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INDICE - *CONTENTS*

F. Buldrini, D. Ubaldi, D. Dallai, G. Pezzi – Flora of the Balze di Verghereto, Monte Fumaiolo and Ripa della Moia.
Flora delle Balze di Verghereto, Monte Fumaiolo e Ripa della Moia. pag. 5

N. Biscotti, G. Del Viscio, D. Bonsanto – Ethnobotanical study on the traditional use of wild plants in a mountainous area of the Apulia region (Subappennino Dauno, Foggia province).
Indagine etnobotanica sull'uso alimentare tradizionale di piante selvatiche in un comprensorio montano della regione Puglia (Subappennino Dauno, provincia di Foggia). » 17

M.L. Gargano, G. Venturella, S. Lazzara, R. Lo Nardo, P. Saporita – Ethnobotanical knowledge in some rural communities of northern Sicily (Palermo, Italy).
Indagini etnobotaniche in alcune comunità rurali della Sicilia settentrionale (Palermo, Italia). » 31

A. Pistoia, D. Innamorati, P. Bertolotto – Preliminary research on the environmental impact of feral goats (*Capra hircus L.*) in protected areas.
*Indagine preliminare sull'impatto ambientale della Capra domestica inselvatichita (*Capra hircus L.*) in aree naturali protette.* » 41

M.L. Gargano, G. Domina, G. Venturella – The neglected Herbarium of Emanuele Taranto Rosso (Sicily, 1801-1887).
L'Erbario dimenticato di Emanuele Taranto Rosso (Sicilia, (1801-1887). » 49

S. Maccioni – The manuscripts of Botanic Museum of Pisa. "Studi per una Flora Economica della Provincia Pisana" by Vincenzo Carmignani (1779-1859).
I manoscritti del Museo Botanico pisano. La Serie "Studi per una Flora economica della provincia pisana" di Vincenzo Carmignani (1779-1859). » 55

L. Peruzzi, D. Viciani, C. Angiolini, G. Astuti, E. Banfi,M.R. Bardaro, E. Bianchetto, G. Bonari, S. Cannucci, D. Cantini, P. Castagnini, M. D'Antraccoli, A. Esposito, G. Ferretti, T. Fiaschi, B. Foggi, G. Franceschi, G. Galasso, G. Gottschlich, L. Lastrucci, L. Lazzaro, F. Maneli, D. Marchetti, G. Marsiaj, M. Mugnai, F. Roma-Marzio, M. Ruocco, G. Salvai, A. Stinca, G. Bedini – Contributions for a vascular flora of Tuscany. X (606-663).
Contributi per una flora vascolare di Toscana. X (606-663) » 67

G. Bonari, F. Selvi, F. Minniti, F. Frignani, C. Angiolini – Contribution to the vascular flora of Castelvecchio Nature Reserve (central Tuscany, Italy).
Contributo alla flora vascolare della Riserva Naturale di Castelvecchio (Toscana centrale, Italia). » 77

A. Stinca, M. Ravo, V. Giacanelli, F. Conti – Additions to the vascular flora of the islands of Procida and Vivara (Campania, southern Italy).
Integrazioni alla flora vascolare delle isole di Procida e Vivara (Campania, Sud Italia). » 87

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CONTRIBUTION TO THE VASCULAR FLORA OF CASTELVECCHIO NATURE RESERVE (CENTRAL TUSCANY, ITALY)

Abstract - *Contribution to the vascular flora of Castelvecchio Nature Reserve (central Tuscany, Italy).* This study reports the outcomes of botanical surveys of vascular plants carried out in the Castelvecchio Nature Reserve, located in the Municipality of San Gimignano (Siena province). The Reserve has an extension of 6.28 km^2 with a predominance of calcareous bedrock. The compiled floristic inventory of the Reserve includes 454 species and subspecies, divided into 73 families and 185 genera. Data on life forms and chorological types are provided. The life-form spectrum revealed a dominance of hemicryptophytes followed by terophytes, whereas the chorological spectrum showed a majority of species with Eurasiatic distribution as opposed to a Mediterranean one, in line with the local macro and microclimatic conditions. Rare species in central Tuscany – such as *Cleistogenes serotina* subsp. *serotina, Ononis natrix* and *Phagnalon sordidum* – and two species on the Italian Red List – *Galanthus nivalis* and *Ruscus aculeatus* – were recorded. Also of interest is the occurrence of phytogeographically relevant entities as *Taxus baccata* and populations of *Fagus sylvatica* subsp. *sylvatica* outside of its altitudinal belt. Compared to other areas of central and southern Tuscany, the Italian endemics – *Digitalis micrantha, Helleborus viridis* subsp. *bocconei*, *Hieracium pallidum* subsp. *lanudae, Melampyrum italicum*, *Polygala flavescens* subsp. *flavescens, Scabiosa uniseta* – were less numerous. The Reserve does not have a species pool typical of limestone as other protected areas of central or southern Tuscany. However, the mosaic of different communities, combined with geological and microclimatic factors, makes the Reserve highly relevant for the conservation of biodiversity in central Tuscany. Its peculiarity is the presence of isolated populations of mesophilous species that are confined to ravines with a cool microclimate and are in contact with xerophilous species of calcareous garrigues. Besides a valuable heterogeneity of environments in the Reserve it is worth nothing that there are only fourteen alien species, mainly with a casual status of invasivity.

Key words - Central Italy, conservation, protected areas, vascular plants.

Riassunto - *Contributo alla flora vascolare della Riserva Naturale di Castelvecchio (Toscana centrale, Italia).* Il presente lavoro riporta la flora vascolare della Riserva Naturale Regionale Castelvecchio, situata nel Comune di San Gimignano (Siena). La Riserva, con substrato di natura prevalentemente calcarea, ha un'estensione di 6,28 km^2. Si riporta l'elenco floristico delle piante vascolari. Vengono inoltre forniti dati sulle forme biologiche e corologiche. Nel nostro contributo risultano 454 specie e sottospecie, suddivise in 73 famiglie e 185 generi. Lo spettro biologico rivela una dominanza di emicriptofite seguite dalle terofite, mentre lo spettro corologico mostra una maggioranza di specie a distribuzione eurasiatica rispetto a quella mediterranea, in accordo con le condizioni macro- e micro-climatiche. Sono presenti entità rare e/o con distribuzione frammentaria in Toscana come *Cleistogenes serotina* subsp. *serotina, Ononis natrix* e *Phagnalon sordidum* e due specie della Lista Rossa Italiana (*Galanthus nivalis* e *Ruscus aculeatus*). È inoltre da segnalare la presenza di entità rilevanti dal punto di vista fitogeografico come *Taxus baccata*, nonché popolazioni eterotopiche di *Fagus sylvatica* subsp. *sylvatica*. Le entità endemiche sono 6 (*Digitalis micrantha, Helleborus viridis* subsp. *bocconei, Hieracium pallidum* subsp. *lanudae, Melampyrum italicum, Polygala flavescens* subsp. *flavescens, Scabiosa uniseta*), un numero relativamente basso rispetto ad altre aree calcaree della Toscana centro-meridionale. Questa Riserva non può quindi essere considerata un'isola biogeografica su calcare dal punto di vista botanico, come altre aree protette in Toscana meridionale. Tuttavia, il mosaico vegetazionale, unito alle particolari condizioni geologiche e microclimatiche, rendono comunque la Riserva Naturale di Castelvecchio un'area di notevole importanza per la conservazione della biodiversità floristica della Toscana centrale dove coesistono popolazioni relitte ed isolate di specie mesofile che sopravvivono grazie al microclima fresco e umido dei valloni, a stretto contatto con quelle xerofile di gariga calcarea. L'eterogeneità ambientale unita all'elevato grado di naturalità rende possibile la presenza di specie rare e/o fitogeograficamente rilevanti e solamente quattordici sono le specie esotiche, la maggior parte delle quali presenti in modo casuale.

Parole chiave - Aree protette, Italia centrale, conservazione, piante vascolari.

Introduction

Uneven availability of biological information around the globe is recognized (Samper, 2004), although the growing importance of the so-called E-taxonomy – with its ambitious aims (Smith & Figueiredo, 2010; Victor *et al.*, 2014) – is gathering reliable data at a rate never seen before, reducing more and more the differences across regions. At the Tuscan level, dedicated books (Arrigoni 2016; 2017; 2018), numerous local contributions (Peruzzi *et al.*, 2015; 2016; 2017b; Bonari *et al.*, 2016a; 2016b; Arrigoni *et al.*, 2017; Selvi, 2017) and the accessibility to on-line databases (Bedini *et al.*, 2016; Peruzzi *et al.*, 2017a) are rapidly improving the floristic knowledge of this part of Italy. While, according to Angiolini *et al.* (2005), in Tuscany there are no areas classified as "*almost unknown*", areas with only a "*general floristic knowledge*" are rather frequent.

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Filling the gaps in knowledge of this heterogeneous territory represents a priority for conservation and management purposes.

In this study, we focused on the Castelvecchio Nature Reserve located in the north of Siena province, in the municipality of San Gimignano. The Reserve hosts forested areas with scarce human activity in the surroundings. Besides a general description of the Reserve (Anselmi, 2001), previous studies have focused on species of conservation interest and vegetation types (Cavalli & Drosera, 1989; Chiarucci & De Dominicis, 1992; De Dominicis *et al.*, 1997; Frignani & Geri, 2007), mostly aimed at drafting a technical report for the definition of a management plan. However, an inventory of vascular plant species occurring in this Reserve is currently missing. Therefore, in this paper we provide the first contribution to the vascular flora of the Castelvecchio Nature Reserve. In particular, we aimed at compiling an inventory of the vascular plants occurring at the Reserve as a tool to carry out an ecological analysis based on species attributes and to focus on the conservation value of this flora.

Study area

Castelvecchio Regional Nature Reserve (Fig. 1) was established by a resolution of the Provincial Council n. 38 of 21th March 1996 in accordance with Article 15 of Regional Law No. 49/95. The Reserve is part of the Nature 2000 network, which is included in the Castelvecchio Site of Community Interest (code IT5190001). This Nature Reserve lies in the Elsa Valley, located in the northwestern part of Siena province, in the municipality of San Gimignano (Fig. 2). It covers an area of 6.28 km^2 with a hilly morphology, being situated in the anti-Apennines. The Reserve is delimited by the Elsa river to the north-northeast, by the Cecina river to the south and by the Era river to the west. The Reserve is also surrounded by two torrential rivers, called Botro di Castelvecchio – which becomes the Botro delle Torri as it descends into the valley – and Botro della Libaia. The two ravines are separated and surround the relief, one to the south and the other to the north, merging at the south-eastern extreme boundary.

Geomorphology and Geology

The main geological formation outcropping in the Castelvecchio Nature Reserve is the so-called Calcare Cavernoso formation, a widely distributed rock in Tuscany, structurally occurring at the sole of the non-metamorphic Tuscan Nappe (Carmignani & Lazzarotto, 2004). Calcare Cavernoso appears to be the result of a massive process of dedolomitization occurring at the expenses of the dolomitic facies of the original Triassic evaporitic-dolomitic succession, following its re-exhumation at the end of the Apennine orogenesis. The intense tectonic fracturing of the dolomite favoured the circulation of meteoric waters in continental phreatic environment, with the consequent dissolution of sulphates and dolomite and the neoprecipitation of calcite (Gandin *et al.*, 2000). Calcare Cavernoso is made up of calcareous breccia with elements deriving mainly from the anidritic formation (Upper Triassic). More recent limestone, such as brecciated, vacuolar or compact dolomite limestone, occasionally chalks, were often more or less reworked in the Neocene. The calcareous nature of the substratum leads to particular karst structures formed after the chemical dissolution of $CaCO_3$,

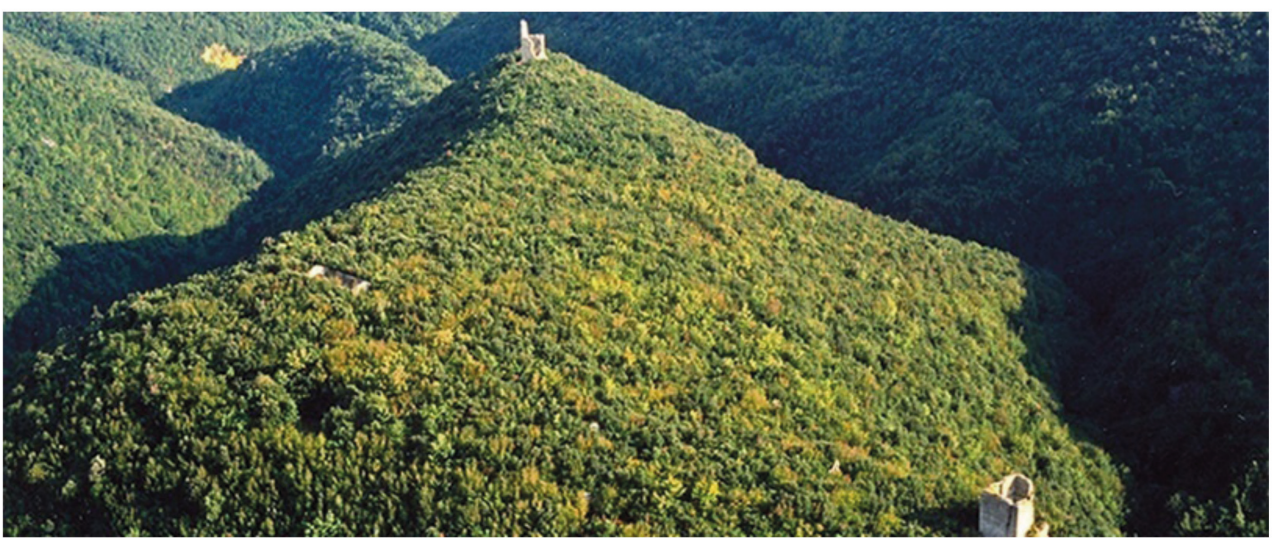

Figure 1. Aerial view of Castelvecchio Nature Reserve in 1979. Photo courtesy of Associazione culturale "Gruppo Storico Castelvecchio".

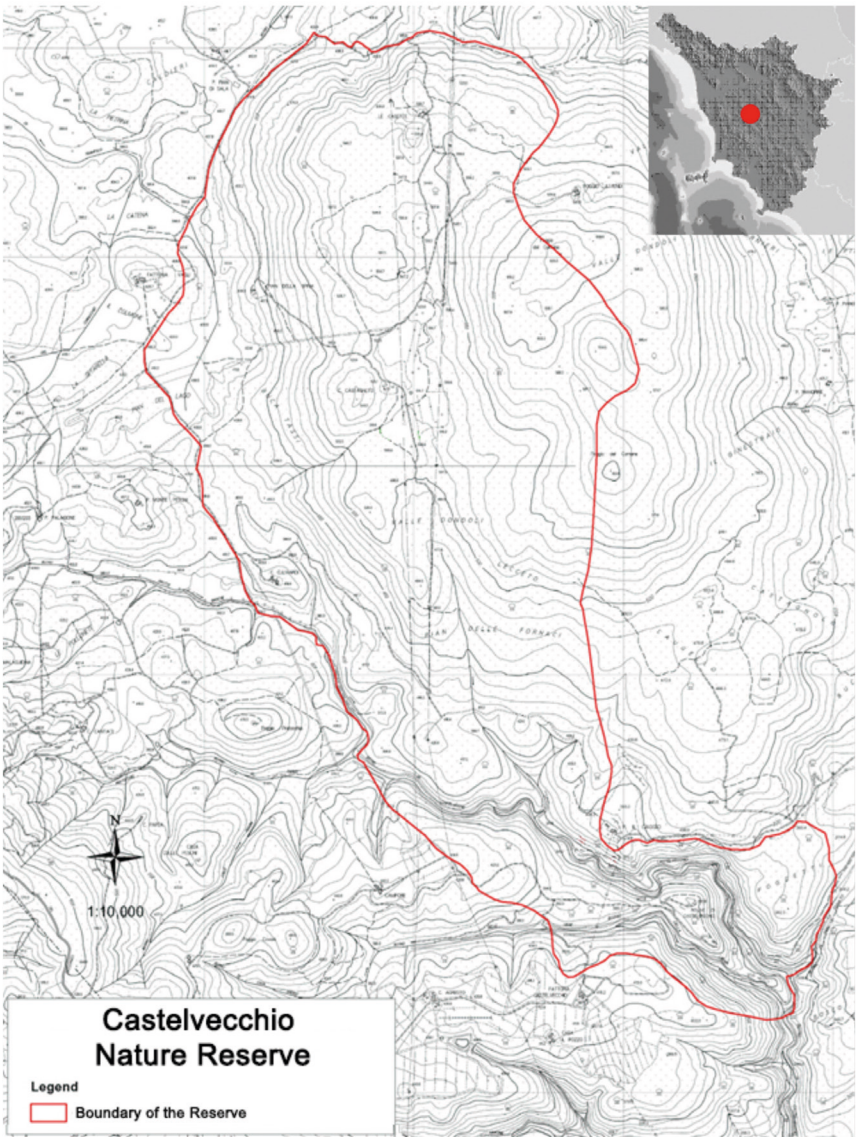

Figure 2. Boundary of the study area (modified from Frignani & Geri, 2007).

such as dolines. Only small areas show outcrops of stratified sand with clays, pebbles, and sediments from recent floods. Situated in the southern part of the Reserve there is a rocky limestone ridge with the ruins of the castle, after which the Reserve is named. This part is mainly characterized by ravines with high slopes. The north-western part of the Reserve includes the east facing portion of the Poggio del Comune (624 m a.s.l.), which is the highest point of the Reserve. The northern and central parts of the protected area are characterized by gentle slopes and lowland areas. The lowest point of the Reserve is located at the confluence of Botro della Libaia and Botro delle Torri (255 m a.s.l.). A karst depression of 35 m in depth and 500 m in diameter also occurs (Costantini *et al.*, 1992).

Climate

Since no specific climatic station for the Castelvecchio Nature Reserve exists in the regional meterological service, we referred to the nearby one of San Gimignano (N 43° 47' - E 11° 02'; 332 m a.s.l.). The climatic formula, according to the classification of Thornthwaite & Mather (1957), is C2-B'2-s-b'4 (Barazzuoli *et al.*, 1993). This formula indicates a subhumid climate (C2), mesothermic (B'2), with a moderate winter rainfall surplus (s) and with concentrated thermal efficiency in the summer season (b'4). The data concerning temperatures and precipitation (available at http://www.sir.toscana.it) for the period 2005-2016 showed an average annual temperature of 16.9 °C, 3.2 °C higher than what was recorded in the period 1951–1981 (i.e., 13.7 °C). The

hottest months are July (26.4 °C) and August (26 °C), the coldest are January and February with an average temperature of 8.8 °C. The average annual rainfall is 817.3 mm with maximum values in October (88.6 mm) and November (126.5 mm). The thermopluviometric diagram (Appendix I, available online) according to Bagnouls & Gaussen (1935), shows that the period of water deficit, deriving from the ratio of precipitation to the average temperature, concerns only July and August. A water surplus is present throughout the rest of the year.

Vegetation types

The study area is characterised by different vegetation types (Fig. 3). The main ones occurring at the Reserve are briefly described following De Dominicis *et al.* (1997) and Frignani & Geri (2007).

The deciduous oak forests are very widespread, both mesophilous – with dominant *Quercus cerris* accompanied by *Acer opalus, Carpinus betulus*, and *Fagus sylvatica* subsp. *sylvatica* – and thermophilous where *Q. cerris* is codominant with *Q. pubescens* subsp. *pubescens*. They are accompanied by *Ostrya carpinifolia, Sorbus torminalis* and, especially when the slopes become very steep, *Q. ilex* subsp. *ilex*. Along the narrow ravines, the particular microclimate allows the occurrence of species characteristic of higher altitudes. Here, a markedly mesophilous *Q. cerris* forest is prevalent together with *Acer pseudoplatanus*, *F. sylvatica* subsp. *sylvatica,* and *Taxus baccata*. Forests with a prevalence of holm oak characterize the calcareous substrates of south facing slopes. Within these evergreen forests, *Quercus ilex* subsp. *ilex* assumes the role of dominant species and, with other mediterranean species, such as *Arbutus unedo*, *Erica arborea*, *Phillyrea latifolia* and some thermophilous broad-leaved trees, such as *Acer monspessulanum* subsp. *monspessulanum*, *Quercus pubescens*, *Q. cerris*, and *Sorbus torminalis*, form dense woods with poor undergrowth. Open garigue communities with *Juniperus oxycedrus* subsp. *oxycedrus*, other sclerophylls and chamaephytes also occur on rocky limestone outcrops and south-facing cliffs. Riparian formations dominated by *Populus alba* and *Salix alba* are also present along the rivers, especially along the Botro delle Grotte Bianche. Scattered groups of *Pinus nigra* subsp. *nigra*, often mixed with natural formations, have been planted here mainly for reforestation purposes, differently from typical pine plantations with *P. pinaster* and *P. pinea* of the coastline, which were established as a shelter belt to protect cropland from salty sea spray (Bonari *et al.*, 2017; 2018). Shrub formations are localized predominatly in karst areas, where several abandoned arable lands occur. These formations represent the degradation stage of deciduous and evergreen forests, varying in the specific composition in relation to the microclimatic, edaphic and land use conditions. This vegetation type is mainly dominated by *Rubus ulmifolius, Spartium junceum* and/or *Prunus spinosa* subsp. *spinosa*. Xerophilous grasslands of the *Festuco-Brometea* Br.-Bl. et Tx. ex Soó 1947 are found scattered within the the Reserve, with a concentration in the area of central karst. These perennial grasslands, often shrubby, are dominated by *Brachypodium rupestre* or *Bromopsis erecta* subsp. *erecta*. In more acidophilous parts, open areas are colonized by *Pteridium aquilinum* subsp. *aquilinum* and re-sprout of *Castanea sativa*. Crops are located near the farms along the boundaries of the Reserve. These areas are devoted to agricultural use; mainly arable land mixed with vineyards and olive groves.

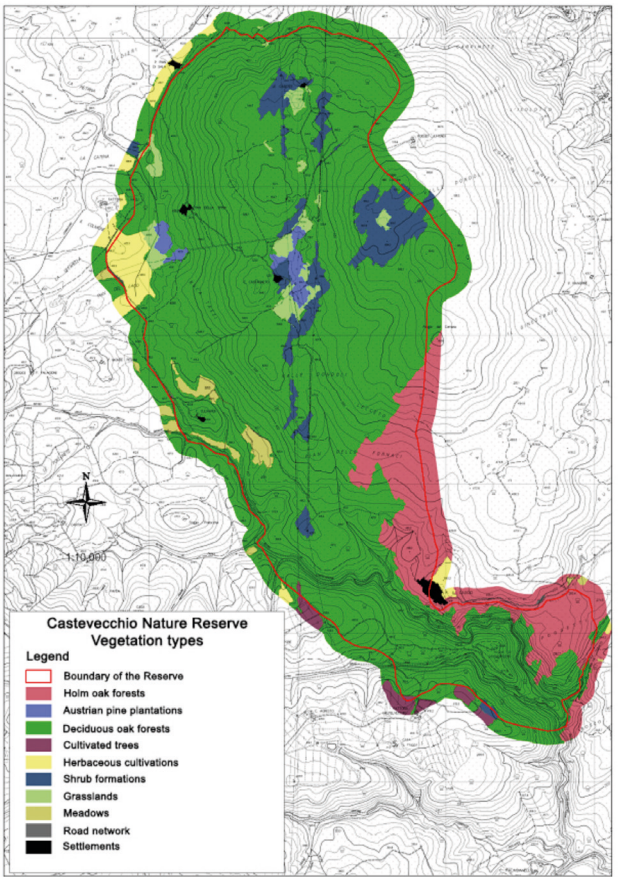

Figure 3. Vegetation physiognomic types in the Castelvecchio Nature Reserve (modified from Frignani & Geri, 2007).

Materials and methods

For the compilation of the floristic inventory of the Reserve, past researches conducted at Castelvecchio were primarily consulted (De Dominicis *et al.,* 1997; Frignani & Geri, 2007; Mendicini, 2009). Moreover,

studies concerning single interesting species were also considered (Cavalli & Drosera, 1989; Chiarucci & De Dominicis, 1992; Frignani, 2011). Field data collection was carried out from June 2007 to September 2017. All the vegetation types present in the Reserve throughout the years were sampled. The specimens collected during the field surveys are preserved at the *Herbarium Universitatis Senensis* (SIENA, acronym according to Thiers, 2015 onwards). For species identification, we mainly referred to Pignatti (1982; 2017a; 2017b; 2018), Tutin *et al.* (1968–1980; 1993) and Castroviejo *et al.* (1984-2005). Scientific binomials and authorities were attributed according to Bartolucci *et al.* (2018) for native taxa and Galasso *et al.* (2018) for non-native taxa. The circumscription and the systematic order of families follow Peruzzi (2010). Genera and species are arranged, within each family, in alphabetical order. Life forms and chorological types were assigned according to Pignatti (1982). For distribution of Italian endemic taxa, we referred to Peruzzi *et al.* (2014, onwards), while we followed Galasso *et al.* (2018) for alien species. Finally, the Red List of the Italian flora (Rossi *et al.*, 2013) and the Tuscan Naturalistic Repertoire (Re. Na.To. Project, see Sposimo & Castelli, 2005; Viciani *et al.*, 2014), were checked to verify the conservation status of each taxon.

Results and Discussion

Quantitative and conservation aspects

Overall, 454 species of vascular plants were identified. Additionally, 13 taxa which have been reported in literature but which lack vouchered herbarium specimens are considered to likely represent field misidentifications. The floristic inventory is reported in Appendix I (available online). The species belong to 73 families and 185 genera. The families with the highest number of species (Tab. 1) are Asteraceae (67 taxa, 14.8%), followed by Fabaceae (52 taxa; 11.5%) and Poaceae (46 taxa; 10.1%).

Two species, *Galanthus nivalis* and *Ruscus aculeatus*, are classified as *least concern* (LC) in the Italian Red List (Rossi *et al.*, 2013), while no taxa belonging to the regional list Re.Na.To. (Sposimo & Castelli, 2005) were found. Other relevant taxa due to their distribution or as newly recorded for the province of Siena, are present (see Peruzzi & Bedini, 2015 onwards). It is worth noting the finding of two perennial species which grow in xerophilous habitats on shallow soils: *Cleistogenes serotina* subsp. *serotina* and *Ononis natrix* subsp. *natrix*, both recorded here for the first time in the Siena province. Another newly recorded taxon for the Siena province is *Phagnalon sordidum*, a species occurring in the western portion of the Italian Peninsula, whose population in the studied area represents the innermost one in Tuscany. Another species we report is *Colutea arborescens*. This species has a mediterranean distribution, typical of calcareous xerophilous enviroments and mediterranean woodlands. Although this species is generally rare in central Tuscany, we found it to be relatively abundant in this area. A typical species of broad-leaf forests in the submontane belt present at Castelvecchio is *Laburnum anagyroides* subsp. *anagyroides* which occurs in the surroundings of the ruins of the castle, in contact with the mediterranean species.

Table 1 - List of families exceeding 9 species.

Family	N° species	% of total flora
Asteraceae	67	14.8
Fabaceae	52	11.5
Poaceae	46	10.1
Lamiaceae	25	5.5
Rosaceae	25	5.5
Caryophyllaceae	17	3.7
Ranunculaceae	13	2.9
Plantaginaceae	11	2.4
Brassicaceae	11	2.4
Orchidaceae	11	2.4
Asparagaceae	10	2.2
Caprifoliaceae	10	2.2

Life-form spectrum

The life-form spectrum of the flora (Fig. 4a) shows a predominance of hemicriptophytes (H = 41.3%) followed by therophytes (T = 21.5%). The H/T ratio (bioclimatic index), indicator of the "mediterranean" or "continental" character of the flora (Sabato & Valenzano, 1975), is equal to 1.92, similarly to values found for others calcareous massifs in southern Tuscany (Frignani *et al.*, 2004; 2008). This finding indicates a sub-Mediterranean character of the area with a marked tendency to temperate-mountain characteristics and is partly in agreement with the bioclimatic map of Italy (Pesaresi *et al.*, 2014; 2017). Moreover, these findings are also a result of the edaphic aridity typical of calcareous substrates and, on the other hand, of the particular humid microclimate present in the narrow ravines that characterize the Castelvecchio Reserve. The amount of phanerophytes (13.1%) along with that of nanophanerophytes (3.3%) is relatively high compared to the Tuscan average (Pignatti, 1994), due to the vast areas covered by forests and

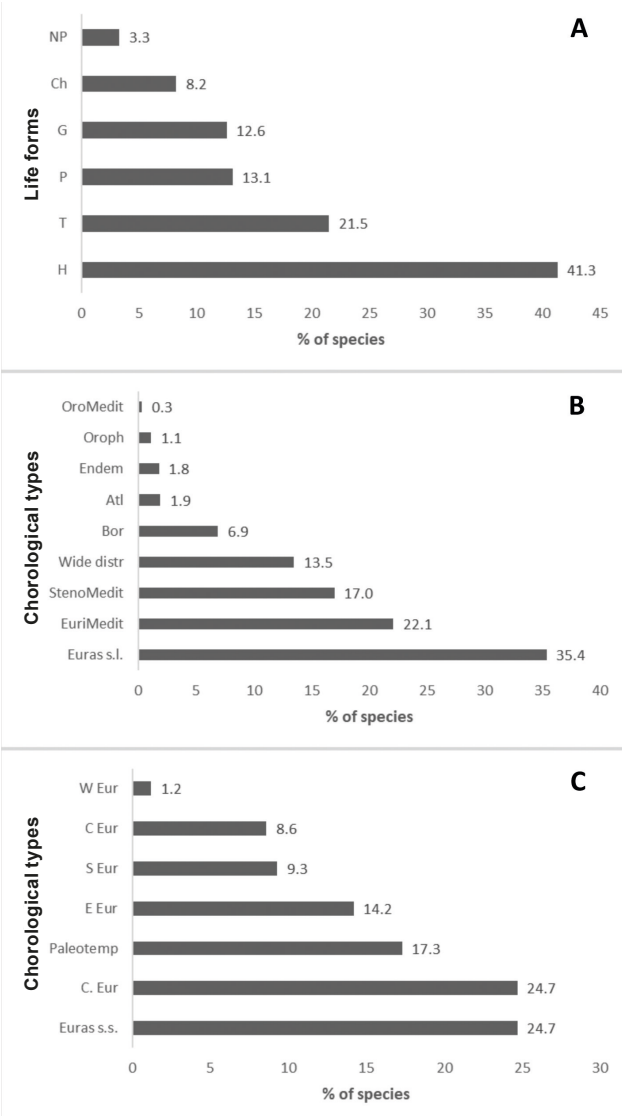

Figure 4. Spectra of life-forms (A), chorological (B) and extended chorological types of the Eurasiatic contingent (C). Life-forms abbreviations: Ch = Chamaephytes; G = Geophytes; H = Hemicryptophytes; NP = Nanophanerophytes; P = Phanerophytes; T = Therophytes. Chorological types abbreviations: Atl = Atlantic; Bor = Boreal; C Eur = Central European; E Eur = Eastern European; Endem = Endemics; Euras s.l. = Eurasiatic; EuriMedit = Eurimediterranean; Eur = European; OroMedit = Oromediterranean; Oroph = South European Orophytes; Paleotemp = Paleotemperate; S Eur = South European; StenoMedit = Stenomediterranean; W Eur = Western European; Wide distr = Wide distribution.

shrublands. Considering the extent of woods in the study area, the percentage of geophytes (12.6%) is rather low, while the chamaephytes (8.2%) show a relatively high abundance.

Chorological and phytogeographical aspects

The chorological spectrum (Fig. 4b) reveals the prevalence of taxa with Eurasiatic distribution (35.4%), in agreement with the wide presence in the Reserve of ravines with cool microclimate. It follows that the Euromediterranean taxa (22.1%) are more abundant than the Stenomediterranean ones, which are only 17%. In the extended spectrum including only Eurasiatic *sensu lato* chorotype (Fig. 4c), made to investigate their presence in the Reserve, the Eurasiatic *sensu stricto* component is the same as the European one (24.7%); it is also worth noting the relatively high percentage of Paleotemperate (17.3%) and Eastern European (14.2%) species. The large number of Eurasian, European and Eastern European species, and the low proportion of Atlantic species (1.9%), are in agreement with the abundance of *Quercus cerris* and *Q. pubescens* forests in the study area (Lattanzi *et al.*, 2004). The very low percentages of Oromediterranean (0.3%) and South European Orophilous (1.1%) species are in line with the geomorphology of the Reserve, dominated by a hilly territory. The species with a wide distribution are 13.5% and are linked to well-defined ecological environments widely present in different parts of the world (Pignatti, 1994), such as wetlands – relatively scarce in the Reserve – or anthropogenic habitats present where arable lands occur. The alien flora (Tab. 2) does not pose a great threat in the study area, since it is represented by a few species (14), four of which are invasive, and exclusive to marginal areas of the Reserve.

The low number of Italian endemic species (6 species; see Tab. 3) on a mainly calcareous substratum was unexpected, especially when compared with other calcareous protected areas on mountains of southern Tuscany, where higher levels of endemism occur (e.g., Mazzeschi & Selvi, 1999; Frignani *et al.*, 2004; 2008; Bonari *et al.*, 2016b). This may be due to the extensive forest cover of the Reserve and to its lower altitude, which does not characterise it as a montane relief. Italian endemics found here, and also distributed in peninsular Italy or central-southern Apennines, are linked to forest environments (*Digitalis micrantha*, *Helleborus viridis* subsp. *bocconei* and *Melampyrum italicum*) or to grasslands and open areas (*Polygala flavescens* subsp. *flavescens* and *Scabiosa uniseta*). Only *Hieracium pallidum* subsp. *lanudae* can be considered a narrow endemic, occurring only in Tuscany and Emilia-Romagna (Bartolucci *et al.*, 2018). Still, the Reserve is interesting because of the presence of populations of *Fagus sylvatica* subsp. *sylvatica* outside of its altitudinal belt. Here the species is present in different scattered groups and can be considered a "quantitatively heterotopic" species (*sensu* Roma-Marzio *et al.*, 2017) since it meets the recently proposed thresholds (i.e., occurring at an altitude ≤ 600 m a.s.l., and with a mean annual temperature generally higher

than 12°C). From the phytogeographical point of view, another relevant species to mention is *Taxus baccata.* It is a paleotemperate species with a scattered distribution in Tuscany, being a relict of the evergreen Colchic forest vegetation, widespread in the Mediterranean region at the end of the Tertiary and later decimated by glaciations. Its presence in extra-Apennine areas of low altitude is to be considered of great phytogeographical interest (Chiarucci & De Dominicis, 1992).

Conclusions

A deeper exploration of the Reserve has led to an increased level of knowledge of the vascular flora of this little-known portion of central Tuscany. Our results showed that this area does not host a species pool specific to limestone as other protected areas of southern Tuscany (i.e., Monte Cetona, Monte Labro or Cornate di Gerfalco; Frignani *et al*., 2008). However, the combination of geological and climatic factors have allowed the establishment of diversified environments and a great variety of forest types with an interesting and heterogeneous flora. The heterogeneity of the habitats contributes to the diversity and to the conservation value of the flora with the presence – in an inner hilly area of Tuscany – of both Mediterranean elements with coastal distribution – here found on the limestone outcrops – and of central European and/or paleotemperate elements, typical of mountain altitudes, here present in the ravines.
This study highlights the presence of a valuable natural environment that hosts rare or phytogeographically relevant species, in contrast with a low number of alien species. Therefore, the Castelvecchio Nature Reserve is to be considered an important area for the conservation of the floristic biodiversity and the natural landscape of central Tuscany.

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Table 2. Alien species present in Castelvecchio Nature Reserve. The status and associated code in Tuscany and in Italy for alien species follow Galasso *et al.* (2018). A = Archaeophyte; CAS = Casual; CLT = Culton; INV = Invasive; N = Neophyte; NAT = Naturalized.

Alien species	**Status in the study area**	**Status in Tuscany**	**Status in Italy**
Artemisia verlotiorum Lamotte	A INV	A INV	N INV
Crepis sancta (L.) Bornm. subsp. *nemausensis* (P.Fourn.) Babc.	A NAT	A NAT	N INV
Cupressus sempervirens L.	Planted	A NAT	A NAT
Erigeron bonariensis L.	A INV	A INV	N INV
Erigeron canadensis L.	A INV	A INV	N INV
Euphorbia maculata L.	A CAS	A INV	N INV
Pinus nigra J.F.Arnold subsp. *nigra*	Planted	NAT	Locally alien
Prunus laurocerasus L.	Planted	A CAS	N INV
Robinia pseudoacacia L.	A INV	A INV	N INV
Setaria italica (L.) P.Beauv. subsp. *italica*	A CAS	A CAS	A CAS CLT
Symphyotrichum squamatum (Spreng.) G.L.Nesom	A CAS	A INV	N INV
Veronica persica Poir.	A CAS	A INV	N INV
Xanthium italicum Moretti	A NAT	A NAT	N INV
Xanthium spinosum L.	A NAT	A NAT	N INV

Table 3. Distribution of Italian endemic taxa (according to Peruzzi *et al.*, 2014) present in Castelvecchio Nature Reserve.

Italian endemics	Distribution
Helleborus viridis L. subsp. *bocconei* (Ten.) Peruzzi	Apennines
Polygala flavescens DC. subsp. *flavescens*	Apennines
Digitalis micrantha Roth ex Schweigg.	Apennines
Melampyrum italicum (Beauverd) Soó	Apennines and N Italy
Hieracium pallidum Biv. subsp. *lanudae* (Gottschl.) Gottschl., Raimondo & Di Grist.	Emilia Romagna and Tuscany
Scabiosa uniseta Savi	Apennines

Bibliography

Angiolini C., Arrigoni P.V., Selvi F., 2005. Stato attuale e progressi delle conoscenze floristiche in Toscana dal 1978 ad oggi. In: Scoppola A., Blasi C. (a cura di), *Stato delle conoscenze sulla flora vascolare d'Italia*, Palombi Editori, Roma, pp. 141-145.

Anselmi B., 2001. *Castelvecchio.* In: Amministrazione Provinciale di Siena (Eds.), *Le Riserve Naturali della Provincia di Siena*: 126-137. Le Balze Editrice, Montepulciano (Siena).

Arrigoni P.V., 2016. Flora analitica della Toscana. Vol. 1. Polistampa Editore, Firenze.

Arrigoni P.V., 2017. Flora analitica della Toscana. Vol. 2. Polistampa Editore, Firenze.

Arrigoni P.V., 2018. Flora analitica della Toscana. Vol. 3. Polistampa Editore, Firenze.

Arrigoni P.V., Ferretti G., Nepi C., 2017. Flora del Prato Fiorito (Bagni di Lucca, Toscana). *Annali del Museo Civico di Rovereto* 31 (2015): 169-245

Bagnouls F., Gaussen H., 1935. Saison sèche et indice xèrothermique. *Bulletin de la Société d'Histoire Naturel de Toulouse* 88: 193-239.

Barazzuoli P., Guasparri G., Salleolini M., 1993. Il Clima. In: Giusti F. (Ed.) *La storia naturale della Toscana meridionale*: 141-171. Pizzi Editore, Milano.

Bartolucci F., Peruzzi L., Galasso G., Albano A., Alessandrini A., Ardenghi N.M.G., Astuti G., Bacchetta G., Ballelli S., Banfi E., Barberis G., Bernardo L., Bouvet D., Bovio M., Cecchi L., Di Pietro R., Domina G., Fascetti S., Fenu G., Festi F., Foggi B., Gallo L., Gottschlich G., Gubellini L., Iamonico D., Iberite M., Jiménez-Mejías P., Lattanzi E., Marchetti D., Martinetto E., Masin R.R., Medagli P., Passalacqua N.G., Peccenini S., Pennesi R., Pierini B., Poldini L., Prosser F., Raimondo F.M., Roma-Marzio F., Rosati L., Santangelo A., Scoppola A., Scortegagna S., Selvaggi A., Selvi F., Soldano A., Stinca A., Wagensommer R.P., Wilhalm T., Conti F., 2018. An updated checklist of the vascular flora native to Italy. *Plant Biosystems* 152(2): 179-303.

Bedini G., Pierini B., Roma-Marzio F., Caparelli K.F., Bonari G., Dolci D., Gestri G., D'Antraccoli M., Peruzzi, L., 2016. Wikiplantbase# Toscana, breaking the dormancy of floristic data. *Plant Biosystems* 150(3): 601-610.

Bonari G., Acosta A.T.R., Angiolini C., 2017. Mediterranean coastal pine forest stands: Understorey distinctiveness or not? *Forest Ecology and Management* 391: 19-28.

Bonari G., Acosta A.T.R., Angiolini C., 2018. EU priority habitats: rethinking Mediterranean coastal pine forests. *Rendiconti Lincei. Scienze Fisiche e Naturali* 29(2): 295-307.

Bonari G., Cantini D., Angiolini C., Selvi F., Scoppola A., Viciani D., Ferretti G., Gabellini A., Perini C., De Dominicis V., Ardenghi N.M.G., Lastrucci L., 2016a. Contribution to the vascular flora of Pietraporciana Nature Reserve (southern Tuscany, Italy). *Atti della Società Toscana di Scienze Naturali, Memorie, Serie B* 123: 9-28.

Bonari G., Piazzini S., Landi M., Roma-Marzio F., Bonini I., Angiolini C., 2016b. Aggiornamenti sulla flora vascolare della Toscana meridionale. *Micologia e Vegetazione Mediterranea* 30(2): (2015) 129-144.

Carmignani L., Lazzarotto A., 2004. Carta geologica della Toscana scala 1:250.000. Firenze, Italy: Litografia artistica cartografica.

Castroviejo S., Aedo C., Ciruiano S., Lainz M., Montserrat P., Morales R., Muñoz Garmendia F., Navarro C., Paiva J., Soriano C. (Eds.), 1984-2005. *Flora iberica.* Real Jardìn Botanico, CSIC, Madrid.

Cavalli S., Drosera L., 1989. Nuove stazioni eterotopiche *di Fagus sylvatica* L. nella Toscana centrale. *Atti della Società Toscana di Scienze Naturali, Memorie, Serie B* 96: 257-364.

Chiarucci A., De Dominicis V., 1992. Due interessanti popolamenti di *Taxus baccata* L. in Toscana. *Atti della Società Toscana di Scienze Naturali, Memorie, Serie B* 99: 1-9.

Costantini E.A.C., Lulli L., Bidini D., Napoli R., Castellani F., 1992. Karst landforms and soils of the Poggio del Comune relief (Central Italy). In: *Proceeding of the Karst-Symposium; Blaubeuren. 2° Inter. Conf. Geomorphology*, 1989, Heft 109: 83-130.

De Dominicis V., Gabellini A., Angiolini C., 1997. *Studio fitoecologico e proposte gestionali per la Riserva Naturale Castelvecchio.* Document of the Department of Life Sciences of University of Siena.

Frignani F., 2011. *Atlante delle Orchidee della Provincia di Siena.* Sistema delle Riserve Naturali della Provincia di Siena, Quaderni Naturalistici, 3: 176 pp.

Frignani F., Angiolini C., Selvi F., De Dominicis V., 2004. La Flora Vascolare della Riserva Naturale Regionale "Cornate-Fosini" (Toscana Meridionale). *Webbia* 59(2): 395-455.

Frignani F., Geri F., 2007. *Aggiornamento degli aspetti floristico-vegetazionali e delle relative indicazioni gestionali delle Riserve della Provincia di Siena.* Convenzione di ricerca Amministrazione Provinciale di Siena.

FRIGNANI F., GIALLONARDO T., ANGIOLINI C., SELVI F., 2008. La Flora vascolare della Riserva Naturale "Monte Penna" (Grosseto, Toscana Meridionale). *Webbia* 63(1): 81-107.

GALASSO G., CONTI F., PERUZZI L., ARDENGHI N.M.G., BANFI E., CELESTI-GRAPOW L., ALBANO A., ALESSANDRINI A., BACCHETTA G., BALLELLI S., BANDINI MAZZANTI M., BARBERIS G., BERNARDO L., BLASI C., BOUVET D., BOVIO M., CECCHI L., DEL GUACCHIO E., DOMINA G., FASCETTI S., GALLO L, GUBELLINI L., GUIGGI A., IAMONICO D., IBERITE M., JIMÉNEZ-MEJÍAS P., LATTANZI E., MARCHETTI D., MARTINETTO E., MASIN R. R., MEDAGLI P., PASSALACQUA N.G., PECCENINI S., PENNESI R., PIERINI B., PODDA L., POLDINI L., PROSSER F., RAIMONDO F.M., ROMA-MARZIO F., ROSATI L., SANTANGELO A., SCOPPOLA A., SCORTEGAGNA S., SELVAGGI A., SELVI F., SOLDANO A., STINCA A., WAGENSOMMER R.P., WILHALM T., BARTOLUCCI F., 2018. An updated checklist of the vascular flora alien to Italy. *Plant Biosystems* 152(3): 556-592.

GANDIN A., GIAMELLO M., GUASPARRI G., MUGNAINI S., SABATINI G., 2000. The Calcare Cavernoso of the Montagnola Senese (Siena, Italy): mineralogical-petrographic and petrogenetic features. *Mineralogica et petrographica Acta* 43: 271-289.

LATTANZI E., PERINELLI E., RIGGIO L., 2004. Flora vascolare del bosco di Foglino (Nettuno, Roma). *Informatore Botanico Italiano* 36(2): 337-361.

MAZZESCHI A., SELVI F., 1999. The vascular flora of Monte Cetona (S.-E. Tuscany, Italy). *Flora Mediterranea* 9: 185-214.

MENDICINI A., 2009. *La flora vascolare della Riserva Naturale Provinciale "Castelvecchio" (Siena, Toscana meridionale): primo contributo.* Tesi di Laurea, Università degli studi di Siena.

PERUZZI L., 2010. Checklist dei generi e delle famiglie della flora vascolare italiana. *Informatore Botanico Italiano* 42(1): 151-170.

PERUZZI L., BAGELLA S., FILIGHEDDU R., PIERINI B., SINI M., ROMA-MARZIO F., CAPARELLI K.F., BONARI G., GESTRI G., DOLCI D., CONSAGRA A., SASSU P., CARIA M.C., RIVIECCIO G., MARROSU M., D'ANTRACCOLI M., PACIFICO G., PIU V., BEDINI G., 2017a. The Wikiplantbase project: the role of amateur botanists in building up large online floristic databases. *Flora Mediterranea* 27: 117-129.

PERUZZI L., BEDINI G. (Eds.), 2015 onwards. Wikiplantbase# Toscana v2.1. Online database avaialble at http://bot.biologia.unipi.it/wpb/toscana/index.html

PERUZZI L., CONTI F., BARTOLUCCI F., 2014. An inventory of vascular plants endemic to Italy. *Phytotaxa* 168: 1-75.

PERUZZI L., VICIANI D., AGOSTINI N., ANGIOLINI C., ARDENGHI N.M.G., ASTUTI G., BARDARO M.R., BERTACCHI A., BONARI G., BONI S., CHYTRÝ M., CIAMPOLINI F., D'ANTRACCOLI M., DOMINA G., FERRETTI G., GUIGGI A., IAMONICO D., LAGHI P., LASTRUCCI L., LAZZARO L., LAZZERI V., LIGUORI P., MANNOCCI M., MARSIAJ G., NOVÁK P., NUCCI A., PIERINI B., ROMA-MARZIO F., ROMITI B., SANI A., ZOCCOLA A., ZUKAL D., BEDINI D., 2016. Contributi per una flora vascolare di Toscana VIII (440-506). *Atti della Società Toscana di Scienze Naturali, Memorie, Serie B* 123: 71-82.

PERUZZI L., VICIANI D., ANGIOLINI C., ASTUTI G., AVANZI A., BALDANZI C., BENESPERI R., BONARI G., BONINI I., D'ANTRACCOLI M., CASTELLANI B., DELL'OLMO L., DI NUZZO L., DOMINA G., ERCOLINI P., FERRETTI G., FONTANA D., GESTRI G., GOTTSCHLICH G., GRAZZINI A., LASTRUCCI L., LAZZARO L., MALFANTI F., MARSIAJ G., PIAZZINI S., PIERINI B., ROMA-MARZIO F., SANI A., SELVI F., VICENTI C., BEDINI G., 2015. Contributi per una flora vascolare di Toscana VII 357-439. *Atti della Società Toscana di Scienze Naturali, Memorie, Serie B* 122: 61-72.

PERUZZI L., VICIANI D., ANGIOLINI C., ASTUTI G., BANFI E., BENOCCI A., BONARI G., BRUNI G., CARAMANTE P., CARÉ M., CARTA A., CASTAGNINI P., CHELI A., CIAMPOLINI F., D'ANTRACCOLI M., FERRETTI G., FERRUZZI S., FIASCHI T., FOGGI B., FONTANA D., GALASSO G., GALLO L., GALVANI D., GESTRI G., GRAZZINI A., LASTRUCCI L., LAZZARO L., LOPPI S., MANGANELLI G., MUGNAI M., PIAZZINI S., PIERINI B., ROMA-MARZIO F., SANI A., SELVI F., SOLDANO A., STINCA A., BEDINI G., 2017b. Contributi per una flora vascolare di Toscana IX (507-605). *Atti della Società Toscana di Scienze Naturali, Memorie, Serie B* 24: 73-86.

PESARESI S., GALDENZI D., BIONDI E., CASAVECCHIA S., 2014. Bioclimate of Italy: Application of the worldwide bioclimatic classification system. *Journal of Maps* 10(4): 538-553.

PESARESI S., BIONDI, E., CASAVECCHIA S., 2017. Bioclimates of Italy. *Journal of Maps* 13(2): 955-960. .

PIGNATTI S., 1982. *Flora d'Italia*. 3 Voll. Edagricole, Bologna.

PIGNATTI S., 1994. *Ecologia del paesaggio*. UTET, Torino.

PIGNATTI S., 2017a. *Nuova Flora d'Italia*. Vol. 1. Edagricole-New Business Media, Bologna.

PIGNATTI S., 2017b. *Nuova Flora d'Italia*. Vol. 2. Edagricole-New Business Media, Bologna.

PIGNATTI S., 2018. *Nuova Flora d'Italia*. Vol. 3. Edagricole-New Business Media, Bologna.

ROMA-MARZIO F., CARTA A., PERUZZI L., BEDINI G., 2017. Heterotopy remastered with a quantitative tool: the case study of European beech (*Fagus sylvatica* L. subsp. *sylvatica*) in peninsular Italy and Sicily. *Atti della Società Toscana di Scienze Naturali, Memorie, Serie B* 124: 87-93.

ROSSI G., MONTAGNANI C., GARGANO D., PERUZZI L., ABELI T., RAVERA S., COGONI A., FENU G., MAGRINI S., GENNAI M., FOGGI B., WAGENSOMMER R.P., VENTURELLA G., BLASI C., RAIMONDO F.M., ORSENIGO S. (EDS.), 2013. *Lista Rossa della Flora Italiana. 1. Policy Species e altre specie minacciate.* Comitato Italiano IUCN e Ministero dell'Ambiente e della Tutela del Territorio e del Mare.

SABATO S., VALENZANO S., 1975. *Flora e Vegetazione di una zona dell'Appennino centro-settentrionale (Rincine). I. La flora.* Centro Sper. Agric. For. Ente nazionale Cellulosae Carta, Roma vol. XIII: 85-192.

SAMPER C., 2004. Taxonomy and environmental policy. *Philosophical Transaction of the Royal Society B* 359: 721-728.

SELVI F., 2017. *Biarum tenuifolium* (Araceae), a new record for the flora of Tuscany. *Atti della Società Toscana di Scienze Naturali, Memorie, Serie B* 124: 95-100.

SMITH G.F., FIGUEIREDO E., 2010. E-taxonomy: an affordable tool to fill the biodiversity knowledge gap. *Biodiversity and Conservation* 19: 829-836.

SPOSIMO P., CASTELLI C. (Eds.), 2005. *La biodiversità in Toscana. Specie e habitat in pericolo. Archivio del Repertorio Naturalistico Toscano (RENATO).* Regione Toscana-Direzione Generale Politiche Territoriali e Ambientali. Firenze.

THIERS B., 2015 onwards [continuously updated]. Index Herbariorum: A global directory of public herbaria and associated staff. – New York Botanical Garden's Virtual Herbarium. Available at http://sweetgum.nybg.org/ih/ (accessed 30 July 2018).

THORNTHWAITE C.W., MATHER J.R., 1957. *Instructions and tables for computing potential evapotranspiration and the water balance (No. 551.57 T515i).* Drexel Institute of Technology, Centerton, NJ (EUA). Laboratory of Climatology.

TUTIN T.G., BURGES N.A., CHARTER A.O., EDMONDSON J.R., HEYWOOD V.M., MOORE D.M., VALENTINE D.H., WALTERS S.M., WEBB D.A., 1993. *Flora Europaea, 2° Ed., Vol. 1.* Cambridge University Press, Cambridge, 581 pp.

TUTIN T.G., HEYWOOD V.M., BURGES N.A., VALENTINE D.H., WALTERS S.M., WEBB D.A., 1968-1980. *Flora Europaea, Vols. 2-5.* Cambridge University Press, Cambridge.

VICIANI D., LASTRUCCI L., DELL'OLMO L., FERRETTI G., FOGGI B., 2014. Natura 2000 habitats in Tuscany (central Italy): synthesis of main conservation features based on a comprehensive database. *Biodiversity and Conservation* 23: 1551-1576.

VICTOR J.E., SMITH G.F., TURLAND N.J., LE ROUX M., PATON A., FIGUEIREDO E., CROUCH N.R., VAN WYK A.E., FILER D., VAN WYK E., 2014. Creating an online world Flora by 2020: a perspective from South Africa. *Biodiversity and Conservation* 23(1): 251-263.

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