M. Privitera, M. Aleffi, G. Bertani, P. Campisi, A. Carratello, M. Codogno, A. Cogoni, L. Miserere, S. Perego, M. Puglisi, F. Sguazzin, R. Tacchi & A. Zimbone

Survey of the bryophyte diversity of the Carnic Alps, including some interesting records for the Italian bryoflora

Abstract

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The results of a bryofloristic study on the Italian Carnic Alps are reported. The bryophytes collected are 177 of wich 53 liverworts and 124 mosses. Among them 10 species are new records for the Friuli-Venezia Giulia region and 2 for the Veneto region. The bryoflora is typically montane and subalpine, very rich and well diversified, with a predominance of boreo-temperate and boreo-arctic-montane species. Among the liverworts it is to highlight the occurrence of the rare taxa in Italy *Blepharostoma trichophyllum* subsp. *brevirete*, *Saccogyna viticulosa*, *Mylia taylorii*, *Scapania gracilis* and *Conocephalum salebrosum*, the last one second record for Italy. Among the mosses, we emphasize the occurrence of *Schistidium dupretii* and *Ulota coartata*, the last one up to now considered extinct in Italy.

Key words: Bryophytes, Southern Alps, Italian Botanical Society.

Introduction

The Carnic Alps extend from east to west for about 100 km between the Gail, a tributary of Drava, and the Tagliamento River. They are a montane range of the Southern Alps located between the Dolomites and the Julian Alps, lying on the border between Austria (Tyrol, Carinthia) and Italy (south Tyrol, north-east area of the Friuli-Venezia Giulia region).

The first contribution on the bryophyte flora of the Friuli-Venezia Giulia, where almost the entire study area falls, is dated back to the end of the eighteenth century with the contribution of Scopoli (1772) on the Carnic Flora. This paper was followed, in the nineteenth century and early decades of the twentieth century, by the studies of Sendtner (1848, 1857), Juratzka (1860, 1864, 1867, 1882), Loitlesberger (1905, 1909), Glowacki (1908, 1910). More detailed bryological information can be found in the papers of Kern (1908), Giacomini (1950) and Fornaciari (1967).

In order to improve the knowledge on the Italian alpine bryophyte flora, the annual excursion of the Bryological Group of the Italian Botanical Society was organized in September 2009 in the territory of Passo Pura, where many different types of mountain and alpine environments with an interesting bryophyte flora were investigated.

Study area

The field work was carried out on 10-12 September 2009. The study area mostly falls within the Friuli-Venezia Giulia region extending to Forcella di Lavardet in the Veneto region and is placed at an altitude between 950 and 1600 m a.s.l. (Fig. 1).

The substrate is mostly composed by weakly acid, violet-reddish sandstone (*Werfen formation*). On the south-western side, the area is delimited by a chain of calcareous mountains (reaching 2500 m a.s.l.) with prevailing limestone and dolomite substrate (ladinic *Schlern formation*) (Selli 1963).

As concerns the bioclimate of the surveyed area, we refer to the station of Passo Mauria (1298 m a.s.l.). Here, the mean annual precipitation is 1553 mm and the mean annual temperature is 6.5°C. The climate is characterized by relatively low temperatures throughout the year; the average monthly temperature is below 0° C in January, February and December. However, frosts always occur in March, April and November and occasionally in May and October. With the exception of winter, the mean monthly precipitation exceeds 100 mm and is uniformly distributed within the months with peaks in May

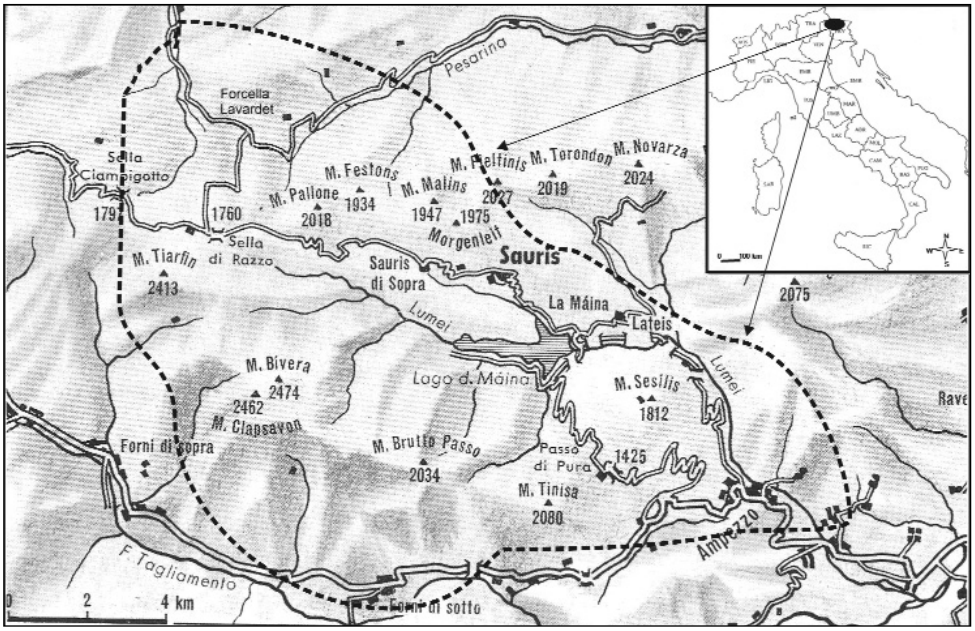

Fig. 1. Study area: location and boundaries.

and November. Even in August the mean precipitation ranges from 130 to 150 mm, distributed in 10-11 days, thus no period of drought occurs (Gentilli 1964). According to the classification by Rivas Martinez & al. (2004), the investigated area falls within the bioclimate Temperate-continental type.

The vascular flora of this area was studied by Pignatti & Poldini (1969) which report a list of 664 species. From the phytogeographic point of view, the studied area falls between the inner and central mesalpic districts (Poldini 1989). The mesalpic district is characterized by a vegetation chiefly dominated by mixed deciduos woods with *Fagus sylvatica*, *Abies alba* and *Picea abies*, widespread in the montane zone mainly on NW-NE slopes (e.g. Stua wood, Colmajer wood). Pure *Fagus*-stands may also occur, even though less frequently.

Material and methods

The material used for this study was collected during field trips in the area indicated in Fig. 1. The nomenclature used follows Hill & al. (2006) and the distribution in the Italian regions Aleffi & al. (2008). As regards the phytogeographical analysis, the chorological elements are drawn from Smith (2004) following the classification of Hill & Preston (1998), where the species are placed into latitudinal and longitudinal categories.

The specimens are kept in CAME, CAG, CAT, PAL and in the personal herbaria of the authors.

Floristic list

The bryophyte *taxa* collected in the investigated areas are listed below in alphabetical order. The *taxa* marked with ** are new reports for the Friuli-Venezia Giulia; the *taxa* marked with * are confirmations of the species in the region. The *taxa* marked with a # are new reports for the Veneto region. For each taxon the localities and habitats within the study area are reported. The nomenclature used and the distribution in the Italian regions follow Aleffi & al. (2008).

LIVERWORTS

Barbilophozia barbata (Schmidel ex Schreb.) Loeske - Casera Tintina – Weiss path: soil (UTM 33T 0324516 5143388).

Barbilophozia lycopodioides (Wallr.) Loeske – Forcella di Lavardet: peat bog (UTM 33T 318179 5152418), soil in wood near peat bog (UTM 33T 318232 5152300).

Blepharostoma trichophyllum (L.) Dumort. - Forcella di Lavardet: peat bog (UTM 33T 318179 5152418). Stua wood: decaying wood (UTM 33T 0324667 5146245). Flobia wood: decaying bark (UTM 33T 0326605 5144154). Malga Tintina: decaying wood (UTM 33T 0324516 5143388). Colmajer wood: decaying wood (UTM 33T 326617 5144078). Forcella di Lavardet: peat bog (UTM 33T 318179 5152418).

** *Blepharostoma trichophyllum* subsp. *brevirete* (Bryhn & Kaal.) R.M.Schust - Colmajer wood: stumps of *Abies alba* (UTM 33T 326590 5144173).

Calypogeia fissa (L.) Raddi - Colmajer wood: stumps of *Abies alba* (UTM 33T 326590 5144173). Casera Tintina – Weiss path: humus (UTM 33T 0324516 5143388).

Calypogeia integristipula Steph. - Flobia wood: decaying bark (UTM 33T 0326605 5144154). Colmajer wood: decaying wood (UTM 33T 326617 5144078). Malga Tintina: rocks within the *Vaccinium myrtillus* L. vegetation (UTM 33T 0324516 5143388).

Calypogeia neesiana (C. Massal. & Carestia) Müll. Frib. – Colmajer wood: stumps of *Abies alba* (UTM 33T 326590 5144173), rotten wood (UTM 33T 324555 5146345). Casera Tintina – Weiss path: decaying wood (UTM 33T 0324516 5143388). Forcella di Lavardet: rotting stump (UTM 33T 318232 5152300). Malga Tintina: rocks within the *Vaccinium myrtillus* vegetation (UTM 33T 0324516 5143388). Stua wood: decaying wood (UTM 33T 0324667 5146245).

Calypogeia suecica (Arnell & J. Perss.) Müll. Frib. - Colmajer wood: stumps of Abies alba (UTM 33T 326590 5144173), decaying wood (UTM 33T 326617 5144078)

Cephalozia bicuspidata (L.) Dumort.: Colmajer wood: stump of *Abies alba* (UTM 33T 326590 5144173), decaying wood (UTM 33T 326617 5144078). Malga Tintina: decaying wood (UTM 33T 0324516 5143388). Forcella di Lavardet: decaying wood (UTM 33T 318232 5152300), peat bog (UTM 33T 318179 5152418).

* *Cephalozia connivens* (Dicks.) Lindb. – Forcella di Lavardet: peat bog (UTM 33T 318179 5152418).

Cephalozia lunulifolia (Dumort.) Dumort. - Colmajer wood: stumps of *Abies alba* (UTM 33T 326590 5144173), rotten wood (UTM 33T 326617 5144078).

Cephaloziella baumgartneri Schiffn. - Colmajer wood: decaying wood (UTM 33T 326617 5144078).

** *Cephaloziella dentata* (Raddi) Steph. - Stua wood: soil (UTM 33T 0324667 5146245).

* *Cephaloziella divaricata* (Sm.) Schiffn. - Casera Tintina – Weiss path: chalky rocks (UTM 33T 0324516 5143388).

** *Cephaloziella rubella* (Nees) Warnst. - Casera Tintina – Weiss path: decaying wood (UTM 33T 0324516 5143388).

Conocephalum conicum (L.) Dumort. - Stua wood: soil and walls along the path (UTM 33T 0324667 5146245). Sauris lake: along the banks (UTM 33T 324555 5146345). Colmajer wood: stumps of *Abies alba* (UTM 33T 326590 5144173). Casera Tintina – Weiss path: moist soil and decaying wood (UTM 33T 0324516 5143388).

** *Conocephalum salebrosum* Szweykowski, Buczkowska & Odrzykoski – Colmajer wood: rocks (UTM 33T 325572 5143795). Stua wood: stumps along the banks of a stream (UTM 33T 0324667 5146245).

* *Frullania fragilifolia* (Taylor) Gottsche & al. - Stua wood: bark of *Fagus sylvatica* (UTM 33T 0324667 5146245).

Jungermannia atrovirens Dumort.: Stua wood: soil (UTM 33T 0324667 5146245). Sauris lake: walls along the path (UTM 33T 324555 5146345). Colmajer wood: walls along the path (UTM 33T 325413 5143874).

Jungermannia gracillima Sm. - Casera Tintina – Weiss path: chalky rocks. (UTM 33T 0324516 5143388).

Jungermannia leiantha Grolle - Stua wood: dry limestone wall and decaying wood (UTM 33T 0324667 5146245). Colmajer wood: decaying wood (UTM 33T 326617 5144078).

* *Jungermannia pumila* With. - Stua wood: soil (UTM 33T 0324667 5146245).
* *Leiocolea badensis* (Gottsche) Jörg. - Colmajer wood: soil and limestones covered by a thin layer of soil (UTM 33T 326531 5144326).
Leiocolea bantriensis (Hook.) Jörg.: Stua wood: soil (UTM 33T 0324667 5146245). Casera Tintina – Weiss path: moist soil (UTM 33T 0324516 5143388). Colmajer wood: rocks along the path (UTM 33T 325413 5143874).
Leiocolea collaris (Nees) Schljakov - Stua wood: walls along the path (UTM 33T 0324667 5146245).
Lepidozia reptans (L.) Dumort - Colmajer wood: stumps of *Abies alba* (UTM 33T 326590 5144173), decaying wood (UTM 33T 326617 5144078). Flobia wood: decaying wood (UTM 33T 0326605 5144154). Malga Tintina: decaying wood (UTM 33T 0324516 5143388). Stua wood: decaying wood (UTM 33T 0324667 5146245).
Lophocolea bidentata (L.) Dumort. - Flobia wood: decaying wood (UTM 33T 0326605 5144154).
Lophocolea heterophylla (Schrad.) Dumort. - Stua wood: decaying wood and concrete walls along the path (UTM 33T 0324667 5146245). Colmajer wood: stumps of *Abies alba* and *Fagus sylvatica* (UTM 33T 326590 5144173), rotten wood (UTM 33T 326617 5144078), rocks (UTM 33T 325572 5143795). Casera Tintina – Weiss path: moist soil and decaying wood (UTM 33T 0324516 5143388).
Lophozia incisa (Schrad.) Dumort. – Malga Tintina: rocks within the *Vaccinium myrtillus* vegetation (UTM 33T 0324516 5143388).
Lophozia longiflora (Nees) Schiffn. – Colmajer wood: stumps of *Abies alba* (UTM 33T 326590 5144173). Malga Tintina: rocks within the *Vaccinium myrtillus* vegetation (UTM 33T 0324516 5143388).
* *Lophozia ventricosa* (Dicks.) Dumort. - Stua wood: soil (UTM 33T 0324667 5146245). Casera Tintina – Weiss path: trunk of *Larix decidua* (UTM 33T 0324516 5143388). Colmajer wood: decaying wood (UTM 33T 326617 5144078).
Metzgeria furcata (L.) Dumort - Stua wood: decaying wood and bark of *Picea abies* (UTM 33T 0324667 5146245).
* *Mylia taylorii* (Hook.) Gray - Colmajer wood: stumps of *Abies alba* (UTM 33T 326590 5144173), rotten wood (UTM 33T 326617 5144078).
Nowellia curvifolia (Dicks.) Mitt. - Stua wood: decaying wood (UTM 33T 0324667 5146245).
Odonthoschisma denudatum (Mart.) Dumort. – Colmajer wood: decaying wood (UTM 33T 326617 5144078).
Pedinophyllum interruptum (Nees) Kaal. - Stua wood: walls along the path (UTM 33T 0324667 5146245). Colmajer wood: rocks along the path (UTM 33T 325413 5143874).
Pellia endiviifolia (Dicks.) Dumort. - Stua wood: soil and rocks along a stream (UTM 33T 324555 5146345). Colmajer wood: rocks (UTM 33T 325572 5143795).
Plagiochila asplenioides (L. emend. Taylor) Dumort. - Stua wood: soil and concrete walls (UTM 33T 0324667 5146245). Colmajer wood: stumps of *Abies alba* (UTM 33T 326590 5144173), rocks along the path (UTM 33T 325413 5143874). Casera Tintina – Weiss path: decaying wood (UTM 33T 0324516 5143388).
Plagiochila porelloides (Torrey ex Nees) Lindenb. - Stua wood: concrete walls along the path, rocks, soil, scarps and decaying wood (UTM 33T 0324667 5146245). Casera

Tintina – Weiss path: moist soil (UTM 33T 0324516 5143388). Colmajer wood: bark of *Fagus sylvatica* (UTM 33T 326590 5144173), limestones covered by a thin layer of soil (UTM 33T 326531 5144326).

Preissia quadrata (Scap.) Nees - Colmajer wood: soil (UTM 33T 326531 5144326), rocks (UTM 33T 325572 5143795), decaying wood (UTM 33T 326617 5144078). Sauris lake: stumps along the lake banks (UTM 33 T 324555 5146345).

* *Ptilidium ciliare* (L.) Hampe - Casera Tintina – Weiss path: trunk of *Larix decidua* (UTM 33T 0324516 5143388).

Ptilidium pulcherrimum (Weber) Vain. - Casera Tintina – Weiss path: trunk of *Larix decidua* and rocks within the *Vaccinium myrtillus* vegetation (UTM 33T 0324516 5143388).

Radula complanata (L.) Dumort. - Colmajer wood: stumps of *Abies alba* (UTM 33T 326590 5144173), decaying wood (UTM 33T 326617 5144078), rocks covered by a thin layer of soil (UTM 33T 326531 5144326). Stua wood: bark of *Fagus sylvatica* and *Picea abies* (UTM 33T 0324667 5146245).

* *Riccardia multifida* (L.) Gray - Colmajer wood: soil (UTM 33T 326531 5144326).

Riccardia palmata (Hedw.) Carruth. - Colmajer wood: stumps of *Abies alba* (UTM 33T 326590 5144173), decaying wood (UTM 33T 326617 5144078), rocks (UTM 33T 325572 5143795). Casera Tintina – Weiss path: humus and rocks within *Vaccinium myrtillus* vegetation (UTM 33T 0324516 5143388). Flobia wood: decaying wood (UTM 33T 0326605 5144154). Malga Tintina: decaying wood (UTM 33T 0324516 5143388). Stua wood: decaying wood (UTM 33T 0324667 5146245).

** *Saccogyna viticulosa* (L.) Dumort. - Casera Tintina – Weiss path: moist soil (UTM 33T 0324516 5143388).

Scapania aequiloba (Schwägr.) Dumort. - Stua wood: decaying wood (UTM 33T 0324667 5146245). Colmajer wood: stumps of *Abies alba* (UTM 33T 326590 5144173), rocks (UTM 33T 325572 5143795). Casera Tintina – Weiss path: humus within *Vaccinium myrtillus* vegetation (UTM 33T 0324516 5143388).

**Scapania cuspiduligera* (Nees) Müll.Frib. - Colmajer wood: limestones (UTM 33T 326531 5144326).

* *Scapania gracilis* Lindb. - Forcella di Lavardet: peat bog (UTM 33T 318179 5152418).

Scapania nemorea (L.) Grolle - Stua wood: dry limestone walls (UTM 33T 0324667 5146245).

* *Scapania umbrosa* (Schrad.) Dumort. - Stua wood: decaying wood (UTM 33T 0324667 5146245).

Trichocolea tomentella (Ehrh.) Dumort. - Casera Tintina – Weiss path: humus within *Vaccinium myrtillus* vegetation (UTM 33T 0324516 5143388).

Tritomaria execta (Schmidel.ex Schrad.) Loeske – Malga Tintina: decaying wood (UTM 33T 0324516 5143388). Colmajer wood: rotten wood (UTM 33T 326617 5144078).

MOSSES

Amblystegium serpens (Hedw.) Schimp. - Stua wood: decaying wood (UTM 33T 0324667 5146245).

Atrichum angustatum (Brid.) Bruch & Schimp. - Forcella di Lavardet: peat bog (UTM 33T 318179 5152418).

Atrichum undulatum (Hedw.) P. Beauv. - Colmajer wood: soil (UTM 33T 326531 5144326), rocks (UTM 33T 325572 5143795).

Brachythecium rivulare Schimp. - Stua wood: damp walls (UTM 33T 0324667 5146245).

Brachythecium rutabulum (Hedw.) Schimp. – Malga Tintina: decaying wood (UTM 33T 0324516 5143388). Colmajer wood: rocks (UTM 33T 325572 5143795), trunk of *Picea abies* (UTM 33T 326590 5144173).

Bryoerytrophyllum recurvirostrum (Hedw.) P.C. Chen – Stua wood: damp limestone walls (UTM 33T 0324667 5146245).

Bryum argenteum Hedw. – Colmajer wood: rocks (UTM 33T 325572 5143795).

Bryum elegans Nees – Colmajer wood: rocks (UTM 33T 325572 5143795).

Bryum torquescens Bruch & Schimp. - Casera Tintina – Weiss path: moist soil (UTM 33T 0324516 5143388).

Buxbaumia viridis (Moug. ex Lam. & DC.) Brid. ex Moug. & Nestl - Colmajer wood: stumps of *Abies alba* (UTM 33T 326590 5144173), rotten wood (UTM 33T 326617 5144078). Casera Tintina – Weiss path: decaying wood (UTM 33T 0324516 5143388).

Calliergonella cuspidata (Hedw.) Loeske - Forcella di Lavardet: peat bog (UTM 33T 318179 5152418). Sauris lake: stumps along a stream banks (UTM 33T 324555 5146345).

Calliergonella lindbergii (Mitt.) Hedenäs – Forcella di Lavardet: in peat bog (UTM 33T 318179 5152418).

Campylium protensum (Brid.) Kindb. - Stua wood: soil and decaying wood (UTM 33T 0324667 5146245).

Campylium stellatum (Hedw.) Lange & C.E.O. Jensen – Stua wood: soil and concrete walls along the path (UTM 33T 0324667 5146245). Colmajer wood: limestones covered by a thin layr of soil (UTM 33T 326531 5144326). Forcella di Lavardet: in peat bog (UTM 33T 318179 5152418).

Campylophyllum halleri (Hedw.) M. Fleisch. - Casera Tintina – Weiss path: moist soil partally flooded (UTM 33T 0324516 5143388). Malga Tintina: damp rocks (UTM 33T 0324516 5143388).

Cirriphyllum crassinervium (Taylor) Loeske & M. Fleisch. - Colmajer wood: decaying bark of Picea excelsa (UTM 33T 326617 5144078).

Climacium dendroides (Hedw.) F. Weber & D. Mohr - Stua wood: soil (UTM 33T 0324667 5146245). Sauris lake: along a stream banks (UTM 33T 0324667 5146245).

Cratoneuron filicinum (Hedw.) Spruce - Stua wood: rocks and stumps along the banks of a stream (UTM 33T 324555 5146345). Forcella di Lavardet: in peat bog (UTM 33T 318179 5152418).

Ctenidium molluscum (Hedw.) Mitt. - Stua wood: soil (UTM 33T 0324667 5146245). Colmajer wood: rocks (UTM 33T 325572 5143795). Casera Tintina – Weiss path: humus within *Vaccinium myrtillus* vegetation (UTM 33T 0324516 5143388). Flobia wood: rocks (UTM 33T 0326605 5144154).

Dichodontium palustre (Dicks.) M. Stech – Forcella di Lavardet: in peat bog (UTM 33T 318179 5152418).

Dichodontium pellucidum (Hedw.) Schimp. - Stua wood: soil and concrete walls along the path (UTM 33T 0324667 5146245).

Dicranella heteromalla (Hedw.) Schimp. Colmajer wood: rocks covered by a thin layer of soil (UTM 33T 326531 5144326).

** *Dicranum majus* Sm. - Colmajer wood: stumps of *Abies alba* (UTM 33T 326590 5144173), decaying bark of *Picea excelsa* (UTM 33T 326617 5144078). Malga Tintina: decaying wood (UTM 33T 0324516 5143388).

* *Dicranum montanum* Hedw. - Malga Tintina: decaying wood (UTM 33T 0324516 5143388).

Dicranum scoparium Hedw. - Stua wood: soil and walls along the path (UTM 33T 0324667 5146245). Forcella di Lavardet: in peat bog (UTM 33T 318179 5152418). Casera Tintina – Weiss path: moist soil, trunks of *Larix decidua*, humus and rocks within *Vaccinium myrtillus* vegetation (UTM 33T 0324516 5143388). Colmajer wood: decaying bark of *Picea excelsa* (UTM 33T 326617 5144078). Flobia wood: rocks (UTM 33T 0326605 5144154).

Didymodon ferrugineus (Schimp. ex Besch.) M.O. Hill - Casera Tintina – Weiss path: moist soil partially flooded (UTM 33T 0324516 5143388).

Didymodon vinealis (Brid.) R.H.Zander - Stua wood: walls along the path (UTM 33T 0324667 5146245).

Distichium capillaceum (Hedw.) Bruch & Schimp. - Stua wood: soil (UTM 33T 0324667 5146245). Casera Tintina – Weiss path: humus and moist soil (UTM 33T 0324516 5143388). Colmajer wood: soil covering rocks (UTM 33T 326531 5144326).

Ditrichum gracile (Mitt.) Kuntze - Forcella di Lavardet: in peat bog (UTM 33T 318179 5152418).

Ditrichum pusillum (Hedw.) Hampe - Casera Tintina – Weiss path: on moist soil (UTM 33T 0324516 5143388).

Drepanocladus aduncus (Hedw.) Warnst. **-** Forcella di Lavardet: peat bog (UTM 33T 318179 5152418).

Drepanocladus sendtneri (Schimp. ex H.Müll) Warnst. – Forcella di Lavardet: peaty soil (UTM 33T 318179 5152418).

Encalypta streptocarpa Hedw. Stua wood: soil and concrete walls (UTM 33T 0324667 5146245). Colmajer wood: limestones (UTM 33T 326531 5144326), rocks along the path (UTM 33T 325413 5143874).

Eucladium verticillatum (With.) Bruch & Schimp. – Malga Tintina: rocky walls (UTM 33T 0324516 5143388).

Eurhynchiastrum pulchellum (Hedw.) Ignatov & Huttunen var. *pulchellum* - Colmajer wood: trunk of *Picea abies* (UTM 33T 326590 5144173).

Eurhynchium angustirete (Broth.) T.J. Kop. – Stua wood: decaying wood and concrete walls along the path (UTM 33T 0324667 5146245). Colmajer wood: rocks (UTM 33T 325572 5143795).

Eurhynchium striatum (Hedw.) Schimp. - Colmajer wood: decaying wood (UTM 33T 326617 5144078).

Fissidens dubius P. Beauv. - Stua wood: soil and concrete walls along the path (UTM 33T 0324667 5146245). Colmajer wood: stumps of *Abies alba* (UTM 33T 326590 5144173), limestones (UTM 33T 326531 5144326). Flobia wood: rocks (UTM 33T 0326605 5144154).

Fissidens osmundoides Hedw. - Forcella di Lavardet: in peat bog (UTM 33T 318179 5152418).

** *Fissidens serrulatus* Brid. - Casera Tintina – Weiss path: humus (UTM 33T 0324516 5143388). Colmajer wood: limestones (UTM 33T 326531 5144326), trunks of *Picea abies* (UTM 33T 326590 5144173).

Fissidens taxifolius Hedw. subsp. *taxifolius* - Stua wood: decaying wood (UTM 33T 0324667 5146245). Colmajer wood: soil (UTM 33T 326531 5144326). Sauris lake: stumps along the banks of a stream (UTM 33T 324555 5146345).

Grimmia lisae De Not. - Stua wood: walls along the path (UTM 33T 0324667 5146245). Malga Tintina: rocks (UTM 33T 0324516 5143388).

Gymnostomum calcareum Nees & Hornsch. - Casera Tintina – Weiss path: chalky rocks and rocky walls (UTM 33T 0324516 5143388).

* *Gyroweisia tenuis* (Hedw.) Schimp. - Stua wood: walls along the path (UTM 33T 0324667 5146245).

* *Hamatocaulis vernicosus* (Mitt.) Hedenäs – Stua wood: decaying wood (UTM 33T 0324667 5146245).

Herzogiella seligeri (Brid.) Z. Iwats. - Stua wood: decaying wood (UTM 33T 0324667 5146245). Colmajer wood: rotten wood (UTM 33T 326617 5144078).

Homalothecium lutescens (Hedw.) H. Rob. var. *lutescens* – Malga Tintina: scarps and soil in the underwood (UTM 33T 0324516 5143388).

Hygrohypnum luridum (Hedw.) Jenn. - Stua wood: rocks (UTM 33T 0324667 5146245). Casera Tintina – Weiss path: moist soil partially flooded (UTM 33T 0324516 5143388).

Hylocomiastrum pyrenaicum (Spruce) M. Fleisch. - Forcella di Lavardet: peat bog (UTM 33T 318179 5152418).

Hylocomium splendens (Hedw.) Schimp. - Stua wood: soil and rocks (UTM 33T 0324667 5146245). Forcella di Lavardet: soil (UTM 33T 318232 5152300), peat bog (UTM 33T 318179 5152418). Colmajer wood: soil (UTM 33T 326531 5144326), rocks (UTM 33T 325572 5143795). Casera Tintina – Weiss path: humus within *Vaccinium myrtillus* vegetation (UTM 33T 0324516 5143388).

Hypnum cupressiforme Hedw. var. *cupressiforme* - Stua wood: rocks and decaying wood (UTM 33T 0324667 5146245). Colmajer wood: decaying wood (UTM 33T 326617 5144078).

Isopterygiopsis pulchella (Hedw.) Z. Iwats. - Stua wood: decaying wood (UTM 33T 0324667 5146245). Colmajer wood: stumps of *Abies alba* (UTM 33T 326590 5144173.

Isothecium alopecuroides (Lam. ex Dubois) Isov. - Stua wood: concrete walls along the path (UTM 33T 0324667 5146245). Colmajer wood: stumps of *Abies alba* (UTM 33T 326590 5144173), rocks (UTM 33T 325572 5143795).

Leptodictyum riparium (Hedw.) Warnst. – Sauris lake: along the lake banks (UTM 33T 324559 5146347).

Leucobryum glaucum (Hedw.) Ångstr. – Forcella di Lavardet: in peat bog (UTM 33T 318232 5152300).

Mnium hornum Hedw. - Casera Tintina – Weiss path: moist soil (UTM 33T 0324516 5143388).

Mnium lycopodioides Schwägr. - Colmajer wood: soil and limestones (UTM 33T 326531 5144326).

Mnium marginatum (Dicks.) P. Beauv. var. *marginatum* - Stua wood: soil (UTM 33T 0324667 5146245. Malga Tintina: soil in the underwood (UTM 33T 0324516 5143388).

Mnium stellare Hedw. - Casera Tintina – Weiss path: moist soil (UTM 33T 0324516 5143388). Colmajer wood: decaying wood (UTM 33T 326617 5144078).

Neckera crispa Hedw. – Colmajer wood: limestones (UTM 33T 326531 5144326). Flobia wood: rocks (UTM 33T 0326605 5144154).

Orthothecium rufescens (Dicks. ex Brid.) Schimp. - Casera Tintina – Weiss path: chalky rocks and on moist soil (UTM 33T 0324516 5143388). Colmajer wood: rocks (UTM 33T 325572 5143795).

Oxyrrhynchium hians (Hedw.) Loeske - Stua wood: soil (UTM 33T 0324667 5146245).

Oxyrrhyinchium speciosum (Brid.) Warnst. – Colmajer wood: soil (UTM 33T 326531 5144326).

** *Oxystegus tenuirostris* (Hook. & Taylor) A.J.E. Sm. – Stua wood: soil (UTM 33T 0324667 5146245).

Palustriella commutata (Hedw.) Ochyra - Stua wood: soil along a stream and damp walls (UTM 33T 0324667 5146245). Sauris lake: stumps along the banks of a stream (UTM 33T 324555 5146345).

Palustriella decipiens (De Not.) Ochyra - Casera Tintina – Weiss path: moist soil partially flooded (UTM 33T 0324516 5143388).

Philonotis seriata Mitt. - Forcella di Lavardet: in peat bog (UTM 33T 318179 5152418).

Plagiomnium affine (Blandow ex Funck) T.J. Kop. – Colmajer wood: trunk of (stump) peccio abbattuto (UTM 33T 326590 5144173).

Plagiomnium cuspidatum (Hedw.) T.J. Kop. - Stua wood: concrete walls (UTM 33T 0324667 5146245.

Plagiomnium elatum (Bruch & Schimp.) T.J. Kop. – Stua wood: soil (UTM 33T 0324667 5146245).

Plagiomnium medium (Bruch & Schimp.) T.J. Kop. - Stua wood: limestone walls (UTM 33T 0324667 5146245).

Plagiomnium rostratum (Schrad.) T.J. Kop. - Stua wood: soil (UTM 33T 0324667 5146245).

Plagiomnium undulatum (Hedw.) T.J. Kop. – Colmajer wood: rocks (UTM 33T 325572 5143795). Stua wood: soil, limestone walls and decaying wood (UTM 33T 0324667 5146245).

Plagiopus oederianus (Sw.) H.A. Crum & L.E. Anderson - Casera Tintina – Weiss path: chalky rocks and scarps (UTM 33T 0324516 5143388).

Plagiothecium denticulatum (Hedw.) Schimp. – Malga Tintina: decaying wood (UTM 33T 0324516 5143388). Colmajer wood: soil (UTM 33T 326531 5144326), stumps of *Picea excelsa* (UTM 33T 326590 5144173).

Plagiothecium laetum Schimp. - Colmajer wood: soil (UTM 33T 326531 5144326). Forcella di Lavardet: soil near the peat bog (UTM 33T 318232 515230).

Plagiothecium nemorale (Mitt.) A. Jaeger - Stua wood: rocks and rotten wood (UTM 33T 0324667 5146245).

Plagiothecium succulentum (Wilson) Lindb. - Casera Tintina – Weiss path: moist soil (UTM 33T 0324516 5143388).

Pleurochaete squarrosa (Brid.) Lindb. - Stua wood: walls along the path (UTM 33T 0324667 5146245).

Pleurozium schreberi (Willd. ex Brid.) Mitt. - Forcella di Lavardet: soil near peat bog (UTM 33T 318232 5152300). Colmajer wood: stumps of *Fagus sylvatica* (UTM 33T 326590 5144173).

Pohlia nutans (Hedw.) Lindb. - Casera Tintina – Weiss path: chalky rocks (UTM 33T 0324516 5143388).

Polytrichastrum alpinum (Hedw.) G.L. Sm. - Casera Tintina – Weiss path: moist soil, humus and rocks within the *Vaccinium myrtillus* vegetation (UTM 33T 0324516 5143388). Colmajer wood: soil (UTM 33T 326531 5144326).

Polytrichastrum formosum (Hedw.) G.L.Sm. - Stua wood: rocks (UTM 33T 0324667 5146245). Colmajer wood: decaying wood (UTM 33T 326617 5144078).

Polytrichum commune Hedw. - Forcella di Lavardet: in peat bog (UTM 33T 318179 5152418).

Pseudoleskea incurvata (Hedw.) Loeske - Malga Tintina: rocks (UTM 33T 0324516 5143388).

Pterigynandrum filiforme Hedw. - Stua wood: decaying wood (UTM 33T 0324667 5146245). Colmajer wood: rotten wood (UTM 33T 326617 5144078).

* *Ptychodium plicatum* (Schleich. ex F. Weber & D. Mohr) Schimp. - Malga Tintina: rocks (UTM 33T 0324516 5143388).

Ptychostomum capillare (Hedw.) D.T. Holyoak & N. Pedersen - Colmajer wood: bark of *Picea excelsa* (UTM 33T 326590 5144173).

Ptychostomum pseudotriquetrum (Hedw.) J.R. Spence & H.P. Ramsay var. *pseudotriquetrum* - Forcella di Lavardet: in peat bog (UTM 33T 318179 5152418). Casera Tintina – Weiss path: moist soil partially flooded (UTM 33T 0324516 5143388).

Ptychostomum pallens (Sw.) J.R. Spence - Stua wood: stones (UTM 33T 0324667 5146245).

Ptycostomum zieri (Hedw.) D.T. Holyoak & N. Pedersen – Bosco Colmajer: soil and rocks covered by a thin layer of soil (UTM 33T 326531 5144326).

Rhizomnium punctatum (Hedw.) T.J. Kop - Stua wood: decaying wood and concrete walls along the path (UTM 33T 0324667 5146245). Colmajer wood: soil (UTM 33T 326531 5144326), stumps of *Abies alba* (UTM 33T 326590 5144173). Casera Tintina – Weiss path: damp soil (UTM 33T 0324516 5143388).

Rhynchostegium confertum (Dicks.) Schimp. – Stua wood: decaying wood (UTM 33T 0324667 5146245).

Rhynchostegium murale (Hedw.) Schimp. - Colmajer wood: rocks (UTM 33T 325572 5143795), bark of peccio abbattuto (UTM 33T 326590 5144173).

Rhytidiadelphus squarrosus (Hedw.) Warnst. – Colmajer wood: rocks (UTM 33T 325572 5143795).

Rhytidiadelphus triquetrus (Hedw.) Warnst. - Stua wood: soil (UTM 33T 0324667 5146245). Colmajer wood: rocks (UTM 33T 325572 5143795). Casera Tintina – Weiss path: moist soil and humus within the *Vaccinium myrtillus* vegetation (UTM 33T 0324516 5143388). Forcella di Lavardet: soil near peat bog (UTM 33T 318232 5152300).

Sanionia uncinata (Hedw.) Loeske - Colmajer wood: rotten wood (UTM 33T 326617 5144078). Stua wood: decaying wood (UTM 33T 0324667 5146245).

Schistidium apocarpum (Hedw.) Bruch & Schimp. - Stua wood: rocks and walls along the path (UTM 33T 0324667 5146245).

Schistidium crassipilum Blom - Casera Tintina – Weiss path: chalky rocks (UTM 33T 0324516 5143388). Colmajer wood: rocks (UTM 33T 325572 5143795).

** *Schistidium dupretii* (Thér.) W.A. Weber - Casera Tintina – Weiss path: chalky rocks (UTM 33T 0324516 5143388). Colmajer wood: limestones (UTM 33T 326531 5144326).

Sciuro-hypnum populeum (Hedw.) Ignatov & Huttunen – Colmajer wood: soil (UTM 33T 326531 5144326).

Sphagnum angustifolium (C.E.O. Jensen ex Russow) C.E.O. Jensen - Forcella di Lavardet: peat bog (UTM 33T 318179 5152418).

Sphagnum auriculatum Schimp. Forcella di Lavardet: peat bog (UTM 33T 318106 5152431).

Sphagnum capillifolium (Ehrh.) Hedw. - Forcella di Lavardet: peat bog (UTM 33T 318090 5152513).

Sphagnum centrale C.E.O. Jensen - Forcella di Lavardet: peat bog (UTM 33T 318232 5152300).

Sphagnum compactum Lam. & DC. - Forcella di Lavardet: peat bog (UTM 33T 318179 5152418).

Sphagnum fallax (H. Klinggr.) H. Klinggr. - Forcella di Lavardet: peat bog (UTM 33T 318179 5152418).

Sphagnum girgensohnii Russow - Forcella di Lavardet: peat bog (UTM 33T 318090 5152513).

Sphagnum magellanicum Brid. - Forcella di Lavardet: peat bog (UTM 33T 318106 5152431).

Sphagnum palustre L. - Forcella di Lavardet: peat bog (UTM 33T 318179 5152418).

Sphagnum rubellum Wilson - Forcella di Lavardet: peat bog (UTM 33T 318179 5152418).

Sphagnum russowii Warnst. - Forcella di Lavardet: peat bog (UTM 33T 318106 5152431).

Sphagnum subsecundum Nees - Forcella di Lavardet: peat bog (UTM 33T 318106 5152431).

Straminergon stramineum (Dicks. ex Brid.) Hedenäs – Stua wood: soil (UTM 33T 0324667 5146245). Forcella di Lavardet: peat bog (UTM 33T 318106 5152431). Casera Tintina – Weiss path: moist soil partially flooded (UTM 33T 0324516 5143388).

* *Syntrichia norvegica* F. Weber - Malga Tintina: rocks (UTM 33T 0324516 5143388).

Tetraphis pellucida Hedw. - Stua wood: decaying wood (UTM 33T 0324667 5146245). Malga Tintina: decaying wood (UTM 33T 0324516 5143388). Flobia wood: decaying wood (UTM 33T 0326605 5144154). Colmajer wood: rotten wood (UTM 33T 326617 5144078). Forcella di Lavardet: decaying wood in peat bog (UTM 33T 318232 5152300).

Tortella fragilis (Hook. & Wilson) Limpr. – Stua wood: soil and concrete walls along the path (UTM 33T 0324667 5146245).

Tortella humilis (Hedw.) Jenn. – Malga Tintina: rocky walls (UTM 33T 0324516 5143388).

Tortella tortuosa (Hedw.) Limpr. - Colmajer wood: stumps of *Abies alba* (UTM 33T 326590 5144173), limestones (UTM 33T 326531 5144326), rocks along the road (UTM

33T 325413 5143874). Casera Tintina –Weiss path: humus within *Vaccinium myrtillus* vegetation (UTM 33T 0324516 5143388). Stua wood: walls along the path, soil and scarps (UTM 33T 0324667 5146245).

Tortula subulata Hedw. - Casera Tintina – Weiss path: chalky rocks (UTM 33T 0324516 5143388).

** *Ulota coartata* (P. Beauv.) Hammar - Stua wood: bark of *Picea abies* (UTM 33T 0324667 5146245).

Ulota crispa (Hedw.) Brid. - Stua wood: bark of *Fagus sylvatica* (UTM 33T 0324667 5146245).

Warnstorfia exannulata (Schimp.) Loeske - Stua wood: soil (UTM 33T 0324667 5146245). Forcella di Lavardet: peat bog (UTM 33T 318179 5152418).

Warnstorfia fluitans (Hedw.) Loeske – Forcella di Lavardet: peat bog (UTM 33T 318090 5152513).

Results and discussion

The result of this survey is a checklist of 177 specific and infraspecific *taxa*, which improves the bryological knowledge of the Italian Alps. The checklist includes 53 *Marchantiophyta* and 124 *Bryophyta*, among which 5 liverworts and 5 mosses are new records for the Friuli-Venezia Giulia and 2 mosses for the Veneto. In particular, the new liverwort records from Friuli-Venezia Giulia are *Blepharostoma trichophyllum* subsp. *brevirete*, *Cephaloziella dentata*, *Cephaloziella rubella*, *Saccogyna viticulosa*, *Conocephalum salebrosum*. *Blepharostoma trichophyllum* subsp. *brevirete* is a circumpolar boreo-arctic montane *taxon* reported in Europe for northern countries (Iceland, Finland, Sweden and Norway) and for Poland, Austria, France and Italy,where it was previously recorded only from the Valle d'Aosta and Trentino-Alto Adige regions (Fig. 2a). *Conocephalum salebrosum* is an holoarctic species found for the first time in Italy at Infernaccio gorges in the Marche region (Tacchi & al. 2009); therefore, this record is the second of the species in Italy (Fig. 2b). Moreover, we emphasize the finding of *Saccogyna viticulosa*, known for Tuscany and only by old reports for Piedmont, Lombardy, Emilia Romagna, Lazio, and doubtfully Sardinia (Fig. 2c). As regards the mosses, *Dicranum majus*, *Fissidens serrulatus*, *Oxystegus tenuirostris*, *Schistidium dupretii*, *Ulota coartata* are new records for Friuli-Venezia Giulia. Among these, the finding of *Schistidium dupretii* has an important value for the Italian bryoflora, being hitherto known only from Trentino-Alto Adige and by old records from Val d'Aosta, Piedmont and Veneto (Fig. 2d). The species is considered endangered at Italian level for the Criterion A(iv) (Blasi & al. 2010).

From a phytogeographical point of view, the report of the suboceanic-boreal-montane species *Ulota coartata* is even more interesting, being known in Italy only by old reports from Piedmont, Lombardy, Trentino-Alto Adige and Veneto (Fig. 2e); for this reason it was considered Regionally extinct.

Finally, *Ditrichum gracile* and *Sphagnum angustifolium* are new records for Veneto, thus confirming their occurrence throughout the Italian Alps.

In addition to the new records, 17 species are confirmed for Friuli-Venezia Giulia, some of which particularly interesting for the Italian bryoflora, rare and certainly deserving a

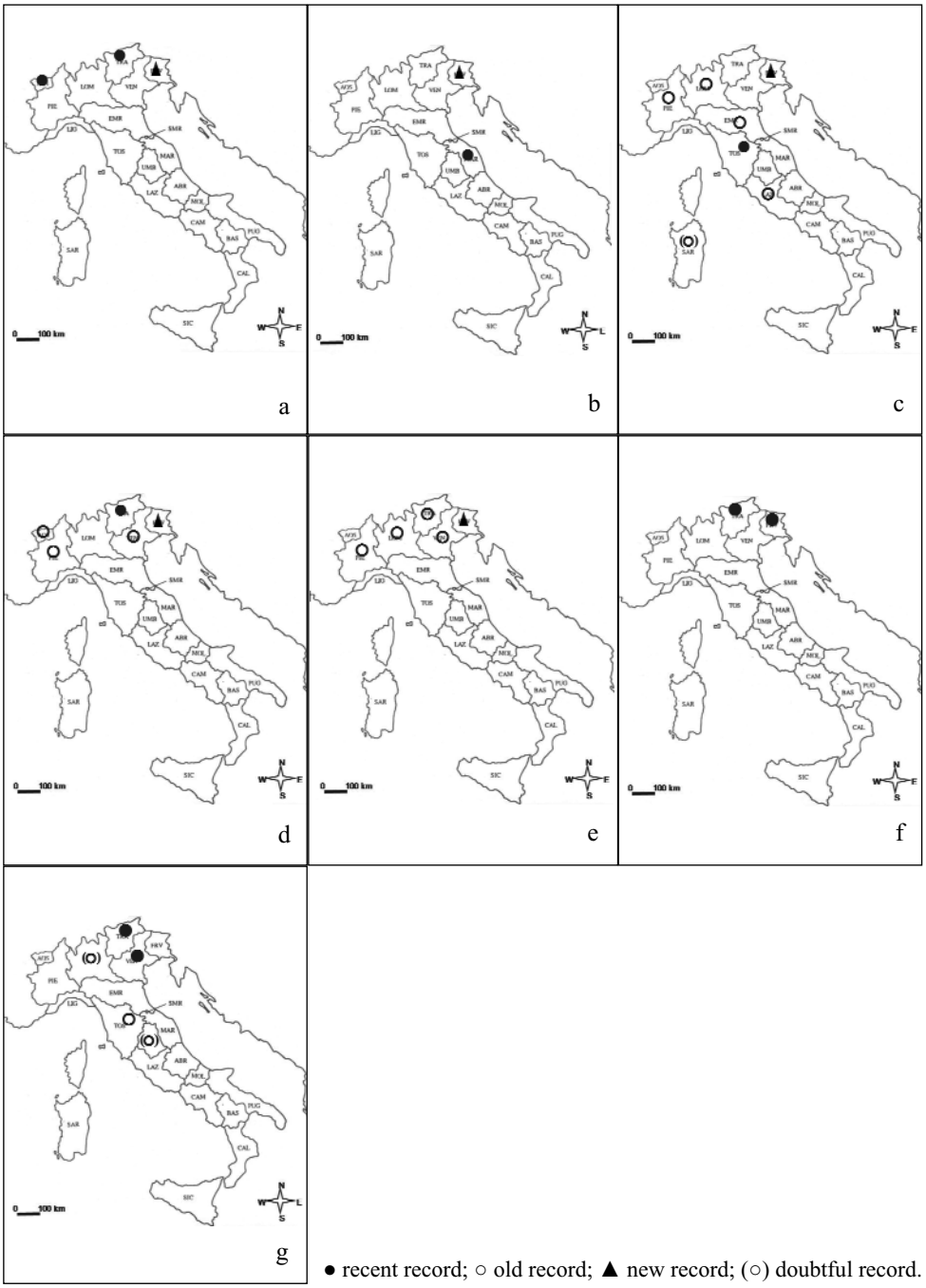

Fig. 2. Italian regional distribution of: a. *Blepharostoma trichophyllum* subsp. *brevirete*; b. *Conocephalum salebrosum*; c. *Saccogyna viticulosa*; d. *Schistidium dupretii*; e. *Ulota coartata*; f. *Mylia taylorii*; g. *Scapania gracilis*.

special protection over time. Among them the liverwort *Mylia taylorii*, considered endangered at Italian level for the Criterion A(iv) in the ambit of the identification and selection of IPAs (Important Plant Areas) (Blasi & al. 2010). It is a suboceanic boreal-montane species, recorded in Italy only for Trentino-Alto Adige and by an old report from Friuli-Venezia Giulia for which it is here confirmed (Fig. 2f). Moreover, *Scapania gracilis*, recorded for Trentino-Alto Adige and Tuscany (old record) and doubtfully for Lombardy, Umbria and Veneto, is confirmed for the latter region. (Fig. 2g). Finally, we quote the finding of *Sphagnum centrale*, considered endangered at European level (Blasi & al. 2010) and *Buxbaumia viridis*, species included on Appendix I of the Bern Convention and on Annex 2 of the EC Habitats and Species Directive and moreover considered Vulnerable in Europe.

Based on the results of this research, the bryophyte flora of Passo Pura shows a ratio liverworts/mosses equals to 0.424, with a relevant liverwort component, according to the climatic features of the investigated area. This value is very high, especially when compared with that of Monte Bondone (Trentino-Alto Adige) which from the paper of Aleffi & Cortini Pedrotti (1996) is deduced to be 0.256. With regard to mosses, the ratio acrocarpous/pleurocarpous is 1.5, a value that is normal. The liverworts belong to many families, as well as the mosses, showing a very diversified bryoflora that reflects the ecological heterogeneity of the investigated environments. In particular, the families of mosses are 30, each including 1 to 12 taxa. The most represented moss families are *Brachytheciaceae*, *Sphagnaceae* and *Pottiaceae* (9.7% each one), followed by *Amblystegiaceae* (8.9%) and then by *Bryaceae* and *Plagiotheciaceae* (5.6% each one).

According to the location of the investigated areas, the Boreo-temperate category prevails (60 species, 35.6%) with 42 Circumpolar, 15 European, 2 Euroasiatic and 1 Euroasiberian species (Tab. 1). The Temperate category (29 species, 17.2%) and the Boreo-arctic-montane category (28 species, 16.7%) are quite well represented, followed by the Boreal-montane category (23 species, 13.7%). As shown in the table, the less represented categories are the Mediterranean occurring only with 4 oceanic species (2.3%) and

Tab. 1. Chorological elements in the investigated area. Abbreviations: 1 Hyperoceanic, 2 Oceanic, 3 Suboceanic, 4 European, 5 Eurosiberian, 6 Eurasian, 7 Circumpolar.

Latitudinal categories	Longitudinal categories							
	1 Hype	2 Ocea	3 Subo	4 Euro	5 Esib	6 Easi	7 Circ	Total (%)
Arctic-montane	-	-	-	-	-	-	1	0.6
Boreo-arctic-montane	-	-	-	4	2	-	22	16.7
Wide-boreal	-	-	-	-	-	-	9	5.2
Boreal-montane	-	-	2	8	-	-	13	13.7
Boreo-temperate	-	-	-	15	1	2	42	35.6
Wide-temperate	-	-	-	-	-	-	3	1.6
Temperate	-	-	3	20	-	-	6	17.2
Southern-temperate	1	2	-	6	2	-	1	7.1
Mediterranean	-	4	-	-	-	-	-	2.3

the Wide-temperate with 3 Circumboreal species (1.6%). Finally, the occurrence of the Circumpolar Arctic-montane species *Syntrichia norvegica* is to emphasize too.

In conclusion, this study has pointed out a rich bryophyte diversity in the Carnic Alps, with a significative set of species rare in Italy. For this reason the Alps can be considered an important site for the biodiversity conservation, surely less affected by human disturbance which is one of the most dangerous cause of biodiversity loss.

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Address of the authors:
Maria Privitera, Marta Puglisi, Alessia Zimbone, Dipartimento di Botanica, Università di Catania, Via A. Longo 19, 95125 Catania.
Michele Aleffi, Roberta Tacchi, SARRF di Scienze Ambientali, c/o Area Ricerca e Sistemi Dipartimentali, Via Gentile III da Varano, 62032 Camerino.
Patrizia Campisi, Alfredo Carratello, Dipartimento di Scienze Botaniche, Università di Palermo, Via Archirafi 38, 90128 Palermo.
Michele Codogno, Dipartimento di Biologia, Università degli Studi di Trieste, Via L. Giorgieri 10, I 34127 Trieste.
Annalena Cogoni, Dipartimento di Scienze Botaniche, Università di Cagliari, Viale S. Ignazio 13, I - 09123 Cagliari.