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First inventory of lichens and lichenicolous fungi in the Khosrov Forest State Reserve, Armenia

Abstract

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In 2015, an international lichenological excursion to Armenia was organized by the Young Biologists Association NGO and Organization for the Phyto-Taxonomic Investigation of the Mediterranean Area. One of the main goals of this excursion was to study lichen diversity of the Khosrov Forest State Reserve. As a result of this inventory, 176 species of lichenized and lichenicolous fungi have been found in the protected area. Out of these, 49 are reported for the first time from Armenia: *Acarospora versicolor*, *Agonimia tristicula*, *Anema decipiens*, *Arctomia fascicularis*, *Arthonia intexta*, *A. phaeophysciae*, *Aspicilia* cf. *glomerulans*, *A. intermutans*, *Bacidina arnoldiana*, *Bagliettoa calciseda*, *Bilimbia sabuletorum*, *Blennothallia crispa*, *Chrysospora testacea*, *Collema subflaccidum*, *Diploschistes gypsaceus*, *Endocarpon pusillum*, *Gonohymenia nigrifella*, *G. schleicheri*, *Gyalolechia juniperina*, *Immersaria iranica*, *Lecania rabenhorstii*, *Lecanora barkmaniana*, *L. juniperina*, *L. semipallida*, *Leprocaulon microscopicum*, *Llimoniella phaeophysciae*, *Lobothallia recedens*, *Peccania coralloides*, *Peltula euploca*, *Physconia thorstenii*, *Piccolia ochrophora*, *Placidium lacinulatum*, *Placopyrenium fuscillum*, *Psorotichia schaeferi*, *Rinodina colobina*, *R. obnascens*, *Scytinium gelatinosum*, *S. turgidum*, *Solenopsora holophaea*, *Thermutis velutina*, *Toninia candida*, *T. squalida*, *Tremella phaeophysciae*, *Usnea lapponica*, *U. wasmuthii*, *Verrucaria dolosa*, *V. macrostoma*, *Xanthoparmelia protomatrae* and *X. tinctina*.

Key words: biodiversity, lichenology, protected areas, new records, oak and juniper forests, South Caucasus.

Introduction

The area of the Khosrov Forest State Reserve has already been recognized as a protected area in the fourth century for hunting and conservation reasons by the Armenian king Khosrov Kotak. In 1958, the Khosrov Forest has officially been established as a State Reserve (Khanjyan 2004). The aim of this protected area is to preserve oak and juniper forest ecosystems and montane vegetation that supports numerous threatened species of

plants and animals. The state reserve is under strict protection, corresponding to IUCN category I. The reserve area covers 29196 ha territory in the central part of the Ararat province in Southern Armenia (Fig. 1) (Anonymous 1999). It is situated between the slopes south of Geghama and north-west of Urts and north-east of the Yeranos mountain ranges, at an altitude varying between 900 and 2500 m. The climate is dry continental with annual precipitation of 350 to 800 mm (Anonymous 2008).

The area is known by its exceptionally rich biodiversity and natural landscapes of frigid vegetation, open arid forests and montane steppes (Fig. 2). Currently 1849 species of vascular plants (including 24 endemic species) and 283 animal species are known from the reserve (Anonymous 2008). The semi-arid and frigid formations occur on foothills and the lower mountain belt, where dominated a vegetation of *Artemisia fragrans*, *Salsola erioides*, *S. dendroides*, etc. The forest ecosystems (1400-2300 m) are generally dominated by oak trees (*Quercus macranthera*) and sparse juniper (*Juniperus polycarpus*, etc.) formations, accompanied by *Fraxinus excelsior*, *Sorbus aucuparia*, *Acer*, *Pyrus*, etc., species (Khanjyan 2004). The riverine forest vegetation is predominated by *Fraxinus*, *Populus*, *Salix*, etc., species. Various grasses, such as the feather grass (*Stipa stenophylla*, *S. capil-*

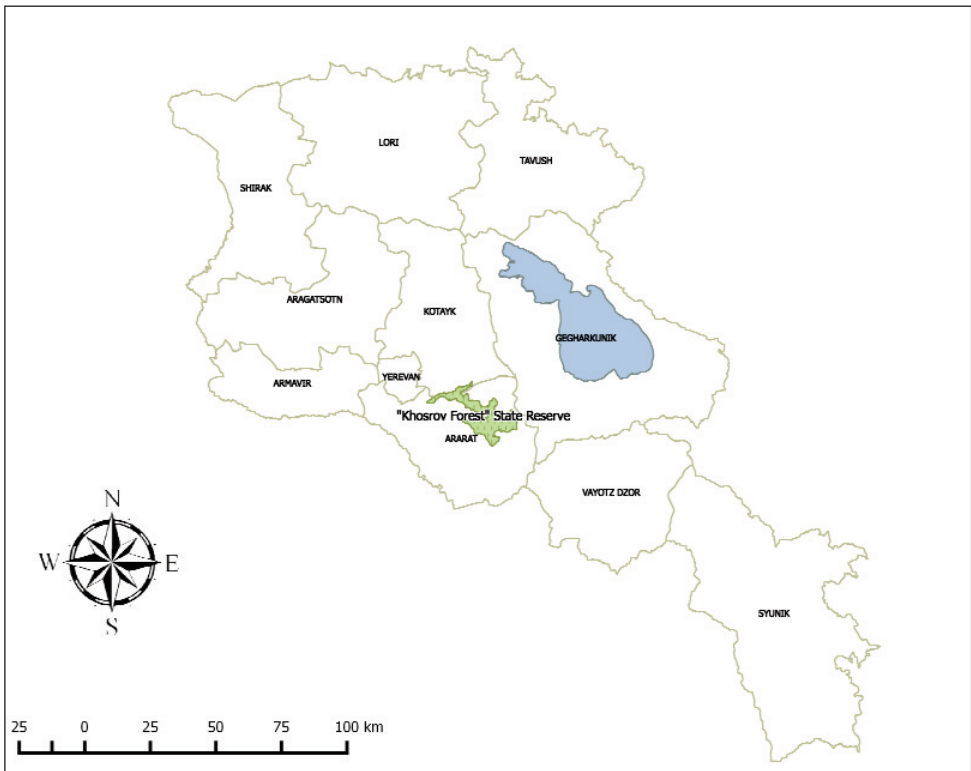


Fig. 1. The map of the Republic of Armenia including marzes (provinces), and location of the Khosrov Forest State Reserve.



Fig. 2. Natural landscapes in the Khosrov Forest State Reserve (photo by Víctor J. Rico).

lata, etc.), tragacanth (*Astragalus microcephalus* and *A. lagurus*) motley grass steppe, etc., dominate in the montane steppes (Anonymous 2008).

Currently, 464 lichens and 2 lichenicolous fungi species are known from Armenia (Harutyunyan & al. 2011; Gasparyan & Sipman 2013; Gasparyan & al. 2014). In the protected area, mainly higher plants, fungi and animals have been investigated and monitored. There are only a few previous lichen records known from the reserve. No comprehensive lichenological surveys have been carried out in the area till date, which could be important for our understanding of lichen diversity in Armenia.

This paper presents the results of the first inventory of lichens in the Khosrov Forest State Reserve, which has been carried out during an international lichenological excursion to Armenia. The excursion was organized in the frame of the OPTIMA Iter Lichenologicum initiative by the Young Biologists Association NGO (Armenia) and OPTIMA (Organization for the Phyto-Taxonomic Investigation of the Mediterranean Area).

Material and methods

During the excursion from 17 to 18 of June, 2015, a total of six localities were visited by the participants of the excursion in the Khosrov Forest State Reserve. The specimens have been collected and identified with routine methods. Secondary metabolites have been studied by thin-layer chromatography (Orange & al. 2010). Additionally, in order to con-

firm the identification based on morphological features, internal transcribed spacer (ITS) of some *Parmeliaceae* and *Physciaceae* specimens have been sequenced (extracts numbered and kept in MAF-Lich.) and compared with available ITS sequences in GenBank (NCBI). Voucher specimens are deposited in the herbaria ABL, B, F, GLM, MACB, MAF-Lich. and PAL.

List of visited localities

- 1.- ARMENIA: ARARAT: Vedi, Urtsadzor, Khosrov Forest State Reserve, 39°59'07"N 44°53'51"E, 1390 m, 17-VI-2015, **a**) on *Ulmus* sp., **b**) on calcareous soil, **c**) on siliceous volcanic rocks, **d**) on limestone, **e**) on *Juniperus* sp., **f**) on bark, mixed forest of *Quercus*, *Juniperus* and *Acer*.
- 2.- ARMENIA: ARARAT: Vedi, Urtsadzor, Khosrov Forest State Reserve, 40°00'42"N 44°54'41"E, 1600 m, 17-VI-2015, **a**) on *Fraxinus excelsior*, **b**) on *Juniperus* sp., **c**) on siliceous volcanic rocks **d**) on limestone, **e**) on aquatic siliceous rocks, **f**) on rocks, **g**) on *Salix* sp., **h**) on *Quercus* sp., **i**) on *Acer monspessulanum*, **j**) on bark, mixed forest of *Quercus*, *Juniperus* and *Acer*.
- 3.- ARMENIA: ARARAT: Vedi, Urtsadzor, Khosrov Forest State Reserve, around a stream, 40°01'14"N 44°55'00"E, 1700 m, 17-VI-2015, **a**) on *Fraxinus excelsior*, **b**) on *Quercus macranthera*, **c**) on siliceous volcanic rocks, **d**) on soil, **e**) on *Juniperus* sp., **f**) on limestone, **g**) on bark, mixed forest of *Quercus*, *Juniperus* and *Acer*.
- 4.- ARMENIA: ARARAT: Vedi, Urtsadzor, Khosrov Forest State Reserve, top of the hill, 40°01'20"N 44°54'33"E, 1850 m, 17-VI-2015, **a**) on *Quercus macranthera*, **b**) on bark, mixed forest of *Quercus*, *Juniperus* and *Acer*.
- 5.- ARMENIA: ARARAT: Goght, Khosrov Forest State Reserve, entrance from Garni, riverside Azat, 40°06'25"N 44°45'16"E, 1300 m, 18-VI-2015, **a**) on *Quercus macranthera*, **b**) on *Populus* sp., **c**) on quartzitic rocks, **d**) on siliceous volcanic rocks, **e**) on *Fraxinus excelsior*, **f**) on *Juglans regia*, **g**) on *Cornus* sp., **h**) on soil, **i**) on limestone, **j**) on bark, mixed forest of *Quercus*, *Juniperus* and *Acer*.
- 6.- ARMENIA: ARARAT: Vedi, Urtsadzor, Khosrov Forest State Reserve, abandoned village, 40°01'10.7"N, 44°54'46.3"E, 1760 m, 17-VI-2015, **a**) on *Malus* sp.

Results and discussion

Overall, 172 species of lichenized and four species of lichenicolous fungi were found in the Khosrov Forest State Reserve. Species are listed in alphabetic order. Species names are followed by the locality or localities numbers, letter corresponding to the substrate and in case of lichenicolous fungi the host lichen species in brackets. Some specimens of *Anaptychia*, *Melanelixia*, *Melanohalea*, *Parmelia*, *Parmelina* and *Physconia*, have been sequenced, in those cases the DNA extraction number is included, in brackets, after the letter corresponding to the substrate. Forty five taxa of lichens and 4 taxa of lichenicolous fungi are new records for Armenia and marked in the list with (*), 14 of the new records represent new records for genera in Armenia and these

have been marked using (**). With these new records, the total number of lichens and lichenicolous fungi known from Armenia reaches 513 species, 507 lichens and 6 lichenicolous fungi.

List of species

- Acarospora assimulans* Vain. – 1c
Acarospora cervina (Ach.) A. Massal. – 1d
Acarospora fuscata (Nyl.) Th. Fr. – 5d
Acarospora insolata H. Magn. – 5d
Acarospora veronensis A. Massal. – 1c, 5d
 **Acarospora versicolor* Bagl. & Car. – 3f, 5d
 ***Agonimia tristicula* (Nyl.) Zahlbr. – 2d, 3c
Alyxoria varia (Pers.) Ertz & Tehler – 2a
Anaptychia ciliaris (L.) A. Massal. – 2j (DNA 4965), 3g (DNA 4966)
Anaptychia roemeri Poelt – 1d, 3c
 ***Anema decipiens* (A. Massal.) Forssell – 1d, 2d
 **Arctomia fascicularis* (L.) Otálora & Wedin – 2a
 **Arthonia intexta* Almq. (in *Lecidella elaeochroma* apothecia) – 2j
 **Arthonia phaeophysciae* Grube & Matzer (on *Phaeophyscia* cf. *hirsuta*) – 2a, 5b
Aspicilia cinerea (L.) Körb. – 2c
Aspicilia contorta subsp. *hoffmanniana* R. Sant. – 1d
Aspicilia desertorum (Kremp.) Mereschk. – 1cd, 2c, 5d
 **Aspicilia* cf. *glomerulans* (Poelt) Poelt – 5d
 **Aspicilia intermutans* (Nyl.) Arnold – 2c
Aspicilia reticulata Kremp. – 3c
Athallia pyracea (Ach.) Arup – 1ae, 2ae, 3be, 4a
 **Bacidina arnoldiana* V. Wirth & Vězda – 2e
 ***Bagliettoa calciseda* (DC.) Gueidan & Cl. Roux – 2d
 **Bilimbia sabuletorum* (Schreb.) Arnold – 2d
 **Blennothallia crispa* (Hudson) Otálora, P.M. Jørg. & Wedin – 3c
Calogaya biatorina (A. Massal.) Arup, Frödén & Søchtink – 1d
Calogaya polycarpoides (J. Steiner) Arup, Frödén & Søchtink – 3a
Calogaya pusilla (A. Massal.) Arup, Frödén & Søchtink – 2d
Caloplaca cerina (Hedw.) Th. Fr. – 1a, 2ah
Caloplaca demissa (Körb.) Arup & Grube – 3c
Caloplaca monacensis (Leder.) Lettau – 1ae, 2a, 3b
Candelariella antennaria Räsänen – 2e, 4a
Candelariella aurella (Hoffm.) Zahlbr. – 2d
Candelariella vitellina (Ehrh.) Müll. Arg. – 1d, 2d
 ***Chrysopsora testacea* (Hoffm.) Choisy – 1d
Circinaria calcarea (L.) A. Nordin, S. Savić & Tibell – 1d, 2ad, 5d
Cladonia pocillum (Ach.) O. J. Rich – 5a
Collema flaccidum (Ach.) Ach. – 2a
 **Collema subflaccidum* Degel. – 3b, 4a
Dermatocarpon miniatum (L.) W. Mann – 2c, 3f, 5d

- Dimelaena oreina* (Ach.) Norman – 3c
 **Diploschistes gypsaceus* (Ach.) Zahlbr. – 2f, 3f
Diploschistes muscorum (Scop.) R. Sant. – 5h
Diploschistes scruposus (Schreb.) Norman – 5d
Diplotomma hedinii (H. Magn.) P. Clerc & Cl. Roux – 2d
Enchylium tenax (Sw.) Gray – 2d
 **Endocarpon pusillum* Hedw. – 3f, 5d
Evernia prunastri (L.) Ach. – 3g
Flavoplaca flavocitrina (Nyl.) Arup, Frödén & Søchtink – 2c
Glypholecia scabra (Pers.) Müll. Arg. – 1d
 ***Gonohymenia nigritella* (Lettau) Henssen – 1d
 **Gonohymenia schleicheri* (Hepp) Henssen – 3c
Gyalolechia flavovirescens (Wulfen) Søchtink, Frödén & Arup – 5d
 **Gyalolechia juniperina* (Tomin) Søchtink, Frödén & Arup – 1b
Immersaria cupreoatra (Nyl.) Calat. & Rambold – 1c, 2c
 **Immersaria iranica* Valadb., Sipman & Rambold – 2c
Lathagrium cristatum (L.) Otálora, P.M. Jørg. & Wedin – 1bd, 5d
Lecania cyrtella (Ach.) Th. Fr. – 3a
Lecania fuscella (Schaer.) A. Massal. – 2a, 3a
 **Lecania rabenhorstii* (Hepp) Arnold – 2d
Lecanora argopholis (Ach.) Ach. – 1c, 5d
 **Lecanora barkmaniana* Aptroot & Herk – 3a
Lecanora bicincta Ramond – 3c
Lecanora bolcana (Pollinii) Poelt – 2c, 3c
Lecanora carpinea (L.) Vain. – 1a
Lecanora chlarotera Nyl. – 1a
Lecanora garovaglii (Körb.) Zahlbr. – 1c, 2c, 3c, 5d
 **Lecanora juniperina* Śliwa – 1ae, 2ab, 3be
Lecanora muralis (Schreb.) Rabenh. – 1d, 2d, 3c, 5d
Lecanora percrenata H. Magn. – 1d, 5d
Lecanora rupicola (L.) Zahlbr. – 2c, 3c
 **Lecanora semipallida* H. Magn. – 2d, 5d
Lecanora wetmorei Śliwa – 2a, 4ab, 5abj
Lecidella elaeochroma (Ach.) M. Choisy – 2aj, 3a, 5j
Lecidella euphorea (Flörke) Hertel – 1a, 2a, 3ag
Lecidella patavina (A. Massal.) Knoph & Leuckert – 3c
Lepraria finkii (de Lesd.) R. C. Harris – 3c
Lepraria nivalis J. R. Laundon – 2d, 3c, 5d
 ***Leprocaulon microscopicum* (Vill.) Gams – 3c
Leptogium saturninum (Dicks.) Nyl. – 2a, 3a
 ***Llimoniella phaeophysciae* Diederich, Ertz & Etayo (on *Phaeophyscia* cf. *hirsuta*) – 1a, 5b
Lobothallia alphoplaca (Wahlenb.) Hafellner – 3c, 5d
Lobothallia praeradiosa (Nyl.) Hafellner – 1cd, 2c
Lobothallia radiosa (Hoffm.) Hafellner – 3c, 5d
 **Lobothallia recedens* (Taylor) A. Nordin, S. Savić & Tibell – 2c

- Megaspora rimisorediata* Valadb. – 1e, 2b
Melanelixia glabra (Schaer.) O. Blanco, A. Crespo, Divakar, Essl., D. Hawksw. & Lumbsch – 1af (DNA 5053), 2aij (DNA 5055), 3abeg (DNA 5054), 5g
Melanelixia subargentifera (Nyl.) O. Blanco, A. Crespo, Divakar, Essl., D. Hawksw. & Lumbsch – 1af (DNA 5065, 5067), 2abij (DNA 5068, 5070), 3aeg, 4ab (DNA 5069), 5fj (DNA 5063)
Melanohalea elegantula (Zahlbr.) O. Blanco, A. Crespo, Divakar, Essl., D. Hawksw. & Lumbsch – 2j, 3g (DNA 5170), 4ab (DNA 5059)
Melanohalea exasperata (De Not.) O. Blanco, A. Crespo, Divakar, Essl., D. Hawksw. & Lumbsch – 1f, 2agi, 4a, 6a
Parmelia sulcata Taylor - 3g (DNA 5003, 5004)
Parmelina tiliacea (Hoffm.) Hale – 2acj (DNA 4961, 4962, 4963, 4988, 4989, 4990, 4991, 5002), 3g (DNA 4992, 4993), 4b (DNA 4994, 4995, 4996), 6a
***Peccania coralloides* (A. Massal.) A. Massal. – 3c
Peltigera canina (L.) Willd. – 2c
Peltigera elisabethae Gyeln. – 3cd
Peltigera ponojensis Gyeln. – 2c
Peltigera praetextata (Flörke) Vain. – 2c
Peltigera rufescens (Weiss) Humb. – 3cd
***Peltula euploca* (Ach.) Ozenda & Clauzade – 5d
Phaeophyscia ciliata (Hoffm.) Moberg – 2g
Phaeophyscia cf. *hirsuta* (Mereschk.) Essl. – 1ae, 2ab, 5b
Phaeophyscia nigricans (Flörke) Moberg – 1ae, 3b, 5a, 6a
Phaeophyscia orbicularis (Neck.) Moberg – 1a, 2aefi, 3a, 4ab, 5aef; 6a
Phaeophyscia sciastra (Ach.) Moberg – 2f, 3c
Physcia adscendens (Fr.) H. Olivier – 1a, 2ef, 3, 3a, 4b, 5ag
Physcia aipolia (Humb.) Fürnr. – 1af, 2aej, 3ag
Physcia biziana (A. Massal.) Zahlbr. – 1af, 2ai, 4a, 5ae
Physcia caesia (Hoffm.) Fürnr. – 3c
Physcia dimidiata (Arnold) Nyl. – 1ad, 2abf, 3e, 4a, 5f
Physcia dubia (Hoffm.) Lettau – 2c
Physcia stellaris (L.) Nyl. – 1af
Physcia tenella (Scop.) DC. – 1f, 2f
Physconia detersa (Nyl.) Poelt – 1f, 3af (DNA 5009)
Physconia distorta (With.) J. R. Laundon – 1a, 2d, 3ab, 5bf
Physconia enteroxantha (Nyl.) Poelt – 2i, 3bc, 5g
Physconia grisea (Lam.) Poelt – 2a
Physconia perisidiosa (Erichsen) Moberg – 2a, 3bg, 4a, 5j (DNA 4973)
**Physconia thorstenii* A. Crespo & Divakar – 1f (DNA 4972, 5010), 2j
***Piccolia ochrophora* (Nyl.) Hafellner – 1a
**Placidium lacunculatum* (Ach.) Breuss - 3f
Placidium rufescens (Ach.) A. Massal. – 1d, 3cd
Placocarpus schaeferi (Fr.) Breuss – 1d, 5d
**Placopyrenium fuscellum* (Turner) Gueidan & Cl. Roux – 2d
Placynthium nigrum (Huds.) Gray – 2d, 3c

- Pleurosticta acetabulum* (Neck.) Elix & Lumbsch – 2a
 ***Psorotichia schaeferi* (A. Massal.) Arnold – 1d
Punctelia borreri (Sm.) Krog – 1f
Pyrenodesmia variabilis (Pers.) A. Massal. – 1bc, 2d, 5d
Ramalina farinacea (L.) Ach. – 3a
Ramalina pollinaria (Westr.) Ach. – 3g
Rhizocarpon disporum (Hepp) Müll. Arg. – 2c, 3c
Rhizocarpon geographicum (L.) DC. – 3c
Rhizoplaca chrysoleuca (Sm.) Zopf – 3c
Rhizoplaca melanophthalma (DC.) Leuckert – 1c
Rhizoplaca peltata (Ramond) Leuckert & Poelt – 1c, 2c, 5d
 **Rinodina colobina* (Ach.) Th. Fr. – 1e, 2a
Rinodina immersa (Körb.) J. Steiner – 2cd
 **Rinodina obnascens* (Nyl.) H. Olivier – 2c
Rinodina pyrina (Ach.) Arnold – 3e
Romjularia lurida (Ach.) Timdal – 2d
Rusavskia elegans (Link) S.Y. Kondr. & Kärnefelt – 5d
Sarcogyne regularis Körb. – 2d
 **Scytinium gelatinosum* (With.) Otálora, P.M. Jørg. & Wedin – 2adf, 3ac, 5d
Scytinium lichenoides (L.) Otálora, P.M. Jørg. & Wedin – 2afj, 3e
 **Scytinium turgidum* (Ach.) Otálora, P.M. Jørg. & Wedin – 3c
 ***Solenopsora holophaea* (Mont.) Samp. – 2d, 3c
Squamarina cartilaginea (With.) P. James – 2c
Staurothele areolata (Ach.) Lettau – 3c
Staurothele fuscocuprea (Nyl.) Zschacke – 2d
Tephromela atra (Huds.) Hafellner – 5a
 ***Thermutis velutina* (Ach.) Flot. – 1c, 1d, 2c
Thyrea confusa Henssen – 1d, 2d
 **Toninia candida* (Weber) Th. Fr. – 2d
Toninia cinereovirens (Schaer.) A. Massal. – 1d (Fig. 3)
Toninia sedifolia (Scop.) Timdal – 3d, 5d
 **Toninia squalida* (Ach.) A. Massal. – 3c
 ***Tremella phaeophysciae* Diederich & M. S. Christ. (on *Pheophyscia orbicularis*) - 4b
 **Usnea lapponica* Vain. – 3g
Usnea substerilis Motyka – 3g
 **Usnea wasmuthii* Räsänen – 3g
 **Verrucaria dolosa* Hepp – 2e
Verrucaria hochstetteri Fr. – 2d
 **Verrucaria macrostoma* DC. – 1d
Verrucaria muralis Ach. – 2d
Verrucaria nigrescens Pers. – 2de, 5d
Xanthocarpia lactea (A. Massal.) A. Massal. – 2d
Xanthomendoza fulva (Hoffm.) Søchting, Kärnefelt & S.Y. Kondr. – 5b
Xanthomendoza ulophyllodes (Räsänen) Søchting, Kärnefelt & S.Y. Kondr. – 2a, 3b, 4a, 5b
Xanthoparmelia conspersa (Ach.) Hale – 5d



Fig. 3. *Toninia cinereovirens* and *Thermutis velutina* on limestone in the Khosrov Forest State Reserve (photo by Maaïke Vervoort).

Xanthoparmelia loxodes (Nyl.) O. Blanco, A. Crespo, Elix, D. Hawksw. & Lumbsch – 3c

**Xanthoparmelia protomatrae* (Gyeln.) Hale – 5d

Xanthoparmelia pulla (Ach.) O. Blanco, A. Crespo, Elix, D. Hawksw. & Lumbsch – 1c, 2c, 3c, 5dh

Xanthoparmelia somloensis (Gyeln.) Hale – 3c, 5dh

**Xanthoparmelia tinctina* (Maheu & A. Gillet) Hale – 1c, 2c, 3cd, 5d

Xanthoparmelia verruculifera (Nyl.) O. Blanco, A. Crespo, Elix, D. Hawksw. & Lumbsch – 5d

Xanthoria parietina (L.) Th. Fr. – 5a, 5f, 5g

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