AGARICA

Mykologisk tidsskrift utgitt av Norges sopp- og nyttevekstforbund

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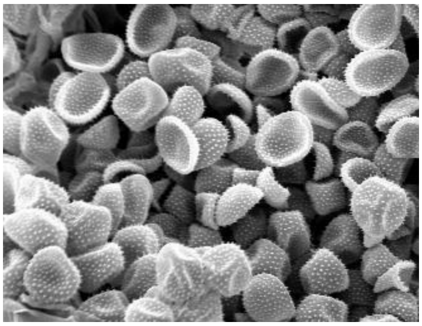

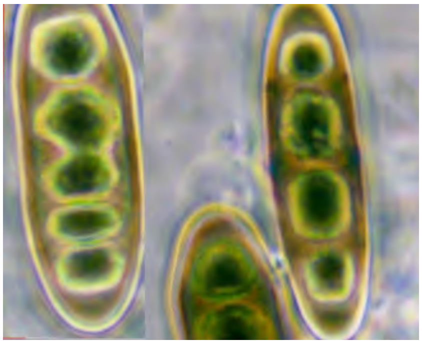

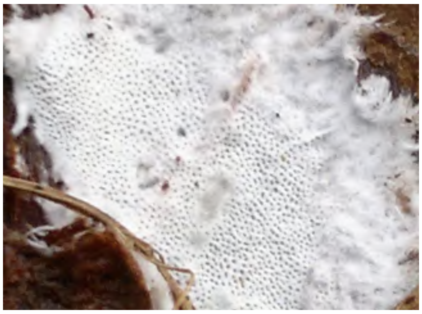

AGARICA

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).

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Forsidebilde: Frygiaslørsopp *Cortinarius phrygianus*. Foto: Tor Erik Branderud.

I venstre kolonne denne siden fra toppen:
Entoloma porphyrogriseum. Foto: H. Holien.

Uredinium of *Frommeëlla tormentillae*. Foto: E. Ørmen and K. A. Lye.

Requienella seminuda, Ascospores. Foto: Björn Nordén.

Skeletocutis alutacea. Foto: Njål Berge.

Kjære leser

Dette volumet av Agarica kan ved første øyesyn forveksles med et spesialnummer dedikert til nye sopparter i Norge. Det er det ikke. Det er tilfeldig og samtidig også morsomt at syv av artiklene i Agarica volum 35 omhandler nye arter for Norge. I tillegg kommer en artikkel med Teppo Rämä ved universitetet i Tromsø som førsteforfatter hvor vi for første gang får en samlet oversikt over det vi vet om marine sopper i Norge og hvor 17 nye arter for landet blir publisert. Dette arbeidet var en del av hans nå fullførte doktor grad.

Vi har også en artikkel som bekrefter funn av rødsporen *Entoloma porphyrogriseum* i Norge og vi har fått med oss en inventering av beitemarksopp i kulturlandskapet i Sunnhordland. Et nyttig verktøy for de rustsoppinteresserte vil være gjennomgangen av slekten *Frommeëlla*. Sist, men ikke minst, tror vi mange vil sette pris på den grundige omtalen av sandfuruskogsopper i Norge som man også finner i denne utgaven.

I tillegg til de 12 fagartiklene har vi fått plass til tre bokanmeldelser som omtaler Glomeromycota, sopp på Svalbard og nyere litteratur om *Tricholoma*.

Roy Kristiansen har lenge vært en dyktig og produktiv bidragsyter til utforskingen av Norges funga – spesielt den delen som omfatter askomycetene. Han er også en av grunnleggerne av Agarica tilbake i 1980. I 2013 fylte Roy 70 år og det markerer vi i dette nummeret. Roy er fortsatt i full aktivitet og bidrar også med en artikkel om fire, uvanlige, hårbevokste diskomyceter fra Norge. Vi er svært stolte og glade for å ha Gro Gulden som medlem av Agarica redaksjonen. Få kan konkurrere med hennes kunnskapsnivå og arbeidsinnsats. Gro fyller 75 år den 30. oktober og vi benytter anledningen til å gratulere også henne med dagen.

Agaricaredaksjonen er stolte og glade for at det finnes så mange ivrige, kunnskapsrike og arbeidsomme mykologer der ute og at så mange velger å dele sine resultater gjennom Agarica. Fortsett med det! Kunnskap er verdt så mye mer når den deles med andre og ikke ligger gjemt i en kontorskuff.

Gry Alfredsen
Setteredaktør for vol. 35

Roy Kristiansen 70 år 6. oktober 2013

Den 6. oktober 2013 fylte Roy Kristiansen på Selbak i Fredrikstad 70 år. Amatørmykolog, amatørmineralog og amatørfilosof. Dette er en person med en enorm vitenskapelig nysgjerrighet, pågangsmot, analytisk evne og entusiasme, noe som har gjort at Roy som amatør har blitt en høyt respektert fagperson innen profesjonell mykologi og mineralogi både nasjonalt og internasjonalt. Og ikke nok med det, Roys filosofiske og spesielt økosofiske interesser førte han inn i et mangeårig interessant og nært vennskap med filosofen Arne Ness.


Foto: I. Kristoffersen.

Etter at Roy pensjonerte seg etter 50 års arbeid i industrien, har han fortsatt sitt utrettelige engasjement med like stor entusiasme som tidligere. Publikasjoner, reiser og foredrag nasjonalt og internasjonalt tar mye av hans tid.

Roys spesielle engasjement innenfor mykologien har resultert i at han har fått to sopper oppkalt etter seg, *Entoloma kristiansenii* og *Lamprospora kristiansenii*. Spesielt de operkulate askomycetene er Roys store interesse, og her rager han som en internasjonal kapasitet. Hans bidrag innenfor mineralogien er kanskje ennå større, og i dette miljøet har han fått et virkelig internasjonalt navn helt på nivå med profesjonelle. Ikke bare fordi han har fått et mineral oppkalt etter seg, kristiansenite, noe som er svært krevende, men som den første europeer ble han for noen år siden tildelt den meget prestisjetunge Pinch-medaljen. Dette er den største anerkjennelse en amatør kan oppnå.

Roy har så lang publisert mer enn 400 vitenskapelig artikler, og han har funnet ca. 30 nye mineraler og mer enn 150 sopparter som er nye for Norge. Det må også nevnes at det var Roy som hadde ideen og som startet tidsskriftet Agarica i 1980, den gang som et organ for Fredrikstad soppforening, men som utviklet seg til et tidsskrift med internasjonal spredning, og med bidrag fra flere av de mest anerkjente mykologer i verden.

Som hans mangeårige tur- og diskusjonskamerat, er det ellers mye som kan sies om Roy, og han fortjener egentlig en egen biografi. Her skal det bare nevnes at Roy er en svært omgjengelig og sosial person, er isbader, og han har tydelig en kunstnerisk åre både som habil tegner og som stand-up-komiker (kan utenat hele repertoaret til Hasse og Tage). Til tross for sitt fredelige sinnelag har han dessuten en imponerende samling av sverd og sabler, og sans for kinesisk kong fu og taoismen.

Det kan være verdt å lytte til en av hans livsfilosofiske uttalelser:

”Mange lar seg underholde for å holde ut tilværelsen. Det blir en flukt fra dem selv”. Roy er sannelig ikke en person som flykter fra seg selv.

Øyvind Weholt

Coccomycetella richardsonii (Odontotremataceae, Ostropales), an ascomycete new to Norway

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Norsk tittel: *Coccomycetella richardsonii*, en sekksporesopp ny for Norge

Holien H, Diederich P, 2014. *Coccomycetella richardsonii*, an ascomycete new to Norway. Agarica 2014, vol. 35: 3-5.

KEYWORDS
Coccomycetella richardsonii, dead wood, distribution, Norway, *Pinus sylvestris*, snag

NØKKELORD
Coccomycetella richardsonii, død ved, furu, høgstubbe, Norge, utbredelse

SAMMENDRAG
Sekksporesoppen *Coccomycetella richardsonii* er påvist i Norge for første gang. Den vokste på en død, avbarket furu på en ombrotrof myr i nordboreal vegetasjonssone i et landskap preget av veksling mellom myr og relativt glissen barskog. De små, svarte fruktlegemene har tannet poreåpning, dypt nedsenket hymenium og sigmoide sporer som er spiralsnodd inne i sporesekkene.

ABSTRACT
The odontotremoid ascomycete *Coccomycetella richardsonii* is reported as new to Norway from wood (snag) of *Pinus sylvestris* in a boreal landscape with mires in an open coniferous forest. The species is characterized by black ascomata with deeply sunken hymenium and sigmoid ascospores that are twisted in the ascus.

INTRODUCTION

The monospecific genus *Coccomycetella* belongs to the family Odontotremataceae that includes mainly saprotrophic species (Sherwood-Pike 1987, Diederich et al. 2002, Baloch et al. 2013). Recently the family was shown to be polyphyletic with two rather distantly related clades, and *Coccomycetella* was suggested to be closely related to the generic type *Odontotrema phacidioides* (Baloch et al. 2013).

During fieldwork in a nature reserve in Verdal, Central Norway, in the summer of 2012, the first author collected lichens on dead decorticated trunks of *Pinus sylvestris*. In one collection of *Pycnora xanthococca* an unknown odontotremoid ascomycete was associated. This species was later identified by the second author as *Coccomycetella richardsonii* Leight. The locality was revisited by the first author in the autumn of 2013 and *C. richardsonii* proved to be quite common on this trunk, but was not found on nearby trees.

THE SPECIES

Coccomycetella richardsonii is mainly characterized by partly immersed to erumpent, c. 0.4–0.5 mm diameter, black ascomata with a dentate pore and deeply sunken hymenium (Figs. 1 – 2). Microscopically it is distinct by the narrow, sigmoid, 1-3-septate ascospores that are twisted in the ascus and by a brownish

Figure 1. *Coccomycetella richardsonii* on wood of *Pinus sylvestris*, a typical habitat for this species (Holien 14302), scale = 0.2 mm. Photo: P. Diederich.

Figure 2. *Coccomycetella richardsonii*, ascoma section (Holien 14302), scale = 100 µm. Photo: P. Diederich.

pigment in the outer excipulum (Figs. 2 - 3). For a detailed description see Sherwood-Pike (1987).

Coccomycetella richardsonii is a saprotrophic species on conifer wood. The Norwegian specimen was growing on a dead, decorticated trunk of *Pinus sylvestris* in an ombrotrophic mire within a nature reserve situated in the northern boreal zone as defined by Moen (1999) (Fig. 4). The species occurred on several square-decimeters with many ascomata. Associated lichen species on the trunk included *Buellia arborea*, *Calicium glaucellum*, *Imshaugia aleurites*, *Protoparmelia oleagina* and *Pycnora xanthococca*. The species is here reported as new to the Norwegian funga as it is neither cited in the index of Norwegian fungi given by the Norwegian Biodiversity Information Centre (2014) nor in the catalog by Aarnæs (2002).

Outside Norway, *C. richardsonii* is reported from dead, decorticated twigs of *Pinus sylvestris* and wood of *Picea* in northern Fennoscandia (Finland and Sweden). It is also reported from wood of *Pinus* in Russia (Karelia) as well as from western North America (Oregon) and northern Canada (Fort Enterprise) (Baloch et al. 2013, Sherwood-Pike 1987). It seems to be a slightly northern species that is probably overlooked. It may be a circumboreal species and it should be searched for in pine dominated forests in northern boreal areas and at high altitudes elsewhere.

Figure 3. *Coccomycetella richardsonii*, ascospore (Holien 14302), scale = 20 µm. Photo: P. Diederich.

Specimen examined

Nord-Trøndelag: Verdal, Fjellmannmyra – Vargdalsfloa nature reserve,

Figure 4. Habitat for the first sample of *Coccomycetella richardsonii* in Norway. Photo: H. Holien.

UTM: UL 52855, 65832, lat/long: 63°41.364’ N, 12°01.429’ E, alt. ca. 450 m, 04.10.2013, H. Holien 14302 (TRH and herb. Diederich).

ACKNOWLEDGEMENTS

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Caliciopsis calicioides, a corticolous ascomycete on *Populus tremula* new to Norway

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Norsk tittel: *Caliciopsis calicioides*, en barklevende sekksporesopp på osp ny for Norge

Jordal JB, Nordén B, Gaarder G, 2014. *Caliciopsis calicioides,* a corticolous ascomycete on *Populus tremula* new to Norway. Agarica 2014, vol 35: 7-12.

KEYWORDS
Caliciopsis calicioides, Eurotiomycetes, Coryneliales, Coryneliaceae, *Populus tremula,* boreal forest

NØKKELORD
Caliciopsis calicioides, Eurotiomycetes, Coryneliales, Coryneliaceae, osp, boreal skog

SAMMENDRAG

Caliciopsis calicioides (Eurotiomycetes, Coryneliales, Coryneliaceae) er en særegen og lett bestemmelig sekksporesopp som vokser i barksprekker på gamle, levende ospetrær. Arten er tidligere ikke rapportert fra Norge. Den ble funnet av oss i Molde, Møre og Romsdal i 2012, og i 2013-2014 fant vi den på noen flere lokaliteter i Molde, Nesset og Tingvoll. Vi har også fått opplysninger om et eldre, upublisert funn fra Hamarøy, Nordland i 1994. I resten av Europa er arten så langt bare kjent fra Sverige og Finland. Den er også kjent fra Nord-Amerika. Den synes ofte å være assosiert med sjeldne eller rødlistede lav og en interessant funga i eldre skog.

ABSTRACT

Caliciopsis calicioides (Eurotiomycetes, Coryneliales, Coryneliaceae) is a peculiar and easily identified ascomycete, growing in bark fissures of old, living *Populus tremula*. The species has not previously been reported from Norway. It was discovered by us in Molde, Møre og Romsdal in 2012, and during 2013 and 2014 we found additional localities in Molde, Nesset and Tingvoll municipalities. An older, unpublished record from Hamarøy, Nordland in 1994 also came to our knowledge. In the rest of Europe, it is so far only known from Sweden and Finland. It is also known from North America. It often seems to co-occur with rare or red-listed lichens and an interesting funga of bark-living fungi in natural like forests.

INTRODUCTION

The genus *Caliciopsis* (Eurotiomycetes, Coryneliales, Coryneliaceae) contains species causing diseases in trees, e.g. *C. pinea* Peck (Benny et al. 1985) and species belonging to a relatively small but conspicuous guild of fungi growing on the bark of seemingly healthy living trees, like *C. calicioides* (Ellis & Everh.) Fitzp. growing on *Populus* (Fitzpatrick 1942). The ascocarps of *C. calicioides* may superficially resemble those of the lichen genera *Chaenotheca* or *Calicium,* hence the name *Caliciopsis,* but it is not lichenized. The structure of the ascocarps is also entirely different. The genus *Caliciopsis* is characterized by long stipitate, deliquescent asci and non-septate spores. The often long and thin ascocarps also have an elevated ascigerous cavity which is seen as a swollen part, placed either near the top, in the middle part or near the base (Fitzpatrick 1942). During field investigations in Molde municipality, Møre og Romsdal in 2012 one of us (B. Nordén) found *C. calicioides*, and this made us search further for this species at other sites. This resulted in findings at some additional localities in 2013 and 2014. Later, an older occurrence of the species from Nordland in 1994 came to our knowledge. We here report the species as new to Norway and shortly present its ecology based on field observations.

MATERIALS AND METHODS

Collections of *C. calicioides* were found on bark of *Populus tremula* during field investigations in Møre og Romsdal in 2012, 2013 and 2014. Positions are taken in UTM (WGS84, zone 32) with handheld GPS, with an accuracy of +/- 10 m. Microscopic slides were prepared from dried material and mounted in water for measurements and photographs. The collections were studied using Wild dissecting microscope and Motic light microscope. Macro photographs were taken with a Canon EOS 650D digital camera with Canon MP-E 65 mm 1-5x macro lens. Micro photographs were made by a Motic microscope camera. Collector abbreviations

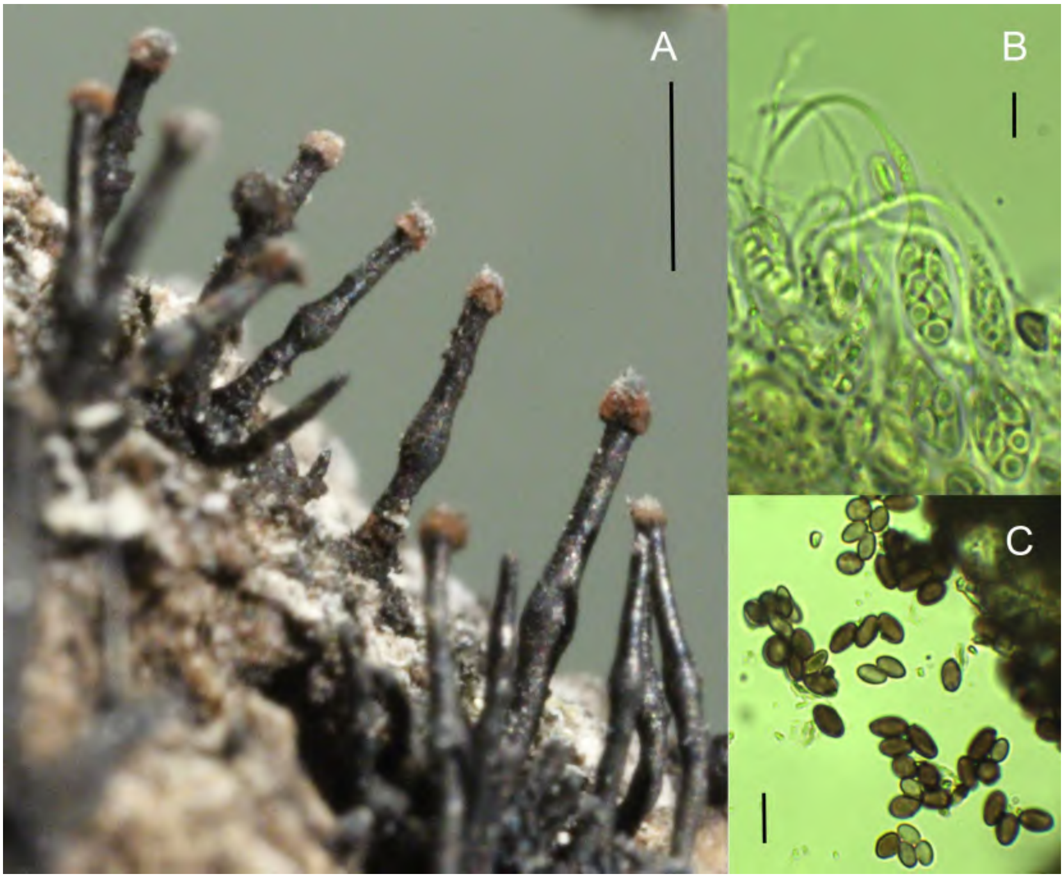

Figure 1. *Caliciopsis calicioides*. A. Ascocarps on bark of *Populus tremula* (Molde: Rislia south). Note the swollen region in the middle of the ascocarp where the centrum cavity with asci is located. Bar=1mm. B. Asci. Bar=10 µm. C. Spores. Bar=10 µm. Photos: J.B. Jordal, 8th March 2014.

include BN (Björn Nordén), GGa (Geir Gaarder) and JBJ (John Bjarne Jordal). Collections will be deposited in O.

DESCRIPTION

The description is based on our material from Møre og Romsdal.

The long and thin black ascocarps occur on the bark of *Populus tremula* (Fig. 1A). The ascocarps are straight to slightly curved, mostly 1.0-2.5 (-3) mm high and 0.1-0.2 mm thick. They are clustered a few or several together arising from minute black stromata. Mature ascocarps have a more or less central bulge (0.2-0.4 mm thick) containing the asci. The asci are clavate or balloon-shaped with a very long tapering stipe, the spore-bearing part is 15-20 x 10-12 µm (Fig. 1B). The ascospores are ellipsoid, gradually changing from almost hyaline (immature) to brown (mature), 6.0-8.5 x 3.5-5.5 µm (Fig. 1C). Released spores move inside the beak of the ascocarp from the hymenium in the bulge to the tip. The tip is bulbous, consisting of hyphae mixed with the mature brown ascospores, which are often staining the tip more or less brown, forming a mazaedium-like structure (Fig. 1A).

Material studied

All finds are on bark of *Populus tremula* in old deciduous forests together with *Betula pubescens* and often mixed with *Pinus sylvestris* and *Sorbus aucuparia*.

Møre og Romsdal: Molde: Brenslefjellet, south-facing hillside; position E 431716 N 6955892, 235 m asl, 16.05.2012, leg. BN & JBJ and 12.01.2013, leg. JBJ; on 16 other trees E 431530-431586 N 6956022-6956091, 270-300 m asl, 04.01.2014, leg. GGa & JBJ (Fig. 3). - south of Bakksætra, northwest-facing hillside, position E 425673 N 6957465, 280 m asl, 20.10.2013, leg. GGa & Steinar Vatne. - Rislia south, west-facing hillside on 5 trees, position E 425190-425226, N 6955682-6955735, 230-250 m asl, 05.01.2014, leg. GGa & JBJ. - Rislia north, west-facing hillside, on 6 trees, position E 425115-425142, N 6956257-6956330, 240-245 m asl, 05.01.2014, leg. GGa & JBJ. Nesset: near Barsteintjørna, east-facing hillside, position E 439957 N 6961379, 270 m asl (within the nature reserve); southeast-facing hillside on 3 trees E 440278 N 6962120, 280 m asl (outside the nature reserve); 09.03. 2013, leg. GGa. Tingvoll: Durmålhaugen, north-facing hillside, on 30 trees, diam. 30-80 cm, deepest bark fissures of each tree 20-60 mm, position E 468992-469232, N 6971602-6971738, 125-220 m asl, 22.03.2014, leg. GGa & JBJ.


Figure 2. Distribution of *Caliciopsis calicioides* in Norway. Bar=200 km.

Additional data (no specimen collected):

Nordland: Hamarøy: Kvannskogen (nature reserve), old deciduous forest with big *Populus tremula*, UTM (WGS84, zone 33) E 0540600 N 7547300 (+/-500 m), 15-20 m asl, 07.03.1994, leg. Mats Karström (Jokkmokk,

Figure 3. Big aspen *Populus tremula* with *Caliciopsis calicioides* in boreal forest. Molde: Brenslefjellet, 4th January 2014. Photo: J.B. Jordal.

Sweden; personal information in email 07.03. 2014, the finder has drawings made from fresh material). M. Karström has also found the species in coastal areas of Norrbotten, Sweden; this material was controlled by Ove Eriksson, University of Umeå.

The distribution is shown in Fig. 2.

HABITAT AND DISTRIBUTION IN NORWAY

Caliciopsis calicioides was growing in bark fissures of old *Populus tremula* trees in old deciduous or mixed forests with *Betula pubescens*, *Sorbus aucuparia*, *Salix caprea* and sometimes *Pinus sylvestris*. The diameter and deepest bark fissure was measured on 57 of the 63 host trees in Møre og Romsdal. The diameter was 30-90 cm, and the deepest bark fissure of each tree was 20-60 mm. The diameter of the largest tree at each locality was 60-90 cm. One tree was broken and had died recently, but still had attached bark. The species seemed to prefer a southern to western/northwestern exposition on the trees, but at the locality Durmålhaugen it was also found exposed to the north and east. It was found up to 3.5 m above the ground. *Caliciopsis calicioides* was mainly growing in fissures where few lichens and mosses were present, but on one tree with a very large population we also found it on exposed bark between the fissures. Two other corticolous fungi on the *Populus* trees were *Lasiobelonium corticale* (Pers.) Raitv. and *Amphisphaerella dispersella* (Nyl.) O.E. Erikss. Two of the six localities in Møre og Romsdal are also the southernmost known localities in Norway of *Staurolemma omphalarioides* (Anzi) P.M. Jørg. & Henssen, a rare lichen species occuring on old *Populus tremula* in coastal areas of Middle Norway (Holien 2011). *Staurolemma omphalarioides* and *C. calicioides* were occuring together on several trees in the locality Brenslefjellet, Molde. The localities in Møre og Romsdal are situated 125-300 m above sea level, mainly in the middle boreal vegetation zone (MB) but with the lowest parts touching the southern boreal vegetation zone (SB). They belong in the markedly oceanic vegetation section (O2). The locality in Hamarøy, Nordland is situated in the middle boreal vegetation zone (MB) and the weakly oceanic vegetation zone (O1) (Moen 1999).

DISCUSSION

Taxonomic notes

Using Fitzpatrick (1942) or Benny et al. (1985) our material easily keys out as *C. calicioides*; the main characteristica are ellipsoidal ascospores and ascigerous locule median to submedian. In *C. subcorticalis* (Cooke & Ellis) Fitzp. and *C. tiliae* Arnold the ascigerous locule is subterminal above a long stalk. Further, *C. subcorticalis* has smaller, subglobose spores and grows on *Quercus*, while *C. tiliae* is only known on *Tilia*. *Caliciopsis toonae* Rikkinen described from China has a median ascigerous locule, but smaller, subglobose spores (Rikkinen 2000). The measures of ascospores and other characteristica in our material, as well as the habitat, is in good compliance with Fitzpatrick (1942) and Benny et al. (1985).

Nomenclature and systematics

Mycobank and Index Fungorum cite *Exophiala calicioides* as the current name of this species with reference to Okada et al. (2000). Okada et al. (2000) use *Sporocybe calicioides* Fr. as basionym. The description by Fries (1832) clearly shows that this is another fungus. Fitzpatrick (1920) questioned *Sporocybe calicioides* Fr. as basionym for *C. calicioides*, and based his new combination on *Hypsotheca calicioides* Ellis & Everh. As there is no connection between *Exophiala calicioides* (Fr.) G. Okada & Seifert and *Caliciopsis calicioides* (Ellis & Everh.) Fitzp. the correct name of our species is *Caliciopsis calicioides*. *Exophiala* has been used for the asexual stage of fungi belonging to Herpotrichiellaceae (Chaetothyriales) and is not closely related to *Caliciopsis* in Coryneliaceae (Coryneliales).

Distribution

In Sweden, 11 localities of *Caliciopsis calicioides* are presented by Artportalen (2014), mainly along the coast of the Baltic sea in the central and northern parts of the country. Delin (2005) and M. Karström (pers. comm. 07.03.2014) give additional information indicating that there may be 20-30 known localities of this species in Sweden. In Finland there are two localities known in the western parts of the country (S. Huhtinen pers. comm. 27.06. and 11.09.2014). The distribution in Norway seems to have its optimum in the middle boreal zone, which coincides well with the data from Sweden and Finland. It also seems to avoid continental areas. Searches on the Internet, e.g. in different national online databases, revealed no further information on this species from other European countries. In North America it is known from northern United States and southern Canada (Fitzpatrick 1942, Benny et al. 1985).

Ecology

All finds of *Caliciopsis calicioides* in Norway have been made in bark fissures of large *P. tremula* in old-growth boreal forests. In Sweden and Finland it was also found on old and big aspens, and one of the Finnish localities has the largest and oldest aspens in the country (Artportalen 2014, Delin 2005, M. Karström and S. Huhtinen pers. comm.). In North America it is found on various species of

Populus (Fitzpatrick 1942, Benny et al. 1985). In Norway, big aspens especially occur outside the distribution area of spruce *Picea abies*, and can have old and stable populations in steep areas in the southern, western and middle parts of Norway, and also some places in the northern parts of the country (Bendiksen et al. 2008). *Caliciopsis calicioides* should be looked for in these regions. However, in 2013-2014 we investigated hundreds of old aspens in many different localities in Møre og Romsdal without finding the species, and we consider it to be rare. Old aspen trees are important substrates for many red-listed species in old boreal forests and needs to be considered in sustainable management. We think that *C. calicioides* should be considered in future revisions of the red lists of Norway, Sweden and Finland.

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We wish to thank Mats Karström for information on this species from Norway and Sweden, and for the permission to publish his find in Hamarøy, Nordland. We also thank Seppo Huhtinen for information regarding the occurrence in Finland. This work was a spin-off from the project ´Pyrenomycetes (Sordariomycetes and similar fungi) in temperate deciduous forests of southern and western Norway´ lead by Björn Nordén and financed by Artsdatabanken (the Norwegian Biodiversity Information Centre).

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Some polypores new to Norway

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Norsk tittel: Noen poresopper nye for Norge

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Nordic distribution, Polypores, Norwegian pore fungi

NØKKELORD
Nordisk utbredelse, norske poresopp

SAMMENDRAG
Antrodiella ichnusana, *Ceriporia metamorphosa*, *Ceriporiopsis guidella*, *Ceriporiopsis pseudogilvescens*, *Oligoporus norrlandicus* and *Skeletocutis alutacea* er rapportert som nye for Norges mycota og deres utbredelse i Fennoscandia er kommentert.

ABSTRACT
Antrodiella ichnusana, *Ceriporia metamorphosa*, *Ceriporiopsis guidella*, *Ceriporiopsis pseudogilvescens*, *Oligoporus norrlandicus* and *Skeletocutis alutacea* are reported as new to Norway and their distribution in Fennoscandia is commented upon.

INTRODUCTION
Polypores have been collected in Norway for at least 160 years and thus, it is rather surprising that there still are recorded species new for the country. The reason is partly a more intense collecting by many amateurs from different parts of the country and partly that some species concepts have been refined resulting in revision of previously variable species. The following species are all deposited in the Oslo University Herbarium (O) unless stated differently. The discussions and statements as to distribution are based on the databases at the Oslo University herbarium, The Museum of natural Science in Stockholm, the Danish Atlas project and the checklist of British Basidiomycetes.

SPECIES LIST
Antrodiella ichnusana Bernicchia, Renvall & Arras, Polyporacae, Fungi Europaei 2005: 127.

The species was originally described from Sardinia in Italy, but has later been reported from, France, Netherlands and Finland (Miettinen et al. 2006). It has certainly a wider distribution than indicated by these widely scattered localities. Large spores (4.5-5.8 x 2-2.1 µm) and fairly large pores, i.e. 3-5 per mm, will separate it from the other European species of the genus. In Italy it was found on *Alnus glutinosa* and *Populus alba,* while in Finland *Alnus* seems to be the most common host even though it is known there from *Prunus padus, Salix caprea Sambucus racemosa* and *Acer platanoides*.

Specimen examined
Vest Agder: Sirdal, Samlogshagen, 8. October 2011, inside dead standing trunk of *Quercus* sp. Leg. Njål Berge.

Description (Ryvarden and Melo 2014: 102): **Basidiocarps** resupinate, annual, soft when fresh, hard when dry, basidiocarps round to irregular up to 3 cm in longest direction, pore surface cream coloured when fresh, darkens to cream or ochraceous or pale tan, pores regular, round (3) 4-5 (6) per mm, tubes concolorous with pore surface, up to 2 mm deep, subiculum cream coloured less than 1 mm thick.

Hyphal system dimitic, generative hyphae with clamps, thin-walled, 1.5-2.5 µm in diam.; skeletal hyphae predominant, interwoven, but not agglutinated, 2-3 µm wide, straight to slightly sinuous, thick-walled, crystalline clusters scattered among the hyphae in dry basidiocarps.

Cystidia or cystidioles absent.

Basidia 8-10 x 4.5-5 µm, hyaline, clavate, tetrasterigmatic with basal clamp.

Basidiospores 4-5 (5.8) x 1.8 – 2.2 µm, cylindrical.

Substrata. Usually *Alnus* spp. but also on other hardwoods such as *Populus*, *Prunus, Quercus*, *Sambucus*, and *Acer.*

Remarks. The species may be confused with *A. romellii* which however has slightly smaller and ellipsoid spores.

Ceriporia metamorphosa (Fuckel) Ryvarden & Gilb., Syn. Fung. (Oslo) 6: 185, 1993. - *Polyporus metamorphosus* Fuckel, Jb. Nassau. Ver. Naturk. 27-28: 87, 1874. Fig. 1

This species was mentioned by Hofton (2011) in his general survey of the Polypores of Fennoscandia, but is treated here in more detail. It is a rather conspicuous species by having fairly large pores, but above all by an imperfect yellow stage with large chlamydospores under or along the perfect poroid basidiocarp. All the three Norwegian localities are situated in the climatic most favourable south Eastern part of the country. One may speculate whether they are new immigrants or have been here since the post glacial warm period from about 3000 to about 500 BC and lived in oblivion up to date when the climate slowly again being more favourable.

In Sweden there are known two specimens, both collected in 1917 by Lars Romell in the Uppsala and Stockholm area.

Specimens examined

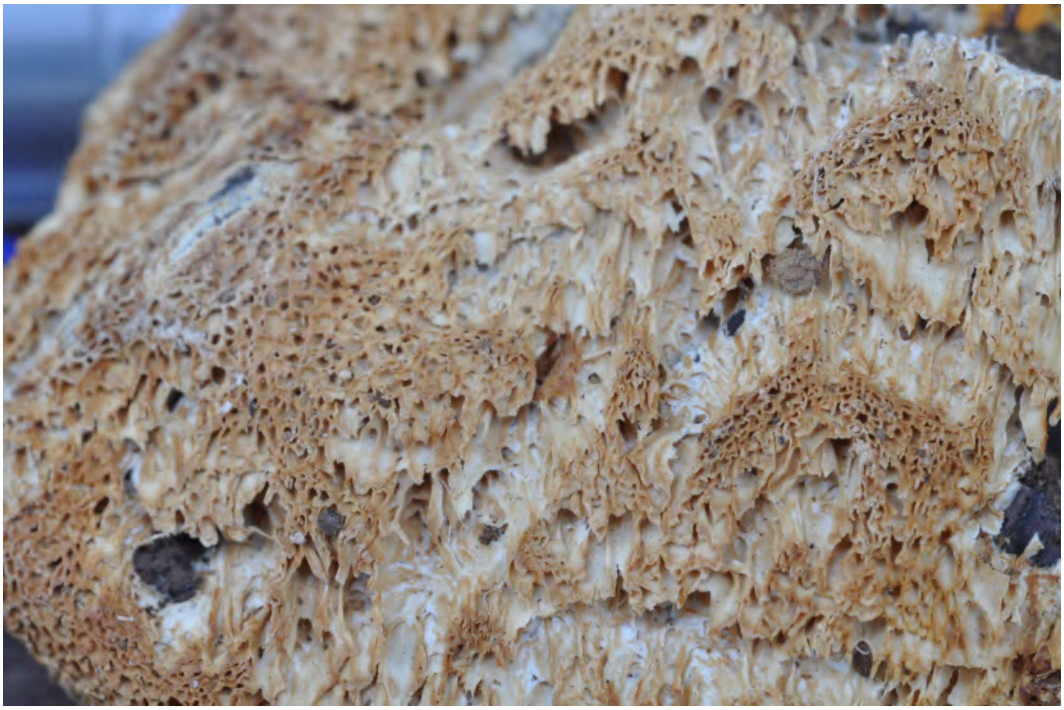
Vestfold: Larvik: Korpen, Larvik, 12.08.2009, on old *Quercus.* Leg. Turid N. Kristiansen and Per Marstad. **Telemark:** Porsgrunn: Bjerkøya, 28.09.2010, on old *Quercus*. Leg. Turid N. Kristiansen og Per Marstad. **Oppland:** Jevnaker: Gunstad Øvre, UTM(WGS84): NM 789 845, Alt.: 260 m, on coarse trunk of hard wood tree, *Quercus robur*?, 2004.08.18, leg. Tor Erik Brandrud.

Description (Ryvarden and Melo 2014:132).

Basidiocarps annual, resupinate, becoming widely effused, interspersed with or associated with ochraceous orange patches of the conidial stage; pore surface pale buff, pores irregular and labyrinthiform, 1-3 per mm, the dissepiments soon becoming deeply lacerate and split to an irpicoid hymenophore; subiculum thin, white to cream-coloured, soft and cottony, less than 1 mm thick; tube layer up to 6 mm thick; marginal areas of basidiocarp sterile, white, soft and cottony and grading into the conidial areas.

Anamorph developing in patches interspersed with the teleomorph, ochraceous to orange, powdery with a soft, white, cottony base and margin; chlamydospores ovoid with a narrow truncate base, slightly thick-walled, hyaline to pale yellow in KOH, negative in Melzer's reagent, smooth, 9-12 x 5-8 µm, developing from short side branches of the conidiogenous hyphae.

Hyphal system monomitic with some thick-walled hyphae; subicular hyphae loosely arranged, hyaline, mostly thin-walled with frequent branching, often adjacent to the septum, 2.5-5 µm in diam., also some scattered thick-walled hyphae with occasional septa or some segments non-septate and resembling skeletal hyphae; tramal hyphae similar.



Figur 1. *Ceriporia metamorphosa.* Photo P. Marstad.

Cystidia or other sterile hymenial elements absent.

Basidia 20-35 x 5-6 µm, narrowly clavate, often with an elongated narrow base, tetrasterigmatic.

Basidiospores 5.5-6.5 x 2-2.5 µm, allantoid to cylindrical.

Substrata. Preferably on *Quercus*, but also reported from *Castanea, Juglans* and *Malus.*

Distribution. A rare species, known from England, France, Germany, Poland, the Czech Republic and central south Norway.

Remarks. The large spores make this a distinct species in the genus.

Ceriporiopsis guidella Bernicchia & Ryvarden, Mycotaxon 88: 220, 2003.

When the specimen cited below was sent one of us (LR) from Trondheim in Mid-Norway, it caused a problem since apparently no name could be found that with certainty could be applied to it. In the end it was sent to Drs. O. Miettinen and T. Niemelä at the Helsinki University. At first they could offer no help and the specimen was laid aside as a problem. Later on O. Miettinen kindly had it sequenced and it was shown to be *C. guidella*, recently described from Northern Italy, some 1500 km south of Trondheim. A revision of *Ceriporiopsis* specimens deposited in Fennoscandian fungaria, may well reveal that *C. guidella* has a wider distribution in Fennoscandia than the single Norwegian collection may indicate.

Specimen examined

Sør-Trøndelag: Trondheim: Bymarka, Storheia, on dead *Betula* sp. 31. August 2009, Leg. J. Klepsland 946 (H).

Description (Ryvarden and Melo 2014: 143). Basidiocarps annual, resupinate, adnate and widely effused, soft and fleshy when fresh, hard, brittle, cartilaginous, shrinking upon drying, margin very thin, almost missing, pore surface with a greasy appearance, the colour ranging from dull yellow to greenish, getting darker upon drying and cracking into a characteristic pattern of small squares, pores round to slightly angular, translucent, 4-5 per mm; dissepiments thin, entire, lacerate with age, subiculum almost totally lacking, present only as a thin line, concolorous with the tubes, the latter concolorous with the pore surface, 4-6 mm deep.

Hyphal system monomitic: generative hyphae with clamps at the septa, thin-walled, 2-3 µm in diam; commonly with numerous oil drops, in parts basally inflated, close to the substratum, consistency dense and fragile in dry conditions.

Cystidia not seen, but fusoid cystidioles 20-30 µm long and 5-6 µm wide in the basal part, present in well preserved hymenium, which however collapses rapidly by drying.

Basidia 15-20 x 4-5 µm, first subglobose, then barrel-shaped and finally clavate, with 4 thin sterigmata.

Basidiospores 4-5 x 2 –2.4 µm, cylindrical.

Substrate. Known from *Acer pseudoplatanus* and *Betula* sp.

Distribution. Known from Italy and now Norway.

Remarks: The pore surface cracks characteristically into a deep pattern of squares or angular pieces, giving a macroscopically peculiar appearance. Microscopically it may remind one of *Ceriporiopsis resinascens*, which however becomes brown with maturity, has a distinct subiculum, larger pores and spores, the latter also having a more cylindrical shape.

Ceriporiopsis pseudogilvescens **(**Pilát) Kinnunen & Niemelä, Karstenia 45: 83, 2005. - *Poria pseudogilvescens* Pilát, Bull. trimest. Soc. mycol. Fr. 51: 378, 1936.

This species which had rested in oblivion since its description has been resurrected as a result of an accurate study of *C. resinascens* (Romell) Domański, which was previously treated by many as a variable species. It was originally described from Nattavarre in Northern Sweden and have since then been found to have a wide distribution in Scandinavia. The database at the Botanical Museum, University of Oslo alone has 186 records of *C. resinascens*.

The basidiocarps of *C. resinascens* are characterised by an even brown basidiocarp attaining a fragile almost cartilaginous consistency when mature which inspired Romell when naming it. *Ceripoiopsis pseudogilvescens* is similar to *C. resinascens*, but the spores of the former are distinctly wide i.e. 2.5-3.1 µm wide compared with 2-2.6 µm for the latter. An accurate examination of the many collections of *C. resinascens* in Norwegian herbaria will by all probability indicate that *C. pseudogilvescens* has a wider distribution than the records reported below.

Specimen examined

Oppland: Nord-Fron: Vinstra ved Smikopp, UTM(WGS84): NP 32744 26037, Alt.: 367 m, on *Sorbus aucuparia*, 2007.10.16, Tom H. Hofton. **Hedmark:** Ringsaker: Nes, Bangsberget (Liberget), UTM(WGS84): PN 034-473, on dead *Populus tremula*, 2004.09-16, Tor Erik Brandrud TEB 478-04. **Sør-Trøndelag:** Trondheim: Storheia, On *Betula pubescens*, 2009.08-31, Jon T. Klepsland 946.

In addition Artdatabanken has a number of unspecified records on their map. None of these records have been deposited in any Norwegian herbaria, thus have not been examined by us,

Description (Ryvarden and Melo 2014: 145).

Basidiocarps annual, resupinate, up to 15 cm long in the longest dimension, waxy and soft when fresh, hard and brittle when dry, up to 4 mm thick, sometimes with obtuse projections simulating slightly developed pilei, margin pale straw coloured, 1-3 mm wide without rhizomorphs, pore surface at first whitish with shades of pink, then darker when touched or wounded, when dry pale resinous brown, pores angular to circular, 2-3 per mm, on sloping substrates partly split and sinuous; tube layer resinous brown when dry, up to 3 mm deep, subiculum thin and dense, cream coloured.

Hyphal system monomitic; generative hyphae with clamps, thin to thick-walled, 2-4 µm in diam, sometimes with scattered crystals.

Cystidia and other sterile hymenial elements absent.

Basidia 13-22 x 4-6 µm, clavate, tetrasterigmatic.

Basidiospores 3.5-6(-7) x 2.5-3.1 µm, broadly ellipsoid.

Substrata. Almost exclusively on *Populus* and *Salix* spp. and only occasionally on other broad leaved trees like *Betula* and *Sorbus aucuparia*.

Distribution. Widespread in central and northern Europe and following *Populus tremula* up to Finnmark at 70° N. Also known from Siberia and Canada.

Oligoporus norrlandicus Berglund & Ryvarden, Cryptog. Mycol. 21: 145, 2000.

The species was described on specimens collected, as the name indicate, in the Swedish province Norrland and is characterized by rather large, ellipsoid and slightly thick-walled spores, larger than the other Fennoscandian species in the genus.

Specimen examined

Rogaland: Egersund: Øygreid, UTM (33N) 651834 - 20325 15. September 2012, on dead *Picea*, leg. N. Berge.

Description (Ryvarden and Melo 2014: 279).

Basidiocarps annual, resupinate, separable, effused, up to 1.5 mm thick, soft when fresh, fragile when dry, no particular taste; margin narrow, white , pore surface white, pores angular, variable in size, 2-4 per mm; tube layer concolorous with pore surface, up to 3 mm thick; subiculum white, very thin.

Hyphal system monomitic; generative hyphae hyaline, thin walled, 2-4 µm in diam.

Cystidia absent.

Basidia 20-25 x 6-7 µm, clavate, tetrasterigmatic.

Basidiospores 5.5-6 x 2.5-3.5 µm broadly ellipsoid, IKI-.

Substrata. The type was collected on *Picea abies.*

Distribution. Known from a few localities in Sweden. Russia and Finland.

Remarks. Above all, it is the wide spores that separate this species from all other resupinate and white *Oligoporus* species. *O. placentus* (Fr.) Gilb. & Ryvarden and *O. rancidus* (Bres.) Gilb. & Ryvarden both have basidiospores with the same length, but they are narrower and cylindrical.

Skeletocutis alutacea (J. Lowe) Jean Keller, Persoonia 10: 353, 1979 - *Poria alutacea* J. Lowe in Overh. & J. Lowe, Mycologia 38: 202, 1946. Fig. 2

The white *Skeletocutis* species are difficult to determine, but *S. alutacea* has a distinct rhizomorphic margin making it rather distinct in the genus.

Specimens examined

Aust-Agder: Evje og Hornnes: Steinsfjellet, UTM(WGS84): MK 31200 93700, Alt.: 250 m, on *Pinus sylvestris*, 2007.12.30, Jon T. Klepsland, **Buskerud:** Rollag: Tundra Naturskog: UTM(WGS84): NM 1169 5764, Alt.: 310 m, on *Salix caprea*, 2004.08.22, Tom H.; Hofton & Bård Engelstad, **Buskerud:** Sigdal: Svarttjenn, UTM(WGS84): NM 35554 60048, Alt.: 315 m, on *Pinus sylvestris*, 2008.09.20, Tom H Hofton. **Telemark** Kvitseid: S of Nordbøen. On dead trunk of *Picea abies*, UTM(ED50): ML 678 873 (M711: 1513 I), Alt.: 220 m, 1999.09.26, Olav Aas, **Vest-Agder:** Sirdal: Skibeli, UTM 33N 6521033-18680. On large branches of *Quercus* lying on the ground 3. November 2011, Leg. N. Berge.

Figur. 2. *Skeletocutis alutacea.* Photo Njål Berge.

Description (Ryvarden and Melo 2014: 391).

Basidiocarps annual, resupinate, effused up to 20 cm, soft, easily separated from substratum; sterile margin white to cream-coloured, cottony to fimbriate or with conspicuous, white to cream-coloured rhizomorphs up to 1 mm in diam; pore surface white to pale ochraceous buff, glancing, the pores circular to angular, 4-8 per mm, with thin, entire dissepiments that appear finely granulose; subiculum white to cream-coloured, soft-fibrous, less than 1 mm thick; tube layer cream-coloured, drying brittle and shattering when cut, up to 1 mm thick.

Hyphal system dimitic; subicular skeletal hyphae thick-walled, hyaline, nonseptate, rarely branched, 2-4 µm in diam; subicular generative hyphae thin-walled, hyaline, with clamps, rarely branched, 2.5-4.5 µm in diam; tramal hyphae encrusted in dissepiments edges.

Cystidia none; fusoid cystidioles present, 11-17 x 4-5 mm.

Basidia 11-17 x 4.5-6 µm, clavate.

Basidiospores 3.5-5 x 1-1.5 µm, cylindrical, slightly curved.

Substrata. Dead wood of various conifer and hardwood genera including *Pinus, Picea, Acer, Fagus, Quercus* and *Salix*.

Distribution. A rare species in central and southern Europe but known north to Denmark and southern Norway.

Remarks. The rather soft, separable basidiocarps and conspicuous white rhizomorphs are good field characters for *S. alutacea*.

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Ryvarden L, Melo I, 2014. Poroid fungi of Europe, Synopsis Fungorum 31:1-455, Fungiflora.

Entoloma gomerense Wölfel & Noordel. – a new species to Northern Europe

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KEYWORDS
Entoloma gomerense, Holmvassdalen Nature Reserve, Norway, old calcareous spruce forest

NØKKELORD
Entoloma gomerense, gammel grankalkskog, Holmvassdalen naturreservat, Norge

SAMMENDRAG
I Norge er *Entoloma gomerense* funnet på fem ulike lokaliteter i Holmvassdalen naturreservat i Nordland i perioden 2008-2013. Denne rødsporen er tidligere kun funnet et fåtall ganger i Sør-Europa, på Kanariøyene og øst i Russland. Beskrivelser av de norske funnene og sammenligninger av artens økologi gis i artikkelen.

ABSTRACT
Entoloma gomerense is found in North-Norway in five different locations in Holmvassdalen Nature Reserve in the period 2008-2013. This *Entoloma* has previously only been found a few times in southern Europe, The Canary Islands, and eastern Russia. Descriptions of the Norwegian finds and comparisons of the species' habitats are presented in the article.

INTRODUCTION

In 2010, an international workshop was held in Grane and Hattfjelldal municipalities in Nordland county, Norway. The aim of the gathering was to find rare and red-listed species, particulary in the genus *Entoloma* (Hanssen 2011). Most of the fieldwork was carried out in Holmvassdalen Nature Reserve in Grane, where a long range of *Entoloma* species already had been found in the period 2007-2009. During the workshop two finds of *E. gomerense* were done, both examined and determined by Machiel Noordeloos during the workshop. Later on, examinations of a large material of *Entoloma* from the same area revealed three additional finds. This time Øyvind Weholt identified the finds and fieldwork had been carried out by Jostein Lorås, Siw Elin Eidissen and Maja Eidissen. This paper presents a short description of the Norwegian finds, information on distribution, and discussion on the species' ecology.

Entoloma gomerense is a species in subgenus *Leptonia* and belongs to the section *Serrulatum*. This section is characterized by more or less blue colours of pileus and stipe and a distinct dark blue lamellae edge. Macroscopically the species is recognized by the dark blue, strongly striate pileus (Fig. 1) that is only partly squamulose and by the blue colour that gradually vanishes and turns more brownish with age. The lamellae have a bluish tint and a distinctly serrulate, blue edge (Fig. 2). The stipe is polished and of the same colour as the pileus. *Entoloma gomerense* is easily distinguished from *E. serrulatum* by the striate pileus. Microscopically it is recognized by clampless basidia and presence of easily observable, more or less pigmented cheilocystida,

Figure 1. *Entoloma gomerense* showing typical black and bluish color of pileus, collected 13.09.2008. Photo: Jostein Lorås.

varying from broadly clavate to to cylindrical and lageniform.

Spores are described for the holotypus as 9.0-10.5 (-11.5) x 6.5-9.0 µm, Q = 1.2-1.4 and 5-6 angled in side view (Wölfel and Noordeloos 2001). Spore measurements of three collections are:

a) 9.5-11 x 7.8-8.4 µm, Q = 1.25-1.49 µm
b) 9.0-11.1 x 7.0-8.6 µm, Q =1.25-1.55 µm
c) 9.5-11.3 x 7.0-8.5 µm, Q = 1.19-1.38 µm

Spores and cheilocystidia from the three collects are depicted in Fig. 3, showing also the variation in the shape of the cheilocystidsia.

Material studied

Norway: **Nordland:** Grane: Holmvassdalen, a) UTM (WGS84) zone 33W 7245275, 421258, 13.09.2008, leg. Maja Eidissen, det. Ø. Weholt; b) UTM (WGS84) zone 33W 7245154, 421150, 31.08.2010, leg. & det. Machiel E. Noordeloos; c) UTM (WGS84) zone 33W 7244745, 421013, 02.09.2010, leg. S. E. Eidissen, det. Machiel E. Noordeloos; d) UTM (WGS84) zone 33W 7244809, 421065, 05.09.2011, leg. J. Lorås and S.E. Eidissen, det. Ø. Weholt; e) UTM (WGS84) zone 33W 7245238, 421231, 04.09.2013, leg. J. Lorås and S. E. Eidissen, det. Ø. Weholt.

Figure 2. Lamellae of *E. gomerense* showing the serrulate, more or less blue edge of lamellaea, collected 05.09.2011. Photo: J. Lorås.

Description of the localities

a) Found among decayed trunks in a meadow of tall-herbs on calcareous soil in old spruce forest (*Pica abies*). This find was examined in 2011.
b) 31.8.2010: Found during the *Entoloma*-workshop, on calcareous ground in herb meadow in old *Picea*-forest (Noordeloos 2012: 521).
c) 2.9.2010: Found during the *Entoloma*-workshop, on calcareous ground in old *Picea*-forest in tall-herb flushes (Norwegian Mycological Database).
d) 5.9.2011: Found in moss in a tall-herb meadow, dominated by *Filipendula ulmaria* and *Aconitum lycoctonum* ssp. *septentrionale*, close to flushes in old calcareous spruce forest.
e) 4.9.2013: Found in a transition site between a tall-herb meadow and an old spruce forest on calcareous, nutrition poor soil.

The finds from Holmvassdalen Nature Reserve have several environmental factors in common, like old spruce forest, calcareous soil and tall-herb habitats with bryophytes in the ground

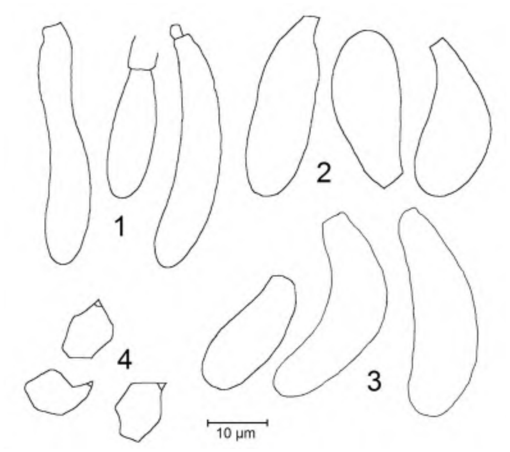

Figure 3. *Entoloma gomerense*. 1. Cystidia 13.09. 2008 (a) 2. Cystidia 05.09.2011 (d). 3. Cystidia 04.09.2013 (e). 4. Spores 04.09.2013 (e).

layer. The humidity of the air in these sites is rather high, since they are situated along the river in Holmvassdalen, partly flowing in the bottom of a canyon-like valley (Fig. 4). The tall-herb meadows form minor circumscribed areas with a whole range of rare fungi: *Entolomas* like *E. alvarense* Noordel. & Vauras, *E. callirhodon* Hauskn. & Noordel., *E. fulvoviolaceum* Noordel. & Vauras, *E. viiduense* Noordel. & Liiv and *E. sublaevisporum* Vila, Noordel. & O.V. Morozova, and also one new previously undescribed species provisionally named *E. holmvassdalensis* (Weholt et al. in prep.). Additionally, the following groups or genera abound at these locations: club fungi, earth tongues and wax caps, thus representing a community of fungi forming a mycosynusium (Nitare 2000).

DISCUSSION

According to Noordeloos, *E. gomerense* generally prefers moist places with mosses and peaty soil (Noordeloos 2012). It was originally described from a few localities on the island La Gomera, of the Canary Islands, found in roadside in evergreen Laurel forest,

Figure 4. The river in Holmvassdalen flows partly in a canyonlike valley, keeping moisture in the air constantly high. Photo: J. Lorås.

between leaves and moss (Wölfel and Noordeloos 2001, Noordeloos 2004). Occurrence in roadside implies that the habitat is a result of human impact, but still large areas of evergreen forest on the island are largely natural than cultural (Nogue et al. 2013). Other findings in Europe are very few, but one from Catalonia, Spain in 1996 was recorded on decayed wood in humid deciduous wood of *Laurus nobilis* and *Osmunda regalis* (Vila 2005). In Russia: Primorsky Territory, Kedrovaya Pad Nature-reserve, *E. gomerense* was found on soil and decayed wood in a flood plain forest (Noordeloos and Morozova 2010).

The habitats in Holmvassdalen seem to differ at key points from those of the other areas (Noordeloos 2004). Firstly, Laurel forest is subtropical, with high humidity and rather constant, mild temperatures thus very unlike the environment in Holmvassdalen, which has seasonal climatic variations as a marked feature. In this area long winters with much snow and short summers are characteristic. It seems that this condition could significantly compensate for the constant high humidity at the localities on La Gomera. This also applies to finds in the flood plain forest in Russia Primorsky Territory and Catalonia, both having a much more humid and milder climate than in Holmvassdalen.

Secondly, the species of trees and vegetation are a very diverge factor. Deciduous forest dominates all described habitats except those of Holmvassdalen, where old spruce forest is typical, mixed with a few birches. The vegetation of vascular plants on the locations is not described for finds outside Holmvassdalen. In this area the habitats of *E. gomerense* are


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Figure 5. Habitat for *E. gomerense* with *Aconitum lycoctonum ssp. septentrionale*, in old calcerous spruce forest. The fern *Athyrium filix-femina* is displacing *Aconitum lycoctonum* ssp*. septentrionale,* which now is about to be decimated due to trampling. Photo: J. Lorås.

characterized by dominance of the tall-herb *Aconitum lycoctonum* ssp. *septentrionale*. This tall-herb seems to have an important ecological function, as it has large leaves protecting against dehydration (Lorås and Eidissen 2011).

Thirdly, it is remarkable that the other finds have no references to calcareous soil, which must be regarded as essential to the habitats in Holmvassdalen. Probably *E. gomerense* in boreal spruce forests is rather calciphilous, confined to limestone habitats. We assume that habitats of the same type as in Holmvassdalen are typical for the species at its northern border. However, to obtain more secure conclusions about habitat ecology further recordings and more precise descriptions of vegetation, humidity etc. in the close vicinity of the finds are necessary.

Threats

Entoloma gomerense undoubtedly seems to be depended of calcareous habitats in its boreal locations. This type of habitat, moist spruce forest on calcareous ground, is threatened by modern forestry and other ecological changes, resulting in a less moist and less stable microclimate (Brandrud et al. 2010). Unfortunately, *Aconitum lycoctonum* ssp. *septentrionale* is vulnerable to trampling, because of a fragile tall stalk (Arnesen and Lyngstad 2012). As a result especially the fern *Athyrium filix-femina* is displacing *Aconitum lycoctonum* ssp. *septentrionale,* which is about to be decimated in Holmvassdalen Nature Reserve (Fig. 5). Loss of species richness may then take place. Therefore further mapping and monitoring of rare species should be made to implement effective management.

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Annulohypoxylon minutellum and *Obolarina dryophila* (Xylariales), two stromatic pyrenomycetes on oak new to Norway

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Norsk tittel: *Annulohypoxylon minutellum* og *Obolarina dryophila* (Xylariales), to store pyrenomyceter på eik nye for Norge

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

KEYWORDS
Ascomycota, pyrenomycetes, Sordariomycetes, Xylariales, *Quercus*

NØKKELORD
Sekksporsopper, pyrenomyceter, kjernesopper, stubbehornordenen, eik

SAMMENDRAG

Sekksporsoppene *Annulohypoxylon minutellum* (Syd. & P. Syd.) Y.M. Ju, J.D. Rogers & H.M. Hsieh og *Obolarina dryophila* (Tul. & C. Tul.) Pouzar rapporteres her for første gang i Norge. *Annulohypoxylon minutellum* er ny for Skandinavia mens *O. dryophila* tidligere er funnet i Sverige og i Danmark. Disse to artene ble funnet på grener på et nylig fallent eiketre i Gullkronene naturreservat i Vestfold. Deres økologi og nomenklatur kommenteres.

ABSTRACT

The ascomycetes *Annulohypoxylon minutellum* (Syd. & P. Syd.) Y.M. Ju, J.D. Rogers & H.M. Hsieh and *Obolarina dryophila* (Tul. & C. Tul.) Pouzar are reported as new to Norway. *Annulohypoxylon minutellum* is new to Scandinavia while *O. dryophila* was previously found in southern Sweden and in Denmark. Both species were found on branches attached to a recently fallen oak in Gullkronene nature reserve in Vestfold.

INTRODUCTION

Ascomycetes of the order Xylariales are important as wood-decayers, parasites and endophytes in woody plants. Despite this their occurrence and distribution are poorly known in many countries, including Norway. During a workshop on pyrenomycetes in Tønsberg in October 2013 a visit was made to Gullkronene Nature Reserve, a forest dominated by beech and old oaks. On a fallen oak I made the first Scandinavian find of *Annulohypoxylon minutellum* (Xylariaceae) and the first Norwegian find of *Obolarina dryophila* (Xylariaceae). The two species, which are large and easy to identify already in the field, are presented here together with notes on their ecology and nomenclature.

Annulohypoxylon minutellum, Figs. 1 and 2.

Description

Stromata cushion-formed, peltate, circular or ellipsoid in outline, (5-) 8-15 mm in diameter and 3-5 mm thick, surface dark brick to blackish. Pigments in KOH vinaceous red. Perithecial contours relatively inconspicuous. Perithecia spherical to ellipsoidal, 400-500 µm in diameter and 500-750 µm high. The papillate ostioles lack a surrounding disc. Asci 130-170 µm × 4-5.5 µm, with inamyloid apical ring, 1.5 µm high and 2 µm broad.

Figure 1. Habitat of *Annulohypoxylon minutellum* and *Obolarina dryophila* in Gullkronene nature reserve, Tønsberg, Vestfold. Both species were found on branches ca 10 cm in diameter. *Annulohypoxylon minutellum* can be seen on the lowermost horizontal branch. *O. dryophila* was found on the uppermost branch but is hardly visible in this picture. Photo: B. Nordén.

Ascospores light brown to brown, ellipsoid-inequilateral, 6.7-8.5 × 3.3-4.5 µm, with perispore dehiscing in 10% KOH. Germ slit short and inconspicous. The material was overripe and asci were found in just one perithecium. The species may be confused with *A. multiforme*, which however never grows on oak and has conspicuous perithecial mounds, olivaceous pigments in KOH, and larger ascospores.

Nomenclature
Annulohypoxylon minutellum (Syd. & P. Syd.) Y.M. Ju, J.D. Rogers & H.M. Hsieh, Mycologia 97(4): 859 (2005). Basionym: *Hypoxylon minutellum* Syd. & P. Syd. 1910. Synonym: *Hypoxylon cohaerens* var. *microsporum* J.D. Rogers & Cand., Mycologia 72: 826 (1980).

Ecology and distribution
Annulohypoxylon minutellum is found on dead branches and trunks of *Quercus robur.* In continental Europe it also occurs on *Castanea sativa* and in other parts of the world it has a broader host range. It is known from Great Britain, France, Portugal, Spain, as well as from India, Taiwan, Colombia, Honduras and Mexico.

Figure 2. Close-up of stromata of *A. minutellum* on the same oak branch as in Fig. 1. Photo: J.B. Jordal.

Material studied

Norway. Vestfold: Tønsberg, Gullkronene nature reserve, near the top of Lille Gullkronen on coarse branches attached to a fallen oak, 59°17'8"N, 10°22'58"E, alt. 30 m. 25.10.2013, leg. B. Nordén (to be placed in O).

Obolarina dryophila, Figs. 3 and 4.

Description

Stromata crust-like, black, 4-70 mm long, 5-20 mm broad and 1-1.3 mm thick, when young covered by a black epistromatic membrane. Perithecia ampulliform 600-1000 µm × 300-400 µm. Asci 52-77 × 10-15 µm, without apical apparatus or with a very faint subapical non-amyloid apical ring. Ascospores, uni- to biseriate, ellipsoidal to bean- or boat-shaped, greyish brown, 13-19 µm × 5-8 µm, with a long helicoid germ-slit, and sometimes with 1 or 2 air guttules. For a more detailed description and a drawing of microcharacters, see Nordén and Sunhede (2001).

Ecology and distribution

Obolarina dryophila develops between the bark and cambium on very recently dead oaks and soon becomes effete. It can be spotted by the black spore deposits (Fig. 3) or in cracks in the bark. The species is known from Sweden, Denmark, France, Czech Republic, and Lithuania.

Nomenclature

Obolarina dryophila (Tul. & C. Tul.) Pouzar; Pouzar, Z, Česká Mykologie 40: 7 (1986). Basionym: *Nummularia dryophila* Tul. & C. Tul.; Tulasne L.R. & Tulasne C, Selecta fungorum carpologia (Paris) 2: 47 (1863). Synonym: *Biscogniauxia dryophila* (Tul. & C. Tul.) Kuntze, (Xylariaceae), Revis. gen. pl. (Leipzig) 2: 398 (1891).

This species was placed in the monotypic genus *Obolarina* due to the lack of an apical apparatus and the presence of a helicoid germ slit (Pouzar 1986). Ju et al. (1998) showed that the species has affinities with *Biscogniauxia* (Xylariaceae), and this was later confirmed by Pažoutová et al. (2010). It should be considered if the species should be treated in *Biscogniauxia*. As the oldest name is *Biscogniauxia dryophila* (Tul. & C. Tul.) Kuntze no new combination would be needed.

Material studied

Obolarina dryophila

Norway. Vestfold: Tønsberg, Gullkronene nature reserve, near the top of Lille Gullkronen on coarse branches attached to a fallen oak log, 59°17'8"N, 10°22'58"E, alt. 30 m. 25.10.2013, B. Nordén . The description is based on material from Sweden (see Nordén and Sunhede 2001) as the Norwegian specimen was relatively old and not in perfect shape.

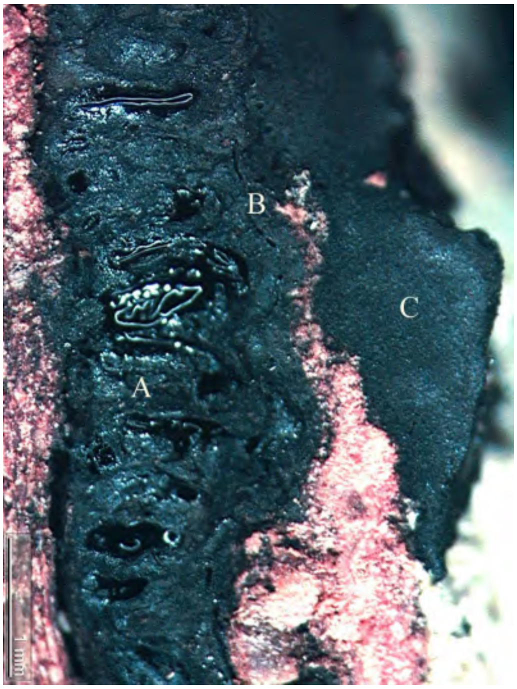

Figure 3. *Obolarina dryophila,* vertical cut through a living stroma situated under the bark of a recently dead oak. A. Perithecial layer. B. Epistromatic membrane. Nordén. C. Sporemass exuded through a crack in the bark. Photo: B. Nordén.

Figure 4. *Obolarina dryophila* stroma on an oak branch, partly covered by the bark. Photo: C. Reisborg.

ACKNOWLEDGMENTS

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Requienella seminuda, a corticolous ascomycete on *Fraxinus excelsior* new to Norway

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Norsk tittel: *Requienella seminuda*, en sekksporsopp på barken av asketrær ny for Norge

Nordén B., Jordal J.B., 2014. *Requienella seminuda*, a corticolous ascomycete on *Fraxinus excelsior* new to Norway. Agarica, vol. 35: 29-34.

KEYWORDS
Bark-living fungi, ash, temperate deciduous forest, broadleaved forest

NØKKELORD
Barklevende sopp, ask, edellauvskog

SAMMENDRAG

Den pyrenomyket-lignende sekksporesoppen *Requienella seminuda* (Eurotiomycetes, Pyrenulales, Requienellaceae) presenteres. Arten er kjent fra Europa og Nord-Amerika, men er ny for Norge och Sverige. Den ble først funnet på Grinde, Leikanger i Sogn og Fjordane i 2011, og i løpet av 2012-2013 fant vi den på 15 nye lokaliteter i Sør-Norge fra Akershus til Sogn og Fjordane. Alle funnene var på bark av gamle, levende asketrær, og den synes ofte å være assosiert med sjeldne eller rødlistede lav.

SUMMARY

The pyrenomycetous ascomycete *Requienella seminuda* (Eurotiomycetes, Pyrenulales, Requienellaceae) is presented. The species is known from Europe and North America but was not previously reported from Norway and Sweden. The first find in Norway was made in Grinde, Leikanger, Sogn og Fjordane in 2011 and during 2012-2013 we found 15 additional localities in different parts of southern Norway from Akershus to Sogn og Fjordane. It was growing on bark of old living *Fraxinus* trees, often in association with rare or red-listed lichenized fungi.

INTRODUCTION

Many species of non-lichenized ascomycetes occur on the bark of living trees as saprobes or weak parasites. In general, the communities of such species are not well known, as they tend to be neglected by most mycologists. We here present a species which is widespread on trunks of ancient *Fraxinus excelsior* (Oleaceae), but has previously not been reported from Scandinavia, *Requienella seminuda* (Pers.: Fr.) Boise. *Requinella seminuda* belongs to the family Requienellaceae in the Pyrenulales, Eurotiomycetes (Lumbsch and Huhndorf 2009).

MATERIALS AND METHODS

Collections of *Requienella seminuda* were attained during various field surveys in temperate deciduous forest and woodlands, both in Norway and Sweden. Only the Norwegian finds are treated in detail here. Positions were taken in UTM (WGS84, zone 32) with handheld GPS with an accuracy of +/- 10 m. The collections were studied using Nikon dissecting and light microscopes, and the description is based on the Norwegian

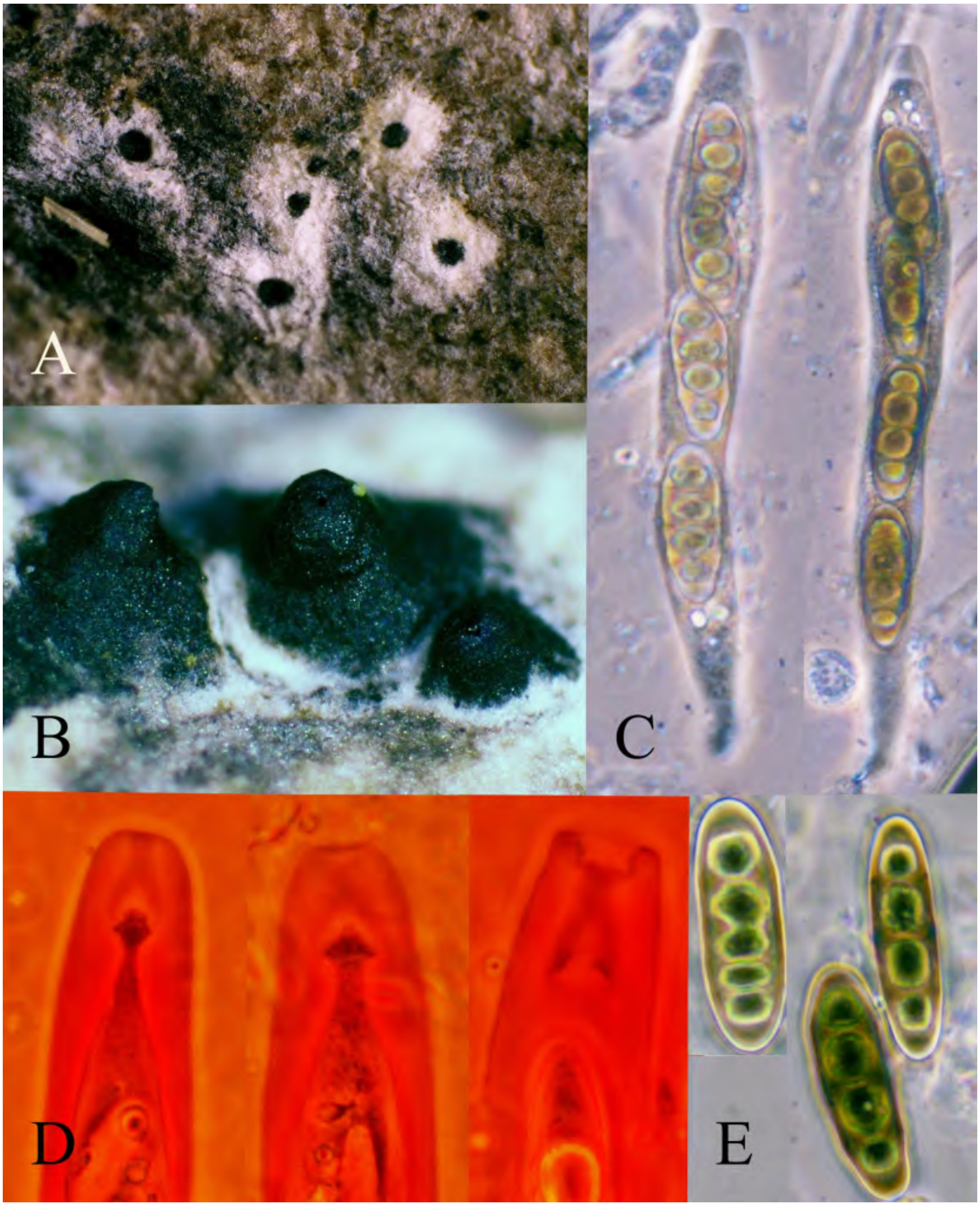

Figure 1. *Requienella seminuda* on bark of *Fraxinus excelsior* from the localities Hordaland: Os: Lio. (A-B) and Sogn og Fjordane: Leikanger: Grinde (C-E). A. Immature ascomata. B. Mature ascomata. C. Asci. D. Ascus tops in Kongo red. Two developmental stages are illustrated, the two ascus tops on the left being younger than the one on the right. E. Ascospores. C and E were photographed using phase contrast. See text for measurements. Photo B. Nordén.

material. Microscopic slides were mounted in water unless otherwise stated. Photographs were taken with Nikon digital cameras. The names of the collectors are abbreviated as BN (Björn Nordén), HB (Harald Bratli) and JBJ (Jon Bjarne Jordal). The specimens will be deposited in herbarium O (Norwegian collections) and in GU (Swedish collections).

Description

Ascomata 0.5-1 mm in diameter, subglobose, with a broad-based pointed papilla with a central ostiole, dispersed/scattered or clustered a few together, black; immersed at first, growing just below the bark surface, appear like a black spot surrounded by a white ring (Fig. 1A), later they break through the bark and finally become visible with half the ascocarps/fruit bodies ranging above the bark surface (Fig. 1B). **Asci** 143–163 × 14–19 µm, cylindrical to narrowly fusoid (Fig. 1C), with a complex apical apparatus (Fig. 1D). **Pseudoparaphyses** 2-3 µm wide, unbranched and septate. **Ascospores** 4-8 per ascus, obliquely uniseriate, 25-35 × 9-12 µm, ellipsoid, 3-5-distoseptate with lenticular, spherical or rhombical lumina, brown (Fig. 1E).

Habitat, substrate and distribution

We first discovered the species in Norway during field investigations in Grinde, Leikanger municipality, Sogn og Fjordane County in 2011. Subsequently it was found to be widespread in forests and woodlands with old *Fraxinus* trees.

Requinella seminuda was growing on rough bark of old, living *Fraxinus* trees, both pollarded and unpollarded, in several different habitats (Fig. 2, Table 1). The circumference of the host trees ranged between 120-390 cm 1.3 m above the ground (n=48 trees). The species was found up to at least 2-2.5 m above the ground. Other corticolous, non-lichenized pyrenomycetous ascomycetes on the trees were for instance *Kirschsteiniothelia aethiops* (Berk. & M.A. Curtis) D. Hawksw., *Lophiostoma myriocarpum* Fuckel and *Navicella pileata* (Tode: Fr.) Fabre. The trees typically had a rich flora of other saprophytic and lichenized fungi, some of which are red-listed in Norway.

Figure 2. Habitat of *Requienella seminuda*, living bark of an old *Fraxinus excelsior* in Hordaland: Etne: Frettestranda. Photo J.B. Jordal.

We found *Requinella seminuda* at 16 sites from Akershus in southeastern Norway, north to Sogn og Fjordane in western Norway. The sites were 3-370 m above sea level and belong mainly to the boreonemoral to southern boreal vegetation zones (Moen 1999), in a few cases bordering the middle boreal zone. The climate varies from weekly to strongly oceanic (sections OC to O3t according to Moen 1999). 75% of the trees were growing on hillsides facing against south or west. The distribution seems to indicate a southern species, but may also be limited by the distribution of *Fraxinus* trees, which become much rarer north of Sogn og Fjordane.

Table 1. Norwegian localities of *Requienella seminuda*. In localities with more than one tree, positions are given as ranges. Abbreviations: UTME=east-coordinate, UTMN=north-coordinate.

County	Municipality	Locality	Habitat	Date	UTME	UTMN	Leg
Akershus	Bærum	Bjørum northeast	seminatural grassland, on bark of four pollarded *Fraxinus excelsior*	21.09. 2012	580750-580799	6644955-6645143	BN
Akershus	Bærum	Tanumbråten north	tall herb broadleaved forest, on bark of six pollarded Fraxinus excelsior	20.09. 2012	582335-582381	6640222-6640318	BN
Hordaland	Bømlo	Spyssøya, Stølsvika south	low herb broadleaved forest, on bark of one unpollarded and one pollarded *Fraxinus excelsior*	11.05. 2013	295859-295865	6626480-6626486	BN, JBJ
Hordaland	Etne	Frettestranda	scree, on bark of two pollarded and one unpollarded *Fraxinus excelsior*	08.05. 2013	340071-340296	6623454-6623506	BN, JBJ
Hordaland	Etne	Lunda	wooded meadow, on three pollarded *Fraxinus excelsior*	15.05. 2013	339736-339755	6624684-6624881	JBJ
Hordaland	Fusa	Femangerlia	scree, on one pollarded *Fraxinus excelsior*	25.05. 2013	320417	6669372	BN, JBJ
Hordaland	Kvinnherad	Alsåker east	scree, on six unpollarded *Fraxinus excelsior*	02.10. 2013	335131-335360	6628780-6628884	BN, JBJ
Hordaland	Odda	Buer east	tall herb broadleaved forest, on two unpol-larded *Fraxinus excelsior*	03.10. 2013	359629-359572	6659165-6659195	BN, JBJ
Hordaland	Os	Lio	low herb broadleaved forest, on five pollarded *Fraxinus excelsior*	24.05. 2013	309677-309761	6682237-6682369	BN, JBJ
Rogaland	Sauda	below Smelvenuten	low herb broadleaved forest, on bark of one pollarded *Fraxinus excelsior*	05.10. 2012	354030	6617824	BN, JBJ
Rogaland	Strand	Fiskåneset east	wooded meadow, on bark of one pollarded *Fraxinus excelsior*	08.10. 2012	328071	6556960	BN, JBJ
Rogaland	Strand	Rag	wooded meadow, on bark of two pollarded *Fraxinus excelsior*	03.10. 2012	326098-326116	6555340-6555365	BN, JBJ
Rogaland	Strand	Vatland	low herb broadleaved forest, on bark of one unpollarded and two pollarded *Fraxinus excelsior*	08.10. 2012	325722-325735	6555448-6555574	BN, JBJ
Rogaland	Tysvær	Pyttane	low herb broadleaved forest, on bark of two unpollarded *Fraxinus excelsior*	14.05. 2013	319060-319096	6582091-6582167	JBJ
Sogn og Fjordane	Leikanger	Grinde, upper	wooded meadow, on one pollarded *Fraxinus excelsior*	09.09. 2011	378396	6785930	JBJ, HB
Sogn og Fjordane	Leikanger	Eitorn	wooded meadow, on six pollarded *Fraxinus excelsior*	15.06. 2012	372739-372930	6788715-6788829	BN, JBJ

Several collections of the species were earlier made in southern Sweden by the first author, from the provinces Blekinge, Småland, Öland, Bohuslän, Västergötland and Västmanland. The species is new also to Sweden (Eriksson 2014).

DISCUSSION

According to Boise (1986) the spores can be 3-7-septate, in our material they were mostly 3-5 septate. *R. seminuda* may be restricted to *Fraxinus* in Scandinavia as we have searched for it in vain on hundreds of *Ulmus* and *Quercus* trees, and other substrates. However, there are indications that there may be different forms of this species or closely related species in other countries, growing on different substrates (Walter Jaklitsch in litt.). There are reports of the species from bark of living *Olea* (France), *Fraxinus*, *Nyssa* and *Quercus* (USA; Boise 1986). It is also known from Great Britain with only one record, on *Sambucus nigra* (British Mycological Society 2014). There exists a variation in the number of septa per ascospore among collections that may warrant genetic investigation, and work on this is underway (Walter Jaklitsch in litt.).

A species with similar spores, *Acrocordiella occulta* (Romell) O. Eriksson, occur on *Ribes*. An old record on *Ribes grossularia* from Sweden was cited by Boise (1986) who together with Barr (1990) considered it a synonym of *R. seminuda*. However, subsequent authors (and Barr in litt., see Hausknecht et al. 2003) have refuted this ((Eriksson and Hawksworth (1986: 115 - Note 4); Harris (1995: 93); Eriksson & Hawksworth (1996: 104 - Note 2026); Hausknecht et al. (2003)).

Eriksson (2014; under *Acrocordiella*) suggested that *Melanomma seminudum* (Fuckel) Sacc. (non *Sphaeria seminuda* Pers.: Fr) recognized by Holm (1957: 59) should be compared to *R. seminuda* as it might be conspecific. However, *Melanomma seminudum* (Fuckel) Sacc. has smaller (200-300 µm in diameter) crowded ascomata, ellipsoid to cuneiform spores with median constriction and normal spore lumina, that are clearly smaller (11-15 × 4.5-5 µm) than in *R. seminuda*, and was found on *Alnus*, *Betula* and *Quercus* in Sweden (Holm 1957).

As *Requinella seminuda* is easily recognized in the field and fairly common on old *Fraxinus* trees in Sweden and Norway, it is somewhat surprising that it was not discovered earlier. If it, as it appears, is restricted to old *Fraxinus* trees, it may be in decline due to the ongoing ash dieback that now occur in most of the distribution of *Fraxinus* in Norway, as are several lichenized fungi on *Fraxinus* in Great Britain (Ellis et al. 2013).

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Marine fungi new to Norway, with an outlook to the overall diversity

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NØKKELORD
DNA-strekkoding, ITS, taksonomi, nye arter, vedboende sopper, Ascomycota, marine sopper

SAMMENDRAG
Havsopper er lite undersøkt i Norge. I denne undersøkelsen rapporterer vi 17 nye arter for Norge og DNA referansesekvenser (barkoder) for syv arter marine sopper. Dessuten gir vi en oversikt over innsatsen som hittil er blitt gjort i landet innen marin mykologi. Totalt er 61 arter marine sopper funnet i landet siden 1895. Sju av disse er blitt beskrevet som nye for vitenskapen, på bakgrunn av norsk materiale. Molekylære undersøkelser tyder imidlertid på en mye større diversitet. Ved å undersøke flere forskjellige habitater og substrater i framtiden, både med morfologiske og molekylære metoder, forventer vi å finne hundrevis av havsopparter i Norge.

ABSTRACT
Marine fungi are severely understudied in Norway. In this survey we publish 17 species new to Norway and DNA reference sequences (barcodes) for seven species of obligate marine fungi. Moreover, we review previous marine mycological efforts in Norway, and compile the first check list of Norwegian marine fungi. Based on temporally and spatially unevenly distributed records, altogether 61 species of obligate marine fungi have been found in Norway since 1895, including seven species described as new to science. However, recent molecular studies on wood-inhabiting marine fungi indicate that a much greater diversity exists. By examining a wide range of habitats and substrates, both with morphological and molecular methods, we expect that thousands of fungi can be detected in Norwegian marine habitats in future. These are likely to include hundreds of obligate marine species.

INTRODUCTION

The coastline of Norwegian mainland measures approximately 25,000 km in length (including fjords and islands) and ranges from the southern tip at N 57°57’ to the north at N 71°11’, and from the western point at E 04°56’ to the east at E 31°03’ (CIA 2014). In addition, the remote archipelago in the Arctic, Svalbard (N 76°28’–80°49’, E 10°31’–36°47’) and Jan Mayen (N 70°49’–71°09’, W 9°04’–7°57’) belongs to Norway. These vast areas include a wide number of different marine environments, providing habitats for a high diversity of various organisms. Fungi living in marine and estuarine habitats are among the poorest studied organisms in marine environments, so also for Norwegian waters. Fungi that are exclusively found growing and sporulating in the marine milieu are termed obligate marine fungi, whereas the terrestrial or freshwater species that can grow (and perhaps also sporulate) in marine waters are called facultative marine species (Kohlmeyer 1974). Many terrestrial species are frequently isolated from marine environments as well, and these are often referred to as marine-derived fungi (Jones 2011a). Most of the filamentous obligate marine fungi, more than 500 species, belong to the phylum Ascomycota, whereas only 12 members of Basidiomycota are known worldwide (Jones et al. 2009). A high number of yeasts belonging to either Ascomycota or Basidiomycota, and also some lower fungi in Chytridiomycota, Neocallimastigomycota and Blastocladiomycota are known to be obligatory inhabitants of the marine environment (Fell 2012, Jones and Pang 2012), but these are out of the scope of this article.

Barghoorn and Linder (1944) made pioneering work on marine fungi, focusing mainly on their taxonomy and diversity. In Norway, the first collection of a marine fungus was made in 1895, when the Swedish botanist Nils Gustaf Lagerheim collected a fungus on *Triglochin maritima* in Kåfjord (Alta), North Norway, which Rehm later described as *Pleospora maritima* sp. nov. (Rehm 1896). The current name of the species is *P. triglochinicola* J. Webster (Webster 1969). The next records were made more than a half century later, in the 1960s (Eriksson 1964, Jones et al. 1972, Eriksson 1973, Schaumann 1975). In the 1970s, the Kohlmeyers visited Espeland (Espegrend) marine biological station in Bergen by the North Sea and sampled algae and wood-inhabiting fungal species. In the 1980s, two fish pathogenic species were reported, but both were found only from fish raised in tanks (Langvad 1989, Pedersen and Langvad 1989). During the following decade, no marine fungi were reported from Norway due to limited research activity. Ryvarden's (1994, 2010) observations on driftwood-inhabiting Basidiomycota in Finnmark were made in upper parts of the shore, and the corticoids found represent terrestrial fungi fruiting on substrates outside the intertidal zone. The cold waters in the north of Norway attracted Pang et al. (2011) to chase arctic species in the first decade of this century. The most recent efforts have focused on wood-inhabiting species in northern waters using culturing techniques as well as DNA sequencing (Rämä et al. 2014b, Rämä et al. in prep.). Not many DNA-based surveys have been conducted on marine fungi (but see e.g. Zuccaro et al. 2003, Lai et al. 2007, Gao et al. 2008, Zuccaro et al. 2008, Nagano et al. 2010). The rDNA Internal Transcribed Spacer (ITS) region has been selected as the official DNA barcoding region for fungi (Schoch et al. 2012), but a limited number of ITS reference sequences are available from marine environments in databases such as BOLD, UNITE and GenBank (Ratnasingham and Hebert 2007, Abarenkov et al. 2010, Benson et al. 2014). Hence, there is a great need for more ITS reference sequences from marine environments that can be used in future DNA-based surveys, including high throughput sequencing of environmental samples.

In this study a number of marine fungi new to Norway are reported based on morphological studies of sporulating structures. Moreover, earlier efforts to map and record marine fungi in Norway are summarized, and all currently known species from Norway are listed.

MATERIALS AND METHODS

Study material

Small pieces of driftwood with fungal structures were collected in the intertidal zone on shore or retrieved from sea bottom in mainland

Norway and Svalbard. Altogether 150 wood pieces were obtained from 70 substrates. In addition, few random collections from plant and algal material onshore were studied. The fungal structures, mainly representing ascomata, were examined using a Leica MZ16 dissecting microscope and Leica DM2500 light microscope. The material is kept in herb TROM.

For some species DNA was obtained from the collected specimens using a modified cetyltrimethylammonium bromide extraction protocol (Murray and Thompson 1980) according to Mysterud et al. (2007). The primer pairs ITS5-ITS4 (White et al. 1990) and LR0R-LR5 (Vilgalys and Hester 1990, Rehner and Samuels 1994) were used to amplify the ITS and the approximately 900 bp first part of the LSU region. The target regions were amplified using the Illustra PuReTaq Ready-To-Go PCR beads (GE Healthcare, Buckinghamshire, UK) following the manufacturer's instructions. The amplifications were performed on a PTC-0200 DNA engine (MJ Research, Waltham, Massachusetts, USA). The PCR program consisted of an initial 3 min denaturation step at 94 °C, followed by 40 cycles of 30 s at 94 °C, 30 s at 52 °C (annealing) and 1 min at 72 °C (synthesis), and termination with a 10 min elongation step at 72 °C. Negative controls were included in order to detect possible contaminations, and positive PCR products were verified on 1 % agarose gels stained with GelGreen Nucleic Acid Gel Stain (Biotum, Hayvard, California, USA), using Superladder-Low 100 bp Ladder (Thermo Fisher Scientific, Surrey, UK) as a standard size marker. The gels were photographed under an UV-transilluminator. PCR products were cleaned using 0.25 units of ExoSAP-IT (Affymetrix, Santa Clara, CA, USA) for 6 µl of PCR product. Samples were incubated 30 min at 37 °C for degrading remaining primers and nucleotides followed by 15 min incubation at 80 °C to inactivate ExoSAP-IT. Sequencing reactions were performed on an Applied Biosystems 3730 DNA analyzer (Foster City, CA, USA) in BigDye Terminator sequencing buffer using PCR primers as sequencing primers and the BigDye Cycle Sequencing kit v3.1 (Applied Biosystems, Foster City, California, USA). The samples were subjected to capillary electrophoresis on an Applied Biosystems 3730 DNA analyser.

Examined databases and literature

Records of marine fungi from Norway were extracted from various literature sources (see references in Table 2), the Kohlmeyer Marine Fungi database maintained by New York Botanical Garden (http://www.nybg.org/) and the Norwegian Mycological Database (NMD 2014) which includes information on the vast majority of Norwegian herbarium specimens. Moreover, we searched for records in the fungal collections in the herbaria of Bergen (BG) and Tromsø (TROM). The fungal nomenclature follows Index Fungorum (2014), and herbaria codes Index Herbariorum (Thiers 2014). Authors of taxon names are provided in Online documentation 1. The term obligate marine fungi is used to refer to species listed in Jones et al. (2009), *Hypocrea schweinitzii* (Fr.) Sacc. found growing and sporulating on wood in the intertidal zone, and to marine species described as new to science after 2009.

RESULTS

Based on morphological examinations of the collected material, 28 different species of marine fungi were detected in this survey (Table 1). Out of these, 17 species were new to Norway, including one undescribed species to science (Table 1). One species was recorded from an algae and one other on plant material, all the others were wood-inhabiting. *Digitatispora marina* Doguet (Fig. 1) was the only basidiomycete fungus found. The records made in Svalbard include three species only known from the arctic waters, *Havispora longyearbyenensis* K.L. Pang & Vrijmoed, *Remispora spitsbergenensis* K.L. Pang & Vrijmoed and *Rostrupiella* sp. nov. Otherwise, the records include common species occurring in temperate waters, such as *Lulwoana uniseptata* (Nakagiri) Kohlm., Volkm.-Kohlm., J. Campb., Spatafora & Gräfenhan, *D. marina*, *Lulworthia* sp., *Sphaerulina orae-maris* Linder, *R. maritima* Linder, *Halosphaeria quadri-remis* (Höhnk) Kohlm. and *Corollospora maritima* Werderm., which has a cosmopolitan distribution (Jones 2011b). ITS and LSU reference sequences (DNA barcodes) were generated from seven of the collected marine taxa (indicated in Table 1, Fig. 1) and accessioned in GenBank (accession numbers KM272359–KM272371).

Table 1. Species detected in this study based on morphological studies of fungal material, mainly ascomata. Species recorded as new to Norway are indicated by (n). ITS and LSU reference sequences were generated from species indicated by (s).
[A] leg. Alfred Granmo; [B] not included in Jones et al. (2009)

Species	County	Substrate	Date
Amylocarpus encephaloides (s)	Troms	unknown wood	10.03.2010
Asteromyces cruciatus (n, s)	Finnmark	*Betula* sp.	15.08.2010
Cf. *Byssothecium obiones* (n)	Svalbard	unknown wood	15.07.2011
Capronia ciliomaris (n)	Troms	*Betula* sp.	08.06.2010
Ceriosporopsis circumvestita	Troms	*Betula* sp.	30.09.2010
Cf. *C. circumvestita*	Troms	*Betula* sp.	07.06.2010
Cf. *C. halima*	Troms	broadleaved tree	16.05.2010
Corollospora comata (n)	Finnmark	unknown wood	18.08.2010
C. luteola (n)	Finnmark	*Betula* sp.	15.08.2010
C. maritima (n, s)	Østfold	*Betula* sp.	01.09.2011
Digitatispora marina (n, s)	Troms	*Betula* sp.	07.06.2010
Cf. *Eiona tunicata* (n)	Finnmark	*Pinus* sp.	05.09.2010
Halokirschsteiniothelia maritima (s)	Troms	*Pinus* sp. (not *P. sylvestris*)	07.06.2010
Halosphaeria pileata (n)	Svalbard	unknown wood	01.10.2012
H. quadri-remis (n)	Troms	*Pinus* sp. (not *P. sylvestris*)	07.06.2010
Havispora longyearbyenensis	Svalbard	unknown wood	15.07.2011
Hypocrea schweinitzii[B] (n)	Østfold	unknown wood	01.09.2011
Laetinaevia marina[A]	Troms	*Ascophyllum nodosum*	09.11.2011
Lulwoana uniseptata	Finnmark	*Pinus sylvestris*	18.08.2010
Lulworthia sp. (s)	Finnmark	*Pinus sylvestris*	14.10.2010
Naïs inornata (n)	Troms	unknown wood	07.06.2010
Cf. *Phialophorophoma litoralis* (n)	Troms	unknown wood of old dock	09.08.2010
Remispora maritima	Troms	unknown wood	07.06.2010
R. spitsbergensis	Svalbard	unknown wood	01.10.2011
R. stellata (n, s)	Svalbard	sea-floor wood	04.10.2011
Rostrupiella sp. nov. (n)	Svalbard	sea-floor wood	07.10.2011
Sphaerulina orae-maris (n)	Troms	plant stem on wood	25.07.2012
Cf. *Tubakiella galerita* (n)	Svalbard	unknown wood	04.10.2011

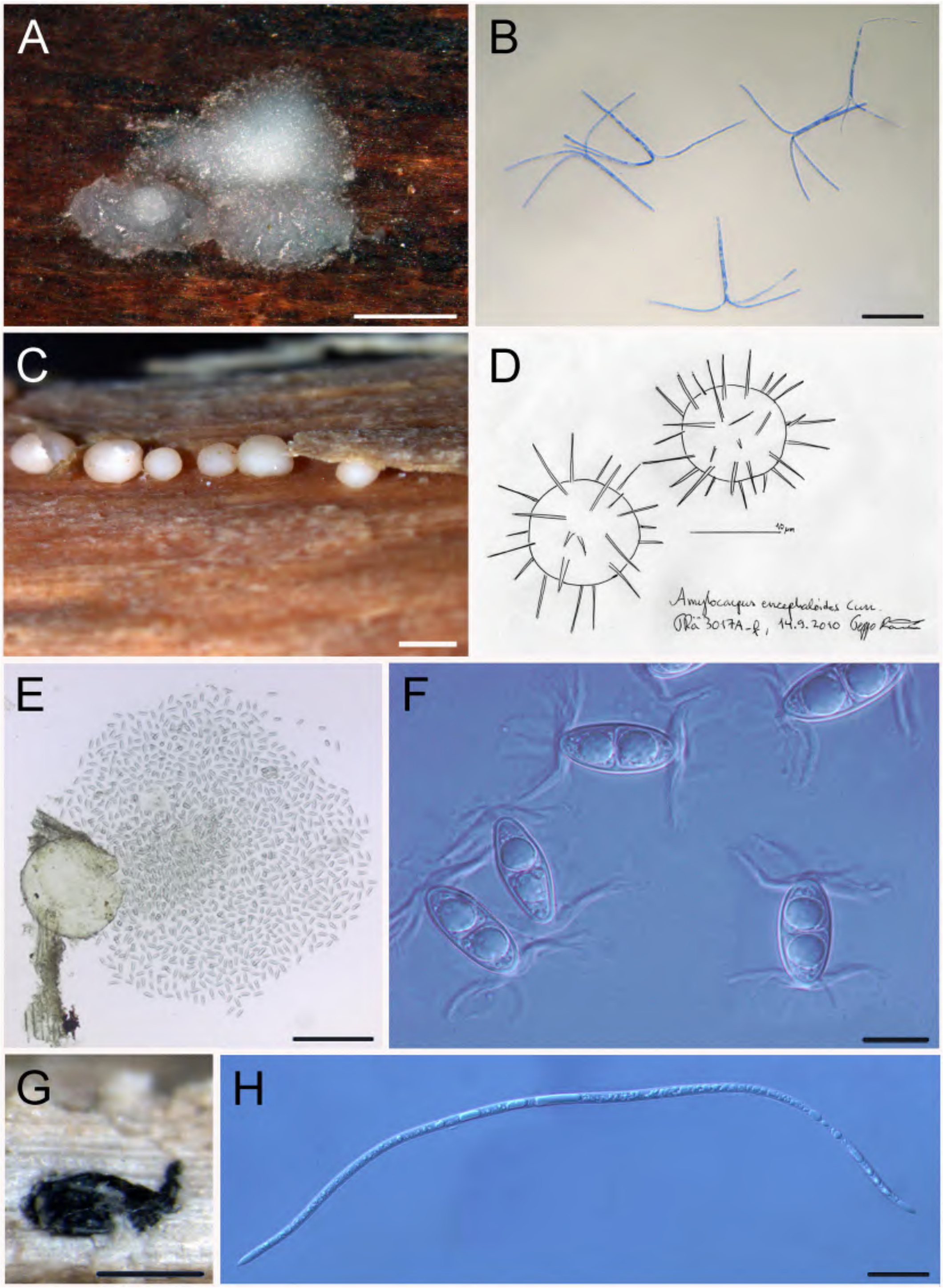

Figure 1. Some species of barcoded marine fungi. A) *Digitatispora marina*, basidioma on wood, B) spores stained with cotton blue in light field (lf); C) *Amylocarpus encephaloides*, ascomata on wood, D) drawing of two spores with stiff spines; E) *Remispora stellata*, globose ascoma with wood residuals and spores in lf, F) close-up of spores with moustache-like appendages, differential interference contrast (DIC); G) *Lulworthia* sp., ascoma immersed in wood, H) a spore in DIC. Bars=20 µm (B, F, H), =ca. 200 µm (E, G), =ca. 1,000 µm (A, C).

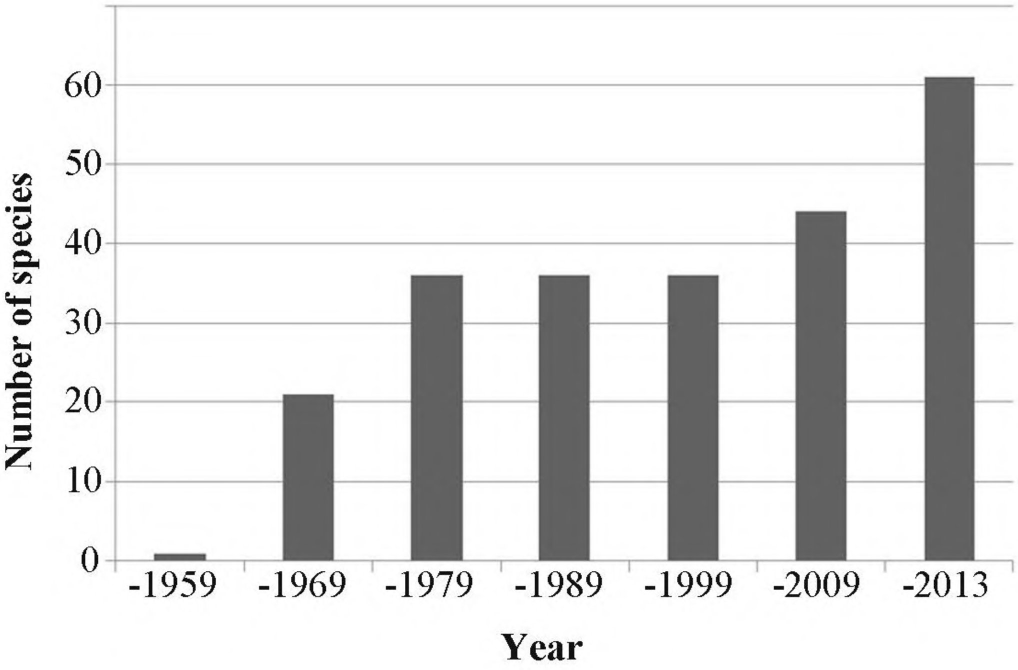

Figure 2. Accumulation of new species of obligate marine fungi recorded from Norway.

Based on literature and database records of marine fungi, an overview of previously recorded marine fungi from Norwegian waters was compiled (Table 2). *Lulworthia* and *Stagonospora* were the most frequent genera detected with five taxa in each. All species belong to Ascomycota. All records, except the ones from fish raising tanks, were made by foreign mycologists.

Combining the records from the current study (Table 1) with results from previous studies (Table 2) gives altogether 61 species of obligate marine fungi that has been found in nature in Norway. Seven of these have been described from Norway as new to science (indicated in Table 2), and several remain undescribed (Table 1 and 2). Sixty-nine percent of the records are from wood and 20 % on/in different species of algae. The records are unevenly distributed in time and space. Most records of marine fungi in Norway were made in 1960s, when altogether 20 new species were recorded (Fig. 2). During the following decade 15 new species to Norway were reported, whereas in 1980s and 1990s no records were made in natural habitats. During this century altogether 25 new species have been recorded. The records are concentrated in four counties in the south and three in the north, and most records, 16 in total, have been made in Hordaland County (Fig. 3).

DISCUSSION

Records of marine fungi

With the results from this survey included, the number of records of morphologically identified obligate marine fungal species adds up to 61. The number of species found in Norway is lower than in other surveyed countries (Hyde 1988, Koch and Petersen 1996, Pang and Jheng 2012), where typically about 100 species of obligate marine fungi are registered when the study focus has been in one or few types of substrates. The lower

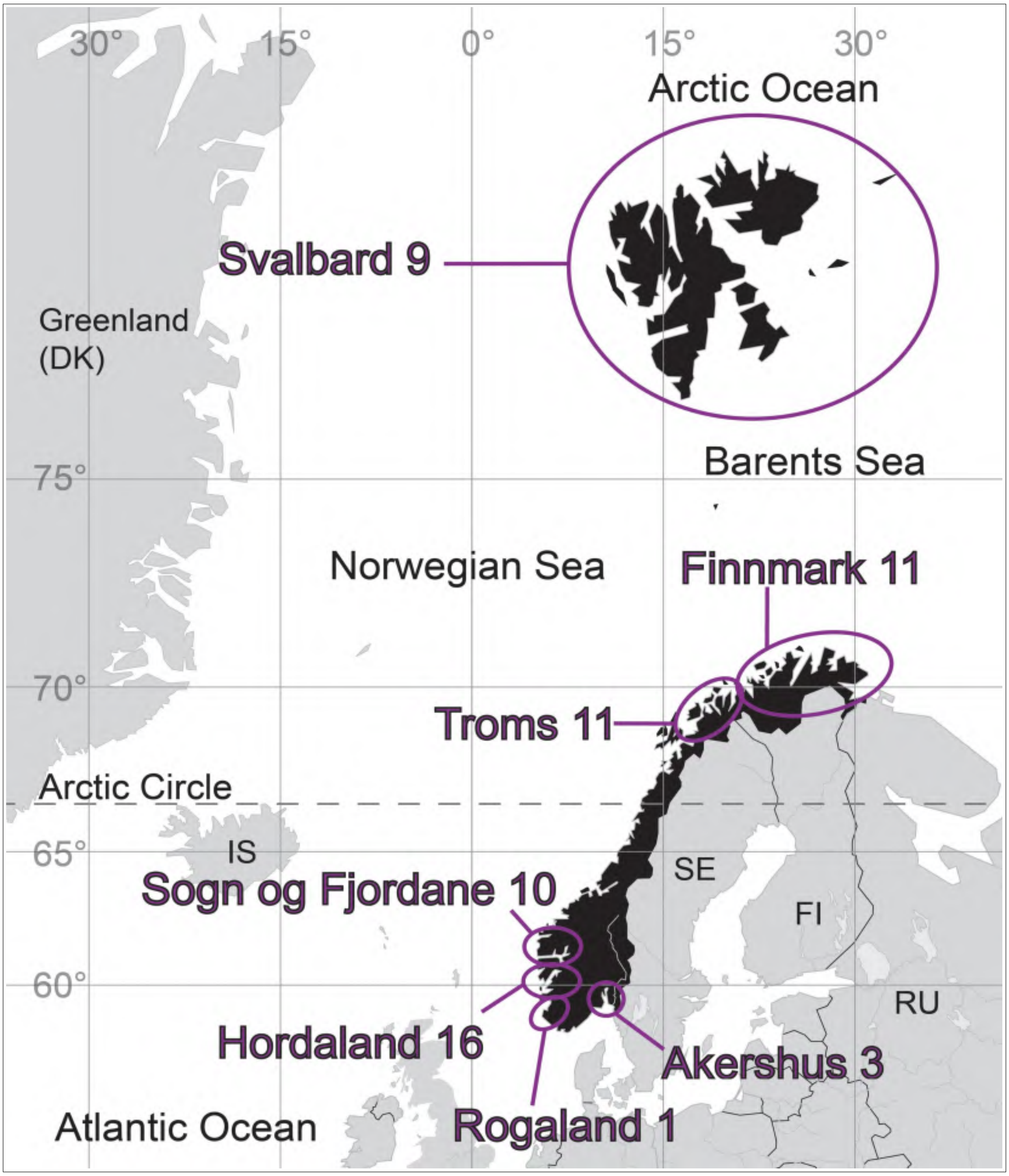

Figure 3. Norwegian records of obligate marine fungi. Counties are circled and their name is followed by the number of species recorded in Norway for the first time.

number of fungi detected in Norway is due to low temporal and spatial sampling intensity. Norwegian marine fungi have not been studied systematically until very recently (Rämä et al. 2014b), and notably, only non-Norwegian mycologists have worked with this group of fungi previously. The earlier records from 1960s represent single obser-

Table 2. Marine fungi recorded in Norway before the current study. The table shows first records of each species.
[A] record possibly made on Russian side of the border in the Barents Sea; [B] not included in Jones et al. (2009); [C] recorded only in fish tanks; [D] type specimen; [E] collected as *Stagonospora abundata* Kohlm. & Volkm.-Kohlm.; [F] on *Laminaria digitata*

Species	County	Substrate	Date	Reference
Amylocarpus encephaloides	Troms	driftwood	10.08.2006	Pang et al. 2011
Aspergillus spp[A]	Finnmark	wood	X/1969	Schaumann 1975
Ceriosporopsis circumvestita	Troms	driftwood	10.08.2006	Pang et al. 2011
C. halima	Sogn og Fjordane	wooden panels	1968-1969	Jones et al. 1972
Cirrenalia macrocephala	Sogn og Fjordane	wooden panels	1968-1969	Jones et al. 1972
Cremasteria cymatilis	Sogn og Fjordane	wooden panels	1968-1969	Jones et al. 1972
Didymella fucicola	Hordaland	*Fucus vesiculosus*	05.09.1972	Kohlmeyer Marine Fungi in NY
Exophiala angulospora[B, C]	West-Norway	*Gadus morhua*	unknown	Gjessing et al. 2011
E. psychrophila[B, C]	Møre og Romsdal	*Salmo salar*	1987	Pedersen & Langvad 1989
Halokirschsteiniothelia maritima	Sogn og Fjordane	wooden panels	1968-1969	Jones et al. 1972
Halosphaeria tubulifera[A]	Finnmark	wood	X/1969	Schaumann 1975
Havispora longyearbyenensis[D]	Svalbard	driftwood	12.08.2006	Pang et al. 2011
Humicola alopallonella	Sogn og Fjordane	wooden panels	1968-1969	Jones et al. 1972
Laetinaevia marina	Troms	*Fucus* sp.	15.07.1962	Eriksson 1973
Lentescospora submarina[A, B]	Finnmark	wood	X/1969	Schaumann 1975
Lindra inflata	Sogn og Fjordane	wooden panels	1968-1969	Jones et al. 1972
Lulwoana uniseptata	Sogn og Fjordane	wooden panels	1968-1969	Jones et al. 1972
Lulworthia floridana	Akershus	wooden panels	1968-1969	Jones et al. 1972
L. halima	Hordaland	leaf	06.09.1972	Kohlmeyer Marine Fungi in NY
L. purpurea	Sogn og Fjordane	wooden panels	1968-1969	Jones et al. 1972
L. sp.[A]	Finnmark	wood	X/1969	Schaumann 1975
L. sp. nov.	Svalbard	driftwood	12.08.2006	Pang et al. 2011
Microascus trigonosporus[B]	Hordaland	bottom sediment	09.10.1969	Schaumann 1975
Monodictys pelagica[A]	Finnmark	wood	X/1969	Schaumann 1975
Nectriella laminariae[D]	Rogaland	*Laminaria* sp.	18.05.1963	Eriksson 1964
Phaeosphaeria sp.	Troms	driftwood	12.08.2006	Pang et al. 2011
Pharcidia laminariicola[D]	Hordaland	*Ectocarpus fasciculatus*[F]	05.09.1972	Kohlmeyer 1973
P. rhachiana[D]	Hordaland	epiphytic lichen	05.09.1972	Kohlmeyer 1973
Phoma herbarum[B, C]	unknown	fish	1980-1989	Langvad 1989
P. sp. - taxon A	Hordaland	-	05.09.1972	Kohlmeyer Marine Fungi in NY
P. sp. - taxon B	Hordaland	-	05.09.1972	Kohlmeyer Marine Fungi in NY
Phycomelaina laminariae	Hordaland	-	06.09.1972	Kohlmeyer Marine Fungi in NY
Pleospora pelvetiae	Hordaland	*Pelvetia canaliculata*	05.09.1972	Kohlmeyer 1973
P. triglochinicola[D]	Finnmark	*Triglochin maritima*	VII/1895	Rehm 1896

Remispora maritima	Hordaland	driftwood	05.09.1972	Kohlmeyer Marine Fungi in NY
R. spitsbergensis[D]	Svalbard	driftwood	10.08.2006	Pang et al. 2011
Sablicola chinensis	Troms	driftwood	12.08.2006	Pang et al. 2011
Paradendryphiella salina	Sogn og Fjordane	wooden panels	1968-1969	Jones et al. 1972
Stagonospora haliclysta[D, E]	Hordaland	*P. canaliculata*	05.09.1972	Kohlmeyer 1973
Aff. *S. abundata* - taxon B[E]	Hordaland	*P. canaliculata*	05.09.1972	Kohlmeyer Marine Fungi in NY
Aff. *S. abundata* - taxon C[E]	Hordaland	*P. canaliculata*	05.09.1972	Kohlmeyer Marine Fungi in NY
Aff. *S. abundata* - taxon D[E]	Hordaland	*P. canaliculata*	05.09.1972	Kohlmeyer Marine Fungi in NY
Aff. *S. abundata* - taxon E[E]	Hordaland	*P. canaliculata*	05.09.1972	Kohlmeyer Marine Fungi in NY
Stemphylium sp.[A]	Finnmark	wood	X/1969	Schaumann 1975
Stigmidium ascophylli	Hordaland	*P. canaliculata*	05.09.1972	Kohlmeyer Marine Fungi in NY
Torpedospora radiata	Sogn og Fjordane	wooden panels	1968-1969	Jones et al. 1972
Cf. *Zalerion varia*	Svalbard	driftwood	12.08.2006	Pang et al. 2011

vations (Eriksson 1964, 1973) and studies partly made outside Norwegian waters (Jones et al. 1972, Schaumann 1975). Jones et al. (1972) used test panels of Scots pine (*Pinus sylvestris*) submerged in the sea and surveyed them for fungi 12 times during one year of submersion, which resulted in total 11 species of Ascomycota and Basidiomycota. Schaumann (1975) attended research cruises on the North Sea and Barents Sea and observed in total 12 taxa on wood and in sediments. Records from the 1970s represent results from a short study visit. During two days, the Kohlmeyers observed altogether 15 species of marine fungi (Kohlmeyer 1973; http://www.nybg.org/). Pang et al. (2011) initiated the first study focusing on Norwegian Arctic waters. The results of this small survey on wood-inhabiting fungi include descriptions of two new species to science (Pang et al. 2008, 2009) and observations of at least one undescribed species (Pang et al. 2011). The present study represents a continuation of this work focusing on marine wood-inhabiting fungi in the northern waters along mainland Norway and around Svalbard. The 17 new species that were recorded included also one undescribed species from Svalbard. Based on morphological and sequence data (Rämä in prep.) we conclude that this species belongs to the recently described genus *Rostrupiella* (Koch et al. 2007).

The spatial distribution of marine fungal records shows that the 40 year-old studies were predominantly made in the south of the country, whereas most of the records from the 21st century are made in the northern parts of the country. The areas in central parts of Norway that lack records should obviously also be studied. These areas support diverse marine flora and fauna, including most of the known coral reefs in Norwegian waters (MAREANO 2014), and are likely to host many new fungi to Norway and to science. The results of Pang et al. (2011) and the current study indicate that the arctic waters around Svalbard should be studied more thoroughly, as more undescribed species are likely to be found there.

Most of the taxa found in Norway are temperate water species, but the list includes also cosmopolitans such as *Corollospora maritima* and *Cirrenalia macrocephala* (Kohlm.) Meyers & R.T. Moore (Hughes

1974, Jones 1993, Jones 2011b), and some most likely arctic species, like *Remispora spitsbergenensis* and *Havispora longyearbyenensis* (Pang et al. 2011). The vast majority of the records are made from wood and one fifth from algae in on-shore habitats. Other substrates include sea-bottom sediment and fungi living on dead plants. However, none of these substrates can be considered well studied in Norway. Consequently, new species to Norway can be found on all kinds of substrates. However, permanently submerged habitats and substrates in temperate and arctic waters of Norway are likely to host most unknown fungal diversity. These habitats and substrates, which include organic material in the deep-sea, cold water corals, sponges and other marine animals, are laborious and costly to survey for morphological fungal structures, and are therefore also poorly studied at a global level (Jones 2011b).

Numbers of marine fungi in Norway

The studies reviewed here are based on morphological identification since the 1890s. Together they provide a much lower number of species than in recent molecular studies carried out in the same area (Rämä et al. 2014b). The culturing-based study by Rämä et al. (2014b) estimated that 250 operational taxonomic units (OTUs) occurred on 50 driftwood logs, based on 97 % similarity clustering of ITS sequences. It was also demonstrated that some OTUs consisted of several phylotypes, suggesting that the diversity would be even higher. Similarly, the high throughput sequencing of fungal DNA from wood samples collected from the same substrate units (Rämä et al. in prep.) indicated that the logs hosted a significantly higher total diversity. Using 97 % sequence similarity in ITS2 as OTU definition, 807 OTUs were detected and approximately 1,400 OTUs were estimated to exist in driftwood along the north Norwegian mainland coast. In both studies, approximately half of the OTUs detected using DNA analyses have affinity to non-marine taxa (Rämä et al. 2014b, Rämä et al. in prep.) and might turn out to be marine-derived terrestrial species.

Indeed, many terrestrial species have been discovered in the marine environment throughout the history of marine mycology (Elliott 1930, Siepmann and Johnson 1960, Shearer 1972), and these are not listed among the obligatory marine fungi (Jones et al. 2009). The list of Jones et al. (2009) includes 530 species which are identified morphologically and are found sporulating in the sea. By taking into account additional species detectable with molecular methods, such as unculturable species, cryptic species and marine-derived fungi, a global estimate of 12,000 marine fungi has been proposed (Jones and Pang 2012). It is obvious that molecular techniques will also inflate the number of species known from Norway even further. Most likely, thousands of species can be revealed the years to come, if a wide selection of substrata can be studied using a combination of DNA analyses and microscopy of fruiting bodies. A relevant question to ask is how many of these will be obligate or facultative marine? RNA-based environmental sequencing studies can be used to reveal the active community (cf. Rajala et al. 2011, Baldrian et al. 2012). However, more intensive sampling, culturing, DNA barcoding and phylogenetic reconstructions are needed to identify OTUs more accurately and to solve whether they represent truly marine species or terrestrial fungal species able to survive in the sea.

CONCLUSIONS

Throughout the history, limited efforts have been made in studying richness of marine fungi in Norway. Moreover, the efforts that have been done are unevenly distributed in time and space. Due to the hitherto infrequent sampling, new species to Norway can be recorded with limited efforts, and using modern DNA sequencing methods in combination with other methods, their number could be multiplied in the future. More effort should be put to RNA based studies revealing the active marine fungal community, the true marine fungi.

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Four uncommon hairy discomycetes (Ascomycota, Pezizales) from Norway

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KEYWORDS
Ascomycota, Pezizales, Pyronemataceae, *Tricharina*, *Wilcoxina*, *Cheilymenia*, *Spooneromyces*

NØKKELORD
Ascomycota, Pezizales, Pyronemataceae, *Tricharina*, *Wilcoxina*, *Cheilymenia*, *Spooneromyces*

SAMMENDRAG

Fire mindre kjente hårbevokste discomyceter (Pyronemataceae, Pezizales) rapporteres fra Norge: *Tricharina ascophanoides* og *Cheilymenia fraudans* fra Torp, Fredrikstad, *Wilcoxina rehmii* fra Kråkerøy ved Fredrikstad og Asmaløy i Hvaler, samt *Spooneromyces laeticolor* fra Forra naturreservat i Nord-Trøndelag. Beskrivelser og illustrasjoner følger sammen med økologiske data.

ABSTRACT

Four less common hairy discomycetes (Pyronemataceae, Pezizales) are reported from Norway: *Tricharina ascophanoides*, and *Cheilymenia fraudans* from Torp, Fredrikstad, *Wilcoxina rehmii* from Kråkerøy, Fredrikstad and Asmaløy, Hvaler, besides *Spooneromyces laeticolor* from Forra nature reserve, Nord-Trøndelag. Descriptions and illustrations are provided along with their ecological data.

INTRODUCTION

The four present species all belong to the family Pyronemataceae (Perry et al. 2007). The genus *Tricharina* was erected by Eckblad (1968), because the genus *Tricharia* was a late homonym of a lichen genus. In the extensive monograph by Yang and Korf (1985 b) *Tricharina* was split into two genera, *Tricharina* emend. and the new genus *Wilcoxina* (Yang and Korf 1985 b).

We are speaking of five species in the genus *Tricharina* in the Nordic countries (Hansen and Knudsen 2000), but thirteen worldwide (Lindemann 2013). The rarest is *T. ascophanoides,* earlier mentioned briefly by Yang and Kristiansen (1989) from Torp, Fredrikstad as a new species to the Scandinavian peninsula, but never characterized. Preceding that paper Yang and Korf (1985a) had erected the anamorph genus *Ascorhizoctonia* for the telemorph *Tricharina*. However, they did not succeeded in obtaining an anamorph on the material they had. Shortly after, however, I consulted Chin Yang as I had several collections of *Tricharina* collected 1982, and three of them turned out to be *T. ascophanoides*. Dr. Yang managed to get one of my collections in culture on agar medium and the anamorph was described as *Ascorhizoctonia ascophanoides* (Yang and Kristiansen 1989). *Tricharina* is probably saprobic.

The genus *Wilcoxina* can be distinguished from *Tricharina* by its morphology and structure, like habitus, hairs, asci, ascospores and habitat (Yang and Korf 1985 b), and it seems as *Wilcoxina* species are mycorrhizal in association with pinaceous conifers, and my two collections are both with conifers. Species of *Tricharina*, however, occurs differently, like burnt ground or clayey soil, while *T. ascophanoides* prefer rotten paper, dead or rotten wood of *Salix*, *Fagus*, small twigs of *Quercus* according to Kirk and Cooper (2014), based on several findings in UK.

The genus *Cheilymenia* is a large and complex genus which comprises 38 species world-wide, mostly coprophilous with a few terrestrial, and is a cosmopolitan genus. Most of them prefer excrements of herbivores with some carnivores.

The genus became highly improved by the detailed monograph of Moravec (2005), which enabled us to better identify the different species.

Thirteen different species are registered from Norway and the majority are coprophilous except for the terrestrial *Cheilymenia vitellina*, and the two subalpine-alpine species *C. chionophila* and *C. sclerotiorum* originally described by Schumacher (1992) and Schumacher and Mohn Jensen (1992).

Spooneromyces was erected by Schumacher and Moravec (1989) to accomodate Karsten's *Peziza laeticolor* (Karsten 1870) from Mustiala in Finland, described as a medium sized, reddish hairy discomycete. The genus comprises two species in Scandinavia: *S. laeticolor* and *S. helveticus* (Olariaga and Hansen 2011).

In the following the four species are described in more details provided with comments.

MATERIALS AND METHODS

Microscopical characters were observed using squash-mounts in both water and Cotton Blue in lactic acid, and Melzer's reagent, on living and dried material.

***Tricharina ascophanoides* Yang & Korf**

Fig. 1, 2 a, b. c.

Figure 1. *Tricharina ascophanoides*. Ascocarps *in situ*. Scale bar 6 mm. Photo R. Kristiansen.

Icones

Boudier 1908 pl. 351
Engel & Häffner, Pilztafel 1986, nr. 53, fig. 200
Dougoud 2002, p. 41
Lindemann 2013, p. 43

Synonyms

Ascorhizoctonia ascophanoides Chin S. Yang & R. Kristiansen 1989.
Ryparobius ascophanoides Sacc. 1892.
Tricharia ascophanoides Boud. 1903.
Helotium ascophanoides (Boud.) Sacc. & Traverso 1910.
Pachydisca ascophanoides Boud.
Lachnea ascophanoides (Boud.) Sacc. & D. Sacc. 1905.

Description

Apothecia shallowly cupulate to disc-like and finally convex, light brown, pale brownish orange to ochraceous brown, 3-6 mm diameter, gregarious. Receptacle beset with hyaline hairs, which are pointed, multiseptate, and thin-walled. Marginal hairs 250-300 x 7-9 µm.

Hymenium: 180-250 µm thick.

Asci 8-spored, cylindrical, narrow toward the base, 150-90 x 10-18 µm.

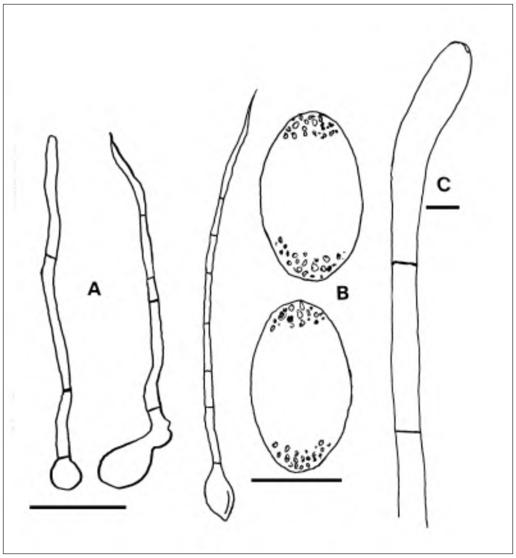

Figure 2. *Tricharina ascophanoides*. A: Marginal hairs, scale bar 50 µm. B: Ascospores, with strong granules, scale bar 10 µm. C: Tip of paraphyse, scale bar 5 µm. Ill. R. Kristiansen.

Ascospores ellipsoid, uniseriate, smooth, aguttulate, but when mature with fine polar granules, hyaline, 14-16 x 9-11 µm.
Paraphyses slender, septate, hyaline, slightly tapering at apex to 5-6 µm, irregular and partly curved.

Habitat

On rotten wood and wet or burnt balls of cellulose.

Material examined

Østfold, Fredrikstad, Borge, Torp. Among mosses growing on wet and/or burnt balls of cellulose in a rubbish dump, 3.07.1982 (RK 145/82); ibid (RK 146/82); ibid. (RK 148/82); ibid. (RK 151/82). 59° 14' 26.01" N 11° 0' 38.20" E Herb. CSY ex RK82.146, TRH, CUP, K, PRM, S.

Comments

All four collections where found on the same day, all within a diameter of 4 to 5 meter, and they turned out to be the same species. Several other operculate discomycetes occurred in the same spot, like *Tricharina gilva, T. ochroleuca, Pulvinula constellatio, Chalazion helveticum* (Kristiansen 1991) *Trichophaea paludosa,* and *Trichophaeopsis bicuspis* (Kristiansen 1985).

The samples were sent to Dr.Yang, who succeeded to produce a culture of the anamorph *Ascorhizoctonia ascophanoides*, described by Yang and Kristiansen (1989).

The species is characterised by its relatively inconspicuous hairs, but is easily recognized by being colorless, as well as its large ascospores with distinct polar granules.

Yang and Korf (1985b) mentioned only *T. ascophanoides* from the Czech Republic and France, but it has later been recorded in Sweden (Eriksson 2009), United Kingdom (Kirk and Cooper 2014), Switzerland (Dougoud 2002), and Germany (Engel and Häffner 1986, Lindemann, 2013).

An updated key to the *Tricharina* species is published by Lindemann (2013).

Wilcoxina rehmii Yang & Korf

Fig. 3, 4 a, b, c.
Norwegian name: Mørkhåret lurvebeger.

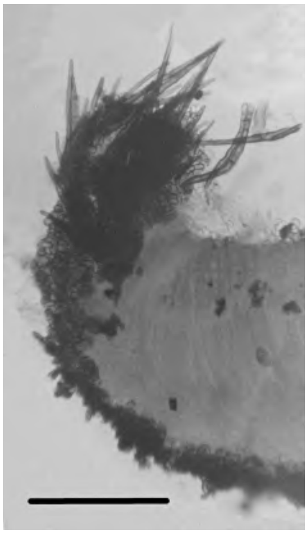

Figure 3. *Wilcoxina rehmii.* Part of median thin section showing marginal hairs, scale bar 1 mm. Photo: R. Kristiansen.

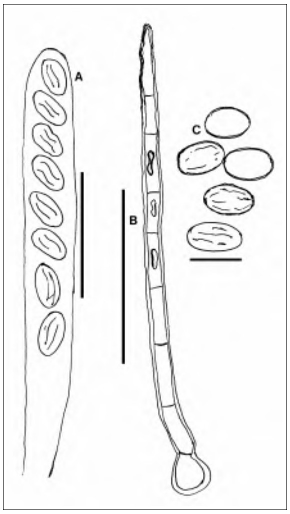

Figure 4. *Wilcoxina rehmii*. A: Asci with spores, scale bar 50 µm. B: marginal hair, scale bar 100 mm. C: Ascospores, scale bar 15 µm. Ill. R. Kristiansen.

Icones

Dougoud 2002, p.42.

Synonyms

Humaria gilva (Boud. in Cooke) Sydow, 1884.
Humaria melaloma (Alb. & Schw.:Fr.) Kanouse, 1947.
Lachnea gilva (Boud. in Cooke) Rehm, 1895.

Description

Apothecia occurs gregarious, at first subglobular, then expanded and become turbinate to shallowly cupulate, rarely 2 mm diameter, 1-1.5 mm high, centrally attached, sessile.

Hymenium grey to greyish white, receptacle brown beset with golden brown hairs.

Asci cylindric, narrow toward base, 8-spored, 220-250 x 11-12 µm.

Ascospores ellipsoid, smooth, 12-14 x 7-8 µm, and usually lined up in the upper part of the ascus.

Paraphyses straight, slender, septate, equal or slightly enlarged at apex to 2-3 µm.

Hairs pointed or blunt at apex, up to 350 x 10-15 µm, septate.

Habitat

On rich soil, forming mycorrhiza in association with pinaceous conifers.

Material examined

Østfold, Fredrikstad, Kråkerøy, Fuglevik. In a slope with exposed shell bed close to a spruce forest with minor *Salix* and *Betula*, 10.06. 1982 (RK 122/82); ibid. 06.07.1985. Associated with *Pulvinula constellatio, Trichophaea hybrida* and *Helvella queletii*. 59° 11' 16.41" N. 10° 56' 55.25" E.

Østfold, Hvaler, Asmaløy, Enerstad. Beneath *Pinus sylvestris* on black soil among *Anemone nemorosa, Hepatica nobilis*, and cherries in a garden, 3.07.1988 (RK 88/03); ibid. 29.06. 1989 (RK 89/26). 59° 3' 58.20" N 10° 56' 12.02" E Herb. CUP.

Comments

This species is previously reported from Rana in Nordland by Yang and Korf (1985 b), collected by Dissing, Sivertsen and Erlandsen several times in the period 1972-1975 (Herb. TRH). Originally found in Germany 1885; later reported from France, Italy, Canary Island (Yang and Korf 1985b) and Switzerland (Dougoud 2002).

This is the most common species in the genus *Wilcoxina*, which comprises three species, and all seem to fruit in the same site for more than one season as Yang and Korf (1985b) emphasized, which is confirmed in the present paper from both locations.

Phylogenetic analyses shows that *Wilcoxina rehmii* and *Tricharina ascophanoides* are not closely related. There are differences in the arrangement of the excipular hairs, excipulum structure, proportion of the asci occupied by spores, etc., and the presence of anamorph referable to *Complexipes* C. Walker versus *Tricharina* with its *Ascorhizoctonia* anamorph (Perry et al. 2007). Interestingly, the common species *Trichophaea hybrida* forms a sister group to *Wilcoxina*.

Cheilymenia fraudans (P. Karst.) Boud.

Fig. 5, 6, 7 a, b. c.

Figure 5. Ascocarps of *Cheilymenia fraudans*. Field of view 3 cm. Photo: R. Kristiansen.

Fugure 6. Ascocarps of *Cheilymenia fraudans* (to the right) associated with *Iodophanus testaceus.* Field of view 4 cm. Photo: R. Kristiansen.

Icones

Moravec 2005, p.180-181.

Synonyms

Peziza fraudans P. Karst. 1871.
Peziza fraudans (P. Karst.) P. Karst., 1871.
Humaria fraudans (P. Karst.) P. Karst., 1885.
Neottiella fraudans (P. Karst.) Saccardo, 1889.

Description

Apothecia gregarious, first turbinate to subglobular becoming shallowly cupulate to discoid, sessile, 1-2 mm in diameter, 1-1.5 mm high. Hymenium yellow red to orange, outer surface and margin beset with inconspicuous pale hairs.

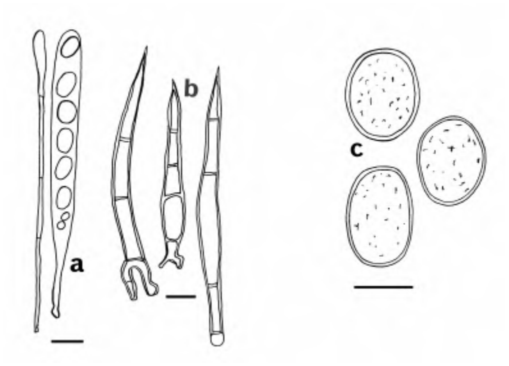

Figure 7. *Cheilymenia fraudans*. a: Ascus with spores and paraphyse, scale bar 2 µm. b: Marginal hairs, scale bar 20 µm. c: ascospores, scale bar 10 µm. Ill. R. Kristiansen.

Asci cylindric, 8-spored, some aborted, 200-250 x 17-20 µm with blunt apex and attenuated base.

Ascospores broadly ellipsoid, subglobose to almost globose, 13-15 x 10-12 µm, hyaline with yellow, refractive content; perispore sparsely covered with fine irregular cyanophilous short warts. deBary bubbles observed on fresh material.

Paraphyses filiform, straight, 3-4 µm wide, rarely septate, equal or slightly enlarged at apex to 8-9 mm, clavate or pyriform.

Marginal hairs short, 80-250 (300) µm, mixed with hyaline and light brown hairs, septate, irregularly curved or straight with pointed or blunt apex and rooting base.

Habitat

On rotten grass with green algae, cow dung.

Material examined

Østfold, Fredrikstad, Borge, Torp, close to Torp stadium. Growing on rotten grass with green algae mixed with sawdust and horse dung near heaps of waste from garden associated with *Iodophanus testaceus*, *Coprinus* sp. and *Conocybe* sp. 2.06.1982 (RK 103/82); ibid. 04.06.1982. 59° 14' 27.78" N 11° 0'

37.78 " E. Herb. J. Moravec, TRH.

Comments

Cheilymenia fraudans was first found by the Finnish mycologist P. A. Karsten in Finland in 1869. Today the species is known from United Kingdom, Switzerland, Italy, Spain, Taiwan and Norway as well as the type locality in Finland, and considered rare by Moravec (2005).

The apothecia of *C. fraudans* are of similar appearance as those of *C. rubra*, but are generally larger, at maturity more flattened and more similar to *C. stercoraria*. For further details, consult Moravec (2005).

Results of molecular and morphological analyses suggest a close relationship between *Cheilymenia* and *Spooneromyces* (Perry et al. 2007), as also suggested by Schumacher and Moravec (1989).

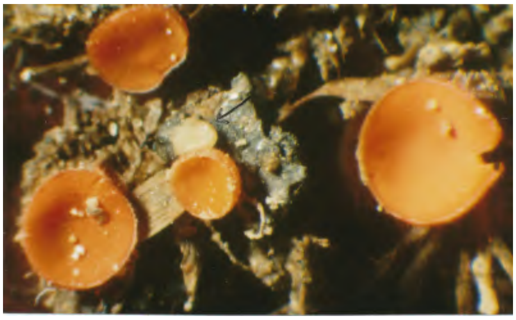

Figure 8. *Spooneromyces laeticolor.* Ascocarp *in situ*. Field of view 2 cm. Photo: R. Kristianen.

***Spooneromyces laeticolor* (P. Karst.) T. Schumach. & J. Moravec** Fig. 8, 9 a, b, c, 10.

Icones

https://www.sites.google.com/site/funghiparadise/ascomycota/pezizales/pyronemataceae/spooneromyces-laeticolor-p-karst-t-schumach-j-moravec-1989.

Olariaga and Hansen 2011.

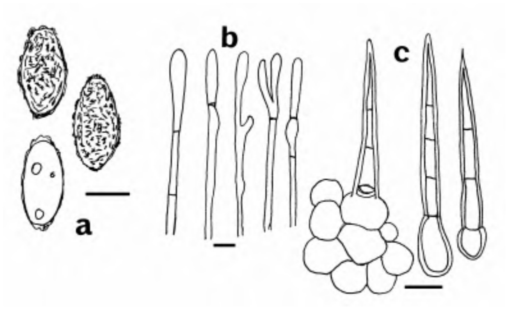

Figure 9. *Spooneromyces laeticolor*. a: Ascospores. Scale bar 10 µm. b: Different habit of paraphyses. Scale bar 5 µm. c: Excipular cells with hairs. Scale bar 50 µm. Ill. R. Kristiansen.

Synonyms

Peziza laeticolor P. Karst., 1870, non *Peziza laeticolor* Berk. & Br.1875.

Lachnea laeticolor (P. Karst.) Sacc. 1889.

Scutellinia laeticolor (P. Karst.) O. Kuntze, 1891.

Ciliaria laeticolor (P. Karst) Boud., 1907.

Melastiza laeticolor (P. Karst.) T. Schumach., 1988.

Melastiza asperula Spooner, 1981.

Description

Apothecia scattered, shallowly cupulate to discoid to flattened, sessile, 1-4 mm in diameter, 1-1.5 mm high. Hymenium and outer surface reddish orange to intensely red,

Figure 10. *Spooneromyces laeticolor.* Scanning electron micrograph of ascospore.

outer surface and margin beset with stiff brown hairs.

Asci cylindrical, 8-spored, 200-270 x 12-15 µm.

Ascospores uniseriate, ellipsoid, biguttulate, 19-24.5 x 9-12 µm excluding spore ornamentation, which appear in the form of warts and crests <1 µm high and 0.5 µm broad, slightly pointed ends, with crests interconnecting and forming a fine reticulum in SEM.

Paraphyses simple or rarely branched, slightly clavate at apices, 4-6 µm diameter, septate, filled with orange granules which turns greenish in Melzer's reagent.

Margin beset with brown scattered hairs, 200-250 (-350) x 18-24 µm, multi-septate, stiff, thick-walled, not forked at the base, arising from superficial excipular cells.

Habitat

On plant debris among pine and spruce needles in August - September.

Material examined

Sør-Trøndelag: Trondheim: Byneset, Onsøy, rotten grass on wet shaded grassland terrain in coniferous wood, ca 200 m asl, associated with *Trichophaea hybrida*, 09.08.1982. Herb. (O). Included in Schumacher and Moravec (1989). Co-ordinates unknown.

Nord-Trøndelag: Levanger: Roknesvollen, Forra naturreservat, 390 m asl, on sandy soil at the riverbank close to Heståa river, in spruce wood (RK 106/98), associated with the very rare *Trichophaea velenovskyi* (RK105/98), both 22.08.1998, and the rare *Pseudographis pinicola* on a dead branch of spruce. 63° 36' 36" N 11° 32' 52" E.

Comments

This species is known from 5 locations in Norway, from the counties of Akershus to Nord-Trøndelag.

Known from Finland (type), Denmark, England, France and Spain (Schumacher and Moravec 1989), Austria (Jeannerot 2010) and recently from Sweden (Olariaga and Hansen 2011). The latter is from Swedish Lappland and represents the northernmost occurrence, while the Norwegian locality in Nord-Trøndelag is fairly close to it.

In addition to *S. helveticus* (Schumacher and Moravec 1989) two additional new species have been assigned to *Spooneromyces*, *viz*. *S. microsporus* from Italy (Jamoni 2008), and *S. daliensis* in China (Zhuang 2005).

Schumacher and Moravec (*loc.cit*) noted the similarity of *Spooneromyces* to *Scutellinia* and *Cheilymenia*, and the molecular analyses by Perry et al. (2007) indicate a close relationship between *Spooneromyces* and *Cheilymenia*.

EPILOGUE

There are several genera (and species) within the family Pyronemataceae with hairy apothecia, although with clearly distinguishing characters. The large genus *Scutellinia* (Schumacher 1990) as well as the genera *Cheilymenia*, *Parascutellinia* and *Spooneromyces* all contain carotenoids with variable colors of red, orange and yellow of the ascocarps, while genera like *Trichophaea*, *Humaria*, *Leucoscypha*, *Trichophaeopsis*, as well as *Wilcoxina* and *Tricharina* mentioned herein have whitish or greyish ascocarps without carotenoids. Besides, there are clear differences in morphology, anatomy and ecology, and phylogenetic analyses have disclosed that they appear in different clades.

The present paper gives examples of four genera related to this subject.

Figure 11 shows the locations of the species from the Østfold county presented in this paper.

ACKNOWLEDGEMENT

I am indebted to Chin S. Yang, Prestige EnviroMicrobiology, Inc., NJ, USA for previous collaboration on *Tricharina* and *Wilcoxina*.

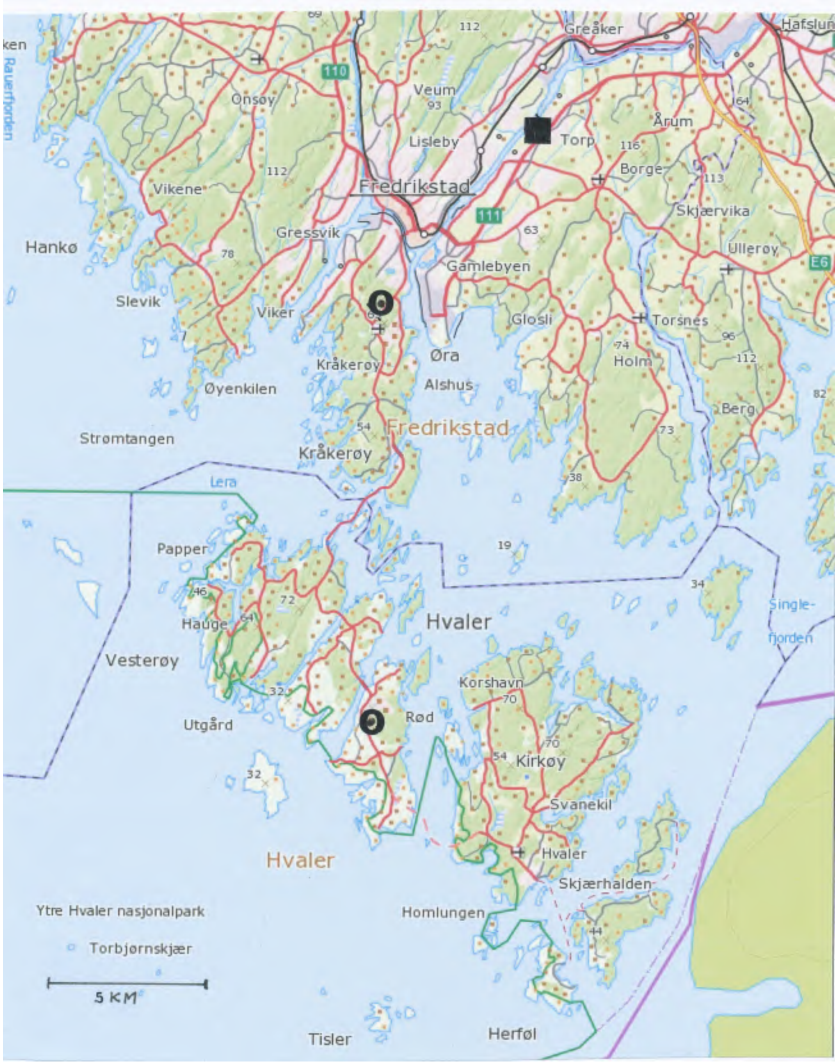

Figure 11. Location of *Tricharina ascophanoides* and *Cheilymenia fraudans* (square), and *Wilcoxina rehmii* (circles) in the vicinity of Fredrikstad, Østfold.

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Norwegian rust fungi - The genus *Frommeëlla*

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Norsk tittel: Norske rustsopper 1. Slekta *Frommeëlla* tepperotrust

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KEYWORDS
Frommea, Frommeëlla, Phragmidium, rust fungi, global warming, Uredinales, *Potentilla erecta*

NØKKELORD
Frommea, Frommeëlla, *Phragmidium*, rustsopp, global oppvarming, Uredinales, tepperot

SAMMENDRAG
Tepperotrust *Frommeëlla tormentillae* er den eneste arten av slekta *Frommeëlla* i Europa. Fram til 2008 var den kjent fra ni norske lokaliteter. I årene 2009-2013, fant forfatteren denne soppen på 38 nye lokaliteter. Soppen var tidligere en kandidat til rødlista, men er nå funnet å være relativt vanlig på deler av Østlandet. Siden tepperotrusten var sjelden på Ivar Jørstad (1887-1967) sin tid, må vi kunne anta at soppen har spredd seg mye de siste 50 årene. Da tepperotrust trenger en lang vekstsesong for å fullføre sin livssyklus, kan mildere vintre med lite snø og dermed lengre vekstsesong forklare dens frammarsj.

ABSTRACT
Frommeëlla tormentillae is the sole species in the genus in Europe. Up to 2008 it was known from nine Norwegian localities only. In five years, from 2009-2012, the author recorded this fungus from 38 new localities, and it should no longer be considered an endangered or rare species in Norway. It is suggested that this apparent increase in abundance is due to milder winters with less snow and consequently a longer growing season, since this fungus develops urediniospores in early autumn and teliospores in late autumn; in more alpine habitats it is not able to complete its life cycle.

INTRODUCTION

Occurrence of rusts in Norway is very well documented. According to Ryvarden and Høiland (1998) the rusts are the best known fungal group in Norway in that respect. Although many rusts were collected by Axel Blytt, Carl Størmer and others during the 18th century, our profound knowledge of this fungal group today is mainly due to the dedicated work by Ivar Jørstad (1887-1967), who collected rust fungi intensively from about 1915 to 1965 (Jørstad 1936, 1940, 1960, 1962, 1964). In the latter half of the 19th century Halvor B. Gjærum collected many rusts also. This means that it is unlikely to discover new native rusts in Norway today, although several rusts on introduced ornamentals and weeds have been discovered (Gjærum et al. 2007, Lye 2013) and a rust from eastern Asia has since the year 2000 attacked a native species (Gjærum et al. 2003). However, due to good documentation of the distribution of rusts in Norway, this group of fungi is much better suited than other fungal groups to reveal changes in the funga due to altered climate and changing land use.

According to previous records (up to 2008) *Frommeëlla tormentillae* (Fuckel) Cummins and Y. Hirats. [often named *Frommea obtusa* Arthur] was so rare i Norway that it could have been considered included in the Norwegian redlist of fungi. According to Jørstad (1962) and Gjærum (1974) it was rare and known from few scattered localities in South Norway from Kristiansand and Eidsberg in the south to Øyer and Grue in the north.

Frommeëlla tormentillae was first collected in Norway by A. Blytt, C. Stømer and A. Aasen in 1895 (Mysen in Østfold). The same year A. Blytt found the fungus in Drammen also, and in 1896 C. Størmer found the rust in Øyer in Gudbrandsdalen. In the years 1937 to 1958 I. Jørstad collected the fungus in five new localities in eastern Norway south of latitude 61° N, and also near Kristiansand in the extreme southern part of the country (Jørstad 1962). After 1958 *F. tormentillae* was not recorded from Norway until I started my investigations in 2009. This means no collections in the years 1897-1936 and 1959-2008 (our major collector of Norwegian rust fungi, Ivar Jørstad, died in 1967). However, in order to classify a fungus as endangered or redlisted, it is not sufficient that a taxon is known from few localities in the past and none at the present time. We need to know the present status through detailed active search. Whether the fungus is rarer at present than in the past, is an essential parameter for any work with endangered species.

MATERIALS AND METHODS

All collections of *Frommeëlla tormentillae* in the herbaria at the Natural History Museum, University of Oslo (O), the Norwegian Institute of Agricultural and Environmental Research, Ås (NPPI) and Tromsø Museum (TROM) were investigated. Thereafter I travelled widely, particularly in the autumn of 2009, to visit old as well as possible new localities for *F. tormentillae*, the sole Norwegian (and European) species in the genus *Frommeëlla.* Also details of uredinia, urediniospores, telia and teliospores were studied in the SEM microscope. Localities for *Frommeëlla tormentillae* in Norway are given in online appendix 1.

MORPHOLOGY

Frommeëlla tormentillae is an easily recognized rust fungus forming prominent orange-yellow rounded to elliptical mealy pustules (uredinia) on the lower side of the leaves of *Potentilla erecta* (L.) Räuschel (Rosaceae), often 50-100 on each leaflet, and each uredinium with several hundred urediniospores (Figs. 1-3). In late autumn (October-November) darker coloured telia are formed from the uredinia or from near these (Fig. 4).

Spermogonia intraepidermal, Group IV, type 10 (Cummins and Hiratsuka 2003) on the upper sides of leaves. Aecia orange-yellow, subepidermal, erumpent, of *Uredo* type (uredinoid). Aeciospores oval, echinulate above, more smooth below, 18-22 × 12-18 µm, borne singly on pedicels; the wall uncoloured; pores equatorial, obscure. Neither spermagonia nor aecia have been recorded from Norway (Gjærum 1974).

Uredinia orange-yellow, rounded to oval, mealy, subepidermal, erumpent, of *Uredo* type, scattered or crowded on the lower side of leaves, calyx as well as on stems and pedicels (Fig. 1). Urediniospores spherical, ellipsoid or oval, echinulate, 14-23 × 14-18 µm as wet, but often hemispherical with one concave side and 10-13 µm in diameter when dry; the wall 1-1.5 µm thick, hyaline or pale yellow; pores 3-4, equatorial, obscure (Figs. 2-3). Paraphyses usually absent.

Telia orange-brown to blackish, rounded to oval, subepidermal, erumpent, scattered or crowded on the lower side of leaves, more rarely on calyx, stems or pedicels. Teliospores borne singly on short pedicels, finger-like,

Figure 1. Leaves and stems of *Frommeëlla tormentillae* with numerous orange uredinia. Photo: K.A. Lye.

smooth, 2-7 celled (most often 4-5 celled) by transverse septa, 50-140 × 18-22 µm, slightly narrowed at the septa; the wall ca. 1 µm thick, uncoloured or pale yellow-brown, but to 3-4 µm thick at the top; pore 1 from each cell, the lower lateral, the single uppermost terminal and central (Fig. 4). Paraphyses absent. The teliospores germinate without dormancy. Basidia are external and Cunningham (1966) showed that depending upon the environment, the promycelium from the teliospores either forms basidiospores on sterigmata, or develops into a long, non-septate hypha instead of forming basidiospores, or becomes septate and disarticulates into its component basidial cells.

NOMENCLATURE

The genus *Frommeëlla* differs from the genus *Phragmidium* because of the single germ pore per teliospore cell (Fig. 4) against 2-3 in *Phragmidium*, and uredinoid aecia (versus caeomoid in *Phragmidium*), but the two genera are closely related (Cummins and Hiratsuka 2003). *Frommeëlla tormentillae* was named *Frommea obtusa* Arthur by Jørstad (1962) as well as by Gjærum (1974). However, when Arthur (1917) described *Frommea obtusa* he designated *Uredo obtusa* F. Strauss as the type of the genus. Laundon (1975) pointed out that *U. obtusa* is a synonym of *Phragmidium potentillae* (Pers.) P. Karst. The fungus described

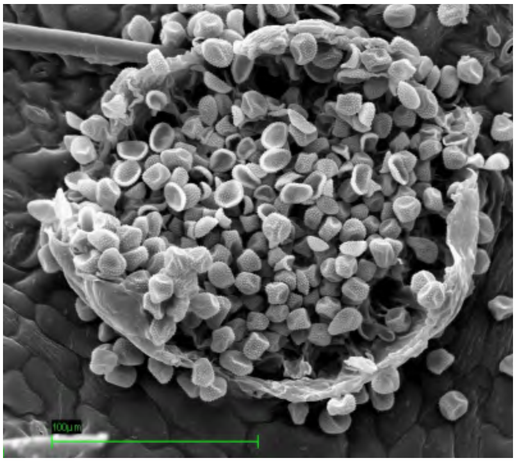

Figure 2. Uredinium of *Frommeëlla tormentillae.* Scale: 100 µm. Note the thin wall surrounding the young uredinium and now broken and mostly carried away. Photo: E. Ørmen and K.A. Lye.

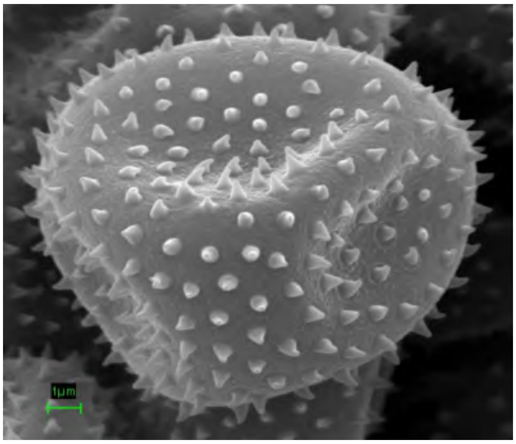

Figure 3. Urediniospore of *Frommeëlla tormentillae.* Scale: 1 µm. Note the tetrahedric structure of the dry spore. Photo: E. Ørmen and K.A. Lye.

by Arthur is, however, not a *Phragmidium*, and therefore Cummins and Hiratsuka (1983) established a new generic name, *Frommeëlla,* for this fungus. This genus consists of two species, the type species *F. tormentillae* (Fuckel) Cummins and Y. Hirats. with the type from Europe, but also known from North America, and *F. mexicana* (Mains) J.W. McCain and J.F. Hennen from America (McCain and Hennen 1990).

Yun et al. (2011) has included *Frommeëlla* in *Phragmidium* since their DNA work did not separate the two genera. If their work is being accepted our fungus will be named *Phragmidium tormentillae* Fuckel.

ECOLOGY

Frommeëlla tormentillae is recorded on *Potentilla erecta* in most habitat types where it occurs. However, since it develops urediniospores in early autumn and teliospores in late autumn,

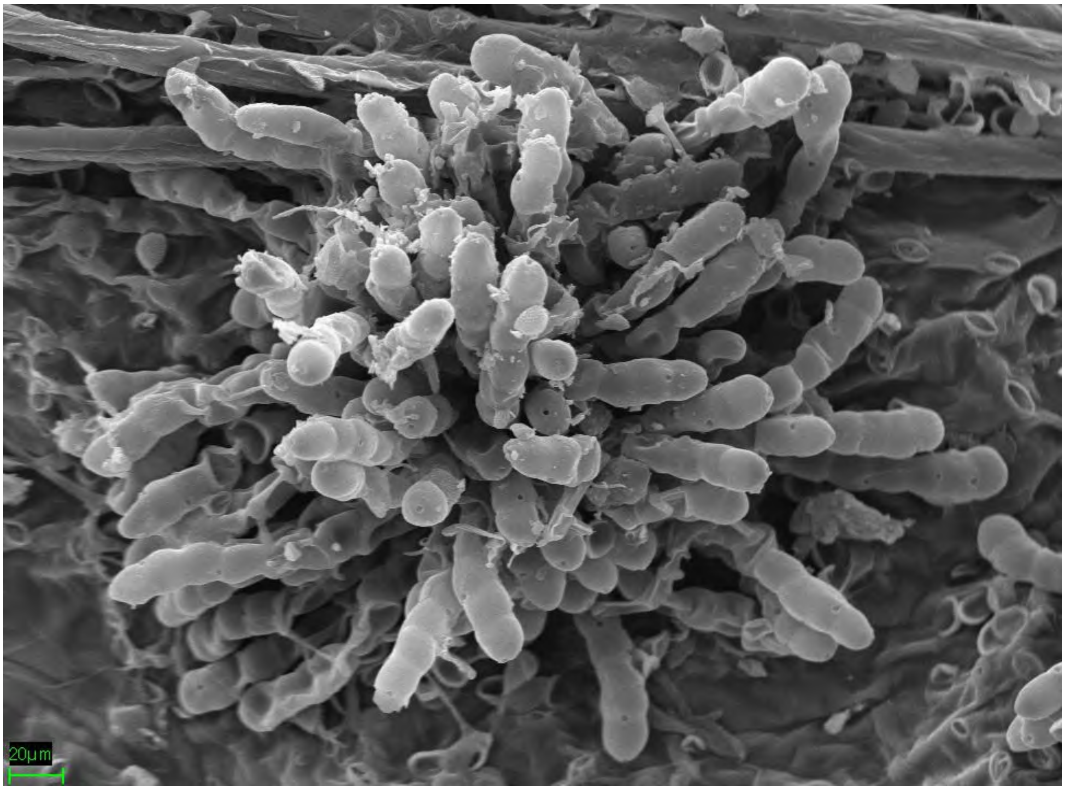

Figure 4. Telium of *Frommeëlla tormentillae.* Scale: 20 µm. Note apical pore in the uppermost cell, lateral pore in other cells. Photo: E. Ørmen and K.A. Lye.

it is bound to have a low altitude limit in Norway. In Norway it is mainly found below 350 m, but with a single record up to 710 m in Ringebu. With a long snow cover and consequently short summers the fungus is not able to complete its life cycle in more alpine habitats. In continental regions development is possibly more rapid as less rainfall and more sunshine will increase local temperatures near ground level.

During this research into the occurrence and expected rarity of *Frommeëlla* all localities recorded in the period 1895-1951 were visited, except the southernmost one near Kristiansand. Surprisingly neither the fungus nor its host was found, although they were often found only a few km away. The reason for this is probably the profound change in the agricultural landscape (Pedersen and Engan 2013). Fifty years ago most farms in southeast Norway had cows and not too heavily manured grasslands where *Potentilla erecta* could thrive. Today these grasslands are either fully cultivated for corn production or they have become forested. Nowadays we find *Potentilla erecta* mainly on roadsides or along tracks and paths in open forest.

DISTRIBUTION

Frommeëlla tormentillae has a typical southeastern distribution in Norway and is particularly common on both the eastern and western side of the inner Oslofjord (Fig. 5). Vascular plants with a similar distribution include *Artemisia campestris* (L.) L., *Calamagrostis arundinacea* (L.) Roth, *Carex acutiformis* Ehrh., *C. pseudocyperus* L., *C. hartmanii* Caj., *Carlina vulgaris* L., *Chimaphila umbellata* (L.) Barton, *Crepis praemorsa* (L.) Walther, *Dryopteris cristata* (L.) A. Gray, *Inula salicina* L. and *Thelypteris palustris* Schott (Fægri and Danielsen 1996). Plants and fungi with such a distribution are believed to need both a warm summer and a not too cold winter for their survival. However, since the distribution of *Frommeëlla* has been in a state of expansion, it has probably not yet reached its full geographical range in Norway. In the coming years we expect *Frommeëlla* to extend its range further west and north. Since it occurs in Britain (Henderson 2000), it must be able to cope with an oceanic climate, and possibly even be able to cross the mountains and find acceptable habitats in the Trøndelag lowlands.

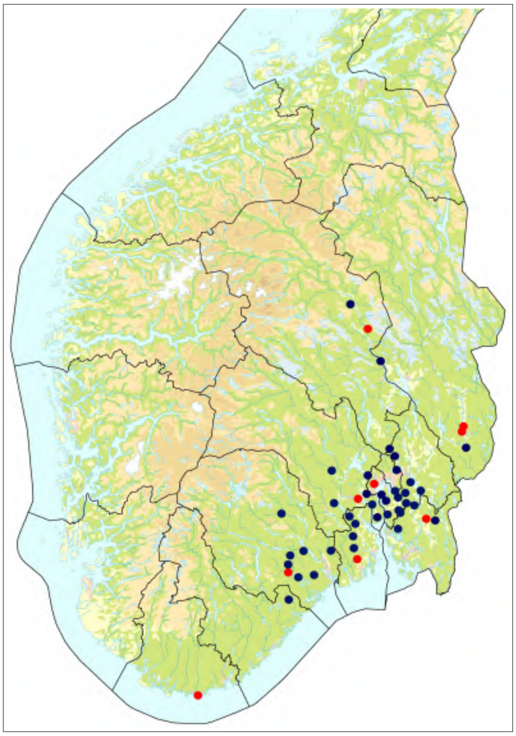

Figure 5. Distribution of *Frommeëlla tormentillae* in Norway 1895-1951 (red dots) and 2009-2013 (black dots). This fungus was not collected from Norway between 1952 and 2008.

In Fennoscandia *Frommeëlla tormentillae* also occurs in Sweden, Finland and Denmark (Gjærum 1974); in Finland it reaches to 62°14' N near Jyväskylä (Liro 1908). In Europe this fungus is widespread from Russia (Tranzschel 1939), Polen (Majewski 1977) and Romania (Săvulescu 1953) in the east to Scotland, Ireland and the Azores in the west (Wilson and Henderson 1966, Gjærum and Dennis 1976).

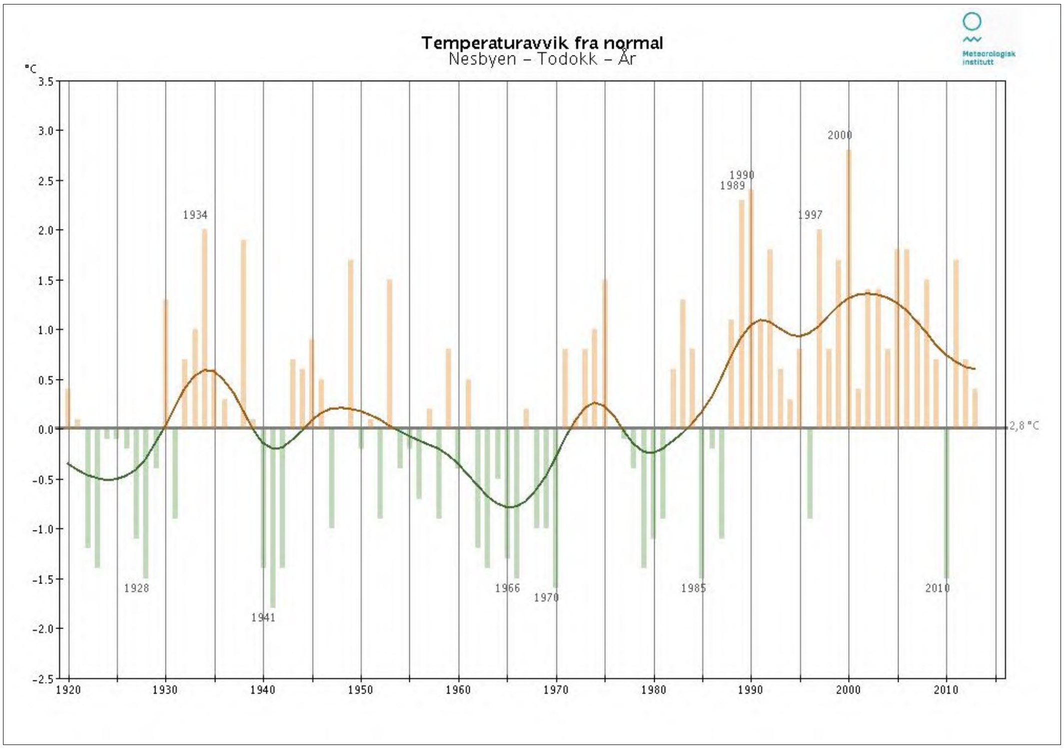

Figure 6. Annual temperature deviation from normal (2.8 °C) at Nesbyen, Eastern Norway (Østlandet) 1920-2013 (yellowish brown columns above average; greenish columns below average). Note the higher temperatures after 1987. From Norwegian Meteorological Institute (2014).

CLIMATE CHANGE

It is well documented that the annual mean temperature has increased in Norway as well as in most parts of the world during recent years. In the area around the Oslofjord and in the lowlands north of Oslo this temperature increase is particularly striking from after the year 1987 (Fig. 6). At Nesbyen (shown in Fig. 6) the annual mean temperature has increased by 2.4° C the last 50 years and is now at 4.2; the temperature increase is particularly high during spring months (Metrologisk institutt, 2014), which effectively increases the length of the growing season. Since Ivar Jørstad died in 1967, he did not collect during this period of global warming. It is likely that *Frommeëlla tormentillae* has taken advantage of global warming and particularly the longer growing season, which has enabled the fungus to produce mature teliospores in previously colder regions and regions with a shorter growing season.

CONCLUSION

It seems very unlikely that the eminent mycologist Ivar Jørstad could have missed the many sites for the rust *Frommeëlla tormentillae* near his home in Oslo and Akershus where it is now growing and is locally abundant. Hence, it is fairly evident that the apparent recent increase in abundance of this fungus is a result of global warming with milder winters with less snow and consequently a longer growing season. However, changes in agricultural practices with fewer domestic animals foraging in the forests may be an additional factor providing more plants for the fungus to parasitize. On the other hand increase in wild populations of roe deer, elk and red deer may counteract the effect of fewer domestic animals in the forests in this respect.

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Fungi of sandy pine forests in Norway, and a comparison of this threatened element elsewhere in Europe(-Asia)

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NØKKELORD
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SAMMENDRAG

Elementet av sandfuruskogsopper i Norge er sammenstilt og presentert, basert på egne kartlegginger 2011-2013, samt på en sammenstilling av data fra nasjonale soppdatabaser. Status for artene er sammenliknet med status i Fennoskandia og ellers i Europa (samt der det finnes kunnskap, også for Asia). I alt 39 arter er spesialiserte sandfuruskogsopper i Norge, med alle eller hoveddelen av sine forekomster i sandfuruskog. Disse opptrer hovedsakelig i tørre, kontinentale, lav(-mose) dominerte furuskoger på sand/grus breelvavsetninger fra slutten av siste istid. Artene ser ut til å være mineralelskende og unngår steder med tykk humus og tett bærlyng-grasvegetasjon. Mange foretrekker noe (base)rikere sandavsetninger og/eller åpninger i humuslaget forårsaket av forstyrrelser (skogbrannpåvirkede steder, brattskråninger med utrasinger eller åpninger langs småveier og stier).

Sandfuruskogselementet inkluderer mange arter av slørsopper (*Cortinarius*), musseronger (*Tricholoma*), harde piggsopper (*Bankera, Hydnellum, Phellodon, Sarcodon*), noen korallsopper (*Ramaria*) og dessuten enkelte poresopper som furufåresopp (*Albatrellus subrubescens*) og furugråkjuke (*Boletopsis grisea*). Noen av disse artene er sterkt begrenset til de store, boreale sandavsetningene i nord- og mellom Fennoskandia(-NV Russland), slike som moslørsopp (*Cortinarius pinophilus*), mens andre har en meget vid europeisk utbredelse, inkludert sandstrandskoger langs Middelhavet, slike som teglrød kragemusserong (*Tricholoma focale*). Imidlertid ser det ut til at forekomstene utenfor Nord-Europa er (svært) små for de fleste arter, noe som reflekterer (i) små, ofte fragmenterte sandfuruskogsforekomster, og (ii) en utarming av habitat-kvalitet pga. ulik påvirkning, særlig eutrofiering fra nitrogen-deposisjon. Elementet (f.eks. den velkjente kransmusserongen *Tricholoma matsutake*) er på tilbakegang også i Asia grunnet bl.a. skogdød og avskoging.

Sammenfatningsvis, ser elementet av sandfuruskogsopper ut til å være fragmentert og på tilbakegang i de fleste deler av sitt eurasiatiske utbredelsesområde, og bør anses som et internasjonalt truet element. De store og relativt lite påvirkede sandfuruskogsarealene i nordre og midtre deler av Fennoskandia(-NV Russland) ser i dag ut til å huse de største, mest artsrike og mest intakte forekomstene av sandfuruskogsopp-elementet i Eurasia. Denne regionen, inkludert Norge, Sverige og Finland har dermed et særlig internasjonalt ansvar i å forvalte dette truete elementet.

ABSTRACT

The element of sandy pine forest fungi in Norway is presented, based on own surveys 2011-2013 and a compilation of data from national mycological databases. The status of the element is compared to that of Fennoscandia and elsewhere in Europe (and when known, also in Asia). Altogether 39 species are specialized sandy pine forests fungi in Norway, with all or the majority of their populations in this habitat. These occur mainly in dry, continental, lichen(-moss)-dominated Scots pine forests on glacifluvial, pleistocene sand-gravel deposits, and appear to be mineralophilic, avoiding thick humus layers and dense *Vaccinium*/grass vegetation. Many prefer somewhat base-richer sand deposits, and/or humus openings due to disturbance (forest-fire influence sites, steep scree slopes or along small roads/paths).

The sandy pine forest element includes a number of taxa of *Cortinarius*, hydnaceous fungi and *Tricholoma*, as well as a few ramarias and characteristic polypores (such as *Boletopsis grisea*). Some of these are more or less restricted to the large, boreal sand deposits of central-northern Fennoscandia(-NW-Russia), such as *Cortinarius pinophilus*, whereas others have a very wide European distribution, including Mediterranean beach forests, such as *Tricholoma focale*. However, the populations outside North Europe are (very) small for most taxa, reflecting (i) small, often fragmented habitat patches of sandy pine forests, and (ii) a depauperation of habitat quality due mainly to nitrogen eutrophication. The element (e.g. the well-known *Tricholoma matsutake*) is declining also in Asia due to severe pine forest die-back and afforestation.

Conclusively, the sandy pine forest fungus element appears to be fragmented and declining in most parts of its Eurasian distributional area, and should be regarded as an internationally threatened element. Furthermore, the large, relatively little disturbed sandy pine forests of central-northern Fennoscandia seem at present to house the largest, most diverse and intact populations of the sandy pine forest fungus element in Eurasia. This region, including Norway, Sweden and Finland thus has a particular responsibility for the management of this threatened element.

INTRODUCTION

The fungi of Scots pine forests on sandy soils (sandy pine heath forests), here termed sandy pine forest fungi, is a characteristic element of the Nordic boreal zone, due to extensive glacifluvial deposits, stemming from the last, Pleistocene Ice-Age. The sandy pine forests and their sandy pine forest fungi are especially well-developed on the deposits along the large rivers of N/C Sweden, N/C Finland, as well as eastern/central parts of S Norway and eastern parts of N Norway (Brandrud and Bendiksen 2014, Nitare 2006a,b, Stridvall and Stridvall 2006). These glacifluvial deposits extends also far into NW Russia, which houses such sandy pine forests as well, especially along the larger rivers (Per Angelstam, pers. comm.).

The Fennoscandian(-NW Russian) populations of the sandy pine forest fungi are at present probably the largest and most intact in Europe, due to natural rareness and severe decline of this element elsewhere (e.g. Vesterholt et al. 2000, Dörfelt and Bresinsky 2003, Arnolds 1988, 1989, 2009). The importance of the Norwegian/Fennoscandian populations is focused in the present paper.

Until recently, this fungus element has been rather little focused and little known in the Nordic countries (but cfr. Soop 2002, Risberg et al. 2004, Stridvall and Stridvall 2006, Nitare 2006a,b), even though the sandy pine forests have been mapped in the woodland key habitat survey in Sweden since 1990 (Nitare 2005, 2011). In Norway, these forests have until quite recently not been included in woodland key habitat surveys. However, this is now being changed, and during the latest three years an extensive surveying of the sand pine forests and their specialized fungi has been performed in Norway, first locally at Elverum, Hedmark (Brandrud 2012) and then on a regional-national scale (Brandrud and Bendiksen 2013, 2014).

The aim of the present study is to present the little known, specialized element of sandy pine forest fungi based on data from a 2011-2013 survey and mycological databases from Norway, and compare this with the status of this element from Fennoscandia/Europe/Eurasia.

MATERIALS AND METHODS

Data on the Norwegian collections of sandy pine forest fungi are taken from the national species databases Artskart (2014) (Norwegian Species Unit) and The Norwegian Mycological Database (NMD 2014), including data from a sandy pine forest survey 2011-2013. Data from this project are under depositing to the mentioned databases. Data on the status in Fennoscandia and elsewhere in Europe, as well as globally are taken from sources mentioned in the text. Data on species records from Sweden, Denmark, Great Britain, Switzerland, Austria and Slovenia are taken from online databases.

RESULTS AND DISCUSSION

The sandy pine forest fungi element in Norway

Based on the 2011-2013 survey data from sandy pine forests, and data from our fungi record databases (Norwegian Mycological Database (NMD 2014) and Artskart 2014, we found 39 species to be sandy pine forest fungi in Norway, that is species with an exclusive association with this habitat, or with its major populations probably in this habitat (Table 1). Of these, 19 are taxa belonging to the genus *Cortinarius*, which stands out as the most important genus/group of sandy pine forests species (cfr. Soop 2002). Altogether 14 species in Table 1 are red-listed at present in Norway, and some of the 13 taxa found new to Norway in sandy pine forests since the last red data list may also be redlisted in the future (Kålås et al. 2010).

Habitat requirements

Most of the specialized sandy pine forest species appear to be mineralophilic species, associated with forest stands with a (i) thin humus layer, and frequently also with (ii) richer mineral particles, that is sand/gravel derived from electrolyte-rich/calcareous rocks, fine-grained glacial lake deposits or deposits influenced by (lime)rich ground water. Some species are also dependent or favoured by small disturbances occurring in openings in the humus, along screes, paths, small roads and sand/gravel pits. Thin-humus sandy soils are found mainly in dry lichen- or lichen-moss(-*Vaccinium vitis-ideae*) dominated sandy pine heath forests, whereas e.g. in dense *Vaccinium myrtillus* vegetation on thicker humus none of these mineralophilic species are found. Furthermore, the sand might be more or less exposed due to natural or man-made disturbances, e.g. in steep slopes, after forest fires or along paths.

The dry, lichen(-moss) dominated sandy pine forests often occur on dry ridges (e.g. esker-ridges) or on steeper, unstable slopes along rivers or old glacifluvial terraces. Also fossil sand dunes/drift sand deposits can be favourable. The well-developed, dry, lichen rich sandy pine forests and their fungi are in Norway/Fennoscandia restricted mainly to areas with a continental climate. In Norway that is especially valleys belonging to the weak continental vegetation series (C1 according

Figure 1. *Cortinarius pinophilus*, a strict sandy pine forest species in Europe: widespread in Fennoscandia, very rare in C Europe (known only from N Italy and W. Hungary). Photo: K.H. Brandrud; Elverum, Norway, TEB 617-11.

to Moen 1998). In the continental climate, drought and regular forest fires (in natural conditions) hinder humus development.

Some of the fungi in Table 1 are strictly associated with sandy pine forests, whereas others may occur also in shallow-soil, lichen/moss dominated pine forests with thin humus, in connections with e.g. rock outcrops, both on richer/calcareous rocks or granitic/siliceous rocks. Based on this, three sub elements can be distinguished:

1. *Strictly sandy pine forest associates*: These include some rare, small *Cortinarius* species such as *C. bayeri*, *C. carabus* and *C. violilamellatus* (Table 1). Among the larger cortinarii, *C. pinophilus* (VU) stand out as a strict sandy pine forest associate in the Norwegian data (Figs. 1, 2). The famous, edible mushroom *Tricholoma matsutake* (NT) is an example of a non-cortinarii with a strong affinity to this forest type (cfr. Risberg et al. 2004, Brandrud 2013a). Also another, appreciated, edible taxon, *Lyophyllum shimeji*, seems in Norway to be more or less restricted to sandy pine forests (Table 1).

2. *Species in sandy pine forests + calcareous/low-herb pine-spruce forests*: This includes species with an affinity to (lime) richer forest types, mainly to dry, rocky, shallow-soil low-herb pine forests, rarely also to calcareous pine/spruce forests. An affinity to the latter applies for e.g. the calciphilous *Cortinarius phrygianus* (EN), *Limacella illinita* (EN) and *Russula roseipes* (NT), whereas others like *Albatrellus subrubescens* (NT), *Bankera fuligineoalba* (NT) and *Boletopsis grisea* (VU) mainly occur in moderately rich low-herb pine forests and very rarely in calcareous districts. The three latter have a core area in low-herb pine forests in inner fjord districts (cf. Holtan and Larsen 2011). In these SW-faced fjord sides, a warm and dry micro climate may compensate for the less continental regional climate. Some of the species included in Table 1 have more collections from calcareous/low-herb pine forests than from sandy pine forests, but since the former habitat is probably surveyed 2-3 times more detailed in Norway, we have included taxa with up to twice as many finds in calcareous coniferous forests as in sandy pine forests.

Figure 2. *Cortinarius pinigaudis*, a mainly Fennoscandian species, but known also from one, sandy pine outpost in W Hungary. Photo: K.H. Brandrud; Vågå, Norway, TEB 383-13.

3. *Species in sandy pine forests + oligotrophic, shallow-soil lichen pine forests*: This combination includes mainly a set of mineralophilic *Cortinarius* species which can also occur in thin soil upon fairly acidophilic, siliceous (quartz-rich) rock surfaces. The most frequent one in this group is *Cortinarius quarciticus*, which is very frequent in sandy pine forests, especially in easternmost Norway (along Glomma, e.g. near Elverum), but is probably much under sampled in poor, shallow soil pine forests of lichen type. The same applies e.g. to the closely related taxa *C. clarobrunneus* and *C. glandicolor.* Also *Sarcodon squamosus* belongs to this element. These species are not red-listed, due to their occurrence in the widely distributed, non-threatened, oligotrophic shallow-soil pine forests in Norway. In an even wider concept, we have the larger number of species growing in more kinds of pine forests, and maybe mainly in sandy pine forests and oligotrophic, shallow-soil lichen pine forests, with seemingly no special preference for any of these habitats. This seems to include most of the species normally growing in the latter type.

Table 1. Sandy pine forest fungi in Norway. Species exclusively or preferentially associated with sandy pine forests. Based on data from NMD 2014 and Artskart 2014, with own, new data added. Habitat-association (sap=sandy pine forests; shp=shallow-soil oligotrophic lichen(-Vaccinium) pine forests; cap=calcareous pine/spruce forests (low-herb types); oth=other forest types (oligotrophic spruce forests, oak forests); unsp=unspecified forest type. RL=redlist categories: EN=endangered. VU=vulnerable. NT=nearly threatened. can=candidate to redlist 2015.

Sandy pine forest fungi:	RL	sap	shp	cap	oth	unsp	SUM
Cortinarius:							
*Cortinarius bayeri***	can	7	0	0	0	0	7
Cortinarius clarobrunneus		33	5*	2	0	1	41
*Cortinarius coleoptera***		34	2*	0	0	0	36
Cortinarius glandicolor		49	7*	0	10	0	66
Cortinarius leucophanes		30	14	1	2	1	48
Cortinarius lux-nymphae		49	3	0	18	5	75
Cortinarius cf. *melitosarx***		10	2*	0	0	0	12
*Cortinarius neofurvolaesus***	can	5	1	0	0	0	6
Cortinarius odhinnii		26	1*	0	0	0	27
*Cortinarius pinigaudis***		27	0*	0	1	0	28
Cortinarius pinophilus	**VU**	20	0	0	0	0	20
Cortinarius suberi		24	7*	6	1	0	38
Cortinarius quarciticus		49	16*	4	0	5	74
*Cortinarius violilamellatus***	can	6	0	0	0	0	6
Other mycorrhizal fungi*:*							
Albatrellus subrubescens	NT	29	12	20	0	10	71
Bankera fuligineoalba	NT	32	20	20	2	40	114
Boletopsis grisea	**VU**	18	7	11	0	9	45
Hydnellum caeruleum		30	22	36	3	24	115
Hydnellum gracilipes	**VU**	17	6	3	1	0	27
Inocybe sambucina		9	0	2	3	3	17
Limacella illinita	**EN**	6	0	7	0	2	15
Lyophyllum semitale		15	4	20	11	10	60
Lyophyllum cf. *shimeji***	can	13	?	?	?	1	14
Phellodon secretus	**EN**	9	3	2	0	0	14
*Ramaria eosanguinea***		20	0	11	5	0	36
Russula roseipes	NT	25	1	30	20	10	86
Sarcodon scabrosus coll.	**VU**	25	8	45	17	6	101
Sarcodon squamosus		33	42	17	0	6	98
Tricholoma apium	NT	12	3	21	0	11	47
Tricholoma arvernense		34	10	41	18	50	153
Tricholoma matsutake	NT	38	10	1	0	15	64
Tricholoma focale (incl. *robustum*)	can	59	12	24	0	14	109
Very rare species in NO; most with status as sandy pine f. sp. in Sweden-Finland:							
Clitopilus paxilloides	**VU**	7	4	0	0	0	11
*Cortinarius anomalellus***		3	2	0	0	0	5
Cortinarius areni-silvae	NT	1	0	0	0	0	1
*Cortinarius carabus***	can	3	0	0	0	0	3
*Cortinarius fusisporus***		5	2	0	0	0	7
Cortinarius phrygianus	**EN**	2	4	0	0	0	6
Ramaria lutea ”mo”**		1	0	0	0	0	1
SUM 39 (14 RL-species)							

*little known species, probably undersampled in shallow-soil, oligotrophic pine forests

**new species to Norway (2009-)2010-2013

Presentation of different species groups

The genus Cortinarius:

The genus constitutes a character element of our sandy pine forests (Table 1), including many taxa with a mainly North European distribution. This element of cortinarii was very little studied prior to the recent sand pine forest surveys, and approximately half of these species (9 taxa) were found new to Norway 2010-2012. Some of these are red-list candidates for the coming red-list. Most species belong to the subgenus *Telamonia*, a taxonomically very complex and formerly little understood group, which in part has been revised the latest 6-8 years, with aid from molecular methods. For instance, the sect. *Brunnei*, with the sand-dwelling *C. clarobrunneus*, *C. carabus* and *C. glandicolor* was revised in Niskanen et al. (2009), where *C. carabus* was described as a new species. Only three species (*C. leucophanes, C. pinophilus* VU*, C. areni-silvae* NT) belong to the large subgenus *Phlegmacium* which includes many specialized, calciphilous taxa. *Cortinarius phrygianus* (EN) belongs to the section/clade *Leprocybe*, which frequently has been included in subgenus *Cortinarius*.

The *Cortinarius* species of sandy pine forests has formerly been treated by Soop (2002), but he did not distinguish between the more or less strict sandy pine forests associates, and those with a wider habitat range. For instance, he mentions some calciphilous species, such as *C. aureofulvus*, *C. cupreorufus,* and *C. pseudoglaucopus* which sometimes occur in calcareous sandy pine forests. These can also in Norway be used as indicators of especially calcareous sandy pine forests, but they are not included in Table 1, since their major habitat is ordinary calcareous pine/spruce forests (not on sand).

A number of of the sandy pine forest cortinarii are apparently absent or very rare in C Europe. Only some of the more frequent and not so specialized ones such as *C. glandicolor, C. lux-nymphae (=C. incisus ss. auct.), C. quarciticus,* and *C. suberi* are reported from more sites, e.g. from Germany and Austria (Arnold 1993, Krieglsteiner and Gminder 2010, Austrian Mycological Society 2014), the latter two also from W Hungary (B. Dima, pers. comm.).

In the following, some of the rarest and most specialized sandy pine forest cortinarii are further commented:

Cortinarius areni-silvae: This robust, fleshy species with a fibrillose pileus and a marginate bulb is an example of a mainly eastern, continental species in Fennoscandia, with only one record in (easternmost) Norway, Rena, near Glomma, (Brandrud 1998), and with major populations farther east, e.g. on the eskers and sand heaths of Medelpad-Jämtland in C/N Sweden (see Tedebrand 2010, Artportalen 2014). However, the species has outpost localities on coastal sand dunes at W Jutland, Denmark (Brandrud 1998). For pictures and description of the species, see Brandrud et al. (1990-2014) and Soop (2011).

Cortinarius bayeri: This is a tiny, small, yellow-brown, fine-scaly *Telamonia* species which in Norway has been found exclusively in sandy pine forests (7 localities; Table 1). The species seems to prefer open, pioneer habitats along small roads or screes, where it grows in (almost) naked sand or in a thin bottom layer of pioneer mosses or lichens. The species has so far been found mainly along River Glomma in the (south)east (found new to Norway in 2011; see Brandrud 2012), and north of Oslo (Gardermoen), but was in 2013 also found further west at Ringerike, and in the central part of S Norway (Vågå, NW Gudbrandsdalen; Brandrud and Bendiksen 2014). The species is distributed in sandy pine forests in Sweden (Soop 2002, Artportalen 2014) and Finland (Salo et al. 2005), and outside Fennoscandia it is reported from one site in Austria (Austrian

Figure 3. *Cortinarius carabus*, a strict sandy pine forest species known only from Fennoscandia. The species prefers nearly exposed sand in small scree patches or along tracks. Photo: T. Frøslev; Åmot, Norway, TEB 611-12.

Mycological Society 2014).

Cortinarius carabus (Fig. 3): This is also a very tiny species, but differs from *C. bayeri* by much darker greybrown-umber brown and darkening basidiomes. This has so far been found only three times in Norway; at two sites together with *C. bayeri*, in the Glomma region, along small road-borders and one find in a scree ravine (found new to Norway in 2012; see Brandrud 2012). This seems to be one of our rarest and most eastern sandy pine forest fungi. However, the fairly many localities in North Finland-North Sweden reported by Niskanen et al. (2009) indicate that this should be possible to find in the neighbouring continental parts of Finnmark/ N Norway. It is at present only known from Fennoscandia (Niskanen et al. 2009).

Cortinarius coleoptera: This one and the former have latin names referring to the dark brown, glossy, beetle-like pileus surface (cfr. Brandrud et al. 1990-2014, Soop 2011). This one, however, is larger, has smaller spores and has a tapering, smooth stipe base very easily removed from the substrate - which in this case is a somewhat thicker lichen-moss layer. The species is not infrequent in sand pine forests (33 localities), especially in the Glomma region (22 localities; Brandrud and Bendiksen 2014) but is probably much under sampled in poor, shallow-soil lichen heaths with pine, since we only recently have really learned to recognize this. It was published as new to Norway by Niskanen et al. (2009; two finds from Norway). Lately, the species was found by molecular methods on the mycorrhizal roots of the pyrolaceous plant *Chimaphila umbellata*, in samples from sandy pine forests at Ringerike (Line Holen, pers. comm.), indicating that this is more frequent (also in sandy sites) than basidiome (fruit-bodiy) sampling hitherto has indicated. The species is known from Fennoscandia, Balticum and Great Britain (Niskanen et al. 2009).

Cortinarius neofurvolaesus: This dark, red-brown *Telamonia* is one of the rarest and apparently most specialized of the sandy pine forest cortinarii. It seems to prefer sandy openings including road-borders. It is up to now found three times in the Elverum district and twice in NW Gudbrandsdalen (Vågå-Sel). It is more widely distributed on the sandy pine heaths of N Sweden (Brandrud et al. 1990-2014, as *C. furvolaesus*), but is hitherto not reported from outside Fennoscandia, except one possible find in Black Forest, Germany (G. Saar, pers. comm.). For pictures, see Soop (2011), Brandrud and Bendiksen (2014).

Cortinarius phrygianus: This characteristic, olive ochre species, with dark pileus scales and stem girdles is known as a rich sandy pine forest species from Sweden (Brandrud et al. 1990-2014, Soop 2002, 2011), but in Norway this has hitherto been found both in more or less calcareous pine/spruce forests (4 sites) and in sandy pine forests (2 sites in NW Gudbrandsdalen, Vågå-Sel). Due to the lower survey intensity of sandy pine forests (e.g. in Vågå-Sel) versus calcareous forests, this one probably may have its major populations - also in Norway - in sandy pine forests. In Finland there are also some few finds, from dry coniferous forests, on sandy soil in calcareous places (Salo et al. 2005). As far as we know, this species is confined or almost confined to Fennoscandia. According to Krieglsteiner (1991), the species has one record in Germany (Bayern; cfr. also Karasch and Hahn 2009), and one record from Switzerland (cfr. also Senn-Irlet et al. 2007). The Austrian Mycological Society (2014) cites one collection from Austria. However, all these are older finds, and may refer to different interpretations of the name phrygianus, including what is now called *C. melanotus*.

Cortinarius pinophilus (Fig. 1): This characteristic, rather fleshy, yellow-brown, strict sandy pine forest-associate a continental valley distribution in Norway, with three, widely separated, apparently isolated core areas; along the river Glomma in the Elverum-Åmot district of Hedmark in SE Norway, in the Lesja valley, Oppland in S/C Norway (in the rain shadow from the Jotunheimen mountains), and in the Karasjok-Upper Anarjohka districts of E Finnmark in N Norway.

Furthermore, one outpost locality to the southwest was found at Ringerike, Buskerud, and one to the northwest at Alta, Finnmark. The species has now 21 known localities from Norway (Brandrud and Bendiksen 2014), and approximately 30 in Sweden (Artportalen 2014, cfr. also Soop 2002, 2011), and it is rather widespread in Finland and occurs also in Estonia (Gry Handberg, pers. comm.). On a European scale, this seems almost confined to the continental, boreal sandy pine heath forest belt in Fennoscandia (probably extending into Russia). Elsewhere it is known only from a few finds from the Prealp glacifluvial deposits of South Tyrol in N Italy (Francesco Bellu, pers. comm.) and similar deposits from W Hungary (Balint Dima, pers. comm.). Outside Europe, it has been recorded in W North America with *Pinus contorta*, *Tsuga* or *Pseudotsuga*, but apparently not in typical sandy soils (Ammirati et al. 2012).

Cortinarius pinigaudis (Fig. 2): This is a large and robust species in the sect. *Armillati* (species with more or less red veil girdles on stipe), usually characterized by its innately fibrillose pileus, and by leaving much remnants of moss/lichens at stipe base, with basal-mycelium usually becoming distinctly pink.

It was described new by Niskanen et al. (2011), based on many records from Finland and Sweden, including three finds from E Norway. Now it is known from 27 sandy pine forest sites in continental valleys of Norway, but according to the habitat given from Finland and Sweden (including rocky pine forests; Niskanen et al. 2011), this could also possibly be found in shallow-soil, rocky sites in Norway. The species is documented by molecular methods from a small site of sandy pine forests in W Hungary (Balint Dima, pers. comm.).

Stipitate, hydnoid fungi (Bankera, Hydnellum, Phellodon *and* Sarcodon):

The hydnaceous fungi is another characteristic element of the sandy pine forests, including at least 6 species in Norway. Many of these are old-growth forest species, very rarely occurring in young forests subjected to clear-cutting (Nitare 2006a,b, 2012). Especially species of *Sarcodon* seem vulnerable to forestry, and many of these are threatened. In Sweden, these have got their own action plan (Nitare 2006b). The dependence on old-growth forests seems to increase to the north. For instance, in a study on *Hydnellum* species in sandy pine forests in North Sweden, Eilertsen (2013) found no fruitbody production of *Hydnellum* in young forests less than 50 years old, but a high frequency in some mature and old stands. However, in an extensive survey of hydnoid fungi in Scotland (Newton et al. 2002, cfr. also van der Linde et al. 2009), a number of the species were found also rather frequently in younger plantations.

Bankera fuligineoalba (Fig. 4): This is one of the more frequent species treated here, with 113 known Norwegian localities per 2013, including a number of localities also in oligotrophic/poor as well as rich, low-herb, shallow-soil pine forests (Table 1). In N Norway, this seems to prefer old-growth (almost) pristine forests (Midteng et al. 2014), whereas in S Norway it occurs also in man-made disturbance zones, e.g. along gravel pit borders. In Denmark it occurs in early successional stages in *Pinus mugo* coastal sand dune plantations (Christensen 1993, Vesterholt et al. 2000). In a study of sandy pine forests from N Sweden, the species was found in mature and old-growth forests; never in forest younger than 50 years (Eilertsen 2013).

The species is rather frequent in Sweden (Nitare 2005, 2012), Finland (Kotiranta et al. 2009) and the Ural region of Russia (Shiryaev 2008). It appears to be much rarer, yet widespread elsewhere in Europe, for instance very rare in Denmark (10 records since 1980, Danmarks Svampeatlas 2014, cfr. also Christensen 1993), Switzerland (11 records, Swizzfungi 2014), Austria (14 records, Austrian Mycological Database 2014), Germany (14 records anno 1990, Krieglsteiner 1991) and Slovenia (9 records, Fungi of Slovenia 2014). *Bankera fuligineoalba* has been reported also from Japan and North America (Otto 2011).

The species was associated with oligotrophic/acid, sandy pine forests in the Netherlands (now probably extinct; Arnolds 1989), whereas it is not infrequent in core areas of Caledonian pine forests on shallow soil in Scotland (Newton et al. 2002). In C. Europe, the habitat preferences are often more unspecific, apparently in various kinds of dry pine forests. Otto (2011) describes the European habitat as follows; "...nutrient poor pine forests (including dunes with pines), often moss/lichens-rich, occasionally found in pine plantations (e.g. afforestations in former brown coal mining areas, Germany), and exceptionally in parks, in the Mediterranean region also found in mixed hardwood-pine forests."

Hydnellum gracilipes: This strange, hydnoid fungus has a reduced, very thin stipe, and the soft, thin pileus is normally attached to the underside of old, often burned logs (Köljalg

Figure 4. *Bankera fuligineoalba*, with a core area in Fennoscandian sandy pine forests; rare but widespread also in resembling, dry pine forest types throughout Europe. Photo: L. Stridvall.

and Renvall 2000, Kuoljok 2003, 2005). It has its major Norwegian habitats in pristine/near-pristine sandy pine forests at Pasvik, Finnmark N Norway (Midteng et al. 2014) and in old-growth stands in NW Gudbrandsdalen and E Telemark-Buskerud (Brandrud and Bendiksen 2014). Also in Sweden, its major populations are in northern, old-growth forests, and the species is regarded as being an indicator of forest-fire influenced old-growth forests (Kuoljok 2003, 2005), a habitat that also corresponds with the one in Pasvik, N Norway (Midteng et al. 2014). The species seems to be almost confined to Fennoscandia (Köljalg and Renvall 2000, Kuoljok 2003, 2005, Kotiranta et al. 2009). One, apparently uncertain record exists from Denmark (Danmarks Svampeatlas 2014). The species has been recently reported from Great Britain based on molecular identification (Ainsworth et al. 2009). One record is indicated from Austria (Austrian Mycological Database 2014) and from Slovenia (Fungi of Slovenia 2014), otherwise no records indicated from C. Europe.

Phellodon secretus: This resembles the former, both in habit and habitat, but is paler with whitish hymenium. It often occurs in the same localities as *H. gracilipes*, and sometimes even under the same logs (Niemelä et al. 2003, Kuoljok and Karlström 2006, Kuoljok 2011). In Norway, it is rarer than *H. gracilipes*, with most finds from Pasvik (Midteng et al. 2014). These “hidden creatures” might be overlooked in surveys of soil-dwelling fungi, and is usually found by those studying wood-inhabiting species. *Phellodon secretus* is hitherto known only from Fennoscandia (Niemelä et al. 2003, Kuoljok 2011) and the Ural region of Russia (Shiryaev 2008).

Sarcodon scabrosus: Material of bitter, hard-fleshed sarcodons with blue-green stipe base from sandy pine forests in Norway seem to belong (mainly) to *Sarcodon scabrosus*, according to ongoing molecular studies of the hydnoids (K.-H. Larsson, pers. comm.; cfr. also Nitare and Högberg 2012). Nitare and Högberg (2012) have shown that there is also another species in this complex associated with *Pinus*; *S. pseudoglaucopus* nom. prov. (whereas *S. glaucopus* is a spruce associate). This occurs in richer/calcareous sandy pine sites or (other) calcareous pine forests, and can be distinguished from *S. scabrosus* by its smaller and paler pileus without any red brown copper-brown colours. In Norway, we know so far only of one, verified (sequenced) collection of this, from a calcareous pine forests in North Trøndelag (K-H- Larsson, pers. comm). *Sarcodon scabrosus* occurs both in dry, shallow soil, oligotrophic lichen-dominated pine forests and in sandy pine forests (Nitare and Högberg 2012), and seems to prefer the latter in Norway. Furthermore, it usually occur in species rich, old-growth sites (cfr. e.g. Midteng et al. 2014). *Sarcodon scabrosus* seems to be rare in all parts of Norway. In Sweden and Finland, however, *S. scabrosus* is reported to be fairly common, especially in northern sandy pine forests (Nitare and Högberg 2012, Kotiranta et al. 2009; Nitare pers. comm.). Further east, in the Ural region of Russia it seems rare (Shiryaev 2008), and apparently this is the situation also in W Europe (Scotland; Newton et al. 2002; Denmark; Danmarks Svampeatlas 2014) and in C Europe (cfr. e.g. Swissfungi 2014, Fungi of Slovenia 2014).

Stipitate, poroid fungi (Albatrellus, Boletopsis):

Albatrellus subrubescens: This species is distinguished from the closely related *A. citrinus* and *A. ovinus* on the association with *Pinus* (versus *Picea*) and the development of orange-redbrown spots (not yellow) on the stipe and pore surface, as well as amyloid spores. It is locally common in sandy pine forests in in continental valleys in the central part of S Norway (NW Gudbrandsdalen; Lesja, Sjodalen), where it frequently occurs in small humus openings along small roads and paths (Brandrud and Bendiksen 2014). It has another core area in shallow-soil, mineral-richer low-herb pine forests in fjord districts, especially the Storfjord-Geiranger region of Møre & Romsdal (Holtan and Larsen 2011). The species is rare or lacking in the northernmost sandy pine heath forests in Norway, but has apparently a more northern distribution in Sweden (Bolin and Krikorev 2012). In Finland it is distributed far up to the north, but it is very rare in the northern parts (Kotiranta et al. 2009).

The species is widely distributed and locally rather frequent in C. Europe (see e.g. Swissfungi 2014, Austrian Mycological Society 2014, Ryvarden and Gilbertson 1993). Here the species obviously has a wider ecology, in various kinds of *Pinus* forests, including mixed broad-leaved forests (Ryvarden and Gilbertson 1993).

Boletopsis grisea (Fig. 5): This species and its sister species *B. leucomelaena* are characterized by the greybrown - blackish pileus contrasting the persistent whitish pore surface. *Boletopsis grisea* differs from the latter by its paler (never blackish), more felty-fibrillose pileus, short stipe and association with *Pinus* (versus *Picea*). It differ also in some microscopical features (Ryvarden and Gilbertson 1993). Three core areas for *B. grisea* can be recognized in Norway; old-growth/pristine sand pine forests at Pasvik N Norway, mineral-rich, shallow soil, steep low-herb pine forests in inner fjord-districts in W Norway, and a number of scattered localities in SE Norway in rocky to sandy pine forests.

Figure 5. *Boletopsis grisea*, one of the characteristic, boreal, Fennoscandian sandy pine forest fungi, widespread but very rare elsewhere in Europe. Photo: L. Stridvall.

The species is rare but widespread in the boreal zones in C and N Sweden, mainly associated with old-growth, sandy pine forests, and probably favoured by regular forest fires (Nitare 2005). *Boletopsis grisea* is widespread also in Finnish pine heath forests (Kotiranta et al. 2009), and extends eastwards at least to the Ural region in Russia (Shiryaev 2008), indicated also from Siberia (Otto 2011). It has not been recorded in Denmark since 1963 (Danmarks Svampeatlas 2014).

The species has been proposed as candidate for the Bern convention (Dahlberg and Croneborg 2003). According to Bern factsheet (ECCF 2001), the species is widespread but (very) rare everywhere in Europe, occurring in montane regions of C Europe (cfr. also Swissfungi 2014, Austrian Mycological Society 2014, Fungi of Slovenia 2014), recorded south to the Canary Islands (ECCF 2001), and northwest to Scotland (NBN Gateway 2014; as *B. perplexa*). The species is everywhere occurring in dry pine forests, according to Otto (2011) in oligotrophic boreal Scots pine forests and heath forests dominated by pines, often lichen- and moss-rich, mainly of *Cladonia* type; an association with inland sand dunes is mentioned from Poland.

The species is regarded as declining in most parts of Europe, included in a number of national red-lists, being threatened by (i) deforestation of oligotrophic pine forests, (ii) air pollution, in particular nitrogen deposition, and (iii) the use of fertilizers and liming to enlarge timber production (ECCF 2001). The species is redlisted in the Czech Republic, Denmark, France, Germany, Norway, Poland, Spain, and Sweden, according to Otto (2011).

The genus Tricholoma:

Four species of the genus *Tricholoma* are included in Table 1 as sandy pine forest fungi in Norway (*T. apium* NT, *T. arvernense*, *T. matsutake* NT and *T. focale*), but many tricholomas occur in sandy soils, and the list could probably have been extended to include at least *T. stans* and *T. sudum*, which both have large populations in sandy pine forests (Brandrud and Bendiksen 2014). However, the exact circumscription and habitat-preferences of these have been little known until recently (Christensen and Heilmann-Clausen 2013), and few database records have precise indications of habitat, so their degree of affinity to sandy soils is difficult to assess. In most parts of Europe except Norway also *T. colossus* has its main habitat in sandy pine forests ((Bolin 2001, ECCF 2001).

Tricholoma apium: This species occurs mainly in sandy pine forests and calcareous (shallow soil) pine forests. It is a more or less southern species in Norway, but has the latest years been found also far north in N Norway in sandy sites in the Karasjok-Anarjohka and in the Pasvik regions of Finnmark (Brandrud and Bendiksen 2014, Midteng and Gaarder 2011, Midteng et al. 2014). With present knowledge, the species have three distribution centers in Norway; (i) a major area in SE Norway in calcareous and sandy pine forests (Brandrud and Bendiksen 2014), a smaller area in mineral-rich steep-slope fjordside pine forests in Møre & Romsdal, W Norway (Holtan and Larsen 2011), and finally, (iii) the small above mentioned sites in Finnmark, N Norway.

The species seems to have its European core area in E Norway-Sweden-Finland(-Estonia). In Sweden the species is found all the way from Scania in the south up to Lycksele Lappmark, with four times as many localities as in Norway (approx. 200 versus almost 50 loc.), and in Finland it has been reported north to Norrbotten (Salo et al. 2005). The species is very rare in Denmark (7 loc.; Danmarks Svampeatlas 2014).

The species has a wide but fragmented distribution in W and C Europe, and seems everywhere to be very rare with only a few records per country, and is in a number of countries regarded as threatened. Most localities are recorded from The Czech Republic (Pilát and Usák 1961, as *T. helviodor*). The species is found west to Scotland (Christensen and Heilmann-Clausen 2013), southwest to Spain and east to Turkey (in *Cedrus* forest, Dogan et al. 2012). Furthermore, the species is reported from western parts of North America (Bessette et al. 2013), and it is also found in eastern North America (Newfoundland, Voitk 2012).

In W and C Europe the species has been recorded from oligotrophic, dry, usually lichen-dominated, sandy pine forests (cfr. Pilát and Ušák 1961, as *T. helviodor*; Karasch and Hahn 2009, Kalamees 2010), in NW Europe it occurs in coastal dunes with *Pinus sylvestris* and (planted) *Pinus mugo* (Christensen and Heilmann-Clausen 2013). The species is not reported from calcareous areas in C. Europe.

The species is redlisted more or less throughout Europe, and it has also been proposed for a European redlist (Ing 1993)

Tricholoma matsutake (Fig. 6): This fungus is highly appreciated for its edibility, especially in Japan (Bergius and Danell 2000). It differs from the often co-occurring *T. focale* in its more umber brown, coarsely, apressed-scaly pileus, the long, repeatedly brown-girdled stipe, and a somewhat sweetish (not farinaceous) smell. In Norway this is an eastern species with a high preference for sandy pine forests, with distributional centers in Pasvik, N. Norway and the Glomma district in SE Norway. These core areas stand in contact with larger distribution areas in C-N. Sweden and Finland (Brandrud 2013a).

North Sweden and North Finland probably have the largest populations in Europe (Bergius

Figure 6. *Tricholoma matsutake* is one of the most famous edible mushrooms of Japan. It is declining in Asia, is very rare and fragmented in C Europe, and now probably has its major, global populations in (northern) Fennoscandian sandy pine forests. Photo: L. Stridvall.

and Danell 2000), and management of the Nordic populations will be a key factor for the survival of this species in Europe. The species is known from approximately 200 localities i Sweden. The Nordic, major distributional area reaches at least east to the St Petersburg region (Nitare, pers. medd.).

Tricholoma matsutake is very rare in C. Europe (in Bayern treated as threatened and not found after 1990; no certain records from Switzerland, one find in Austria, Austrian Mycological Society 2014; some more from The Czech Republic, Pilát and Usák 1961), but exact status uncertain due to possible mixing with very rare, closely related taxa (*T. dulciolens, T. ilkkai,* and the southern *T. caligatum*; see Christensen and Heilman-Clausen 2013).

Tricholoma matsutake has become rare in Japan due mainly to a rapid decline of the pine forests there. This forest decline is caused by invasions of the pine wood nematode (*Bursaphelenchus xylophilus;* pine wilt disease; Mamiya 1988, Kishi 1995). Also in SW China *T. matsutake* and its pine forests have declined for a long time, due to intensive cultural influence including deforestation (Geslani 2008).

The “matsutake-group” is a large and morphologically difficult species complex with at least 7 taxa in the northern hemisphere. We probably have 5 species in Europe. In addition to *T. matsutake* s. str., we find *T. dulciolens* in rather oligotrophic, often sandy *Picea*(!) forests, *T. ilkkai* nom. prov. in dry, calcareous pine(-spruce) forests, and finally *T. caligatum* in Mediterranean districts under pine and possibly also *Quercus* (Christensen and Heilmann-Clausen 2013). In Turkey another closely related taxon is described; *Tricholoma anatolicum* growing under *Cedrus* trees (Ota et al. 2012). In North and Central America a couple of species very close to, but somewhat paler than *T. matsutake* s. str. "takes over" (*Tricholoma magnivelare* coll.; Chapela and Garbelotto 2004). However, according to genetic studies, also "the true" *T. matsutake* occurs, although rare, in eastern North America (Chapela and Garbelotto 2004).

Tricholoma focale: This resembles *T. matsutake*, but differs e.g. in the more redbrown colours and a strong mealy smell (at least when cut). *Tricholoma focale* is one of the most frequent sandy pine forest species in Norway with more than 60 localities recorded in this habitat per 2013. It typically occurs along small roads, paths and in small screes, often together with *Albatrellus subrubescens*.

The species is widely distributed in Norway, with large populations e.g. in eastern/continental valleys such as NW Gudbrandsdalen and Østerdalen in S Norway (Brandrud and Bendiksen 2014) as well as Pasvik in N Norway (R. Midteng, pers. comm.). It also occurs rather frequently in the calcareous areas around lake Mjøsa.

The species appears to have its European core areas in E Norway-Sweden-Finland, probably also further east into Russia (found east to Siberia, Dörfelt and Bresinsky 2003). The species is widely distributed in Sweden, north to Norrbotten, with only a few, scattered finds in S Sweden (altogether more than 250 known localities). In Finland it is rather common and in the north even common (Salo et al. 2005). Also in Denmark the species has a rather wide distribution, in sandy areas (approximately 40 localities in the Danish Fungi Atlas; Danmarks Svampeatlas 2014).

Tricholoma focale has a very wide, but rather fragmented distribution in Europe, from almost subarctic N Norway to the Mediterranean Sea including North Africa and the Canary Islands (Dörfelt and Bresinsky 2003, Izoquierdo et al. 2004, Christensen and Heilmann-Clausen 2013). The species is rare in C Europe (Christensen and Heilmann-Clausen 2013), but has a core area in Germany on the sandy ice-front deposits in Brandenburg in former E Germany (Dörfelt and Bresinsky 2003). The species is recorded also from pine forests regions in Japan (e.g. Murata et. al. 2002), where it is much used as an edible mushroom, although not regarded as valuable as *T. matsutake*. *Tricholoma focale* is regionally rather frequent in North America, according to Bessette et al. (2013) and Voitk (2012).

The species seems to have sandy pine forests as its major habitat throughout Europe. In Germany the species is recorded in sandy, oligotrophic pine stands, especially old lichen-dominated pine forests, as well as sand dune pine forests along the coast (Dörfelt and Bresinsky 2003).The species is not recorded from calcareous areas in C Europe. In Mediteranean areas the species occurs e.g. under *Pinus pinaster* in coastal sandy soil, in the Canary Island under *Pinus canariensis* (Dörfelt and Bresinsky 2003, Izoquierdo et al. 2004).

Tricholoma focale is regarded as threatened in almost entire Europe except Fennoscandia (due to large populations), for instance in Great Britain (Evans et al. 2006), Bavaria, Germany (Karasch and Hahn 2009), the Czech Republic (Holec and Beran 2006), Switzerland (Senn-Irlet et al. 2007). The species is also included on a proposal for a European redlist (Ing 1993). The decline in large parts of Europe seems to be due to small populations and a strongly declining habitat (dry (sandy) pine forests) caused mainly by high nitrogen depositions (Dörfelt and Bresinsky 2003, Vesterholt et al. 2000). The species probably has as strong decline as *T. matsutake* in Asia due to pine forest pathogens and deforestation.

The Norwegian/Nordic populations in a European perspective

The sandy pine forest element in Norway is species rich, with 39 specialists (Table 1), probably in reality more than 40 specialists if a couple *Tricholoma* species (*T. sudum, T. stans*) are added (now with lack of precise and updated habitat data). The number may change in future; we have still limited knowledge.

Furthermore, some eastern species can be added to the list, with a strict occurrence in sandy pine heaths of N Sweden and N. Finland, e.g. *T. roseoacerbum*. On a Nordic scale, *Tricholoma colossus* can probably also be added (Bolin 2001, ECCF 2001). As an approximation, about 45 species must be regarded as sandy pine forest specialists in Fennoscandia, and many more have an important (although probably not major) habitat in such sites; e.g. *Hydnellum ferrugineus*, *H. peckii, Phellodon tomentosus* and *Cortinarius*, sect. *Dermocybe* (*C. croceus, C. semisanguineus*, etc.).

As shown above, some of our sandy pine forest species have a wider ecology elsewhere in Europe. This applies to e.g. *Albatrellus subrubescens* and *Bankera fuligineoalba*. However, most of these are strict sandy pine forest specialists throughout Europe, from coastal, sandy *Pinus pinea-P. pinaster* forests of the Mediterranean region including the Canary Islands via glacial deposits in the Prealps to the extensive glacial deposits of Northern Europe including Balticum, The Netherlands and parts of Germany and Poland. In some countries such as The Netherlands most of the indigenous pine forest taxa (e.g. all the hydnoid ones) are associated with sand deposits (cfr. e.g. Arnolds1989, 2009). As a rule, these sand associates are rare in Europe outside Fennoscandia.

Some of the *Cortinarius* habitat-specialists are with present knowledge absent from the rest of Europe; including *C. areni-silvae, C. carabus,* and *C. coleoptera*, and others like *C. pinigaudis* and *C. pinophilus* seem very rare (see specific treatment above). Among the hydnoid taxa, both *Hydnellum gracilipes* and *Phellodon secretus* appear to be northern, mainly/only (Scotland-)Nordic-W Russian species, with a more or less taiga distribution. The tricholomas appear widespread in Europe, from Mediterranean areas to north of the polar circle, but international literature indicate that these are very rare outside Fennoscandia (see above). It is suggested that approx. 70-80% of the European populations of the sandy pine forest tricholomas nowadays are found in the Nordic countries (Brandrud 2013b).

The sandy pine forests show a rather fragmented occurrence in Europe outside Fennoscandia(-NW Russia), and these fragments are also strongly declining and being depauperated at present, due to e.g. urbanization, forestry (including shift in tree species and fertilization) and especially eutrophication due to high N-depositions (e.g. Dörfelt og Bresinsky 2003 from Germany, Arnolds and Jansen 1992, Arnolds 2009 from The Netherlands, and Vesterholt et al. 2000 from Denmark, see also Dahlberg and Croneborg 2003). In Norway there are no historical indications of a decline due to N-deposition or acidification (see e.g. Gulden and Hanssen 1992 on hydnaceous fungi), although there are indications that shallow-soil pine forests are approaching a critical limit for nitrogen loads for ectomycorrhizal fungi in SW Norway (Aarrestad et al. 2013), whereas our eastern sandy pine forests as well as those in N Sweden and N. Finland are in regions with low, not critical N-depositions, but these may be threatened by forest fertilization (Aarrestad et al. 2013).

It should be added that for the old-growth forest species such as *Hydnellum gracilipes* and *Sarcodon scabrosus*, also the Fennoscandian-NW Russian, larger, continuous sandy pine forests must be regarded as fragmented, due to an increasing influence of forestry, also in remote regions, leaving only remnants of forests in natural conditions, with old trees, regular forest fires, etc.

Some of our sandy pine forest species such as *Tricholoma matsutake* are widespread in Asia including Japan, whereas others such as *Tricholoma apium* are not known for instance from Japan (A. Yamada, pers. comm.). Probably some of the hydnoid-poroid taxa such as *Boletopsis grisea* and *Sarcodon squamosus* are present in Asia as well, but they are referred collectively in the literature (as *Boletopis leucomelaena* and *Sarcodon imbricatus*). *Bankera fuligineoalba* is recorded from Japan according to Otto (2011). The occurrence of our Norwegian-Nordic sand-dwelling cortinarii in Asia/Japan is hardly documented.

The pine forests of parts of Asia and especially of Japan are suffering a serious decline due to the invasion of the pine wood nematode (*Bursaphelenchus xylophilus*), causing great damage and death of the native pines such as *Pinus densifolia* (pine wilt disease; Mamiya 1988, Kishi 1995). Also in SW China, an important region for matsutake export, the habitat is reported to be declining, due to too heavy cultural influence and deforestation of the local pine forests (Geslani 2008). Formerly, *Tricholoma matsutake* probably had its largest populations in Japan, Korea and SW China, but now the populations may be as large, and much more stable and intact in Northern Fennoscandia.

The sandy pine forest fungi are regarded as threatened on the most national red-lists in Europe, and many of the more well-known are included on a proposal for a European red-list (Ing 1993).

Based on the above distributional and threat patterns, we conclude the following:

- The sandy pine forest fungi element apparently has its largest populations and its largest Eurasian diversity in the Fennoscandian pine heaths.
- Elsewhere in Europe and Asia, the habitat for these sandy pine forest fungi is fragmented and seriously declining due to eutrophication, deforestation, area-loss and (in Asia) the pine wilt disease.
- The Fennoscandian sites are of special international importance for the conservation and management of this threatened habitat and their fungi.
- The most regionally threatened sandy pine forests species should be considered for a European Red-List.

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Entoloma porphyrogriseum Noordel. confirmed from Norway

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Norsk tittel: *Entoloma porphyrogriseum*, en rødsporesopp bekreftet fra Norge

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KEYWORDS
Entoloma porphyrogriseum, distribution, Norway, calcareous spruce forest

NØKKELORD
Entoloma porphyrogriseum, Norge, utbredelse, kalkskog

SAMMENDRAG
Entoloma porphyrogriseum er bekreftet som del av fungaen i Norge basert på nylig innsamlet materiale fra Steinkjer i Nord-Trøndelag. Den vokser i fuktig lågurtvegetasjon i kalkgranskog. Arten kan forveksles med *E. poliopus* var. *parvisporigerum* og *E. pseudocoelestinum* og diagnostiske forskjeller mot disse artene blir diskutert. *Entoloma porphyrogriseum* er med dette kjent fra Danmark, Italia, Norge, Tyskland og Østerrike.

ABSTRACT
Entoloma porphyrogriseum is confirmed as present in Norway based on recently collected specimens from Steinkjer, Nord-Trøndelag. It was found in humid, low-herb vegetation in a calcareous spruce forest. The species is most likely to be confused with *E. poliopus* var. *parvisporigerum* and *E. pseudocoelestinum* and the distinctions from these species are discussed. *Entoloma porphyrogriseum* is so far known from Austria, Denmark, Germany, Italy and Norway.

INTRODUCTION

The genus *Entoloma* is a large genus comprising about 350 known species in Europe with more than 200 species known from the Nordic countries (Noordeloos 1992, 2004, Knudsen and Vesterholt 2012). Many species are difficult to separate due to intraspecific variation in spore shape and size and the type of pigmentation in the covering layer of the pileus.

During field work in calcareous coniferous forests in Steinkjer municipality, Nord-Trøndelag county, central Norway in 2013, a species of *Entoloma* with a distinctly striate, porhyraceous brownish cap and a polished, bluish grey stipe was collected by the first author and identified by the second author as *Entoloma porphyrogriseum*. The species has previously been reported from Norway (Nordland, Grane) by Knudsen and Vesterholt (2012), based on a collection consisting of three specimens examined by the second author. Since the porphyraceous tinges of the pileus were not clearly discernible, and not mentioned in the submitted information, the specimens from Grane were identified with some uncertainty. However, the data available, such as the observation of the striate margin and bluish stipe, as well as the microscopically features, keyed it out as *E. porphyrogriseum*. The aim of this paper is to confirm the presence of *E. porphyrogriseum* in Norway.

Figure 1. *Entoloma porphyrogriseum*, habitus (Holien 106/13). Photo: H. Holien.

Furthermore we give a short description of the collected specimens and the habitat where they occurred and point out characters which separate *E. porphyrogriseum* from similar species.

THE SPECIES

Entoloma porphyrogriseum was first described by Noordeloos (1987) based on material from Jylland, Denmark. It belongs to the subgenus *Leptonia* in stirps *Asprellum* (Noordeloos 1992, 2004, Vesterholt 2002). A good picture is found in Noordeloos (2004, page 1326), and the first color drawings are shown by Vesterholt and Brandt-Pedersen (1990). According to the original description *Entoloma porphyrogriseum* is mainly characterized by a dark purplish brown (porphyraceous brown), translucently striate pileus with a darker (blackish) and somewhat squamulose, slightly depressed to distinctly umbilicate centre, glabrous beyond that. The smooth and polished stipe is described as steel blue to pure grey (Vesterholt and Brandt-Pedersen, 1990) or light grey to greyish blue, light pruinose in the upper part and distinctly white tomentose at the base. Diameter of the cap range between 15 and 30 mm whereas the length of the stipe varies from 5 to 60 mm. The gill edge is sterile with hyaline cheilocystidia.

Since the only collection known was the original one from Denmark, the description of spores in earlier literature was based on measurements reported by Vesterholt and Brandt-Pedersen (1990), given as 7.5-10 x 6-

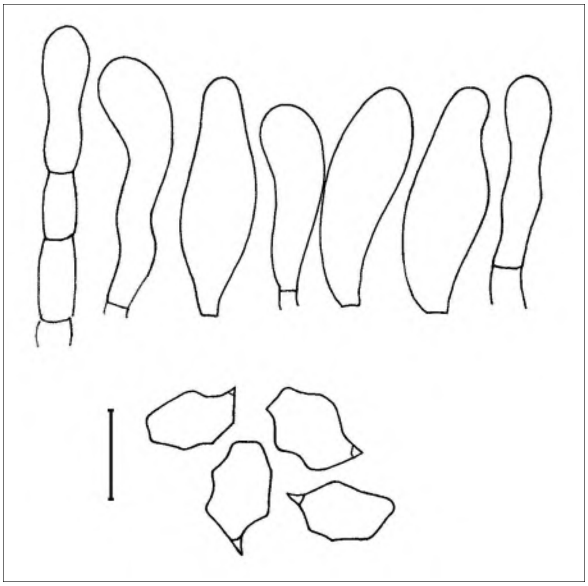

Figure 2. *Entoloma porphyrogriseum*, cheilocystidia and basidiospores (Holien 106/13). Scale = 10 µm. Ill. Ø. Weholt.

8 µm. Hence, the spore size in the first volume of *Entoloma* was repeated (Noordeloos 1992). Average sizes were 9.0-9.5 x 6.4-7.0 µm, and Q-value was 1.2-1.6, with average Q = 1.3-1.6. This shows that the spores are rather small, and should in the keys be placed in a group with average spores less than 10 µm. Cheilocystidia were described as cylindrical to narrowly clavate or sublageniform, size 30-60 x 6-15 µm.

Not until 1995 (Noordeloos et al. 1995) the species was found outside Denmark, and several collections from Austria, Germany and Italy were examined, leading to a slightly better description of microscopical variation. The spore size was then given as 7.5-11.1 x 5.6-8.7 µm, average 9.3 x 7.0 µm, Q-value as 1.2-1.5. Cheilocystidia were reported as slightly smaller than previously given, 25-41 x 6-13 µm, about the size of the basidia.

DISCUSSION OF NORWEGIAN MATERIAL

Macroscopically the specimens from Steinkjer comply perfectly well with the description in the literature, in particular with the picture found in Noordeloos (2004). The specimens are shown in Fig. 1.

The spore size was in the range 8.5-11.0 x 6.1-7.0 µm, average 9.8 x 6.6 µm, Q-value = 1.3-1.7, average Q = 1.5, based on 25 spores. The cheilocystidia observed were somewhat smaller than given in the literature, scarcely protruding the basidia, but the shape, as shown in Fig. 2, is considered to concord sufficiently well with the illustrations depicted by Noordeloos et al. (1995). However, the shape variation appears to be greater than previously shown. The specimens from Grane are also characterized by small cheilocystidia, but with shape of the same type as the specimens from Steinkjer. Consequently, the collection from Steinkjer, supports the assumption that the specimens from Grane also belong to *E. porphyrogriseum*.

Entoloma porphyrogriseum is most often confused with *E. poliopus*, particularly *E. poliopus* var. *parvisporigerum*. However, this species lacks the striate, porphyraceous brown pileus and is more distinctly squamulose. Microscopically it has larger and differently shaped cystidia, but almost similar spore size. Another possible confusion is *E. pseudocoelestinum* with violaceous tinged pileus and small spores, but it has a fertile gill edge without cheilocystidia.

Specimens examined: Norway, **Nord-Trøndelag:** Steinkjer: Vestre Dyen, UTM: PS 2923, 1029; 64.095°N, 11.648°E, alt. ca. 80 m, 12.08.2013, H. Holien 106/13 (TRH). **Nordland:** Grane: Holmvassdalen, UTM: VN 4481, 2178; 65.332°N, 13.330°E, alt. ca. 250 m, 07.09.2011, J. Lorås & S-E. Eidissen 44/2011 (Ø. Weholt, private herb.).

DISTRIBUTION AND ECOLOGY

The Norwegian specimens of *E. porphyrogriseum* from Steinkjer were found in an open and humid location with herb-rich vegetation in a young calcareous spruce forest. Among associated vascular plants were e.g. *Cirsium heterophyllum, Listera ovata*, *Pyrola rotundifolia* and *Rubus saxatilis*. In an old spruce forest very close to this spot a number of fungi characteristic of calcareous spruce forests were recorded, among them *Bankera violascens*, *Cortinarius serarius*, *C. solis-occasus, C. spilomeus*, *Hydnellum geogenium* and *Ramaria testaceoflava*.

The collection from Grane was reported to grow in rich, calcareous low-herb vegetation with e.g. *Thalictrum alpinum*. An old calcareous spruce forest was bordering this open field. Several other rare fungi were associated, e.g. *Camarophyllopsis micacea*, *Entoloma coeruleoflocculosum* and *E. scabropellis*.

The original collection from Denmark was reported to grow in open grassland near *Salix repens* on calcareous soil. The specimens from other countries were reported from grassy, open habitats with spruce, on calcareous soil, hence apparently similar to the Norwegian records.

Entoloma porphyrogriseum has so far been reported from Austria, Denmark, Germany and Italy (Noordeloos 1987, Noordeloos et al. 1995, Hausknecht and Zuccherelli 1996). According to Vesterholt (2002) it is probably a rare species and therefore a potential candidate for the Norwegian red list of species.

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Variasjoner i mangfold og fruktifisering av beitemarksopp basert på 11 års inventering av kulturlandskap i Sunnhordland, Vest-Norge

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NØKKELORD
Beitemarksopp, inventeringsfrekvens, langtidsstudier av fruktifisering

KEYWORDS
Grasslandfungi, frequency of investigation, longtime study of fructification

ABSTRACT

Hovaneset is located in the municipality of Stord and are one of the richest localities for grassland fungi in the southwestern part of Norway (Sunnhordland). All together 71 different grassland fungi are known from the area including 32 species which are found on the Norwegian red list. The area has been investigated several times the last 11 years (2003-2013), and the last four years almost once a week in the season resulting in totally 80 visits. Every year some new species were found, but after the season had been expanded to a visit almost every week the number increased profoundly. The number of redlisted species was almost doubled from the year before. Even in 2013 six new species appeared, four of them redlisted. Among them was the very seldom *Clavaria pullei*. Only eleven species were retrieved each year, and these were mostly ordinary species. Nine species, most of them red listed, were found only once. Even after 11 years of investigation the number of species for some groups does not even out, which can indicate a potential for more undiscovered species. The number of species found varied during the season, but were on the highest from the end of August to the middle of September. On every visit in this period, between 37 and 51 % of the species occurring in the area was found. Several new species were found when the investigation started early in the season, and experience from 11 years of investigation shows that several species have a very irregular fructification between years. This is mostly species from genus *Hygrocybe* and the family Clavariaceae.

SAMMENDRAG

Hovaneset er i dag en av de mest artsrike beitemarkene i Sunnhordland med totalt 71 ulike arter beitemarksopp der 32 står på den norske rødlisten. Området har vært inventert flere ganger årlig de siste 11 årene (2003-2013), og de siste fire årene nesten ukentlig i soppsesongen. Området er besøkt totalt 80 ganger i løpet av denne tiden. Hvert år har det dukket opp nye arter, men først når den årlige inventeringen ble intensivert i 2010 steg antallet arter drastisk, og antall rødlistearter ble nesten fordoblet fra året før. Selv det siste året ble det funnet seks nye arter der fire av disse

var rødlistearter, bl.a. den meget sjeldne brun køllesopp (*Clavaria pullei*). Bare 11 arter er gjenfunnet hvert år, og dette er i hovedsak ordinære arter. Ni arter er kun funnet i et av årene, de fleste av dem er rødlistearter. Selv etter 11 års inventering ser antallet for flere av soppgruppene ikke ut til å flate ut, noe som kan tyde på et potensial for enda flere funn. Antall arter varierer gjennom sesongen, men er størst fra slutten av august til midten av september. På en enkelt inventering i denne perioden ble det funnet mellom 37 og 51% av de artene som nå er kjent fra området. Flere arter ble funnet når inventeringen startet tidlig, og erfaringene fra 11 års inventering viser at mange arter har svært uregelmessig fruktifisering. Dette gjelder særlig arter innenfor vokssopp (*Hygrocybe*) og fingersopp (Clavariaceae).

INNLEDNING

Til Sunnhordland regnes den sørligste delen av Hordaland som vanligvis omfatter kommunene Stord, Fitjar, Tysnes, Sveio, Bømlo, Kvinnherad og Etne. Kunnskap om forekomst av beitemarksopp i Sunnhordland var før tusenårsskiftet svært mangelfull. Gjennom de siste 10-12 årene er kulturlandskap blitt omfattende inventert, noe som har ført til et stort tilfang av kunnskap om utbredelsen av ulike arter av beitemarksopp (NSD 2014). Stord er den eneste kommunen der det tidligere har vært registrert beitemarksopp av betydning. De fleste registreringer er gamle, og noen funn går helt tilbake til Axel Blytt på slutten av 1800-tallet (NSD 2014).

Til beitemarksoppene regner vi vanligvis noe få slekter og familier som i hovedsak ser ut til å trives best i kulturlandskapet. Dette er vokssopp (*Hygrocybe*), rødsporesopp (*Entoloma*), fingersopper (*Clavaria, Clavulinopsis, Ramariopsis*) og jordtunger (Geoglossaceae), samt slektene narrevokssopp (*Camarophyllopsis*), narremusseronger (*Porpoloma*), grynmusseronger (*Dermoloma*) og hettesopper (*Mycena*).

Mange beitemarksopp er sjeldne og krevende. Det er særlig ugjødslete beitemarker og slåtteenger som er hovedbiotopene for disse. Opphør av beite fører til gjengroing, og gjødsling fører til favorisering av mer næringskrevende arter både av karplanter og sopp. Gjengroing kan i noen grad reverseres ved å gjenintrodusere beitedyr slik at soppen kommer tilbake, mens gjødsling ser ut til å være en mer irreversibel prosess (Arnolds 1989, Vesterholt og Knudsen 1990). En del arter foretrekker kalkrike lokaliteter, men vi finner også mange sjeldne og rødlistede arter som trives godt på mer fattig og sur jord. Mange av disse artene er derfor gode indikatorer for verdifulle kulturlandskap, sannsynligvis bedre indikatorer enn karplanter (Rald 1985, Öster 2008). Beitemarksopp forekommer også ofte ”klumpvis” på samme lokalitet.

Generelt er det en klar korrelasjon mellom antall arter som blir funnet på en lokalitet og intensiteten av inventeringen (Parker-Rhodes 1955, Watling 1995). I følge Parker-Rhodes er det sjelden at en ved ett besøk finner mer enn 25% av de artene som vokser her. Orton (1986) konkluderer med at data fra minst 10 år er nødvendig for å få et riktig bilde av de artene som vokser på en bestemt lokalitet. Newton et al. (2003) inventerte fem lokaliteter med gamle beitemarker mellom 10 og 16 ganger i løpet av en periode på tre år (1999-2001). Artsmangfoldet økte for hvert besøk, og det konkluderes med at minst 16 besøk på en lokalitet er nødvendig for å få et godt bilde av soppmangfoldet på lokaliteten. Straatsma et al. (2001) inventerte et skogsområde i 21 år fra mai til september. Nye arter dukket opp hvert år, men bare åtte arter ble funnet alle årene.

Økt inventeringen av beitemarker i Sunnhordland de siste ti årene har ført til at det i de fleste kommunene nå er kjent mellom 50 og 100 ulike arter, mange sjeldne og rødlistet (NSD 2014). Det er tidligere vist at Sunnhordland har en særlig rik og variert forekomst av jordtunger (Fadnes 2011a), og for de fleste andre gruppene er utvalget av arter stort.

Sunnhordland ser derfor ut til å være et kjerneområde for lokaliteter med sjeldne og rødlistede beitemarksopp, og gjennom 11 års egen inventering av gamle beitemarker i Sunnhordland (Moe og Fadnes 2007, Fadnes 2011b, 2013), er det tydelig at det er mange faktorer, foruten geologiske og edafiske, som spiller inn når det gjelder hvilke arter vi faktisk finner på en bestemt lokalitet. Viktige faktorer som denne artikkelen fokuserer på er fruktifiseringstidspunkt, tidspunkt og frekvens av inventering og årlige variasjoner i fruktifisering hos ulike arter. Målet med denne studien var derfor å studere variasjoner i mangfold og fruktifisering av beitemarksopp gjennom 11 års inventering av kulturlandskap i Sunnhordland, Vest-Norge

MATERIALE OG METODER

Lokaliteten som er hovedgrunnlaget for denne artikkelen, Hovaneset, er inventert fra 2003 til 2013. Fra 2003 til 2009 ble det foretatt tilfeldige besøk på lokaliteten i soppsesongen. Intensiteten varierte fra to til fem besøk pr sesong. I 2010 økte antall besøk til ti, og de tre siste årene (2011-13) er lokaliteten besøkt 15 ganger pr år, dvs. ett besøk i uken i soppsesongen. Totalt er Hovaneset inventert 80 ganger i løpet av disse 11 årene. Ved hver inventering er et fast spor på ca. 2 km blitt fulgt, og på denne måten er hele området blitt systematisk undersøkt ved hvert besøk. Alle funn er registrert ved hvert besøk. Sjeldne og rødlistede arter er koordinatfestet, og belegg er sendt soppherbariet i Oslo (NSD). Mer ordinære arter er i hovedsak registrert i Artsobservasjoner.no

Sopp som i hovedsak er knyttet til næringsrik jord og møkk er notert men ikke tatt med i denne undersøkelsen. En lokalitet kan også ha flere delforekomster av en art. I en delforekomst er det vanskelig å si hvor gammelt mycelet er og hvor stor utbredelse det har, men en avstand på mer enn 10m mellom forekomstene er foreslått som to separate mycel (Jordal 2013). I denne undersøkelsen er forekomstene minst 25m fra hverandre før de er blitt regnet som to delpopulasjoner. På Hovaneset er delforekomster hovedsakelig av rødlistearter registrert (Tabell 2).

Narrevokssoppene hører i dag systematisk under familien Clavariaceae (Boertman 2012), selv om de morfologisk er mer like vokssoppene. I denne artikkelen er narrevokssoppene behandlet sammen med vokssoppene. Jordtungene innenfor slekten *Microglossum* har vha DNA analyser vist seg i slektskap å stå et stykke unna de andre jordtungeslektene *Geoglossum* og *Trichoglossum* (Sandnes 2006). I denne artikkelen er de imidlertid behandlet sammen i familien Geoglossaceae. Griffith et al. (2013) har gjort en lignende tilpasning.

I 2013 ble det laget en utredning om truete beitemarksopp og et forslag til seks prioriterte arter (Jordal 2013). Utvalget er basert på utvalgskriteriet *kritisk truet* (CR) på rødlisten (Brandrud et al. 2010) eller høy andel av europeisk bestand i Norge. De seks foreslåtte artene er rosa vokssopp (*Hygrocybe calyptriformis*), tinnvokssopp (*H. canescens*), grå narremusserong (*Porpoloma metapodium*), slimjordtunge (*Geoglossum difforme*), vrangjordtunge (*Microglossum atropurpureum*) og vranglodnetunge (*Trichoglossum walteri*).

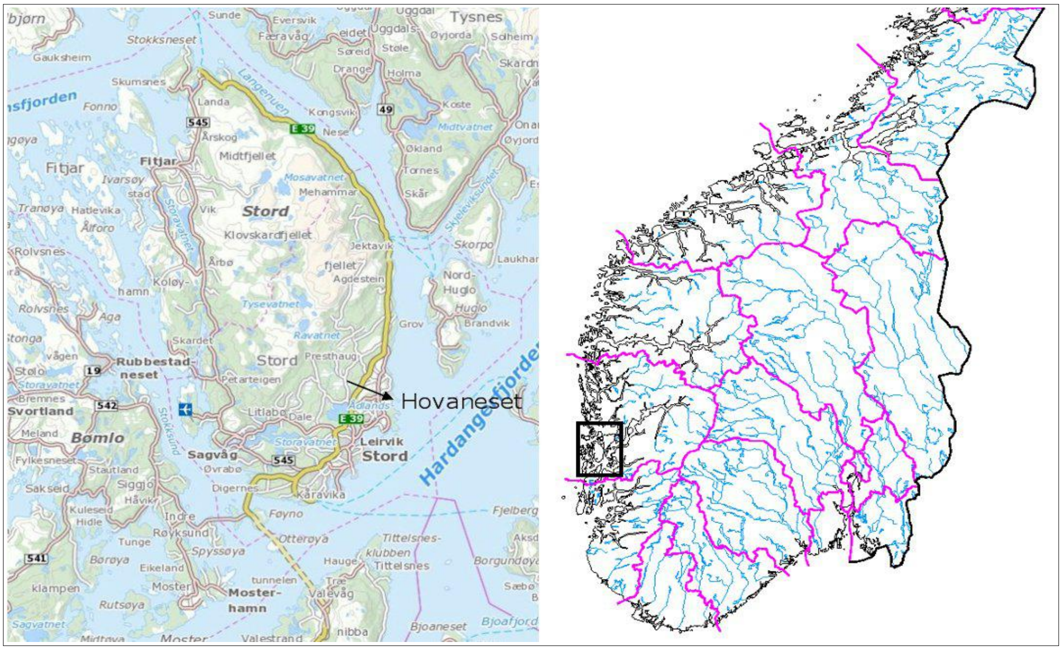
Beskrivelse av lokaliteten Hovaneset

Hovaneset er et nes i Langenuen like nord for Leirvik på østsiden av Stord (Fig. 1). Det er en stor naturbeitemark på ca. 70 daa med noen små myrete partier og beites av sau (Fig. 2). Det er stor sannsynlighet for at det har vært brukt noe gjødsel på de flateste partiene. Dette vises igjen i utbredelsen av beitemarksopp som i hovedsak er funnet i de noe mer kuperte randsonene av neset. Beitemarken er avgrenset av kalkrike strandberg der det i bergsprekker og på forvitringsjord vokser karplanter som pusleblom (*Anagallis minima*), knoppsmåarve (*Sagina nodosa*) og vårrublom (*Erophila verna*) i tillegg til fjellplantene rødsildre (*Saxifraga oppositifolia*) og gulsildre (*S. aizoides*). I selve beitemarken vokser en rekke krevende gras og urter som kamgras (*Cynosurus cristaus*), hjertegras (*Briza media*) og vill-lin (*Linum cathariticum*). Beitemarken varierer fra skrinn jord med gjeldkarve (*Pimpinella saxifraga*) og dvergsmyle (*Aira praecox*) til mer fuktige parti med engstarr (*Carex hostiana*) og blåstarr (*C. flacca*). Her vokser og den sjeldne og rødlistede arten bustsivaks (*Isolepis setacea*), som er kjent fra lokaliteten tidligere. Den ble etter lengre tids søk gjenfunnet i 2013. Gjennom 10 års inventering av sopp er det funnet over 70 beitemarksopper der 32 står på rødlisten og 15 er truet (Fadnes 2013). Hovaneset har vært nyttet av folk i Stord helt tilbake til bronsealderen, og det er her funnet flere gamle gravrøyser. Med 80 besøk er nok Hovaneset den beitemarken i Sunnhordland som er best undersøkt (Fadnes 2011b, 2013).

RESULTATER

Endringer i soppmangfoldet på Hovaneset i perioden 2003-2013

Figur 3 viser endringene i funn av beitemarksopp de siste 11 årene på Hovaneset. Antallet arter som ble funnet hadde en jevn økning fram til år 2009. Dette gjelder både det akkumulerte antallet av alle arter og av rødlistearter. Alle de samme artene ble ikke funnet hvert år, men antallet varierte mellom 20 og 26 og antallet rødlistearter mellom fire og sju. Dette endret seg mye da sesongen ble utvidet i 2010, og antall besøk på lokaliteten økte til 10 per år. Tretten nye arter ble funnet dette året, og 11 av disse var rødlistearter. Besøksfrekvensen økte ytterligere i 2011-2013 til ukentlige besøk og det ble fortsatt gjort nye funn hvert år. Totaltallet er i dag 71 ulike arter der 32 er rødlistet. Antall rødlistearter er nesten tredoblet siden 2009, og dette skyldes trolig i stor grad



Figur 1. Hovaneset, geografisk plassering i Stord, Sunnhordland.
Hovaneset, situated in Stord municipality, Sunnhordland, Western Norway.

Figur 2. Lokaliteten Hovaneset med Langenuen og Kvinnheradsfjellene i bakgrunnen.

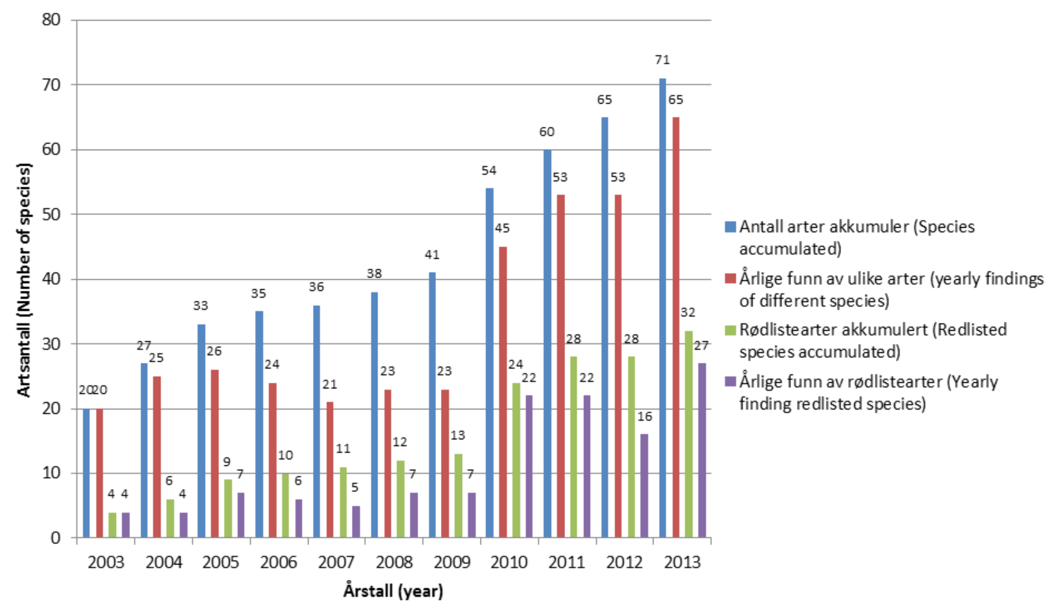
The locality Hovaneset with the fjord Langenuen and the mountains of Kvinnherad municipality in the background. Photo: P. Fadnes.

intensiverte undersøkelser. Antallet arter som er blitt funnet hvert år er mer enn fordoblet. På det meste er 65 ulike arter, deriblant 27 rødlistearter, funnet på et år (2013). I Tabell 1 er det vist hvordan de ulike artene er fordelt på soppslekter/familier.

Figur 4 er basert på 80 inventeringer og viser akkumulert antall av ulike soppgrupper gjennom 11 år. Kurvene viser en jevn stigning i antall arter fra alle soppgruppene hvert år frem til 2010. Etter dette skjer det imidlertid et markant sprang i alle gruppene grunnet intensiverte undersøkelser og deretter en jevn stigning i artsantallet for hvert år. Den eneste gruppen som flater helt ut etter 2010 er jordtungene. Artssammensetningen varierer fra år til år for alle gruppene. Den tidlige starten fra og med 2010 har særlig ført til økning i antall vokssopper og rødsporesopp. Vokssopper, som dukket opp som nye arter etter at inventeringen startet tidlig i 2010, var bl.a. flammevokssopp (*Hygrocybe intermedia*), rødnende lutvokssopp (*H. ingrata*), lutvokssopp *(H. nitrata*), svartdugget vokssopp (*H. phaeococcinea*), papillvokssopp (*H. subpapillata*) og gulfotvokssopp (*H. flavipes*). Ingen av disse var kjent fra Hovaneset før 2010 og alle er rødlistet.

Av nye rødsporesopp som ble funnet etter 2010 er melrødspore (*Entoloma prunuloides*), lillagrå rødspore (*E. griseocyaneum*) og lillastilket rødspore (*E. mougeotii*). En annen rødspore som ble funnet i 2010 er seinere bestemt til mulig kalkrødspore (*E.* cf *fridolfingense*) som er meget sjelden med få funn i Norge forutsatt at bestemmelsen er korrekt. Bare sju av de 18 rødsporesoppene som er kjent fra Hovaneset var funnet før 2010.

Den økte frekvensen av inventering førte også til at det ble funnet røykkøllesopp (*Clavaria fumosa*), grå grynmusserong (*Dermoloma cuneifolium*) og elegant små-



Figur 3. Endringer i soppmangfoldet på Hovaneset i perioden 2003-2013.
Changing in the diversity of fungi on Hovaneset in the period 2003-2013.

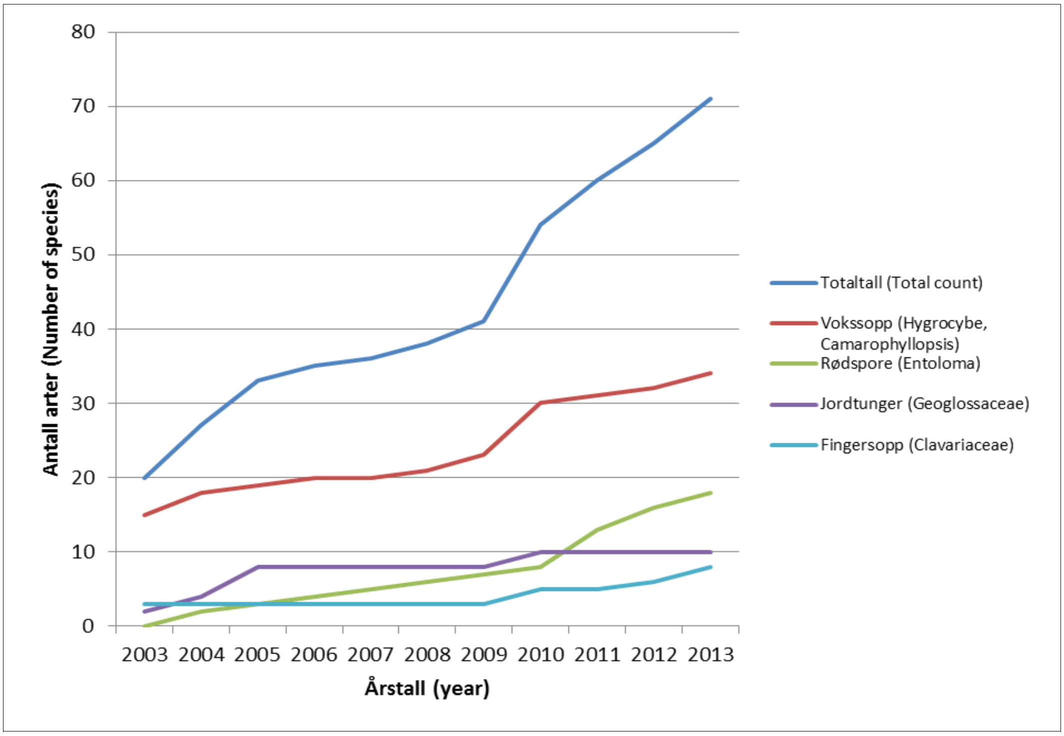
fingersopp (*Ramariopsis subtilis*) her for første gang. Grå grynmusserong representerer også første funn av denne på Vestlandet (NSD 2014). Selv siste år (2013) ble det funnet seks nye arter som ikke er registrert her tidligere. Fire av disse var rødlisteartene brun køllesopp (*Clavaria pullei*), musserongvokssopp (*Hygrocybe fornicata*), bittervokssopp (*H. mucronella*) og grå småfingersopp (*Calvulinopsis cinereoides*). Av brun køllesopp ble det i tillegg funnet to delforekomster og av musserongvokssopp tre. Det ble og bestemt to nye arter rødspore, striperødspore (*Entoloma juncinum*) og blyblå rødspore (*E. lividocyanulum*) som er relativt vanlige arter. Dette er med stor sannsynlighet arter som er funnet tidligere men ikke blitt bestemt.

Ukentlige variasjoner i fruktifiseringen av beitemarksopp

Figur 5 viser de ukentlige variasjonene i antall forskjellige arter som ble funnet i sesongen

Tabell 1. Antall arter fordelt på ulike soppgrupper funnet på Hovaneset
Number of species divided on different groups of fungi found on Hovaneset.

Soppgruppe	**Totaltall**	**Rødlistearter**
Vokssopper, Narrevokssopper (*Hygrocybe, Camarophyllopsis*)	32 + 2	16
Jordtunger (Geoglossaceae)	10	4
Rødsporesopp (*Entoloma*)	18	7
Fingersopp (*Clavaria, Clavulinopsis, Ramariopsis*)	8	4
Andre (*Dermoloma*)	1	1
Beitemarksopp totalt	71	32



Figur 4. Akkumulerte funn av ulike soppgrupper i perioden 2003-2012.
Accumulated findings of different groups of fungi found in the period 2003-2012.

2011-2013 basert på ca 15 ukentlige inventeringer hvert år.

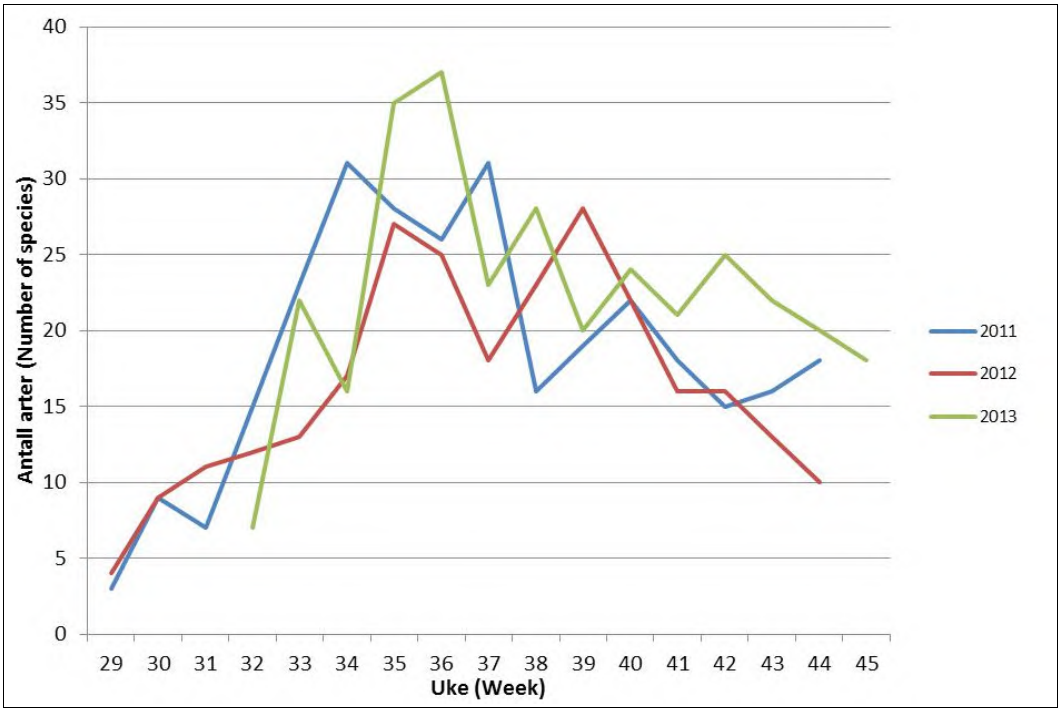
Det er få funn av beitemarksopp før midten av august (uke 34). Deretter er det en topp fram til midten av september (uke 37). Dette går igjen for alle tre årene, men det er og mindre topper seinere ut over i oktober. Funnene ved hver inventering i denne perioden representerer mellom 37 og 51 % av totalantallet av sopp som nå er kjent fra lokaliteten. Året 2012 har jevnt over et lavere ukentlig artsantall enn de to andre årene.

Figur 6 viser akkumulerte verdier for ulike grupper av beitemarksopp funnet på Hovaneset i 2013. Utviklingen i 2011 og 2012, som ikke er med her, viser samme trend. Etter midten av oktober (uke 41-42) øker ikke artsantallet, og kurvene flater ut. Kurvene viser også at antallet rødsporesopp flater ut først, mens vokssopper og jordtunger når toppen samtidig med totalantallet, noe som viser at det er blant disse artene vi finner de som fruktifiserer seinest.

Observasjon av enkeltarter

Tabell 2 viser at mange arter ikke blir gjenfunnet hvert år, og ofte er dette rødlistearter.

Noen arter er vanlig og fruktifiserer årlig, og 11 arter er funnet hvert år på Hovaneset. Disse er gul vokssopp (*Hygrocybe chlorophana*), brun engvokssopp (*H. colemanniana*), kjeglevokssopp (*H. conica*), mønjevokssopp (*H. coccinea*), seig vokssopp (*H. laeta*), engvokssopp (*H. pratensis*), pappegøyevokssopp (*H. psittacina*), russelærvokssopp (*H. russocoriacea*), krittvokssopp (*H. virginea*), gul småkøllesopp (*Clavulinopsis helveola*) og skjelljordtunge (*Geoglossum fallax*). De fleste av disse har også lang fruktifiseringsperiode og forekommer med flere delforekomster som



Figur 5. Ukentlige funn av beitemarksopp, Hovaneset 2011-2013. (Juli: 29-31, August 31-35 September: 35-39, Oktober : 40-44, November: 44-45).

Weekly findings of grasslandfungi, Hovaneset 2011-2013).

mest sannsynlig representerer ulike mycel. Brun engvokssopp, som er sjelden og rødlistet (VU), er funnet på seks delforekomster. Rød honningvokssopp (*H. splendidissima*) og vrangjordtunge (*Microglossum atropurpureum*) er begge funnet i ni av årene og er ganske vanlige med mange delforekomster.

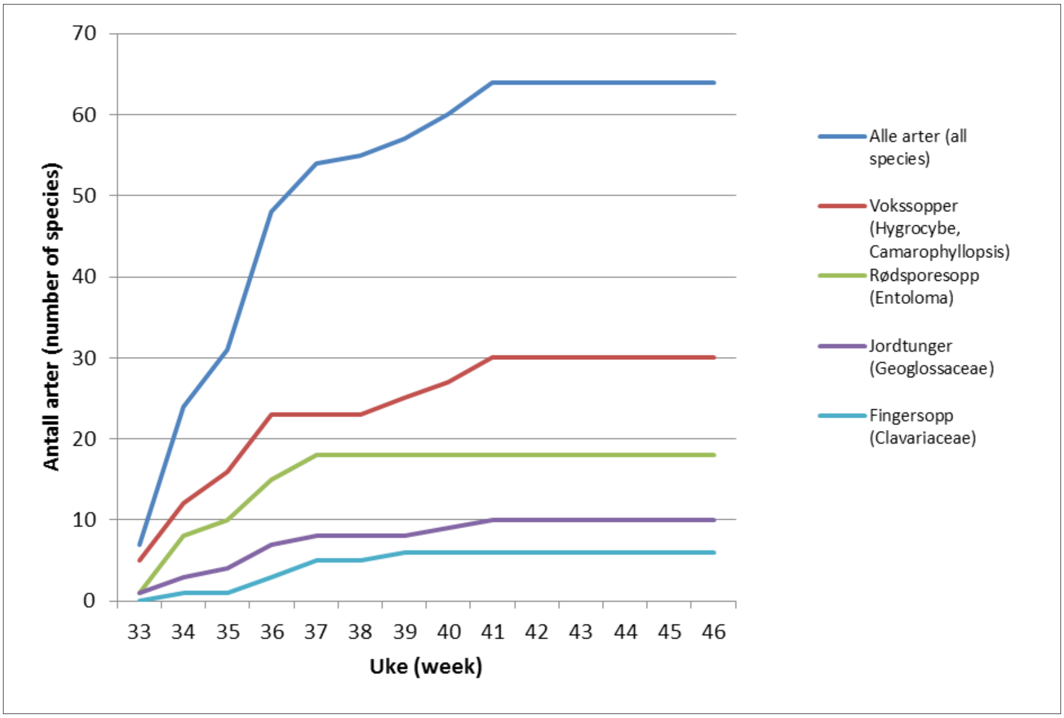
Flere arter er bare funnet én gang i løpet av de elleve årene inventeringen har foregått. I tillegg til dem som ble funnet for første gang i 2013 er dette: røykkøllesopp (*Clavaria fumosa*), gyllen vokssopp (*H. aurantiosplendens*) og papillvokssopp (*H. subpapillata*).

Røykkøllesopp er funnet på et fåtall lokaliteter i Sunnhordland, og der har den vist svært uregelmessig forekomst fra år til år. På Hovaneset ble den for første og eneste gang funnet i 2010. Brun køllesopp (*Clavaria pullei*) er en svært sjelden fingersopp med kun noen få funn på landsbasis (NSD). I 2013 ble den funnet for første gang med to delpopulasjoner på Hovaneset.

Sauevokssopp (*H. ovina*) ble funnet på Hovaneset første gang området ble inventert i 2003. Det tok seks år til den ble gjenfunnet på samme plass. Det er seinere funnet fire andre delforekomster av arten her, som også viser uregelmessig fruktifisering fra år til år.

Stanknarrevokssopp (*Camarophyllopsis foetens*) er lett å gjenkjenne på lukten, men den er relativt liten og kan være vanskelig å oppdage. Den er funnet på flere lokaliteter i Sunnhordland, men fruktifiserer svært uregelmessig. På enkelte lokaliteter er den kun funnet en gang, mens den på Hovaneset bare er funnet tre ganger (2004, 2005 og 2011) trass i at eksakt lokalisering er kjent.

Sumpjordtunge (*Geoglossum uliginosum*) ble funnet første gang i 2005 og er seinere blitt funnet nesten hvert år de siste årene fra



Figur 6. Akkumulerte funn av beitemarksopp, Hovaneset 2013. (Juli: 29-31, August: 31-35 September: 35-39, Oktober: 40-44, November: 44-45).

Accumulated findings of grasslandfungi, Hovaneset 2013.

slutten av juli til midten av november. Den er, i motsetning til mange andre sjeldne arter, et sikkert årlig funn i de fuktige partiene av beitemarken (Fadnes 2011a).

Tabell 2 viser at de ulike soppene har forskjellig fruktifiseringstidspunkt og lengde på fruktifiseringen. De fleste rødsporene er tidlige arter og forsvinner tidlig. Dette gjelder også enkelte vokssopper som flammevokssopp, lutvokssopp (*H. nitrata*) og rødnende lutvokssopp (*H. ingrata*). Gjennom de totalt 80 besøkene på Hovaneset siden 2003, har det gjennom hele inventeringsperioden dukket opp nye delforekomster av mange sjeldne arter (Tabell 2), og for de ulike artene varierer antall delforekomster fra en til ti.

Frost har en negativ innvirkning på fruktlegemene til sopp, særlig på små og tynnkjøttete arter. I løpet av oktober og november 2012 og 2013 var det flere frostperioder, og første snøfall kom i begynnelsen av desember. Dette så ikke ut til å ha avgjørende betydning for mange av artene. Flere av artene overlevde eller kom med nye fruktlegemer etter frostperiodene. Dette gjaldt fingersopper (*Clavulinopsis*), jordtunger og mange vokssopper. De fleste jordtungene ble gjenfunnet etter flere korte frostperioder. Både rød honningvokssopp og skarlagenvokssopp (*H. punicea*), som er seine arter, kom med nye fruktlegemer etter frostperiodene. Dersom frost uteblir kan mange av disse artene bli funnet helt i slutten av desember (Fadnes 2007).

DISKUSJON

En storstilt inventering av kulturlandskap det siste tiåret har gitt mye ny kunnskap om artsmangfoldet av beitemarksopp i Sunnhordland. Bare i Stord var det noen eldre funn av betydning, men flere av disse lokalitetene er ikke

Tabell 2. Oversikt over rødlistearter funnet på Hovaneset, delforekomster, funnår og fruktifiseringstidspunkt.
Redlisted species found on Hovaneset, number of occurences, year of finding and time of fructification.

Art	**Norsk navn**	**RL**	**Delforekomster**	**Funn År**	**Funnperiode**
Camarophyllopsis foetens	Stanknarrevokssopp	VU	2	2004, 05, 11	11.09-10.10
Camarophyllopsis schulzeri	Gulbrun narrevokssopp	NT	9	2008, 10, 11, 12,13	5.08-17.10
Clavaria pullei	Brun køllesopp	EN	2	2013	21.08-13.09
Clavaria fumosa	Røykkøllesopp	NT	1	2010	10.10
Clavulinopsis cinereoides	Grå småfingersopp	NT	1	2013	02.12
Dermoloma cuneifolium	Grå grynmusserong	VU	3	2010,13	07.09-14.10
Entoloma atrocoeruleum		NT	6	2010,11,12,13	12.08-16.09
Entoloma chalybaeum	Svartblå rødspore	NT	5	2007,10,11,12,13	12.08-14.09
Entoloma corvinum	Ravnerødspore	NT	4	2004,06,08,10,11,12,13	5.08-17.10
Entoloma cf. *fridolfingense*	Kalkrødspore	EN	2	2011,13	21.08-28-08
Entoloma griseocyaneum	Lillagrå rødspore	VU	7	2011,12,13	02.08-27.09
Entoloma mougeotii	Fiolett rødspore	NT	4	2011,12,13	10.08-07.09
Entoloma prunuloides	Melrødspore	VU	3	2011,13	07.09-20.09
Geoglossum simile	Trolljordtunge	NT	1	2010,11,13	22.08-24.10
Geoglossum uliginosum	Sumpjordtunge	EN	5	2005,09,10,11,12,13	01.08-30.10
Hygrocybe aurantiosplendens	Gyllen vokssopp	NT	1	2009	02.10
Hygrocybe colemanniana	Brun engvokssopp	VU	6	2003-13	22.08-12.11
Hygrocybe flavipes	Gulfotvokssopp	NT	6	2010,11,12,13	22.08-03.10
Hygrocybe fornicata	Musserongvokssopp	NT	3	2013	14.10-12.11
Hygrocybe ingrata	Rødnende lutvokssopp	VU	2	2010,11,12,13	05.08-14.09
Hygrocybe intermedia	Flammevokssopp	VU	5	2010,11,12,13	05.08-18.09
Hygrocybe mucronella	Bittervokssopp	NT	1	2013	14.10
Hygrocybe nitrata	Lutvokssopp	NT	1	2010,13	02.08-30.08
Hygrocybe ovina	Sauevokssopp	VU	5	2003,09,10,11,12,13	14.08-05.10
Hygrocybe phaeococcinea	Svartdugget vokssopp	NT	2	2010,12,13	12.08-17.10
Hygrocybe quieta	Rødskivevokssopp	NT	10	2006,08,10,11,12,13	22.08-17.10
Hygrocybe russocoriacea	Russelærvokssopp	NT	7	2003-13	23.09-05.12
Hygrocybe splendidissima	Rød honningvokssopp	VU	7	2005-13	14.09-05.12
Hygrocybe subpapillata	Papillvokssopp	VU	1	2010	12.08
Microglossum atropurpureum	Vrangjordtunge	VU	8	2005-13	21.08-05.12
Ramariopsis subtilis	Elegant småfingersopp	NT	1	2010,11,13	07.09-16.10
Trichoglossum walteri	Vranglodnetunge	VU	9	2003,05,06,10,11,13	07.09-31.10

lenger intakte. En av de soppene som ble funnet av Axel Blytt allerede i 1886 var grå narremusserong (*Porpoloma metapodium*). Den ble gjenfunnet for første gang i Stord i 2009. Funnstedet er likt, slik at dette kan være samme funn som Blytt gjorde på slutten av 1800 tallet. Dersom det er tilfellet, forteller det noe om hvor gamle mycel i beitemarker kan bli. I dag er det funnet over 80 ulike arter beitemarksopp i kommunen der 41 av disse står på rødlisten, mange i høy truethetsgrad. På Hovaneset er alle disse artene funnet med unntak av ca. 10. Av de 34 kjente vokssoppene (*Hygrocybe*) i Stord, er det kun skifervokssopp (*H. lacmus*) og mørkskjellet vokssopp (*H. turunda*) som ikke er funnet her. Den store økningen i funn av til dels sjeldne og rødlistede beitemarksopp sier noe om at det fremdeles er mange områder med gammelt kulturlandskap i regionen som holdes i hevd med årlig beitepress og fravær av gjødsling.

Til sammen er det funnet 32 ulike vokssopper, to narrevokssopper, ti jordtunger, 18 rødsporesopp, åtte fingersopper og en grynmusserong på Hovaneset. Av disse står 32 på rødlisten og 15 av dem er truet i kategoriene *sårbar* (VU) og *sterkt truet* (EN). Dette utmerker og Hovaneset som et svært viktig referanseområde for mangfoldet av beitemarksopp i Stord.

Kun 11 arter er funnet hvert år inventeringen har foregått. Dette er i hovedsak ordinære arter med unntak av brun engvokssopp (*H. colemanniana*). Ni arter er kun funnet i et av årene inventeringen har pågått. Foruten to rødsporesopp, er alle rødlistet og enten i slekten vokssopp eller i familien fingersopp. Dette er i tråd med observasjoner gjort av Straatsma et al. (2001).

Mange arter har tydeligvis ganske uregelmessig fruktifisering fra år til år og det trengs derfor mange besøk dersom en skal få det riktige inntrykket av artsmangfoldet i en beitemark. (Orton 1986, Newton et al. 2003).

Et interessant trekk når en studerer data over akkumulert artsantall for ulike soppgrupper er at kurvene ikke ser ut til å flate ut selv etter 11 år. Hvis alle artene som vokser her er funnet, skulle en forvente at kurvene asymptotisk hadde nærmet seg en grenseverdi. Det gjør de ikke. Tilsvarende observasjoner ble gjort av Newton et al. (2003). For de fleste gruppene viser akkumuleringskurvene en kraftig økning i antall artsfunn når antall årlige besøk øker til 10 pr år (2010) og seinere til 15 (2011-13). Det er kun kurven for jordtungene som flater ut etter 2010, mens de andre har en jevn stigning. Dette kan muligens bety at de jordtungene som vokser her er funnet, men at selv etter 80 besøk er det fremdeles et potensiale for å finne flere arter av vokssopp og rødsporesopp. Rødsporesoppene har relativt få funn de første årene. Etter at inventeringsfrekvensen økte med tidlig start på sesongen, har antallet rødsporesopp som er funnet mer enn fordoblet seg. Dette er en naturlig utvikling siden rødsporesopp generelt kommer tidlig i sesongen.

Når en studerer funn fra Hovaneset i sesongene 2011- 13 varierer de både mellom år og uker. Dersom en betrakter hver inventering som et enkelt besøk, ligger frekvensen av funn for en inventering helt opp i 50 % av totaltallet som til nå er funnet her hvis den blir foretatt i riktig uke. Dette viser at det er mulig å finne langt mer enn 25 % av totalantallet ved et enkelt besøk dersom dette skjer når fruktifiseringen er på sitt optimale (Parker- Rhodes 1955). For året 2013 sett under ett, ble hele 90 % av artene som nå er kjent fra Hovaneset funnet. Dette fremhever 2013 som et toppår for beitemarksopp i Sunnhordland, men også i 2011 og 2012 ble ca. 75 % av de nå kjente artene funnet i løpet av sesongen.

Akkumulerte artsdata for de ulike soppgruppene gjennom et år viser at kurven for rødsporesopp flater ut først mens vokssopper og jordtunger når sitt maksimum i første del av oktober. Dette er som forventet, men det viser seg og at for noen soppgrupper dukker det opp nye arter ganske seint i sesongen. Blant annet ble grå småfingersopp funnet så seint som i begynnelsen av desember.

Den store økningen i kunnskap om artsmangfoldet gjennom 11 års inventering, kan skyldes flere ting. Det er mest trolig at alle artene har vært der hele tiden, og at utviding av sesongen til 15 uker er en av årsakene til økningen. En annen årsak er at mange arter med stor sannsynlighet har en svært uregelmessig fruktifisering fra år til år.

For sopp som danner ektomycorrhiza, er det blitt vist at det ofte er liten overensstemmelse mellom mycel som finnes under bakken og de fruktlegemene som en finner under en inventering (Horton og Burns 2001). Genetiske analyser av mycel fra jord viser og ofte funn av mycel av arter som ikke er blitt sett fruktifisere på stedet. Siden flere sider av økologien til beitemarksopp ikke er kjent, er det vanskelig å sammenligne, men det kan være en ukjent faktor som gjør at noe lignende gjør seg gjeldende også for disse soppgruppene. Dette kan forklare sjeldenheten til noen av artene og den uregelmessige fruktifiseringen fra år til år.

De ni artene som kun er funnet en gang i løpet av 11 års inventering, er det naturlig å betrakte som uregelmessige når det gjelder fruktifisering. Andre arter er kun funnet i et fåtalls år. Observasjoner fra flere lokaliteter i Sunnhordland viser at særlig sjeldne arter innenfor fingersoppene (*Clavaria*) og noen vokssopper opptrer med særlig uregelmessig årlig fruktifisering. I tillegg til de to *Clavaria* artene som er funnet en gang på Hovaneset er det gjort tilsvarende erfaringer med andre arter innenfor slekten *Clavaria* i Sunnhordland. Fiolett greinkøllesopp (*Clavaria zollingeri*) og vridd køllesopp (*C. amoenoides*) har på andre hyppig inventerte lokaliteter vist seg å fruktifisere svært uregelmessig fra år til år. Av vokssoppene er det artene papillvokssopp, gyllen vokssopp, musserongvokssopp og bittervokssopp som kun er funnet i et av de årene Hovaneset har vært inventert, men og andre arter bl.a. sauevokssopp ser ut til å fruktifisere svært uregelmessig. Musserongvokssopp, som er funnet på en rekke lokaliteter i Sunnhordland, er sjelden gjenfunnet flere år på rad.

Øket inventeringsfrekvens har også ført til at mange sjeldne arter etter hvert er funnet med flere delforekomster. To av disse, vrangjordtunge og vranglodnetunge som begge er foreslått som prioriterte arter (Jordal 2013), er svært vanlige på Hovaneset og er i dag funnet med hhv åtte og ni delforekomster. For øvrig er alle de foreslåtte prioriterte artene funnet på ulike lokaliteter i Sunnhordland.

Årlige tidspunkt for fruktifisering er basert på lokale funndata og kan selvsagt variere fra andre steder i landet (NSD 2014). Det viser imidlertid at tidspunktet for inventering er avgjørende for om enkelte arter skal bli funnet ved et gitt besøk. Mange fruktifiserer tidlig i sesongen og tidlig inventering fra 2010 på Hovaneset førte til at et stort antall nye arter ble oppdaget. Ved å gjenta tidlig inventering de påfølgende årene, er flere av disse gjenfunnet hvert år. Dette gjelder bl.a. mange vokssopper og rødsporesopp, og viser at inventeringstidspunkt blir svært avgjørende for om en finner mange sjeldne arter. Utvalget på en bestemt lokalitet kan derfor være avhengig av både dato for inventering og hvor ofte og hvilket år den ble gjort. Dette kan kanskje og forklare sjeldenheten til noen arter.

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Ny musseronglitteratur

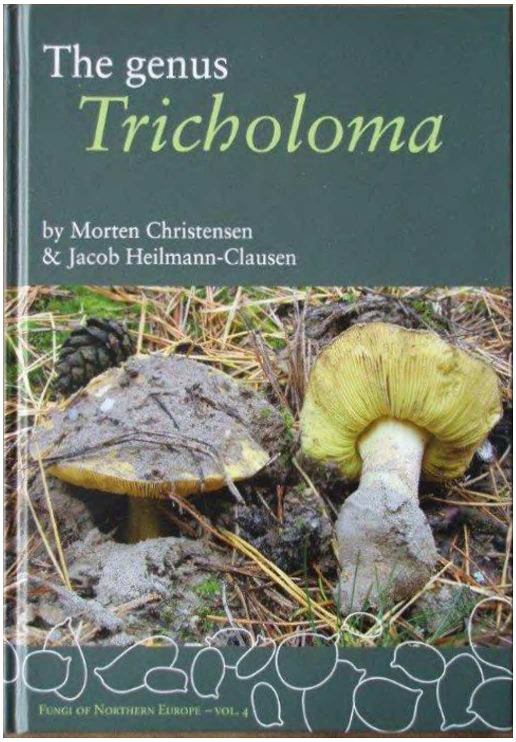
Christensen M, og Heilmann-Clausen J, 2013: The genus Tricholoma. Fungi of Northern Europe – vol. 4, 2013, 228 sider. Kan bestilles fra www.svampe.dk under Svampetryk. Pris DKr. 250 for medlemmer av Foreningen til svampekundskabens fremme, DKr. 300 for andre.

Bessette, AE, Bessette, AR, Roody, WC og Trudell, SA, 2013: Tricholomas of North America. A mushroom field guide. University of Texas Press, Austin, 2013, 208 sider. Pris: $ 29,95.

Kibby G, 2013: The genus Tricholoma in Britain, utgitt av forfatteren, desember 2012, 44 sider, A4-format, heftet. Kan bestilles fra www.nhbs.com. Pris: £ 15,50.

På kort tid har vi fått tre nye verker om musseronger (slekten *Tricholoma*). Det har vi ventet på lenge! Svært lenge har vi vært henvist til sør- og mellomeuropeiske verker om slekten (av M. Bon, A. Riva og R. Galli) og undertegnedes for lengst foreldete Musserongflora. Boken om Nord-Europas musseronger vil utvilsomt bli standardverket for oss i Norden lenge. De andre to, som dekker Nord-Amerikas og Storbritannias musseronger, er mindre aktuelle for oss, men interessante ut fra et soppgeografisk perspektiv. De tre bøkene behandler omtrent like mange arter: den nordeuropeiske 67 arter og den nordamerikanske og den britiske begge ca 70 arter, men de amerikanske forfatterne fremholder at slekten er dårlig kjent der borte. Mye er likt i de tre bøkene, foruten overlapp i artsinventar også i presentasjonen av stoffet – bl. a. med gjennomgående svært gode fargebilder. Samlet gir de inntrykk av at musseronger fremdeles langt på vei kan identifiseres på grunnlag av egenskaper vi kan observere i felt (form, farge, lukt, vegetasjonsforhold m.m.), og det er gledelig og nesten påfallende hvor stort samsvar de utviser i navnsettingen.

The genus *Tricholoma*, bind 4 i serien "Fungi of Northern Europe"



Forfatterne, de to danske mykologene Morten Christiensen og Jacob Heilmann-Clausen, har arbeidet med boka i mer enn 20 år og i den anledning besøkt de fleste deler av Europa. Den gir oss blant annet etterlengtede presentasjoner av flere sjeldne nordiske musseronger, så som sienamusserong (*T. joachimii*) og fjellsvovelmusserong (*H. hemisulphureum*) som først har blitt funnet i den senere tid, og av musserongene som nylig er beskrevet slik som oliven skjellmusserong (*T. olivaceotinctum*) og dystermusserong (*T. borgsjoeënse*). Alle disse inngår jo i Funga Nordicas nøkler, men når de ikke er avbildet og heller ikke tatt inn i noen felthåndbøker, kan de være vanskelige å bli kjent med.

Boka følger samme lesten som de tre foregående bindene i serien med en innledningsdel som inneholder beskrivelse av slektens viktigste makro- og mikroskopiske karakterer, økologi, typiske musserongvoksesteder og dertil noe om truete, giftige og spiselige arter – alt kortfattet og 'to-the-point'. Hoveddelen behandler 67 arter med gjennomgående to siders oppslag for hver art. Her gis beskrivelse av artene med både makro- og mikroskopiske karakterer, kort omtale av økologi og utbredelse, fargefotografi (som regel ett, iblant 2-3 for hver art), tegninger av sporer og dessuten lett skjematiske utbredelseskart. En kort diskusjon om nærstående arter og usikre momenter i artsavgrensingen m.m. avslutter beskrivelsene. Etter mitt skjønn er dette forbilledlig utført. Forfatterne har hele veien lagt til grunn beskrivelser av sine egne funn (en oppgave over disse fins bak i boken), og teksten er ryddig med alle sett av opplysninger for alle arter.

Bestemmelsesnøkkelen(e) fyller ni sider og bygger så godt som utelukkende på feltkarakterer. Mikroskopiske karakterer er i blant føyd til men anvendes bare to steder som hovedskilletegn. Derimot er lukt benyttet hele elleve ganger som nøkkelkarakter - så pass godt på luktesansen! Husk også å sjekke treslag i felt; de benyttes ofte i nøkkelen. Nøkkelen inneholder også bokas tre nye arter som foreløpig er beskrevet provisorisk: *T. ilkkaii* - en av kransmusserongene, *T. bryogenum* – en av svovelmusserongene og *T. boreosulphurescens* – en nordlig slektning av reddikmusserongen. Alle er definert med assistanse av ITS-sekvensering, men de lar seg heldigvis også nøkle ut på morfologisk grunnlag.

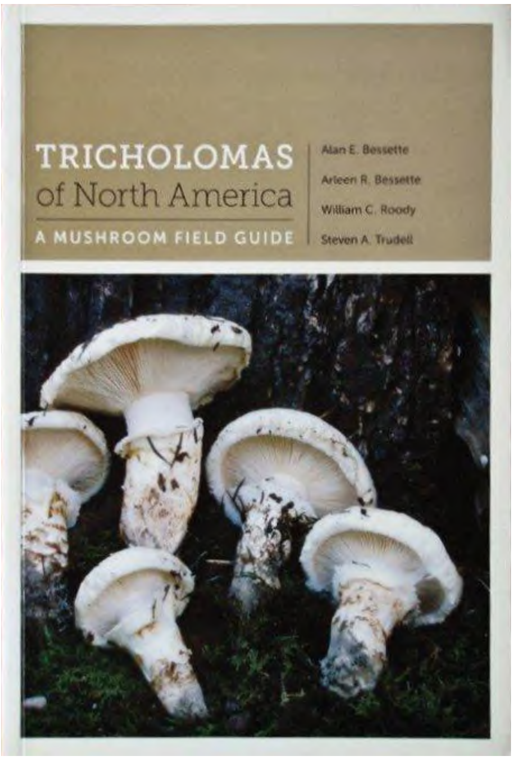
Forfatterne har forsøkt å oppklare vanskelige artskomplekser i slekten bl.a. ved hjelp av ITS-sekvensering, uten at de helt har løst alle problemene. Men her kan forventes mer oppklaring i en annonsert vitenskapelig artikkel av forfatterne i samarbeid med mer molekylært orienterte kolleger. I Norge kjenner vi i dag 39 av artene som er med i boka, men vi kan nok forvente å finne flere her – noen fordi et stadig mildere klima vil gi vekstmuligheter spesielt for løvskogsarter som nå har nordgrenser i Danmark og Sør-Sverige, andre på grunn av forfatternes oppklarende arbeid blant annet ved å beskrive de nye artene. Løvskogsartene vil nok lenge være sjeldenheter, men en boreal art som den nybeskrevne *T. bryogenum* kan sågar vise seg å være en vanlig art hos oss!

Boka inneholder også en tolkning av illustrasjonene i elleve andre mye benyttete bøker, over seks sider, som kan være svært nyttig for artsforståelsen; bl. a. illustrasjoner i J.E. Langes «Flora Agaricina Danica» og E. Ludwigs «Pilzkompendium» samt de mellomeuropeiske musserongmonografiene nevnt innledningsvis. Fortjenstfullt er også at de har neotypifisert hele 15 arter og derved bidratt til en høyst nødvendig basis for nomenklaturen innen slekten. En nomenklaturisk skivebom fins på s. 182 hvor *T. stiparophyllum* (reddikmusserong) har fått autorsiteringen (S. Lundell) P. Karst. (en umulig konstellasjon da Karsten døde før Lundell begynte å publisere; N. Lund som var en elev av Elias Fries er korrekt her). *Tricholoma stiparophyllum* er nå blitt det vitenskapelige navnet på reddikmusserong, en art som vi i følge gammel friesisk tradisjon her i Norden har kalt *T. album*. Navneforvirringen som har fulgt etter forfatternes nytolkninger av navnene *T. album* og *T. lascivum* kunne muligens ha vært unngått ved en mer smidig anvendelse av nomenklaturreglene, men vi venner oss vel til det.

Boka er den eneste av de tre nye musserongbøkene som gjør et forsøk på å presentere en moderne klassifisering av slekten, dette i form av et slektstre bygget på morfologiske karakterer og sekvensering av ITS-regionen – riktignok med berettiget forbehold om at mer omfattende analyser er nødvendige. Treet fordeler artene på 16 klader (clades), hvorav noen store (med 13-15 arter), andre mindre, og halvparten meget små (med 1-2 arter). Noen av kladene tilsvarer tidligere definerte seksjoner i *Tricholoma* mens andre er nye og med hensikt ikke formalisert ennå. Det henvises igjen til den kommende artikkelen – en publikasjon det kan stilles store forventninger til. Noen arter har en underlig plassering i treet, f. eks. brungul musserong (*T. arvernense*) og røykmusserong (*T. fucatum*) – begge langt fra broket musserong (*T. guldeniae*) og lundmusserong (*T. sejunctum)* som de ofte sammenlignes med - og i hoveddelen av boka befinner de seg sammen med en av Europas mer sørlige arter, *T. viridifucatum* M. Bon (som ikke er med i treet). Rekkefølgen av artene i bokas hoveddel følger dette slektstreets klader, men uten at det er markert på noe vis, slik at det blir litt vanskelig å forstå hvor man skal lete etter en art uten å bruke indeks bak i boka eller sideangivelsene i bestemmelsesnøkkelen. I likhet med de andre bøkene i denne fortreffelige serien fins musserongboka også i dansk språkdrakt.

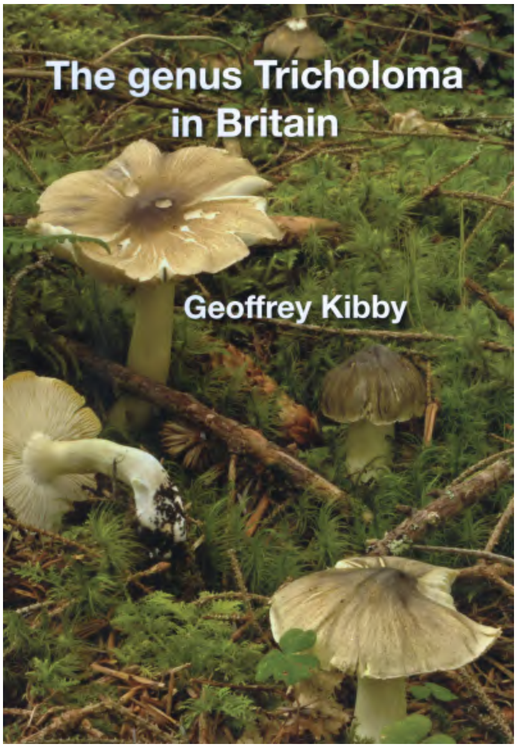
Tricholomas of North America. A mushroom field guide

De to første forfatterne av boka, Alan og Arleen Bessette, har laget flere populærbøker om nordamerikanske storsopper (nå sist, i 2014, en praktbok om askomyceter i Nord-Amerika). Billedmaterialet er stadig et av hovedelementene i bøkene deres. Selv har de bakgrunn fra USAs østlige stater mens de ofte har samarbeidet med forfattere fra andre deler av Nord-Amerika, denne gangen med Steve Trudell med ekspertise fra vestkysten. Mykologisk er det stor forskjell på det øst- og vestlige Nord-Amerika og som en konsekvens av dette har boka separate bestemmelsesnøkler for østlige og vestlige arter. Et nyttig tillegg til nøklene er en tabell som angir arter som har spesielle mikroskopiske kjennetegn. Artene presenteres med få unntak med ett fargebilde – ikke helt få med flere bilder og noen helt uten, beskrivelse av morfologi og voksested (occurrence) og diskusjon om forhold til nærstående arter m.m. Omtalene er relativt korte og forfatterne sier selv i forordet at mye er kompilert informasjon som de tross alt anser som verdifull fordi den fyller et gap mellom informasjon i vitenskapelige artikler og det lille som fins om musseronger i amerikanske populærhåndbøker. Musserongene, i likhet med slørsoppene, er dårligere kjent i Nord-Amerika enn mange andre storsoppslekter hvor kjente storsoppforskere som A.H. Smith for lengst har publisert monografier (flere mye brukt også i Europa). De ca 70 artene som boka presenterer er sikkert langt i underkant av hva kontinentet har å by på. Tretti av disse artene, og spesielt mange nordlige arter, er trolig identiske med hva vi finner i Europa, men et problem forfatterne stadig gir uttrykk for er at de nok identifiserer sine arter med europeiske,



og bruker de tradisjonelle «europeiske» navnene, men ofte tviler de på om artene egentlig er identiske på begge sider av Atlanteren. Noen ganger er identifikasjonen også tvilsom, som for eksempel når det gjelder *T. sejunctum* som er angitt som en hovedsakelig barskogsart med fem bilder som etter mitt skjønn viser gulkantmusserong (*T. viridilutescens*).

The genus *Tricholoma* in Britain



Forfatteren, Geoffrey Kibby, er redaktør av det populære tidsskriftet «Field Mycology» som den britiske soppforeningen (British Mycological Society) utgir og han har tidligere skrevet og utgitt tilsvarende bøker om rørsopper (Boletales), kremler (*Russula*), fluesopper (*Amanita*) og sjampinjonger (*Agaricus*) – den første og siste anmeldt i henholdsvis vol. 32 og 33 av Agarica. Bøkene er illustrert med gode fargefotografier og har bestemmelsesnøkler og kortfattede artsbeskrivelser. Denne om musseronger omhandler ca 70 musserongarter til tross for at hittil bare 42 arter er kjent i Storbritannia i følge den britiske sjekklista fra 2005. Stort sett inneholder boka de samme artene som er med i Funga Nordica, men i tillegg noen få sydlige arter i Europa. To arter beskrevet av briten P. D. Orton fra skotske furuskoger er også med, men begge er synonymisert med gallemusserong (*T. virgatum*) i den nye boka om Nord-Europas musseronger. Enkelte andre, som f. eks. paddemusserong (*T. bufonium*) er også med, mens den nå er forsvunnet inn i andre arter i svovelmusserongkomplekset i den nordiske boka, siden den mer eller mindre purpurrøde hattfargen som var flaggkarakteren for arten har vist seg ikke å ha systematisk betydning. Bakerst fins forklaring på faguttrykk brukt i boka, en liste som kan være nyttig også i andre sammenhenger hvor engelske termer benyttes.

Summa summarum: Boka om slekten *Tricholoma* i Nord-Europa anbefales på det varmeste for alle som har lyst til å bli kjent med musseronger eller oppdatere sine musserongkunnskaper. De amerikanske og britiske bøkene vil alltid være interessante å orientere seg i når det gjelder artsoppfatninger og utbredelse, men tilfører ellers lite nytt når det gjelder forståelse av slektskapsforhold innen slekten eller av arter innen artskomplekser.

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Gro Gulden

Tor Carlsen, Pernille Bronken Eidesen, Gro Gulden, Klaus Høiland, Kolbjørn Mohn Jenssen: Sopp på Svalbard

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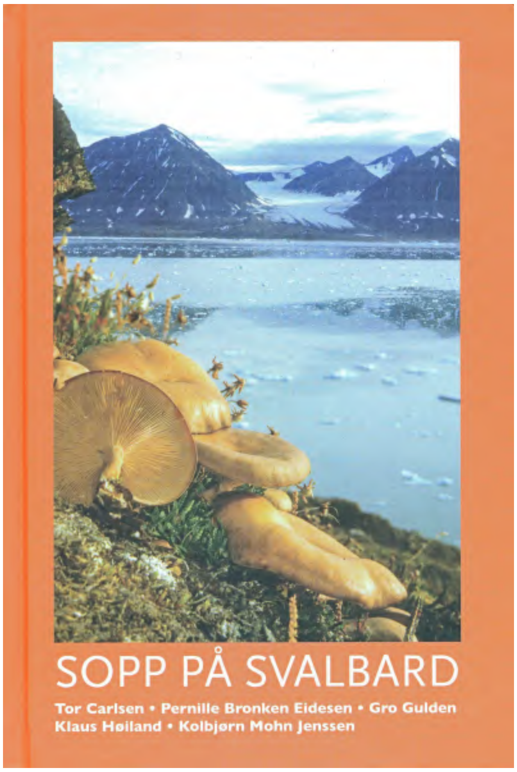


I 1988 fikk jeg oppleve Svalbards flora og funga – å se med egne øyne at det i dette karrige øyriket kunne vokse så mange sopper – mest ukjente og noen kjente arter - var eventyrlig. Det ble arrangert Artic Alpine Conference (ISAM III). Gro Gulden og Kolbjørn Mohn Jenssen foretok innsamlinger og fotograferte og hadde kanskje allerede den gang en bok om Svalbards sopper i tankene. Nå er boken her – sammen med Tor Carlsen, Pernille Bronken Eidesen og Klaus Høiland – alle med flere feltsesonger og god kjennskap til Svalbards natur bak seg, har de skrevet en bok til glede for Svalbards soppinteresserte befolkning, turister og mykologer.

Boken er lagt opp etter det klassiske mønster for en funga, med generelt stoff om morfologi, beskrivelse av artene og spesiell vekt på økologi og tilpasninger til det arktiske klima. Det er registrert ca 1300 arter på Svalbard hvor halvparten er lav som ikke omtales i denne boken. Interessant er det å lese om soppenes utbredelse på Svalbard og om utforskningen av fungaen helt fra de første polarekspedisjonene og opptil i dag. Bokens hovedvekt er på de store soppene, og det meste dreier seg om hattsopper – ikke alle slekter som forekommer er tatt med, men eksempler fra de fleste. Det er registret 278 storsopper på Svalbard og 81 er omtalt. Boken innledes med en generell del, ca 25 sider, så følger beskrivelse av stilksporesoppene ca 100 sider, mens sekksporesoppene og slimsoppene dekkes med ca 10. Mykorrhizasoppene finner sine partnere som vierarter, dvergbjørk, reinrose og harerug. Hver orden innledes med en beskrivelse av ordenen og hvilke slekter som er tatt med.

Av rørsopper er det bare funnet to arter, fjellskrubb *Leccinum rotundifoliae* og en ubeskrevet art. Skivesoppene er delt inn etter sporepulverfarge. Her brukes «lyssporete sopper» isteden for det vanlige «hvitsporete sopper». Dette håper jeg kan bli et begrep som vi alle kan fortsette å bruke. Lyssporete slekter er representert med 17 slekter, de rødsporete med en slekt, de brunsporete med 6 slekter og de svartsporete med 5 slekter. Antall arter som er med i slektene varierer fra 1-5. Dette gir et godt innblikk hvilke hattsopper som man kan forvente å finne. Er det matsopper blant disse – de fastboende og turistene vil gjerne vite det? Her kan det svares ja. Fjellridderhatten *Lepista multiformis* utmerker seg som en god matsopp, polarsjampinjongen *Agaricus aristocratus* er sikkert en delikatesse og noe å hente er det også i flere av de andre slektene. Dessuten finnes det flere røyksopper som er spiselige så lenge de er hvite inni. Dette bringer oss over til øvrige basidiomyceter: køllesopper, poresopper, barksopper, frynsesopper og gelésopper som også er med i boken og dekker tilsammen 24 sider. Ascomycetene er omtalt på ca 10 sider – her omtales de mest iøynefallende artene som høstmorkler, kransøyer og mosemorkler.

Bakerst i boken finnes listen «Storsopper på Svalbard» hvor alle arter som er omtalt i boken er merket med en stjerne. Artene er ordnet alfabetisk etter vitenskapelige navn – en meget nyttig liste for dem som vil sammenligne med arter som for eks. er kjent fra fastlands Norge.

Vil man lese mer om de ulike slektene som forekommer på Svalbard, så finnes en liste over anbefalt litteratur.

Forfatterne har gjort et grundig arbeid med boken som anbefales på det varmeste – den er velskrevet og soppene er illustrert med gode bilder. Et ønske kunne være at flere arter innenfor de «store slektene» hadde vært med – det ville gitt et enda bredere bilde av fungaen på Svalbard.

Anna-Elise Torkelsen

Kantarellnavlesopp (*Lichenomphalia alpina*) med grønt lavtallus (*Botrydina*). Norge: Oppland, Dovre. Foto KMJ.

Kantarellnavlesopp - *Lichenomphalia alpina*

Karakteristikk: En liten skarpt gul sopp som minner om en liten kantarell.

Beskrivelse: Hatt 0,5–3 cm, konveks, etter hvert nedsunket i midten, skarpt egg-gul, som tørr blekere. Skiver nedløpende, fjerntstilte, egg-gule som hatten. Stilk 1–4 × 0,1–0,3 cm, glatt, litt blekere enn hatten. Ved stilkbasis er et mørkegrønt, kornet belegg av lavtallus, *Botrydina*. Dette består av enkeltceller av grønnalger omspunnet av sopphyfer, men det dannes ikke distinkte skjell som hos ovenstående art.

Økologi og utbredelse: Funnet flere steder på Svalbard og virker stedvis ganske hyppig, for eksempel rundt Isfjorden, St. Jonsfjorden, Kongsfjorden, Van Mijenfjorden og Krossfjorden. Fruktlegemene vokser i små grupper på åpen jord eller mellom moser og andre laver. Den er også, som foregående art, funnet på torvjord, for eksempel på palser eller oppfrysningsmark. Utbredelsen er sirkumpolar, men den kan også gå ned i lavlandet i kyststrøk, for eksempel på øyer i Nord-Atlanteren. Den er også funnet i Andes. I fastlandsfjellene i Norge er den ganske vanlig og funnet helt opp i høyalpin region.

Kommentar: Dette er en av de arktisk-alpine hattsoppene som kommer tidligst i sesongen, allerede i juni i norske høyfjell. Den likner på en miniatyr av ekte kantarell, men de er ikke i slekt med hverandre. På Svalbard er kantarellnavlesopp blitt sanket og spist som kantarell. Folk har funnet den velsmakende og har ikke hatt noe ubehag etterpå. Når det snakkes om kantarell på Svalbard, er det nok denne arten det dreier seg om. Vanlig kantarell fins ikke!

Torvnavlesopp – *Lichenomphalia umbellifera*

Synonym: *Omphalina ericetorum*

Karakteristikk: Liten brun, beige til nesten kremhvit tynnkjøttet sopp med nedløpende skiver og stilk som alltid er mer eller mindre brun øverst.

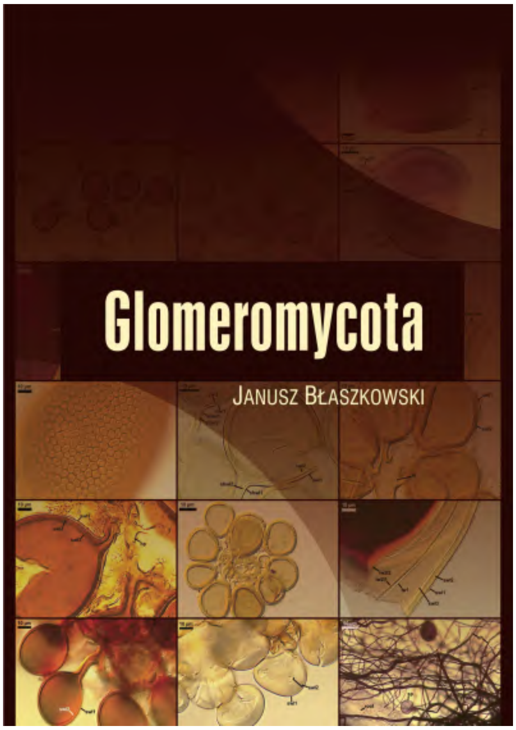
Beskrivelse: Hatt 0,5–2 cm, først hvelvet med nedbøyd kant, så nedsunken i midten og til sist traktformet til navlet, glatt; kanten er bølget og oftest tydelig radiært, gjennomskinnelig stripet. Som ung er hatten rødbrun til olivenbrun, blekner etter hvert til gulbrun, gul, kremfarget til nesten hvit. Skiver nedløpende, fjerntstilte, hvitaktige, kremfargete eller gule. Stilk 1-3 × 0,1-0,2 cm, finlodden (lupe!), som ung rødbrun til olivenbrun, etter hvert blekner stilken og blir kremfarget, unntatt toppen som alltid forblir rødbrun til olivenbrun (og som er en viktig skillekarakter mot de andre, lyse artene av lavnavlesopper), basis hvitlodden. Ved stilkbasis fins små mørkegrønne korn av lavtallus, *Botrydina*, som imidlertid kan være sparsomme og i blant tilsynelatende mangle helt.

Torvnavlesopp (*Lichenomphalia umbellifera*). Svalbard: Isfjorden, Endalen. Foto GG.

Janusz Blaszkowski: Glomeromycota

W. Szafer Institute of Botany, Polish Academy of Sciences, Kraków, 2012. 303 sider. ISBN 978-83-89648-82-2

Boken kan bestilles direkte fra forlaget gjennom e-post adressen wydawnictwa@botany.pl og koster 31 €, om lag 260 kr (eks. MVA og forsendelse).



Boken Glomeromycota av den polske taksonomen Janusz Blaszkowski er den første omfattende monografien av soppene som danner arbuskulær mykorrhiza (AM). Phylum *Glomeromycota* er monofyletisk, som betyr at alle taxa innenfor dette phylum er evolusjonært nært beslektet. Likevel viser det et stort morfologisk og genetisk mangfold blant arbuskulær mykorrhiza soppene. Før boken ble publisert var taksonomisk informasjon om denne soppgruppen bare publisert i separate artikler, ofte med svært utdaterte nøkler og oppsummeringer. Heldigvis fins også noen svært gode artsbeskrivelser på enkelte informative nettsider, som for eksempel http://invam.wvu.edu.

Taksonomi og klassifisering av *Glomeromycota* har endret seg betraktelig de siste tiårene. Det er for tiden mye aktivitet på dette området etter at DNA-sekvensering ble et sentralt element i videre utvikling av taksonomi og klassifisering av AM-soppene. Samtidig er det her den største begrensningen i boken ligger. Særlig innenfor slekten *Glomus* har det vært store endringer i klassifiseringen, og de er ikke med i boken. Det foregår fortsatt betydelige endringer i klassifiseringen og nye artsbeskrivelser kommer stadig. En art som ser ut til å være vanlig i Norge, *Septoglomus jasnowskae*, er ennå ikke med. Boken kan derfor ikke betraktes som komplett, og en må regne med at ved bruk i en eventuell kartlegging kan ikke alle funn identifiseres. Alt tyder på at denne boken var foreldet allerede kort tid etter at den ble trykket sommeren 2012. En revidering forventes allerede om 2-3 år. Likevel er boken så nyttig at jeg bruker den nesten daglig i arbeidet mitt.Boken inneholder sju kapitler og i tillegg referanser, geografiske data knyttet til funn, og indekser over soppene og vertsplanter. Boken innledes med en gjennomgang av den historiske utviklingen for denne soppgruppa, et separat kapittel om taksonomi og klassifisering, samt et kapittel om metoder for innsamling og identifisering. Svært viktig er i tillegg kapitlet om morfologiske karakteristikk av sporedanning og strukturer i bl.a. sporeveggen, noe som er avgjørende for identifisering av artene. Det kreves riktignok en del øvelse og litt erfaring for å tolke begrepene som benyttes.

Hoveddelen av boken består av en systematisk og rikt illustrert gjennomgang av de 137 beskrevne artene med nødvendige nøkler. Hver art er beskrevet ifølge en standard protokoll som inneholder en beskrivelse av basionym, navnets etymologi, en detaljert gjennomgang av de viktigste morfologiske kjennetegn, en beskrivelse av mykorrhiza (strukturer, vertsplanter) som dannes, den fylogenetiske posisjonen, informasjon om utbredelse og habitat, og en oppsummering av materialet som ligger til grunn for artsbeskrivelsen. Det hele avsluttes med et nyttig avsnitt med blant annet sammenligninger med andre arter.

For de som er ukjent med denne sopp-gruppen er boken en god introduksjon, men det tar tid å lære seg det mangfoldet som finnes. Start med de artene som du finner oftest. Bygg dette så gradvis ut til en bredere kunnskap om denne økologisk viktige soppgruppa, som har en så interessant posisjon i alle av klodens økosystem.

Theo Ruissen

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