

THE MOSS FLORA OF A MOUNTAIN BOTANICAL GARDEN IN LIGURIA (NW ITALY):
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ABSTRACT

The moss flora of a small (i.e., 0.6 ha) mountain botanical garden in central Liguria (NW Italy) was investigated in order to draw up the first checklist of the taxa occurring in the site, that belong to a Special Area of Conservation within the Natura 2000 network. The garden, located on an ophiolitic bedrock but offering a great variety of substrates and microhabitats, is intended for vascular plants and there is no Bryophyte species introduced by humans, except for *Sphagnum* spp. Despite this, it presents a remarkable moss specific richness, resulting in a total of 36 taxa. Of these, 2 taxa are new to Liguria and 4 taxa are confirmation for Liguria. Our study suggests that small botanical gardens may be useful for enhancing local and regional bryological knowledge.

KEY WORDS: Botanical Garden, Bryophytes, checklist, Natura 2000, ophiolites, Pratorondanino.

INTRODUCTION

The importance of botanical gardens is widely recognized in many areas of scientific research, education and cultural heritage. In particular, mountain botanical gardens play an important role in nature education, but also in biodiversity conservation (Del Prete, 1996). In fact, they are often located in non-anthropized places, being able to play a significant role in species or habitat conservation. In particular, the mountain botanical garden “Giardino Botanico Montano di Pratorondanino” (hereafter the Garden) accomplishes an important role in the protection and conservation of local flora (Del Prete, 1996; Peccenini, 2005). Although founded and managed for many years by a group of volunteers (i.e., Gruppo Ligure Amatori Orchidee – G.L.A.O.), the Garden was recognized as a protected area of provincial interest (since 1998) and is currently included in a Special Area of Conservation under the Directive 92/43/CEE ‘Habitat’ (IT1331501 Praglia – Pracaban – M. Leco – P. Martin). For a detailed description of the origin and the history of the Garden see G.L.A.O. (2005).

The Garden is dedicated to vascular plants with more than 400 species, including many species of Orchidaceae as well as local endemic species typical of ophiolite substrates and exotic plants of particular value and conservation interest. All these plants are grown in semi-natural settings recreated ad hoc in the early founding years, thus providing a multitude of microenvironments and substrates, despite the small size of the Garden (i.e., 0.6 ha). Through the years, Bryophytes colonized the Garden from the surrounding areas reaching high value of coverage. Considering the fact that high abundance of mosses often reflects high moss species richness (Økland & Økland, 1996; Økland, 2000; Bergamini et al., 2001; Vanderpoorten &

Goffinet, 2009; Vanderpoorten et al., 2010; Glime, 2017) we considered the Garden a good study area to implement the awareness of the mosses occurring in the Liguria region, whose knowledge is currently low compared to the national average (Poponessi et al., 2014). Our main aim was to draw up a checklist of the Bryophytes living in the Garden.

STUDY AREA

The study area coincides with the mountain botanic garden “Giardino Botanico Montano di Pratorondanino”. The Garden is located in an inland area in the north-western Apennines, and more specifically in the Stura valley, in the municipality of Campo Ligure, within the province of Genoa. Its total extension is about 6000 m². Its altitude is 750 m a.s.l. and, despite the proximity to the sea (i.e., about 10 km), the area can be considered as belonging to the sub-mountain zone because of its particularly cold climate (G.L.A.O., 2005). According to the worldwide bioclimatic classification system of Rivas-Martínez (WBCS), the bioclimate is temperate oceanic, with hyperumid ombrotype and supratemperate thermotype (Pesaresi et al., 2017).

The Garden was created in 1979 and was established as a provincial protected area in 1998 (through the *Deliberazione del Consiglio Regionale della Liguria* n. 33 of 13/10/98); the Garden is currently managed by the Metropolitan City of Genoa (formerly the Province of Genoa). Its World Database on Protected Areas (WDPA) code is 178985, while its code in the *Elenco Ufficiale delle Aree naturali Protette* (EUAP) is EUAP1064. The Garden is also included within the Special Area of Conservation IT1331501 “Praglia - Pracaban - M. Leco - P. Martin” within the Natura 2000 network.

The Garden occurs on ophiolitic rocks belonging to the Voltri group, in particular on serpentine with high schistosity (Capponi & Crispini, 2008). There are also several calcareous outcrops, artificially built by the G.L.A.O. for the cultivation of certain vascular species. Also, the dry stone walls bordering an ancient water drainage channel, excavated prior to the foundation of the Garden, provide an additional rocky substrate for Bryophytes. Beyond the geological variability, a high environmental and micro-environmental diversity also contributes to an overall high ecological biodiversity: meadow, woody and aquatic environments can be found in the Garden among the rocky outcrops. From a bryophytic perspective, ecological variability is reflected in a wide range of substrates (such as rock, soil, wood, bark, wetlands etc.) and microhabitats.

MATERIALS AND METHODS

Because of the lack of agreement on Bryophyte sampling methods (Berg et al., 2016), we opted for a simple sampling method, collecting the specimens we found during various inspections in all areas of the Garden. This method ensured good representativeness due to the small size of the study area and its easy overall accessibility. Sampling was carried out in each microhabitat and substrate occurring within the Garden, as is common practice in collecting mosses (Loeske, 1925; Raup, 1926; Newmaster et al., 2005). Investigating microhabitats and substrates separately assure to capture the widest floristic richness. The specimens were deposited in the *Herbarium Universitatis Genuensis* (GE). For each taxon, the status in Liguria (Aleffi et al.,

2024) and the level of protection (Hodgetts et al., 2019) have been checked. The nomenclature of taxa followed Aleffi et al. (2024).

RESULTS

Overall, we collected 74 specimens belonging to 36 species (Tab. 1). Some of these species, such as *Hypnum cupressiforme* Hedw. var. *cupressiforme*, have been found in large amounts throughout the Garden, while others were found as single specimen occurring only in specific environments. The majority of taxa (i.e., 30 taxa) were known to occur in Liguria, while 4 species have to be confirmed for Liguria (i.e., according to Aleffi et al. 2024, no longer reported after 1968) and 2 species are new for Liguria (Tab. 1).

Three species, i.e., *Sphagnum capillifolium* (Ehrh.) Hedw., *Sphagnum palustre* L. and *Leucobryum glaucum* (Hedwig) Ångström, are listed in Annex V of the Habitats Directive 92/43/EEC.

DISCUSSION

As expected, the checklist of the mosses of the Garden highlighted a considerable specific richness despite the small size of the area. The most frequently species was *Hypnum cupressiforme* Hedw. var. *cupressiforme*, a very common species found in a wide variety of environmental conditions (Dierßen, 2001; Cortini Pedrotti, 2006). However, two less common varieties of *Hypnum cupressiforme* (i.e., var. *lacunosum* Brid. and var. *subjulaceum* Molendo) were also found. The peculiar lithology occurring in the Garden, which offers a variety of substrates, is particularly relevant for the biodiversity of bryophytic (as well as vascular) plants: for example, *Hypnum cupressiforme* var. *subjulaceum* is specifically associated to alkaline substrates (Cortini Pedrotti, 2006). Overall, other species related to basic environments have been found, such as *Entodon concinnus* (De Not.) Paris, *Tortella tortuosa* (Hedw.) Limpr. and *Schistidium crassipilum* H.H.Blom. Species related to acid outcrops are also present: for instance, *Dicranoweisia cirrata* (Hedw.) Lindb., *Hypnum resupinatum* Taylor and *Leucobryum glaucum* (Dierßen, 2001; Cortini Pedrotti, 2001; 2006).

The wide availability of different microhabitats is underlined by the diversity of life forms (*sensu* Mägdefrau, 1982) in the Garden. The most commonly found life forms are turf and rough mat, but were also encountered cushion, weft, smooth mat, tuft and dendroid mosses (Hill et al., 2007). On the one hand, mats and wefts (e.g., *Calliergonella cuspidata* (Hedw.) Loeske and *Brachythecium rutabulum* (Hedw.) Schimp. var. *rutabulum*) are generally related to damp habitats, while cushions (e.g., *Grimmia trichophylla* Grev. and *Schistidium crassipilum*) are adapted to water conservation and can therefore colonise sunny and dry environments (Glime, 2017). Finally, the importance of wet areas is underlined by the presence of the two species of *Sphagnum*, which are strictly related to the presence of available water in the soil (Clymo & Hayward, 1982; Cortini Pedrotti, 2001). Although they were artificially introduced into the Garden, they originated an autonomous microhabitat that has persisted for decades within a small wetland. Due to its harvesting and anthropic use over the centuries (Hodgetts et al., 2019), *Sphagnum* genus has been included by the European Union in Annex V of the Habitats Directive (Council Directive 92/43/EEC), i.e., in the list of the species of community interest whose taking

in the wild and exploitation may be subject to management measures. In the same Annex it is also listed *Leucobryum glaucum* (Hedwig) Ångström. This species is reported to be very rare in the Mediterranean region (Aleffi, 2016); it is collected for nursery, decorative or architectural purposes (Aleffi, 2016; Hodgetts et al., 2019), and its current state of conservation in Italy is reported to be unfavourable-inadequate in all three biogeographic regions (Ercole et al., 2021). On the whole, the spontaneity of the bryophytic richness also underlines the notable naturalness of the environments occurring in the Garden.

According to the most recent knowledge, 2 taxa are new to Liguria (Tab. 1). Since Bryophyte species (except for *Sphagnum* spp.) were never voluntarily introduced into the Garden and all these taxa are present in nearby regions (specifically, they are all present in Piedmont), they can be considered spontaneous within the Garden. Thus, this work represents the first record of these taxa within the Liguria region. Similarly, our findings are the confirmation of the presence of four species not reported since 1968 in Liguria (Tab. 1).

The new and confirmed taxa for Liguria are shortly described below. The ecological and chorological information are derived from Dierßen (2001), Smith (2004), Cortini Pedrotti (2001; 2006) and Hill et al. (2007). Altitudinal distribution refers to Italy. Italian distribution refers to Aleffi et al. (2024), while Mediterranean distribution refers to Ros et al. (2013).

New taxa for Liguria:

Brachythecium tommasinii (Sendtn. ex Boulay) Ignatov & Huttunen (Brachytheciaceae): quite rare moss occurring in shaded sites, from the mountain to the alpine zone, usually on basic rocks and stones. Present in Piedmont, Trentino-Alto Adige, Veneto, Friuli-Venezia Giulia (to be confirmed for Lombardy), and in some central and southern Italian regions. Present in some Mediterranean states.

Hypnum cupressiforme Hedw. var. *subjulaceum* Molendo (Hypnaceae): photophytic and cryophytic moss, occurring on basic rocks, from the colline to the alpine zone. Present in Piedmont, Trentino-Alto Adige, Friuli-Venezia Giulia, to be confirmed for Aosta Valley, Lombardy and Veneto. Present in some regions of central and southern Italy, and in some Mediterranean states.

Confirmed taxa for Liguria:

Dicranoweisia cirrata (Hedw.) Lindb. (Rhabdoweisiaceae): photophytic and mesotherm moss, occurring on acidic rocks, occasionally epiphytic, in light sites, from the basal to the mountain zone. Present in every other region of northern Italy except Aosta Valley, and in some central and southern Italian regions. Present in many Mediterranean states. Reported in Borzonasca (province of Genoa) by Fleischer (1893).

Entodon concinnus (De Not.) Paris (Entodontaceae): photophytic moss, usually occurring on basic soil, in light sites, from the basal to the mountain zone. Present in every other region of northern Italy (to be confirmed for Emilia-Romagna and Piedmont), rare elsewhere in Italy. Present in few Mediterranean states. Reported, as *Cylindrothecium concinnum*, in Genoa by De Notaris (1869) and in Sanremo (province of Imperia) by Jäggli (1938).

Table 1: the checklist of the Bryophytes found in “Giardino Botanico Montano di Pratorondanino”.

Taxon	Family	Status in Liguria
<i>Amblystegium serpens</i> (Hedw.) Schimp.	Amblystegiaceae	
<i>Atrichum undulatum</i> (Hedw.) P. Beauv.	Polytrichaceae	
<i>Brachythecium rutabulum</i> (Hedw.) Schimp. var. <i>rutabulum</i>	Brachytheciaceae	
<i>Brachythecium tommasinii</i> (Sendtn. ex Boulay) Ignatov & Huttunen	Brachytheciaceae	New
<i>Calliergonella cuspidata</i> (Hedw.) Loeske	Pylaisiaceae	
<i>Campyliadelphus chrysophyllus</i> (Brid.) R.S.Chopra	Amblystegiaceae	
<i>Climacium dendroides</i> F. Weber & D. Mohr	Climaciaceae	
<i>Dicranella heteromalla</i> (Hedw.) Schimp.	Dicranellaceae	Recently found
<i>Dicranoweisia cirrata</i> (Hedw.) Lindb.	Rhabdoweisiaceae	Confirm
<i>Entodon concinnus</i> (De Not.) Paris	Entodontaceae	Confirm
<i>Fissidens taxifolius</i> Hedw.	Fissidentaceae	
<i>Grimmia trichophylla</i> Grev.	Grimmiaceae	
<i>Hypnum andoi</i> A.J.E.Sm.	Hypnaceae	Recently found
<i>Hypnum cupressiforme</i> Hedw. var. <i>cupressiforme</i>	Hypnaceae	
<i>Hypnum cupressiforme</i> Hedw. var. <i>lacunosum</i> Brid.	Hypnaceae	Recently found
<i>Hypnum cupressiforme</i> Hedw. var. <i>subjulaceum</i> Molendo	Hypnaceae	New
<i>Hypnum resupinatum</i> Taylor	Hypnaceae	
<i>Kindbergia praelonga</i> (Hedw.) Ochyra	Brachytheciaceae	
<i>Leucobryum glaucum</i> (Hedwig) Ångström	Leucobryaceae	
<i>Lewinskya affinis</i> (Schrad. ex Brid.) F.Lara, Garilleti & Goffinet	Orthotrichaceae	Recently confirmed
<i>Microeurhynchium pumilum</i> (Wilson) Ignatov & Vanderp.	Brachytheciaceae	Confirm
<i>Orthotrichum anomalum</i> Hedw.	Orthotrichaceae	
<i>Oxyrrhynchium hians</i> (Hedw.) Loeske	Brachytheciaceae	
<i>Plagiomnium medium</i> (Bruch & Schimp.) T. J. Kop.	Mniaceae	
<i>Plasteurhynchium meridionale</i> (Schimp.) M.Fleisch.	Brachytheciaceae	Recently confirmed
<i>Polytrichum commune</i> Hedw.	Polytrichaceae	
<i>Polytrichum formosum</i> Hedw.	Polytrichaceae	
<i>Ptychostomum capillare</i> (Hedw.) Holyoak & N.Pedersen	Bryaceae	
<i>Rhynchostegium confertum</i> (Dicks.) Schimp.	Brachytheciaceae	
<i>Rhytiadelphus squarrosus</i> (Hedw.) Warnst.	Hylocomiaceae	
<i>Schistidium apocarpum</i> (Hedw.) Bruch & Schimp.	Grimmiaceae	Recently confirmed
<i>Schistidium crassipilum</i> H.H.Blom	Grimmiaceae	Confirm
<i>Sphagnum capillifolium</i> (Ehrh.) Hedw.	Sphagnaceae	
<i>Sphagnum palustre</i> L.	Sphagnaceae	
<i>Tortella tortuosa</i> (Hedw.) Limpr.	Pottiaceae	
<i>Tortula muralis</i> Hedw. subsp. <i>muralis</i> var. <i>muralis</i>	Pottiaceae	

Microeurhynchium pumilum (Wilson) Ignatov & Vanderp. (Brachytheciaceae): sciophytic moss, occurring on basic soil and rocks, from the basal to the mountain zone. Present in Piedmont, Lombardy, Friuli-Venezia Giulia and Emilia-Romagna, to be confirmed for Trentino-Alto Adige. Present in many central and southern Italian regions. Present in many Mediterranean states. Reported as *Eurhynchium pumilum* in Genoa and in Albisola Marina (province of Savona) by Piccone (1863) and in Rapallo (province of Genoa) by Fleischer (1893). Reported as *Rhynchostegium pumilum* in Genoa and near Savona by De Notaris (1869).

Schistidium crassipilum H.H.Blom (Grimmiaceae): common xerophytic moss, occurring on basic rocks, from the basal to the mountain zone. Present in every other region of northern Italy except Aosta Valley, and in many central and southern Italian regions. Present in many Mediterranean states. This species is listed as to be confirmed for Liguria as a result of the taxonomic revision within the *S. apocarpum* complex (Blom, 1996), in which *S. crassipilum* was also described; since for the revision no samples from Liguria were reviewed, and in the absence of subsequent reports, the presence of this species in Liguria was considered uncertain (Aleffi et al., 2020).

Recently found floristic novelties in Liguria

Among the mosses found in the Garden, there are some taxa reported or confirmed for Liguria only recently. Four species were found during a study on the Bryophyte flora of Monte Bignone, municipality of Sanremo, in the province of Imperia (within the project Biodiv'ALP: COBIODIV - Dagnino & Mariotti, 2021), and include *Hypnum cupressiforme* Hedw. var. *lacunosum* Brid. (new to Liguria), *Lewinskya affinis* (Schrad. ex Brid.) F.Lara, Garilleti & Goffinet, *Plasteurhynchium meridionale* (Schimp.) M.Fleisch. and *Schistidium apocarpum* (Hedw.) Bruch & Schimp. (confirmed for Liguria). Moreover, two taxa, i.e. *Dicranella heteromalla* (Hedw.) Schimp. and *Hypnum andoi* A.J.E.Sm., were recently found within the beech forests of Aveto Regional Natural park, in the Ligurian Apennines (Massa et al., 2023). The occurrence of these taxa in the Garden therefore represents the second recent finding for Liguria.

CONCLUSIONS

Our study suggests that botanical gardens, even those exclusively designated to vascular plants, may play an important role in the study and in the conservation of Bryophyte diversity, due to their heterogeneity in terms of substrate and microhabitat. In this regard, small botanical gardens with many indigenous plants and no anthropogenic introduction of mosses can serve as a valuable location to deepen the bryological knowledge of the areas in which they are included, helping to fill knowledge deficits.

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