The Inocybe-Conocybe workshops at Dombås 2021-2022

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ABSTRACT
Some results from the *Inocybe*(-*Conocybe*) workshops at Dombås 2021-2022 are presented, with emphasis on the 2021 *Inocybe* results, based on extensive ITS-DNA sequencing and phylogenetic analyses. Among the 60 *Inocybe* s. lat. species sequence-verified in 2021, 30 were new to Norway. Most species were found in subalpine tall-herb *Betula* forests and calcareous low alpine *Betula nana-Salix* thickets, and more than half of the species are believed to be preferentially alpine-subalpine taxa.

INTRODUCTION

In 2021 a Norwegian project on *Inocybe* s. lat. and *Conocybe* s. lat. was initiated, with emphasis on sorting out the complex and little known species diversity by barcoding and phylogenetic analysis. The title of the project is "*The hidden diversity of the genera Conocybe s.lat. and Inocybe s. lat. (agaricoid basidiomycetes) in Norway*", and the project is funded 2021-23 by the Species project (Artsprosjektet) in the Norwegian Biodiversity Information Centre (Artsdatabanken). During 2021-2022 the project has arranged two workshops at Dombås (Trolltun hotel & cabins), in cooperation with The Norwegian Association for Mycology and Foraging (Norges sopp og nyttevekstforbund NSNF) and NorBOL, NHM University of Oslo.

The major aims of these workshops have been to:

- get a better knowledge of the Norwegian alpine-subalpine *Inocybe* (-*Conocybe*) communities, which are believed to be especially well-developed in the calcareous Dovre region, including species verifications by barcoding
- involve European experts on *Inocybe* in the project, and
- to contribute to the competence building among NSNF members especially devoted to biodiversity mapping.

The workshops had a main focus in *Inocybe* s. lat., since this group is especially well-developed in (sub)alpine regions. What we found of *Conocybe* species during the workshops constituted in fact only approximately 10% of our collected *Inocybe* material. In the following, we will only focus on the *Inocybe* outcomes of the workshops. *Inocybe* is treated in a wide sense in our project, also including the genera *Inosperma, Pseudosperma* and *Mallocybe*.

The workshops have been a fruitful cooperation between the *Inocybe-Conocybe* project, the NSNF mycological association, and NorBOL/NHM at the Univ Oslo. NorBOL/NHM did participate with a barcoding team at both Dombås workshops, preparing ITS-DNA sequencing of most of the collected *Inocybe-Conocybe* material (approximately 350 collections + some from other genera). In this three-way cooperation, the project has been able to contribute with the best European expertise on *Inocybe*, including good knowledge on hotspot habitats, and presenting exhibitions and commenting on interesting species. The NSNF association has contributed with a good and enthusiastic mapping/surveying team, practical arrange-

ment, and NHM/NorBOL has offered extensive barcoding treatment and handling of material to herbarium. In the end, the project members have been able to contribute also on interpretations on the sequences, including construction of phylogenetic trees. It should be noted that the entire process of (NorBOL) sequencing and subsequent phylogenetic analyses of the sequences takes time, and only the results from the first workshop is completed per January 2023. The approximately 150 sequenced samples from 2022 workshop are still under processing, but according to expert identifications during the workshop, these seem to include more than 30 species not found in 2021, resulting in nearly 100 *Inocybe* species recorded during the two workshops. In 2022 some habitats not visited in 2021 were included, such as alpine, calcareous *Dryas* heaths, rich, sandy pine forests along the Lågen river and a general higher focus on the often *Inocybe*-rich sandy roadsides. In the following, we will focus on the results from 2021.

RESULTS 2021

In Table 1. results from the Dombås 2021 workshop are presented. Altogether 60 *Inocybe* s. lat. species were verified by ITS-DNA sequencing. Half of these taxa were new to Norway. This is a remarkably high degree of "hidden diversity" (even higher than we have experienced with *Cortinarius* and *Entoloma*). Some of these new species have a precise match with types and thus a proper name, including *I. alberichiana, I. cygnea, I. iseranensis, I. lampetiana, I. oloris, I. paragiacomi*, *I. pararubens* v. *padjelantae* and *Pseudosperma vinosistipitatum* (Table 1) Most of these names are brand new ones,

Figure 1. *Inocybe carissima*, a species published autumn 2022 (see Bandini et al. 2022b). In connection with the Dombås workshop this was found richly fruiting in luxuriant tall-herb vegetation along brook in spruce forest at Fodnes, Nord-Aurdal, Valdres. The species belongs to the *I. pholiotinoides* group, characterized e.g. by the yellowing of gills and stipe, and the cystidia turning golden yellow with KOH. *I. carissima* seems to be the only species in this group that grows in spruce forests. Photo B. Dima.

described during the last three years; see e.g. Bandini et al. (2021, 2022a) and Vauras & Larsson (2020). *Inocybe carissima* is the most recent of our species, being described November 2022, based partly on material from the workshop (Table 1, Figure 1; see also Bandini et al. 2022b). But most of the new-to-Norway represent taxa with still no match on reference sequences, and these are apparently yet undescribed. Many of these are sisters to more well-known species, and have here working names relating to these sister relationships, such as *I. curvipes2, I. pholiotinoides2* (Figure 2), *I. subpaleacea2*, and *I. virgatula2*. Some of the new ones may be (semi-)cryptic species, hard to distinguish from their sisters. Some have a match with a GenBank sequence, but the naming of this is not yet verified by type-sequencing, such as our OTU293 with working name *Inocybe xanthomelas2* s. PAM (sensu Pierre-Arthur Moreau).

According to available data, more than half of the species seem to be preferentially subalpine-alpine species (Table 1). Some of these may also occur in the lowlands, but still have their major populations in the mountains. Just a few of our Dombås species appear to be more or less strict alpine-arctic taxa, such as *I. favrei* and *I. phaeocystidiosa*. It should, however, be noted that 2021 was a poor season in the middle alpine zone (such as in *Salix herbacea* snowbeds), so we did only a little collecting at higher levels this year. Some of the most frequently found species, such as *Pseudosperma bulbosissimum* (7 sequence-verified collections) were found both in subalpine and alpine zone (Figure 3). This has no verified lowland finds in Norway. However, more ubiquitose species also occur. Two of

Figure 2. *Inocybe pholiotinoides2*, a taxon closely related to *I. carissima*, but more scaly, well distinguished in ITS sequence, and so far sequence-verified only once, from tall-herb *Betula pubescens* forest (near alpine zone; Bessheim, Vågå). Photo: B. Dima.

the other most frequent species in the Dombås 2021 material, *I. virgatula* (7 verified collections. *Figure 4*) and *I. cincinnata* (4 verified collections) appear to be very widespread; from lowland coniferous forests to alpine *Betula nana-Salix* heathlands. Some *Inocybe* species shows a remarkable climatic amplitude. *Inocybe leiocephala* was in 2021 found in a *Salix herbacea* snowbed at a roadside in Grimsdalen, but is otherwise sequence-verified from thermophilous deciduous forests in SE Norway, up to arctic tundra sites at Svalbard.

Still many alpine *Inocybe* s. lat. were not found during the 2021 Dombås workshop. Of the 22 subalpine-alpine inocybes recorded in Dovre region prior to 2021, only 11 were re-found during the workshop. Of those 11 species that was not re-found, more or less strict alpine species such as *I. alpigenes, I. argenteolutea* and *I. canescens* can be mentioned.

Due to rather dry conditions, moister and north-faced habitats were focused during the 2021 workshop. Both tall herb *Picea* forests and tall herb *Betula* forests showed to be (locally) very rich habitats for *Inocybe*, especially along brooks, with influence also of spring- and flood water (Table 1). A few species were also found along open, alpine river banks (Grimsdalen) with a high degree of flooding and disturbance. Especially large troops of the dwarfish *I. rupestris2* s. TEB (OTU290) were collected here, a characteristic species that now seems ripe to be formally described. This was not re-found in 2022. Also low alpine, calcareous, dry more or less grazed

Figure 3. *Pseudosperma bulbosissimum* was one of the most frequent species in our sequenced material from Dombås 2021. Seven collections from subalpine *Betula* forest and alpine *Betula nana-Salix* heaths were verified. The species, being recognized e.g. on the more or less bulbous stem base, has hardly been known from Norway up to now, with just a couple of collections from Svalbard and one from Kongsvold, Dovre. Photo: B. Dima.

Betula nana-Salix spp. heaths and moist *Salix lapponum-S-glauca* thickets gave many *Inocybe* finds. In some cases it is not clear from the collectors notes whether the find belongs to the former or latter habitat types, which often occurs in dense mosaic patterns.

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Figure 4. Inocybe virgatula (I. fuscidula s. auct.) was together with *Pseudosperma bulbosissimum* the most frequent species in the sequenced material from 2021. This species is known to be frequent in lowland coniferous forests, but the workshop data shown that this is also frequent in subalpine *Betula* forests, with occurrences also up in the alpine zone. Photo: B. Dima.

Table 1. The taxa of *Inocybe* s. lat., including *Inosperma, Peudosperma* and *Mallocybe* verified with ITS-DNA sequences from the workshop at Dombås 2021, their habitat and distribution.

Sp name in **bold**: preferential alpine-subalpine. OTU no = Operational Taxonomic Unit number in our ITS-DNA phylogeny analyses. New to Norw = New to Norway. (x) = technically new, but part of formerly published complexes. **X** = described as new to science during the project.

Localities: Domb = Dombås east; south of Trolltun (subalpine). Fok = Fokstua east/Foksåe (alpine-subalpine). Grims = Grimsdalen (subalpine-alpine). Joris = Delta of Jori into river Lågen (subalpine).Oppd = Oppdal, Vinstradalen & Lertjønne (alpine). Bessh = Bessheim near Gjende (alpine-subalpine). Valdres (Fodnes, Lomen (subalpine).

**I. grammata*: *Pinus*, sand. *I. rupestris2* s. TEB, *M. leucoloma*2+ 4.: alpine river bank; w/ *Salix* thickets. *M. granulosa, M. leucoloma4* s.Cripps: sandy roadside; *Salix* thickets

Inocybe s. lat.	OTU no	**Tot seq**	**New to Norw**	sites	Tall herb Picea	Tall herb Betula	Flooded delta Salix Alnus	Betula nana-Salix heaths	Moist Salix shrub/ brook	Salix herb Snow beds
***Inocybe*; nodulose-spored: (20 species)**										
I. acuta	2	**1**		Jori			x			
I. curvipes2	297	**2**	**x**	Oppd					x	
I. diabolica	82	**1**		Foks				x		
I. favrei	57	**2**		Foks					x	
I. grammata	20	**1**		Jori			x*			
I. helobia	94	**1**		Jori			x			
I. hirculus	21	**2**		Foks				x		
I. humilis	22	**1**		Bessh						
I. nematoloma2 (I. jacobi3)	226	**1**		Valdr	x					
I. jacobi2 s. Cesca	228	**1**	**x**	Grimsd				x		
I. lacera	100	**3**		Foks					x	x
I. lapponica2	298	**1**	**x**	Oppd					x	
I. occulta	30	**1**		Oppd					x	
I. paragiacomi	253	**1**	**x**	Oppd				x		

I. phaeocystidiosa	38	**2**		Foks, Grim				x	x	
I. soluta3	249	**1**	**x**	Valdres	x					
I. pseudoteraturgus	43	**2**		Grims		x		x		
I. rivularis	47	**2**		Foks, Grim, Otta	x			x		x
I. salicis-herbaceae2 s.PAM	294	**3**	**x**	Grim, Oppd				x	x	x
I. xanthomelas2 s.PAM	293	**1**	**x**	Jori			x			
***Inocybe*; smooth spored: (26 species)**										
I. alberichiana	212	**2**	**x**	Domb, Vald	x	x				
I. appendiculata	70	**2**		Grim		x				
I. carissima	121	**2**	**x**	Valdres	x					
I. cincinnata	78	**4**		Domb, Foks	x	x		x		
I. cygnea (geophylla pp.)	279	**1**	**x**	Grim		x				
I. fuscidula2	283	**1**	**x**	Grim				x		
I. griseolilacina3 s. EL	284	**1**	**x**	Hjerkin		x				
I. hirtelloides2 s. EL	215	**1**	**x**	Grim				x		
I. iseranensis (rupestris pp)	291	**1**	**x**	Fokst					x	
I. lampetiana	275	**1**	**x**	Domb		x				
I. leiocephala	102	**1**		Grimsd						x
I. leptocystis2 s.Matheny	222	**1**	**x**	Grim		x				
I. lindrothii	106	**1**		Domb		x				
I. moelleri	220	**1**		Grim		x				
I. obscurobadia2 s. JV	288	**1**		Domb		x				
I. oloris (geophylla pp.)	274	**1**	**x**	Grim		x				
I. pallidocremea	116	**2**		Valdres	x					
I. pararubens v. padjelantae	286	**1**	**x**	Grim				x		
I. pholiotinoides2	276	**1**	**x**	Bessh		x				
I. pudica2	277	**2**	**x**	Fokst		x				

I. pyriodora (fraudans)	221	**2**		Grim, Bess		x				
I. rupestris s.EL	278	**2**	**x**	Fokst					x	
I. rupestris2 s.TEB	290	**2**	**x**	Grim			x*			
I. subpaleacea2	285	**1**	**x**	Grim				x		
I. virgatula (fuscidula s.auct.)	191	**7**		Domb, Grim, Valdres	x	x		x	x	
I. virgatula2	202	**1**	**x**	Grim		x				
***Inosperma:* (2 species)**										
In. subhirsutum	198	**4**		Foks, Grims				x	x	
In .subhirsutum2	261	**1**	**x**	Oppd					x	(x)
***Pseudosperma:* (3 species)**										
P. bulbosissimum	160	**7**		Foks, Grims Oppd, Bess		x		x	x	(x)
P. rimosum2	301	**1**	**x**	Valdres	x					
P. vinosistipitatum	265	**2**	**x**	Oppd, Valdresflya					x	x
***Mallocybe:* (9 species)**										
M. arthrocystis	170	**2**		Otta	(x)					
M. dulcamara	171	**2**		Domb, Bess		x		x		
M. dulcamara2 s. Cripps	306	**2**	**x**	Grim, Oppd				x	x	
M. fuscomarginata	173	**1**		Oppd				x		(x)
M. granulosa (squamoso-annulata s.auct)	305	**1**		Jori			x*			
M. leucoblema	177	**2**		Grims, Otta	x	x				
M. leucoloma2	270	**2**	**x**	Foks, Grim			x*		x	
M. leucoloma3	304	**1**	**x**	Grim		x				
M. leucoloma4 s. Cripps	303	**2**		Jori			x*			
Tot **60 species (32 ±alpine)**			**30**		11	21	8	19	16	8