The genus *Xanthomendoza* in Norway

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Lindblom, L., Blom, H. H. & Timdal, E. 2019. The genus *Xanthomendoza* in Norway. *Graphis Scripta* **31** (7): 54–75. Oslo. ISSN 2002-4495.

We distinguish five *Xanthomendoza* species in Norway, viz., *X. borealis*, *X. fallax*, *X. fulva*, *X. oregana*, and *X. ulophyllodes*, based on morphology and molecular evidence. This paper gives an updated taxonomy of the Norwegian species of *Xanthomendoza*, and addresses previous misconceptions. *Xanthomendoza ulophyllodes* is reported as occurring in Norway. The species was previously misunderstood in Norway and removed from the Nordic checklist. We show that the nuclear internal transcribed spacer (nrITS) is a useful barcode marker for the treated species. We provide a key and short descriptions of the species, with notes on specific issues, ecology, geographic distribution, illustrations, maps, and a DNA reference library (DNA barcoding).

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Introduction

Thirty years ago, Kärnefelt (1989) published a comprehensive revision of the systematics of the order Teloschistales, including the two families Letrouitiaceae and Teloschistaceae. Important and generally accepted conclusions from his investigation were that the taxonomy at that time did not reflect a natural system, and that good morphological phylogenetically informative characters were lacking (Kärnefelt 1989). For example, the cladistic analysis based on morphological characters showed that the genus *Xanthoria* was paraphyletic, and that a probable monophyletic *X. fallax* group could be distinguished. At that time molecular methods (DNA sequences) for lichens were not available, because fungal-specific primers had not yet been developed. The first molecular studies of the family Teloschistaceae were initiated in the late 1990s, and led to more intensive studies and results on the systematics of genera and species in the family. Several studies confirmed Kärnefelt's (1989) hypothesis of non-monophyly of *Xanthoria* and a monophyletic *X. fallax* group, excluding *X. candelaria* (Arup & Grube 1999, Søchting & Lutzoni 2003, Gaya et al. 2003). However, it was not until 2013 that a comprehensive revision based on combined morphological and molecular characters of the Teloschistaceae was published, where taxonomic consequences of the results were implemented in a sensible framework (Arup et al. 2013).

The genus *Xanthomendoza* S. Y. Kondr. & Kärnefelt was originally erected to accommodate one species, *X. mendozae* (Kondratyuk & Kärnefelt 1997). The monospecific genus was circumscribed using characters in the cortical layers and the medulla, bacilliform conidia, and attachment by so-called umbilicus hapters. A molecular study analysing the ITS marker later found that the genus was nested in a monophyletic group together with several species of *Xanthoria*

Published 2019-12-09 by The Nordic Lichen Society, http://nhm2.uio.no/lichens/NLS.

(Søchting et al. 2002). Consequently the genus was recircumscribed and 16 species were transferred from *Xanthoria* to *Xanthomendoza* (Søchting et al. 2002). The genus as a well-supported monophyletic group has subsequently been detected by multigene analyses in several investigations (Gaya et al. 2012, Arup et al. 2013). Arup et al. (2013), in a comprehensive study of the systematics of the Teloschistaceae, showed with a combined analysis of three molecular markers that the genus *Xanthomendoza* is a well-supported monophyletic group of approximately 20 species, both sorediate and non-sorediate. The sister group of *Xanthomendoza* includes two crustose genera (*Parvoplaca* and *Pachypeltis*), but not the species in *Xanthoria* that are morphologically most similar by having a foliose growth form. The main morphological characters used to circumscribe the genus *Xanthomendoza* are foliose growth form (except for *X. trachyphylla*), lower surface with rhizines in almost all species, narrowly ellipsoid to ellipsoid ascospores with a medium to long septum, and long, bacilliform to narrowly ellipsoid conidia (Arup et al. 2013). See Lindblom (2006) for a comprehensive account of the history of the systematics of the *Xanthoria candelaria* group (Poelt & Petutschnig 1992a, b), *Xanthoria fallax* group (Søchting & Lutzoni 2003), and the genus *Xanthomendoza* (Søchting et al. 2002).

In Norway the genus *Xanthomendoza* is represented only by sorediate taxa, which often have been referred to as the *X. fallax* or *X. ulophyllodes* group. The species in this group are characterized by the presence of soredia as well as oblong or bacilliform conidia and presence of true rhizines (Søchting & Lutzoni 2003). The group was earlier sometimes called the *Xanthoria candelaria* group (e.g., Poelt & Petutschnig 1992a). However *X. candelaria*, which has ellipsoid conidia and hapters instead of true rhizines, was transferred to the genus *Polycauliona* which is only distantly related to *Xanthomendoza* (Arup et al. 2013).

In the first modern lichen flora covering the macrolichens of the Nordic countries (Dahl & Krog 1973), two small sorediate *Xanthoria* species, *Xanthoria candelaria* and *X. fallax,* were recorded from Norway. Krog et al. (1980), in the first edition of the flora of the macrolichens of Norway, maintained that taxonomy. However, in the second edition (Krog et al. 1994), the *Xanthoria* section was revised to (at least partly) follow the systematic revision by Poelt & Petutschnig (1992a). Thus, specimens collected in Norway that previously had been identified as *X. fallax* were redetermined into one of the three species *X. borealis*, *X. fulva*, and *X. ulophyllodes*. Reports of *Xanthoria fallax* in Norway were regarded as based on misidentifications (Krog et al. 1994, p. 350), but see notes under the description of *X. fallax* below.

A few years later, a new species in this group was described from Sweden, namely *Xanthoria poeltii* (Kondratyuk & Kärnefelt 1997, transferred to *Xanthomendoza* by Søchting et al. 2002). Although no material collected in Norway was cited in the original description, Santesson et al. (2004) regarded all reports of *X. ulophyllodes* in the Nordic countries (Finland, Norway, Sweden) as *X. poeltii*. This decision resulted in general confusion about whether *X. ulophyllodes* occurs in Norway, or, if all reports of *X. ulophyllodes* should be regarded as *X. poeltii*. A third possibility was that the material labelled *X. ulophyllodes* in Norwegian herbaria actually consisted of specimens of both *X. poeltii* and *X. ulophyllodes*. Adding to the complex situation, *X. poeltii* was recently synonymised with *X. oregana* (Lindblom & Blom 2014). The confusion and lack of resources to tackle the systematics of *Xanthomendoza* in Norway has persisted for several years, and might be the reason why the species of this common and conspicuous genus were not included in the latest popular Norwegian lichen flora (Holien & Tønsberg 2006). The identification of the species included in the group is admittedly not straightforward and often requires a certain degree of experience, since morphological plasticity within species is very large (Lindblom 1997, Arup et al. 2013). This paper is an attempt to provide an updated taxonomy of the Norwegian material of *Xanthomendoza* sensu Arup et al. (2013), and address previous misconceptions. We avoid

addressing complicated issues concerning the systematics of the family Teloschistaceae, for example the long debated case of the genus *Oxneria* where some of the species treated here has been included by some authors (Lindblom 2006, Gaya et al. 2012, Arup et al. 2013, Ahti et al. 2015). We focus on basic information on the taxa occurring in Norway, not making a complete systematic revision. Here we provide a key and short descriptions of the *Xanthomendoza* species occurring in Norway, with notes on specific issues, ecology, geographic distribution, illustrations, maps, and a DNA reference library (DNA barcoding).

Material and Methods

This study is based on several years of field observations as well as studies of herbarium material of *Xanthoria* s. lat. and *Xanthomendoza* in several parts of the world. Main herbaria for collections from Norway are BG, O, TRH, and UPS (see *Specimens examined* for each species). Herbarium collections of all included species have been studied, and all species have been observed and collected in the field in Norway. We have not made detailed examinations of quantitative characters from Norwegian specimens, for example, spore size, lobe width, and conidia measurements for this paper, neither have we investigated secondary chemistry.

For molecular specimen identification purposes (DNA barcoding, Schoch et al. 2012), we sequenced the fungal nrITS (ITS1 – 5.8S – ITS2) marker as recommended by Leavitt et al. (2013, 2015). The ITS marker has been proved informative on various taxonomic levels in several groups in the order Teloschistales (see for example, Lindblom & Ekman 2005, 2006, 2007, Lindblom & Søchting 2008, Arup et al. 2013, Leavitt et al. 2013, Lindblom & Blom 2014). Sequences from all Norwegian *Xanthomendoza* species were acquired from three sources: (1) Sequencing using standard methods in the DNA Lab at the University of Bergen (Lindblom & Ekman 2006, Øvstedal et al. 2018); (2) Sequencing within the NorBOL project at the Canadian Centre for DNA Barcoding (Marthinsen et al. 2019); (3) Downloading sequences from GenBank. To compare species found in Norway with the same species in other parts of their geographical distribution area, or to use as outgroup (*X. mendozae*), we downloaded sequences from GenBank that we assumed had a high probability of being correctly identified.

Sequence editing, alignment construction, and calculations of genetic distances were carried out in Geneious v. 11.0.5 (https://www.geneious.com). Genetic distances were calculated as uncorrected *p*-distances; the proportion of nucleotide sites at which two sequences are different obtained by dividing the number of nucleotide differences by the total number of nucleotides compared, with no correction for multiple substitutions (Nei & Kumar 2000). Comparison of intra- and interspecific genetic distances was used to assess the existence of barcode gaps for each species, i.e., gaps between the largest intraspecific and the smallest interspecific distances (Schoch et al. 2012, but see Collins & Cruickshank 2013).

Two data sets were prepared, (1) one consisting of all Norwegian sequences of *Xanthomendoza* available to us and of a few selected extra-Norwegian reference sequences of the Norwegian species, and (2) one of all available sequences of *X. fallax*, *X. huculica*, and *X. ulophyllodes*. In the former data set, *X. mendozae* was included to root the tree because it represents the most basal lineage of *Xanthomendoza* in the ITS phylogeny of Arup et al. (2013); in the latter, *X. fulva* was chosen to root the tree as it is phylogenetically closer to the *X. fallax/ulophyllodes* clade.

The two datasets were analysed in v. 2.2.7 of SATé-II (Liu et al. 2012), using MAFFT (Katoh et al. 2005, Katoh & Toh 2008) as aligner, MUSCLE (Edgar 2004a, b) as merger, FastTree (Price et al. 2010) as tree evaluator, and with default settings in the GUI except for that the maximum iterations after last improvement in the maximum likelihood (ML) score was set to 10. The ML tree

Table 1. Sequences used in this study; newly generated (GenBank accession numbers in bold) or downloaded from GenBank (regular font).

Species, lab id	Geographic origin, voucher	GenBank
	Norway	
***X. borealis* 1**	Oppland, Dovre: 2013 Klepsland JK13-L562 (O)	MK811659
***X. borealis* 2**	Sør-Trøndelag, Oppdal: 2014 Timdal WG1-0795 (O)	MK812442
***X. borealis* 3**	Troms, Storfjord: 2003 Blom s.n. (BG)	EU360765
***X. fallax* 1**	Oslo: 2004 Timdal s.n. (O)	**MN238695**
***X. fallax* 2**	Telemark, Porsgrunn: 2015 Timdal 13672 (O)	**MN238696**
***X. fallax* 3**	Telemark, Skien: 2014 Timdal 13300 (O)	**MN238697**
***X. fulva* 1**	Hedmark, Tolga: 2006 Løfall et al. bpl-L11068 (O)	MK812487
***X. fulva* 2**	Vestfold, Tønsberg: 2014 Rui & Timdal WG1-0499 (O)	MK812265
***X. fulva* 3**	Sogn og Fjordane, Vik: 2012 Nordén & Jordal A12-2690 (O)	MK811973
***X. fulva* 4**	Østfold, Eidsberg: 1998 Løfall bpl-L 3423 (O)	**MN238698**
***X. oregana* 1**	Østfold, Aremark: 1998 Løfall bpl-L 3678 (O)	KJ396108
***X. ulophyllodes* 1**	Oppland, Nord-Fron: 2002 Lindblom & Blom L240 (BG)	**MN238699**
***X. ulophyllodes* 2**	Oppland, Nord-Fron: 2019 Timdal et al. 18531 (O)	**MN688210**
***X. ulophyllodes* 3**	Oppland, Sør-Fron: 2019 Haugan s.n. (O)	**MN688211**
	Other countries	
***X. borealis* 4**	Russia, Siberia: Mattsson 276 (LD)	EU360754
***X. fallax* 4**	Austria: Arup L97529 (LD)	AF353955
***X. fallax* 5**	USA, California: Honegger 46t1 (Z, ZT)	AM292809
***X. fallax* 6**	Switzerland: Honegger 68t1 (Z, ZT)	AM292815
***X. fallax* 7**	USA, Minnesota: Honegger 329t1 (Z, ZT)	AM292849
***X. fallax* 8**	Switzerland: Honegger 142t1 (Z, ZT)	AM408397
***X. fallax* 9**	France: Honegger 61t2 (Z, ZT)	AM408413
***X. fallax* 10**	Russia: 2007 Kondratyuk 20709 (KW)	EU681346
***X. fallax* 11**	USA, Wisconsin, 1999 Søchting 9572 (C)	HQ650706
***X. fallax* 12**	USA, Alaska: Gaya et al. (DUKE)	JQ301687
***X. fallax* 13**	Canada, Ontario: 2015 McMullin (OAC)	KT695326
***X. fallax* 14**	Canada, Ontario: 2015 Ivanova (OAC	KT695410
***X. fallax* 15**	Czech Republic (hb. Malícek 7658)	MH145372
***X. fallax* 16**	Czech Republic (hb. Malícek 6935)	MH145374
***X. fallax* 17**	Czech Republic (hb. Malícek 7869)	MH145375
***X. fallax* 18**	Sweden, Skåne: 2015 Lindblom & Blom (non-invasive sample)	**unpublished**

***X. fallax* 19**	Sweden, Skåne: Arup (non-invasive sample)	**unpublished**
***X. fallax* 20**	Sweden, Östergötland: 2012 Hagström (LD)	**unpublished**
***X. fulva* 5**	Chile: Frödén 1544 (LD)	KC179134
X. huculica	Czech Republic: Vondrak 11246 (PRA)	MH145373
X. mendozae	Chile: 1999 Søchting 10209 (C)	KC179138
***X. oregana* 2**	Sweden: Kondratyuk 2 (LD)	KC179142
***X. oregana* 3**	USA: McCune 31146 (LD)	KC179141
***X. ulophyllodes* 4**	Russia: Kuznetsova s.n. (H)	KC179144
***X. ulophyllodes* 5**	USA, Wisconsin: Honegger 176 (Z, ZT)	AM408398
***X. ulophyllodes* 6**	USA, Wisconsin: Honegger 177t1 (Z, ZT)	AM408399
***X. ulophyllodes* 7**	Switzerland: Honegger 318t1 (Z, ZT)	AM408400
***X. ulophyllodes* 8**	Switzerland: Honegger 370t1 (Z, ZT)	AM408401
***X. ulophyllodes* 9**	USA, Wisconsin, 1999 Søchting 9571 (C)	AY081159
***X. ulophyllodes* 10**	Russia: 2006 Urbanavichus (H)	EU681340
***X. ulophyllodes* 11**	Ukraine: 2000 Kondratyuk et al. (KW)	EU681341
***X. ulophyllodes* 12**	Russia: 2007 Kondratyuk 20709 (KW)	EU681342
***X. ulophyllodes* 13**	Russia: 2006 Kuznetsova (H)	KC179144
***X. ulophyllodes* 14**	Canada, Ontario: 2015 McMullin (OAC)	KT695394
***X. ulophyllodes* 15**	Vondrak 18145	MG954175
***X. ulophyllodes* 16**	Vondrak 18148	MG954176
***X. ulophyllodes* 17**	Vondrak 18159	MG954177
***X. ulophyllodes* 18**	Vondrak 18696	MG954178
***X. ulophyllodes* 19**	Russia: Vondrak 16088 (PRA)	MK778645

evaluation by FastTree used GTR+G20 as model of evolution and Shimodaira-Hasegawa test (SH test) for evaluation. The analyses of both datasets stopped at 10 iterations (i.e., there was no improvement of the ML scores after the first alignment and tree evaluation was obtained in both analyses). The 'best' tree was chosen and edited in TreeGraph2 (Stöver & Müller 2010).

Results

New nrITS sequences were generated from seven collections of *Xanthomendoza* from Norway and three from Sweden (Tab. 1). The first dataset comprised 20 sequences including reference and outgroup sequences. The resulting alignment is 533 nucleotides in length with 26.8 % variable sites. A conspicuous 11 bp long insertion in the ITS2 was observed consistently in *X. fallax*, *X. ulophyllodes*, and *X. mendozae*. The observed p-distances in the total ITS revealed no overlap of intraspecific (maximum 1.5 %, *X. fallax*) and interspecific variation (1.8–17.0 %) (Tab. 2). This indicates a barcode gap (Schoch et al. 2012) between all species in our admittedly small data set.

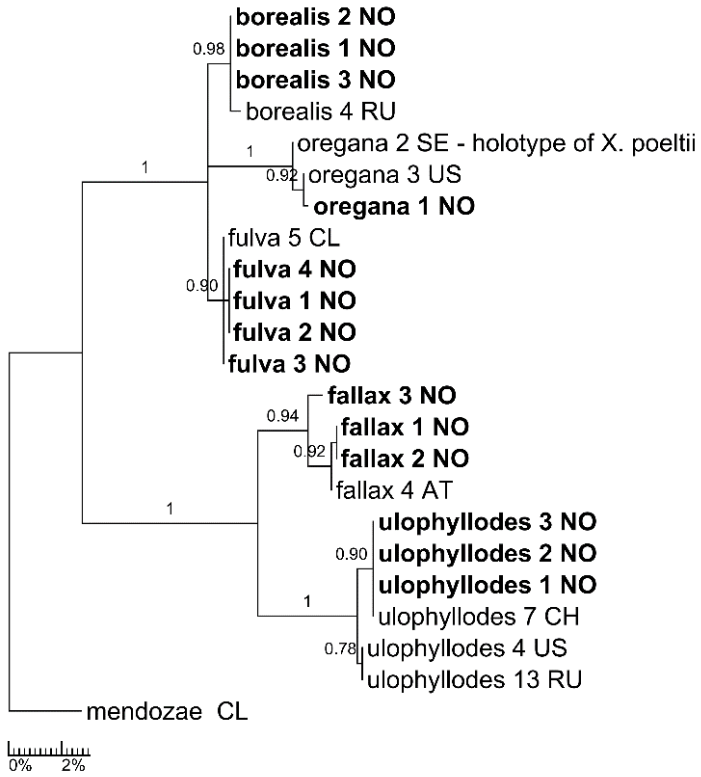

Figure 1. Maximum Likelihood analysis (nrITS) of *Xanthomendoza* species found in Norway. *Xanthomendoza mendozae* is included as outgroup. SH test support values > 0.5 are given above branches.

The ML tree (Fig. 1) shows that the specimens group according to our a priori species determinations based on morphological characters. In addition, the sequences included as species references corroborate the names, and thus the taxonomy, that we have applied.

The second analysis, which included all available sequences of *X. fallax*, *X. huculica*, and *X. ulophyllodes*, with an additional sequence of *X. fulva* as outgroup, consisted of 41 sequences. The resulting alignment was 607 base pairs long with 16.8% variable sites. The ML tree (Fig. 2) grouped the ingroup in two highly supported clades, a *X. fallax/huculica* clade and a *X. ulophyllodes* clade. The former clade consisted of two short-branched subclades with moderate SH test support values of 0.74 and 0.88, respectively. Norwegian specimens occurred in both subclades, and our only specimen named *X. huculica* (downloaded from GenBank) occurred in the former subclade.

Discussion

Based on morphology, ecology, and molecular evidence, we recognise five *Xanthomendoza* species in Norway: *X. borealis*, *X. fallax*, *X. fulva*, *X. oregana*, and *X. ulophyllodes* (Figs. 3, 5, 7, 9, 10). All of them are sorediate, and never or very rarely apotheciate (*X. fulva*). In most cases, the species can be reliably determined by a combination of morphological characters, for example colour of upper

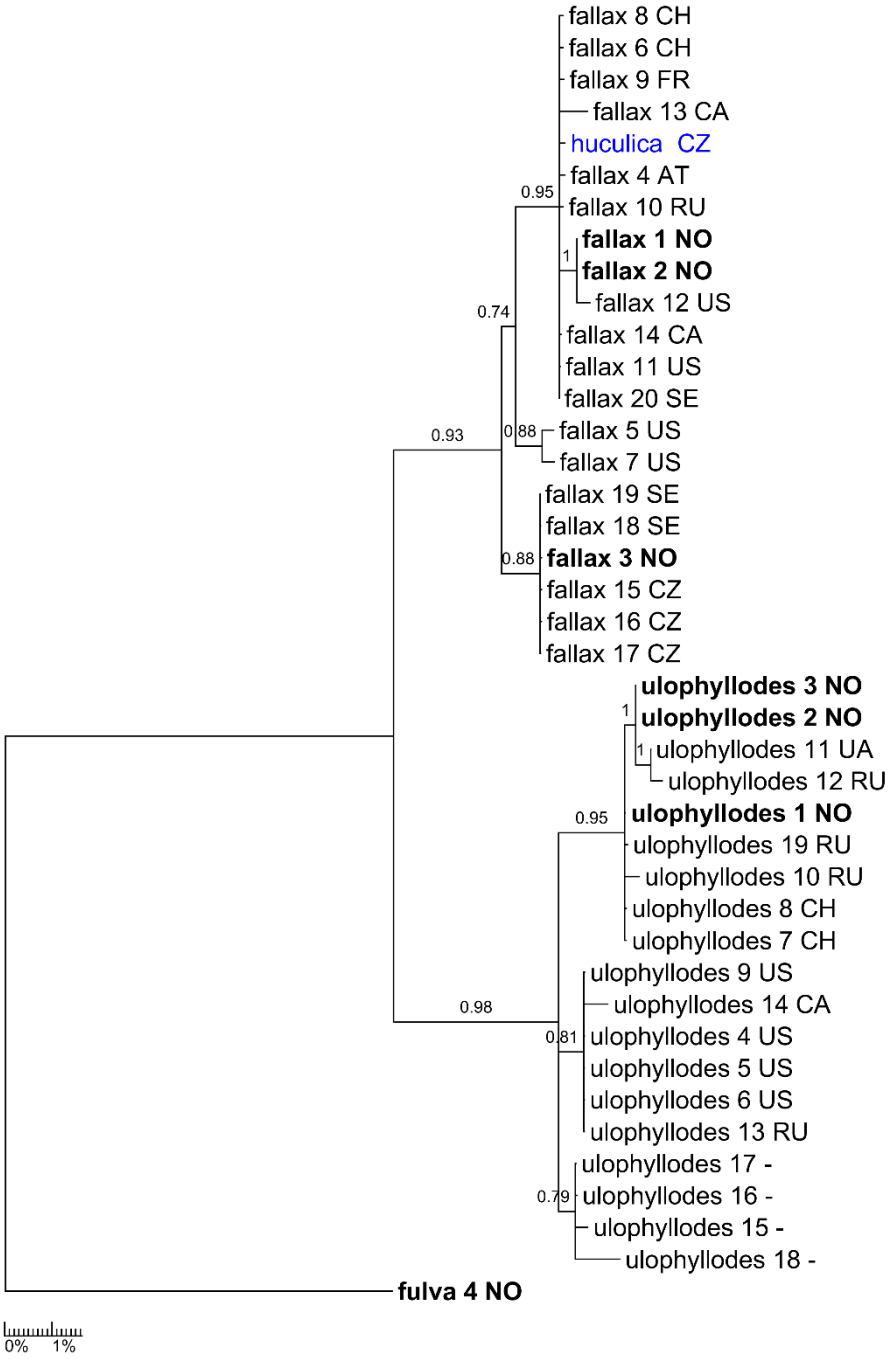

Figure 2. Maximum likelihood analysis (nrITS) of *Xanthomendoza fallax* and *X. ulophyllodes*. SH test support values > 0.5 are given above branches.

Table 2. Observed p-distances within and between species of *Xanthomendoza* sampled in Norway plus one sequence from the type species of the genus (n = number of sequences). Intraspecific distances are in bold.

	X. borealis	*X. fallax*	*X. fulva*	*X. oregana*	*X. ulophyllodes*	*X. mendozae*
	n=3	**n=3**	**n=4**	**n=1**	**n=3**	**n=1**
X. borealis	**0**	14.3–14.5	1.8	4.7	15.3	12.2
X. fallax		**0–1.5**	14.1–14.3	16.2–16.4	6.1–6.5	12.9
X. fulva			**0**	4.9	15.8	12.0
X. oregana				**n.a**	17.0	14.6
X. ulophyllodes					**0**	14.0
X. mendozae						**n.a**

surface, lobe morphology, and characteristics of soralia. However, morphological plasticity frequently results in difficulties to interpret variable characters (Lindblom 1997, Arup et al. 2013), to the degree where even an experienced user struggles. The results from our investigation show that molecular barcodes provide a useful tool to unequivocally determine morphologically atypical specimens to species (Fig. 1, Tab. 2).

Genetic distances indicate that there are substantial barcode gaps between the five *Xanthomendoza* species occurring in Norway. There is one peculiar case, though, between *X. borealis* and *X. fulva*, the distance is below 2 %. This is a very small distance, compared to the only species in our data set (including Norwegian specimens of the five species) with within-species variation above zero, *X. fallax*, with 1.5 %. However, the tree shows that both *X. borealis* and *X. fulva* are distinct monophyletic groups with strong support. Together with *X. oregana*, they form a clade where the three species are distinct, but their phylogenetic relationships are unresolved (Fig. 1).

The second analysis, which included all available sequences of *X. fallax*, *X. huculica*, and *X. ulophyllodes* (Fig. 2), indicates that *X. huculica* is synonymous with *X. fallax*. Alternatively, the two subclades with 0.74 and 0.88 support values might represent two species, as indirectly indicated by Malíček et al. (2018) when they distinguished between the two species in their Czech material (sequences *fallax* 15-17 and *huculica* in our Fig. 2). The branch lengths separating the two subclades are short, however, actually shorter than subclades seen in *X. ulophyllodes* in Fig. 2. Furthermore, the morphologically, ecologically, and geographically similar Norwegian *fallax* 2 and 3 occur in different subclades, which adds to our conviction that only one species should be accepted.

The Species

The descriptions provided below are based on Norwegian material. Thus, no information on secondary chemistry is included, since we did not screen Norwegian specimens (but see for example Lindblom 1997, Søchting et al. 2002). Nomenclature follows Nordin et al. (2019), except for *X. oregana* (*'X. poeltii'*, see Lindblom & Blom 2014).

Key to the species of *Xanthomendoza* in Norway:

The species in the genus *Xanthomendoza* in the sense of Arup et al. (2013) are included in the key. Accordingly, foliose lichens characterized by the following combination of morphological characters are keyed out here: thallus and apothecial disc yellow to orange to orange-red, with a distinct K+ blood red spot test reaction (anthraquinones present), presence of a lower cortex (sometimes less developed), presence of true rhizines (long, free or attached to substrate), and presence of long, bacilliform to narrowly ellipsoid conidia.

All five species occurring in Norway are included in the detailed key by Lindblom (1997) and four of them in the key in Lindblom (2004; lacking *X. borealis*). See Lindblom et al. (2005) for a key including other Norwegian species in genera previously included in *Xanthoria* (*Xanthoria* s. lat.), *Rusavskia* and *Polycauliona*.

1. Thallus orange, pruinose at least in parts; lobes mostly erect; soralia produced from lower surface . . . . . ***X. borealis***
– Thallus light yellow to dark orange, never pruinose; lobes horizontal to raised; soralia located at lobe margins or below 2

2. Thallus not rosette-forming; often several thalli confluent, lobes imbricate (*X. fulva*) or irregular (*X. oregana*); conidia bacilliform or ellipsoid-bacilliform 3*
– Thallus rosette-forming; marginal lobes horizontal, adpressed (central lobes can be raised); conidia bacilliform 4

3. Thallus dull to dark orange; lobe tips rounded, mostly unbranched; pycnidia prominent, darker than upper cortex; conidia bacilliform . . . . . ***X. fulva***
– Thallus bright yellow to light orange; lobe tips irregular, with fine branchlets; pycnidia immersed, coloured as upper cortex; conidia shape variable, ellipsoid to bacilliform . . . . . ***X. oregana***

4. Soredia produced in marginal crescent-shaped slits, bordered by the remaining upper and lower cortex ("bird nests"), soredia colour lighter than the upper surface or greenish yellow (“soredia”) . . . . . ***X. fallax***
– Soredia produced from lobe margins; soredia coloured as the upper thallus surface (“blastidia”) . . . . . ***X. ulophyllodes***

*) Luxuriant forms of *X. fulva* are extremely difficult to distinguish from *X. oregana*, see *Notes* for *X. fulva* below.

***Xanthomendoza borealis* (R. Sant. & Poelt) Søchting, Kärnefelt & S.Y. Kondr.** Fig. 3

Norwegian: Fjellmessinglav

Description: Thallus up to 15 mm, consisting of aggregated convex lobes that are ascending to erect, with downward bent margin and narrow lobe tips. The upper surface orange with a reddish tinge and thin white pruina (visible at least on some lobes). Rhizines few and the thallus fixed to the substratum by a central hold-fast. Soralia undefined, soredia formed on the lower side of the lobe tips. Soredia orange (bark colour or rarely slightly paler). Apothecia not observed. Pycnidia rare, immersed in or slightly protruding from the upper surface, with the same colour as the upper lobe surface.

Figure 3. *Xanthomendoza borealis*. Field photograph of O-L-148963, Norway, Oppland, Dovre. Scale bar: 2 mm. Photo: E. Timdal 2005-08-03.

Ecology: Saxicolous, mostly in dry fissures or hollows beneath overhang of walls and large boulders. Collected on calcareous schists, phyllites and limestone, often on rock surfaces with a thin layer of rock detritus.

Distribution: Mountain areas of central and northern Norway (Fig. 4).

Notes: For further descriptions of *X. borealis* and comparisons to similar species, see Poelt & Petutschnig (1992a, b), Lindblom (1997), and Lindblom & Søchting (2008).

Specimens examined: **Norway**. *Hedmark*: Os, Kjurrudalen, V for Bergemyra, UTM: PQ 08 38, alt. 740 m, på østvendt bergvegg, 2002-09-15, H. C. Gjerlaug 5781B (BG L-86059). *Oppland*: Dovre, Grimsdalen, S-slope of Mt Jegerhø, UTM(WGS84): NP 2789 8171, alt. 1140 m, under overhanging rock on boulder in steep, S-facing slope; calcareous rock, 2007-08-01, E. Timdal 10606 (O L-149117); Dovre, Grimsdalen, Nordre Tverråi, UTM(WGS84): NP 32 85, alt. 1050–1100 m, S-facing, vertical rock wall in low alpine zone, calcareous rock, 2005-08-03, E. Timdal 10534 (O L-148963); Dovre, Kattuglehøe S, UTM(WGS84): NP 2995 8257, alt. 1280 m, på kalkrik berghylle (fyllitt) under overheng, 2013-08-04, J. T. Klepsland JK13-L562 (GenBank MK811659) (O L-198333); Dovre, c. 100 m W of Verkenssætri, UTM(ED50): NP 282 814, alt. 1020–1040 m, under overhanging rock in steep, SW-facing slope, 1995-07-04, R. Haugan & E. Timdal 8062 (GenBank: EU360766) (O L-15117); Dovre, Værkensæter, UTM(WGS84): NP 2808 8117, alt. 1040 m, 2005-08-05, E. Timdal 10898 (O L-153476); Lom, Høydalssæter, UTM(WGS84): MP 4839 3705, alt. 940 m, vertical side of boulder, under overhanging rock, 2013-06-29, M. Bendiksby, R. Haugan & E. Timdal 12964 (O L-184377); Vågå, along path between Nordre and Søndre Brurskardknappen, UTM(ED50): MP 899 132, alt. 1200 m, on boulder in low-alpine zone, under overhanging rock, 1996-08-28, E. Timdal 8480 (O L-23404). *Sogn og Fjordane*: Luster, N

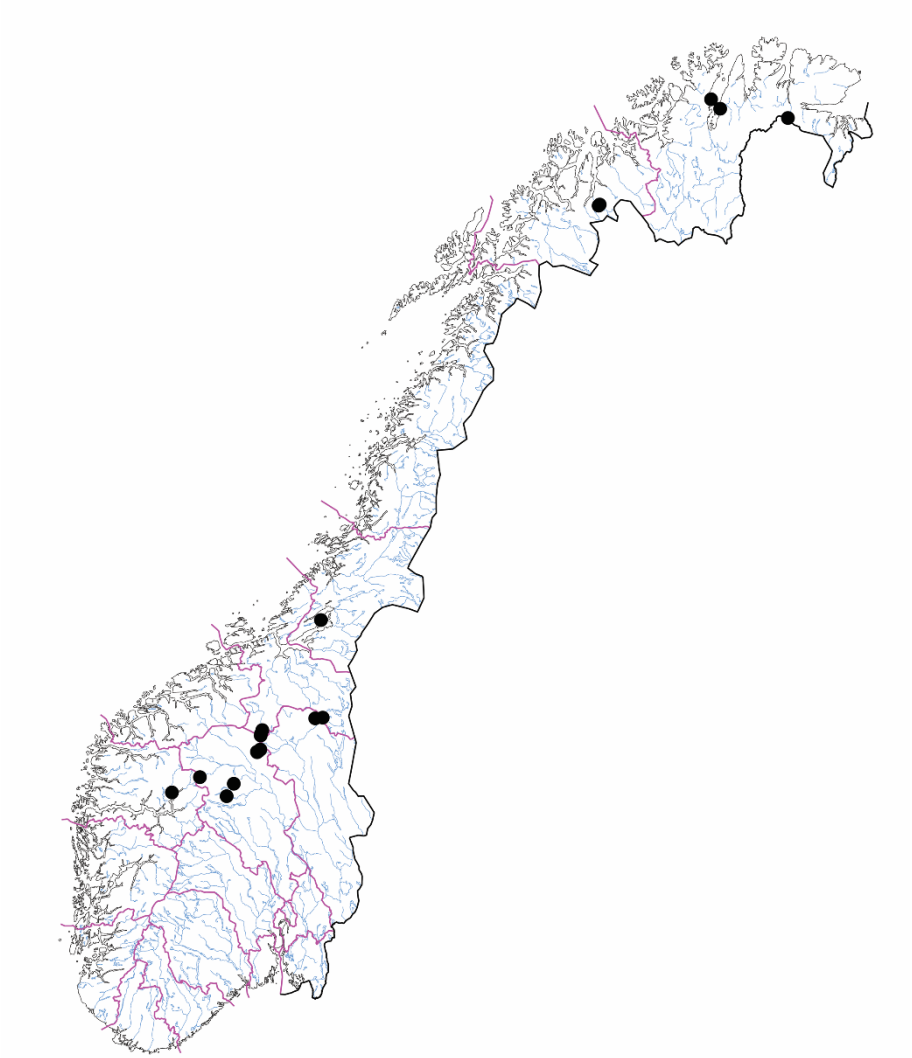

Figure 4. *Xanthomendoza borealis*. Distribution in Norway.

of Gaupne, steep slope NE of Gjetarknubben, 61.42342°N 7.30840°E, alt. c. 750 m, on perpendicular limestone slate below overhang, facing S, exposed, 2018-06-13, U. Arup L18300 (LD). *Sør-Trøndelag*: Oppdal, Kongsvoll, 62°18.18'N, 9°36.29'E, alt. 900 m, on building wall (rock), under barn bridge, 2014-09-02, E. Timdal WG1-0795 (GenBank MK812442) (O L-196336); Oppdal, Vårstien, [UTM(WGS84): NQ 322–334 114–167], [alt. 760–1000 m], 1854-08, J. E. Zetterstedt (UPS L-55107); Oppdal, Kongsvoll, S. Knutshö, [UTM(WGS84): NQ 309–315 073–085], alt. 900 m, in Spalten einer NW exponierten Felswand an der Landstrasse, 1960-09-09, A. Henssen 12165b (UPS L-55106); Oppdal, river Driva between Grønbakken and Kongsvoll, UTM(WGS84): NQ 3103 0594, alt. 910 m, rock wall in the alpine region, 2010-08-10, E. Timdal 11741 (O L-163794); Røros, Rörås, Hammerdal, [UTM(WGS84): PQ 188–192 395–409], [alt. 650-720 m],

1895-07-14, E. P. Vrang (S L57024). *Nord-Trøndelag*: Inderøy, the farm Ø. Vang, UTM(ED50): PR 030–032 824–826, alt. 120–140 m, on sun-exposed, vertical, calcareous rock in pasture, 1998-09-30, H. Bratli 2823 (O L-39341). *Troms*: Storfjord, Stuoraoaivi, UTM(WGS84): DB 777 840, alt. 770 m, shelf under overhang of big boulder, calcareous shist, 2003-08-08, H. H. Blom (GenBank EU360765) (BG L-86610); Storfjord, Gustavsvingen, UTM: DB 794 854, alt. 100 m, horizontal rock under humid overhang, 2003-08-07, R. Haugan (BG-L-86612). *Finnmark*: Porsanger, W to SW of Skallenes, the slope of Mt. Guotkovarre, [UTM(WGS84): MU 326–333 177–184], alt. 50–150 m, 1968-08-08, R. Santesson 19900 (UPS L-55103); Porsanger, ca. 25 km E of Börselv, a field between Vieksa and Goddekvarre, [UTM(WGS84): MU 425–438 013–030], [alt. 20–180 m], so-called orohemiarctic belt, *Empetrum*-lichenes heath, 1967-07-08, H. Vänskä 1300 (UPS L-55102); Tana, 4 km SSE of the Polmak church, on a heap of stones marking the boundary between Norway and Finland (no. 344), [UTM(WGS84): NT 374 693], alt. 270–280 m, 1967-07-26, H. Vänskä 1711 (UPS L-55105); Tana, 4 km SSE of the Polmak church, on a heap of stones marking the boundary between Norway and Finland (no. 344), [UTM(WGS84): NT 374 693], alt. 270–280 m, 1967-07-26, H. Vänskä 1711 (UPS L-55105).

***Xanthomendoza fallax* (Hepp) Søchting, Kärnefelt & S.Y. Kondr.** Fig. 5

Norwegian: Buktmessinglav

Nomenclatural note: The basionym of this name has been cited as *Physcia fallax* Hepp ex Arnold, Flora 20: 307 (1858) by, e.g., Lindblom (1997) and Søchting et al. (2002). This name is a *nomen nudum* and hence invalid. Furthermore, if valid, it would have been an illegitimate homonym of *Physcia fallax* (Weber) DC. (Nimis 2016). Poelt & Petutschnig (1992a), however, correctly cited the scheda to *Placodium fallax* Hepp, Flechten Europas Band XI, no. 633 (1860) as the basionym.

Description: Thallus up to 30 mm, rosette-forming, with lobes that are horizontal (or only slightly raised), plane, with slightly downward bent margin and rounded wide tips. The upper surface yellow to light orange, smooth. Rhizines frequent, long, often visible from above. Soralia marginal, forming ± crescent-shaped slits, with the upper cortex often persistent and forming a hood (bird nest soralia, see fig. 3 in Poelt & Petutschnig 1992a). Soredia powdery, yellow to greenish yellow (medulla colour). Apothecia not observed in Norwegian collections. Pycnidia common, immersed in or slightly protruding from the upper surface, slightly darker colour than the upper lobe surface.

Ecology: In Norway only found on bark of planted broadleaved deciduous trees (*Acer*, *Betula*, *Fagus*, *Fraxinus*, *Populus*, *Tilia*, *Ulmus*) in exposed situations.

Distribution: *Xanthomendoza fallax* is at present known from three extant populations in suburban environments in SE Norway (Oslo, Porsgrunn, and Skien) and from a fourth probably extinct population in a park near Horten (Fig. 6). At the last site, it was unsuccessfully searched for in 2000 and 2001 (Lindblom & Timdal 2004).

Barcode note: In our alignment, the ITS sequences have a characteristic insert between nucleotides 395 and 407, a feature that *X. fallax* shares only with *X. ulophyllodes*, as well as the chosen outgroup *X. mendozae*.

Notes: According to Krog et al. (1994), all earlier reports of *X. fallax* sensu stricto in Norway should be disregarded, being based on misdeterminations. Almost 10 years later, LL and ET independent of each other found two collections from two localities in southern Norway in herbarium O (Horten and Oslo). In addition, the species was still present at one of the localities (Lindblom & Timdal 2004). Subsequently, several additional discoveries of large populations in the cities of Porsgrunn and Skien have been made. In Norway, *X. fallax* is exclusively found on broadleaved deciduous

Figure 5. *Xanthomendoza fallax*. Field photograph of O-L-136166, Norway, Telemark, Skien. Scale bar: 2 mm. Photo: E. Timdal 2005-05-07.

trees, whereas in Sweden it also occurs on anthropogenic substrates such as walls surrounding churchyards and castles (Frödén & Lindblom 2003, Lindblom 2007, Lindblom & Blom pers. obs.).

For discussion of *X. huculica*, see *Discussion*, above. For further descriptions of *X. fallax* and comparisons to similar species, see Poelt & Petutschnig (1992a, b) and Lindblom (1997).

Specimens examined: **Norway**. *Oslo*: Oslo, S Tåsen, [UTM(WGS84): ca. NM 978 472], [alt. 110 m], alm, 1927-05-25, P. K. Haugsjå (O L-41325); Oslo, Søndre Tåsen, UTM(WGS84): NM 9781 4720, alt. 110 m, on the trunk of an old *Ulmus glabra* in garden of housing cooperative, 2004-08-27, E. Timdal (GenBank MN238695) (O L-131408); Oslo, Søndre Tåsen, UTM(WGS84): NM 9781 4721, alt. 114 m, old *Ulmus glabra*, trunk, garden, 2008-02-24, R. Haugan 8010 (O L-157284. *Vestfold*: Horten, Borre nasjonalpark, [UTM(ED50): NL 834–840 834–840], [alt. 1–20 m], 1971-05-30, E. Dahl & H. Krog (O L-41326). *Telemark*: Porsgrunn, the park between Storgata and Sverres gate, UTM(WGS84): NL 3755 5587, alt. 10 m, On *Tilia*, 2008-05-11, E. Timdal 10887 (O L-152899); Porsgrunn, city park near the railway station, 59°08.42'N, 9°39.39'E, alt. 10 m, on trunk of *Populus* sp., 2014-05-02, E. Timdal 13294 (O L-194168); Porsgrunn, Porsgrunn city, in park by the railway station, 59°8.43'N, 9°39.39'E, alt. 10 m, on *Populus* in city park, 2015-01-04, E. Timdal 13672 (GenBank MN238696) (O L-198950); Porsgrunn, Porsgrunn railway station, UTM(WGS84): NL 3768 5575, alt. 15 m, *Acer platanoides*, trunk, 2009-05-20, R. Haugan 8594 (O L-161158); Porsgrunn, UTM(WGS84): NL 3756 5588, alt. 15 m, på tynne stammer, greiner og kvister inne i hekk av storlind, på *Tilia platyphyllos*, 2008.06.19, J. T. Klepsland JK08-L045 (O L-158231); Skien, Gjerpen church, UTM(WGS84): NL 3471 6516, alt. 70 m, on poplar tree in the churchyard, 2007-03-10, E. Timdal (O L-146497); Skien, Mæle, NW side of intersection of Mælagata with small road just N of Mæle manor, UTM(WGS84): NL 3394 6456, alt. 40–50 m, on trunk of *Ulmus* in the road side, 2005-05-07, E. Timdal 9921 (O L-136166); Skien, Mæle, Gjerpensgate, at

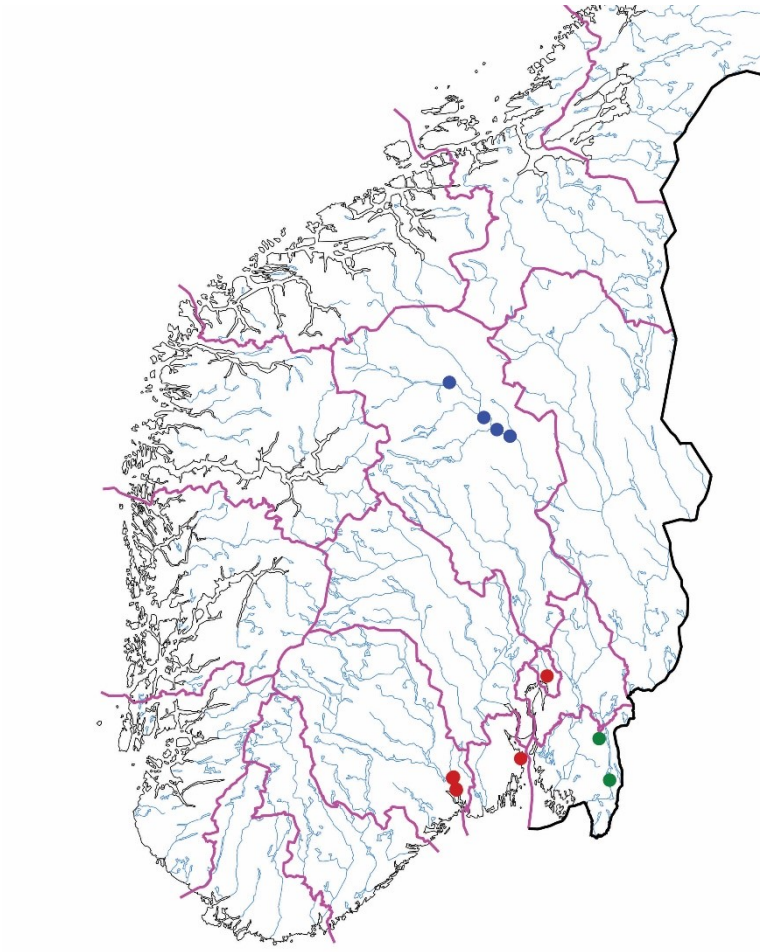

Figure 6. Distribution in Norway of *Xanthomendoza fallax* (●), *X. oregana* (●), and *X. ulophyllodes* (●).

the entrance to "Statens hus", UTM(WGS84): NL 3415 6451, alt. 40 m, on bark of *Tilia* by the road, c. 0.8 m above ground, on the SW side of the tree, 2007-03-10, E. Timdal DSC_9173-7 (O L-146509); Skien, Gjerpensgate, avenue N of Mæla gård, UTM(WGS84): NL 3415 6451, alt. 40–50 m, on bark of *Acer* by the street, with *Xanthoria parietina*, 2014-07-05, L. Lindblom & H. H. Blom L502 (BG L-97395); Skien, by the entrance gate to (Store) Mæla gård, UTM(WGS84): NL 3394 6456, alt. 40–50 m, on *Fraxinus excelsior*, 2014-07-05, L. Lindblom & H. H. Blom L501 (BG L-97394); Skien, Skien railway station, 59°13.08'N, 9°36.16'E, alt. 40 m, on trunk of *Ulmus* at edge of park, 2014-05-02, E. Timdal 13300 (GenBank MN238697) (O L-194174); Skien, small park SW of the railway station, UTM(WGS84): NL 3441 6448, alt. 40 m, on old *Tilia*, 1–2.5 m above ground, SW side of tree, 2007-03-10, E. Timdal DSC_9169 (O L-146513).

Figure 7. *Xanthomendoza fulva*. Field photograph of O-L-135112, Norway, Buskerud, Hole. Scale bar: 2 mm. Photo: E. Timdal 2004-10-20.

***Xanthomendoza fulva* (Hoffm.) Søchting, Kärnefelt & S.Y. Kondr.** Fig. 7

Norwegian: Leppemessinglav

Description: Thallus up to 9 mm, coalescing with adjacent thalli and often covering large patches. Lobes horizontal to slightly raised, narrow, plane to convex, richly branched; lobe tips rounded, mostly unbranched. The upper surface orange to dull orange, with thin almost opaque smooth upper cortex. Rhizines scattered, short, and thin, sometimes visible from above. Lower lobe parts sometimes also attach to the substrate. Soralia marginal or submarginal at lobe tips, forming more or less rounded small cortex slits, sometimes with persistent upper cortex (miniature "birds nest soralia", cfr *X. fallax*). Soredia powdery and concolorous with, or somewhat lighter than, the upper cortex. Apothecia very rare. Pycnidia fairly common, visible as prominent protruding orange red to dark red warts ("orange pimples").

Ecology: Corticolous on a wide range of deciduous tree species, on phorophytes with basic bark or acidic bark (*Betula*) affected by nutrient rich dust, usually in open to semi-shaded habitats but also collected from shaded sites. *Xanthomendoza fulva* characteristically occurs on tree bases and lower parts of trunks, often forming extensive orange patches.

Distribution: Southeastern subcontinental species, collected north to Steinkjer, Trøndelag. The westernmost locality is situated near Førde, Sogn og Fjordane (Fig. 8). In Sweden, *X. fulva* is

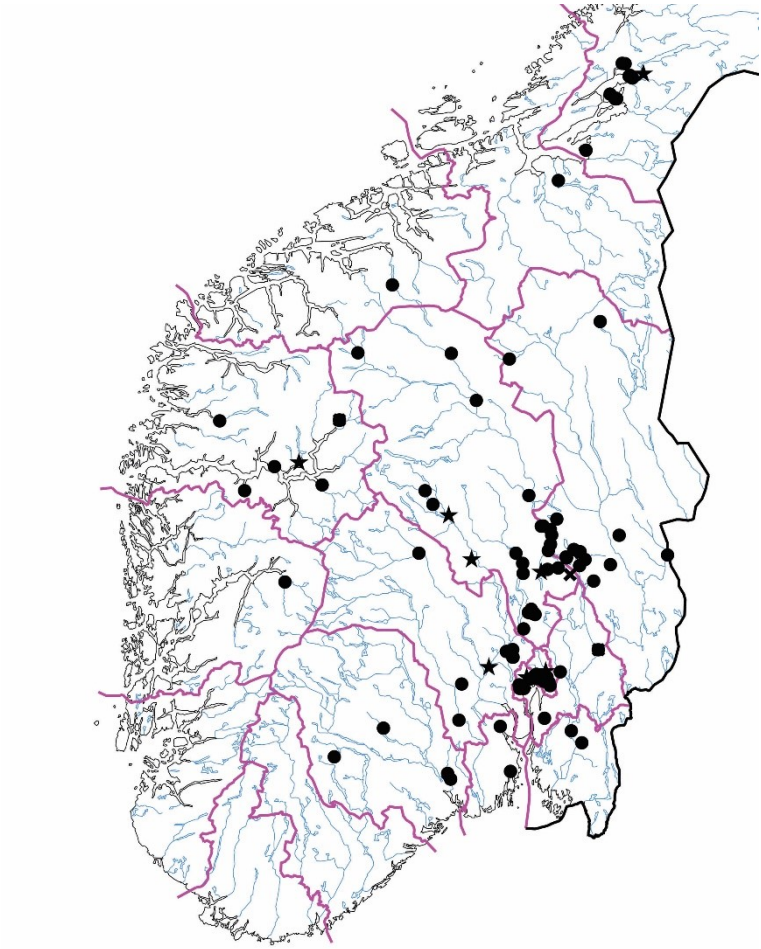

Figure 8. *Xanthomendoza fulva*. Distribution in Norway. ★: symbol in centre of municipality; ×: observation.

reported as far north as Jämtland, Hälsingland, and Ångermanland, that is, with a northern distribution limit equivalent to that in Norway (Nordin et al. 2019, www.artportalen.se).

Notes: For further descriptions of *X. fulva* and comparisons to similar species, see Poelt & Petutschnig (1992a, b) and Lindblom (2006). The description in Lindblom (1997) is not accurate, however, since she accepted too much morphological within-species variation in *X. fulva* (material that was later recognized as *X. weberi* or *X. galericulata* in addition to *X. fulva* s.str., see Lindblom 2006).

Extremely luxuriant forms of *X. fulva* are difficult to distinguish from *X. oregana* or *X. ulophyllodes*, mainly because the lobes become wider and thicker, and even the characteristic dull orange colour can be lighter yellow. The thallus size of *X. fulva*, however, is smaller than both. In addition *X. fulva* never develops into rosette-like thalli as *X. ulophyllodes*, but rather develops

numerous small, imbricate thalli covering the substrate. *Xanthomendoza oregana* also has ascending lobes, but they are broader, growing in all directions, and the thalli usually aggregate into denser and larger units than *X. fulva*. Barcode sequences separate these three species unequivocally (Fig 1).

Selected specimens examined: **Norway**. Only one specimen per province ('fylke') is listed. *Østfold*: Eidsberg, Eidsberg stasjon, UTM(ED50): PL 305 997, alt. 150 m, på frittstående stor lind [*Tilia* sp.], 1998-03-21, B. P. Løfall bpl-L3423 (GenBank MN238698) (O L-31908). *Akershus*: Bærum, Grini, [UTM(ED50): NM 902–913 467–476], [alt. 140–160 m], 1927-05-28, P. K. Haugsjå (O L-45808). *Oslo*: Disen, UTM(WGS84): NM 999 464, alt. 130 m, on *Tilia*, 2006-04-30, E. Timdal 10168 (O L-142755). *Hedmark*: Tolga, Øverhusa, UTM(WGS84): PQ 1510 1661, alt. 825 m, på osp (*Populus tremula*) i kulturlandskap, 2006-06-11, B. P. Løfall, E. Timdal, R. Haugan, J. T. Klepsland bpl-L11068 (GenBank MK812487) (O L-147714). *Oppland*: Sel, Otta, at the «Otta skysstasjon», UTM(ED50): NP 281 491, alt. ca. 300 m, on solitary *Betula* by parking lot, 2002-07-14, L. Lindblom & H. H. Blom L236 (BG L-76811). *Buskerud*: Hole, Sundvollen hotel, 60°3.73'N, 10°18.60'E, alt. 70 m, on the trunk of an old *Acer* at the garden entrance, 2014-11-04, E. Timdal (O L-200809). *Vestfold*: Tønsberg, Sem church, 59°17.51'N, 10°23.23'E, alt. 20 m, on *Ulmus* in churchyard, 2014-08-10, S. Rui & E. Timdal WG1-0499 (GenBank MK812265) (O L-196295). *Telemark*: Skien, Fossum, avenue ca 500 m SSE of Fossum manor, UTM(WGS84): NL 3223 6692, alt. ca. 45 m, on ornamental *Tilia*, 2015-07-07, L. Lindblom & H. H. Blom L503 (BG-L-98537). *Hordaland*: Eidfjord, Øvre Eidfjord, just E of Sæbø, the N-facing slope of hill 116, UTM(WGS84): LM 974 998, alt. 60–80 m, corticolous on trunk of solitary *Betula*, 2005-04-29, T. Tønsberg 35154 (BG-L-81820). *Sogn og Fjordane*: Vik, Lee, UTM(WGS84): LN 6104 6540, hagemark, styva alm, bark, 2012-06-16, B. Nordén & J. B. Jordal A12-2690) (GenBank MK811973) (O L-199397). *Møre og Romsdal*: Nesset, near S end of lake Eikesdalsvatnet, on the E side, UTM(ED50): MQ 572 297, alt. 40 m, on pollarded *Ulmus glabra* in S-facing slope, 1997-09-29, S. Rui & E. Timdal 8809 (O L-26747). *Sør-Trøndelag*: Klæbu, Klæbu kirke, Stove, mellom prestegården og kirka, UTM(WGS84): NR 7397 1941, alt. 140 m, på store gamle almetrær (*Ulmus glabra*), 2008-03-13, R. Haugan 08032 (BG L-86450). *Nord-Trøndelag*: Steinkjer, Egge gård (W of Egge church), UTM: PS 20 02, [alt. 60–80 m], on *Acer*, 1981-09-21, T. Tønsberg 6251a (TRH L-650152).

***Xanthomendoza oregana* (Gyeln.) Søchting, Kärnefelt & S.Y. Kondr.** Fig. 9

Syn.: *Xanthomendoza poeltii* (S.Y. Kondr. & Kärnefelt) Søchting, Kärnefelt & S.Y. Kondr.

Norwegian: Tunmessinglav

Description: Thallus up to 30 mm, consisting of slightly raised to ascending lobes forming ± large congregations (tufts). Rather than forming a rosette, the lobes give an "unruly" impression of the thallus. The upper surface bright yellow to orange, smooth or sometimes slightly wrinkled. Rhizines scattered, free or attached to substrate. Soralia of undefined shape, marginal-submarginal. Soredia orange (bark colour). Apothecia not observed in Norwegian collections. Pycnidia common, immersed-protruding, with darker colour than the upper surface (note the variable conidia described in Lindblom 1997).

Ecology: Corticolous, on deciduous trees. The two Norwegian specimens were collected on *Acer platanoides* and *Betula verrucosa*, respectively. In S Sweden it occurs in open sites like parks, church-yards and solitary trees in the agricultural landscape.

Distribution: Southeasternmost Norway, known only from Østfold (Fig. 6). In Sweden, *X. oregana* is reported from southern Sweden (Nordin et al. 2019; www.artportalen.se) at approximately the same northern limit as in Norway. The distribution of *X. oregana* further south in Europe is poorly known.

Figure 9. *Xanthomendoza oregana*. Herbarium photograph of O-L-35242, Norway, Østfold, Aremark. GenBank: KJ396108. Scale bar: 2 mm. Photo: E. Timdal.

Notes: *Xanthomendoza poeltii* was recently synonymised with *X. oregana* (Lindblom & Blom 2014). *Xanthomendoza oregana* is sometimes difficult to separate from *X. fulva* and *X. ulophyllodes*. Compared to *X. fulva*, *X oregana* is mostly larger with wider and longer lobes and thicker upper cortex. In contrast to *X. fulva*, *X. oregana* never develops rounded "bird nests" with soredia at the lobe apices, but soredia are developed from the marginal to submarginal cortex. Compared to *X. ulophyllodes*, *X. oregana* has somewhat thinner lobes and upper cortex, and never develops a structured rosette-like thallus with appressed marginal lobes. For a detailed description of *X. oregana* and comparisons to similar species see Lindblom (2006).

Specimens examined: **Norway**. *Østfold*: Aremark, Rive søndre, UTM(ED50): PL 518 736, alt. 120 m, på spisslønn [*Acer platanoides*] i gårdstun, 1998-05-10, B. P. Løfall bpl-L3678 (GenBank KJ396108) (O L-35242); Eidsberg, Lundeby, UTM(WGS84): PM 410 038, alt. 165 m, på stor, døende hengebjørk (*Betula verrucosa*), 2000-07-06, B. P. Løfall bpl-L7277 (O L-78007).

***Xanthomendoza ulophyllodes* (Räsänen) Søchting, Kärnefelt & S.Y. Kondr.** Fig. 10

Norwegian: Bergmessinglav

Description: Thallus up to 32 mm, rosette-forming, with lobes that are mostly horizontal (sometimes very slightly raised), plane, with slightly downward bent margin and rounded wide tips. The upper surface yellow to light orange, smooth to shiny. Rhizines frequent, long, often visible from above.

Figure 10. *Xanthomendoza ulophyllodes*. Herbarium photograph of BG-L-103816, Norway, Oppland, Nord-Fron. GenBank: MN238699. Scale bar: 2 mm. Photo: E. Timdal.

Soralia marginal to submarginal, making lobe margins appear fuzzy, "fur trimmed" with abundant soredia. Soredia orange to yellow (bark colour). Apothecia not observed in Norwegian collections. Pycnidia common, immersed in or slightly protruding from the upper surface, slightly darker colour than the upper lobe surface.

Ecology: Saxicolous, on schistose outcrops and boulders in shaded or semi-shaded habitats, but also collected on *Betula*, probably *B. verrucosa*.

Distribution: Known only from central and north Gudbrandsdal, SE Norway (Fig. 6).

Barcode note: In our alignment, the ITS sequences have a characteristic insert between nucleotides 395 and 407, a feature that *X. ulophyllodes* shares only with *X. fallax*, as well as the chosen outgroup *X. mendozae*.

Notes: Poelt & Petutschnig (1992b) reported this species from one locality in Oppland (Sør-Fron, Rudland, 1938-09-13, S. Ahlner, H) and included two more Scandinavian occurrences on their distribution map, one in Oppland and one in Skåne ("Südschweden"; precise localities and collections unknown). Krog et al. (1994) revised Norwegian material to follow the taxonomy of Poelt & Petutschnig (1992a, b). Hence, Norwegian specimens that were up to that time determined as *X. fallax* were referred to either *X. borealis*, *X. fulva*, or *X. ulophyllodes*. However, confusion remained regarding *X. ulophyllodes* in Scandinavia, particularly after the description of a new species in the group, *X. poeltii*, in Sweden (Kondratyuk & Kärnefelt 1997, transferred to

Xanthomendoza by Søchting et al 2002). Santesson et al. (2004) regarded all reports of *X. ulophyllodes* in the Nordic countries (Finland, Norway, Sweden) as *X. poeltii*. This decision resulted in general confusion about whether *X. ulophyllodes* occurs in Norway or if all reports of *X. ulophyllodes* should be regarded as *X. poeltii*. A third possibility was that the material labelled *X. ulophyllodes* in Norwegian herbaria actually consisted of specimens of both *X. poeltii* and *X. ulophyllodes*. Adding to the complex situation, *X. poeltii* was recently synonymised with *X. oregana* (Lindblom & Blom 2014).

Here, we conclude that *X. ulophyllodes* in fact occurs in Norway and that the collection of Ahlner from Rudland represents that species. We would like to emphasize that as early as in 1983, Rolf Santesson recognized a taxon in herb. UPS that corresponds to *X. ulophyllodes*, as he used the name *Xanthoria fallax* var. *fallax* on determination labels on Ahlner's material collected in Norway.

For further descriptions of *X. ulophyllodes* and comparisons to similar species, see Poelt & Petutschnig (1992a, b) and Lindblom (1997).

Specimens examined: **Norway.** *Oppland*: Nord-Fron, S of Kleiva, just N of resting area by E6, S facing slope with mixed forest, S facing vertical rock, 61.58626°N, 9.81885°E, alt. 270 m, 2002-07-15 L. Lindblom & H. H. Blom L240 (GenBank MN238699) (BG L-103816); Nord-Fron, Øya, a steep rocky slope (schistose rocks), alt. 260–320 m, 1949-09-10, S. Ahlner (UPS L-780446); Nord-Fron, Øya. S-exposed slope on mica schist, alt. c. 280 m, 1949-09-09, S. Ahlner (UPS L-780451); Nord-Fron, Hestskobakken, 61°35.18'N, 9°49.14'E, alt. 280 m, exposed, vertical rock wall, 2019-08-24, Timdal et al. 18531 (GenBank: MN688210) (O L-226226); Sør-Fron, W of Forr, on rocks in a birch forest, *Betula*, 1938-09-14, S. Ahlner (UPS L-780454); Sør-Fron, Rudland, berget ovanför landsvägen, björk i klippbrant. 1938-09-13 S. Ahlner (UPS L-780462); Sør-Fron, Rudland, berget ovanför landsvägen, klippvägg, 1938-09-13, S. Ahlner (UPS L-780460) (a duplicate specimen in H was cited by Poelt & Petutschnig (1992b), unfortunately, it was not available for us to check); Sør-Fron, Rudland, S of Steberg, 61°32.95'N, 10°0.53'E, 200 m alt., S faced, vertical to overhanging side of large boulder, grazed woodland, 2005-08-31, R. Haugan 7717 (O L-151726); Sør-Fron, Rudland, 61.6130°N, 9.9278°E, 2019-08-24, R. Haugan s.n. (GenBank: MN688211) (O L-226227); Vågå, Prestberget, NP 0455 6044, alt. 430 m, vertikal til noe overhengende bergvegg, 2005-09-01, R. Haugan prest905 (O L-145360).

Acknowledgements: We are grateful to herbaria TRH and UPS for providing loans of Norwegian *Xanthomendoza* material. Special thanks to Astri Botnen (BG) and Siri Rui (O) for all service with curating and digitalising our collections, as well as keeping track of them in the herbaria. Ulf Arup (LD) kindly let us include two unpublished sequences in our *X. fallax*/*X. ulophyllodes* ITS data set. Leena Myllys (H) and Ulrik Søchting (Copenhagen) assisted an attempt to locate a specimen cited by Poelt & Petutschnig. Reidar Haugan (Oslo) visited Ahlner's localities in Gudbrandsdalen and collected fresh material for sequencing. Sequencing was financed in part by the Norwegian Barcode of Life project (NorBOL, funded by the Research Council of Norway and the Norwegian Biodiversity Information Centre). Olaf Grolle Olsens legat (Univ. of Bergen) is acknowledged for a travel grant to LL in 2001.

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