Atractosporocybe polaris – a new clitocyboid agaric described from arctic-alpine and northern boreal regions in Svalbard and Scandinavia

Gro Gulden, Ellen Larsson
Gro Gulden[1], Natural History Museum, University of Oslo, Box 1172 Blindern, NO-0318 Oslo, Norway

Ellen Larsson[2], Dept. of Biological and Environmental Sciences, University of Gothenburg, Box 461, SE-40530 Göteborg, Sweden

Corresponding author: gro.gulden@nhm.uio.no

Norsk tittel: *Atractosporocybe polaris* – en ny «traktsopp» beskrevet fra arktisk-alpine og nordboreale områder på Svalbard og i Skandinavia

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NØKKELORD
Arktisk-alpin mykologi, *Atractosporocybe, Clitocybe inornata*, molekylærsystematikk, taksonomi

SAMMENDRAG
Arten *Atractosporocybe polaris* er beskrevet som ny for vitenskapen fra arktisk-alpine og nordboreale områder på Svalbard og i Skandinavia basert på fylogenetiske analyser av ITS og LSU data fra nukleært ribosomalt DNA. Av utseende ligner den ribbetraktsopp (*A. inornata*), men har mørkere skiver, glattere hattkant og bare svak lukt; anatomiske forskjeller er ikke funnet. Arten vokser blant mose, lav, urter, lyng og dvergbusker (*Salix* og *Dryas*) i arktiske og alpine områder og i vier- og orekratt (*Salix* og *Alnus*) i nordboreale områder, og er en typisk kalkgrunnsart.

ABSTRACT
The new species *Atractosporocybe polaris*, identified from the arctic archipelago of Svalbard and Scandinavia, is here described as new to science based on ITS and LSU sequence data from nuclear ribosomal DNA. In morphology it differs from *A. inornata* by darker gills, a smooth or faintly grooved cap margin, and a comparatively faint smell. It grows in arctic tundra and heathland among mosses, lichens, ericaceous plants, herbs, graminoids, and dwarf *Salix* and *Dryas* on calcareous ground. In Scandinavia it is found in the northern boreal zone growing among *Salix* scrubs and *Alnus*.

INTRODUCTION

Agarics with a clitocyboid habitus, originally described in the genus *Clitocybe* have been in focus of several recent molecular phylogenetic studies (Vizzini et al. 2010, Vizzini et al. 2011, Vizzini and Ercole 2012). The polyphyletic genus *Clitocybe* has been split up in several new genera to accommodate recovered clade relationships of monophyletic clades. *Atractosporocybe* was erected for species with greyish brown basidiomata, adnate to subdecurrent gills, and hyaline, long ellipsoid fusiform spores (Alvarado et al. 2015). The genus is currently monotypic, including the familiar

species that we until now have known as *Clitocybe inornata* (Sowerby) Gillet.

For many years and on several collecting trips to the arctic archipelago of Svalbard a fungus very similar to *Atractosporocybe inornata* (Sowerby) P. Alvarado, G. Moreno & Vizzini has been observed. The overall similarity with *A. inornata* is obvious but it differs by more or less lacking the grooves on the cap margin, having darker gills and a comparatively faint smell. The size and shape of the basidiospores are the characteristic and same as those of *A. inornata*. To find out if the fungus we find on Svalbard is identical to that found in the more southern parts of Scandinavia and Europe a molecular study was undertaken.

In the herbarium of the Natural History Museum in Oslo (O), several collections of the species from Svalbard have been deposited, often filed as *Clitocybe aggregata* (= *Lyophyllum decastes* coll.), all from dwarf willow sites. Also in the herbaria of Tromsø (TROM) and the University of Gothenburg (GB) there are some northern and alpine collections of *A. inornata* from *Salix* shrubs and northern boreal *Betula* and *Alnus* sites that could be suspected to represent the same taxon as on Svalbard.

In this study we describe the new species, *Atractosporocybe polaris*, a close relative to *A. inornata* but with a northern boreal to arctic-alpine geographic distribution range.

MATERIALS AND METHODS

The description of macro-morphology is based on fresh material and photographs. Colour designations follow Kornerup and Wanscher (1962), J.E. Lange's colour map published in Larsen (1932) and Cailleux (1981). Light microscopy study and measurements were done on squash preparations in KOH (5%), Cotton blue-lactic acid, and Melzer's reagent. The separate description and diagnose of the type material is followed by a more general description of the new species based on all examined collections.

Molecular work

Fourteen specimens of *A. inornata* and *A.* cf. *inornata* from Svalbard, Sweden and Norway were selected for sequencing in this study. The sequenced specimens are indicated with asterisk in the lists of specimens examined and presented in Table 1. For comparison and putting our sequence data in a phylogenetic context additional ITS and LSU sequence data of *A. inornata*, *Leucocybe* and *Clitocybe subditopoda* were retrieved from GenBank, taken from a previous study on *Atractosporocybe* and *Leucocybe* (Alvarado et al. 2015). Based on results from earlier molecular phylogenetic studies of Agaricales and the Tricholomatoid clade, *Clitocybe nebularis*, *Collybia tuberosa* and *Lepista nuda* were selected as the outgroup for rooting of trees (Matheny et al. 2006, Alvarado et al. 2015).

Sequences from the complete ITS region and about 900 base pairs (bp) of the 5´ end of the LSU nuclear ribosomal DNA were generated for the study. DNA extractions, PCR, and sequencing were performed as described in Larsson and Örstadius (2008). Primers used to amplify the complete ITS region and the 5´ end of the LSU region were ITS1F (Gardes and Bruns 1993) and LR21, LR0R, and LR7 (Hopple and Vilgalys 1999). Primers used for sequencing were ITS1, ITS4 (White et al. 1990), Ctb6 (http://plantbio.berkeley.edu/~bruns/) and LR5 (Hopple and Vilgalys 1999). Sequences were edited and assembled using Sequencher 5.1 (Gene Codes, Ann Arbor, Michigan, U.S.A.). Sequences generated for this study have been deposited in GenBank under the accession numbers (KU709846–KU709860).

Alignment was performed using the L-INS-i strategy as implemented in MAFFT v. 7.017 (Katoh and Standley 2013). The alignment was adjusted manually using the data editor

Table1. Data of sequenced specimens of *Atractosporocybe* included in the phylogenetic analyses, generated for this study or taken from GenBank.

Species	Coll. ID. / Origin	Ecology, substrate	GB no.
A. inornata	GG129/85 / Norway	Low herb conif. forest, calcareous	KU709846
A. inornata	GG708/67 / Norway	Spruce forest, calcareous	KU709847
A. inornata	LAS89/082-A / Sweden	Coniferous forest, calcareous	KU709848
A. inornata	GG85/10 / Norway	Mixed coniferous forest	KU709849
A. inornata	Skifte1193 / Norway	Birch forest	KU709850
A. inornata	TEB732-04 / Norway	Spruce-pine forest	KU709851
A. inornata	TEB379-00 / Norway	Rich pine (-spruce) forest	KU709852
A. inornata	PM141/92 / Norway	Pine forest	KU709853
A. inornata	WeholtO-56562/ Norway	Oak forest	KU709854
A. inornata	FR2014113 / France		KP192661
A. inornata	AH39144 / Spain		KJ680991
A. inornata	AH14204 / Spain		KJ680996
A. inornata	TO AV261012h / Italy		KJ680994
A. polaris	GG215/09 Holotype/ Svalbard	Arctic heath *Salix*, *Dryas*	KU709855
A. polaris	GG54/09 / Svalbard	Arctic heath *Salix*, *Dryas*	KU709856
A. polaris	SK10-06 / Sweden	*Salix*, border of rich mire	KU709857
A. polaris	LL000805 / Sweden	*Salix* bush, at forest road	KU709858
A. polaris	O-64025 / Sweden	*Salix* bush, at forest road	KU709859
A. polaris	SS920818 / Norway	*Salix*, bush, litter and naked soil	KU709860

in PAUP* 4.0b12 (Swofford 2003). For inferring phylogenetic relationships among species heuristic searches for the most parsimonious trees were performed using PAUP* (Swofford 2003). All transformations were considered unordered and equally weighted. Gaps were treated as missing data. Heuristic searches with 1,000 random-addition sequence replicates and TBR branch swapping were performed, saving at most 25 trees in each replicate. Relative robustness of clades was assessed by the bootstrap method using 1,000 heuristic search replicates with 100 random taxon addition sequence replicates and TBR branch swapping, the latter saving at most 25 trees in each replicate. In addition a Bayesian analysis was carried out in MrBayes 3.0 (Ronquist and Huelsenbeck 2003), with a best-fit model of nucleotide evolution supplied by MrModeltest 2.2 (Nylander 2004). Eight default-setting Metropolis-Coupled Markov Chain Monte Carlo (MCMCMC) chains were run for 10 million generations with trees sampled every 5,000 generations and an initial burn-in of 1000 trees. After discarding the trees prior to the burn-in threshold a 50% majority-rule consensus phylogram was computed from the remaining 25.000 trees.

RESULTS

The aligned complete data set consisted of 28 sequences and 1601 characters. After exclusion of ambiguous regions mainly from the beginning and at the end of the data set 1539 characters remained for the analysis. Of these, 1374 were constant, 31 were variable but parsimony uninformative, and 134 were parsimony informative. The maximum parsimony analysis yielded 22.512 equally most parsimonious trees (length = 214 steps, CI = 0.8224, and RI = 0.8995). One of the trees is presented in Figure 1. The tree is presented as a phylogram to show character state changes on branches.

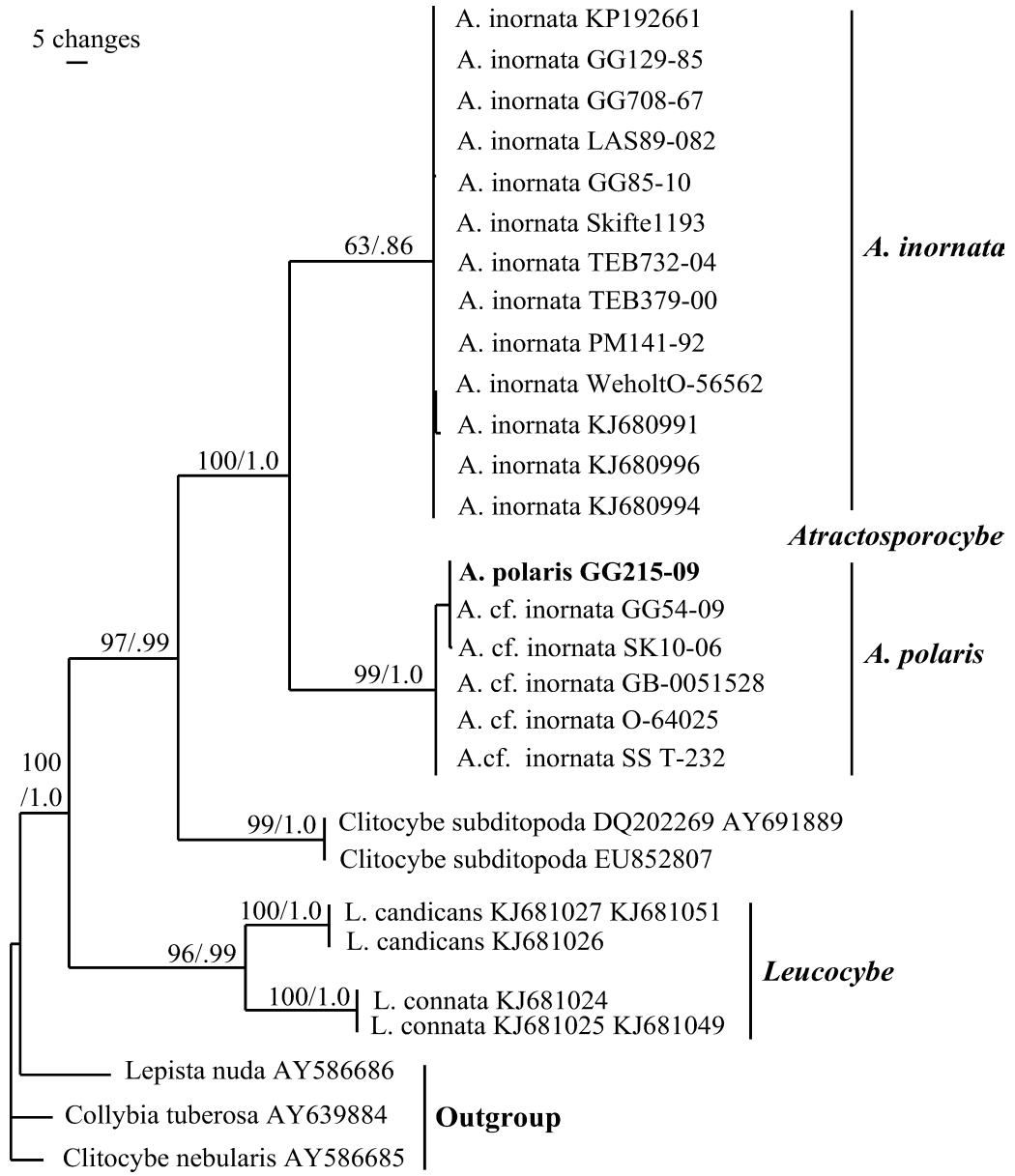

Figure 1. One of the most parsimonious trees from the phylogenetic analysis, based on ITS and LSU sequence data, that show *Atractosporocybe* to form two supported clades corresponding to *A. inornata* and the herein new described species *A. polaris*. Parismony bootstrap values and Bayesian Posterior probabilities are indicated on branches. The sequence originating from the holotype of *A. polaris* is marked in bold. GB-0051528 and O-64025 are parts of a single collection deposited in GB and O respectively.

Figure 2. *Atractosporocybe polaris*, holotype, from Svalbard: Nordenskiöld Land, Revneset, GG 215/09 (O-76093). Photo: G. Gulden.

The bootstrap analysis recovered *Leucocybe* (96%), *Clitocybe subditopoda* (99%) and *Atractosporocybe* (100%) as monophyletic clades and with strong bootstrap support. *Atractosporocybe* splits up in two supported clades corresponding to *A. inornata* sensu stricto (63%), and *A. cf. inornata* (99%) with a northern boreal and arctic-alpine distribution. The sequence differences between the two clades are 4 substitutions and one 2 base pair (bp) insertion/deletion event in the ITS1 region, 6 substitutions and one 1 bp insertion/deletion event in the ITS2 region, and one substitution and one 1 pb insertion/deletion event in the first 900 bp of the 5´ end of the LSU.

As suggested by MrModeltest, the nucleotide evolution model HKY+G was used for the ITS1 spacer; SYM+I was used for the 5.8S gene; HKY+G was used for the ITS2 spacer; and GTR+I+G was used for the LSU in the Bayesian analysis. The MCMC analysis converged well in advance of the burn-in threshold and chain mixing was found to be satisfactory, as assessed by using Tracer v1.5 (Drummond et al. 2012). In the Bayesian analysis the same clades as in the MP analysis were recovered and Bayesian posterior probability (BPP) is indicated on branches (Figur 1). The Bayesian tree topology was identical to the MP bootstrap tree.

Figure 3. *Atractosporocybe polaris*, holotype, showing watery grey gills and hollow stipe, GG 215/09 (O-76093). Photo: G. Gulden.

Taxonomy

Atractosporocybe polaris Gulden & E. Larss. sp. nova – Figs. 2 - 5
Mycobank: MB 815967

Type collection: *Cap* 3.5-4 cm, moderately depressed in central part, margin incurved without or with very faint grooving, smooth, somewhat shiny, faintly innately radially fibrillose with a beige to pale grey brown over all colour, paler, almost ivory in central part, at margin with a cracking, white pruina that lasts for a long time. *Gills* slightly decurrent, moderately crowded, beige to grey brown, in places with darker edge. *Stipe* 3–3.5 × 0.3–0.5 cm, cylindrical, stuffed then somewhat hollow, grey brown like the ground colour of the cap, with longitudinal stripes of pruina, base white tomentose, with white, branched rhizomorphs. *Flesh* white. *Smell* and taste not noted. Two specimens united at stem base. *Spores* 8–10(–10.5) × 4–4.5 µm, Av_{40} = 9.0 × 4.2 µm, Q = 2.1–2.2, Qav = 2.1, fusoid-rhomboid with applanation or shallow depression above apiculus, acyanophilic, inamyloid. *Basidia* 28–36 × 6.5–7 µm, 4-spored, hyaline, without siderophilous granulation. *Hymenophore* regular, of 3–5 µm wide pale brown hyaphae. *Cystidia* absent. *Pileipellis* a cutis of radial, ± cylindrical hyphae, 3–12 µm wide, with medium long segments, evenly pale brown from wall pigment and ± brown zebra-incrusted, no pileocystidia. *Stipitipellis* of similar hyphae, caulocystidia absent. *Clamps* large, some as medaillons, abundant in all tissues.

Etymology: From the polar region.

Holotype: Norway: Svalbard: Nordenskiöld Land, Revneset, in *Dryas* and *Salix polaris* heath on calcareous ground, 16. August 2009, leg. G. Gulden and E. Larsson, GG215/09, (Herb. O-76093, GenBank No. KU709855).

General description: based on observations of fresh specimens and herbarium material from Svalbard and northern Scandinavia – Figs. 2 - 6.

Cap 2.5–10 cm, young convex-umbonate with inrolled margin that sometimes is slightly grooved, initially almost white and somewhat shiny from a white, sticky, fully covering pruina, becoming plane to slightly depressed, often with a remaining small central umbo, margin incurved and pubescent for a long time, slightly grooved or not, the pruina cracks and gradually disappears, most persistent at margin, surface often with ± dark spots mainly in central half, also faintly innately radially fibrillose, often appearing ± radially flamed, underneath pruina matt, dry, dark grey brown (T 70, T 51, R 70, N 70, P 70), becoming grey beige to ivory with age (M-L-K 92, 4B3-5B3), not hygrophanous. *Gills* emarginate-decurrent, close, with many lamellulae inserted from margin, thin, up to 7 mm high, easily removable from the flesh, beige to dark grey, dark grey brown, often appearing darker than the cap (M 50, N 70, P 51, R 70, 5C4, f 2, i 4), edge concolorous or in places darker than the sides. *Stipe* 2.5–10 × 0.3–1.1 cm, cylindrical, corticated, young stuffed, becoming hollow and sometimes laterally compressed, fibrillose, white tomented at base, often with white, branched rhizomorphs, coloured ± like the cap. *Flesh* rather thin in pileus, firm-elastic, whitish, hyaline grey above lamellae and in cortex, pale greyish in cap centre. *Smell* weak, pleasant, slightly farinaceous; *taste* mild to somewhat unpleasant. *Spore deposit* white.

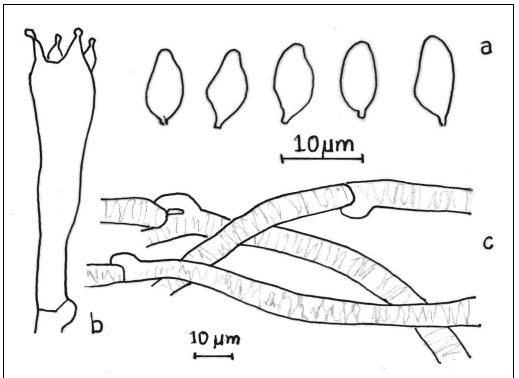

Figure 4. *Atractosporocybe polaris*, holotype, showing anatomical characters (a) spores, (b) basidium, and (c) hyphae in the pileipellis. Ill.: G. Gulden.

Spores 8–11(–12.5) × 3–4.5 µm, Av_{210} = 9.3 × 3.9 µm, Q = 2.0–2.9, Qav = 2.4, narrowly rhomboid or fusoid, with suprahilar applanation-depression, hyaline, acyanophilic, inamyloid. *Basidia* 25–38 × 6–7 µm, 4-spored, hyaline, becoming brown-walled, not sidero-philous. *Hymenophoral trama* regular, of 3–8.5 µm wide, almost hyaline to evenly brownish hyphae. *Pileipellis* a cutis of radially repent, cylindrical, 3.5–12 µm wide hyphae with brown zebra-incrustations. Hyphae of *stipiti-pellis* similar. *Clamps* present at all septa, rather large and sometimes as medallion clamps. *Pigment* membranal and incrusting.

Habit and habitats: More or less caespitose, often in aggregated groups, forming rings, arcs and rows (longest observed row ca. 100 m). On calcareous ground, often on unstable and periodically water soaked soils, almost naked or covered with mosses and lichens, dwarf *Salix*, and herbs and sedges such as *Saxifraga oppositifolia*, *Dryas octopetala, Bistorta vivipara, Cassiope tetragona, Carex misandra*; also found on solifluction lobes together with *Lepista multiformis* (Romell) Gulden.

Distribution: In arctic, subarctic, alpine and northern boreal regions of the northern

Figure 5. *Atractosporocybe polaris*, from Svalbard: Nordenskiöld Land, Revneset, GG 216/09 (O-76094). Photo: G. Gulden.

hemisphere; August. So far known from northern and central Scandinavia and from Svalbard, but is likely to have a broader, northern boreal and circumpolar distribution.

Published photos: Gulden and Jenssen (1988) p. 15 and back cover (as *C. inornata*), Carlsen et al. (2013), p. 44 (as *Clitocybe "polaris"*).

Specimens examined

Atractosporocybe polaris

Norway, Svalbard: Sabine Land: Sassendalen at Gjelhallet, 20. July 1981, G. Gulden, GG128/81 (O); Gjelrabbane, on beach terrace, in the *Dryas-Cassiope* zone, 25. July 1981, G. Gulden, GG198/81 (O). Nordenskiold Land: Revneset, 16. Aug. 2009, G. Gulden and E. Larsson, GG216/09 (O-76094) and GG215/09*, HOLOTYPUS (O-76093). Dickson Land: Kapp Wijk, near the cabin, in *Dryas* heath, 6. Aug. 1960, J. Stordal, JS11.686 (O-362406), as *Clitocybe aggregata*; on the plane E of the cabin, 6. Aug. 1960, J. Stordal, JS11717 (O-362408) as *Clitocybe aggregata*; in *Dryas* and *Cassiope tetragona* tussock, 10. Aug. 1960, J. Stordal, JS11.774 (O-362401) and JS11.786 (O-362407) as *Clitocybe aggregata* (Figure 6); Ekmanfjorden, Coraholmen, 9. Aug. 1960, J. Stordal, JS11.764 (O-362419) as *Clitocybe aggregata*. Oscar II Land: Ny-Ålesund, the close vicinity, 30. July 1960, leg. B. Falkanger and P. Sunding, det. J. Stordal as *Clitocybe aggregata*, (O-362409); at the airfield, 14. Aug. 1988, leg. M. Lange, GG81/88 (O-362418); Lovén

Figure 6. Watercolour picture showing *Atractosporocybe polaris* collected on Svalbard by Jens Stordal (J.S. 11.786), Ill.: J. Stordal.

glacier, at base of bird cliff, 12. Aug. 1988, leg. K.M. Jenssen, GG41/88 (O-195477); Gåsebu, 10–50 m a.s.l., 4. Aug. 2009, G. Gulden and R. Blaalid, GG54/09* (O-76095). Haakon VII Land: Blomstrandhalvøya, in a 10 m long row on solifluction soil among *Dryas* and *Saxifraga oppositifolia,* 5. Aug. 1986, G. Gulden, GG170/86 (O-76096).
Norway, mainland: Troms: Kåfjord, Kåfjord-dalen, Oterholmen, 100 m a.s.l., *Alnetum*, 18. Aug.1992, S. Sivertsen* (TROM F-232).
Sweden: Jämtland: Östersund, ÖSK-reservatet, under small *Salix* bush with litter and naked soil, 5. Aug. 2000, L. Lundberg*, (O-64025 and GB-005 1528, split collection). Lule Lappmark: Jokkmokk, Tuvori, *Salix*, border of rich mire, 24. July 2010, S. Kuoljok, SK10-06* (GB-008 7903).

Atractosporocybe inornata
Norway, mainland: Hedmark: Ringsaker, Stavsjø, pine forest, 5. Sept. 1992, P. Marstad and A. Hov, PM141/92* (O-165090). Oppland: Lunner, Grindvold, Sløvikelva SE, near the road, spruce-pine forest on calcareous shallow soils, 19. Oct. 2004, T. E. Brandrud, TEB732-04* (O-167050); Østre Toten: S of Kapp, Kile, rich pine(-spruce)forest dominated by *Hylocomium splendens* on calcareous ground, 18. Oct. 2000, T. E. Brandrud, TEB379-00* (O-169038). Buskerud: Hole, Vik, spruce forest, 18. Aug. 1967, G. Gulden, GG708/67* (O-56554); Ringerike, Gullerud, mixed coniferous forest on calcareous ground, 3. Oct. 2010, G. Gulden, GG85/10* (O-294108). Telemark: Bamble, between Langesund and Stadthelle, oak forest on calcareous soil, 26. June 1980, Ø. Weholt* (O-56562); Porsgrunn, Frierflauene, herb rich coniferous forest on calcareous ground, 23. Sept. 1985, G. Gulden, GG129/85* (O-56557). Nordland: Narvik, Skjomen, Klubbvik, 29. Aug.1981, A. Granmo (TROM F-1319). Tromsø, Tromsdalen, on mossy ground in the forest band (*Betula*), O. Skifte 1193* (TROM F-1318). Finnmark: Porsanger, Iggaldas, Stabbursnes, E-side of

road E6, among grass in deciduous forest, 17. Aug. 1981, G. Mathiassen and A. Granmo 226/81 (TROM F-1317).
Sweden: Västergötland: Götene, Medelplana, ONO Sjöskog, in coniferous forest on calcareous ground, 30. Sept. 1989, leg. L. and A. Stridvall, 89/082-A*, det. L. Stridvall (GB-006 0527).

Notes: The general aspect of *A. polaris* and *A. inornata* is rather much the same. However, the remarkably dark gills, the mostly even cap margin, and a faint smell distinguish *A. polaris*. Also habitat preferences and geographical range help to distinguish the two species. The dark colour, especially of the gills, easily awakes associations to *Lyophyllum*. In at least one collection (GG 280/86) a darkening of the flesh at cap margin and gill edges was observed; we believe the discolouring might be due to prolonged exposure to sunlight. *Atractosporocybe inornata* is generally described with a particular smell (fishy, spicy, or reminding of radish, mice urine, camembert, etc.) and inodorous material has been described as a separate taxon, subsp. *occidentalis* (Bigelow 1982). Smell is a notoriously difficult character to evaluate, especially in cold surroundings where it tends to be faint. In contrast to our observations and annotations with some collections, Lamoure (1972) describes material from *Dryas* habitats in Alpine Sweden and France, most probably of *A. polaris*, with a very characteristic, fishy smell. Rhizomorphs is a feature seen in both of the *Atractosporocybe* species, but the character is often left out in species' descriptions (e.g. Breitenbach and Kränzlin 1999, Bessette et al. 1995, Ludwig 2012) although Harmaja (1969) in his monograph of the genus *Clitocybe* states that they are almost always present. Also in the diagnosis of the new genus *Atractosporocybe* there is no mention of rhizomorphs, a character regarded as taxonomically important in the genus *Rhizocybe* erected at the same time (Alvarado et al. 2015).

DISCUSSION

In this study we have shown that sequence data of specimens previously determined as *A. inornata* originating in northern regions (arctic-alpine to northern boreal) and southern regions (nemoral to boreal) of Europe form two supported clades. The northern clade is here recognised as *A. polaris* and the southern clade represents *A. inornata* s. str.. The *A. polaris* clade is strongly supported (BT99%, BPP 1.0) while *A. inornata* has got a rather low support value (BT63%, BPP .86) in the analyses. However, the relatively large and unambiguous sequence differences between the two clades, with 10 substitutions and 2 insertion/deletion events in the ITS region, and one substitution and one insertion/deletion event in the first 900 bp of the 5′ end of the LSU, together with differences in morphology and distribution range, support the two clades as independent evolutionary lineages.

The arctic-alpine specimens of *A. polaris* occur in heathland and tundra vegetation among mosses and lichens, together with *Dryas*, dwarf *Salix*, *Bistorta*, *Carex* and graminoids, and the two more southern samples of this species from the Scandinavian mainland were collected among *Salix* shrubs and in *Alnus* vegetation. The specimens of *A. inornata* from the nemoral-southern boreal ecosystems in Scandinavia occurred in mixed coniferous forests and in oak (*Quercus*) forests while one specimen was from a birch (*Betula*) forest in North Norway. The four sequences retrieved from GenBank originate from Spain, Italy and France and show *A. inornata* to have a broad geographic distribution in Europe. Both species typically grow on calcareous ground. Interestingly, both *A. polaris* and *A. inornata* occur in the northern boreal region, but here *A. inornata* most probably is restricted to forests in locally warm sites.

In the literature there are some records from northern boreal and arctic-alpine regions of *A. inornata* that probably represent *A. polaris* suggesting *A. polaris* to have a fairly broad northern distribution. The first Scandinavian record of the species seems to be by Lamoure (1972) who reports *C. inornata* from the Abisko mountains in Swedish Lapland. Her material was found in *Dryas* heaths and characterised by dirty grey beige (gris-beige sale) gills, a distinct fish like smell, and spores measuring 8–9 × 3–3.5 µm. Lamoure (1972) and Kühner and Lamoure (1986) later on also report alpine material from Arc alpine in Vanoise, France. Schmid-Heckel (1985) describes one collection of *C. inornata* from the northern calcareous Alps in Bayern, Germany, that agrees well with *A. polaris*. He indicates a cap margin without any ribs, gills that are evenly watery grey, and spores measuring (7–)8–9(–10) × 3–3.5(–4) µm. Most interestingly, Hallgrímsson (2010) reports *C. inornata* from Iceland, from heathland with ericaceous plants and dwarf shrubs as well as from leaf or needle litter in woodlands. One of the four collections in the herbarium of Akureyri (AMNH) was collected among *Dryas* in a skiing area (Glerárdalur near Akureyri) and another originated from a relatively old larch plantation (Hallormsstaðir). Annotations with the alpine material tell about very small and relatively dark specimens, and that is very much like the Svalbard material in herb. O that was originally identified as *C. aggregata*; a photo of the larch forest material shows a mushroom with pale gills reminiscent of an ordinary *C. inornata*. Both of the *Atractosporocybe* species may thus be present in Iceland and *A. inornata* probably has been introduced with the *Larix*. Material recorded from the arctic zone in Greenland, from Qeqertarsuaq (Godhavn) just S of where the high arctic zone begins (Lamoure et al. 1982), most probably also belongs in *A. polaris* as do records by Karatygin et al. (1999) of *C. inornata* from in Arctic Siberia north of the tree line (Polar Ural and the Taimyr peninsula). Occurrence of *A. polaris* in North America seems probable but further search is necessary in order to confirm this.

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