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RESEARCH ARTICLE

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An updated checklist of the vascular flora of Montagna di Torricchio State Nature Reserve (Marche, Italy)

Sandro Ballelli[1], Riccardo Pennesi[1], Giandiego Campetella[2], Marco Cervellini [2,3], Stefano Chelli[2], Kevin Cianfaglione[2], Domenico Lucarini[1,†], Karina Piermarteri[2], Federico Maria Tardella[1], Andrea Catorci[2], Roberto Canullo[2]

1 *Herbarium Universitatis Camerinensis (CAME), Unit of Plant Diversity and Ecosystems Management, School of Biosciences and Veterinary Medicine, University of Camerino, Camerino, Italy* **2** *Unit of Plant Diversity and Ecosystems Management, School of Biosciences and Veterinary Medicine, University of Camerino, Camerino, Italy* **3** *Department of Biological, Geological and Environmental Sciences, University of Bologna, Bologna, Italy*

Corresponding author: Stefano Chelli (stefano.chelli@unicam.it)

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Abstract

This study aims to increase floristic knowledge of Marche by means of a survey in the Montagna di Torricchio State Nature Reserve (central Italy). The Reserve, located in the central Apennines, covers about 3.2 km^2 at altitudes ranging from 820 to 1,491 m a.s.l. It has been owned and managed as a strict reserve by the University of Camerino since 1970: all the anthropic activities ceased about 50 years ago, except for a minimal area where mowing and cattle grazing are still allowed.

The floristic list consists of 789 specific and subspecific taxa belonging to 81 families and 352 genera. Two species are new for Italy (*Taraxacum calocarpum* and *T. pulchrifolium*) and 14 for Marche regional flora. Compared to previous floristic studies, we found 127 more taxa but we showed a certain stability in the life-form spectrum, suggesting limited effects of dynamic processes related to climate and land-use changes. The negligible number of alien species (11) is probably related to the limitations to anthropic activities in the Reserve. The occurrence of taxa never recorded for Italy and Marche highlights the floristic value of the Reserve for species conservation in the central Apennines.

Keywords

Central Apennines, Endemic species, Floristic diversity, Herbarium CAME, Nature conservation

Introduction

The only comprehensive flora of Marche dates back to the 19th century (Paolucci 1890), but many floristic and phytosociological contributions have been published concerning specific taxa and restricted sectors (Brilli-Cattarini et al. 2005). Accordingly, there are few gaps in floristic knowledge of the Region.

This study refers to the protected area of the Montagna di Torricchio State Nature Reserve (hereafter "Reserve") in the Province of Macerata. It is a mountain district in the Umbria-Marche Apennines. Anthropic activities (agriculture, semi-extensive livestock husbandry and forest cutting) ceased inside the Reserve about 50 years ago, except for a small area where mowing and cattle grazing are still allowed.

The first inventory of the vascular flora of Reserve was published by Ballelli and Francalancia (1982, 1987). Also, bryophytes, lichens, and freshwater algae of this area have been recently investigated (Bartolelli et al. 2003; Panfili 2003; Tacchi et al. 2006; Staffolani and Hruska 2008; Rizzi and Giordani 2010). Despite this, the floristic information regarding the area is still incomplete, and a comprehensive study is necessary. This need is also linked to the cessation of agro-silvopastoral activities, which allowed the activation of ecological processes that have been markedly changing the landscape features of the area and the coenological composition of the plant communities, dynamics that have been one of the subjects of research in the Reserve since its institution (Ivan et al. 1994; Francalancia et al. 1995; Catorci et al. 2012a; Wellstein et al. 2014; Tardella and Catorci 2015; Chelli et al. 2016, 2019; Cervellini et al. 2017).

Moreover, the Reserve is located on the northern side of the Sibillini Mountains National Park, and in the midst of significant pastoral landscapes where shepherding and forest management are still active (Catorci et al. 2012a). A nodal point between the Apennines and the influence of the Mediterranean climate that rises from the Nera River Valley, this area is a potential hot spot for the Marche biodiversity and an important laboratory for understanding the modifications due to variations in climate and landscape use.

Accordingly, the goals of this research are to compile a checklist of the vascular flora of Reserve and to perform a first evaluation of the changes that have occurred in the last decades.

Study area

The Torricchio Reserve extends over about 3.2 km^2 (centroid coordinates 42°57'21"N, 13°01'03"E; Suppl. material 1: 1.1), along the Val di Tazza in the basin of the Chienti River (central Apennines, Italy). The altitude of the study area ranges from 820 m ("Le Porte") to 1,491 m a.s.l. (Monte Cetrognola). In the lowest valley sector, the mountain slopes are very steep and rocky, whereas in the high Val di Tazza the slopes are less steep, and the mountain tops semi-flat.

The study area has been a Biogenetic Reserve since 1979; in 1991 it was acknowledged as a State Nature Reserve and, at present, is encompassed inside the Special

Area of Conservation (SAC) "IT5330022 – Montagna di Torricchio" and in the Special Protection Area (SPA) "IT5330030 – Valnerina, Montagna di Torricchio, Monte Fema e Monte Cavallo" of the Natura 2000 network. Since 2006, it has been part of the worldwide network for Long-Term Ecosystem Research (ILTER, LTER Italy: LTER_EU_IT_033 "Montagna di Torricchio").

Geology

The geological substrate is mainly composed of limestones. In very steep south-facing slopes, the soils are 25 cm-deep at most, very rich in debris, and basic to neutral. In less steep slopes, especially the northerly ones, soils are up to 40–50 cm-deep, with high organic matter content and have neutral to sub-acid pH. The flat areas in the bottom of the valley have very deep (over 1 m), clayey, totally decarbonated soils, without skeleton, whose pH ranges from sub-acid to weakly acid (Deiana and Pieruccini 1976; Kwiatkowski and Venanzoni 1994).

Climate

From the bioclimatic viewpoint, the study area is included in the lower and upper Supratemperate bioclimatic belts (Pesaresi et al. 2017) and is characterized by winter cold stress and summer drought stress (Orsomando et al. 2000). The mean annual temperature is around 11 °C (Chelli et al. 2019); the mean annual precipitation is about 1,250 mm (Venanzoni 2003), with two peaks in spring and autumn and a minimum in summer with a slight drought period from mid-July to August, particularly on south-facing slopes (Chelli et al. 2019; Suppl. material 1: 1.2).

Vegetation types

The vegetation is mainly composed of forests, shrublands, and grasslands (Francalancia 1976; Venanzoni and Kwiatowski 1994; Venanzoni et al. 1999; Borfecchia et al. 2003; Gafta 2006; Suppl. material 1: 1.3). Forest communities cover the slopes of the lower Val di Tazza. *Ostrya carpinifolia* Scop. forests and mixed forests with *O. carpinifolia* and *Quercus pubescens* Willd. are widespread up to about 1,000 m in north-facing and south-facing slopes, respectively; *Fagus sylvatica* L. forests extend over about 1,000 m a.s.l. Grasslands are widespread on the slopes and semi-flat lands of the upper Val di Tazza, interrupted by beech copses and shrubland communities characterised by *Cytisophyllum sessilifolium* (L.) O.Lang, *Spartium junceum* L., and *Prunus spinosa* L. The main grassland types are characterized by *Bromopsis erecta* (Huds.) Fourr. on the south-facing slopes, *Sesleria nitida* Ten. on the driest and steepest slopes with shallow soils, *B. erecta* and *Briza media* L. on north-facing slopes and semi-flat lands of the mountain

tops, *Brachypodium rupestre* (Host) Roem. & Schult., on deeper soil conditions. There are *Cynosurus cristatus* L. dominated hay meadows, mown in July and then open to cattle grazing, in a small area of the upper Val di Tazza. Other habitats include rocky walls and gorges with *Quercus ilex* L. shrubs and chasmophytic vegetation, nitrophilous and hygro-nitrophilous communities, ruderal environments, and some springs and small depressions with stagnant water.

Over the centuries, the Val di Tazza has been a source of timber for the villages, while the high mountain slopes have been an important place of spring and summer sheep grazing, followed by transhumance of flocks to the Tyrrhenian coast for the winter. Since 1970, the study area has been owned and managed by the University of Camerino, and traditional activities such as sheep and cow grazing and coppicing have been prohibited except in a small flat area covered by hay meadows, which is regularly mown (see also Pedrotti 1978, 1981, 1994, 2010).

Materials and methods

To update and increase the floristic knowledge of the study area, 77 floristic field surveys in 1987–2018 (all in the period April–October) were carried out.

The collected plants were identified using standard floras (Fiori 1923–1929; Zangheri 1976; Tutin et al. 1964–1980, 1993; Pignatti 1982; Pignatti et al. 2017a, 2017b, 2018, 2019; Castroviejo et al. 1986–2019; Tison and de Foucault 2014). To identify samples belonging to critical groups, we used specific taxonomic studies (Grau 1970; Tornadore and Garbari 1979; Chrtekjun 1992; Puppi and Cristofolini 1996; Del Carratore et al. 1998; Garbari et al. 2003, 2007; Peruzzi et al. 2007; Brullo et al. 2009; Arnelas and Devesa 2011; Ardenghi et al. 2014, 2015a, 2015b; Arrigoni 2014; Roma-Marzio et al. 2015, 2017; Conti et al. 2019; Bartolucci et al. 2020). Some herbarium specimens belonging to critical genera were sent to specialists for revision: *Alchemilla* L. (G. Tondi, Rome), *Festuca* L. (I. Markgraf-Dannenberg, Zurich), *Hieracium* L. and *Pilosella* Hill (G. Gottschlich, Tübingen), *Rosa* L. (J. Milbradt, Erlangen), *Rubus* L. (A. Gilli, Vienna), *Taraxacum* F.H.Wigg. (J. Štěpánek and J. Kirschner, Prague), *Thymus* L. (F. Bartolucci, L'Aquila).

The *exsiccata* of collected plants are stored in the 'Sandro Ballelli' Herbarium, part of the *Herbarium Universitatis Camerinensis* (CAME).

The nomenclature of the floristic list (Suppl. material 1: 1.4) follows the updated checklists of the vascular flora native (Bartolucci et al. 2018a, 2018b, 2018c, 2019a, 2019b) and alien (Galasso et al. 2018a, 2018b, 2018c, 2019a, 2019b) to Italy, with the exception of native hybrids, not considered in the above-mentioned checklists. Life forms and chorological types were deduced from Pignatti (1982), Pignatti et al. (2017a, 2017b, 2018, 2019) and Aeschimann et al. (2004).

The systematic order of the families follows Bartolucci et al. (2018c) and Galasso et al. (2018a). Taxa are ordered alphabetically within each family. For each taxon the following information is reported: accepted name, endemic, cryptogenic and/or alien status, conservation status, life form and chorology.

Abbreviations or symbols used in the floristic list (Suppl. material 1: 1.4) are:

E Italian endemic (Peruzzi et al. 2014, 2015; Bartolucci et al. 2018c)
A Alien taxa: [CAS (occurring as a casual alien in the studied area), NAT (occurring as a naturalized alien in the studied area), INV (occurring as an invasive alien in the studied area)]
C Cryptogenic (doubtfully native taxon, whose origin of occurrence in Italy is unknown)
* new record for the study area
** new record for Marche regional flora
*** new record for Italy
# confirmed for Marche regional flora

Results

The checklist consists of 789 species and subspecies, distributed in 81 families and 352 genera (Suppl. material 1: 1.4). Forty-six taxa are endemic to Italy (Suppl. material 1: 1.5), and only 11 are alien (including one cryptogenic taxon; Suppl. material 1: 1.6).

The most represented families are Asteraceae (112 taxa), Poaceae (73 taxa), Fabaceae (66 taxa), Rosaceae (40 taxa), Lamiaceae (39 taxa), Caryophyllaceae (37 taxa), and Brassicaceae (36 taxa). The richest genera are *Trifolium* (18 taxa) and *Hieracium* (14 taxa), *Carex*, *Galium*, *Poa* and *Ranunculus* (10 taxa) and *Cerastium* (9 taxa).

One hundred twenty-seven taxa are new for the study area, and among which two species are new for Italy (*Taraxacum calocarpum* Sonck and *T. pulchrifolium* Markl.; Suppl. material 1: 1.7) and 14 for Marche (*Pinus sylvestris* L. (alien), *Dianthus carthusianorum* L. subsp. *carthusianorum*, *Primula intricata* Gren. & Godr., *Salvia virgata* Jacq., *Cirsium vulgare* (Savi) Ten. subsp. *vulgare*, *Hieracium bifidum* Kit. ex Hornem. subsp. *subimbricatum* Gottschl., *H. caesioides* Arv.-Touv. *s.l.*, *H. murorum* L. subsp. *anisobasis* Gottschl., *H. murorum* L. subsp. *heteroserratum* Gottschl., *H. pietrae* Zahn, *Pilosella densiflora* (Tausch) Soják, *Taraxacum parnassicum* Dahlst., *T. perincisum* (Murr) Murr, *T. rubicundum* (Dahlst.) Dahlst. Three taxa, *Luzula sylvatica* (Huds.) Gaudin subsp. *sieberi* (Tausch) K.Richt., *Bromopsis transylvanica* (Steud.) Holub and *Alyssum diffusum* Ten. subsp. *diffusum*, are confirmed for the Marche regional flora. Fifty-three taxa are included in the IUCN Red List of the Italian Flora (Rossi et al. 2013; Orsenigo et al. 2018, 2020).

The life-form spectrum (Suppl. material 1: 1.8) of the flora shows a dominance of hemicryptophytes (50.9%) and therophytes (19.2%), while less represented are the geophytes (13.3%), phanerophytes (7.8%), chamaephytes (6.3%), and nanophanerophytes (2.5%).

Regarding chorological types (Suppl. material 1: 1.9), the checklist includes 31.3% of European, 26.7% of Eurasian, 24% of Mediterranean, 7.0% of Boreal, and 6.3% of Endemic taxa, while Asian, Atlantic, and wide-distribution taxa are less than 5%.

Discussion

Ballelli and Francalancia (1982, 1987), in their floristic studies, recorded 685 taxa for the study area, 23 of which are not confirmed in the present study. The updated checklist consists of 789 taxa, corresponding to about 21.5% of the regional vascular flora (Bartolucci et al. 2018c; Galasso et al. 2018a). The low number of alien species, mainly casual, indicates that the strict nature reserve management has had a positive filtering effect.

Among the 53 taxa included in the IUCN Red List of the Italian Flora, only one (*Fritillaria montana* Hoppe ex W.D.J.Koch) is considered as Near Threatened (NT), 44 taxa are classified as Least Concern (LC), while 8 taxa are considered as Data Deficient (DD; Rossi et al. 2013; Orsenigo et al. 2018, 2020).

As far as life-form spectrum is concerned, the dominance of hemicryptophytes (50.9%) confirms the mountain character of the flora. This could be explained considering that around 230 ha (73% of the Reserve area) are covered by grasslands, where hemicryptophytes reach their ecological optimum (Pinzi 1995). The contribution of therophytes (19.2%), mostly concentrated in the lower and rocky sites of the Reserve, testifies to the typical Mediterranean aspect of the current flora. It is worth noting that the frequency of geophytes (13.2%) is near the upper threshold value for continental and Mediterranean Europe, ranging from 10 to 15%, as proposed by Pichi-Sermolli (1948). Phanerophytes and nano-phanerophytes account for 10.3% and reflect the distribution of woods and shrubs in the Reserve (Canullo and Venanzoni 1989; Canullo and Spada 1996). Chamaephytes (6.4%) are related to the only three peaks that reach moderate altitudes, namely the low slopes of Monte Fema (1,250 m), Colle Rotondo (1,377 m) and Monte Cetrognola (1,491 m).

Concerning the analysis of chorotypes, the Eurasian taxa, together with the European and, to a lesser extent, the Boreal ones, remained dominant compared to values reported by Ballelli and Francalancia (1982, 1987), reaching a cumulative value of 65%. This result confirms the mountain and continental character of the flora. On the contrary, the Mediterranean element appears to be less represented (24%) than in the previous floristic list (24.9%). There is a low percentage of Atlantic taxa (2.3%), which could be considered as a western biogeographical connection group. Species with a wide distribution range account for very limited value (1.6%) as do the alien taxa (11 species, 1.4%); the latter result indicates weak anthropic influence. Finally, the distributions of 2 taxa (0.3%) have yet to be well-defined.

Conclusions

The goals of this research were to compile a checklist of vascular plants of the protected area of the Montagna di Torricchio State Nature Reserve and evaluate changes that have occurred in the last decades from a floristic point of view. Overall, we found 789 *taxa*, mainly hemicryptophytes and principally with Eurasian, European, and Boreal chorotypes, confirming the mountain and continental character of the flora.

Despite the identification of 127 more *taxa* than the previous floristic survey, we have observed a certain stability in the life-form spectrum structure. This suggests that dynamic processes related to climate change and the cessation of human activities have had a minimal effect at the studied spatial scale (see also Chelli et al. 2019). In particular, the negligible number of alien species is probably related to the weak impact of the anthropic influence. In Italy, 19.5% of the national vascular flora is non-native *taxa*, while in the Marche Region it is only about 14% (Galasso et al. 2018a). Analyses of the impact of alien species on terrestrial systems in LTER-Italy sites showed that both abiotic filters imposed by environmental conditions and competition with the native community pose certain limits to the spread of alien species (Malavasi et al. 2018).

The new species reported for Italy and the Marche Region, along with the occurrence of several rare species, highlight the role of the Reserve for species conservation in the central Apennines.

Floristic studies are foundational for the ongoing research in the Reserve and neighbouring areas, and provide a reference for the ecological processes underway in the Apennine area (Bracchetti et al. 2012; Catorci et al. 2012b; Troiani et al. 2016; Malatesta et al. 2019). Such continuously updated studies fulfil the Reserve's objective of increasing knowledge about natural processes, and contribute to long-term studies of the LTER-Italy network (Rogora et al. 2018).

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Supplementary material 1

Supplementary materials

Authors: Sandro Ballelli, Riccardo Pennesi, Giandiego Campetella, Marco Cervellini, Stefano Chelli, Kevin Cianfaglione, Domenico Lucarini, Karina Piermarteri, Federico Maria Tardella, Andrea Catorci, Roberto Canullo

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