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Lichens of the family Teloschistaceae in Dagestan, an eastern part of the Caucasian biodiversity hot-spot

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With 4 figures and 2 tables

Abstract: *Teloschistaceae*, one of the largest families of lichenized fungi, has its known Eurasian diversity hot-spots in the Mediterranean basin and in arid continental territories. The Caucasus is a natural boundary between these territories and the diversity of *Teloschistaceae* is therefore expected to be high in this region. We studied the easternmost part of the Caucasus, Dagestan, a region neglected by lichenologists in the past, but with recent lichenological activity. We provide here a checklist of 85 species of *Teloschistaceae*, 39 of them new to Dagestan from our field work in 2015, and four species new to Russia (*Athallia nesodes*, "*Caloplaca*" *emilii*, "*Caloplaca*" *xerica* and *Gyalolechia epiphyta*). This total is higher than the numbers known from some well-surveyed Central European countries, but lower than numbers reported from Mediterranean countries. It suggests a rather high diversity of *Teloschistaceae* in Dagestan, although the absence of well-developed maritime and Mediterranean habitats (which are usually rich in species of *Teloschistaceae*) precludes an even higher diversity.

Key words: *Caloplaca*, diversity potential, Russia, *Variospora*, *Xanthocarpia*.

Introduction

Among regions of northern Eurasia, the Caucasus Mountains have one of the most diverse floras of vascular plants (more than 6500 species; Anonymous 2003). The lichen biota is not so well known, but a high diversity has been recorded in some areas (Urbanavichus & Ismailov 2013, Urbanavichus & Urbanavichene 2014). Its eastern

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part, belonging to the territory of Dagestan (Russia), is being progressively surveyed for lichens (Urbanavichus & Ismailov 2013, Ismailov & Urbanavichus 2013a, 2014, Ismailov 2015), but this type of general biotic inventory needs to be supported by more detailed surveys of specific lichen groups. In the summer of 2015, we visited local lichen diversity hot-spots to collect lichens of the family *Teloschistaceae*: (a) lowland habitats at the Caspian Sea coast with maritime species and species of European lowland forests, (b) inland steppes and forest-steppes with species of arid continental Eurasian regions and some Mediterranean species, and (c) mountains with species of various ecological and geographical groups, including some arctic-alpine and oceanic species. Our records are compared here with previous data on *Teloschistaceae* in Dagestan highlighting the value of fieldwork that concentrates on particular groups of lichens. We also compare the currently known *Teloschistaceae* diversity in Dagestan with diversity on this group in other territories in Europe and Russia.

Materials and methods

List of localities:

(1) Belidzhi, Samur, coastal grasslands with Artemisia, alt. –10 m, 41.882032N, 48.535618E; 15.7.2015;

(2) Belidzhi, Samur, oak-hornbeam lowland forest, alt. –5 m, 41.864932N, 48.504375E; 16.7.2015;

(3) Rubas, steppe hills above town, alt. 100 m, 41.870546N, 48.285685E; 17.7.2015;

(4) Karabudakhkentsky District, Gubden, alt. 780 m, 42.546047N, 47.499475E; 18.7.2015;

(5) Gergebil', Gunib, flat "Plato Gunib", pine-birch-aspen forests, montane/alpine meadows, alt. 1700–2200m, 42.414789N , 46.921263E; Ibid.: 42.405366N, 46.891433E; 42.406282N, 46.929176E; 42.410997 N, 46.904691E; 18. –23.7.2015;

(6) Makhachkala, Taulargol & Maliy Uytash, granite outcrops at villages, alt. c. 50 m, 42.836798N, 47.582764E; Ibid.: 42.825325N, 47.585451E; 42.809376N, 47.597353E; 24.7.2015;

(7) Makhachkala, Chabak, siliceous rocks at village, alt. 100–250 m, 42.787070N, 47.587468E; 24.7.2015;

(8) Makhachkala, Achi, at sea coast, alt. –5 m, 42.685650N, 47.727059E; 25.7.2015;

(9) Makhachkala, Talgi, alt. 400–600 m, 42.881655N, 47.408035E; Ibid.: 42.876766N, 47.433710E; 26.7.2015.

Sampling and specimens identifications: Although many species were identified directly in the field, we collected voucher specimens for all recorded species (Table 1). Our specimens are deposited in PRA (coll. Vondrák; 193 specimens), DAG (coll. Ismailov; 88) and the private herbarium of G.Urbanavichus (hb. Urbanavichus; 216). Identifications based on morphological and anatomical characters were supported by nrITS sequence barcoding of forty specimens. Most of these belong to species with poor phenotypic characteristics (genera *Athallia*, *Calogaya*, *Flavoplaca*, *Variospora* and *Xanthocarpia*, see Table 2).

DNA extractions and PCR settings are described in Vondrák et al. (2016a). Obtained sequences were submitted to NCBI's BLAST website (Johnson et al. 2008; http://blast.ncbi.nlm.nih.gov/Blast.cgi) to confirm taxonomic identity. In most cases the identification with the use of nrITS sequences was simple because of ≥98% identity with sequences of well-known taxa, but highly similar sequences were not present in NCBI's database in some cases (e.g. "*Caloplaca*" *asserigena*, *Rufoplaca* sp.). Identification of specimens (sequences) in the genera *Variospora* and *Xanthocarpia* was the most

difficult. In these cases, we decided to generate maximum likelihood trees (Figs 3, 4) including our data (not only sequences from Dagestan, see Table 2) together with close NCBI's sequences. Sequences were aligned by the on-line application MAFFT 7 (Katoh & Standley 2013) with the L-INS-i method (Katoh et al. 2005); alignments were not modified by Gblocks. Maximum likelihood (ML) phylogenetic analyses were run in PhyML 3.0 in the application PHYLOGENY.FR (Dereeper et al. 2008) with the default nucleotide substitution model (HKY85+I+G) and with 250 bootstrap replicates. ML phylogenetic reconstructions were adjusted in CorelDraw X3 (Figs 3, 4).

Literature data extraction: During work for a compilation of the Russian lichen checklist (Urbanavichus 2010), it was found that species of *Teloschistaceae* have been reported from Dagestan only in few papers (Barkhalov 1983, Ismailov & Urbanavichus 2013a, b, 2014, 2015, Ismailov 2015, Urbanavichus et al. 2010, Urbanavichus & Ismailov 2013). Data on *Teloschistaceae* from these sources were extracted for this checklist (Table 1).

Nomenclature: We use the nomenclature proposed by Arup et al. (2013). Twenty species in our list (names in inverted commas in Table 1) are still not accommodated in any of the new genera and these species "incertae sedis" are named "*Caloplaca*" or "*Xanthoria*" according to the classical nomenclature. The names *Massjukiella nowakii* (="*Xanthoria*" *n.*) and *Olegblumia demissa* (="*Caloplaca*" *d.*) are not accepted here, because *Olegblumia demissa* (Kondratyuk et al. 2015) was not validly combined (without citation of the correct basionym), and *Massjukiella* proposed in Fedorenko et al. (2012) is illegitimate following Arup et al. (2013).

Results

Based on the literature, 48 species have been previously recorded from Dagestan. However, the specimen published as *Parvoplaca tiroliensis* represents another listed species (*Athallia cerinelloides*) and *Caloplaca chlorina* is based on a dubious record (Table 1). The number of known species nearly doubled after our fieldtrip, with a total of 85. *Athallia nesodes*, "*Caloplaca*" *emilii*, "*Caloplaca*" *xerica* and *Gyalolechia epiphyta* are new to Russia; *Athallia brachyspora*, *A. nesodes*, *Calogaya* aff. *ferrugineoides*, "*Caloplaca*" *asserigena*, "*C.*" *emilii*, *Gyalolechia epiphyta*, *Pyrenodesmia concreticola*, *Pyrenodesmia erodens*, *Variospora* aff. *dolomiticola*, *Xanthocarpia interfulgens* and "*Xanthoria*" *nowakii* are new to the Caucasus.

The most diverse genera are *Calogaya* (7 species), *Gyalolechia* (7), *Athallia* (6), *Flavoplaca* (6), *Pyrenodesmia* (6) and *Xanthocarpia* (5); all of them containing only crustose species. Indeed, 71 of the 85 species are crustose; more complex growth forms are in the minority. Most species are saxicolous (60), mainly because some large genera are restricted to inorganic substrata (e.g. *Pyrenodesmia*, *Variospora* and *Xanthocarpia*). In other genera, such as *Caloplaca* s.str. or *Gyalolechia*, saxicolous lichens constitute less than 50% of the total number of species. The majority of recorded species (55) form apothecia and lack vegetative diaspores; 23 species produce both apothecia and vegetative diaspores and only four species (*Leproplaca cirrochroa*, *L. xantholyta*, "*Caloplaca*" *demissa* and "*Caloplaca*" *lucifuga*) reproduce only asexually by vegetative diaspores and rarely by conidia.

The species included in the list exhibit a variety of geographical ranges, but more than half of the species are common and broadly distributed in Europe. Some Mediterranean species appear to have their eastern limits in Dagestan: *Blastenia crenularia*, "*Caloplaca*" *emilii*, "*C.*" *haematites*, *Variospora aurantia* and *V. flavescens*,

Table 1. List of species of the family *Teloschistaceae* known from Dagestan. Previous references: 1, Urbanavichus & Ismailov (2013); 2, Urbanavichus et al. (2010); 3, Ismailov & Urbanavichus (2014); 4, Ismailov & Urbanavichus (2015); 5, Ismailov & Urbanavichus (2013a), 6, Ismailov & Urbanavichus (2013b); 7, Ismailov (2014); 8, Ismailov (2015); 9, Barkhalov (1983). Our record sites follow numbers in the text (mat. & meth.). Substrates: AC (*Acer*), AL (*Alnus*), BE (*Betula*), FR (*Fraxinus*), PI (*Pinus sylvestris* s.lat.), PO (*Populus*), QU (*Quercus*), UL (*Ulmus*), bry (bryophytes), calc (calcareous rock), sil (siliceous rock). Asterisks indicate ITS sequence barcoding. Vouchers deposited in herbaria of the authors (author acronyms and number of specimens indicated).

Species	**Previous references**	**Our records / substrates**	**Vouchers**	**Notes**
Athallia brachyspora	NA	5* / calc*	AI, JV	Similar in appearance with *Xanthocarpia* species (Fig. 1A vs. Fig. 2), but differs in short and thick spores (c. 8–12 × 5–7.5 µm).
Athallia cerinelloides	NA	2,5* / BE, QU, shrubs*	AI, GU, JV	Identity of the specimen from alpine shrubs (loc. 5) confirmed by ITS bar-coding, which recognizes it from very similar *A. saxifragarum*.
Athallia holocarpa (incl. *A. vitellinula* and *Caloplaca vitellinaria)*	1,2	1, 6*,7 / sil*	GU2, JV4	All JV specimens were associated with *Candelariella vitellina* (Fig. 1B) and fit well the conception of *Caloplaca vitellinaria* Szatala. ITS sequence (KU926984) groups with *Athallia holocarpa*. We considered *C. vitellinaria* synonymous with *A. holocarpa*. One GU specimen was identified as *Athallia vitellinula* that is also considered synonymous to *A. holocarpa* (Vondrák et al. 2016b)
Athallia pyracea	1,2,6	2,3,4*,5,7,9 / AC, FR, PO, QU, UL, shrubs*	AI3, GU5, JV7	Specimens on Mediterranean shrubs often with small apothecia (<0.5 mm diam.), distinctly smaller than apothecia in most European populations.
Athallia skii	NA	1*,8* / Artemisia*, shrubs*	AI, GU, JV2	
Blastenia ammiospila	1	5 / tufts	AI, GU, JV	
Blastenia crenularia	3	6*,7 / sil*	AI, JV4	ITS sequences will be published in a *Blastenia*-focussed paper.
Blastenia hungarica	1	5* / BE, PI*	AI3, GU4, JV2	ITS sequences will be published in a *Blastenia*-focussed paper.
Bryoplaca sinapisperma	1	NA		
Calogaya arnoldii	NA	5,6* / calc, sil*	JV3	ITS sequences will be published in a *Calogaya*-focussed paper.
Calogaya biatorina	1	5 / calc	AI, GU3, JV2	
Calogaya decipiens	1,2	6 / calc	AI2, GU2	Only once collected, but common species

Calogaya aff. ferrugineoides	NA	9* / calc*	JV	ITS sequence close to NCBI's sequences of an epiphytic *C. ferrugineoides* (ident. about 96%). The saxicolous specimen from Dagestan may represent another species.
Calogaya lobulata	2	3,5*,7,8,9 / QU, shrubs (*Ephedra**)	GU3, JV6	
Calogaya pusilla	NA	5*,6* / sil*, calc*	JV6	ITS sequences will be published in a *Calogaya*-focussed paper. Specimen from the loc. 5 resembles *C. biatorina*, but its ITS sequence is placed in *C. pusilla*.
Calogaya schistidii	NA	5 / mosses in calc. crevices	AI	
Caloplaca cerina s.lat.	1,2,6,7	4*,5,7 / QU, PO, shrubs*	AI4, GU16, JV4	ITS of the sample from submediterranean scrub habitats (loc. 4; KU926994) is almost identical (>99%) with two NCBI sequences from Greek Mediterranean habitats (clade D2 in Šoun et al. 2011).
(Caloplaca chlorina)	1	NA		Literature (1) refers to epiphytic occurrence on *Betula*; probably misidentified *C. monacensis* (voucher missing).
Caloplaca monacensis	NA	5 / BE	AI, JV2	
Caloplaca stillicidiorum s.lat.	1	4,5,6 / bry, shrubs, tufts	GU6, JV3	
"Caloplaca" albolutescens	4	8 / conc	AI, JV	
"Caloplaca" albopruinosa	1	5 / calc	GU2, JV2	
"Caloplaca" anularis	NA	5 / calc	AI2, JV	
"Caloplaca" asserigena	NA	5* / PI* (twigs)	AI, GU	Its ITS not similar to any NCBI sequences (*C. asserigena* is missing from there). Our specimens have identical morphology and ecology (growing on pine twigs in foggy forests) with numerous specimens from Macaronesia (PRA, herb. Vondrák).
"Caloplaca" conversa	5	NA		
"Caloplaca" demissa	NA	6 / sil	AI, GU4	*Caloplaca demissa* was recently combined into the monotypic *Olegblumia* by Kondratyuk et al. (2015), but the combination is not valid.
"Caloplaca" emilii	NA	9/cal	JV	
"Caloplaca" grimmiae	NA	6 / sil	AI	
"Caloplaca" haematites	1,2	3,7,9 / QU,shrubs	GU, JV5	
"Caloplaca" inconnexa	1	5 / calc	GU2, JV2	
"Caloplaca" lucifuga	NA	2 / QU, CA*	AI, GU	

"Caloplaca" micromontana	NA	5 / calc	JV4	see Frolov et al. 2016
"Caloplaca" microstepposa	NA	3,9 / calc	AI, JV3	see Frolov et al. 2016
"Caloplaca" obscurella	1	3,5 / BE, shrubs	AI, GU2, JV2	
"Caloplaca" raesaenenii	NA	3*,5* / bones*, tufts*, shrubs, wood	AI, GU, JV5	Known as xerophilous and thermophilous lichen, but we recorded it also close to alpine zone (loc. 5).
"Caloplaca" teicholyta	1	6 / calc	AI2, GU2, JV	
"Caloplaca" transcaspica s.lat.	NA	3,9 / calc	JV3	
"Caloplaca" ulcerosa	NA	1,8 / PT, shrub	AI, GU, JV2	
"Caloplaca" xerica	NA	5 / calc	AI, JV	In nutrient-rich site (cattle shalter); usually absent from pure limestone.
Flavoplaca communis	NA	8* / calc, shrubs*	JV3	Known as coastal saxicolous lichen; our records on coastal shrubs are exceptional.
Flavoplaca coronata	NA	6* / calc	AI, JV2	
Flavoplaca dichroa	NA	5*,9 / calc	JV3	
Flavoplaca flavocitrina	NA	3,8 / calc, conc, shrubs	JV3	
Flavoplaca oasis	NA	8* / conc	JV	
Flavoplaca polycarpa	1	5,9 / calc	AI, GU2, JV3	
Gyalolechia bracteata	1	5 / calc soil	GU3	
Gyalolechia epiphyta	NA	5* / calc*, PT	JV2	Substrate generalist, usually recorded from bark or moss cushions, but also occurring on calcareous rocks.
Gyalolechia flavorubescens	1,7	5,9 / FR, PT, wood	AI5, GU3, JV3	
Gyalolechia flavovirescens	1	5 / calc*	AI	
Gyalolechia fulgens	1,9	5* / calcareous soil*	GU11, JV	
Gyalolechia lenae	1	5 / calc	GU5	
Gyalolechia subbracteata	1	5* / calcareous soil*	GU3, JV	

Leproplaca cirrochroa	1	5 / calc	AI, GU6, JV2	
Leproplaca xantholyta	1	5 / calc	GU3, JV	
(Parvoplaca tiroliensis)	1	NA		Incorrectly identified; revised as *Athallia cerinelloides*.
Polycauliona phlogina	NA	3,4 / shrubs	JV3	
Pyrenodesmia alociza	1	9 / calc	AI, GU, JV	
Pyrenodesmia badioreagens	1	NA		
Pyrenodesmia chalybaea	1	5,9 / calc	AI2, GU6, JV5	
Pyrenodesmia concreticola	NA	9* / calc*	AI, JV4	
Pyrenodesmia erodens	NA	5,9 / calc	AI, JV12	Two morphotypes often occur together; (1) sorediate, +/- sterile thalli, (2) non-sorediate, richly fertile thalli. (see also Frolov et al. 2016; Fig. 1)
Pyrenodesmia variabilis	1,9	3,5,9 / calc	GU5, JV10	
Rufoplaca sp.	NA	6,7 / sil	JV2	*Rufoplaca* sp.div. have closest NCBI sequences (similarities 94–96%). Morphologically it also belongs to *Rufoplaca* (thin ascospores with thin septa).
Rusavskia digitata	1	5 / calc	GU	
Rusavskia elegans	1,9	5 / calc	AI5, GU11, JV	
Rusavskia papillifera	1	5 / calc	GU, JV	
Rusavskia sorediata	1	5 / calc	AI, GU3, JV	
Rusavskia sp.	NA	5 / calc	JV	Closest NCBI sequences (similarities 99%) are named „*R. elegans*", but our specimen has broad and flat yellow lobes that differ from *R. elegans* s.str.
Seirophora contortuplicata	1,9	5 / calc	AI, GU3	
Seirophora lacunosa	8	NA		
Variospora aurantia	1	5,6 / calc	AI, GU10, JV2	
Variospora flavescens	NA	8 / calc	AI, GU	
Variospora aff. *dolomiticola*	NA	5*,6,9 / calc*	AI3, JV6	Fig. 1C
Variospora sp.	NA	5,9* / calc*	JV6	Fig. 1D
Xanthocarpia crenulatella s.lat.	1	4*,5*,9* / calc*	GU, JV3	Figs 2A, B
Xanthocarpia ferrarii	NA	3* / calc*	AI, JV	Fig. 2C

Xanthocarpia interfulgens	NA	5,6* / calc*	AI, GU, JV3	Fig. 2D, F
Xanthocarpia marmorata	1	4*,5,9 / calc*	AI, GU6, JV	Fig. 2E
Xanthocarpia tominii	NA	2 / roofing tiles	AI	
Xanthomendoza fallax	1	5 / calc	AI3, GU5, JV2	
Xanthomendoza fulva	1	5 / AL, BE	GU9	
Xanthomendoza huculica (= Oxneria huculica)	NA	5 / AL, BE, QU	GU7	*Xanthomendoza huculica* is distinguished from *X. fallax* s. str. by the presence of typical marginal soralia, differently shaped lobes, narrower ascospores, and a thinner ascospore septum. *Xanthomendoza huculica* is mainly corticolous, although some saxicolous or lignicolous specimens are known, whilst *X. fallax* is usually saxicolous (Kondratyuk in Oksner 2010).
Xanthomendoza trachyphylla	1	NA		
Xanthomendoza ulophyllodes	1	NA		
Xanthoria calcicola	9	NA		
Xanthoria parietina	1,2,6,7,8	1,2,5,8,9 / trees, shrubs	AI4, GU15, JV2	
"Xanthoria" nowakii (= *Massjukiella nowakii* nom. illeg.)	NA	5* / calc*	AI, JV	By NCBI Blast, our ITS sequence is closest to *Polycauliona pollinarioides* and *P. tenuiloba* (both with identities 98%). Sequences of morphologically similar *P. candelaria* are identical in only 95–96%. Sequences of *Xanthoria nowakii* are absent from NCBI.

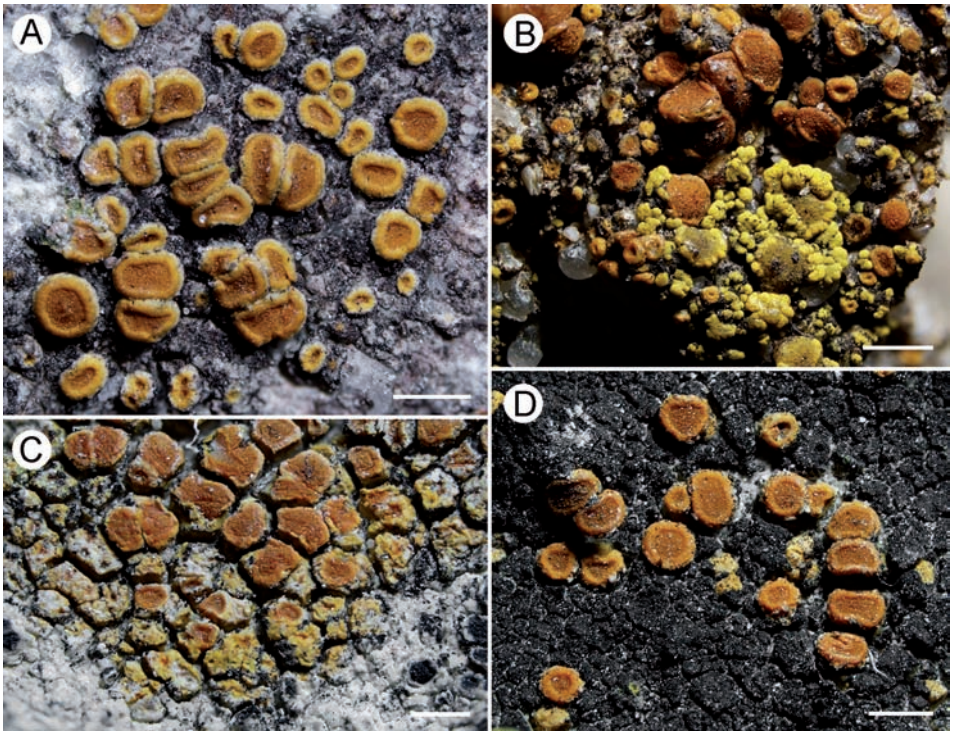

Fig. 1. A. *Athallia brachyspora* (JV14438); B. *Athallia holocarpa*, phenotype described as "*Caloplaca vitellinaria*" (JV14428); C. *Variospora* aff. *dolomiticola* (JV14472); D. *Variospora* sp. (JV14439). Bars = 0.5 mm.

and apparently also the oceanic "*Caloplaca*" *asserigena*. In contrast, *Gyalolechia lenae* reaches its western limit in the study area. Maritime species are few, namely *Athallia skii*, *Flavoplaca communis* and *Caloplaca ulcerosa*.

Discussion

Species delimitations in Variospora and Xanthocarpia

Most *Teloschistaceae* species are restricted to a particular substrate, but closely related species may occur on different substrata. In the genera *Athallia* and *Blastenia*, an epiphytic species is often closely related to a saxicolous one (Vondrák et al. 2016b). Some large genera, however, are restricted to a single substrate type (Vondrák et al. 2016b). Most *Pyrenodesmia*, *Variospora* and *Xanthocarpia* species are restricted to calcareous rocks and all species of *Rufoplaca* are restricted to siliceous substrata. Several species within these genera commonly occur sympatrically in close proximity. Our preliminary results suggest more complex species delimitations within genera restricted to a single substrate type.

Table 2. ITS nrDNA sequences generated in this study. Details about geography and ecology of the specimens are available in http://botanika.prf.jcu.cz/lichenology/data.php. Specimens collected by J.Vondrák, except for two cases where the collector name is indicated.

Species	**Geography**	**Specimen nr/ herbarium**	**NCBI acc.nr**
Athallia cerinelloides	Russia, Dagestan	JV14445/PRA	KU926977
Athallia holocarpa	Russia, Dagestan	JV14428/PRA	KU926984
Athallia pyracea	Russia, Dagestan	JV14460/PRA	KU926979
Athallia pyracea	Russia, Dagestan	JV14448/PRA	KU926980
Athallia skii	Russia, Dagestan	JV14420/PRA	KU926981
Calogaya ferrugineoides	Russia, Dagestan	JV14473/PRA	KU927000
Calogaya lobulata	Russia, Dagestan	JV14432/PRA	KU926999
Caloplaca asserigena	Russia, Dagestan	JV14535/PRA	KU926993
Caloplaca brachyspora	Russia, Dagestan	JV14438/PRA	KU926985
Caloplaca cerina	Russia, Dagestan	JV14459/PRA	KU926994
Caloplaca concreticola	Russia, Dagestan	JV14436/PRA	KU926988
Caloplaca raesaenenii	Russia, Dagestan	JV14457/PRA	KU926982
Caloplaca raesaenenii	Russia, Dagestan	JV14463/PRA	KU926983
Caloplaca skii	Russia, Dagestan	JV14443/PRA	KU926978
Flavoplaca communis	Russia, Dagestan	JV14419/PRA	KU926992
Flavoplaca coronata	Russia, Dagestan	JV14484/PRA	KU926990
Flavoplaca dichroa	Russia, Dagestan	JV14427/PRA	KU926991
Flavoplaca oasis	Russia, Dagestan	JV14435/PRA	KU926989
Gyalolechia epiphyta	Russia, Dagestan	JV14462/PRA	KU926995
Gyalolechia fulgens	Russia, Dagestan	JV14437/PRA	KU926997
Gyalolechia subbracteata	Russia, Dagestan	JV14430/PRA	KU926998
Rufoplaca sp.	Russia, Dagestan	JV14429/PRA	KU926986
Rusavskia sp.	Russia, Dagestan	JV14433/PRA	KU926987
Variospora cf. *dolomiticola*	Russia, Dagestan	JV14447/PRA	KU926976
Variospora cf. *sororicida*	Russia, Dagestan	JV14439/PRA	KU926975
Variospora dolomiticola	Czech Republic	JV12514/PRA	KU927015
Variospora glomerata	Greece	JV8652/PRA	JN813421
Variospora latzelii	Greece	JV8598/PRA	JN813418
Variospora sp.	Czech Republic	JV6863/PRA	KU927002
Variospora sp.	Greece	JV8310/PRA	KU927003
Variospora sp.	Slovakia	JV9862/PRA	KU927004
Variospora sp.	Turkey	JV9794/PRA	KU927005
Variospora sp.	Slovakia	JV9114/PRA	KU927006
Variospora sp.	Turkey	JV9797/PRA	KU927007
Variospora sp.	Crimea	JV5643/PRA	KU927008
Variospora sp.	Turkey	JV8572/PRA	KU927009
Variospora sp.	Russia, Orenburg region	JV14619/PRA	KU927010
Variospora sp.	Russia, Bashkirtostan	JV9518/PRA	KU927011
Variospora sp.	Turkey	JV12675/PRA	KU927012
Variospora sp.	Turkey	JV12692/PRA	KU927013
Variospora sp.	Turkey	JV12664/PRA	KU927014

Variospora sp.	Iran	coll. Haji Moniri 3157/hb. aji Moniri	KU927016
Variospora sp.	Greece	JV9112/PRA	JN813398
Xanthocarpia crenulatella s.lat.	Russia, Dagestan	JV14423/PRA	KU926969
Xanthocarpia crenulatella s.lat.	Russia, Dagestan	JV14426/PRA	KU926970
Xanthocarpia crenulatella s.lat.	Russia, Dagestan	JV14441/PRA	KU926972
Xanthocarpia ferrarii	Russia, Dagestan	JV14442/PRA	KU926968
Xanthocarpia interfulgens	Russia, Dagestan	JV14444/PRA	KU926971
Xanthocarpia interfulgens	Russia, Dagestan	JV14425/PRA	KU926973
Xanthocarpia marmorata	Russia, Dagestan	JV14424/PRA	KU926974
Xanthocarpia sp.	Russia	coll. Zhdanov s.n./PRA	KU927001
Xanthoria nowakii	Russia, Dagestan	JV14465/PRA	KU926996

Identification of lichens from Dagestan raised the problem of how to specimens of *Variospora* (sect. *dolomiticola*) and *Xanthocarpia*. The problem is not solved yet, but at least we were able to position ITS sequences from our specimens within *Variospora* (Fig. 3) and *Xanthocarpia* (Fig. 4). An intricate *Variospora dolomiticola* complex (Fig. 3, in grey) includes a continuum between extensive yellow crusts and lichens with a strongly reduced thallus (*Variospora* sp., Fig. 1D). Some of them are obligatorily lichenicolous (often on other *Teloschistaceae*), but others are lichenicolous only in their initial stages. Within the ITS phylogeny of the *Variospora dolomiticola* complex, we were not able to recognize any phenotypically delimited lineage, except for a supported clade (Fig. 3, in white) of lichens with strongly reduced thallus specifically lichenicolous on species of *Calogaya*; this lineage could represent a separate species or a subspecies within *V. dolomiticola*.

Some species within *Xanthocarpia* are well delimited phenotypically, e.g. *X. lactea*, *X. marmorata* (Fig. 2E), *X. ochracea* and *X. tominii*, but most specimens with strongly reduced thallus (Figs 2A-C) and with long spores and thin spore septa form several ITS-based clades or grades that cannot be distinguished with certainty, for instance "*X. ferrarii*" and "*X. crenulatella*". Moreover, *X. crenulatella* s.lat. (as seen in Fig. 4) may represent an assemblage of microspecies, because it is phenotypically quite heterogeneous and other species have been described within it (*X. borysthenica* and *X. feracissima*). *Xanthocarpia interfulgens* probably contains two species (Fig. 4); one has thick yellow areoles around apothecia (Fig. 2D), another has a thin, ±yellow thallus covered by white pruina (Fig. 2F).

Potential for diversity of Teloschistaceae in Dagestan

It is difficult to estimate the true number of *Teloschistaceae* in Dagestan, but our list probably contains only a few of the alpine species as we did not sample in the highest parts of the region (e.g. Bogosskiy and Nukatl' ridges). Additional species may be found also in more humid forested areas with mixed beech-hornbeam forests in the south-western part of Dagestan. Our total of 85 species thus probably significantly underestimates the true diversity.

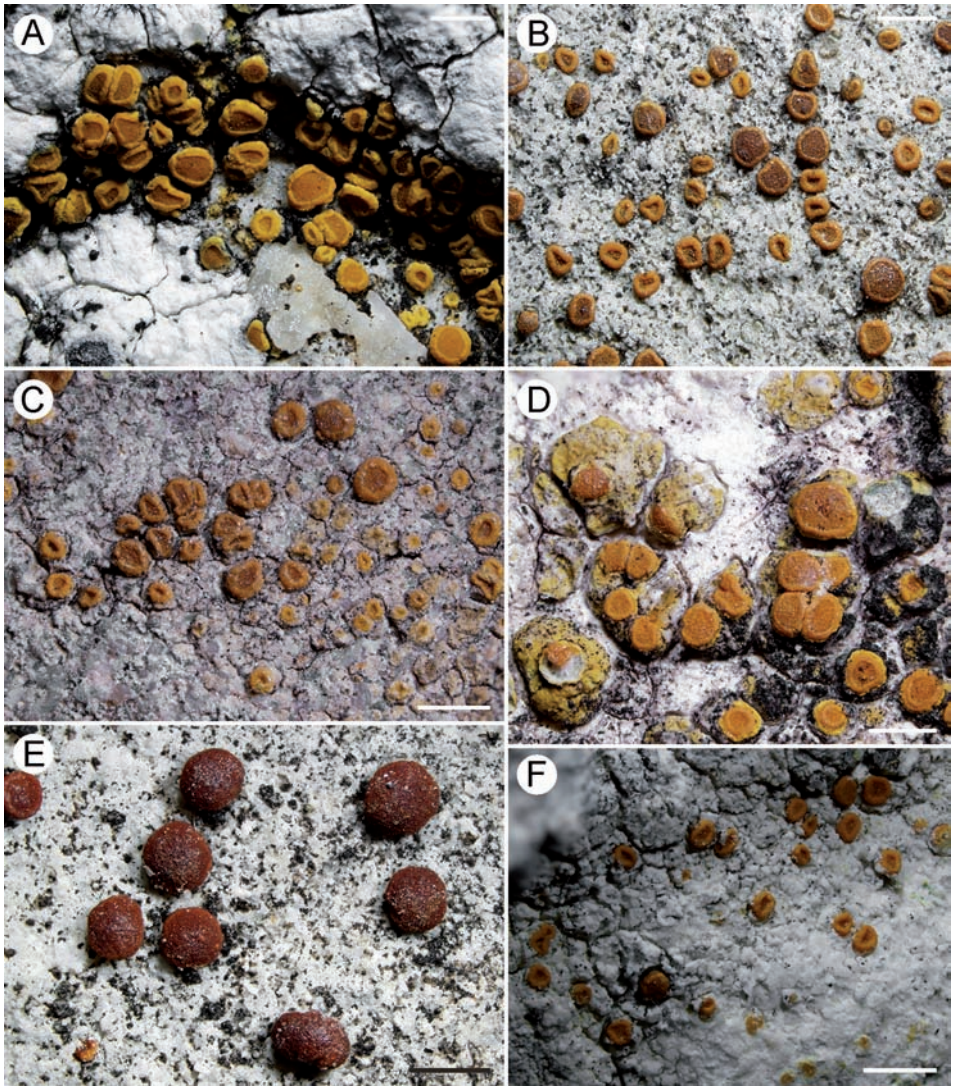

Fig. 2. A. *Xanthocarpia crenulatella* s.lat. (JV14426); B. *X. crenulatella* s.lat. (JV14441); C. *X. ferrarii* (JV14442); D. *X. interfulgens* with typical yellow thallus (JV14444); E. *X. marmorata* (JV14424); F. *X. interfulgens* with strong white pruina. Bars = 0.5 mm.

Qualitative comparison between the *Teloschistaceae* diversity of Dagestan and any other Eurasian region is difficult, and perhaps pointless, because most regional species lists are incomplete. However, we can at least compare the numbers of species known from some Eurasian regions of similar size. For instance, rather well-surveyed central European countries, such as the Czech Republic with 80 species (Liška & Palice 2010)

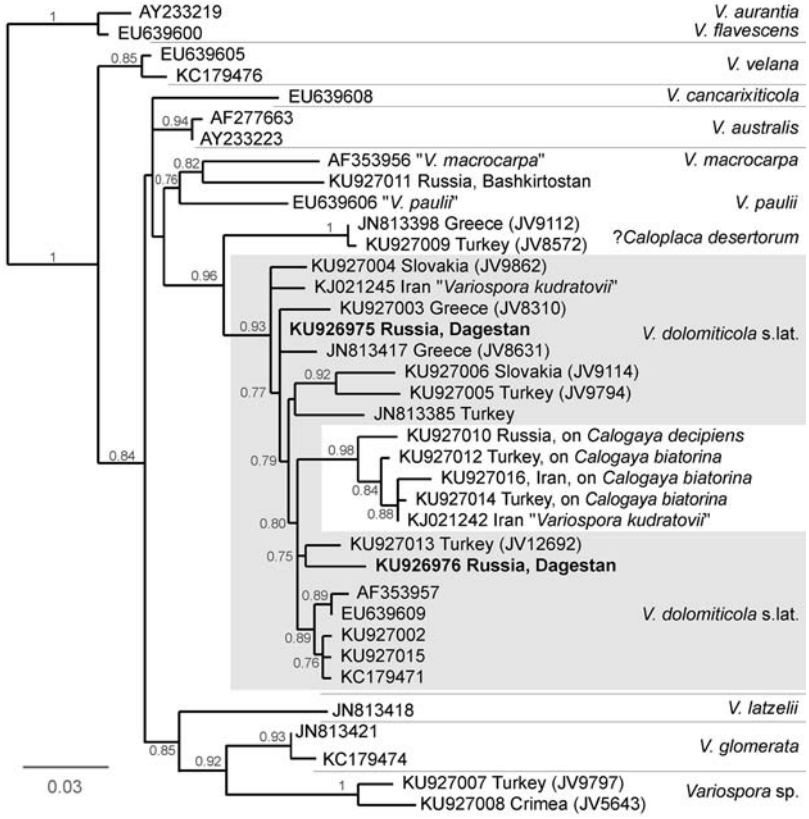

Fig. 3. Maximum likelihood ITS nrDNA phylogeny of *Variospora*. Sequences from Dagestan are in bold. Bootstrap values >0.75 are depicted at nodes. The grey field indicates the *Variospora dolomiticola* complex (excluding a group of species lichenicolous on crustose *Teloschistaceae*).

and Austria with 120 species (Hafellner & Türk 2001), probably have a lower diversity of *Teloschistaceae* than Dagestan because they lack maritime habitats and have few of the species of Mediterranean environments or of continental deserts and steppes. Larger Mediterranean countries, especially those with high mountains, undoubtedly have higher potential than Dagestan because of better developed coastal and Mediterranean habitats, both supporting numerous *Teloschistaceae*. For instance, about 160 species are known from Italy (Nimis & Martellos 2008). Comparing with diversity hot-spots in Russia, Dagestan is one of the best surveyed territories for *Teloschistaceae*: 119 species are known from Crimea (Khodosovtsev, in litt.), 112 from the western part of the Caucasus, 63 from the Russian part of Altai, 81 from the whole Ural and only 84 species from the whole Russian Far East (all data by Urbanavichus, in litt.).

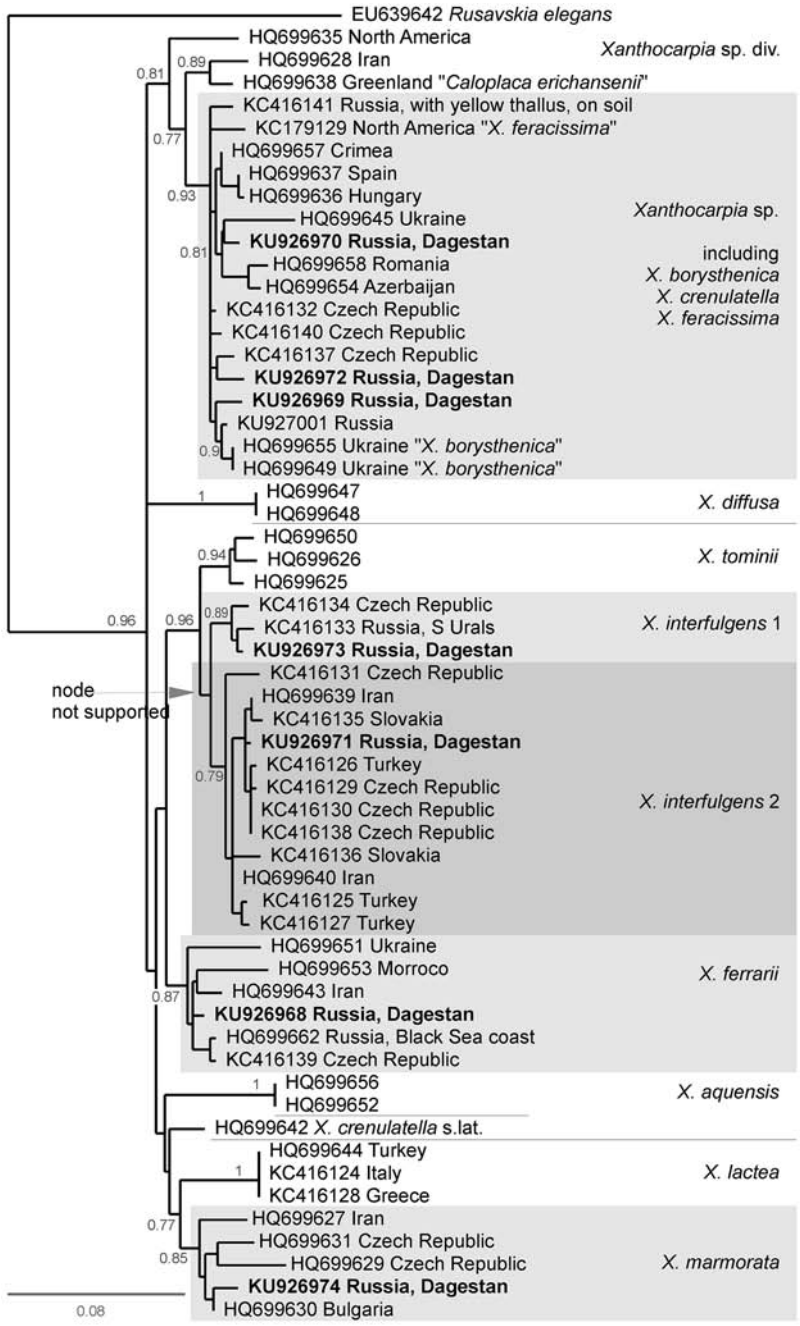

Fig. 4. Maximum likelihood ITS nrDNA phylogeny of *Xanthocarpia*. Sequences from Dagestan are in bold. Bootstrap values >0.75 are depicted at nodes.

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