

AN OVERVIEW OF THE GENUS *GRIMMIA* (BRYOPHYTA) OF ALBANIA AND KOSOVO

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Abstract: An overview of the genus *Grimmia* (Bryophyta) for Albania and Kosovo is presented in this paper. 386 *Grimmia* samples have been collected and identified in about 130 different locations for Albania, and 367 samples from about 40 locations for Kosovo. Up to date there are 24 *Grimmia* species known for Albania and 18 for Kosovo. Albania and Kosovo both have a rich *Grimmia* flora, due to geographic position and high mountain ranges with diverse rock types. There are three *Grimmia* species for Albania which have threat status, all vulnerable (VU), in the checklist and country status of European bryophytes: *Grimmia crinita*, *G. fuscolutea* and *G. mollis*. Many more species have conservation value in the context of SE Europe, especially in Bulgaria and Romania. However for Albania and Kosovo several other species seem to be rare and should be considered for future conservation: *Grimmia anodon*, *G. elongata*, *G. caespiticia*, *G. decipiens*, *G. longirostris* and *G. reflexidens*.

Key words: Albania, bryophytes, distribution, floristics, *Grimmia*, Kosovo, threat status

INTRODUCTION

The research on the Albanian bryoflora dates back to the late 19th century with HÖHNEL (1893), BAUMGARTNER (1915), SZEPESFALVY (1926), etc. Nevertheless, these studies were very sporadic and few in numbers. Based on these literature records COLACINO and SABOVLJEVIĆ (2006) published the first checklist of bryophytes with 238 moss taxa and 86 liverworts. In the last two decades the exploration of the Albanian bryoflora has been more intense (e.g. COLACINO and MARKA 2009, PAPP *et al.* 2009, 2010, 2018, MARKA and XHULAJ 2011, MARKA and SABOVLJEVIĆ 2011, MARKA *et al.* 2013, 2018, VAN ZANTEN 2013, MARKA 2014). Currently there are *ca* 460 moss taxa known for Albania (HODGETTS and LOCKHART 2020).

The situation of Kosovo* is similar with that of Albania, with the first records dating back to the second half of the 20th century (PAVLETIĆ 1955, MARTINČIČ 1963, 1980). Based on these literature records PANTOVIĆ and SABOVLJEVIĆ (2017) summarised the first checklist of Kosovo bryophytes with 303 mosses and 28 liverworts. Thus, the bryoflora of Kosovo is underexplored and recent explorations (KRASNIQI and MARKA 2018, 2021*a, b*) have contributed with 57 new moss records to it.

To improve knowledge on the bryophytes of these two countries, which apparently are the least explored in Southeast Europe – beyond the investigation of important moss biodiversity areas, and publication of checklists and red lists – another task would be to focus on the bigger and interesting bryophyte genera. Therefore, in this paper an overview of the genus *Grimmia* is presented for Albania and Kosovo, as a result of close collaboration of the authors in the recent years.

The genus *Grimmia* Hedw. belongs to the Grimmiaceae family (class Bryopsida), and it is a widespread genus with 93 species worldwide (GREVEN 2003), 40 in Europe (HODGETTS *et al.* 2020) and 35 in Southeast Europe (HODGETTS and LOCKHART 2020). The distribution of *Grimmia* species depends on climate, substrate, altitude, and the presence of suitable habitats. *Grimmia* species are saxicolous, occurring on all types of rock, but the majority prefers acidic substrates. In general, the basiophilous species prefer warm and dry habitats while acidophilous taxa prefer cold habitats. Therefore, most species occur in montane and alpine areas (GREVEN 2003). Due to the many mountain ranges and massifs in both Albania and Kosovo, their geological diversity and climate conditions, these countries are also rich in *Grimmia* species. Finally, in the context of climate changes, monitoring the possible changes in their occurrence, distribution and population patterns would be important for the evaluation of their threat status and potential conservation.

MATERIAL AND METHODS

A combination of literature records and the herbaria of both authors is used to compile the *Grimmia* checklist and distribution for both countries. There are 12 administrative units (prefectures) for Albania and 7 (districts) for Kosovo (Fig. 1). In Appendices 1 and 2 details are given on the sites where *Grimmia* samples were collected during many field trips in the last decade. More concretely, 386 *Grimmia* samples have been collected and identified in about 130 different locations in Albania and 367 samples from about 40 locations

* Kosovo is a partially recognised state.

in Kosovo. Nomenclature of the species follows HODGETTS *et al.* (2020) and comments for conservation status are based on HODGETTS and LOCKHART (2020). The voucher specimens are deposited in the respective herbaria of each author's institution.

Geography of Albania

Albania, lying between latitudes 39.4° and 42.4° N and longitudes 19.2° and 21.0° E, with an area of 28,748 km² is one of the most mountainous coun-

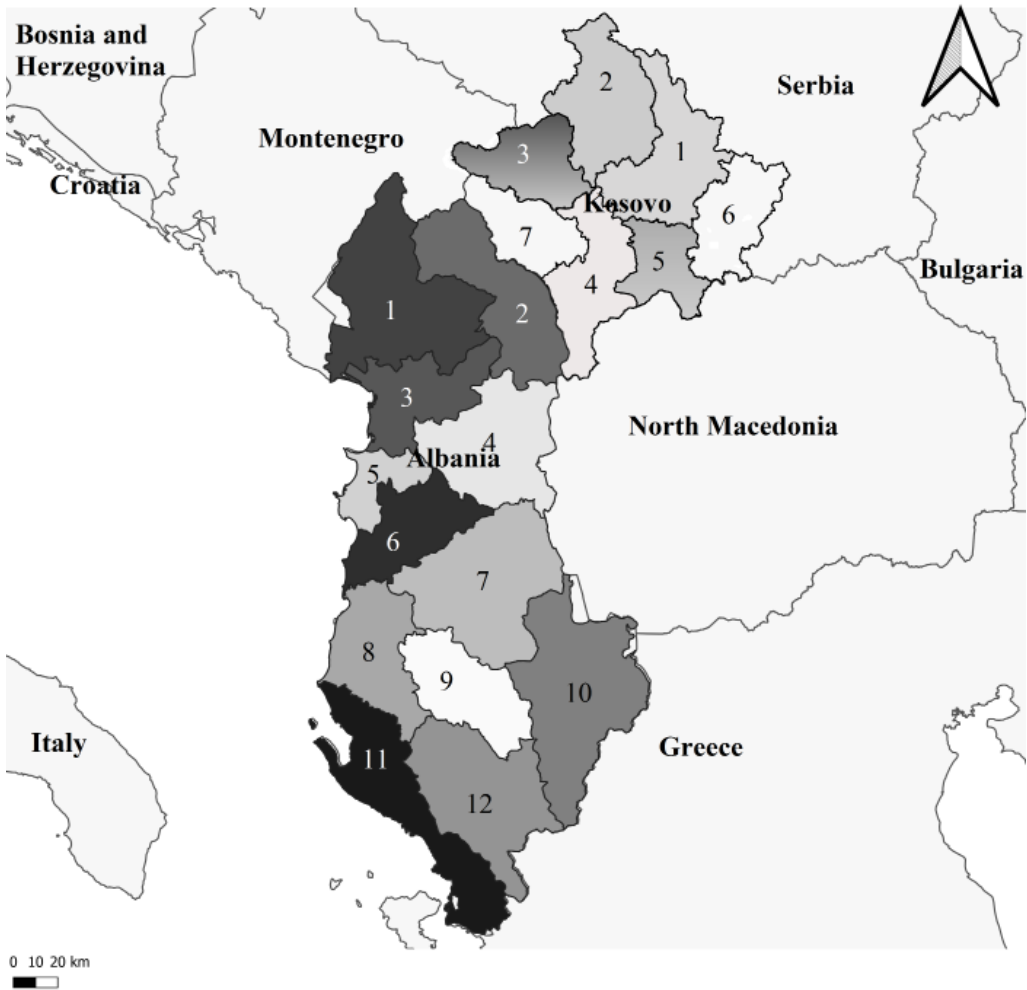


Fig. 1. Administrative map of Albania and Kosovo. Prefectures of Albania: 1 = Shkodër, 2 = Kukës, 3 = Lezhë, 4 = Dibër, 5 = Durrës, 6 = Tiranë, 7 = Elbasan, 8 = Fier, 9 = Berat, 10 = Korçë, 11 = Vlorë, 12 = Gjirokastrë. Districts of Kosovo: 1 = Prishtinë, 2 = Mitrovicë, 3 = Pejë, 4 = Prizren, 5 = Ferizaj, 6 = Gjilan, 7 = Gjakovë.

tries in the world. The mountainous terrain covers more than 70% of the territory and there are many peaks more than 2,000 m above sea level: Korab Mts in the east (2,764 m), Jezerca Mts (2,694 m), Grykat e Hapëta (2,625 m), Radohina (2,570 m), etc. in the Albanian Alps, Gramoz Mts (2,523 m), Nemërçka Mts (2,485 m), and Tomorr Mts (2,417 m) in the south and southeast, etc. (RAKAJ 2017). From a geological aspect, Albania belongs to the Dinarides s. l.; however the geological structure of Albania is called the Albanides, divided in internal and external zones. The Internal Albanides are from the Triassic and Jurassic ages, characterised by a developed magmatism and by the presence of an ophiolitic belt and with three tectonic zones: Gashi, Korabi, and Mirdita. The external Albanides include the following zones: the Alps, Ionian, Kruja, and Krasta-Cukali zones (PIFKÓ 2017). The various substrates in the mountainous areas are limestones, serpentines, flysch, granite, etc. (BARINA 2017). Albania has a Mediterranean climate, which is divided in 4 zones and 13 subzones. The fourth zone is the Mediterranean mountainous zone, above 1,000 m a.s.l., with 4 subzones (northern, eastern, southeastern, and southern) (ANONYMOUS 1988). The highlands have a Mediterranean continental climate, but the inland temperatures are affected more by differences in elevation than other factors (RAKAJ 2017). The average annual temperatures and average rainfalls in the four respective subzones of the Mediterranean mountainous zone of Albania are as follows: northern (4–11 °C, 2,000–2,500 mm), eastern (2–10 °C, 1,300–1,800 mm), southeastern (7–10 °C, 900–1,200 mm), southern (6–12 °C, 1,200–2,400 mm) (ANONYMOUS 1988). Albania has a rich vascular flora, with more than 3,000 taxa, including endemics, subendemics and Tertiary relicts as well (ANONYMOUS 1988). The flora of Albania is of Mediterranean and Central European character, and four vertical vegetation belts are distinguished: 1) Mediterranean woods and shrubs, 2) oak forests, 3) beech forests, and 4) alpine pastures (ANONYMOUS 1988).

Geography of Kosovo

Kosovo, with an area of 10,887 km², is situated in the Balkan Peninsula between northern latitudes 41° 50' 58" and 43° 51' 42" and between eastern longitudes 20° 01' 30" and 21° 48' 02" (IKMN 2005). The major and central part of Kosovo (80.7%) is mainly lowland, with two distinct plateaus: 'Fusha e Kosovës' (510–570 m a.s.l.) and 'Rrafshi i Dukagjinit' (350–450 m a.s.l.). These plateaus are surrounded by mountain ranges: 'Bjeshkët e Nemuna' Mts. in the western part, 'Sharri' Mts. in the south, 'Gollaku' Mts. in the east and 'Kopaoniku' Mts. in the north. The average elevation is 810 m a.s.l., the lowest and the highest elevations are 270 m and 2,656 m (Gjeravica Peak). In the

mountain reliefs, geological formations of the Palaeozoic and Mesozoic are the most widespread (IKMN 2005). The climate is meso-continental with important influences of Adriatic-Mediterranean climate. The average annual rainfall is 598 mm, and the average annual temperature is 10 °C (with extremes of –27 °C and 39 °C). There are about 3,000 taxa of vascular plants known for Kosovo, 19 endemics, 138 Balkan endemics, and 68 relicts, and many sites have natural heritage values according to the criteria of the World Heritage Convention (MUSTAFA *et al.* 2011, 2018).

RESULTS AND DISCUSSION

Grimmia species of Albania

Up to date there are 24 *Grimmia* species known for Albania: 21 of them are part of the collection of the second author, 2 species, *Grimmia caespiticia* (MARKA *et al.* 2018) and *G. fuscolutea* (PAPP *et al.* 2018), are reports of recent publications, and *G. crinita* is an old record from literature (SZEPESFALVY 1926). Their distribution in various prefectures is summarised below in Table 1. The richest prefectures are Kukës, Korçë, Shkodër, and Dibër. This is due to the presence of many high mountain ranges in these areas, temperate climate conditions and diversity of bedrocks as well.

There are *Grimmia* species with high, average, low or even rare occurrence in Albania. Thus, species with high occurrence are *Grimmia pulvinata*, followed by *G. dissimulata*, *G. ovalis*, *G. tergestina*, and *G. orbicularis*, and rare species, with occurrence from 1 to 2 sites, are *Grimmia anodon* (2), *G. caespiticia* (1), *G. crinita* (1), *G. decipiens* (2), *G. fuscolutea* (1), *G. longirostris* (2), *G. mollis* (1), and *G. reflexidens* (2) (Fig. 2). The five *Grimmia* species with the highest frequency are also the most constant and widespread species in the 12 prefectures.

Grimmia species of Kosovo

Thus far there are 18 *Grimmia* species known for Kosovo. Seventeen of them are part of the collection of the first author; only *Grimmia elongata* is reported from literature (MARTINČIČ 2006). Their distribution in various districts is summarised below in Table 2. The richest districts in *Grimmia* are Prizren, Gjakovë, and Pejë, where the high mountain ranges do occur, and where most of the field trips have been carried out.

Data on the absolute frequency of *Grimmia* species in Kosovo are given in Figure 3. The commonest species are *Grimmia hartmanii* and *G. pulvinata*, followed by *G. ramondii*, *G. alpestris*, and *G. anomala*. In comparison with Albania's

Table 1. The distribution of the *Grimmia* species in the Albanian prefectures. The numbers in the site column correspond to the site numbers in Appendix 1. The symbols for literature references are as follows: a = HÖHNEL (1893), b = BAUMGARTNER (1915), c = SZEPESEFALVY (1926), d = MARKGRAF (1931), e = PETROV (1960), f = KÁRPÁTI and VAJDA (1961), g = ERZBERGER (2007), h = PAPP *et al.* (2010), i = MARKA and XHULAJ (2011), j = MARKA *et al.* (2013), k = VAN ZANTEN (2013), l = MARKA *et al.* (2018), m = PAPP *et al.* (2018).

No.	Species	Berat	Dibër	Durrës	Elbasan	Fier	Gjirokastrë	Korçë	Kukës	Lezhë	Shkodër	Tiranë	Vlorë	Site	References
1	<i>G. alpestris</i>	+							+		+			6, 70, 71, 74, 102	b
2	<i>G. anodon</i>							+						36, 52	h
3	<i>G. anomala</i>	+							+		+			6, 71, 101, 102	g, i
4	<i>G. caespiticia</i>								+						l
5	<i>G. crinita</i>								+						c
6	<i>G. decipiens</i>	+	+	+	+	+	+	+	+	+	+	+		4, 5	h, i, m
7	<i>G. dissimulata</i>	+	+	+	+	+	+	+	+	+	+	+	+	1, 2, 8, 10, 11, 20, 24, 27, 31, 38, 40, 42, 43, 44, 48, 58, 63, 64, 80, 84, 86, 92, 94, 107, 108, 117, 118, 121, 122, 123, 124, 127, 128	h, m
8	<i>G. funalis</i>	+							+					8, 73, 79	l
9	<i>G. fuscolutea</i>			+											m
10	<i>G. hartmannii</i>	+	+	+	+	+	+	+	+	+	+	+	+	3, 4, 5, 16, 56, 57, 67, 70, 72, 73, 79, 93, 102, 124	f, i
11	<i>G. laevigata</i>	+	+	+	+	+	+	+	+	+	+	+	+	2, 7, 8, 18, 41, 42, 49, 77	a, h, k
12	<i>G. lisae</i>	+	+	+	+	+	+	+	+	+	+	+	+	8, 17, 18, 48, 63, 80, 82, 88, 108	k
13	<i>G. longirostris</i>							+			+			85	h
14	<i>G. meridionalis</i>			+	+	+	+	+	+	+	+	+	+	63, 87, 88, 99, 110	m

Table 1. (continued)

No.	Species	Berat	Dibër	Durrës	Elbasan	Fier	Gjirokastrë	Korçë	Kukës	Lezhë	Shkodër	Tiranë	Vlorë	Site	References
15	<i>G. mollis</i>							+						52	j
16	<i>G. montana</i>		+		+			+	+					6, 16, 32, 77, 79	h, i
17	<i>G. muehlenbeckii</i>							+	+					38, 73, 74, 79	a, h
18	<i>G. orbicularis</i>	+		+	+	+	+	+	+	+	+	+		1, 9, 18, 20, 22, 31, 40, 59, 82, 87, 88, 90, 94, 95, 96, 105, 109, 110, 121, 123, 124	h, m
19	<i>G. ovalis</i>		+		+			+	+		+			4, 7, 8, 16, 18, 32, 34, 35, 37, 38, 42, 49, 50, 52, 60, 62, 69, 74, 75, 77, 78, 79, 80, 81, 82, 102, 108	h, i, k
20	<i>G. pulvinata</i>	+	+	+	+	+	+	+	+	+	+	+		4, 9, 11, 13, 14, 17, 19, 20, 23, 24, 25, 26, 28, 30, 31, 33, 34, 35, 38, 39, 40, 41, 42, 46, 47, 48, 49, 51, 52, 53, 54, 58, 59, 61, 62, 63, 64, 65, 66, 68, 76, 80, 83, 85, 87, 88, 89, 91, 97, 98, 100, 103, 104, 106, 110, 111, 112, 113, 114, 115, 116, 118, 119, 120, 121, 123, 125, 126, 127, 128	a, b, d, e, f, h, i, k, m
21	<i>G. ramondii</i>								+					71, 72, 73, 79	l
22	<i>G. reflexidens</i>							+	+					49, 69	h
23	<i>G. tergestina</i>	+	+	+	+	+	+	+	+	+	+	+		8, 12, 15, 18, 20, 21, 22, 23, 24, 25, 29, 32, 33, 35, 38, 40, 45, 52, 59, 62, 78, 97, 99, 107, 121, 122, 124	a, h, m
24	<i>G. trichophylla</i>			+				+	+	+	+	+		13, 32, 34, 55, 65	h, k

Table 2. The distribution of the *Grimmia* species in each of the Kosovo districts. The numbers in the site column correspond to the site numbers in Appendix 2. The symbols for literature references are as follows: a (PAVLETIĆ 1955), b (MARTINČIĆ 1980), c (SABOVljević 1998), d (BLOCKEEL *et al.* 2002), e (MARTINČIĆ 2006), f (KRASNIQI and MARKA 2018), g (KRASNIQI and MARKA 2021a), and h (KRASNIQI and MARKA 2021b).

No.	Species	Ferizaj	Gjakovë	Gjilan	Mitrovicë	Pejë	Prishtinë	Prizren	Site	References
1	<i>G. alpestris</i>		+			+		+	9, 11, 14, 15, 16, 17, 18, 19, 20	b, e, g, h
2	<i>G. anodon</i>					+			5	h
3	<i>G. anomala</i>					+	+		6, 7, 9, 9, 11, 13, 14, 15, 16, 17	g, h
4	<i>G. caespiticia</i>					+		+	14, 15, 16	e
5	<i>G. dissimulata</i>							+	15, 16	g
6	<i>G. elongata</i>		+						-	e
7	<i>G. funalis</i>	+				+		+	13, 14	b, c, g
8	<i>G. hartmannii</i>		+		+	+		+	6, 7, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 37	e, f, g, h
9	<i>G. laevigata</i>								24, 28, 31	
10	<i>G. lisae</i>			+				+	13, 24	g
11	<i>G. montana</i>	+			+			+	14, 15, 16, 18, 19, 20, 36	b, c, e, g
12	<i>G. muehlenbeckii</i>					+		+	1, 2, 3, 5, 6, 15	g, h
13	<i>G. ovalis</i>		+	+	+	+		+	6, 11, 14, 19, 20, 29, 34, 35, 37	e, g
14	<i>G. pulvinata</i>		+	+	+	+	+	+	8, 16, 21, 22, 23, 25, 26, 27, 28, 29, 30, 31, 33	a, e, f, h
15	<i>G. ramondii</i>	+				+		+	1, 2, 3, 5, 6, 13, 14, 15, 16, 17	d, g, h
16	<i>G. reflexidens</i>	+						+	11, 14, 16, 18, 19, 20	c, g
17	<i>G. tergestina</i>			+				+	11, 14, 16, 26	g
18	<i>G. trichophylla</i>				+	+		+	6, 13, 17, 21	g, h

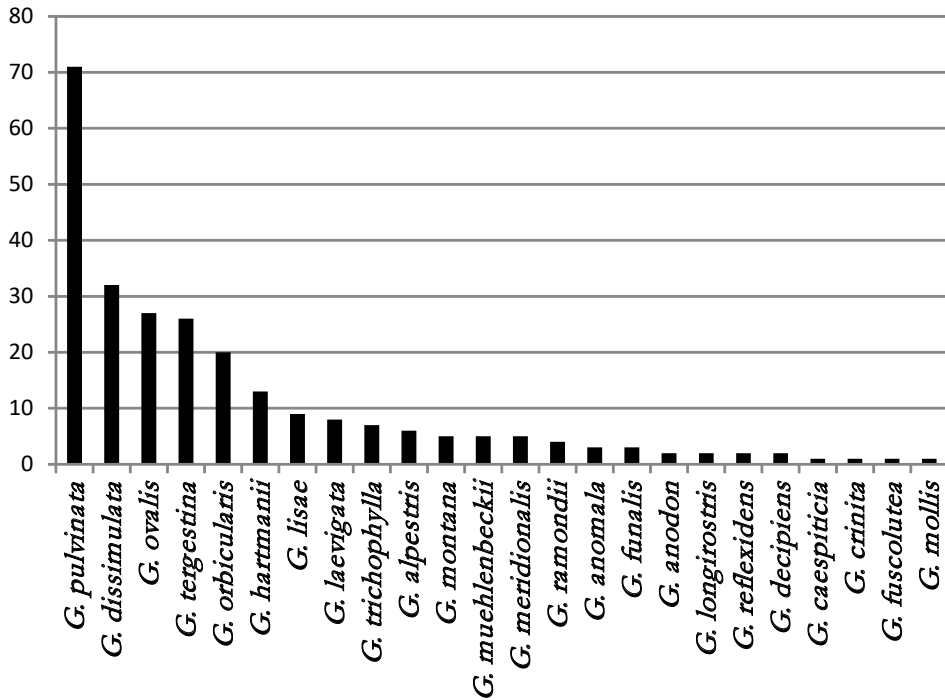


Fig. 2. The occurrence of *Grimmia* species in Albania, expressed in absolute number of sites where it is present.

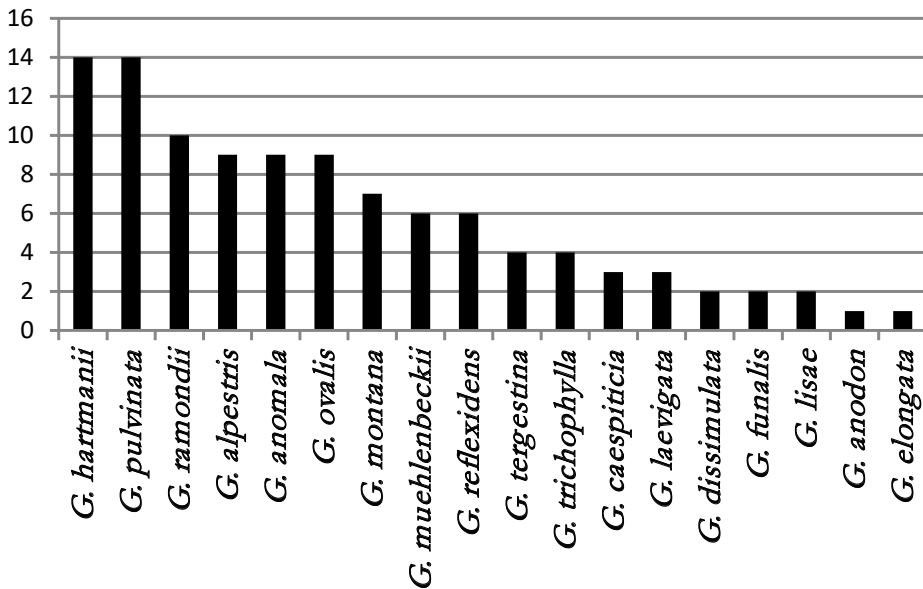


Fig. 3. The occurrence of *Grimmia* species in Kosovo expressed in absolute number of sites where it is present.

commonest species, the situation looks different for Kosovo. However, these differences may be explained by the fact that fewer areas were investigated in Kosovo; and the areas investigated were mainly at higher elevations and mostly on acidic rocks.

CONCLUSIONS

Albania and Kosovo both have a rich *Grimmia* flora, due to their geographic position and high mountain ranges with diverse rock types. There are three *Grimmia* species in Albania which have threat status, all vulnerable (VU), in the checklist and country status of European bryophytes (HODGETTS and LOCKHART 2020): *Grimmia crinita*, *G. fuscolutea*, and *G. mollis*. Many more species have conservation value in the context of SE Europe, especially in Bulgaria and Romania. However, in Albania and Kosovo several species seem to be rare and should be considered for future conservation: *Grimmia anodon*, *G. elongata*, *G. caespiticia*, *G. decipiens*, *G. longirostris*, and *G. reflexidens*.

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Összefoglaló: Kutatásunk során áttekintést készítettünk a *Grimmia* (Bryophyta) nemzetségről Albánia and Koszovó területén. Mintegy 130 albániai lelőhelyről 386 *Grimmia* példányt, 40 koszovói lelőhelyről pedig 367 példányt gyűjtöttünk be és határoztunk meg. Jelenleg 24 *Grimmia* faj ismert Albániából és 18 faj Koszovóból. Földrajzi helyzetüknek és a változatos kőzetekből álló magas hegyeiknek köszönhetően mind Albániának mind Koszovónak viszonylag gazdag *Grimmia* flórája van. Albániában a *Grimmia crinita*, *G. fuscolutea* és a *G. mollis* sérülékeny (VU) besorolást kapott az albániai vörös listában, továbbá az európai mohavédelmi országlistában. Délkelet Európában, különösen Bulgáriában és Romániában jóval több fajnak van valamilyen konzervációs besorolása. Albániában és Koszovóban a következő ritka fajok lehetséges jövőbeni besorolása vár még eldöntésre: *Grimmia anodon*, *G. elongata*, *G. caespiticia*, *G. decipiens*, *G. longirostris* and *G. reflexidens*.

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Appendix 1. Collecting site details for Albania, arranged alphabetically according to the prefectures.

Site	Prefecture	Municipality	Location	Coordinates	Sampling date	Sample numbers
1	Berat	Skrapar	Çorovodë	40° 30' 00.2" N, 20° 13' 37.4" E, 195 m	13.10.2010	2
2	Berat	Skrapar	Kanionet e Osumit	40° 28' 27.7" N, 20° 15' 15.4" E, 400 m	13.10.2010	2
3	Dibër	Bulqizë	Liçeni i Zi	41° 27' 11" N, 20° 18' 03" E, 1,600 m	21.10.2006	1
4	Dibër	Lurë	Fushë Lurë	41° 48' 41" N, 20° 12' 32" E, 1,100 m	17.08.2007	6
5	Dibër	Lurë	Liçenet e Lurës	41° 46' 36" N, 20° 11' 49" E, 1,700 m	18.08.2007	1
6	Dibër	Lurë	Liçenet e Lurës	41° 47' 31" N, 20° 11' 43" E, 1,700 m	18.08.2007	5
7	Dibër	Kala e Dodës	Kala e Dodës	41° 50' 18" N, 20° 27' 23" E, 1,156 m	26.09.2014	2
8	Dibër	Sllovë	Radomirë	41° 48' 44" N, 20° 29' 37" E, 1,400 m	26.09.2014	12
9	Durrës	Krujë	Krujë	41° 31' 24" N, 19° 47' 36" E, 700 m	25.03.2005	4
10	Durrës	Krujë	Krujë	41° 31' 37" N, 19° 47' 54" E, 830 m	25.03.2005	2
11	Durrës	Krujë	Sarisalltik	41° 30' 56" N, 19° 48' 32" E, 1,085 m	19.08.2007	5
12	Durrës	Cudhi	Qafë Shtamë	41° 31' 23" N, 19° 49' 05" E, 620 m	13.05.2006	1
13	Durrës	Cudhi	Qafë Shtamë	41° 31' 13" N, 19° 53' 31" E, 1,000 m	13.05.2006	2

Appendix 1. (continued)

Site	Prefecture	Municipality	Location	Coordinates	Sampling date	Sample numbers
14	Durrës	Cudhi	Qafë Shtamë	41° 31' 18" N, 19° 53' 55" E, 1,230 m	19.08.2007	1
15	Elbasan	Elbasan	Elbasan	41° 06' 14" N, 20° 00' 27" E, 440 m	05.04.2008	2
16	Elbasan	Gramsh	Lenie	40° 45' 37" N, 20° 26' 00" E, 1,720 m	25.09.2007	6
17	Elbasan	Librazhd	Polis	41° 09' 16.2" N, 20° 15' 08.9" E, 575 m	12.10.2010	3
18	Elbasan	Librazhd	Qafë Dardhë	41° 05' 44.5" N, 20° 16' 37.0" E, 1,385 m	12.10.2010	18
19	Fier	Divjakë	Divjakë	40° 58' 33" N, 19° 28' 57" E, 10 m	02.06.2009	1
20	Gjirokaštër	Petran	Bënjë	40° 14' 39.8" N, 20° 25' 57.2" E, 350 m	22.10.2005	13
20	Gjirokaštër	Petran	Bënjë	40° 14' 39.8" N, 20° 25' 57.2" E, 350 m	14.10.2010	8
21	Gjirokaštër	Petran	Bënjë	40° 14' 40" N, 20° 25' 56" E, 340 m	18.10.2016	1
22	Gjirokaštër	Petran	Badlonjë	40° 12' 27.7" N, 20° 23' 16.2" E, 260 m	14.10.2010	2
23	Gjirokaštër	Libohovë	Hoshtevë	40° 13' 00.8" N, 20° 14' 41.6" E, 735 m	15.10.2010	6
24	Gjirokaštër	Libohovë	Gryka e Selcës	40° 06' 19.6" N, 20° 18' 13.1" E, 470 m	16.10.2010	4
25	Gjirokaštër	Libohovë	Hoshtevë	40° 13' 04.5" N, 20° 14' 84.9 E, 805 m	01.08.2012	2

Appendix 1. (continued)

Site	Prefecture	Municipality	Location	Coordinates	Sampling date	Sample numbers
27	Gjirokaštër	Tepelenë	Dragot	40° 17' 30" N, 20° 04' 43" E, 140 m	07.10.2016	1
28	Gjirokaštër	Tepelenë	Gryka e Luzatit	40° 14' 45" N, 20° 01' 46" E, 355 m	04.05.2017	1
29	Gjirokaštër	Çarshovë	Çarshovë	40° 05' 50" N, 20° 33' 35" E, 330 m	18.10.2016	1
30	Gjirokaštër	Këlcyrë	Gryka e Këlcyrës	40° 17' 48" N, 20° 09' 40" E, 170 m	03.05.2017	1
31	Korçë	Bilisht	Tren	40° 40' 36" N, 21° 00' 15" E, 860 m	04.04.2008	4
32	Korçë	Drenovë	Bredhi i Drenovës	40° 35' 12.72" N, 20° 50' 39" E, 1,440 m	21.07.2009	5
33	Korçë	Drenovë	Dardhë	40° 31' 53.9" N, 20° 48' 42.4" E, 1,674 m	22.07.2009	2
34	Korçë	Drenovë	Dardhë	40° 30' 11.6" N, 20° 49' 49.7" E, 1,283 m	22.07.2009	3
35	Korçë	Drenovë	Dardhë	40° 31' 21.6" N, 20° 49' 40.3" E, 1,254 m	23.07.2009	6
36	Korçë	Drenovë	Dardhë	40° 31' 31.9" N, 20° 49' 50.1" E, 1,450 m	23.07.2009	1
37	Korçë	Lekas	Gjergjevicë	40° 35' 01.8" N, 20° 35' 03.0" E, 1,338 m	27.10.2007	1
38	Korçë	Lekas	Gjergjevicë	40° 35' 03.1" N, 20° 34' 20.5" E, 1,228 m	20.07.2009	6
39	Korçë	Leskovik	Gërmenj	40° 12' 16.7" N, 20° 39' 52.9" E, 1,065 m	25.07.2009	2

Appendix 1. (continued)

Site	Prefecture	Municipality	Location	Coordinates	Sampling date	Sample numbers
40	Korçë	Leskovik	Radanj	40° 12' 36.6" N, 20° 37' 54.1" E, 1,093 m	25.07.2009	4
41	Korçë	Leskovik	Shelegur	40° 10' 48.7" N, 20° 38' 50.4" E, 1,007 m	25.07.2009	2
42	Korçë	Leskovik	Radanj-Shelegur	40° 11' 55.1" N, 20° 38' 26.0" E, 1,193 m	26.07.2009	8
43	Korçë	Leskovik	Gërmenj	40° 13' 49.4" N, 20° 39' 45.6" E, 1,058 m	26.07.2009	3
44	Korçë	Leskovik	Gërmenj	40° 13' 32.5" N, 20° 39' 50.9" E, 1,046 m	26.07.2009	1
45	Korçë	Miras	Sinicë	40° 31' 10.6" N, 20° 50' 55.0" E, 1,144 m	23.07.2009	1
46	Korçë	Pogradec	Pogradec	40° 54' 50" N, 20° 38' 42" E, 820 m	03.04.2008	3
47	Korçë	Pustec	Liçenas	40° 46' 37.1" N, 20° 54' 32.3" E, 853 m	24.07.2009	1
48	Korçë	Pustec	Liçenas	40° 46' 10.5" N, 20° 55' 46.6" E, 851 m	24.07.2009	4
49	Korçë	Vithkuq	Vithkuq	40° 34' 04.3" N, 20° 36' 03.5" E, 1,411 m	20.07.2009	4
50	Korçë	Vithkuq	Vithkuq	40° 34' 19.1" N, 20° 35' 02.4" E, 1,381 m	20.07.2009	2
51	Korçë	Voskopojë	Voskopojë	40° 38' 34" N, 20° 36' 02" E, 1,285 m	05.04.2008	1
52	Korçë	Voskopojë	Voskopojë	40° 39' 00.9" N, 20° 34' 59.7" E, 1,131 m	19.07.2009	5

Appendix 1. (continued)

Site	Prefecture	Municipality	Location	Coordinates	Sampling date	Sample numbers
53	Korçë	Voskopojë	Voskopojë	40° 37' 28,0" N, 20° 35' 38.8" E, 1,258 m	20.07.2009	1
54	Korçë	Voskopojë	Voskopojë	40° 38' 34" N, 20° 36' 02" E, 1,285 m	19.11.2011	1
55	Kukës	Bujan	Markaj	42° 20' 56.399" N, 20° 3' 3.599", 740 m	09.07.2014	2
56	Kukës	Gryk-Çajë	Buzë madhe	41° 56' 51.7" N, 20° 29' 29.7" E, 1,855 m	25.09.2009	1
57	Kukës	Gryk-Çajë	Laku i Dardhës	41° 57' 30.6" N, 20° 27' 41.8" E, 1,613 m	25.09.2009	2
58	Kukës	Gryk-Çajë	Gryka e Çajës	41° 53' 51.6" N, 20° 25' 00.65" E, 658 m	22.06.2012	2
59	Kukës	Gryk-Çajë	Ura e Lapajve	41° 53' 46" N, 20° 25' 02" E, 640 m	26.09.2014	3
60	Kukës	Krumë	Kurrizi i Gajrepit	42° 12' 28.86" N, 20° 27' 20.72" E, 1,025 m	21.06.2012	1
61	Kukës	Krumë	Cahan	42° 12' 4.87" N, 20° 28' 9.79" E, 1,170 m	21.06.2012	1
62	Kukës	Krumë	Pashtrik	42° 12' 28.82" N, 20° 29' 58.77" E, 1,670 m	21.06.2012	4
63	Kukës	Kukës	Polla e Zezë	42° 03' 02.8" N, 20° 20' 03.6" E, 619 m	16.07.2009	7
64	Kukës	Margegaj	Valbonë	42° 27' 38" N, 19° 55' 03" E, 400–1,000 m	11.06.2005	3
65	Kukës	Margegaj	Tropojë	42° 23' 46" N, 20° 11' 12" E, 420 m	06.06.2006	3

Appendix 1. (continued)

Site	Prefecture	Municipality	Location	Coordinates	Sampling date	Sample numbers
66	Kukës	Margegaj	Dragobi	42° 24' 46" N, 20° 01' 12" E, 420 m	07.06.2006	1
67	Kukës	Margegaj	Çerem	42° 30' 09.47" N, 19° 56' 45.54" E, 1,438 m	14.07.2011	2
68	Kukës	Margegaj	Liqeni Xhemes	42° 27' 60.3" N, 19° 55' 10.4" E, 792 m	14.07.2012	1
69	Kukës	Margegaj	Çerem	42° 29' 56.1" N, 19° 57' 55.5" E, 1,240 m	07.07.2014	2
70	Kukës	Margegaj	Çeremi	42° 30' 08.2" N, 19° 59' 40.0" E, 1,710 m	07.07.2014	2
71	Kukës	Margegaj	Markofshë	42° 29' 52" N, 19° 59' 26" E, 1,850 m	07.07.2014	8
72	Kukës	Margegaj	Markofshë	42° 29' 21" N, 19° 59' 02" E, 1,730 m	07.07.2014	3
73	Kukës	Margegaj	Qafa e Trokuzit	42° 30' 21.8" N, 20° 00' 42.2" E, 2,066 m	10.07.2014	9
74	Kukës	Shishtavec	Guri i mëngjesit	41° 56' 40.2" N, 20° 37' 06.6" E, 1,955 m	15.07.2009	5
75	Kukës	Shishtavec	Kallabak	41° 56' 42.5" N, 20° 34' 31.2" E, 1,511 m	15.07.2009	1
76	Kukës	Shishtavec	Novosej	41° 58' 37.5" N, 20° 34' 13.2" E, 1,232 m	25.09.2009	1
77	Kukës	Shishtavec	Kallabak	41° 56' 44.3" N, 20° 34' 23.5" E, 1,483 m	25.09.2009	5
78	Kukës	Shishtavec	Shishtavec	41° 56' 40.2" N, 20° 37' 06.6" E, 1,955 m	20.06.2012	2

Appendix 1. (continued)

Site	Prefecture	Municipality	Location	Coordinates	Sampling date	Sample numbers
79	Kukës	Shishtavec	Kallabak	41° 55' 49.68" N, 20° 35' 52.62" E, 2,000 m	20.06.2012	7
80	Kukës	Surroj	Surroj	42° 02' 48" N, 20° 19' 59 E, 620 m	18.09.2013	6
81	Kukës	Topojan	Topojan	41° 59' 58.9" N, 20° 31' 24.5" E, 1,009 m	25.09.2009	1
82	Kukës	Topojan	Tropojë	42° 23' 49.3" N, 20° 11' 07.12 E, 434 m	14.07.2012	3
83	Kukës	Tropojë	Gryka e Lumës	42° 25' 00" N, 20° 09' 37" E, 470 m	09.07.2014	1
84	Lezhë	Rrëshen	Rrëshen	41° 44' 49" N, 19° 55' 43" E, 200 m	30.04.2016	3
85	Shkodër	Fierzë	Poravë	42° 14' 36" N, 20° 03' 10" E, 580 m	08.06.2006	2
86	Shkodër	Kastrat	Hot	42° 20' 15" N, 19° 26' 06" E, 38 m	03.06.2006	1
87	Shkodër	Kelmend	Rrapsh	42° 24' 54" N, 19° 30' 14" E, 700 m	05.06.2005	3
88	Shkodër	Kelmend	Rrapsh	42° 24' 33" N, 19° 30' 28" E, 715 m	05.06.2005	7
89	Shkodër	Kelmend	Selcë	42° 31' 50" N, 19° 38' 58" E, 960 m	05.06.2005	1
90	Shkodër	Kelmend	Selcë	42° 32' 11" N, 19° 41' 46" E, 1,400 m	07.06.2005	3
91	Shkodër	Kelmend	Leqet e Hotit	42° 24' 54" N, 19° 30' 14" E, 700 m	21.07.2005	1

Appendix 1. (continued)

Site	Prefecture	Municipality	Location	Coordinates	Sampling date	Sample numbers
92	Shkodër	Kelmend	Tamarë	42° 27' 19" N, 19° 33' 38" E, 215 m	21.07.2005	2
93	Shkodër	Kelmend	Lëpushë	42° 30' 58.50" N, 19° 43' 18" E, 1,650 m	22.07.2005	2
94	Shkodër	Kelmend	Rrapsh	42° 24' 54" N, 19° 30' 14" E, 700 m	03.06.2006	3
95	Shkodër	Kelmend	Fushë Lojë	42° 31' 46" N, 19° 38' 57" E, 1,170 m	05.06.2006	1
96	Shkodër	Kelmend	Leqet e Hotit	42° 24' 55" N, 19° 30' 12" E, 650 m	05.06.2006	1
97	Shkodër	Pukë	Pukë	42° 12' 35" N, 20° 05' 46" E, 600 m	12.06.2005	3
98	Shkodër	Pukë	Pukë	42° 02' 53" N, 19° 53' 10" E, 930 m	08.06.2006	2
99	Shkodër	Pult	Kir	42° 14' 30" N, 19° 41' 38" E, 1,750 m	16.08.2007	2
100	Shkodër	Shalë	Gropa e Thethit	42° 24' 23.35" N, 19° 45' 33" E, 930 m	19.07.2005	1
101	Shkodër	Shalë	Qafa e Pejës	42° 26' 38" N, 19° 46' 20" E, 1,750 m	19.07.2005	1
102	Shkodër	Shalë	Qafa e Pejës	42° 26' 38" N, 19° 46' 20" E, 1,750 m	15.08.2007	8
103	Shkodër	Shkodër	Zogaj	42° 04' 20.27" N, 19° 23' 45.14" E, 30 m	09.06.2012	1
104	Shkodër	Shkrel	Gjajçë	42° 23' 42" N, 19° 38' 27" E, 910 m	18.07.2005	3

Appendix 1. (continued)

Site	Prefecture	Municipality	Location	Coordinates	Sampling date	Sample numbers
105	Shkodër	Shkrel	Qafë Razëm	42° 20' 06.29" N, 19° 32' 29.16" E, 925 m	10.06.2012	1
106	Shkodër	Shkrel	Razëm	42° 20' 46.17" N, 19° 33' 08.78" E, 1,075 m	10.06.2012	1
107	Shkodër	Shkrel	Dedaj	42° 17' 28.55" N, 19° 31' 52.40" E, 450 m	10.06.2012	4
108	Shkodër	Vau i Dejës	Koman	42° 04' 28" N, 19° 47' 01" E, 130 m	24.04.2016	3
109	Tiranë	Dajt	Linzë	41° 20' 40" N, 19° 51' 53" E, 230 m	30.10.2004	1
110	Tiranë	Dajt	Linzë	41° 20' 57" N, 19° 53' 50" E, 450 m	30.10.2004	5
111	Tiranë	Dajt	Dajt	41° 19' 34" N, 19° 56' 02" E, 755 m	06.11.2004	2
112	Tiranë	Dajt	Dajt	41° 19' 49" N, 19° 55' 51.82" E, 805 m	06.11.2004	3
113	Tiranë	Dajt	Dajt	41° 20' 2.10" N, 19° 55' 51" E, 862 m	06.11.2004	1
114	Tiranë	Dajt	Linzë	41° 21' 03" N, 19° 53' 51" E, 480 m	03.04.2005	3
115	Tiranë	Dajt	Dajt	41° 21' 21" N, 19° 55' 05" E, 1,000 m	19.05.2005	1
116	Tiranë	Dajt	Dajt	41° 22' 16" N, 19° 54' 54" E, 1,200 m	25.05.2005	4
117	Tiranë	Dajt	Dajt	41° 21' 21" N, 19° 55' 05" E, 1,000 m	01.06.2005	1

Appendix 1. (continued)

Site	Prefecture	Municipality	Location	Coordinates	Sampling date	Sample numbers
118	Tiranë	Dajt	Dajt	41° 21' 34" N, 19° 54' 45" E, 1,050 m	18.06.2005	2
119	Tiranë	Dajt	Dajt	41° 22' 28" N, 19° 55' 10" E, 1,255 m	20.08.2007	1
120	Tiranë	Dajt	Dajt	41° 21' 46" N, 19° 54' 33" E, 1,050 m	04.06.2009	1
121	Tiranë	Dajt	Dajt	41° 21' 49.5" N, 19° 54' 35.5" E, 1,050 m	02.06.2010	8
122	Tiranë	Krrabë	Qafë Krrabë	41° 12' 40" N, 19° 57' 10.6" E, 443 m	05.06.2009	2
123	Tiranë	Krrabë	Qafë Krrabë	41° 11' 59.7" N, 19° 56' 11" E, 690 m	05.06.2009	3
124	Tiranë	Krrabë	Krrabë	41° 12' 40" N, 19° 57' 10.6" E, 443 m	21.06.2011	4
125	Tiranë	Zall-Bastar	Zall-Bastar	41° 25' 54" N, 19° 55' 41" E, 380 m	14.05.2006	1
126	Tiranë	Zall-Bastar	Feken, Qafë mollë	41° 23' 37" N, 20° 01' 10" E, 1,300 m	19.05.2006	2
127	Vlorë	Orikum	Llogora	40° 13' 15" N, 19° 34' 37" E, 670 m	22.08.2007	2
128	Vlorë	Orikum	Llogora	40° 11' 59" N, 19° 35' 26.5" E, 1,030 m	19.05.2010	2

Appendix 2: Collecting site details for Kosovo, arranged alphabetically according to the districts.

Site	District	Municipality	Location	Coordinates	Sampling dates	Sample numbers
1	Pejë	Pejë	Hajle	42° 44.402' N, 20° 9.125' E, 1,650 m	11.08.2015	4
2	Pejë	Pejë	Hajle	42° 45.030' N, 20° 9.217' E, 2,027 m	11.08.2015	2
3	Pejë	Pejë	Hajle	42° 44.959' N, 20° 8.856' E, 2,081 m	11.08.2015	3
4	Pejë	Pejë	Hajle	42° 44.533' N, 20° 8.820' E, 1,795 m	11.08.2015	1
5	Pejë	Pejë	Hajle	42° 44.533' N, 20° 8.820' E, 1,795 m	21.09.2019	7
6	Pejë	Pejë	Lagja e Kaprojve	42° 42.873' N, 20° 9.053' E, 1,103 m	11.08.2015	18
7	Pejë	Pejë	Reka e Allagës	42° 44.000' N, 20° 9.440' E, 1,403 m	11.08.2015	4
8	Prishtinë	Prishtinë	Butovcë (Gërmi)	42° 40.786' N, 21° 14.028' E, 1,029 m	17.05.2018	4
9	Prizren	Dragash	Restelicë	41° 55.060' N, 20° 38.716' E, 1,958 m	01.08.2015	5
10	Prizren	Prizren	Bistra	42° 9.156' N, 20° 57.485' E, 1,853 m	02.10.2018	5
11	Prizren	Prizren	Kalaja e Prizrenit	42° 12.522' N, 20° 44.734' E, 521 m	15.08.2014	34
12	Prizren	Prizren	Prevallë	42° 9.968' N, 20° 57.440' E, 1,560 m	15.08.2014	1
13	Prizren	Prizren	Prevallë	42° 10.730' N, 20° 57.779' E, 1,585 m	15.08.2014	59

Appendix 2. (continued)

Site	Prefecture	Municipality	Location	Coordinates	Sampling date	Sample numbers
14	Prizren	Prizren	Prevallë	42° 10.730' N, 20° 57.779' E, 1,585 m	01.10.2018	38
15	Prizren	Prizren	Prevallë	42° 10.730' N, 20° 57.779' E, 1,585 m	02.10.2018	33
16	Prizren	Prizren	Prroi i Durlës	42° 11.012' N, 21° 2.175' E, 1,737 m	05.08.2014	54
17	Prizren	Prizren	Prroi i Durlës	42° 11.012' N, 21° 2.175' E, 1,737 m	30.09.2018	19
18	Prizren	Suharekë	Pashallare	42° 14.434' N, 20° 54.665' E, 2,029 m	09.08.2014	9
19	Prizren	Suharekë	Pashallare	42° 14.920' N, 20° 54.690' E, 1,746 m	09.08.2014	15
20	Prizren	Suharekë	Pashallare	42° 14.640' N, 20° 54.900' E, 1,802 m	09.08.2014	27
21	Gjilan	Kamenicë	Poliçkë	42° 36.52' N, 21° 40.2' E, 678 m	19.08.2021	2
22	Gjilan	Kamenicë	Poliçkë	42° 37.16' N, 21° 40.12' E, 665 m	19.08.2021	1
23	Gjilan	Kamenicë	Kitka	42° 39.13' N, 21° 40.7' E, 1,026 m	19.08.2021	2
24	Gjilan	Kamenicë	Kitka	42° 39.15' N, 21° 40.8' E, 1,020 m	19.08.2021	1
25	Gjilan	Kamenicë	Kopernicë	42° 36.48' N, 21° 36.50' E, 631 m	19.08.2021	1
26	Gjilan	Novobërd	Novobërd	42° 37.10' N, 21° 27.80' E, 1,204 m	18.08.2021	2

Appendix 2. (continued)

Site	Prefecture	Municipality	Location	Coordinates	Sampling date	Sample numbers
27	Gjilan	Novobërd	Novobërd	42° 37.12' N, 21° 26.52' E, 1,250 m	18.08.2021	1
28	Gjilan	Novobërd	Novobërd	42° 37.10' N, 21° 25.58' E, 1,044 m	18.08.2021	1
29	Gjilan	Novobërd	Novobërd	42° 36.24' N, 21° 25.46' E, 891 m	18.08.2021	3
30	Gjilan	Viti	Debellde	42° 15.50' N, 21° 23.34' E, 1,064 m	25.08.2021	1
31	Gjilan	Viti	Debellde	42° 17.22' N, 21° 22.19' E, 628 m	25.08.2021	2
32	Gjilan	Viti	Letnicë	42° 17.22' N, 21° 27.16' E, 643 m	25.08.2021	1
33	Gjilan	Viti	Letnicë	42° 17.48' N, 21° 26.60' E, 611 m	25.08.2021	2
34	Mitrovicë	Mitrovicë	Shalë e Bajgorës	43° 0.15' N, 21° 1.7' E, 1,612 m	16.08.2021	1
35	Mitrovicë	Mitrovicë	Shalë e Bajgorës	43° 0.31' N, 21° 1.14' E, 1,662 m	16.08.2021	1
36	Mitrovicë	Mitrovicë	Shalë e Bajgorës	43° 0.54' N, 21° 1.7' E, 1,618 m	16.08.2021	1
37	Mitrovicë	Mitrovicë	Shalë e Bajgorës	42° 58.14' N, 21° 0.57' E, 1,547 m	16.08.2021	2