

THE VASCULAR FLORA OF THE FORESTE CASENTINESI, MONTE FALTERONA, CAMPIGNA NATIONAL PARK (NORTHERN APENNINES, ITALY): UPDATING THE CHECKLIST

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Plant species inventories are crucial for botanical research and plant conservation, as they provide fundamental data regarding the measurement and distribution of biodiversity. To be effective, floristic lists must be prepared and continuously updated at global and local level. For these reasons, this study was aimed to update and discuss the vascular plant list of the flora of the Foreste Casentinesi, Monte Falterona, Campigna National Park, an important Italian Protected Area located in the Northern Apennines (Italy). We implemented the existing checklist published in 2010 (with data updated to 2008) by analysing both published and unpublished data up to 31.12.2023. We also carried out some museum checks on exsiccata in the Central Italic Herbarium of Florence and in other herbaria. The study was also aimed to verify whether the updated native and alien floristic richness of the area resulted to be higher or lower than expected. In total, the number of species recorded are 1415. Of these, 1172 species from 100 families are considered native confirmed by data obtained after 1960, while others can be distinguished as non-native to the Foreste Casentinesi, Monte Falterona, Campigna National Park territory (mostly cultivated), doubtful, or in some cases excluded. There was an increase of 58 species compared to 2010, of which 45 are native. According to the best performing species-area formula with respect to vascular plant species, in the Foreste Casentinesi, Monte Falterona, Campigna National Park the native floristic richness resulted to be a little higher than expected (1172 against 1159). At the same time, the alien floristic richness (naturalised and invasive species, as no casuals were detected) resulted to be much lower than expected (24 against 109), reinforcing the already well-known great conservation value of this area. The extent of the Foreste Casentinesi, Monte Falterona, Campigna National Park's phytodiversity is confirmed to be very high. This is caused by the fact that this territory hosts forest ecosystems of great value, considered among those best preserved at European level, and has a geographical position that makes it a connection between two very differentiated floristic contingents, one coming from the north (Alps, Northern Apennines) and the other from the south (Italian Peninsula, Central and Southern Apennines). The updated characteristics of the chorology shows in fact that various plants in Italy have their southern or northern distribution limit here. However, the Italian endemism that characterises the flora is essentially north-Apennine and peninsular (3.1%), while the most consistent chorotype, in percentage terms, is the European *sensu lato* (> 25.5%). The life-form spectrum, the presence of rare, conservation-interest, doubtful and alien species are also updated and discussed. The characteristics of all the confirmed flora and of the flora of conservation interest with respect to the various habitats are outlined. The updated checklist provides the Foreste Casentinesi, Monte Falterona, Campigna National Park with an essential database to manage this territory, and quite precisely quantified the plant diversity present here. Moreover, it has highlighted the lacunae in floristic knowledge, towards which future research should be directed, giving information about rare plants, species not reported after 1960, and taxa, which need to be studied taxonomically more in depth, since the flora varies over time and the checklists, like any other information tool, must be implemented and continuously improved.

Key words: chorology, conservation, distribution, floristic inventory, plant taxonomy, Protected Area

Introduction

Plant species inventories are crucial for botanical research and plant conservation, as they provide fundamental data regarding the measurement and distribution of biodiversity (Mace, 2004; Funk, 2006; Smith & Figueiredo, 2010; Peruzzi, 2018; Borsch et al., 2020; Wagensommer, 2023). To be effective, inventories must be prepared and continuously updated at global (e.g. Govaerts et al., 2021; Schellenberger Costa et al., 2023), national (e.g. Buttler & Hand, 2008; Danihelka et al., 2012; Dimopoulos et al., 2013; 2016; Niketić et al., 2018; Bartolucci et al., 2018; 2024; Galasso et al., 2018, 2024;

Baasanmunkh et al., 2022; Odorico et al., 2022) and regional level (e.g. Anzalone et al., 2010; Hand et al., 2019, 2024; Beierkuhnlein et al., 2021).

Also on a local scale, each Protected Area requires a high level of knowledge to be able to best implement the conservation and promotion policies of its territory, and, therefore, species inventories have been carried out in many Protected Areas (e.g. Conti, 1995; Anzalone et al., 1997; Conti et al., 2020; Boychuk, 2021). For this reason, the Foreste Casentinesi, Monte Falterona, Campigna National Park has promoted numerous research initiatives over time regarding the naturalistic components, including the

vascular flora. Since 2005, the Foreste Casentinesi, Monte Falterona, Campigna National Park Authority has in fact commissioned a project to find, gather and update all the information relating to the reports of floristic species in its territory, aimed at creating an updated checklist and a computerised database of the vascular flora. This was done not because the floristic information was poor but, on the contrary, because it was a lot but highly non-homogeneous, in terms of type of source, date, nomenclature, and was therefore difficult to use. This project also led to the publication of a summary study (Viciani et al., 2010), which represented the first comprehensive list of the vascular flora of the Foreste Casentinesi, Monte Falterona, Campigna National Park.

The area named in the past «Foreste Casentinesi», considered in their broadest sense (so only partially coinciding with the current Foreste Casentinesi, Monte Falterona, Campigna National Park territory), have a very ancient history. The first data date back to 1012, a year, when, according to an uncertain tradition, the first monastic nucleus of the Camaldolesi settled in the area (Padula & Crudele 1988; Padula, 1995; Cavagna & Cian, 2003). However, it is certain that the monks expanded their property to a large part of this area, spread the cultivation of *Abies alba* Mill., prevented the growth of *Fagus sylvatica* L., and took care of the forest and developed a rigorous forestry code. Thus, they can be recognised as the initiators of the traditional *Abies alba* cultivation, considered a model to be followed until recent time. The subsequent events have been a subject of accurate and exhaustive historical reconstruction in various studies, which contain further information and insights (Cacciamani, 1965; Clauser, 1965; Siemoni, 1975; Gabbrielli & Settesoldi, 1977; Gabbrielli, 1978; Padula, 1983; Cavagna & Cian, 2003).

There are numerous scholars, who have carried out excursions and collected specimens in this area. As early as 1557, the famous botanist Ulisse Aldrovandi passed through Mt. Falterona and La Verna while travelling towards the Sibillini mountains (Pampanini, 1924; Pichi Sermolli, 1998), and at least one specimen (*Eryngium amethystinum* L.) in Andrea Cesalpino's Herbarium, probably one of the oldest in the world, dated 1563, comes from La Verna site (Cesalpino, 1583; Pichi Sermolli, 1998). Linnaeus (1753) described *Tozzia alpina* L. on basis of samples coming from this area, expressly citing Micheli (1729), with whom he was in contact (Viciani & Nepi, 2019). Since the list of scholars is very long, we refer to the study by Viciani et al. (2010), which contains an exhaustive examination of the

botanists, studied and/or published reports for this territory until 2009.

In 2010–2024, there have been numerous and important additional floristic reports and new data coming from taxonomic studies (e.g. Gonnelli & Bottacci, 2012; Viciani et al., 2013, 2021; Arrigoni, 2014; Nardi, 2015; Buldrini et al., 2017; Peruzzi et al., 2017, 2018, 2019, 2021; Gestri et al., 2021; Laghi et al., 2023; Pica & Laghi, 2023; Lastrucci et al., 2024). The Authority of the Foreste Casentinesi, Monte Falterona, Campigna National Park also continued its policy and promoted the constant updating of data, so new locations were added to the already known flora. Moreover, in this period, species nomenclature has often profoundly changed, passing from that of Pignatti (1982a,b,c) to that of the Portal to the Flora of Italy (2023). The aim of this study was to produce and implement a new commented floristic checklist, updated to 31.12.2023. Moreover, since D'Antraccoli et al. (2024) recently highlighted and adapted for Italy the best performing species-area formula with respect to vascular plant species, another task was to verify if, according to this formula, the updated native and alien floristic richness resulted to be higher or lower than expected.

Material and Methods

The physical environment

The Foreste Casentinesi, Monte Falterona, Campigna National Park territory covers an area of 368 km², divided more or less equally between Romagna and Tuscany (Fig. 1). It is situated across the Apennines and, therefore, it has a predominantly mountainous and sub-mountainous character. The highest peak is reached on Mt. Falco (1657 m a.s.l.) and Mt. Falterona (1654 m a.s.l.), while the minor altitudes are around 500 m a.s.l., with even lower peaks (see also Fig. S1 in Electronic Supplement 1). The Romagna territory is characterised by narrow, steep, embedded valleys, while the Tuscan territory is characterised by more gentle slopes and includes a small part of Mugello, a part of Casentino (which encompasses the upper River Arno valley, which springs are situated on the southern slopes of Mt. Falterona), and a continuation towards the east reaching the altitudes of the famous Franciscan Sanctuary of La Verna. More detailed information about orography, morphology, hydrography, and other characteristics can be found in Padula & Crudele (1988), Padula (1995), Cavagna & Cian (2003) and on the website of the Foreste Casentinesi, Monte Falterona, Campigna National Park (www.parcoforestecasentinesi.it).

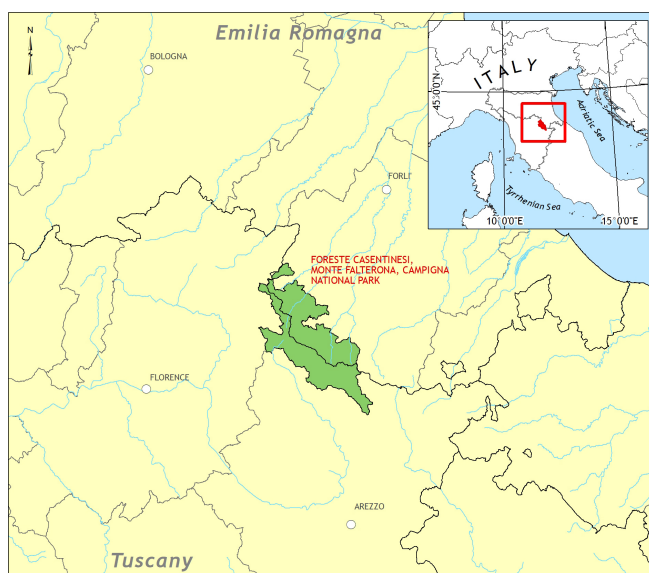


Fig. 1. Geographical position and limits of the Foreste Casentinesi, Monte Falterona, Campigna National Park, located in the northern Apennines between Tuscany and Emilia Romagna administrative regions (Italy).

Four main geological formations are present in the study area (Carmignani et al., 2013). Most of the Tuscan side is formed of sandstone (known as «Macigno»), divided in two types, namely Chianti sandstone, particularly at higher altitudes, formed of siliceous sandstone with low percentages of limestone, and Mugello sandstone, formed of silty schists and at lower levels of marl and fine siliceous and calcareous sandstone. The La Verna altitudes in the south-eastern Tuscan part of the Foreste Casentinesi, Monte Falterona, Campigna National Park are formed of solid «Alberese» limestone, which emerges above a chaotic series of clayey rocks. The Romagna side is more homogenous because sandstone-marly flysch formations are more widespread, formed of sandstones, siltstones and marls with intercalations of calcareous clasts and marly limestone. In the study area, there are also other geological formations, though with limited surfaces.

At the highest thermos-pluviometrical stations (Campigna and Camaldoli, at an altitude of about 1100 m a.s.l.), the annual average temperature ranges between 8°C and 8.4°C. The annual precipitation is very high, over 1750 mm (Padula & Crudele, 1988). Towards the crests, the difference in altitude accounts for lower temperature values and probably much higher rainfall values, while at lower altitudes there is an opposite trend. In general, the climate of the study area can be defined as a mountain type climate, not distinctly oceanic nor continental, with mesic temperature and heavy rainfall, which both reach their maximum between October and February and their minimum between June and August. Winters are relatively severe. Summers are relatively cool and humid, and the an-

nual temperature range is quite mild, although in recent decades global climate change has led to an increase in temperature in this area, too (Meteoblue, 2023). In terms of bioclimatic approach, the study area mostly falls within the temperate oceanic bioclimate, and only to a minimal extent, at lower altitudes, in the temperate sub-Mediterranean (Pesaresi et al., 2017).

The vegetation of the study area

The vegetation of the entire territory is characterised from a physiognomic point of view by large forest areas, many of which are of high conservation interest. It is well known the case of Sasso Fratino, the first integral Italian nature reserve, included in 2017 by the UNESCO Commission in the World Heritage Site among the old European beech forests, within the serial site «Ancient and Primeval Beech Forests of the Carpathians and Other Regions of Europe». However, there are also various and peculiar non-forest types in the study area, such as grasslands and pastures, shrublands, riparian and aquatic vegetation. Moreover, there are also important reforestations and arboretums in the study area (Crudele et al., 2002). Numerous vegetation-related studies relating to some areas or to some vegetation types of this territory are reported in the literature, from fundamental (e.g. Zangheri, 1966) to many others, referred in Viciani et al. (2010). The Foreste Casentinesi, Monte Falterona, Campigna National Park has also sponsored, for internal uses, the creation of a vegetation map of its area, with a scale of 1 : 10 000, of which a derived map with a scale of 1 : 50 000 (Verdecchia et al., 2009) and the descriptive notes (Viciani & Agostini, 2009) have been published. Further information is present in some subsequent vegetation studies (e.g. Lelli et al., 2021; Viciani et al., 2022; Lastrucci et al., 2023), that have been taken into account in the present study.

The floristic information included in this study was obtained by analysing both published and unpublished studies, which are reported in the bibliography of the floristic list in Electronic Supplement 1. The data are updated to 31.12.2023. The information was selected when it expressly or reasonably referred to localities that are completely or partly situated within the study area. Further information on the considered floristic data is present in Viciani et al. (2010). The nomenclature of species is given in accordance with the Portal to the Flora of Italy (2023). In agreement with the latter, the published data were generally considered still current, when they were dated after 1960. When it was possible to clarify some doubts, museum checks were carried out. Specifically, we visited the Central Italic Herbarium of Florence (Herbarium

Centrale Italicum, FI; the international abbreviations of herbaria are in accordance with Thiers, (2023), the Herbarium of La Verna (Herbarium Alvernae) preserved at the homonymous Franciscan Sanctuary, and the Herbarium Zangherii, stored in the herbarium of the Civic Museum of Natural History of Verona (VER). When the only information was derived from unpublished sources, like degree theses, phytosociological surveys or other similar sources, and no specimen that could be checked was available, the reports were considered as data to be confirmed. Many clarifications have been specified case by case in the notes to the species in Electronic Supplement 1.

In addition to the scientific name of the plants and the list of locations, the following information has been characterised. Raunkiaer (1934) life form classification is provided according to Pignatti (1982a,b,c) and Pignatti et al. (2017a,b, 2018, 2019), with the following groups: chamephytes, geophytes, hemicryptophytes, hydrophytes, helophytes, phanerophytes, and therophytes. Chorological categories are based on Pignatti (1982a,b,c) and Pignatti et al. (2017a,b, 2018, 2019), simplified as follows: cosmopolitan/wide distribution, boreal, Eurasian, European, European Orophile, South-European, South-European Orophile, South European-Mediterranean, Mediterranean, Mediterranean Orophile, and Apennine Endemic species. Non-native plants were distinguished in cultivated (known only in the culture) and alien species. According to their status in Tuscany and Emilia-Romagna, alien species were sub-divided in alien invasive and alien naturalised (no alien casual was found). The habitats, around which the taxa gravitate primarily, have been distinguished on the following groups: non-acid shrubs and bushes; acidophilic heaths and shrubs; mesophilic woods (e.g. beech woods, mixed woods) and their borders and clearings; humid woods, riparian tree communities and their borders and clearings; relatively thermoxerophilic woods and their borders and clearings; high-altitude semi-mesophilic grasslands; grasslands in the steep rocky areas close to the crest; humid and hay meadows, tall herb edge communities, riparian herbaceous plant communities; dry grasslands; rocks, both heliophilous and sciaphilous rocky environments, walls, stony ground soils, talus slopes; ruderal and sinanthropic environments, including uncultivated land in the first post-cultivation stages and weeds in cultivated land; ponds, water bodies with hydrophytes.

In the list of plant species (Electronic Supplement 1), we indicated, whether the taxon is doubtful, excluded or reported before 1960 and not found again after this year, and whether it is rare in the study area and, if its presence is of phytogeographic importance.

We also indicated, if the taxon is included in some attention lists of local conservation interest (see also Electronic Supplement 1) and/or in the most recent Italian Red Lists (Rossi et al., 2013, 2020). In this case, the national threat status is indicated with the abbreviations accepted by IUCN (2012).

To verify whether the native and alien floristic richness of the study area resulted to be higher or lower than expected, we refer to D'Antraccoli et al. (2024). They compared many formulas and found that the best performing species-area formula with respect to vascular plant species resulted to be the Arrhenius' Power function ($S = c \times A^z$). They calculated the constants for native ($c = 245.2$ and $z = 0.263$) and alien ($c = 10.1$ and $z = 0.404$) species in Italy, so we could apply this formula to our data.

Results and Discussion

The complete floristic list, reported in Electronic Supplement 1, is made up of 1415 taxa. Of them, 77 species are cultivated non-native plants. Eleven species were excluded and 131 species are doubtful or not found after 1960. Without considering excluded, doubtful and cultivated plants, the flora is made up of 1172 native and 24 alien species. The confirmed native taxa are divided into 100 families. The most numerous families are Asteraceae (138 species), Poaceae (107 species) and Fabaceae (89 species). Lamiaceae (55 species), Rosaceae (54 species), Caryophyllaceae (47 species), Apiaceae (46 species), Brassicaceae (46 species) and Orchidaceae (49 species) are also well represented. Compared to Viciani et al. (2010), there was an increase in 58 new taxa, of which 45 species were native due to the inclusion of new floristic records. This is also caused by changes in species status in the opposite direction. For instance, *Ribes petraeum* Wulfen or *Anacamptys laxiflora* (Lam.) R.M. Bateman, Pridgeon & M.W. Chase, regarded as confirmed, were recently considered doubtful, as reported in Viciani (2012) and Pica & Laghi (2023). Table 1 shows a summary of the data comparing the 2008 list and the 2023 checklists.

Detected and expected floristic richness

According to the formula proposed by D'Antraccoli et al. (2024), in the Foreste Casentinesi, Monte Falterona, Campigna National Park the native floristic richness (Fig. 2) resulted to be a little higher than expected (1172 against 1159 species). At the same time, alien floristic richness (casual, naturalised and invasive species) resulted to be much lower than expected (24 against 109 species). This data reinforce the already well-known great conservation value of the study area.

Table 1. The flora of the Foreste Casentinesi, Monte Falterona, Campigna National Park: data from the floristic lists of 2008 and 2023 compared

Parameters	Viciani et al. (2010)	Present study
Total number of species	1357	1415 (+58)
Confirmed native species	1127	1172 (+45)
Non-native cultivated species	74	77 (+3)
Alien species	18	24 (+6)
Doubtful occurring species at present (including species not confirmed after 1960)	138	131 (-7)
Excluded species	0	11 (+11)
Families	97	100 (+3)

The life-form spectrum

The life-form spectrum (Fig. 3) shows very similar values to those found in 2008 (Viciani et al., 2010). In accordance with the climatic-environmental position of the study area, it shows a clear prevalence of hemicryptophytes (45%). Therophytes account for approximately 23% of the total number of species; they are most likely distributed prevalently in open areas of the lower altitudes. Geophytes and phanerophytes are well represented (15% and 11%, respectively), while chamaephytes remain below 5%. Hydrophytes and helophytes increase slightly (from 0.9% to 1.2%), compared to the previous floristic list (Viciani et al., 2010); although wetlands are very rare, small and fragmented in the study area, recent research has increased the list of aquatic and marsh species (e.g. Buldrini et al., 2017; Viciani et al., 2022; Lastrucci et al., 2023).

As it had already been highlighted previously (e.g. Viciani et al., 2010), if we calculate the life-form spectrum relating to the forest flora alone, in addition to a notable proportion of phanerophytes (26%), we also have a very high proportion of geophytes (28%). In boreal deciduous broadleaf forests, this is an indication of habitat maturity, as the nemoral geophytes are adapted to inhabit fully-developed forest habitats (Ferrari et al., 1979; Walter, 1979; Blasi et al., 1990). In accordance with Midolo et al. (2024), in these forests hemicryptophytes are always dominant (41%), while therophytes decrease strongly (3%).

The chorological spectrum

The general chorological spectrum is shown in Fig. 4. It is very similar to that presented in Viciani et al. (2010), although there are some differences. The most represented chorotype is the European sensu lato species (> 25.5%), within which the South-European Orophiles (5.4%) and the South-Europeans (3.5%) have the largest proportions, followed by the Eurasian (19.1%) and the Boreal (12.4%) ones.

The elements of connection between the Boreal and Tethys sub-kingdoms are also important, among which the South European-Mediterranean one stands out (18%), while the Mediterranean spe-

cies are present in a low proportion (6.1%). The European Orophiles and the South-European Orophiles, together with the Mediterranean Orophiles, despite having not too high proportion (less than 10% in total), characterise the flora of the study area in an orophilous sense. The Apennine endemic taxa (> 3%) constitute a small part compared to the other groups. But they represent a very important component from a phytogeographic point of view. Among Apennine endemic taxa, there are plants with various distributions. For instance, there are punctiform endemisms limited to the study area and Abruzzo (e.g. *Hieracium dentatum* Hoppe subsp. *xanthostylophorum* Furrer & Zahn); taxa common in the whole of Italy and Corsica (e.g. *Robertia taraxacoides* (Loisel.) DC.) or distributed between Northern Italy and the central Apennines (e.g. *Tephrosieris italica* Holub, *Sedum monregalense* Balbis); species centrally distributed in the northern Apennines, which reach their southern or eastern limit in the study area (e.g. *Festuca violacea* Schleich. subsp. *puccinellii* (Parl.) Foggi, Graz., Rossi & Signorini, *Murbeckiella zanonii* (Ball) Rothm., *Sesleria pichiana* Foggi, Graz. Rossi & Pignotti); taxa common between the northern and central Apennines (e.g. *Festuca inops* De Not., *Centaurea arrigonii* Greuter, *C. nigrescens* Willd. subsp. *pinnatifida* (Fiori) Dostál), species distributed more or less over the entire Italian Peninsula (e.g. *Polygala flavescens* DC., *Arenaria bertolonii* Fiori, *Viola eugeniae* Parl.). The endemic taxa that characterise this flora are essentially distributed in the Apennines and on the Italian peninsula. Indeed, as already noted previously (Viciani et al., 2010), although several species from the Tuscan-Emilia Apennines and the Alps reach this territory, the study area is phytogeographically closer to the peninsular Apennines than to the more northern Apennines, also because numerous northern Apennine endemic taxa are missing in the Foreste Casentinesi, Monte Falterona, Campigna National Park (e.g. *Armeria arenaria* (Pers.) F.Dietr. subsp. *marginata* (Levier) Arrigoni, *Primula apennina* Widmer, *Festuca riccerii* Foggi & Gr.Rossi; see Alessandrini et al., 2003).

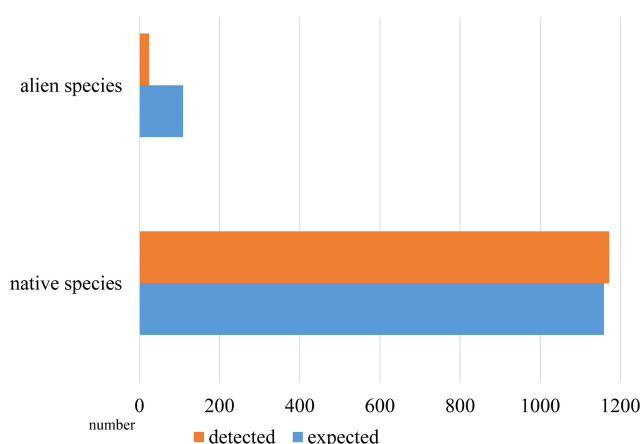


Fig. 2. The detected and expected floristic richness of the Foreste Casentinesi, Monte Falterona, Campigna National Park, Italy based on to the formula proposed by D'Antraccoli et al. (2024).

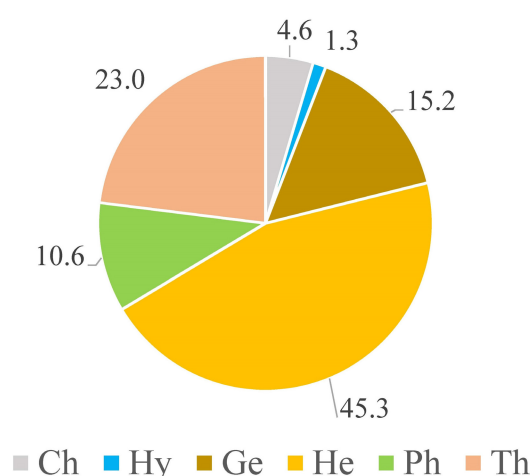


Fig. 3. The life-form spectrum of the flora of the Foreste Casentinesi, Monte Falterona, Campigna National Park, Italy. Designations: Ch – chamephytes, Hy – hydrophytes and helophytes, Ge – geophytes, He – hemicryptophytes, Ph – phanerophytes, Th – therophytes.

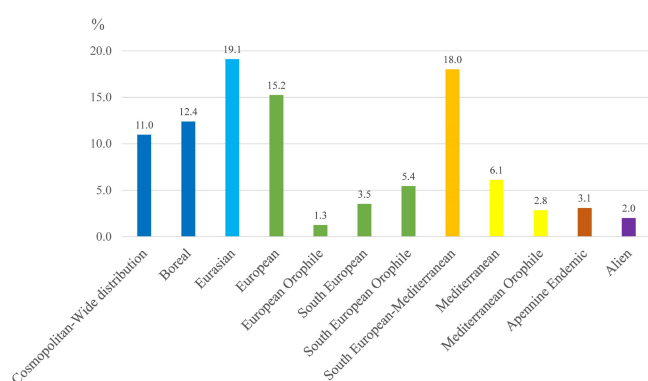


Fig. 4. The chorological spectrum of the flora of the Foreste Casentinesi, Monte Falterona, Campigna National Park, Italy.

Alien species

The plants considered non-native in the study area amount to 101 taxa, most of which are cultivated in arboretums, reforestations, woods or farming and urbanised environments. Only a small part of them (24 species) reproduces naturally in

the study area, and can be defined as alien plants. According to Richardson et al. (2000), Blackburn et al. (2011) and to the Portal to the Flora of Italy (2023), they can be divided to naturalised and invasive species (see Fig. 5), as no casual species was detected. Amongst the naturalised alien plants, the herbaceous plants to be mentioned are, for example, *Brunnera macrophylla* (Adams) I.M. Johnston, *Oenothera glazioviana* Micheli, *Bromopsis inermis* (Leyss.) Holub, which have been reported more or less recently (see Frignani et al., 2006; Peruzzi et al., 2017, 2021; Laghi et al., 2023). At the same time, among naturalised trees *Pinus nigra* J.F. Arnold often tends to actively reproduce in pastures and open areas on calcareous substrata, *Pinus pinaster* Aiton often colonises open areas and low-altitude degraded forests on siliceous substrates, while *Alnus cordata* (Loisel.) Duby and *Juglans regia* L. sometimes spread in meso-hygrophilous environments and along water courses. Invasive alien plants are not numerous, but they must be carefully monitored. In this respect, the herbaceous plants to be mentioned are *Erigeron canadensis* L. and *Artemisia verlotiorum* Lamotte for ruderal environments, while *Paspalum distichum* L. and *Helianthus tuberosus* L. for riparian and wet habitats. Among trees, *Ailanthus altissima* (Mill.) Swing., *Robinia pseudacacia* L. and *Acer negundo* L. have the ability to spread quickly in various types of environments by transforming them. The relatively few alien taxa in this territory are the result of the further spread of already established invasive species and, again in the last 15 years, of accidental escapes from ornamental, horticulture and reforestation activities, which represent the main primary introduction pathway of alien plants in Europe (Arianoutsou et al., 2021; Galasso et al., 2024).

As above shown in Fig. 4, alien species form only 2% of the confirmed flora, confirming the good naturalness and conservation value of this territory. As for their areas of origin, more than half come from America, particularly North America (Fig. 6).

Rare species, phytogeographical and conservation interest species

The geographical position of the Foreste Casentinesi, Monte Falterona and Campigna National Park makes this area a connecting territory between two very differentiated floristic contingents. In fact, several species, which presence is of phytogeographical interest, have in Italy their southern or northern distribution limit in the study area.

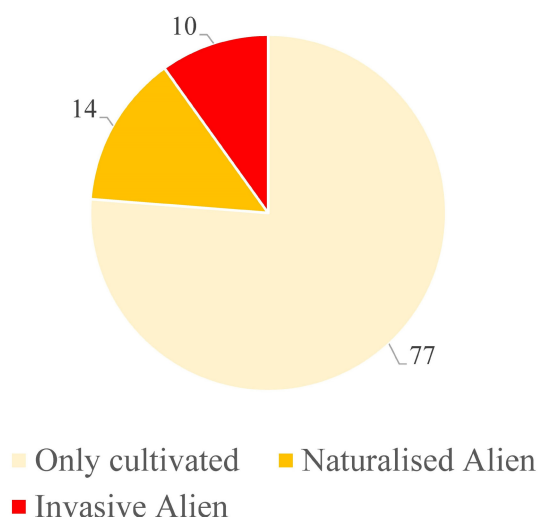


Fig. 5. The structure of non-native flora in the Foreste Casentinesi, Monte Falterona, Campigna National Park (Italy) subdivided in only cultivated, naturalised and invasive species.

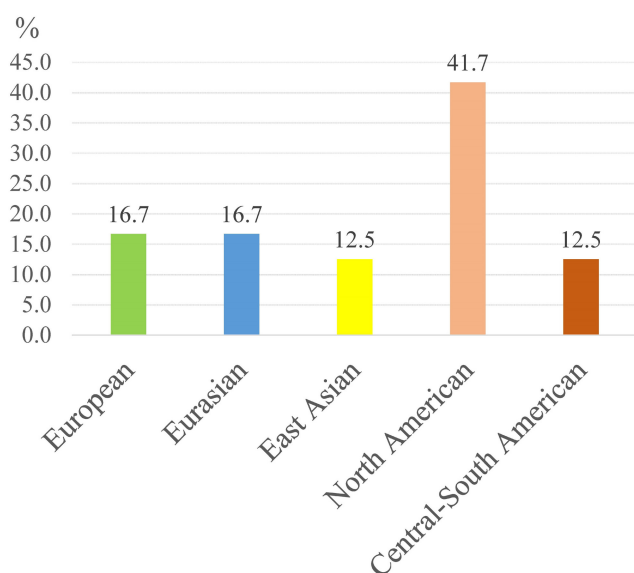


Fig. 6. The original distribution of alien species detected in the Foreste Casentinesi, Monte Falterona, Campigna National Park, Italy.

Among the vascular plant taxa, which are on their southern border in the study area, the following examples can be mentioned: *Alnus incana* (L.) Moench, *Cardamine trifolia* L., *Allium victorialis* L., *Festuca violacea* subsp. *puccinellii*, *Murbeckiella zanonii*, *Sesleria pichiana*, *Tozzia alpina*, and *Vaccinium vitis-idaea* L. Also among ferns and fern allies, some species are situated on their southern border in the study area, namely *Lycopodium clavatum* L., *Spinulum annotinum* (L.) A.Haines, *Phegopteris connectilis* (Michx.) Watt., *Dryopteris expansa* (K. Presl) Fraser-Jenkins et Jermy, and *Matteuccia struthiopteris* (L.) Tod. can be mentioned (Gonnelli, 2005; Landi et al., 2016). On the other hand, some plants (e.g. *Ribes mul-*

tiflorum Kit. ex Roem. & Schult., *Carex macrolepis* DC., *Leucopoa dimorpha* (Guss.) H.Scholz & Foggi) have their northern or north-eastern distributional limit in the study area.

The species considered as rare in the floristic list are numerous. Many of them are rare within the Foreste Casentinesi, Monte Falterona, Campigna National Park, but not in Italy and Europe. This is the case of several stenomediterranean species which, due to climate and altitude reasons, are very rare in the study area, but not in other places. Of a similarly relative rarity are those plants belonging to environments that are scarcely present in the study area, like aquatic habitats (e.g. *Potamogeton* spp., *Myriophyllum spicatum* L.) or traditionally agricultural systems, which have now reduced considerably (e.g. *Agrostemma githago* L., *Delphinium consolida* L., *Centaurea cyanus* L.). However, among the latest reports there are also plants of absolute rarity present in aquatic environments (*Hottonia palustris* L., *Utricularia australis* R.Br., *Carex pseudocyperus* L.). The species that are rare both in the study area and in the Apennines are more interesting from the conservation point of view. To the taxa already mentioned as of phytogeographic interest, we can add, for example, *Anemonastrum narcissiflorum* (L.) Holub, *Trollius europaeus* L., *Isopyrum thalictroides* L. There are also a lot of taxa considered rare, at least in the whole of Italy, both because they are naturally not widely spread (e.g. *Streptopus amplexifolius* (L.) DC., *Epipogium aphyllum* Sw., *Neottia cordata* (L.) Rich., *Ruscus hypoglossum* L.) and because of reduction or changes in the preferred habitats (e.g. *Carex strigosa* Huds., typical of mature riparian woods, which are always becoming more rare). The Authority of the Foreste Casentinesi, Monte Falterona, Campigna National Park has promoted the setting up and updating of a geodatabase, which collects the list of species considered to be of interest with all the known georeferenced locations (Viciani et al., 2018).

Most of the above-mentioned taxa are also of conservation interest, as they are included in various national and regional lists. Specifically, among the confirmed native species, there are 91 taxa included in the Emilia Romagna regional law 2/1977, 175 species in the annexes of the Tuscany regional law 56/2000 (currently the same as the subsequent law 30/2015), 41 species in the Repertorio Naturalistico Toscano project (Regione Toscana, 2023), and 73 taxa in the old regional Red List (Conti et al., 1997). In addition, 46 taxa are included in the new national red lists, of which 8 species in Rossi

et al. (2013) and 38 species in Rossi et al. (2020). Most of these categories overlap. Some of the taxa are listed in the new national red lists because they are included in European lists, and not all are of particular interest or rarity (e.g. *Ruscus aculeatus* L., *Himantoglossum adriaticum* H.Baumann, *Galanthus nivalis* L.), while others are more or less rare and of conservation relevance (e.g. *Hottonia palustris* L., *Epipactis palustris* (Mill.) Crantz, *E. purpurata* Sm., *Orchis provincialis* L.). Several species are endemic to Italy (e.g. *Arenaria bertolonii*, *Arisarum proboscideum* (L.) Savi, *Tephrosieris italica*) but not all of these are particularly rare or of interest at a local level (e.g. *Festuca inops*, *Sesleria italica* (Pamp.) Ujhelyi).

Data on the number of species of conservation interest at European/Italian level and at regional/local level are present in Fig. 7. Various conservation risk categories for the species included in the Italian Red Lists are reported in Fig. 8.

Characteristics of the flora in various environments

When the confirmed native flora has been divided into a percentage basis according to the habitat preferences of species (Fig. 9), we found that, even in this forest context, most of the taxa belong to herbaceous communities, primarily those of dry grasslands and sinanthropic-ruderal environments. Even when the habitats are grouped according to the main types, we can see that species preferring habitats of herbaceous communities are about 66% of the total number, while species preferring forest habitats are about 27%, and species preferring shrubland habitats are about 6%.

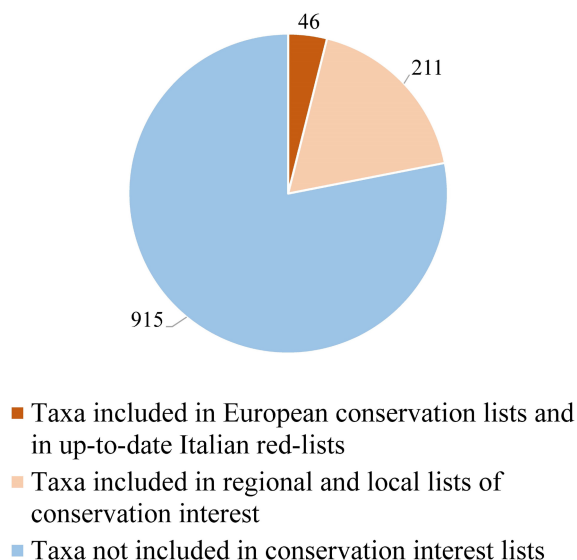


Fig. 7. The number of species of conservation interest at European/Italian level and at regional/local level detected in the Foreste Casentinesi, Monte Falterona, Campigna National Park, Italy.

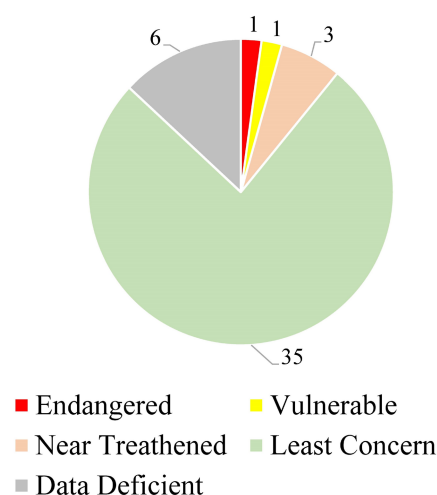


Fig. 8. Various conservation risk categories for the species included in the Italian Red Lists of the Foreste Casentinesi, Monte Falterona, Campigna National Park, Italy.

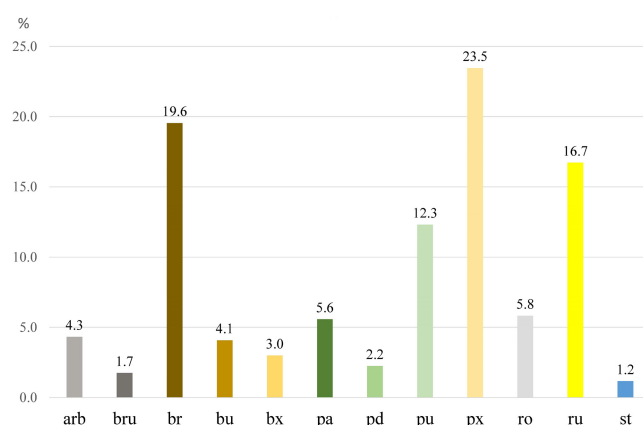


Fig. 9. The flora of the Foreste Casentinesi, Monte Falterona, Campigna National Park (Italy) subdivided with reference to habitat preferences. Designation of habitats: arb – non-acid shrublands; bru – acidophilic heathlands and shrublands; br – mesophilic woods; bu – humid woods, riparian tree coenoses; bx – relatively thermo-xerophilic woods; pa – high altitude semi-mesophilic grasslands; pd – grasslands in the steep rocky areas close to the crest; pu – humid and hay meadows, tall herb edge communities, riparian herbaceous coenoses; px – dry grasslands; ro – rocky environments, walls, stony ground soils, talus slopes; ru – ruderal and sinanthropic environments; st – ponds, water bodies.

If only the species of conservation importance are considered (in total, i.e. species both of national and local interest), it is interesting to note (Fig. 10) that herbaceous habitats, particularly dry grasslands, upper mountain and altitude mesophilic and humid grasslands, together with rocky environments, have the highest conservation value, containing about 58% of the important plants. The largest number of taxa of conservation interest (27%) belongs to mesophilic forests that confirms the importance of nemoral flora in the study area.

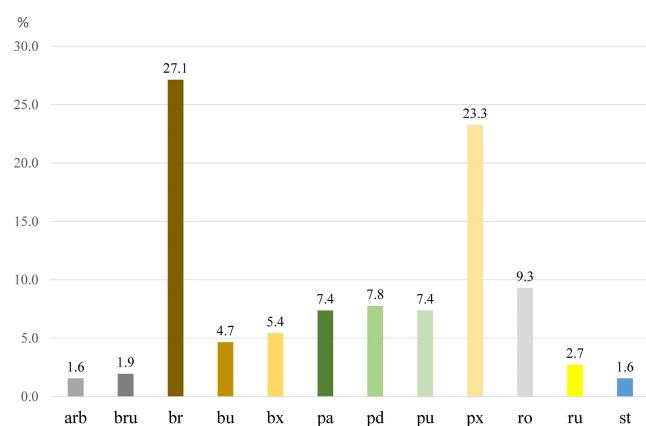


Fig. 10. The flora of conservation interest of the Foreste Casentinesi, Monte Falterona, Campigna National Park subdivided with reference to habitat preferences. Designation of habitats: arb – non-acid shrublands; bru – acidophilic heathlands and shrublands; br – mesophilic woods; bu – humid woods, riparian tree coenoses; bx – relatively thermo-xerophilic woods; pa – high altitude semi-mesophilic grasslands; pd – grasslands in the steep rocky areas close to the crest; pu – humid and hay meadows, tall herb edge communities, riparian herbaceous coenoses; px – dry grasslands; ro – rocky environments, walls, stony ground soils, talus slopes; ru – ruderal and sinanthropic environments; st – ponds, water bodies.

Excluded and doubtful species

Species to be excluded are 11, while doubtful (including not reported after 1960) species are 131 in total. The few species considered excluded (e.g. *Helictochloa praetutiana* (Parl. ex Arcang.) Bartolucci, F.Conti, Peruzzi & Banfi, *Cirsium palustre* (L.) Scop., *C. bertolonii* Spreng., *Oreoselinum nigrum* Delarbre) are the result of some investigations carried out on exsiccata in herbaria (mainly FI and VER), which did not allow us to confirm the identification. Regarding doubtful species, a lot of information refers to problems related to nomenclature, because some names, like *Festuca ovina* L. sensu lato or *Alchemilla vulgaris* L. sensu lato, were previously used to identify plants of the same group, which were later better defined and correctly named. A small part of the species has most probably been reported on the basis of identification errors, but their exsiccata were not found in the herbaria (e.g. *Luzula pedemontana* Boiss. & Reut., *Oloptum miliaceum* (L.) Röser & H.R.Hamasha, *Festuca robustifolia* Mgf.-Dbg., *Ribes petraeum*; see also Viciani, 2012; Viciani & Gonnelli, 2015). Some plants, which are likely to be present in the study area (e.g. *Mentha arvensis* L., *Erysimum pseudorheticum* Polatschek, *Carduus chrysacanthus* Ten.), have been considered doubtful because they have been reported in degree theses or in unpublished data, and specimens could not be verified. The species, which have not been found after 1960, are mostly the result of old reports,

often already quoted by Zangheri (1966) on the basis of specimens from the second half of XIX century or early XX century, or just quoted and not found again recently, and therefore cannot be confirmed. A part of the non-confirmed reports consists of crop commensal plants, which were once present on the upper mountain, where various farming activities took place. Today these activities have disappeared almost completely. However, some data of interest about the presence of taxa of conservation importance can also be taken from this list. For example, the only certain location in Tuscany, even though outdated, of *Arabis auriculata* Lam. was reported by Fiori (1924, 1925) based on his own specimens dated by 1923 and traced and checked at the Herbarium Centrale Italicum (FI).

Conclusions

Even though the floristic importance of this area was well-known, compiling and continuous updating the checklist, provided the Foreste Casentinesi, Monte Falterona, Campigna National Park with an essential database to manage the territory. We could quite precisely quantify the plant diversity present in the study area, which has turned out to be remarkable, and analyse its essential characteristics. Moreover, we highlighted the gaps in floristic knowledge, towards which future research should be directed, giving information about rare plants, species not reported after 1960, and taxa, which need to be studied systematically in more details. In addition, the checklist has also been used as a database in reintroduction projects (Abeli et al., 2017) and for more in-depth spatial analyses on rare and interesting species (Viciani et al., 2018). However, the new data resulting from the updating of the last 15 years demonstrate that the study of the plant species in this territory certainly cannot be considered as finalised. It is because the flora varies over time and the checklist, like any other information tool, must be implemented and continuously improved to keep the knowledge of the vascular flora of this important area updated.

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Supporting Information

Additional data for the paper of Viciani & Alberti (2024) may be found in the **Supporting Information**.

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ФЛОРА СОСУДИСТЫХ РАСТЕНИЙ НАЦИОНАЛЬНОГО ПАРКА «ФОРЕСТЕ-КАСЕНТИНЕЗИ, МОНТЕ-ФАЛЬТЕРОНА И КАМПИНЬЯ» (СЕВЕРНЫЕ АПЕННИНЫ, ИТАЛИЯ): ОБНОВЛЕННЫЙ СПИСОК ВИДОВ

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Инвентаризация видов растений имеет решающее значение для ботанических исследований и сохранения растений, поскольку она предоставляет фундаментальные данные об оценке и распространении биоразнообразия. Для большей эффективности флористические списки должны составляться и постоянно обновляться как на глобальном, так и на локальном уровнях. Поэтому целью данного исследования стало обновление и обсуждение списка сосудистых растений флоры национального парка «Форесте-Касентинези, Монте-Фальтерона и Кампинья», важной особо охраняемой природной территории (ООПТ), расположенной в Северных Апеннинах (Италия). В данной работе представлен актуальный список видов сосудистых растений, опубликованный в 2010 г. (по данным на 2008 г.), дополнив его как опубликованными, так и неопубликованными данными по состоянию на 31.12.2023 г. Также была проведена инвентаризация некоторых музейных экземпляров в Центральном итальянском гербарии Флоренции, а также в других гербариях. Исследование также было направлено на проверку того, оказалось ли обновленное видовое богатство аборигенной и чужеродной флоры территории исследования выше или ниже ожидаемого. Всего было зарегистрировано 1415 видов. Из них 1172 вида, относящихся к 100 семействам, считаются аборигенными, подтвержденными данными, полученными после 1960 года, в то время как другие можно отнести к чужеродным растениям на территории национального парка «Форесте-Касентинези, Монте-Фальтерона и Кампинья» (в основном культивируемым), сомнительным или, в некоторых случаях, исключенных из флоры. По сравнению с 2010 г. количество видов увеличилось на 58, из которых 45 таксонов являются аборигенными. Согласно формуле оценки соотношения видов и площади в отношении видов сосудистых растений, в национальном парке «Форесте-Касентинези, Монте-Фальтерона и Кампинья» видовой богатство аборигенной флоры оказалось несколько выше ожидаемого (1172 против 1159 видов). В то же время видовое богатство чужеродной флоры (натурализовавшиеся и инвазионные виды, поскольку случайно занесенные виды не были обнаружены) оказалось намного ниже ожидаемого (24 против 109 таксонов), что в очередной раз подтверждает высокую природоохранную ценность этой территории. Подтверждено, что фиторазнообразие национального парка «Форесте-Касентинези, Монте-Фальтерона и Кампинья» очень велико. Это обусловлено тем, что на этой территории находятся лесные экосистемы большой природоохранной ценности, считающиеся одними из наиболее сохранившихся на европейском уровне, а также тем, что географическое положение данной ООПТ делает ее связующим звеном между двумя сильно различными флористическими комплексами, один из которых происходит с севера (Альпы, Северные Апеннины), а другой – с юга (Итальянский полуостров, Центральные и Южные Апеннины). Характеристики хорологии обновленной флоры данной ООПТ показывают, что различные растения в Италии находятся здесь на своей южной или северной границе ареала. Однако итальянский эндемизм, характеризующий данную флору, в основном североапеннинский и полуостровной (3.1%), в то время как европейский хоротип является наиболее обширным (> 25.5%). Также проведено обсуждение спектра жизненных форм, наличия редких, имеющих природоохранную ценность, сомнительных и чужеродных видов. Представлены характеристики флоры всех достоверно подтвержденных видов и видов, представляющих интерес для сохранения в отношении различных типов местообитаний. Обновленный список видов предоставляет национальному парку «Форесте-Касентинези, Монте-Фальтерона и Кампинья» необходимую базу данных для управления этой территорией и довольно точно количественно определяет разнообразие растений, известных здесь. В данной работе также выявлены пробелы в знаниях о флоре, на устранение которых следует направить будущие исследования, предоставив информацию о редких растениях, видах, не зарегистрированных после 1960 г., и растений, которые необходимо более подробно изучить с таксономической точки зрения, поскольку флора меняется с течением времени, а таксономические списки, как и любой другой источник информации, необходимо использовать и постоянно улучшать.

Ключевые слова: инвентаризация флоры, особо охраняемая природная территория, распространение, сохранение, таксономия растений, хорология