

**Orthotrichaceous mosses
(Orthotricheae, Orthotrichaceae)
of the genera *Lewinskya*, *Nyholmiella*,
Orthotrichum, *Pulviger*a and *Ulota*
Contributions to the bryophyte flora of Georgia 1**

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Abstract – A collection made by Hans-Joachim Zündorf between 2004 and 2014 in Georgia was studied, comprising 383 specimens of orthotrichaceous mosses from 105 different localities. The study yielded a total 27 species in this group: seven species of *Lewinskya*, two of *Nyholmiella*, 13 of *Orthotrichum*, one of *Pulviger*a as well as four species of *Ulota*. Ten species are new records for the bryophyte flora of Georgia: *Lewinskya sordida*, *L. vladikavkana*, *Nyholmiella gymnostoma*, *Orthotrichum consobrinum*, *O. hispanicum*, *O. patens*, *O. philibertii*, *O. stellatum*, *Ulota coarctata* and *U. intermedia*. Our records of *Orthotrichum hispanicum*, *O. stellatum* and *Ulota intermedia* are also the first for the wider Caucasus region. The number of known species of the tribe Orthotricheae in Georgia has thus been raised to 30. The diversity of species in this group is very similar to the neighboring region of NE Turkey. The high number of species encountered during the study reveals Georgia as a very important area for Orthotrichaceae.

Caucasus / Colchis / Turkey / Western Asia

INTRODUCTION

Situated at the border of East Europe and West Asia, Georgia is a highly diverse country with respect to physical geography and climate, as well as biodiversity. Within its borders, there are such different environments as the high mountains of the Greater Caucasus in the north, dry continental areas in the east, the Lesser Caucasus range in the center and south and an area with warm and oceanic climate near the Black Sea coast in the west (e.g. Nakhutsrishvili, 2013). The country lies in the heart of the Caucasian biogeographical unit, recognized as one of the top 25 global biodiversity hotspots (Myers *et al.*, 2000).

Research on vascular plants has a long tradition in Georgia, resulting among other things in the publication of an internationally respected flora (Ketskhoveli *et al.*, 1971-2011). In contrast, bryological exploration was much less intensive in

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the country and mainly conducted by foreign researchers. Brotherus (1892) published one of the first bryological works on the territory. Later, Russian bryologists, most notably A. L. Abramova and I. I. Abramov (see references in Ignatov *et al.*, 2006; Bakalin *et al.*, 2016), worked in Georgia. In recent years, Chikovani & Svanidze (2004) summarized all available sources to compile an annotated bryophyte checklist of Georgia, comprising 174 liverwort and 638 moss taxa and Bakalin *et al.* (2016) published a checklist of liverworts and hornworts comprising 172 species.

To promote bryological research in Georgia, scientists from the Friedrich-Schiller-University Jena, Germany, collaborate with the Ivane Javakhishvili State University, Tbilisi, Georgia, based on a partnership agreement of both universities. Since 2004, scientists from the Department of Systematic Botany in Jena undertake expeditions every year to Georgia to study the rich flora of the region, focusing mainly on vascular plants and bryophytes. These expeditions provide a unique opportunity to give Georgian and German students an understanding of bryophytes. Simultaneously, the expeditions resulted in a large bryophyte collection hold at the Herbarium Haussknecht in Jena (JE) and the Georgian Academy of Science (TBI). With this publication, we start the new series: ‘Contributions to the bryophyte flora of Georgia’, which deals with all kinds of research conducted on this Georgian bryophyte collection.

This first contribution covers the orthotrichaceous mosses collected in Georgia. Chikovani & Svanidze (2004) listed 25 taxa in this group for Georgia. However, some names on the list are commonly regarded as synonyms today (Ros *et al.*, 2013), reducing the number of accepted species of Orthotrichaceae tribe Orthotricheae (Goffinet & Vitt, 1998) to 17. These species are now attributed to the genera *Lewinskya* F.Lara, Garilleti & Goffinet, *Nyholmiella* Holmen & E.Warncke, *Orthotrichum* Hedw., *Pulviger* Plášek, Sawicki & Ochyra and *Ulota* D.Mohr according to the recent proposals by Plášek *et al.* (2015) and Lara *et al.* (2016).

MATERIAL AND METHODS

Specimens were mainly collected by Hans-Joachim Zündorf between 2004 and 2014, except 10 collections (from localities 36, 64, 85, 101, 103, which are from 1988 also by H.-J. Zündorf as well as two collections from locality 34, which are from 1982 by F. K. & J. Meyer). Altogether 383 specimens from 105 different localities were studied.

The collection sites are distributed over most of Georgia, excluding only the disputed regions of Abkhazia and S Ossetia as well as the easternmost, dry part of the country (Fig. 1). Geographical coordinates of all localities are listed in the Appendix and a distribution map for each encountered species based on the studied material is provided.

All specimens are kept in JE mostly with duplicates in TBI and also a few duplicates in G, KRAM, LE, MAUAM, MO, NY and OSTR. Nomenclature follows Ros *et al.* (2013), Plášek *et al.* (2015) and Lara *et al.* (2016) for bryophytes and Gagnidze (2005) for vascular plants.

The following information is provided for all species: numbers of the studied localities according to the list given in Appendix and represented in Fig. 1, chorological importance of the finding; taxonomical comments if appropriate; worldwide distribution for rare species or species new to Georgia; occurrence in

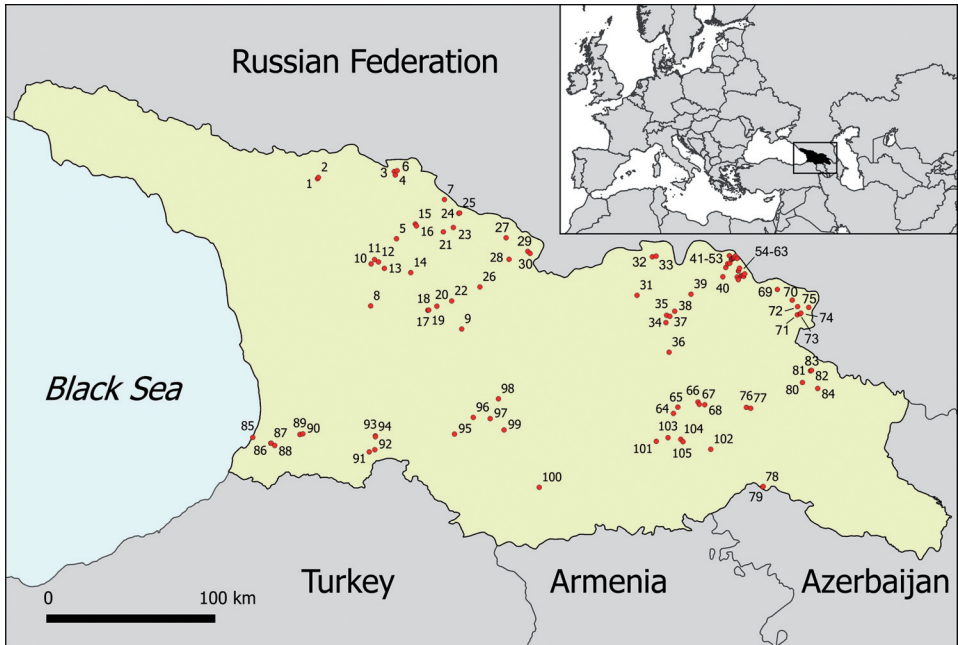


Fig. 1. Map of Georgia with indication of the numbers of the sampled localities (1-105) according to the list given in Appendix (inserted in the upper right corner is the map of Europe and western Asia showing the situation of Georgia).

neighboring countries of Armenia, Azerbaijan, the Russian Caucasus and Turkey; extension and abundance in the country; noteworthy remarks about the studied specimens if any; habitat characteristics; and altitudinal range expressed in m above sea level.

RESULTS

Lewinskya affinis (Brid.) F.Lara, Garilleti & Goffinet

Fig. 2

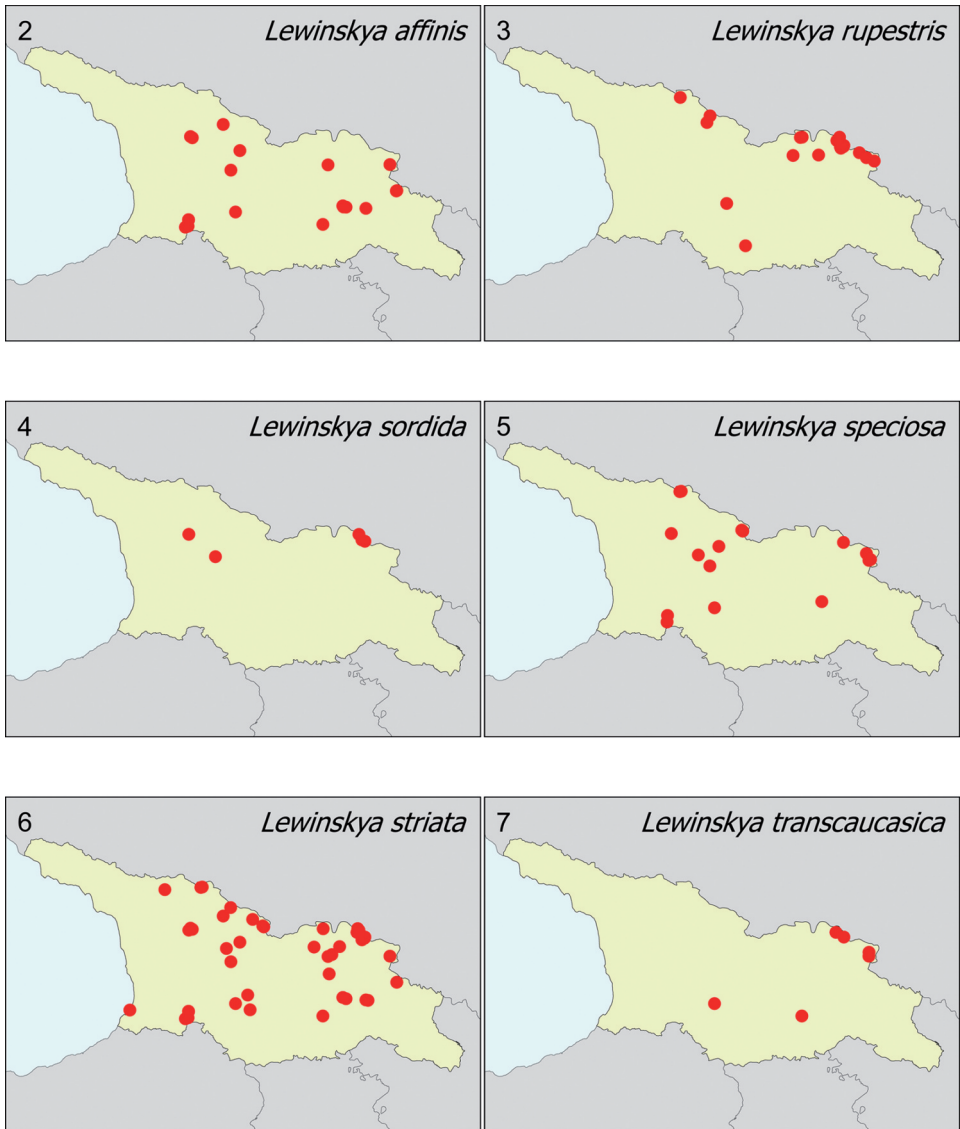
Localities: 9, 11, 12, 21, 26, 35, 66-68, 71, 76, 81, 83, 91-94, 96, 101.

This species is known from all neighboring countries (Kürschner & Erdağ, 2005; Ignatov *et al.*, 2006; Lara *et al.*, 2010). In Georgia, it was reported as 'common' by Chikovani & Svanidze (2004). We also found it frequently but not in lowland regions. It often grew together with *L. speciosa* (Nees) F.Lara, Garilleti & Goffinet and *L. striata* (Hedw.) F.Lara, Garilleti & Goffinet. *Lewinskya affinis* was found epiphytic on many different trees including *Acer* L. spp., *Carpinus* L. spp., *Castanea* Mill. sp., *Corylus* L. sp., *Fagus orientalis* Lipsky, *Fraxinus* L. sp., *Populus* L. spp., *Prunus* L. spp., *Pyrus communis* L., *Quercus* L. spp., *Sorbus* L. sp. and *Tilia* L. sp. as well as occasionally on rocks; 600-1850 m.

***Lewinskya rupestris* (Schleich. ex Schwäger.) F.Lara, Garilleti & Goffinet Fig. 3**

Localities: 4, 23, 25, 31-33, 39, 44, 52, 54, 55, 60-63, 69, 70, 75, 98, 100.

This species is known from all neighboring countries (Kürschner & Erdağ, 2005; Ignatov *et al.*, 2006; Lara *et al.*, 2010). Most collections originated from altitudes above 1400 m, where the species was frequent. It occurred on different kinds of rocks, but also epiphytic on *Betula* L. spp., *Carpinus* spp. and *Fraxinus* sp.; 800-2600 m.



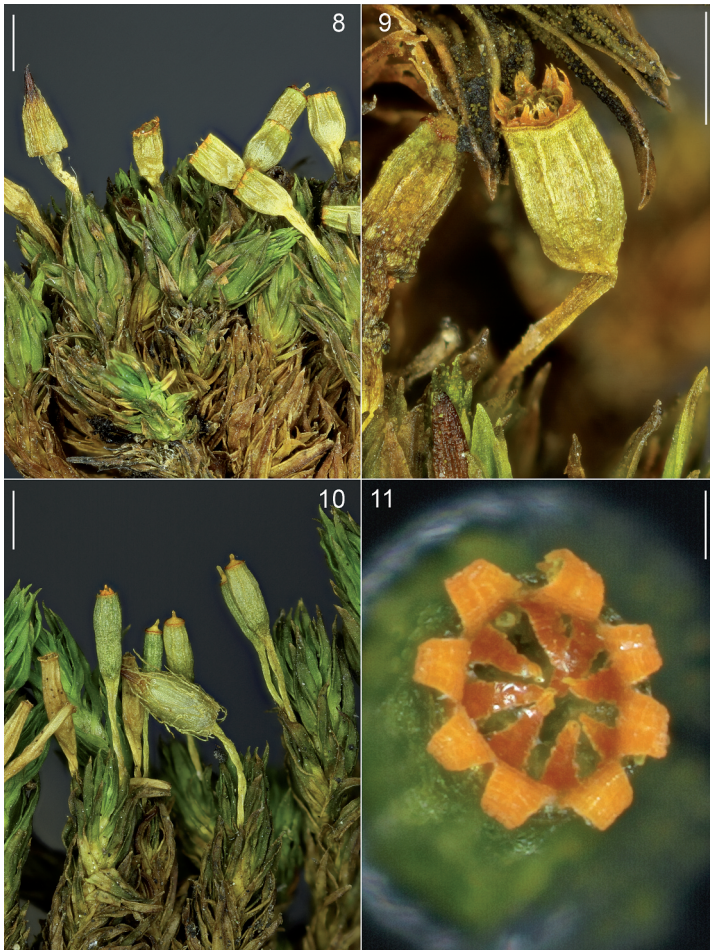
Figs 2-7. Distribution in Georgia based on the studied material of the next species: **2.** *Lewinskya affinis*; **3.** *L. rupestris*; **4.** *L. sordida*; **5.** *L. speciosa*; **6.** *L. striata*; **7.** *L. transcaucasica*.

Lewinskya sordida (Sull. & Lesq.) F.Lara, Garilleti & Goffinet

Figs 4, 8, 9

Localities: 10, 19, 46, 56, 63.

New record for Georgia. This species was long known from the Caucasus under the name *Orthotrichum caucasicum* Venturi based on a collection from Ingushetia in the Russian Caucasus (Venturi, 1887), but Lewinsky (1993) placed it in the synonymy of *O. sordidum* Sull. & Lesq. *Lewinskya sordida* is known from Asia, Europe and North America (Lara *et al.*, 2016), whereas it occurs in the neighboring countries Armenia, the Russian Caucasus and NE Turkey (Akatova *et al.*, 2004; Ignatov *et al.*, 2006; Lara *et al.*, 2010). It often grew together with *L. vladikavkana* (Venturi) F.Lara, Garilleti & Goffinet, a co-occurrence also noted by Akatova *et al.* (2004). A mixed stand (locality 46) showed that the sporophytes



Figs 8-11. Photographs of *Lewinskya sordida* (8, 9) and *L. vladikavkana* (10, 11). **8.** Habit (from locality 10, Zündorf 27142); **9.** Mature deoperculate capsule with the characteristic cancellate exostome teeth (from locality 10, Zündorf 27142); **10.** Habit, specimens with almost mature sporophytes (from locality 43, Zündorf 25547); **11.** Mature peristome (from locality 46, Zündorf 27334). Scale bars: 1 mm for 8-10; 0.1 for 11.

of *L. sordida* mature earlier than those of *L. vladikavkana*, being dehisced on July 31st at 1450 m, whereas *L. vladikavkana* was still immature. It was found epiphytic on *Abies* Mill. sp., *Betula* spp., *Fagus orientalis* and *Juniperus* L. sp.; 1450-2200 m.

***Lewinskya speciosa* (Nees) F.Lara, Garilleti & Goffinet**

Fig. 5

Localities: 3, 5, 9, 12, 20, 26, 29, 30, 62, 66, 70, 71, 74, 92, 93, 96.

This species is known from all neighboring countries (Kürschner & Erdağ, 2005; Ignatov *et al.*, 2006; Lara *et al.*, 2010). In Georgia, it was found widespread but most frequently at altitudes between 1400 and 1900 m. It occurred epiphytic on *Abies* sp., *Alnus* Mill. spp., *Betula* spp., *Corylus* sp., *Fagus orientalis*, *Juniperus* sp., *Populus* spp., *Prunus* spp., *Salix* L. spp. and *Tilia* sp.; 600-2350 m.

***Lewinskya striata* (Hedw.) F.Lara, Garilleti & Goffinet**

Fig. 6

Localities 1, 3, 5, 9, 10-12, 21, 22, 24, 26, 27, 29, 30, 31, 33, 35, 36, 38, 39, 42-46, 55, 56, 59, 62, 63, 66, 68, 71, 76, 77, 82, 83, 85, 91-94, 96, 98, 99, 101.

This species is known from all neighboring countries (Kürschner & Erdağ, 2005; Ignatov *et al.*, 2006; Lara *et al.*, 2010). In Georgia, it is one of the commonest orthotrichaceous species, found in a wide range of habitats and on many different trees and shrubs; 100-2200 m.

***Lewinskya transcaucasica* Eckstein, Garilleti & F.Lara**

Figs 7, 12

Localities: 42, 63, 71, 72, 96, 101.

This species was recently described from the studied material and is only known from Georgia so far (Eckstein *et al.*, 2017). It was mainly found in the subalpine and altimontane belts of the Greater and Lesser Caucasus. Only one locality (101) is situated in the coline-submontane belt of the Lesser Caucasus. It always grew as an epiphyte on trunks of *Betula* sp., *Quercus* sp., *Salix* spp. and *Sorbus* sp.; 800-2300 m.

***Lewinskya vladikavkana* (Venturi) F.Lara, Garilleti & Goffinet**

Figs 10, 11, 16

Localities: 24, 42-44, 46, 55, 56, 59, 62, 63, 71, 74, 99.

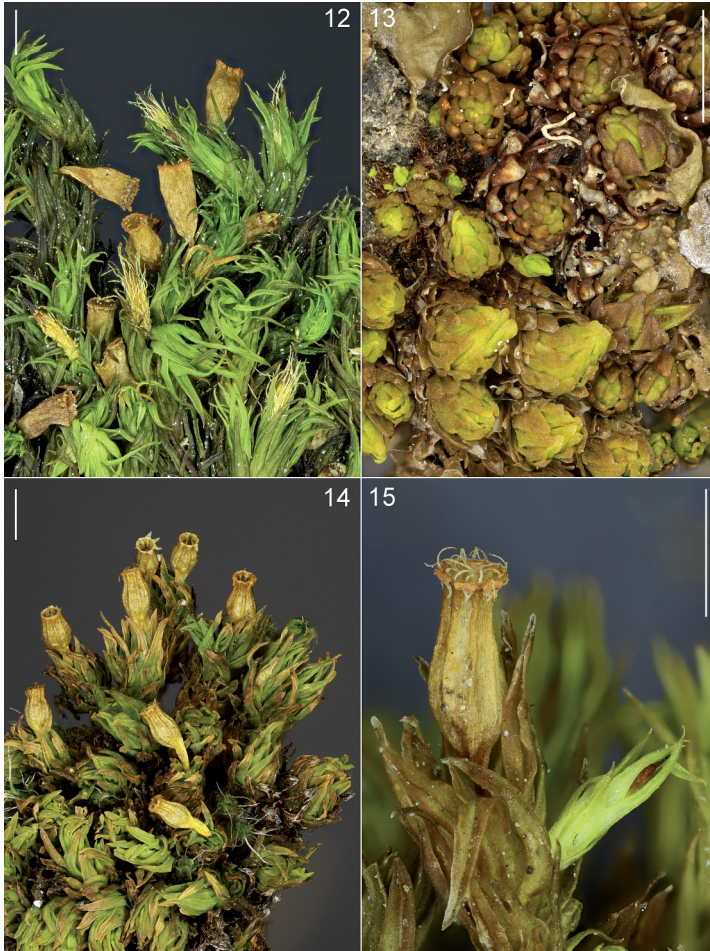
New record for Georgia. This easily recognizable species is only known from the Altai mountains in south Siberia (Ignatov & Lewinsky-Haapasaari, 1994), from the northern part of the Greater Caucasus (Venturi, 1887; Akatova *et al.*, 2004) as well as from NE Turkey, where it was only recently discovered by Lara *et al.* (2010). In Georgia, it mainly occurs in the central part of the Greater Caucasus and rarely in the Lesser Caucasus. It was found exclusively as an epiphyte growing on *Alnus* spp., *Betula* spp., *Fagus orientalis*, *Juniperus* sp., *Malus* Mill. sp., *Prunus* spp., *Salix* spp. and *Sorbus* sp.; 1450-2200 m.

***Nyholmiella gymnostoma* (Bruch ex Brid.) Holmen & E.Warnecke**

Figs 13, 17

Localities: 71, 72, 92.

New record for Georgia. Three from five Georgian collections had sporophytes. This species is known from Europe, Asia and North America (Smith, 2004), whereas it occurs in the neighboring countries Azerbaijan, the Russian Caucasus (Ignatov *et al.*, 2006) and Turkey (Kürschner & Erdağ, 2005). It seems to be rare in Georgia and was only found epiphytic on *Populus* spp.; 1600-2300 m.



Figs 12-15. Photographs of five remarkable species from Georgia **12.** *Lewinskya transcaucasica* (from locality 72, Zündorf 25277), holotype; **13.** A mixed stand of *Nyholmiella gymnostoma*, darker shoots in the upper right half, and *N. obtusifolia*, paler colored shoots in the lower left half (from locality 72, Zündorf 25289); **14.** *Orthotrichum alpestre* (from locality 7, Zündorf 26615); **15.** *Orthotrichum hispanicum* (from locality 13, Zündorf 26336). Scale bars: 1 mm.

Nyholmiella obtusifolia (Brid.) Holmen & E. Warncke

Figs 13, 18

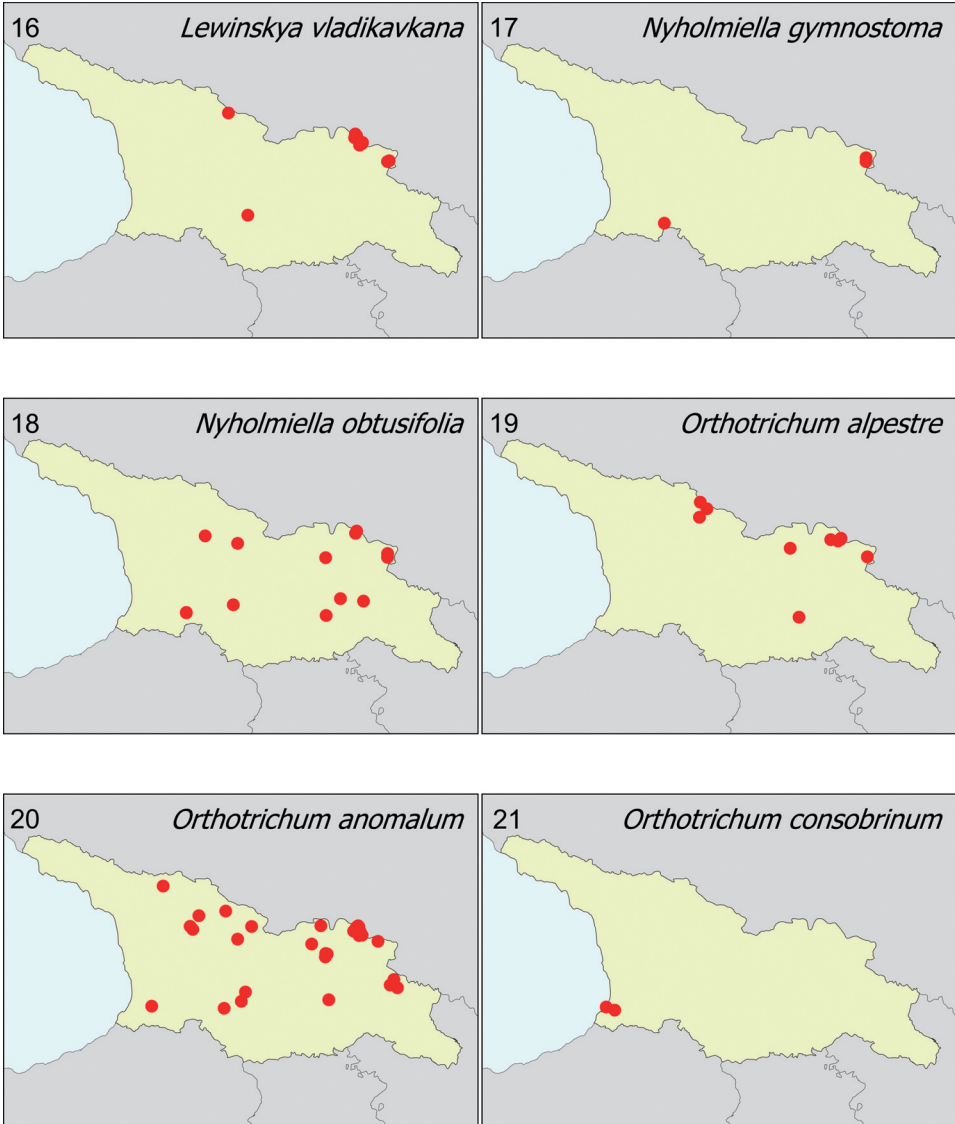
Localities: 14, 26, 35, 44, 47, 66, 71, 72, 76, 93, 94, 96, 103.

This species is known from all neighboring countries (Kürschner & Erdağ, 2005; Ignatov *et al.*, 2006; Lara *et al.*, 2010). It was found widespread in Georgia but was mostly represented by small collections. The predominately asexually reproducing species was once found with sporophytes at 1100 m. It occurred exclusively epiphytic on a wide range of trees including *Fraxinus* sp., *Juglans* L. sp., *Populus* spp. and *Salix* spp., and was also frequently found near settlements on fruit trees such as *Cerasus* Mill. spp., *Cydonia oblonga* Mill., *Malus* sp. and *Pyrus communis*; 500-2300 m.

Orthotrichum alpestre* Hornsch. ex Bruch & Schimp.*Figs 14, 19**

Localities: 7, 21, 24, 31, 40, 55, 62, 63, 73, 101.

In the region, this species is known from the Russian part of the Caucasus, Azerbaijan (Ignatov *et al.*, 2006) and Turkey (Lara *et al.*, 2010). In Georgia, it was only known from the Lesser Caucasus so far (Chikovani & Svanidze, 2004). We mainly found it in the Greater Caucasus region, occurring as an epiphyte on the bark of trees such as *Betula* spp., *Corylus* sp., *Fagus orientalis*, *Malus* sp. and *Sorbus* sp. also occasionally saxicolous; 1200-2700 m.



Figs 16-21. Distribution in Georgia based on the studied material of the next species: 16. *Lewinskya vladikavkana*; 17. *Nyholmiella gymnostoma*; 18. *N. obtusifolia*; 19. *Orthotrichum alpestre*; 20. *O. anomalum*; 21. *O. consobrinum*.

Orthotrichum anomalum* Hedw.*Fig. 20**

Localities: 2, 6, 12, 13, 23, 26, 28, 31, 33-35, 37, 41, 44-46, 48-54, 57, 58, 62, 64, 69, 80, 81, 84, 90, 95, 97, 98.

This species occurs in all neighboring countries (Ignatov *et al.*, 2006; Lara *et al.*, 2010). It is very common and evenly distributed in Georgia. It was found mostly saxicolous on different rocks, especially on basic slate and limestone, but also on basalt or granite as well as occasionally epiphytic on different trees and shrubs such as *Betula* spp., *Corylus* sp., *Fraxinus* sp., *Juniperus* sp., *Populus* spp., *Prunus* spp. and *Pyrus communis*; 450-2000 m.

Orthotrichum consobrinum* Cardot*Fig. 21**

Localities: 85, 86.

New record for Georgia. Worldwide, this species is only known from the Sino-Japanese region, N Spain and NE Turkey (Lara *et al.*, 2009). The new Georgian localities are situated in the SW of the country near the Black Sea in a region with humid and warm climate. They confirm Lara *et al.* (2010)'s suspicion that the species also could occur in lowland Georgia. It grew epiphytic on *Carpinus* sp. and *Castanea* sp.; 100-250 m.

Orthotrichum cupulatum* Hoffm. ex Brid.*Fig. 22**

Localities: 8, 12, 95.

It seems to be frequent in the region, occurring in all neighboring countries (Ignatov *et al.*, 2006; Lara *et al.*, 2010). For Georgia, Chikovani & Svanidze (2004) reported it as 'common in all areas'. However, it only was represented with three specimens in the studied collection. It was found saxicolous on basic rocks; 900-1000 m.

Orthotrichum diaphanum* Schrad. ex Brid.*Fig. 23**

Localities: 14, 78, 79, 102-105.

This species occurs in all neighboring countries (Ignatov *et al.*, 2006; Lara *et al.*, 2010). It was mainly recorded from areas in and around cities in the present study. This seems to confirm own observation from central Europe where it is one of the epiphytes most tolerant to air pollution. It was found epiphytic often growing together with *O. pumilum* Sw. ex anon. on *Fraxinus* sp., *Populus* spp. and *Pyrus communis*; 500-850 m.

Orthotrichum hispanicum* F.Lara, Garilleti & Mazimpaka*Figs 15, 24**

Localities: 13, 19, 46.

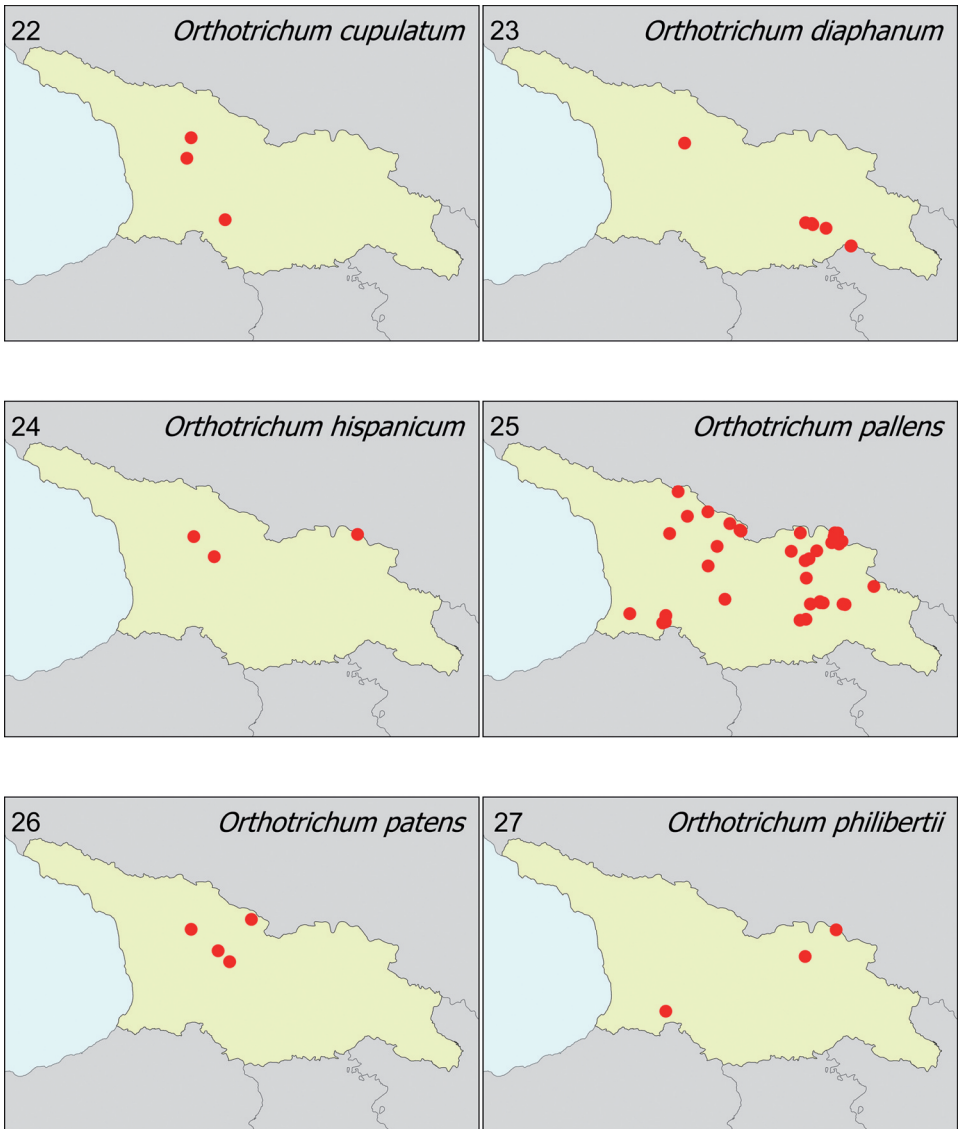
New record for Georgia and also for the Greater Caucasus mountain range. This species was only recently described from Spain (Lara *et al.*, 2000), but is now known from the Balearic Islands, France, Greece, the Netherlands as well as Libya, Turkey and India (Garilleti *et al.*, 2009). The new localities in Georgia lie within this range between Turkey and Kashmir with the nearest locality in Turkey ca 400 km to the SW. It was found exclusively as an epiphyte on *Abies* sp., *Buxus* L. sp. and *Juniperus* sp., 700-1600 m.

Orthotrichum pallens* Bruch ex Brid.*Fig. 25**

Localities: 3, 9, 12, 15, 24, 26, 27, 29-31, 33, 35, 36, 38-40, 42-44, 46, 52, 55-57, 59, 63, 65-68, 76, 77, 83, 89, 91-94, 98, 101, 103.

This species is frequent in the region, occurring in all neighboring countries (Ignatov *et al.*, 2006; Lara *et al.*, 2010). In Georgia, it is one of the commonest

species of orthotrichaceous mosses. It was found epiphytic on many different trees and shrubs, frequently on *Acer* spp., *Alnus* spp., *Betula* spp., *Carpinus* spp., *Corylus* sp., *Fagus orientalis*, *Sorbus* sp. and *Quercus* spp., but also on *Castanea* sp., *Cerasus* sp., *Crataegus* L. sp., *Cydonia oblonga*, *Fraxinus* sp., *Juglans* sp., *Juniperus* sp., *Lonicera* L. sp., *Malus* sp., *Populus* spp., *Pyrus communis*, *Rhamnus* L. sp. and *Tilia* sp., occasionally saxicolous, 600-2350 m.



Figs 22-27. Distribution in Georgia based on the studied material of the next species: 22. *Orthotrichum cupulatum*; 23. *O. diaphanum*; 24. *O. hispanicum*; 25. *O. pallens*; 26. *O. patens*; 27. *O. philibertii*.

Orthotrichum patens* Bruch ex Brid.*Fig. 26**

Localities: 9, 12, 20, 27.

New record for Georgia. Worldwide, this species has a mainly European distribution but is also known from Armenia, Azerbaijan, the Russian part of Caucasus and Turkey (Kürschner & Erdağ, 2005; Ignatov *et al.*, 2006). It seems to be rare in Georgia and only be represented by small populations since the studied collections mostly consisted of scattered shoots between other orthotrichaceous species. Epiphytic on trunks of *Acer* sp., *Carpinus* sp., *Corylus* sp. and *Fagus orientalis*; 600-1450 m.

Orthotrichum philibertii* Venturi*Fig. 27**

Localities: 35, 47, 93.

New record for Georgia. This species is mainly distributed in the Mediterranean with additional records from Norway, Romania and Switzerland (Lo Guidice *et al.*, 2000). It was not reported from neighboring countries so far. However, distributional information is probably incomplete because some authors regarded it as synonymous with *O. pumilum* (e.g. Ignatov *et al.*, 2006). In Georgia, it was found at few localities in the Greater as well as the Lesser Caucasus mountain range. This small species maybe underrepresented in the studied collection because it can be easily overlooked or mistaken for the similar *O. pumilum*. It grew epiphytic on trunks of *Cydonia oblonga*, *Fraxinus* sp. and *Pyrus communis*; 1100-1500 m.

Orthotrichum pumilum* Sw. ex anon.*Fig. 28**

Localities 35, 64, 78, 79, 93, 94, 101, 103-105.

This species is frequent in the region, occurring in all neighboring countries (Ignatov *et al.*, 2006; Lara *et al.*, 2010). In Georgia, it was reported as 'common' by Chikovani & Svanidze (2004) under the name *O. fallax* Bruch. Our material was mostly collected near settlements or in the vicinity of cities. It was found often together with *O. diaphanum* epiphytic on *Fraxinus* sp., *Juglans* sp., *Populus* spp., *Prunus* spp., *Pyrus communis* and *Quercus* spp.; 500-1500 m.

Orthotrichum scanicum* Grönvall*Fig. 29**

Localities: 3, 46, 96.

Its worldwide distribution comprises Europe, North Africa as well as SW and central Asia (Medina *et al.*, 2009). In Georgia, it was only known from one specimen collected in 1881 by Brotherus (Medina *et al.*, 2009). By us, it was found in small quantity growing epiphytic on *Abies* sp., *Alnus* spp. and *Juniperus* sp.; 1450-1800 m.

Orthotrichum stellatum* Brid.*Fig. 30**

Localities: 9, 84.

New record for Georgia and also for the Greater Caucasus mountain range. Worldwide, the species is known from Eastern North America (Vitt, 2014), Europe (Frey *et al.*, 2006) and NE Turkey (Lara *et al.*, 2010). The new records extend the known range of *O. stellatum* in Asia somewhat eastwards. In Georgia, it was only found at two localities epiphytic on *Acer campestre* L. and *Carpinus orientalis* Mill.; 550-600 m.

Orthotrichum stramineum* Hornsch. ex Brid.*Fig. 31**

Localities: 5, 10, 12, 20, 22, 25, 27, 38, 39, 59, 66, 81.

This species occurs in all neighboring countries (Kürschner & Erdağ, 2005; Ignatov *et al.*, 2006; Lara *et al.*, 2010). Although reported as 'very often' in Georgia

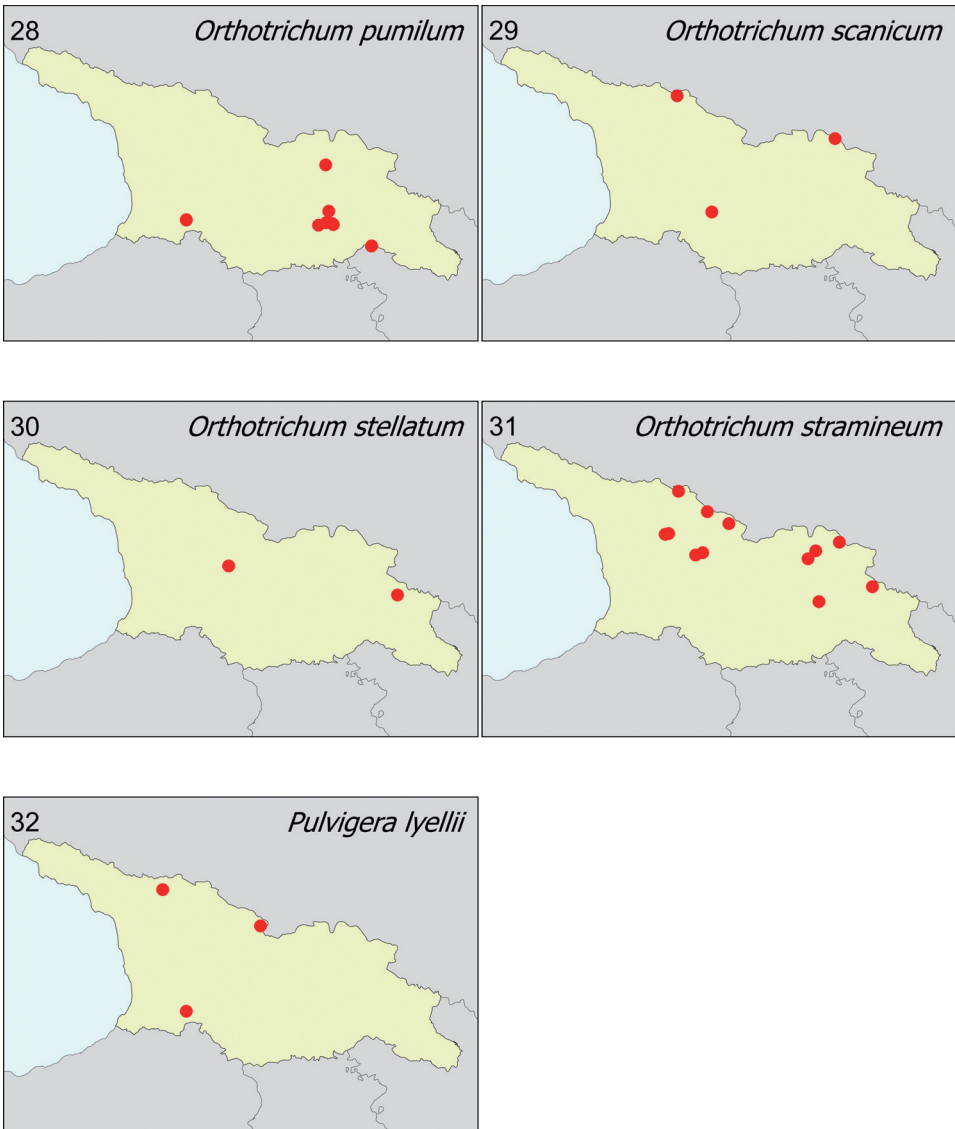
by Chikovani & Svanidze (2004), it was only collected in the northern half of the country and not in the Lesser Caucasus during this study. The species was found epiphytic on *Abies* sp., *Acer* spp., *Alnus* spp., *Betula* spp., *Fagus orientalis*, *Populus* spp., *Quercus* spp. and *Sorbus* sp., as well as sporadic on rock, 900-2100 m.

Pulviger a lyellii (Hook. & Taylor) Plášek, Sawicki & Ochyra

Fig. 32

Localities: 1, 29, 93.

It is known from Azerbaijan, the Russian part of the Caucasus and Turkey (Kürschner & Erdağ, 2005; Ignatov *et al.*, 2006; Lara *et al.*, 2010). This species is



Figs 28-32. Distribution in Georgia based on the studied material of the next species: 28. *Orthotrichum pumilum*; 29. *O. scanicum*; 30. *O. stellatum*; 31. *O. stramineum*, 32. *Pulviger a lyellii*.

apparently rare in Georgia but was found in different regions (see also Chikovani & Svanidze, 2004). In the studied collection, it was only represented as single shoots between other orthotrichaceous species. It was found mostly along streams growing as an epiphyte on *Alnus* spp. and *Prunus* spp.; 1000-1600 m.

Ulota coarctata (P.Beauv.) Hammar

Fig. 33

Localities: 18, 20.

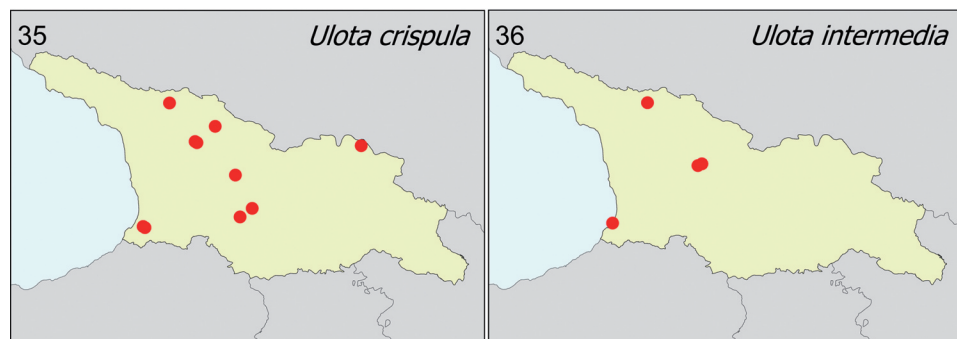
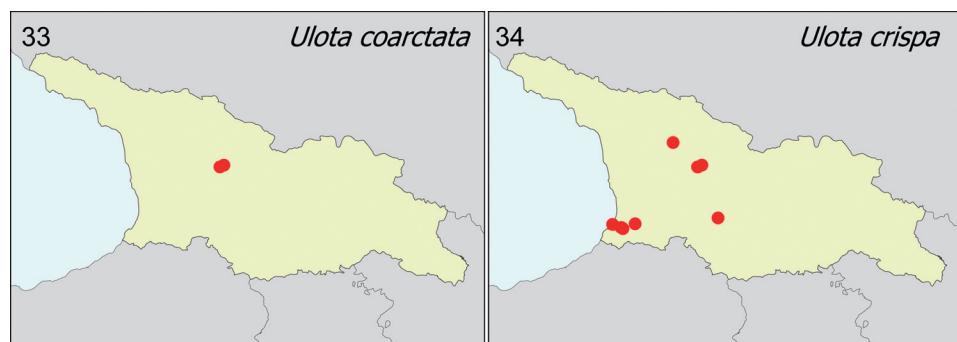
New record for Georgia. This moss is known from eastern North America (Vitt, 2014), Europe (Caparrós *et al.*, 2014) and the Russian Caucasus (Ignatov *et al.*, 2006). Only recently, it was also discovered in NE Turkey, the first record for Asia (Lara *et al.*, 2010). However, during our study we came across an old specimen of *U. coarctata* (as *U. ludwigii* Brid.) in JE labeled with 'Rhizé (Lazistan), no. 1055'. It was collected by B. Balansa in 1866 near Rizé in NE Turkey and probably represents the oldest known record for that species in Turkey. In Georgia, *U. coarctata* was only found in small quantity at two localities in the mountains north the city Tkibuli. It grew as an epiphyte on *Abies nordmanniana* (Steven) Spach and *Fagus orientalis* in open montane forests; 1250-1450 m.

Ulota crispa (Hedw.) Brid. *s. str.*

Fig. 34

Localities: 11, 17, 18, 20, 85-89, 96.

Recently, Caparrós *et al.* (2016a, b) showed stable morphological differences in the *Ulota crispa* complex resulting in the recognition of the three Holarctic



Figs 33-36. Distribution in Georgia based on the studied material of the next species: **33.** *Ulota coarctata*; **34.** *Ulota crispa*; **35.** *Ulota crispula*; **36.** *Ulota intermedia*.

species *U. crispera* s. str., *U. crispula* Bruch and *U. intermedia* Schimp. These three very similar species were all described in the 19th century but later mostly regarded as one variable species under the oldest name *U. crispera* (Smith & Hill, 1975; Smith & Proctor, 1993; Erzberger, 2003). Therefore, old records of these species are somewhat ambiguous and should be checked in the light of the new differentiating characters reported by Caparrós *et al.* (2016a). In the neighbouring of Georgia, *U. crispera* was reported from Armenia, the Russian Caucasus and Turkey (Kürschner & Erdağ, 2005; Ignatov *et al.*, 2006; Lara *et al.*, 2010). Chikovani & Svanidze (2004) recognized *U. crispera* and *U. crispula* for Georgia whereas *U. crispera* was reported as ‘common’. In the present study, *U. crispera* was collected mainly in the eastern part of the country. It was found epiphytic on *Abies* sp., *Alnus* spp., *Betula* spp., *Carpinus* spp., *Castanea*, *Fagus* sp. and *Juglans* sp.; 100-1500 m.

***Ulota crispula* Brid.**

Fig. 35

Localities: 1, 9, 11, 12, 16, 42, 86, 88, 96, 98.

Chikovani & Svanidze (2004) reported *U. crispula* as ‘rare’ in Georgia, but older records should be reevaluated (see note under *U. crispera* s. str.). According to our material both species seem to be about equally frequent in Georgia. *Ulota crispula* was found as an epiphyte on *Alnus* spp., *Betula* spp., *Carpinus* spp., *Castanea* sp., *Corylus* sp., *Fagus* sp. and *Quercus* spp.; 250-1700 m.

***Ulota intermedia* Schimp.**

Fig. 36

Localities: 1, 18, 20, 85.

New record for Georgia and also for the Greater Caucasus mountain range. According to Caparrós *et al.* (2016a) this species shows a disjunct Holarctic distribution with presence in western and eastern North America, Europe as well as in central and eastern Asia. To our knowledge, it was not reported from the Caucasus region so far. However, its known distribution is certainly still incomplete because it was not recognized as a distinct species for so long (see note under *U. crispera* s. str.). In Georgia, *U. intermedia* was only found in small quantity at three locations in the Greater Caucasus and one location near the Black Sea. At the first three locations, it occurred together with *U. crispera* and at the latter location together with *U. crispula*. It was found to be the rarest species of the *U. crispera* complex in Georgia, occurring as an epiphyte on *Abies* sp., *Alnus* spp. and *Fagus orientalis*; 100-1500 m.

DISCUSSION

In their checklist of Georgia, Chikovani & Svanidze (2004) reported 25 taxa of orthotrichaceous mosses, including three varieties and two forms. However, six of the taxa they included are here regarded as synonymous and the two forms were generally not accepted (*O. cupulatum* f. *fenestrata* (Velen.) Laz. and *O. fastigiatum* f. *simplex* Laz.). Their names and the corresponding accepted names based on Gariletti *et al.* (2002), Ros *et al.* (2013) and Natural History Museum, University of Oslo (2017), are as follows:

O. anomalum var. *saxatile* Milde = *O. anomalum*

O. elegans Schwägr. = *L. speciosa*

O. fastigiatum Bruch., and *O. octoblephare* Brid. = *L. affinis*

O. rupestre var. *ovatum* Vent. in Husn. = *L. rupestris*

O. stramineum var. *defluens* Vent. = *O. stramineum*

Therefore, we recognize 17 taxa of orthotrichaceous mosses reported by Chikovani & Svanidze (2004) for Georgia. Later, *O. scanicum* (Medina *et al.*, 2009), *O. crenulatum* Mitt. (Ellis *et al.*, 2016) and *L. transcaucasica* (Eckstein *et al.*, 2017) were added, raising the number of orthotrichaceous species in Georgia to 20.

In the present study, 27 species of the tribe Orthotricheae were found. Among them, ten species are new records for the bryophyte flora of Georgia: *Lewinskya sordida*, *L. vladikavkana*, *Nyholmiella gymnostoma*, *Orthotrichum consobrinum*, *O. hispanicum*, *O. patens*, *O. philibertii*, *O. stellatum*, *Ulota coarctata* and *U. intermedia*. For *Orthotrichum hispanicum*, *O. stellatum* and *Ulota intermedia* the records are not only new to Georgia but also to the wider Caucasus region. Of the species reported from Georgia before, only *O. microcarpum* De Not., *Ulota rehmannii* Jur. (Chikovani & Svanidze, 2004) and the recently reported *O. crenulatum* (Ellis *et al.*, 2016) were not found among the studied specimens. Now, 30 species of orthotrichaceous mosses are known from the territory of Georgia: seven species of *Lewinskya*, two species of *Nyholmiella*, 15 species of *Orthotrichum*, one species of *Pulviger* and five species of *Ulota*.

Considering the relatively small area of Georgia (69,700 km²), the species richness in the studied genera is remarkable and is comparable to NE Turkey, which was recently referred to as ‘an unnoticed but very important area for the Orthotrichaceae’ by Lara *et al.* (2010). Their study area is located just across the border from SW Georgia. The species spectrum of the 28 orthotrichaceous species reported by Lara *et al.* (2010) for NE Turkey is very similar to that of Georgia with 24 shared species. Of those found in NE Turkey, only *O. callistomum* Fisch.-Oost. ex Bruch & Schimp., *O. rogeri* Brid., *O. schimperi* Hammar, and *O. vittii* F. Lara, Garilleti & Mazimpaka are not yet known from Georgia, but can be expected there. The high diversity of Orthotrichaceae in NE Turkey can be explained with the proximity of two very different, but equally interesting biomes, namely the Colchis refugium of the Tertiary flora and the Irano-Turanian region with affinities to south-central Asian mountain floras (Lara *et al.*, 2010). This is certainly also true for Georgia, to which the ‘unnoticed, but very important area for the Orthotrichaceae’ by Lara *et al.* (2010) can now be expanded.

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APPENDIX

Index of localities represented in Fig. 1. They are arranged by administrative divisions of Georgia. Coordinates are rounded to three places after decimal point.

Samegrelo-Zemo Svaneti: **1** N Chuberi 43.076 N 42.184 E, 1050 m; **2** *ibidem* 43.083 N 42.190 E, 1200 m; **3** N Mestia 43.113 N 42.733 E, 1800 m; **4** *ibidem* 43.095 N 42.741 E, 1550 m; **5** *ibidem* 43.118 N 42.754 E, 1800 m; **6** S Lentekhi 42.762 N 42.750 E, 700 m; **7** NE Zhibiani 42.967 N 43.093 E, 2700 m; **Imereti:** **8** N Zqaltubo 42.408 N 42.565 E, 380 m; **9** near Katskhi 42.286 N 43.217 E, 600 m; **Rache-Lechkhumi and Kvemo Svaneti:** **10** S Kulbaki 42.630 N 42.568 E, 1750 m; **11** NW Kulbaki 42.652 N 42.593 E, 1200 m; **12** *ibidem* 42.640 N 42.621 E, 1000 m; **13** N Zubi 42.606 N 42.663 E, 700 m; **14** SW Surmushi 42.584 N 42.852 E, 500 m;

15 NE Lentekhi 42.839 N 42.884 E, 1100 m; **16** *ibidem* 42.829 N 42.893 E, 1250 m; **17** NE Tkibuli 42.385 N 42.974 E, 1500 m; **18** *ibidem* 42.386 N 42.980 E, 1450 m; **19** *ibidem* 42.386 N 42.981 E, 1450 m; **20** *ibidem* 42.406 N 43.039 E, 1250 m; **21** E Chikhareshi 42.798 N 43.085 E, 1300 m; **22** SE Nikortsminda 42.434 N 43.145 E, 1200 m; **23** S Tsana 42.821 N 43.157 E, 1400 m; **24** NE Zeskho 42.895 N 43.196 E, 1950 m; **25** *ibidem* 42.897 N 43.202 E, 1900 m; **26** SE Mravaldzali 42.508 N 43.347 E, 1800 m; **27** E Ghebi 42.767 N 43.535 E, 1450 m; **28** N Utsera 42.654 N 43.556 E, 1100 m; **29** SE Shovi 42.695 N 43.690 E, 1600 m; **30** *ibidem* 42.685 N 43.707 E, 1800 m; **Mtskheta-Mtianeti**: **31** S Gudauri 42.464 N 44.473 E, 1650 m; **32** path between Zminda Sameba to Kasbegi-glacier 42.667 N 44.583 E, 2600 m; **33** NW Gergeti 42.670 N 44.610 E, 2000 m; **34** between Pasanauri and Bachari 42.320 N 44.680 E, 1020 m; **35** Pasanauri 42.359 N 44.685 E, 1100 m; **36** near Ananuri castle 42.163 N 44.703 E, 850 m; **37** near Pasanauri 42.353 N 44.708 E, 1100 m; **38** SW Tsinamkhari 42.380 N 44.743 E, 1200 m; **39** near Roshka 42.470 N 44.860 E, 2100 m; **40** Arghuni gorge near Shatili 42.562 N 45.088 E, 2000 m; **41** *ibidem* 42.611 N 45.109 E, 1500 m; **42** *ibidem* 42.631 N 45.123 E, 1700 m; **43** *ibidem* 42.673 N 45.134 E, 1900 m; **44** *ibidem* 42.633 N 45.138 E, 1600 m; **45** *ibidem* 42.653 N 45.148 E, 1450 m; **46** *ibidem* 42.655 N 45.153 E, 1450 m; **47** *ibidem* 42.659 N 45.155 E, 1500 m; **48** *ibidem* 42.660 N 45.161 E, 1400 m; **49** *ibidem* 42.660 N 45.165 E, 1400 m; **50** *ibidem* 42.663 N 45.168 E, 1400 m; **51** *ibidem* 42.664 N 45.170 E, 1400 m; **52** *ibidem* 42.671 N 45.178 E, 1400 m; **53** *ibidem* 42.659 N 45.190 E, 1400 m; **54** near Ardoti 42.560 N 45.191 E, 1700 m; **55** between Ardoti and Andaki 42.547 N 45.199 E, 1800 m; **56** between Mutso and Ardoti 42.592 N 45.199 E, 1650 m; **57** *ibidem* 42.594 N 45.201 E, 1650 m; **58** near Mutso 42.607 N 45.208 E, 1700 m; **59** *ibidem* 42.566 N 45.219 E, 2000 m; **60** S Mutso 42.568 N 45.224 E, 1850 m; **61** *ibidem* 42.568 N 45.233 E, 1900 m; **62** *ibidem* 42.564 N 45.238 E, 1900 m; **63** NE Khone 42.577 N 45.244 E, 2200 m; **64** near Jvari monastery 41.838 N 44.734 E, 600 m; **65** near Zedazeni monastery 41.871 N 44.766 E, 1200 m; **66** NW Tskhvarichamia 41.899 N 44.909 E, 1350 m; **67** *ibidem* 41.886 N 44.919 E, 1200 m; **68** E Tskhvarichamia 41.884 N 44.958 E, 1150 m; **Kakheti**: **69** near Girevi 42.495 N 45.479 E, 2000 m; **70** NE Dartlo 42.439 N 45.585 E, 1900 m; **71** SW Omalo 42.361 N 45.622 E, 1700 m; **72** E Dartlo 42.404 N 45.624 E, 2300 m; **73** NE Dartlo 42.367 N 45.643 E, 1850 m; **74** SE Dartlo 42.370 N 45.647 E, 1800 m; **75** NE Diklo 42.400 N 45.703 E, 2200 m; **76** E Gombori 41.870 N 45.256 E, 1400 m; **77** near Tetri Tsklebi 41.865 N 45.288 E, 1600 m; **78** near Udabno 41.445 N 45.373 E, 850 m; **79** *ibidem* 41.448 N 45.376 E, 700 m; **80** NW Kvareli 42.003 N 45.658 E, 450 m; **81** N Sabue 42.064 N 45.716 E, 900 m; **82** *ibidem* 42.067 N 45.722 E, 950 m; **83** *ibidem* 42.067 N 45.723 E, 1050 m; **84** road to Nekresi monastery 41.971 N 45.768 E, 550 m; **Adjara**: **85** N Batumi 41.710 N 41.720 E, 100 m; **86** NE Batumi 41.679 N 41.850 E, 250 m; **87** *ibidem* 41.679 N 41.852 E, 250 m; **88** *ibidem* 41.667 N 41.878 E, 800 m; **89** *ibidem* 41.726 N 42.058 E, 850 m; **90** *ibidem* 41.729 N 42.079 E, 1000 m; **91** E Beshumi 41.633 N 42.554 E, 1850 m; **Samtskhe-Javakheti**: **92** SW Zarzma 41.644 N 42.594 E, 1600 m; **93** mokhe 41.718 N 42.598 E, 1500 m; **94** *ibidem* 41.714 N 42.599 E, 1500 m; **95** Atskuri 41.728 N 43.165 E, 950 m; **96** W Borjomi 41.817 N 43.300 E, 1100 m; **97** SE Borjomi 41.810 N 43.421 E, 900 m; **98** between Borjomi and Khashuri 41.916 N 43.480 E, 800 m; **99** Bakuriani 41.750 N 43.520 E, 1900 m; **100** Paravani 41.443 N 43.772 E, 2100 m; **Kvemo Kartli**: **101** near Betania monastery 41.689 N 44.611 E, 800 m; **102** Gamarjveba 41.647 N 45.001 E, 500 m; **Tbilisi**: **103** vicinity of Tbilisi 41.709 N 44.695 E, 700 m; **104** *ibidem* 41.700 N 44.786 E, 550 m; **105** Botanical Garden of Tbilisi 41.687 N 44.803 E, 500 m.