført av Perry et al. (2007) fant Nicolas van Vooren (2014) det betimelig å revidere typematerialet av både *Lachnea velenovskyi* fra Tsjekkia og *Spooneromyces microsporus* fra de italienske alper. Resultatet av revisjonen ble

Figur 1. Reknesvollen, Øvre Forra naturreservat. Beitemarker og myrlandskap.
Reknesvollen, Upper Forra nature reserve. Pastures and marshy landscape.

at *Lachnea velenovskyi* ble omkombinert i slekten Spooneromyces som karakteriseres med stive multisepterte overflatehår, vortete sporer og et karotenoid-holdig hymenium. Revisjonen viste også at *S. microsporus* er synonymt med *S. velenovskyi*. Disse revisjonene er tatt med og diskutert av Moyne et al. (2015).

ØVRE FORRA NATURRESERVAT

Roknesvollen (ca. 400 moh.) er et seterområde i Øvre Forra naturreservat hvor tradisjonen med setring strekker seg mange hundre år tilbake. Setra ligger i områdene omkring Forra (Storelva), mellom Hårskallen (735 moh.) i vest og innsjøen Feren i øst. Området består av et åpent myrlandskap og beitemarker (Fig. 1), hvor elva Forra flyter i slake svinger gjennom landskapet. Langs elvebreddene er det kantskoger av bl.a. gran. Også sideelvene Glunka og Heståa preger landskapet. Øvre Forra utgjør som helhet et enestående naturområde og fjellkulturlandskap med ulike og varierte verneinteresser. Naturreservatet er ca. 108 km^2 stort. Totalt er det bl.a. samlet nesten 550 kollekter av storsopper, hovedsakelig basidiomyceter i naturreservatet.

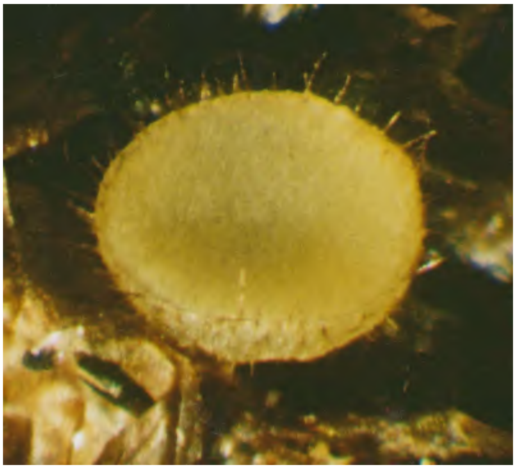
MATERIALER OG METODER

Mikroskopiske karakterer, observasjoner og fotografering er gjort på friskt materiale. Det er laget squash-preparater i vann og i Cotton blue i melkesyre. Til undersøkelse av mikroskopiske karakterer er anvendt et Olympus stereomikroskop og et Kyowa lysmikroskop (Kyowa Optical Co., Ltd, Japan).

Spooneromyces velenovskyi **(Vacek i Svrček) van Vooren**

Fig. 2, 3, 4, 5, 6

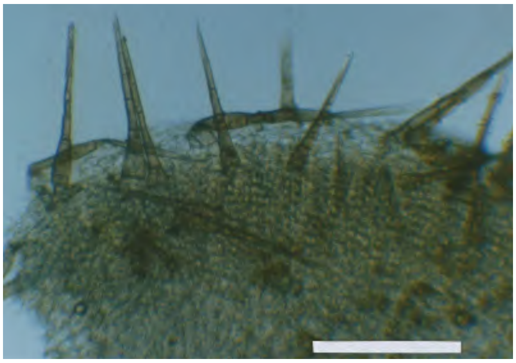
Basionym: *Lachnea velenovskyi* Vacek ex Svrček, Sbom. Nár. Mus. v. Praza, Rada B, Prfr. Vedy 4B 6: 51. 1948



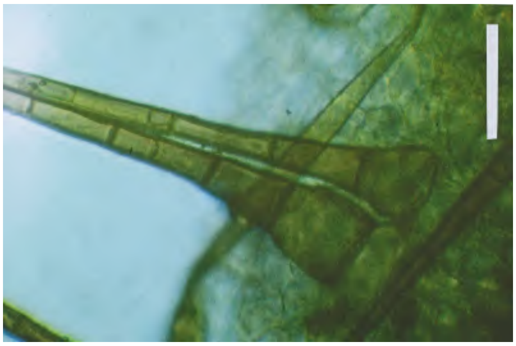
Figur 2. *Spooneromyces velenovskyi*. Apothecier. Skala 3 mm.
Spooneromyces velenovskyi. *Ascocarp. Scale 3 mm.*

Synonymer:
Humaria velenovskyi (Svrček) Korf & Sagara, Phytol. 24: 1. 1972
Mycolachnea velenovskyi (Svrček) Candoussau. Munibe, 27: 189, 1975
Trichophaea velenovskyi (Svrček) Häffner & Christian, Zeitschr. Mykol.57: 161,1991

Apothecier grundt skålformet, 1.5–4.5 mm diameter og ca. 1.5 mm høye, stilkløse, sparsomt besatt med relativt korte stive lysbrune hår. Hymenium grålig til gulgrå.



Figur 3. Ytre eksipulum med stive spisse hår. Skala 200 µm.
Outer excipulum with stiff pointed hairs. Scale 200 µm.



Figur 4. Hår med oppsvulmet basis. Skala 40 µm.
Hair with swollen base. Scale 40 µm.

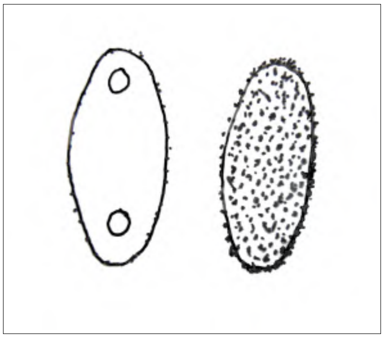
Asci: 8-sporet, sylindrisk, en-radet, 170–190 x 9–10 µm.

Sporer smalt ellipsoide – subfusoide, 14–16 x 5.5–7,0 µm, med to små dråper ved polene og med cyanofile lave vorter eller korte pigger, isolerte og delvis sammenflytende opp til 1 µm høye og brede.

Et scanning elektronmikrografi viser imidlertid et helt annet mønster, som fremstår som regelmessige perforeringer eller huller. Scanningbilde er eksakt lik det som er publisert av Häffner og Christian (1991).

Parafyser: rette, septerte, 4–5 µm brede, litt fortykket i toppen.

van Vooren (2014) illustrerer små vacuoler mellom septa.



Figur 5. Sporer. Til venstre i vann; til høyre i Cotton blue.
Spores in water (left) and Cotton blue (right).

Figur. 6. Scanning elektronmikrografi av sporer. Skala 10 µm.
Scanning electron micrography of spores. Scale 10 µm.

Hår: stive spisse lysbrune, 4–6 septerte, med tydelig oppsvulmet basis, 148–320 x 29-46 µm.

Undersøkt materiale
Nord-Trøndelag, Levanger, Roknesvollen, Øvre Forra naturreservat, 390 moh, i granskog på sandjord og nålestrø ved elvebanke nær Heståtangen, (RK 106/98), sammen med *Spooneromyces laeticolor* (RK105/98), 22.08. 1998. 63° 36' 36" N, 11°32'52" E.

S. laeticolor er registrert i Soppherbariet på Tøyen, UiO, fra Akershus, Hordaland, Oppland og Sør-Trøndelag, mens mitt funn fra Nord-Trøndelag ble omtalt av Kristiansen (2014).

Kommentarer
Spooneromyces velenovskyi er en sjelden art med bare få funn i verden. Originalbeskrevet fra Böhmen i Tsjekkia (Vacek i Svrček 1948), hvor den ble observert på brent mark blant moser og barnnåler.

Korf og Sagara (1972) gjorde 13 innsamlinger i Japan og plasserte arten i slekten Humaria.

Candoussou (1975) angir arten blant *Picea* sp.; Häffner og Christian (1991) beskriver et funn på dyre-ekskrement på myr i Bayern, Tyskland.

Billekens (1995) beskriver og illusterer flere funn i Nederland på nåler og barkavfall av *Picea* sp. Dissing et al. (2000) angir to funn fra Danmark.

Fargen på hymeniet har vært diskutert ved flere anledninger og variasjonene er store, fra grålig – gråbrunlig – matt oransje – rosaoransje – okergul og flere. Fargen skyldes trolig et karotenoid-holdig pigment, som påvirkes ved ulik grad av lyseksponering De tre øvrige artene i slekten er betydelig mer fargerike (van Vooren 2014).

Det synes som om de to artene, *S. velenovskyi* og *S. laeticolor* også forekommer sammen i de franske alper.

Det finnes en utmerket nøkkel til å skille de nærstående slektene og artene i *Trichophaea*, *Paratrichophaea* og *Trichophaeopsis* (Bronckers 2003), hvor *S. velenovskyi* er ført til Trichophaea-slekten.

TAKK

En stor takk til Hans Arne Nakrem og Harald Folvik på Naturhistorisk museum, Tøyen, Universitetet i Oslo, for preparering og fotografering av prøver i scanning elektron mikroskop.

REFERANSER

Benkert D, Kristiansen R, 2008. *Octospora splachnophila* Benkert & Kristiansen spec. nov. (Ascomycota, Pezizales): Im 19. Jahrhundert gesammelt, im 21. Jahrhundert benannt. Zeitschrift für Mykologie 74 (1): 111-118.

Billekens P, 1995. Over *Humaria velenovskyi*. Coolia 38: 173-176.

Bronckers RJC, 2003. Een sleutel tot de Europese soorten van de genera *Trichophaea*, *Trichophaeopsis* en *Paratrichophaea*. *Sterbeeckia* 23: 9-27.

Candoussau F, 1975. Récolte de (*Mycolachnea velenovskyi*) (Vacek in Svrcek) Korf & Sagara dans le bois de Baraibar au Pays Basque. Munibe, 27 (3/4) : 189-191.

Dissing H, Eckblad F-E, Lange M, 2000. Pezizales, i: Hansen L, Knudsen H, (red.) Nordic Macromycetes. Volume I. Ascomycetes. Nordsvamp, Copenhagen. s. 55-127.

Häffner J, Christian J, 1991. Rezente Ascomycetenfunde X. *Trichophaea velenovskyi* (Vacek in Svrcek) comb. nov. - neu für Deutschland ! Zeitschrift für Mykologie 57: 161-165.

Jamoni PG, 2008. Una nuova enti tà dalla Valsesia: *Spooneromyces microsporus* sp.nova. Funghi e Ambiente: 108, 5-9.

Korf RP, Sagara N, 1972. Japanese discomycetes notes. XVIII. *Humaria velenovskyi* comb. nov. (Pyronemataceae, Mycolachneeae). Phytologia 24: 1-4.

Kristiansen R, 1998. Discomyceter(Pezizales) fra Kongsvinger-distriktet 1996-1998. Agarica 15 (nr.24/25): 67-84.

Kristiansen R, 2013. Tre sjeldne bryoparasittiske discomyceter (Pezizales) fra Norge. Agarica 33: 81-86.

Kristiansen R, 2014. Four uncommon hairy discomycetes (Ascomycetes, Pezizales) from Norway. Agarica 35: 49-58.

Moyne G, Moingeon J-M, Moingeon S & Page C.2015. *Spooneromyces laeticolor* (Pezizales) nouveau pour la Franche-Comté. Ascomycete.org 7: 117-120 (electronic version only).

Perry B, Hansen K, Pfister DH, 2007. A phylogenetic overview of the family Pyronemataceae (Ascomycota, Pezizales). Mycological Research 111: 1-23.

Schumacher T, Moravec J, 1989. *Spooneromyces*, a new genus to accommodate *Peziza laeticolor* and the new species *S. helveticus*. Nordic Journal of Botany 9: 425-430.

Svrček M, 1948. Ceské druhy podceledi Lachneoideae (cel. Pezizaceae). Bohemian species of Pezizaceae subf. Lachneoideae). Sborn. Nár. Mus. v. Praze, Rada B, Prir. Vedy 4B (6): 1-95. 12 plates.

van Vooren N, 2014. Type-revision of *Lachnea velenovskyi,* a new species of the genus *Spooneromyces* (Pezizales). Ascomycete.org 6 (4): 89-92 (electronic version only).

Sienet ja metsien luontoarvot
[Sopp og naturverdier i ulike skogbiotoper] (Indicator fungi)

Tea von Bonsdorff, Ilkka Kytövuori, Jukka Vauras, Seppo Huhtinen, Panu Halme, Teppo Rämä, Lasse Kosonen, Stefan Jacobsson.
Norrlinia vol. 27, 2014. 272 sider.
ISBN 978-952-10-9945-8

På finsk med engelske sammendrag.
Bestillinger: kasvimuseo@helsinki.fi
Pris 35€ + porto.

En finsk praktserie av bøker utgitt av Finlands naturhistoriske sentralmuseum (Luomus - Naturhistoriska centralmuseet) fikk enda et verdifullt tilskudd da denne indikatorsoppboka ble publisert sommeren 2014. Boka er resultat av et mangeårig prosjekt der flere av Finlands ypperste feltmykologer har deltatt, noen av dem også meget dyktige fotografer og tegnere. Selv om bokserien utgis på finsk av finansierings- og forvaltningshensyn, har man denne gangen også tenkt på potensielle brukere utenfor Finland og satset på fyldige engelske sammendrag for alle de 14 skogbiotopene som presenteres.

I følge introduksjonen i boka, er bare kjuker, barksopper og lav tidligere blitt benyttet som indikatorer på skogens tilstand i Finland, selv om det fins utmerkete indikatorarter i mange andre soppgrupper også. Disse trenger ikke å være truete eller ekstremt sjeldne, men de kan likevel ha visse livskrav som er knyttet til verdifulle og verneverdige habitater.

Bruk av indikatorarter har litt liknende utvikling i Norge, men her i landet har en del kartleggere av verdifull skog allerede en god stund hatt markboende sopparter med på sine skoginventeringer. Det samme gjelder Sverige, der markboende sopp er godt representert i boka, *Signalarter, indikatorer på skyddsvärd skog, flora över kryptogamer* (Nitare (red.), 1. utgave 2000, 4. utgave 2010). Den finske indikatorsoppboka er likevel den første i Norden som har sitt hovedfokus på markboende storsopper (skivesopper, rørsopper, korall-sopper, piggsopper og et fåtall begersopper) og deres indikatorverdi. Boka presenterer en metode for poengsetting for 545 sopparter (noen av dem artsgrupper) som indikatorer for verdifulle skogsmiljøer. Alle disse er med i en sammendragstabell på slutten av boka med indikatorverdi (IA) på en skala fra 1 til 5 og rødlistekategori (IUCN). Interessant for andre nordiske naturkartleggere er at selv om Finland får sin neste rødliste først i 2020, er foreslåtte nye rødlistearter og forslag til endring av rødlistekategori fra 2010 med i boka, merket med stjerne etter IUCN-symbolet.

Etter innledende, generelle kapitler kommer hoveddelen der 14 skogbiotoper presenteres som livsmiljø for sopp etterfulgt av en liste over indikatorarter for hver av dem og med indikatorverdi (IA) og rødlistekategori (IUCN) i en egen kolonne. Arter skrevet med fete bokstaver presenteres i detalj på side angitt i siste kolonne. 147 av artene er presentert mer detaljert, med gode fotografier, mikroskopiske tegninger (alle sporetegninger i samme skala) og utbredelseskart, noe som kan tenkes å være nyttig og interessant også for en utenlandsk bruker av boka. Det gis en generell forklaring på engelsk om oppbyggingen av artspresentasjonene rett etter introduksjonen. Engelske presentasjoner er lette å finne i faktabokser med grønngrå bakgrunnsfarge.

Når det er brukt så mye krefter på å nå utenlandsk publikum, hadde det vært ønskelig å få med engelsk tekst også i figurtekstene til artspresentasjonene og i tabellforklaringene til sammendragstabellen, som fungerer som register på slutten.

Mange av de 147 artene som presenteres i detalj er lite kjente, for eksempel flere slørsopper (*Cortinarius)* i underslekten *Telamonia.* En del av artene er trolig avbildet for første

Cortinarius boreasensis A.H. Smith

(*Cortinarius ionosmus*)

Orvokkiseitikki

Cortinariaceae

IA 4 *Ilkka Kytövuori*

Itiöemä ohutmaltoinen, ohutjalkainen, orvokintuoksuinen. Lakki 3–7 cm, aluksi puolipallomainen – kartiomainen, pian laakeneva, laakean kupera tai laakean kartiomainen, täysikasvuisessa lakissa leveä ja matala keskuskohouma ja usein

Orvokkiseitikin itiöitä (×1600). – Ks. Kuusamo, Oulangan kansallispuisto, tuore kalkkikuusikko, 26.8.2007 *Kytövuori 07-836* (H). Piirros Ilkka Kytövuori.

Orvokkiseitikki (*Cortinarius boreasensis*). – Ks. Kuusamo, Oulangan kansallispuisto, tuore kalkkikuusikko, 26.8.2007 *Kytövuori 07-836* (H). Kuva Ilkka Kytövuori.

Norrlinia 27

gang i en publikasjon. Typestudier i bl.a. slekten *Cortinarius* og *Inocybe* har ført til endret navnebruk, og boka følger resultater fra den nyeste forskningen. (For eksempel heter tvillingslørsopp, *Cortinarius barbarorum,* nå *C. metarius* og sumptrevlesopp, *Inocybe nematoloma, I. subexilis.*) Heldigvis er de tidligere brukte navnene angitt som synonymer, så man klarer å henge med.

På slutten av boka beskrives det to nye arter, *Psathyrella boreifasciculata* og *Ramaria boreimaxima,* den siste tidligere feilaktig kalt *R. magnipes* i en del nordisk sopplitteratur (bl.a. i *Norske soppnavn* 2011). De aller fleste bilder i boka er av god til meget god kvalitet, men bildet av kjempekorallsopp, *R. boreimaxima,* viser dessverre en altfor gul sopp for å gi riktig inntrykk av den heller lærfargete arten.

Forfatterne har naturlig nok hatt mest kunnskap om typisk soppinventar i forskjellige verneverdige barskogsbiotoper. En som selv har inventert faste soppruter i fjellbjørkeskog i Enontekiö hver høst i nærmere ti år, merker noen små mangler og unøyaktigheter i opplysningene: huldreslørsopp (*Cortinarius ionophyllus)* er nevnt fra fjellbjørkeskog i teksten men er ikke oppgitt for Enontekiö Lappland på kartet, selv om den vokser der også. (Soppsamlingene er i liten grad digitalisert i Finland, så det er ikke lett å få med seg alle utbredelsesdetaljene.) Fjellbjørkslørsopp (*Cortinarius septentrionalis)* er plassert blant indikatorartene for rike fjellbjørkeskoger, men etter egen erfaring er den mest produktiv i fattigere og tørrere bjørkeskoger, med krekling blåbær og skrubbær i feltsjikt, og unngår de rikeste skogene.

En viktig funksjon til indikatorartboka er å tjene som bestemmelseslitteratur for både naturforvaltere og andre fagfolk og amatører. Det hadde vært ønskelig at denne innholdsrike, informative boka med vakre bilder og vellykket layout ble tatt i bruk i Skandinavia også, selv om en god del skriftlig informasjon fortsatt blir bak språkmuren.

Katriina Bendiksen

Innholdsfortegnelse AGARICA vol. 36

ISSN-0800-1820