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## A preliminary list of subalpine and alpine bryophytes of Rize, North-East Turkey

\*Gökhan ABAY<sup>1</sup>

<sup>1</sup>Department of Plant Materials and Propagation Techniques, Division of Landscape Architecture, Recep Tayyip Erdogan University, Rize, Turkey;

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### Abstract

Based on the published papers, floristic investigations of bryophytes (liverworts and hornworts) were carried out for subalpine and alpine localities in the boundary of Rize province in Turkey. The number of bryophyte taxa in these regions is 140 (119 mosses and 21 liverworts) with the lists cited in this paper. The hepatic list includes 15 genera and also mosses 55 genera. The largest genera of liverworts and mosses were found to be *Scapania* with four taxa and *Sphagnum* is with 13. *Racomitrium heterostichum*, *R. macounii*, *Ditrichum pusillum*, and *Hymenoloma crispulum* were the most common moss species. Two liverworts, *Aneura pinguis* and *Scapania undulata* were noted as the most common. When the altitudinal data were analyzed, it was seen that 2300 m. is the most survey area of intensive collecting. Upper limits of the taxa are observed at 3060 and 3065 m. Bryophyte records above 3000 m were not very rich according to the available information. The study provides an updated and useful catalog of the bryophytes occurring above forest boundary of Rize.

**Keywords:** Mosses, liverworts, subalpine, alpine, Rize, Turkey

### 1. Introduction

Studies on subalpine and alpine bryophytes in many regions of the world are well documented in terms of floristics, endemism, phytogeographic, and ecological considerations (Watson, 1925; Bartram, 1949; Delgadillo, 1971, 1979; Spence, 1986; Enroth, 1990; Austrheim et al., 2005; Bruun et al., 2006; Jägerbrand et al., 2006; Sabovljević, 2006; Dibble et al., 2009; Hinds et al., 2009; Miller, 2009; Ignatov et al., 2010; Puglisi et al., 2011; Ah-Peng et al., 2014; Ceschin et al., 2015).

Although the diversity of vascular plants (Güleryüz, 2000; Atay et al., 2009) and knowledge about vegetation (Vural, 1996) in subalpine and alpine regions of different parts in Turkey are well known, the diversity of bryophytes in these areas is poorly documented. All studies on the bryophytes of these regions have been done as general floral studies, some of which include species of alpine or subalpine sections. In particular, there are no bryofloristic studies directly about alpine or sub-alpine zones in

Turkey, but many papers including subalpine and alpine bryophyte species and also new record bryophyte taxa reported from the high elevations have been performed from various locations in Turkey over the last five years (Ezer and Kara, 2012; Kırmacı et al., 2012; Özdemir et al., 2012; Batan and Özdemir, 2013; Batan et al., 2013; 2016a, 2016b, 2016c; Kırmacı and Kürschner, 2013; Kırmacı and Erdağ, 2014; Kara et al., 2014).

One of the most comprehensive bryofloristic lists about Rize was given as a checklist by Abay et al. (2016). The aim of the present study is also to provide information about bryophytes collected along subalpine and alpine areas of Rize in Turkey with their current names.

#### 1.1. Area Description

The province Rize, north-east of Turkey, is surrounded by Artvin in the east, Trabzon in the west, and Erzurum in the south. It has an area of about 4000 km<sup>2</sup>. The forest boundary in the province lies at about

\* Corresponding author: [gokhan.abay@erdogan.edu.tr](mailto:gokhan.abay@erdogan.edu.tr)

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2000 to 2400 m. The upper part of forest line consists of subalpine and alpine meadows. The alpine area is covered with snow between the months of November and March. The highest summit of the Eastern Black Sea Mountains is within the boundaries of the province and there are 18 summits with an altitude above 3300 m. The most important of these are Kaçkar (3932 m), Verçenik (3709 m), Altıparmak (3605 m), Kemer kaya (3562 m), Dilek (3549 m), Aksu (3434 m), Demir (3354 m), and Cimil (3344 m). There are many small glacial lakes around some of these summits (Vural, 1996).

## 2. Materials and methods

The altitudinal limits of listed bryophytes were determined considering the upper limit of forest vegetation in Vural's work, published in 1996. Accordingly, the study is based on the published 12 papers including subalpine and alpine bryophytes above 2000 m. asl. within the boundary of Rize between the years 1955 and 2016. Besides, bryophyte distributions within subalpine and alpine areas of the province were analyzed using information collected by Henderson and Muirhead (1955), Henderson (1964), Kürschner and Parolly (2006a, 2006b), Abay et al. (2006, 2007, 2009a, 2009b), Keçeli et al. (2008), Uyar et al. (2008), Kırmacı et al. (2012), and Kırmacı and Kürschner (2013). The current named lists were categorized alphabetically and separately. The hepatics nomenclature was updated according to Ros et al. (2007), Ros et al. (2013) and Lara et al. (2016) were also used for mosses. The synonyms of the hepatics and mosses were given at the end of the text with an appendix.

## 3. Results and Discussion

### 3.1. Results

The liverwort and moss lists report data on 140 subalpine and alpine taxa recorded from different localities above 2000 m asl. within the Rize province. The hepatics list includes 15 genera and 21 taxa. The largest number of liverwort species was found in the genus *Scapania* (4). Following is the genera, *Cephalozia*, *Jungermannia*, and *Tritomaria*, each having two taxa. Finally, the others were represented by one taxon. In case of mosses, they are represented by 55 genera and 119 taxa. The genus *Sphagnum* is the richest comprising 13 members. *Grimmia* (9), *Racomitrium* (7), *Dicranum* (5), *Lescurea* (5), *Philonotis* (5), *Brachythecium* (4), *Ditrichum* (4), and *Ptychostomum* (4) are some other rich genera.

The liverworts and mosses listed below are from subalpine and alpine areas of Rize.

### ALPHABETICAL LIST OF MARCHANTIOPHYTA (Liverworts)

*Aneura pinguis* (L.) Dumort.  
*Anthelia julacea* (L.) Dumort.  
*Barbilophozia hatcheri* (A. Evans) Loeske

*Cephalozia bicuspidata* (L.) Dumort.  
*C. pleniceps* (Austin) Lindb.  
*Diplophyllum albicans* (L.) Dumort.  
*Eremonotus myriocarpus* (Carrington) Pearson  
*Jungermannia hyalina* Lyell  
*J. obovata* Nees  
*Marsupella funckii* (F. Weber & D. Mohr) Dumort.  
*Pellia endiviifolia* (Dicks.) Dumort.  
*Porella arboris-vitae* (With.) Grolle  
*Radula lindenbergiana* Gottsche ex C. Hartm.  
*Reboulia hemisphaerica* (L.) Raddi  
*Riccardia chamedryfolia* (With.) Grolle  
*Scapania irrigua* (Nees) Nees  
*S. paludosa* (Müll. Frib.) Müll. Frib.  
*S. subalpina* (Nees ex Lindenb.) Dumort.  
*S. undulata* (L.) Dumort.  
*Tritomaria exsecta* (Schmidel ex Schrad.) Loeske  
*T. quinquentata* (Huds.) H. Buch

### ALPHABETICAL LIST OF BRYOPHYTA (Mosses)

*Andreaea rupestris* Hedw.  
*Anomodon viticulosus* (Hedw.) Hook. & Taylor  
*Atrichum tenellum* (Röhl.) Bruch & Schimp.  
*Aulacomnium palustre* (Hedw.) Schwägr.  
*Bartramia ithyphylla* Brid.  
*Brachytheciastrum velutinum* (Hedw.) Ignatov & Huttunen  
*Brachythecium geheebii* Milde  
*B. glareosum* (Bruch ex Spruce) Schimp.  
*B. mildeanum* (Schimp.) Schimp. ex Milde  
*B. rivulare* Schimp.  
*Bryum argenteum* Hedw.  
*B. schleicheri* DC.  
*Ceratodon purpureus* (Hedw.) Brid.  
*Coscinodon cribrosus* (Hedw.) Spruce  
*Cratoneuron filicinum* (Hedw.) Spruce  
*Dichodontium palustre* (Dicks.) M. Stech  
*Dicranodontium denudatum* (Brid.) E. Britton  
*Dicranoweisia cirrata* (Hedw.) Lindb.  
*Dicranum bonjeanii* De Not.  
*D. flexicaule* Brid.  
*D. fuscescens* Sm.  
*D. polysetum* Sw. ex anon.  
*D. scoparium* Hedw.  
*Didymodon luridus* Hornsch.  
*D. vinealis* (Brid.) R.H. Zander  
*Distichium capillaceum* (Hedw.) Bruch & Schimp.  
*D. inclinatum* (Hedw.) Bruch & Schimp.  
*Ditrichum flexicaule* (Schwägr.) Hampe  
*D. heteromallum* (Hedw.) E. Britton  
*D. pusillum* (Hedw.) Hampe  
*D. subulatum* Hampe  
*Encalypta vulgaris* Hedw.  
*Fontinalis antipyretica* Hedw.  
*Grimmia alpestris* (F. Weber & D. Mohr) Schleich.  
*G. decipiens* (Schultz) Lindb.  
*G. elatior* Bruch ex Bals.-Criv. & De Not.  
*G. laevigata* (Brid.) Brid.  
*G. longirostris* Hook.

- G. montana* Bruch & Schimp.  
*G. ovalis* (Hedw.) Lindb.  
*G. pulvinata* (Hedw.) Sm.  
*G. trichophylla* Grev.  
*Hedwigia ciliata* (Hedw.) P. Beauv.  
*Helodium blandowii* (F. Weber & D. Mohr) Warnst.  
*Heterocladium dimorphum* (Brid.) Schimp.  
*Hymenoloma crispulum* (Hedw.) Ochyra  
*Hypnum andoi* A.J.E. Sm  
*Isothecium alopecuroides* (Lam. ex Dubois) Isov.  
*I. myosuroides* Brid.  
*Lescuraea incurvata* (Hedw.) E. Lawton  
*L. patens* Lindb.  
*L. plicata* (Schleich. ex F. Weber & D. Mohr) Broth.  
*L. radicata* (Mitt.) Mönk  
*L. saxicola* (Schimp.) Molendo  
*Leskea polycarpa* Hedw.  
*Lewinskya rupestris* (Schleich. ex Schwägr.) F.Lara, Garilleti & Goffinet  
*Mnium lycopodioides* Schwägr.  
*M. marginatum* (Dicks.) P. Beauv.  
*Palustriella commutata* (Hedw.) Ochyra  
*P. decipiens* (De Not.) Ochyra  
*P. falcata* (Brid.) Hedenäs  
*Paraleucobryum enerve* (Thed.) Loeske  
*Philonotis caespitosa* Jur.  
*P. calcarea* (Bruch & Schimp.) Schimp.  
*P. fontana* (Hedw.) Brid.  
*P. seriata* Mitt.  
*P. tomentella* Molendo  
*Pogonatum urnigerum* (Hedw.) P. Beauv.  
*Pohlia ludwigii* (Spreng. ex Schwägr.) Broth.  
*P. nutans* (Hedw.) Lindb.  
*P. obtusifolia* (Vill. ex Brid.) L.F. Koch  
*Polytrichastrum alpinum* (Hedw.) G.L. Sm  
*Polytrichum commune* Hedw.  
*P. juniperinum* Hedw.  
*P. piliferum* Hedw.  
*Pseudoleskea incurvata* (Hedw.) Loeske  
*Pseudoleskeella nervosa* (Brid.) Nyholm  
*Ptychostomum capillare* (Hedw.) Holyoak & N. Pedersen  
*P. imbricatum* (Müll. Hal.) Holyoak & N. Pedersen  
*P. pallens* (Sw.) J.R. Spence  
*P. pseudotriquetrum* (Hedw.) J.R. Spence & H.P. Ramsay var. *pseudotriquetrum*  
*Racomitrium canescens* (Hedw.) Brid.  
*R. elongatum* Ehrh. ex Frisvoll  
*R. ericoides* (Brid.) Brid.  
*R. heterostichum* (Hedw.) Brid.  
*R. macounii* Kindb. subsp. *macounii*  
*R. macounii* subsp. *alpinum* (E. Lawton) Frisvoll  
*R. microcarpon* (Hedw.) Brid.  
*Rhizomnium punctatum* (Hedw.) T.J. Kop.  
*Rhynchostegium riparioides* (Hedw.) Cardot  
*Rhytiadelphus squarrosus* (Hedw.) Warnst.  
*R. triquetrus* (Hedw.) Warnst.  
*Rhytidium rugosum* (Hedw.) Kindb.  
*Sanionia uncinata* (Hedw.) Loeske  
*Sarmentypnum sarmentosum* (Wahlenb.) Tuom. & T.J. Kop.  
*Schistidium atrofusum* (Schimp.) Limpr.  
*S. confertum* (Funck) Bruch & Schimp.  
*S. flaccidum* (De Not.) Ochyra  
*Sphagnum auriculatum* Schimp.  
*S. capillifolium* (Ehrh.) Hedw.  
*S. centrale* C.E.O. Jensen  
*S. compactum* Lam. & DC.  
*S. fallax* (H. Klinggr.) H. Klinggr.  
*S. girgensohnii* Russow  
*S. inundatum* Russow  
*S. magellanicum* Brid.  
*S. platyphyllum* (Lindb. ex Braithw.) Warnst.  
*S. squarrosum* Crome  
*S. subsecundum* Nees  
*S. teres* (Schimp.) Ångstr.  
*S. warnstorffii* Russow  
*Straminergon stramineum* (Dicks. ex Brid.) Hedenäs  
*Syntrichia norvegica* F. Weber  
*Tortella inclinata* var. *densa* (Lorentz & Molendo) Limpr.  
*T. tortuosa* (Hedw.) Limpr.  
*Tortula hoppeana* (Schultz) Ochyra  
*T. marginata* (Bruch & Schimp.) Spruce  
*T. subulata* Hedw.  
*Weissia controversa* Hedw.

### 3.2. Discussion

The altitudinal limits of subalpine and alpine bryophyte taxa in Rize province are most strongly concentrated at 2100, 2190, 2300, 2360, and 2650 m, and records of the taxa below 2650 m are more numerous than the upper elevations. When the altitudinal data are analyzed, the highest intensity of collection area is 2300 m. Upper limits of the taxa are observed at 3060 and 3065 m. *Pohlia obtusifolia* was recorded at 3060 m (Kırmacı et al., 2012), and *Marsupella funckii*, *Distichium capillaceum*, *Ditrichum flexicaule*, and *Bartramia ithyphylla* were from 3065 m (Abay et al., 2009b). Bryophyte records above 3000 m were not very intensive according to available information.

A short discussion on mountain and alpine species from different countries is provided in this study. Sabovljevic (2006) gives a knowledge of bryophytes in the region of the Western Alps (Italy and France) and here some taxa such as *Cephalozia pleniceps*, *Andreaea rupestris*, *Brachythecium mildeanum*, *Sanionia uncinata* were given in a preliminary list of Rize. A list of moss species of small local mountain area in Dagestan Republic (East Caucasus) is presented by Ignatov et al. (2010). The taxa reported here; *Brachythecium rivulare*, *Cratoneuron filicinum*, *Dicranum bonjeanii*, *Mnium lycopodioides*, *M. marginatum*, *Palustriella commutata*, *Polytrichastrum alpinum*, *Polytrichum juniperinum*, *Pseudoleskeella nervosa*, *Ptychostomum capillare*, *Sanionia uncinata*, and *Tortella tortuosa* were also

found in any certain high mountainous area of Rize. The mosses *Dicranum flexicaule*, *D. polysetum*, *Pseudoleskea patens*, *Palustriella commutata*, *Racomitrium canescens*, *Schistidium atrofusum* and *Tortella tortuosa* reported in the present study were also found in some upper mountain belt of central Italy, by Puglishi et al. (2011).

As a result, the liverwort and moss lists about subalpine and alpine regions of Rize may be far from completion because a lot of high mountains have not been researched in detail and there are unexplored places in these sections of the province. Several possible explanations can be suggested about why the maximum studied elevations are limited to 3065 m only. Maybe, the upper mountain belts of Rize are under snow or it is extremely difficult to access there during most of the year.

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## APPENDIX

### ALPHABETICAL LIST OF SUBALPINE AND ALPINE LIVERWORT TAXA OF RIZE INCLUDING SYNONYMS

*Lophozia quinquedentata* (Huds.) Cogn. (= *Tritomaria quinquedentata* (Huds.) H. Buch)

### ALPHABETICAL LIST OF SUBALPINE AND ALPINE MOSS TAXA OF RIZE INCLUDING SYNONYMS

*Barbula lurida* (Hornsch.) Lindb.(= *Didymodon luridus* Hornsch.)

*Bryum caespiticium* Hedw. (= *Ptychostomum imbricatulum* (Müll. Hal.) Holyoak & N. Pedersen)

*B. capillare* Hedw. (= *Ptychostomum capillare* (Hedw.) Holyoak & N. Pedersen)

- B. neodamense* Itzigs. (= *Ptychostomum pseudotriquetrum* (Hedw.) J.R. Spence & H.P. Ramsay var. *pseudotriquetrum*)  
*B. pallens* Sw. (= *Ptychostomum pallens* (Sw.) J.R. Spence)  
*B. schleicheri* var. *latifolium* (Schwägr.) Schimp. (= *Bryum schleicheri* DC.)  
*Bucklandiella heterosticha* (Hedw.) Bednarek-Ochyra & Ochyra (= *Racomitrium heterostichum* (Hedw.) Brid.)  
*B. macounii* (Kindb.) Bednarek-Ochyra & Ochyra subsp. *alpinum* (E. Lawton) Bednarek-Ochyra & Ochyra (= *Racomitrium macounii* subsp. *alpinum* (E. Lawton) Frisvoll)  
*B. macounii* (Kindb.) Bednarek-Ochyra & Ochyra (= *Racomitrium macounii* Kindb.)  
*B. microcarpa* (Hedw.) Bednarek-Ochyra & Ochyra (= *Racomitrium microcarpon* (Hedw.) Brid.)  
*Calliergon stramineum* (Dicks. ex Brid.) Kindb. (= *Straminergon stramineum* (Dicks. ex Brid.) Hedenäs)  
*Dicranoweisia crispula* (Hedw.) Milde (= *Hymenoloma crispulum* (Hedw.) Ochyra)  
*Dicranum albicans* Bruch & Schimp. nom. illeg. incl. spec. prior. (= *Paraleucobryum enerve* (Thed.) Loeske)  
*Drepanocladus uncinatus* (Hedw.) Warnst. (= *Sanionia uncinata* (Hedw.) Loeske)  
*Grimmia campestris* Burch. ex Hook. (= *Grimmia laevigata* (Brid.) Brid.)  
*G. flaccida* (De Not.) Lindb. (= *Schistidium flaccidum* (De Not.) Ochyra)  
*Lescuraea mutabilis* var. *saxicola* (Schimp.) I. Hagen (= *Lescuraea saxicola* (Schimp.) Molendo)  
*Orthotrichum rupestre* Schleich. ex Schwägr. (= *Lewinskya rupestris* (Schleich. ex Schwägr.) F.Lara, Garilleti & Goffinet)  
*Platyhypnidium riparioides* (Hedw.) Dixon. (= *Rhynchostegium riparioides* (Hedw.) Cardot)  
*Pseudoleskea atrovirens* (Dicks.) B. & S. var. *brachyclados* B. & S. (= *Lescuraea incurvata* (Hedw.) E. Lawton)  
*P. patens* (Lindb.) Kindb. (= *Lescuraea patens* Lindb.)  
*P. radicata* (Mitt.) Macoun & Kindb. (= *Lescuraea radicata* (Mitt.) Mönk)  
*Ptychodium plicatum* (Schleich. ex F. Weber & D. Mohr) Schimp. (= *Lescuraea plicata* (Schleich. ex F. Weber & D. Mohr) Broth.)  
*Sphagnum contortum* auct. non Schultz (= *Sphagnum auriculatum* Schimp.)  
*Tortella densa* (Lorentz & Molendo) Crundwell & Nyholm (= *Tortella inclinata* var. *densa* (Lorentz & Molendo) Limpr.)  
*Warnstorfia sarmentosa* (Wahlenb.) Hedenäs (= *Sarmentypnum sarmentosum* (Wahlenb.) Tuom. & T.J. Kop.)