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Population structure of *Erythronium dens-canis* L. (Liliaceae) in the northern Apennines (Italy)

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Abstract

Relationships between age, time of emergence, and leaf traits of individuals were investigated in a population of *Erythronium dens-canis* L. in a hilly woodland area named *Farneto-C*, near Bologna, Italy. In 2015, 591 individuals were counted, 19 of which were flowering (FLO), 442 were mature non-flowering (MNF) and 130 were juveniles (JUV). FLO emerged at the end of February, whereas most MNF and JUV appeared at the middle and end of March, respectively. The mean aboveground survivorship of MNF was 24 days. Most MNF had large, oval to shield-shaped leaves with red-brown mottling, whereas most JUV leaves were smaller, usually oblong or lanceolate with a rough maculation or none. These results suggest that both timing of emergence and leaf shape are related to the age of the bulb. Based on leaf background, plants were classified into three major types with a likely genetic basis in the 2015 and 2016 surveys (the latter limited to FLO): a dominant silvery type (SLV, 62–74%), silvery-and-green type (S&G, 23–32%), and a less frequent vivid-green type (GRN, 3–5%). Several subtypes were also identified, but only one was dominant within each type. The three basic patterns appear to be phenotypically stable and no differences between MNF and FLO were found; once the juvenile stage has passed, each plant produces the same leaf type year after year. In addition, our results on the discoloration time-course of red-brown spots suggest that the functional role of leaf mottling is not related to pollinator attraction. Instead, leaf mottling could play a role in camouflage against herbivores.The observed massive grazing on flowers, more than leaves, could explain why the frequency of mature individuals was biased towards the non-flowering ones.

Keywords

demography, discoloration, leaf traits, mottling, spring ephemerals, survival rate

Introduction

Spring ephemerals can be considered as model species for addressing plant responses to environmental changes (Lapointe 2001), especially since climate change has become a major issue for ecologists and conservationists (e.g. Dormann and Woodin 2002, Totland and Alatalo 2002, Parmesan 2006, Pfeifer et al. 2006, De Frenne et al. 2011, Marchin et al. 2014). As seasonality determines changes in soil and atmospheric temperature as well as in nutrient, light and pollinator availability, responses displayed by spring ephemerals are of various kinds and involve adaptation in many physiological, morphological, and reproductive traits, implying a fine control of phenological transitions (e.g. Lapointe 2001, Yamagishi et al. 2005, Augspurger and Sank 2017). For example, species within the genus *Erythronium* L. (Liliaceae, Tulipeae) are typical spring ephemerals that have been the object of several studies dealing with responses to seasonal changes (Lambert et al. 2010, Gandin et al. 2011, Kim et al. 2015, Augspurger and Sank 2017), especially those involving effects of temperature on phenology of leaves and bulbs as well as on seed germination.

All *Erythronium* species are bulbous geophytes with the phenological characteristics of spring ephemerals (Schemske et al. 1978, Lapointe 2001).They play a relevant role in some forest ecosystems due to their high biomass and effectiveness in preserving soil nutrients (Muller and Bormann 1976, Muller 1978). This genus is distributed in the northern hemisphere with five Eurasian species (Bartha et al. 2015) and about 24 species in North America (Mathew 1992, Allen and Robertson 2002, Allen et al. 2003). The numerous American *Erythronium* species (trout lilies) have life cycles that are quite different between high-mountain and forest taxa, but all are strictly connected with snow and snowmelt (Vézina and Grandtner 1965, Lapointe 2001, Yamagishi et al. 2005), so these plants are particularly exposed to the effects of climate change. In fact, mean bulb size decreases with increasing soil temperatures (Gandin et al. 2011) and, in recent years, there is concern for a growing pollination mismatch (Lambert et al. 2010, Thomson 2010). For the Japanese species *E. japonicum*, too, several contributions have been devoted to the phenological and ecophysiological responses to temperature variation in seeds, bulbs, and leaves (Yoshie and Fukuda 1994, Sawada et al. 1997, Kondo et al. 2002).

On the contrary, few papers have considered the life cycle and ecology of *E. dens-canis* (dog's tooth violet) (Guitiàn et al. 1999, Mondoni et al. 2012). This is the only European species of the genus *Erythronium*; it is distributed in the southern part of the continent, ranging from the Iberian Peninsula through southern France and northern Italy to the whole Balkan Peninsula down to Greece, with some populations pushing north of the Alps and some others east of the Balkans (Govaerts 2017). The species' distribution range is apparently limited by the January 0°C isotherm to the north and by long summer drought to the south. In Italy, *E. dens-canis* is widely distributed in deciduous woods at the southern edge of the Alps and in the northern and central Apennines, with frequent gaps (Pignatti 1982, Kleih 2010). The plants flush from bulbs in late winter and carry out their yearly photosynthetic and reproductive cycle within a couple of months by exploiting full sunlight in the understory; then, they rapidly senesce and die at the time of tree leafing out and closure of the forest canopy.

The single flower of *E. dens-canis* is a small lily, white to rosy in colour, nodding at the top of a red stalk and with a basal pair of elongated, finely mottled leaves. However, many mature plants in natural populations do not flower and are characterized by a single, large leaf. These non-flowering individuals most probably have not yet attained the sexually competent stage (La Rocca et al. 2014). Very young individuals and seedlings have a small leaf with a tenuous, unapparent design of light-brown spots, or a green leaf with no pattern at all. The dominant leaf mottling type of mature *E. dens-canis* plants consists of red-brown spots or patterns on a grey-glaucous ("silvery") background, the latter originated through detachment of the epidermis from mesophyll cells resulting in light reflection (La Rocca et al. 2014). The red-brown motif is produced by a single layer of mesophyll cells containing a red vacuolar pigment (anthocyanin; Esteban et al. 2008), which, however, will vanish within a few weeks leaving bright-green areas (La Rocca et al. 2014). Concerning the function of mottling, three alternative hypotheses have been proposed: 1) a specific function in pollinator attraction to flowers (La Rocca et al. 2014), 2) a possible role in photoprotection (Esteban et al. 2008), and 3) as camouflage against herbivores (Givnish 1990).

Due to the importance of obtaining demographic data for investigating plant responses to environmental change, the present work addresses a population of *E. dens-canis* occurring in an area of the Nature Park of Gessi Bolognesi (Farneto). In particular, we aimed to answer the following questions: 1) Is there any relationship between age and time of emergence of individuals? 2) Are leaf shape and leaf mottling related to the phenological stage of individuals? 3) What is the functional role of mottling in the species? By answering these questions, we can provide insight into the relationships between individual leaf traits and population structure (i.e., age classes) and dynamics (i.e., time of emergence and survival) in *E. dens-canis*.

Materials and methods

Definitions

'Number of individuals' refers to the actual amount of plants recorded at the study site of *Farneto-C* during each field survey in 2015 and 2016. 'Occurrence' is any plant record based on the related photograph at each survey (therefore, there may be up to 11 occurrences per individual). 'New plant' is an individual recorded for the first time in a given survey, and 'cohort' is used for the assemblage of all plants first found in a given survey.

Sites and sampling

Data were mostly collected in 2015 and 2016 in a site of about one ha, named by us *Farneto-C*, which hosts one of a few scattered populations occurring in the Nature Park

of Gessi Bolognesi (44°25'N 11°24'E, 270–290 m altitude). *Farneto-C* is a moderately steep area at the edge of a closed karst valley (*Buca dell'Inferno*), with a thin soil layer on chalk substrate, rock outcrops and stones, and sinkholes and grottoes all around. The area is covered by a light wood of downy oak (*Quercus pubescens* Willd.) and hop-hornbeam (*Ostrya carpinifolia* Scop.) with some young flowering ash (*Fraxinus ornus* L.), Montpellier maple (*Acer monspessulanum* L.), and wild service tree (*Sorbus torminalis* (L.) Crantz). The understory is sparsely covered with shrubs (*Ruscus aculeatus* L., *Asparagus acutifolius* L.) and perennial herbs (*Cyclamen hederifolium* Aiton, *Helleborus viridis* L., *Pulmonaria apennina* Cristof. & Puppi, *Viola reichenbachiana* Jord. ex Boreau, *V. alba* Besser). Of the ephemeral geophytes appearing in late winter, dog's tooth violet is among the earliest to emerge together with *Scilla bifolia* L., while *Anemonoides nemorosa* (L.) Holub will bloom some weeks later. A population of *Galanthus nivalis* L. (snowdrop) lives on moist ground nearby.

Preliminary surveys were performed since 2012 allowing us to define the general characters and phenology of the population. A thorough study with weekly field surveys was conducted in 2015 (from February 16 to April 26) on a roughly rectangular area of 127 m^2 marked with wood pegs; photographic images of all individuals were thus obtained from emergence to leaf senescence (plant sequences). In total, 3078 images (occurrences) were obtained, with some gaps in sequences mainly due to unrecognized plants (22.4% of all occurrences). Therefore, the probability that some plants escaped detection was extremely low. In 2016, 170 flowering individuals were monitored from February 4 to April 13 by 12 surveys with 1228 occurrences on a surface of about 1600 m^2 . However, only individuals found in at least five surveys (N = 126) were further considered for the statistics. The 2016 sampling was necessary for the investigation of leaf traits in flowering individuals, which resulted under-represented in 2015. Photographs of individual or small groups of plants were usually taken with a Nikon D90 digital camera equipped with DX 18-105 mm objective.

Demography

Individuals recorded in 2015 and 2016 were classified into three stage classes: 1) flowering individuals (FLO), 2) mature non-flowering (MNF) individuals, and 3) juveniles (JUV). The distinction was mainly based on leaf size (longer than 5 cm in MNF, shorter in JUV) and background (light or lacking in JUV).

Leaf shape and decoration

Plants were not labelled in the field, due to several difficulties and risks. However, to allow a semi-automatic recognition in subsequent images (corresponding to subse-

quent surveys), the first photograph of each new plant, once expanded, was tagged with distinctive individual characters (descriptors). With the exception of the red-brown spot colour, leaf traits were completely stable following leaf expansion, so that we used leaf shape and background as main descriptors. Leaf shape was categorized using standard traits commonly found in botanical descriptions: shield-shaped (SH), oval (OV), elongate (EL), and lanceolate (LA). After preliminary surveys, we defined the following types of leaf background: silvery (SLV), silvery-and-green (S&G), and vivid-green (GRN). Within these three types, a few subtypes were recognized: for SLV type, subtypes *pictorial* (PC, silvery ground with red-brown patterns), *striped* (ST), *others* (OTH, other infrequent subtypes); for S&G type, subtypes *chess-like* (CH), *spotted* (SP), *others* (OTH); for GRN type, subtypes *mottled* (MO, green background with red-brown patterns), *grey spots* (GS), *uniform green* (UN). See also Table 1. We also investigated the discoloration of spots as a further descriptor and we detected the following classes: red-brown spots (*brs*), partially depigmented spots (*pid*), and wholly green-discolored spots (*whg*).

Results

Demography

Overall, 591 plants were counted in the selected area during the 2015 survey. The majority were MNF (442), 130 were JUV, and only 19 were FLO, with an overall density of 4.7 plants/m^2. The time of emergence of the three age classes was clearly sequential albeit superposed.

The earliest plants of *E. dens-canis* flushed in the second half of February 2015 (weeks 7–9) in small numbers, soon after a heavy snowstorm followed by quick snowmelt. They were mainly FLO accompanied by a few MNF. A massive outburst of MNF then occurred, with a peak of new plants at mid-March (week 11), whereas the emergence of JUV was slower, gradual and culminated at week 13 (Fig. 1A). The overall population growth in 2015 thus had a maximum in the first days of April driven by MNF individuals, followed by a decline (Fig. 1B). A sudden wave of generalized senescence and death, with frequent fungal attack, intervened in the last ten days of April (week 17) although isolated juvenile specimens with lanceolate leaves (JUV-LA) were still found until June (not shown).

By taking into account all MNF sprouted in March 2015, their average epigeous growth period was 24 days. Fig. 2 illustrates aboveground vegetation periods and losses of the three most numerous generations or cohorts of MNF new plants, i.e., individuals first found in weeks 10, 11 and 12, respectively. The rate of disappearance was relatively constant, with an average 9% loss of MNF individuals per week during March. However, about half of them was still in place at the end of April, when mass senescence and die-back occurred.

Table 1. Assignment of *E. dens-canis* individuals to leaf pattern categories. Major types: SLV (silvery), S&G (silvery-and-green), GRN (vivid green). Key to SLV subtypes: SLV-PC, pictorial (silvery ground with red-brown patterns); SLV-ST, silvery striped; SLV-OTH, other infrequent silvery forms. Key to S&G subtypes: S&G-CH, silvery-and-green chess-like; S&G-SP, silvery-and-green spotted; S&G-OTH, other, infrequent silvery-and-green subtypes. Key to GRN subtypes: GRN-MO vivid green mottled (green ground with red-brown patterns; mature plants only); GRN-GS, vivid green with grey spots (juveniles only); GRN-UN, uniform vivid green (juveniles only). MNF and JUV were investigated in 2015, FLO plants in 2016.

	SLV				S&G				GRN				TOT
	PC	ST	OTH	SLV-TOT	CH	SP	OTH	S&G-TOT	MO	GS	UN	GRN-TOT	
FLO 16	86	3	4	93 (73.8%)	26	2	1	29 (23.0 %)	4	0	0	4 (3.2 %)	126
MNF 15	165	71	39	275 (62.2 %)	76	56	11	143 (32.4 %)	11	9	4	24 (5.4 %)	442
JUV 15	24	3	15	42 (32.8 %)	7	20	9	36 (28.1 %)	2	43	5	50 (39.1 %)	128

Leaf shape and decoration

The two basal leaves of FLO were always EL, while the large leaf of MNF was typically SH to OV, less frequently EL. On the other hand, the leaf of JUV was usually OV, EL or LA (Fig. 3). Most new MNF plants with SH or OV leaves appeared early in March (weeks 10–11), whereas those with EL leaves peaked one week later (Fig. 3A). JUV emerged with a double peak of OV leaves at weeks 11 and 13, and a peak of plants with EL and LA leaves at week 13 (Fig. 3B).

Nearly two-thirds of all MNF and one-third of JUV exhibited a SLV mottling pattern (Table 1). The PC subtype (Fig. 4A) was the most common one within the SLV type, representing 37.3% and 18.5% of all MNF and JUV, respectively. Less frequent variants of SLV featured a ST leaf or OTH rare subtypes. The type S&G was found in 32.4% and 28.1% of all MNF and JUV, respectively. It usually occurred as a CH (Fig. 4B), or SP subtype. Finally, some MNF (5.4%) belonged to the GRN type, half of them with a MO subtype (Fig. 4C). Data on leaf background obtained in 2016 from 126 FLO showed a similar trend, but with more SLV plants (ca. 74%) and less S&G (ca. 23%). Relatively numerous JUV (33%) displayed leaves with a GRN-CS background (Fig. 4D). In addition, some JUV, identified as seedlings, had GRN-UN leaves (Fig. 4E). The detailed leaf pattern assignment of all *E. dens-canis* plants, either mature or juvenile, is presented in Table 1.

In 2015, discoloration occurred in the second half of March for most plants, with a maximum at week 13. As shown in Fig. 5A, almost all FLO and MNF initially had red-brown motifs (native *brs* stage), except for a few, late-emerging individuals. Later, the red-brown pattern faded away (pigment disappearing, *pid* stage), to be converted into wholly green meanders or spots (*whg* stage). The discoloration proceeded so rapidly that the intermediate *pid* stage was often missed during weekly surveys. Although JUV plants tended to emerge later than mature ones (Fig. 1 and 3), red-brown-spotted juveniles underwent the discoloration process approximately at the same pace as adult

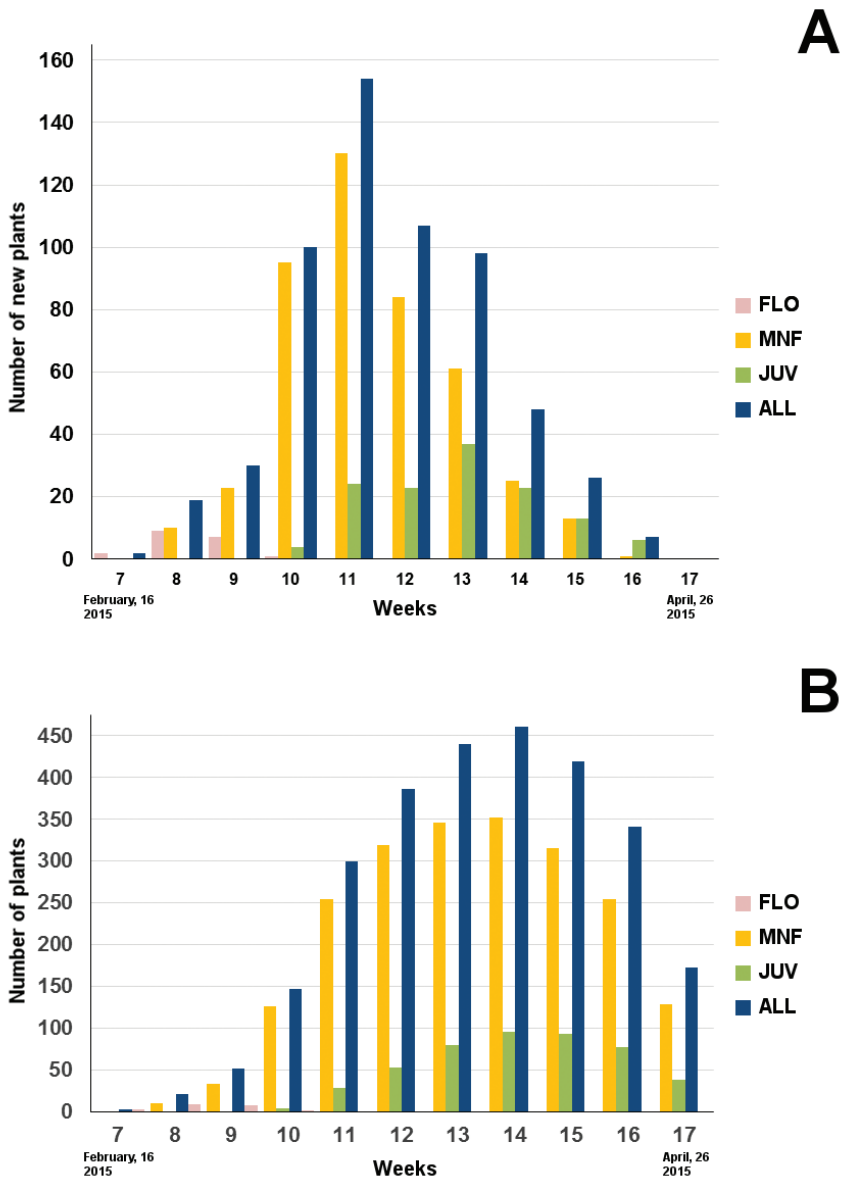

Figure 1. Number of individuals of *Erythronium dens-canis* during spring 2015 in *Farneto-C*. The histograms show the number of flowering (FLO), mature non-flowering (MNF) and juvenile (JUV) plants. **A** New plants and **B** all plants.

plants. Many JUV with natively GRN leaves (mostly GRN-CS with some GRN-UN) emerged after the discoloration of mature plants, except a few, which emerged at weeks 11–12 when most mature plants were still red-brown-spotted (Fig. 5A, B).

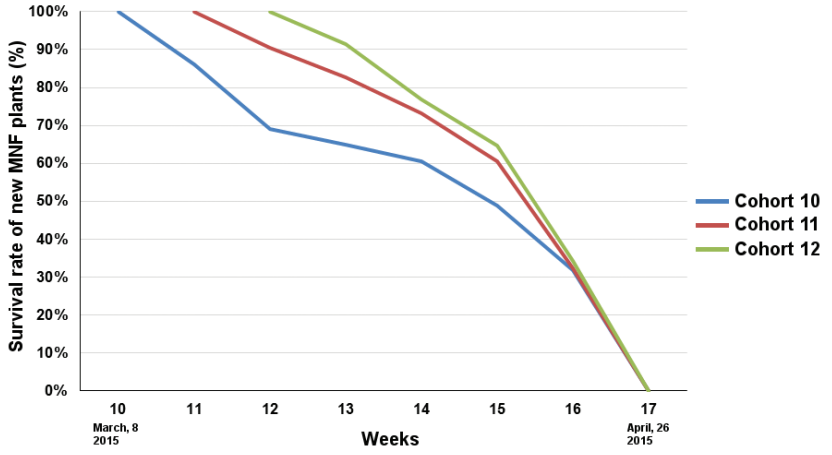

Figure 2. Survivorship of MNF *E. dens-canis* plants in March 2015. The three major cohorts are shown: Cohort 10 (in blue) with 94 new plants found on March 8th (week 10); Cohort 11 (in red) with 127 new plants found on March 12th (week 11); Cohort 12 (in green) with 82 new plants found on March 19th (week 12).

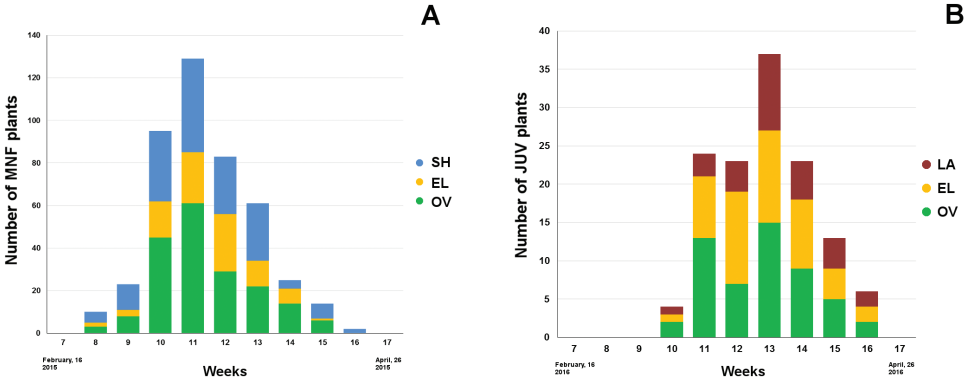

Figure 3. Leaf shape in new plants of *E. dens-canis*. Histograms of **A** mature non-flowering individuals (MNF) with oval (OV), shield-like (SH) and elongate (EL) leaf shapes, and **B** juvenile (JUV) plants with oval (OV), elongate (EL) and lanceolate (LA) leaf shapes.

Discussion

The *Erythronium dens-canis* population examined at *Farneto-C* was mainly formed by MNF, mostly emerged at mid-March, and characterized by a single, large, usually OV or SH leaf. In February 2015, a small number of FLO preceded the outburst of MNF, as also occurred in the 2016 sampling of FLO. The early emergence of *Erythronium* flowers is due to the relatively long time required for flowering, fruit maturation and bulb renewal (about two months) before tree canopy closure and possible dry periods set

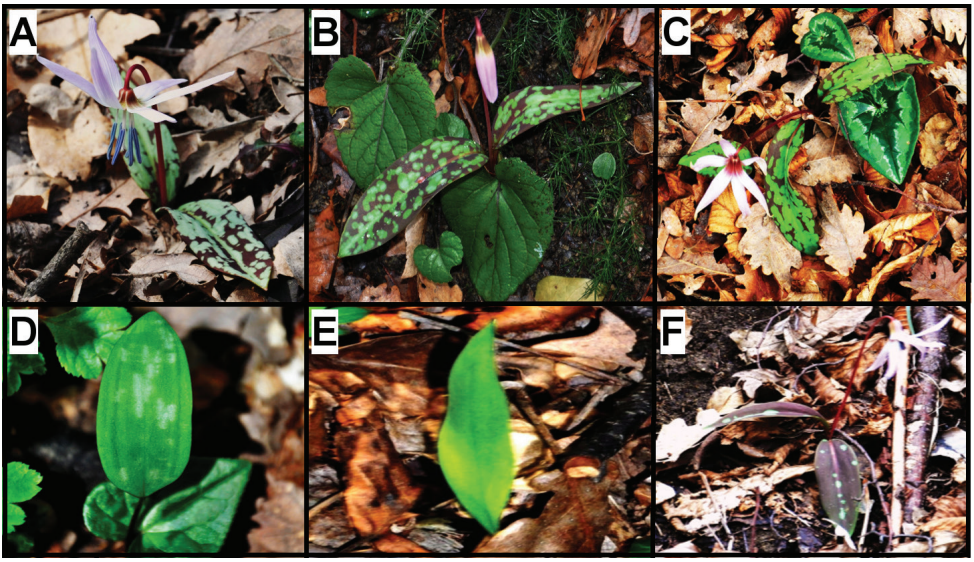

Figure 4. Different patterns of *E. dens-canis* leaves. **A** Silvery pictorial pattern (SLV-PC) characterized by red-brown (and later green) drawings on a grey-silvery background (Feb. 27, 2015) **B** Silvery-and-green chess-like leaves with red-brown spots (S&G-CH, Feb. 13, 2016) **C** Green-mottled leaves with red-brown spots (GRN-MO, Feb. 24th, 2016) **D** A rare rusty variant of SLV with red-brown leaves (Mt. Adone, 550 m of altitude, March 15, 2015) **E** A juvenile leaf with clear-silvery spots on green background (GRN-CS, April 11, 2015) **F** Juvenile lanceolate (JUV-LA) uniformly green (GRN-UN) leaf. Photos taken at Farneto (except **D**).

in. Since FLO are credited with an age of 6-7 years (La Rocca et al. 2014), most MNF individuals are probably 3- to 6-years old. JUV amounted to *ca*. 22% of the total, and included seedlings and other very young specimens mainly with small EL or LA leaves. They had an estimated age of 1 to 3 years and tended to emerge later than MNF. In other words, both leaf shape and time of emergence seem to be a function of the physiological age of the bulb. Hence, our data suggest that physiological ripeness and timing of spring emergence are inversely correlated: the younger the bulb, the later it will emerge.

Concerning leaf background, the three basic types found at *Farneto-C* appear to be phenotypically stable: once the juvenile stage is over, every year each plant produces the same leaf type. Therefore, a S&G or GRN-MO leaf does not represent a developmental stage leading to the widespread SLV type: SLV, S&G, and GRN-MO plants coexist in what appears to be a genetically balanced polymorphism. However, the higher percentage of SLV leaves and lower percentage of S&G leaves in FLO compared with MNF might suggest a transition of some S&G plants to the widespread SLV-PC type. This point needs confirmation on a longer time scale. Within each of the three principal background types, only one subtype is likely to represent the final, stable form: for SLV plants it is the PC subtype, for S&G plants it is the CH subtype, and for the GRN plants it is MO. Other variants are probably juvenile or transitional characters, or they may represent a local response to a harsh environment (see below).

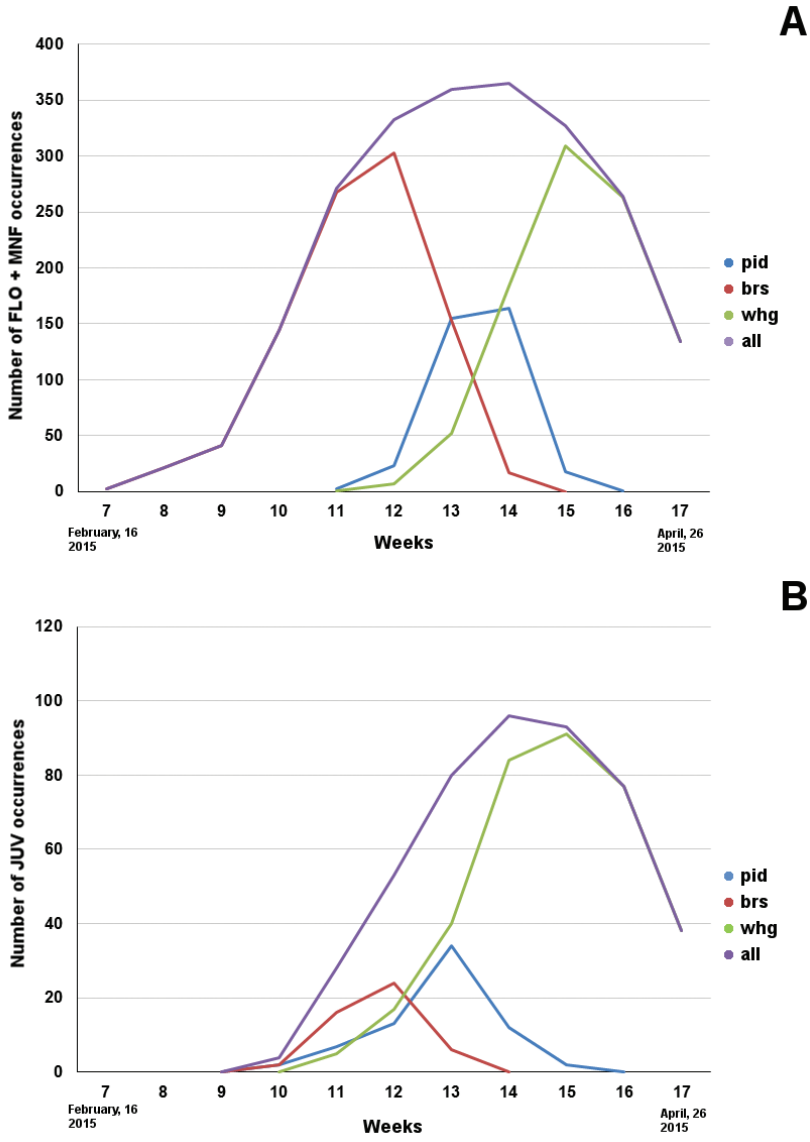

Figure 5. Discoloration: loss of red pigment from red-brown spots in *E. dens-canis* leaves. Time course of the discoloration in **A** adult plants (FLO and MNF), and **B** JUV plants.

The main leaf traits of dog's tooth violet observed in other localities (La Rocca et al. 2014; personal observations) appear similar to those of Farneto, whereas the frequency of minor pattern variants seems to fluctuate. For example, *rusty* specimens (silvery with nearly complete red-brown coverage) occur with some frequency on Apennine highlands, e.g., in the Contrafforte Reserve (personal observations; Fig. 4F). Online photo-

graphs of *E. dens-canis* from official websites (e.g., University of Trieste, project Dryades http://dryades.units.it/euganei/index.php?procedure=taxon_page&id=6797; Forum Acta Plantarum http://www.actaplantarum.org/floraitaliae/viewtopic.php?t=2723) support the general prevalence of the PC subtype, although they occasionally show a leaf design of an infrequent type, e.g., *rusty*. In any case, some phenotypes often found at Farneto (S&G-CH and GRN-MO) seem to be rare or possibly absent in other Italian populations (personal observations). This issue deserves further investigations on the variability and genetics of *E. dens-canis* throughout its range.

The discoloration time-course of the red-brown spots on *E. dens-canis* leaves was similar for all age groups, with some exceptions. The fact that adult plants (flowering or not) exhibited similar leaf patterns (background and spots) and underwent parallel discoloration processes is inconsistent with a specific function of mottling in pollinator attraction to the flowers, as hypothesized by La Rocca et al. (2014). On the other hand, a possible role of leaf mottling in photoprotection (Esteban et al. 2008) seems consistent, at least, with the presence of a *rusty* highland variant. However, one of the most likely explanations of *Erythronium*'s mottling remains camouflage against herbivores, as proposed by Givnish (1990). In our case, discoloration timing is consistent with mimicry: the elaborate red-brown pattern could mimic soil colour and dead leaves, and when it finally disappears, to be replaced by a vivid green drawing, the time is ripe for tree leafing out, increased shadowing, and herb growth in the understory. At Farneto, roe deer actively fed on *E. dens-canis* flowers rather than on leaves, with a selective preference for still closed, nutrient-rich blossoms in late winter, and fruits in spring (Pupillo and Marconi 2016). Guitiàn et al. (1999) also reported on fruit nibbling in Spain. The average aboveground survival rate of MNF was fairly long (24 days) testifying that leaves were less heavily grazed; when it was short, this had often to do with trampling and digging by wild boars rather than grazing. Although data are not available on the survival rate of FLO, results similar to MNF were expected and confirmed by our observations. Interestingly, we noticed that flowers damaged in 2014 failed to bloom in 2015, whilst some flowered in 2016, suggesting lengthy recovery times. Thus, ungulates may limit the reproductive success of *E. dens-canis* and contribute to the biased frequency of mature individuals towards the MNF. Indeed, in the study site, only flowers growing on slopes or under tree cover seem to have a chance of bringing their capsules to maturation. Similarly, Muller (1978) found that about 99% of the *E. americanum* plants crowding in the Brookhaven Forest were MNF, so that our results may be more common than expected. In conclusion, leaf mottling could play a role in camouflage against leaf-eaters, but it appears inefficient against flower-eaters.

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RESEARCH ARTICLE

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An atlas of orchids distribution in the Campania region (Italy), a citizen science project for the most charming plant family

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Abstract

A database of the orchids of Campania has been built up since 2000 with data collected for academic purposes, research projects and, more recently, with the contributions of enthusiastic amateurs and scholars, thus becoming a real citizen science project leading to the realization of an online Atlas (http://www.floracampana.unina.it/Orchidee/index.html). In this paper, the collection and storage of the data and the synthesis of them are presented. On 31 December 2016, the database accounted for 14680 records from more than 30 contributors relating to 126 taxonomic entities (species, subspecies, hybrids and a few "*sensu lato*"). The bibliographic records number 3663 (24.9%) and cover a time range of four centuries (from 1616 to 2016). Amongst the 11017 field records (observations), more than 99% are geo-referred and are "punctual" type (precision less than 100 m). The spatial and temporal distribution of the data has been analysed and biases have been underlined. The observations show a clear difference in the study effort year by year but always with a significant contribution of the citizen scientists. The analysis of the spatial distribution shows that the observations are preferably collected in protected areas, around main roads and on the roadsides. Many cells of the grid still lack information and these should be the object of future research.

Keywords

Orchidaceae, Campania, floristic database, citizen science

Introduction

Although the expression "citizen science" is becoming a hot topic and the phenomenon itself is facing a great development worldwide (Bonney et al. 2009, Silvertown 2009, Conrad and Hilchey 2011, Gura 2013), it has never diminished in the study of orchids as generations of enthusiastic amateurs and non-professional researchers have always significantly contributed to the knowledge of this charming plant family (van der Cingel 2001) in many fields (cultivation, morphometry, taxonomy, systematics, biogeography, plant-pollinator relationship etc.). The contribution of citizen scientists is becoming essential for projects that require the collection of large amounts of data over long periods or in large areas such as conservation ecology projects which need mapping and monitoring.

In Italy, projects involving researchers and volunteers in the collection of distributional data of wild plants and the online atlas have been started, for example, by the Wikiplantbase project in Tuscany, Sardinia, Liguria and Sicily (Bedini et al. 2016, Peruzzi et al. 2017). For decades, many associations and groups of non-professional researchers and volunteers have been collecting data on the distribution of plants in large areas especially in north-eastern Italy. Over a long period, the Trentino Province has been explored and the cartography of the native orchids has been significantly advanced by taking advantage of the participation of more than 200 contributors (Perazza and Perazza 2005). The methodology adopted in that project can be assumed as a real guideline for in-field data collection.

Starting from the last years of the 20th century, many research projects on the distribution of native orchids have taken place in the Campania region (Southern Italy) from the grid maps prepared by Büel 1982 followed by Nazzaro et al. 1996, to the recent surveys which put a higher precision (GPS data) on the basis of the cartographic restitution (Nazzaro et al. 2002, Croce 2012; Croce and Nazzaro 2012). The cartography of the orchids family is important both for obtaining more complete base knowledge and to acquire distributional and ecologic data for conservation purposes. Finally, the orchids living in an area are useful biological indicators of the environmental quality (Bianco 2012).

The compilation of a catalogue with the distribution data for orchids in Campania, started at the beginning of 2000. In 2005, it accounted for 6960 records (Nazzaro et al. 2006) from field surveys in the Cilento National Park (Prov. Salerno, southern Italy), the Taburno-Camposauro Regional Park (Prov. Caserta, southern Italy), Roccamonfina volcano, Vesuvius and other small areas. Since then, many contributors have taken part in the implementation of the database and also, as a result of the development of the internet and of devices such as smartphones and tablets, which have allowed faster communications and data collection and sharing, as well as the increasing number of nature lovers attending websites, forums and social networks have all led to a significant rise in the numbers of contributors. Contributors share their data in very different ways, from a unique photograph of a plant needing help for its identification to the

completion of their own private observation datasets collected over several years of research in the field (e.g. Sorgente and Croce 2016).

In this study, the structure and main features of the database and a synthesis of the data collected are described. Since sampling bias is a problem affecting large databases concerning plants and animal distribution (Kadmon et al. 2004), simple analysis to evaluate the temporal and spatial bias in the sampling patterns have been undertaken.

Materials and methods

Aims and geographical limits

The database gathers occurrences of native orchids mainly in the Campania region although data falling within a few kilometres out of the administrative boundaries of the region have also been accepted. The Campania region stretches along the southern Tyrrhenian Sea and covers an area of 13595 km^2. The landscape varies from large coastal plains to the sub-apennine ridges of Lattari and Cilento mountains which extend from the coast inland and the Apennine that rises 2000 m a.s.l. in the Matese Mountains. The large volcanoes of Roccamonfina, Campi Flegrei and Vesuvius lie on the northwest. The islands of Ischia, Capri and Procida also belong to the region. The territory can be divided into 5 provinces: Avellino, Benevento, Caserta, Naples (from 2014 "Metropolitan City of Naples") and Salerno.

Taxonomic scheme

The identification of the recorded entities is given following a taxonomic scheme mainly derived from GIROS 2016. The nomenclature is also checked on "The Plant List" site (The Plant List 2013). When the subspecies is not identified or its identification is doubtful, records are labelled as "s.l." (*sensu lato*). The original names are however kept and the nomenclature will be an object for study for a future regional checklist.

Table 1. Observations and data for each of the 5 provinces of Campania Region and for outer areas.

Province	Records	Area (km^2)	Records/km^2
Avellino	125	2792	0.04
Benevento	683	2071	0.33
Caserta	4677	2639	1.77
Napoli	1775	1171	1.52
Salerno	3671	4923	0.75
Adjacent outer areas	86	–	–

Structure of the database

The first version of the database was a simple set of MS Excel sheets. Recently the records have been stored in a MS Access database, allowing fast and easy queries on the data, the update of the nomenclature, the management of the bibliographic records and data export in a large number of formats.

The database is made up of 4 related tables (Suppl. material 1). Two kinds of data are recorded in the database: observation and bibliographic.

An observation datum refers to a unique record of presence of a species observed on the ground. Contributors specify the Coordinate Reference System adopted in order to project the data properly on the map. The best precision level (preferable measured with a GPS) is requested from the volunteer contributors. The coordinates are however checked and validated (always converted to metric units) and observations can however be classified into 4 kinds of data according to the level of precision:

Punctual: the record has a precision less than 100 m (derived from GPS or topographic maps);

1 km^2 grid cell centroid: data has a mean precision, allowing its position in a 1×1 km cell of the adopted grid;

10 km^2 grid cell centroid: data has a low precision, allowing its position in one of the 10×10 km cells of the adopted grid;

Not geo-referenced: data is too vague or has wrong attributes (e.g. it is in the sea or it is far from the region boundaries if projected) and it is not possible to provide a geo-reference.

The adopted grids are referred to the UTM WGS84 33N Coordinate Reference System (EPSG code 32633).

The identification of the observed taxon is often validated with the aid of the referees for the project on the basis of photographs. The first original identification name is kept for possible future re-attributions to other taxa. The full date of the observation, the number of plants in the site and, optionally, other information such as locality, altitude, substrate, vegetation are requested from each contributor. To encourage data sharing each contributor can send his own observation as a message (e.g. a whatsapp message with the position and the photograph of the observed taxon) or compiling an Excel sheet providing all the requested information. The method explained in Perazza 1994, adopted in most of the research projects, is recommended as a protocol for data gathering.

Another kind of data derives from published literature. Bibliographic records include the original taxon names (the one given by the author), locality and date (year) of publication. Any other information, such as date of observation, altitude, habitat or rarity provided by the authors, is also recorded.

The taxonomy of bibliographic records was revised and updated to the adopted taxonomic schemes. Each bibliographic record was then linked, when possible, to a unique 10×10 km grid cell following two steps:

1. A polygon is drawn representing the extension of the locality reported by the author, according to the method used by Santangelo et al. 2008;
2. When the polygon is completely included in a single cell, the record is assigned to that cell.

When the polygon extends, even partially, on to two or more cells, the polygon was assigned to the cell covered to the greater extent by the polygon. When the polygon is too large or too vague (e.g. it covers two or more cells completely), or the locality is impossible to locate, the data are treated as "not geo-referenced". Even the bibliographic records representing a catalogue of the existing literature (i.e. when the author reports a presence on a previously published record), are treated as "not geo-referenced".

Cartographic operations (grid cell assignment, counts, etc.) and maps drawing have been carried out with QUANTUM GIS 2.14 "Essen" (QGIS Development Team 2016).

Bias analysis

Since the presence of the orchids has not been recorded following a randomised sampling design, the database could be affected by sampling bias. Thus, the punctual georeferenced observations were analysed in order to assess their bias in time and space and specifically fit into two possible distribution patterns:

a. the observations were collected preferably in areas perceived as relevant for their natural heritage (e.g. protected areas);
b. contributors explored mainly the areas around the roads so that observation sites fall into areas easy to reach and to explore by car ("road effect"), mainly located near the roads or on the roadsides.

To test this hypothesis, from the punctual type observations, a set of localities (with unique coordinates) was extracted. A null model was then created generating the same number of points as the localities, randomly distributed in the region area.

The differences in the position between the observation localities and the randomly distributed ones, inside or outside protected areas (parks, reserves and Sites of Community Importance – SCI *sensu* Directive 92/43/EEC) were tested using the Chi-Square test.

The road effect was analysed from two points of view. To test the "highway effect" (Soberón et al. 2000), a 2 km wide buffer was drawn around the State highways and the motorways and the differences in the number of localities falling inside or outside the buffer, actual versus randomised, were tested. Such a buffer measure is the same

one used in surveys analysing the roadside bias (Hijmans et al. 2000) and, moreover, the buffer covers about one third of the total regional surface.

On the other hand, another source of bias is the so called "roadside effect" (Kadmon et al. 2004) due to the distribution of the observations along the roads accessible by car. Therefore, from the shapefile of the roads, a distance raster was built and used to give to each point (actual or randomised) a distance from the nearest road. Then the distances were grouped in buffers of different width and the differences tested in the distribution of the observation localities against the same number of localities randomly distributed falling inside the same buffer, using the Chi-Square test. In addition, the distribution of the overall localities to the randomly distributed points was compared using the Kolmogorov-Smirnov test. The highways, motorways and other roads were extracted from the shapefile of the roads of the Campania region (Geoportale Regione Campania: http://sit.regione.campania.it/portal/portal/default/Cartografia). The statistical analyses were undertaken with PAST (Hammer et al. 2001). Geographic analysis have been carried out with QUANTUM GIS 2.14 "Essen" (QGIS Development Team 2016).

Results and discussion

On 31 December 2016, the database accounted for 14680 records.

Even if the present paper does not aim to discuss taxonomy or nomenclature, the object of a forthcoming critical check-list, the 14680 records can be provisionally referred to 126 taxonomic entities amongst which are 94 specific or infraspecific entities (including some species sensu lato) and 32 hybrids (Suppl. material 2).

Literature data

Bibliographic records account for 3663 (24.9% of the total archive) data derived from 68 different bibliographic sources dated from 1616 to 2016 (Suppl. material 3). They report a total of 83 entities including only 4 hybrids (Suppl. material 2). Amongst them, some are errors according to other authors (e.g. *Orchis militaris*), doubtful citations (e.g. *Dactylorhiza majalis* or *Orchis patens*) or species reported for larger areas only partially falling into the present boundaries of the Campania Region (e.g. "Lucania") and therefore will probably be excluded from the Campania Checklist. The most cited species are *Anacamptis morio*, *A. papilionacea*, *Serapias lingua*, *A. pyramidalis*, *Orchis italica* and *O. provincialis.*

Only 128 bibliographic records were not geo-referenced. The 3535 geo-referenced bibliographic records cover 99 grid cells out of the 183 covering the Campania region (Figure 1) with a maximum of 339 and a mean of 35.7 records per cell. Most citations refer to the Southern areas (Cilento, Alburni and Vallo di Diano National Park) and to the Sorrento Peninsula. Considering the distribution of the species reported in lit-

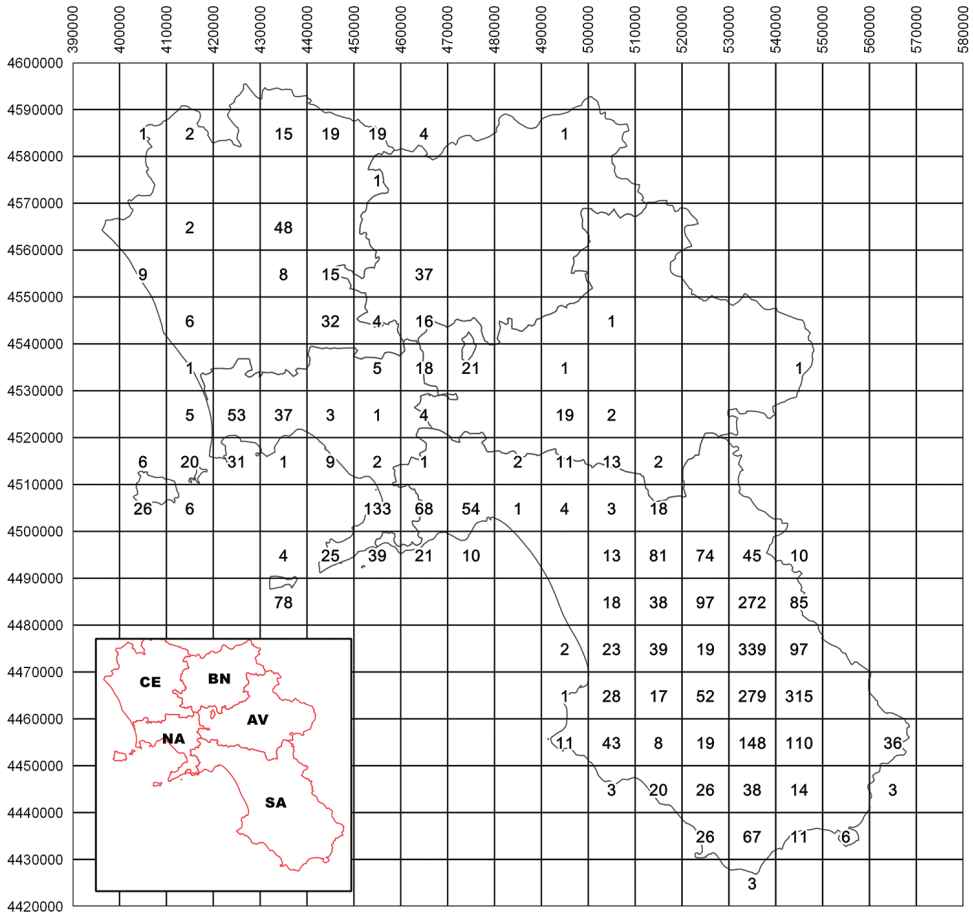

Figure 1. Number of bibliographic records (citations) in the 10 km × 10 km cells of the grid on 31 December 2016. Coordinates are expressed in metres, UTM WGS84 33N. Province abbreviations: AV = Avellino, BN = Benevento, CE = Caserta, NA = Naples, SA = Salerno.

erature in the 99 grid cells, the most common species are *Serapias lingua*, *Anacamptis pyramidalis* and *Ophrys apifera*.

The richness of taxa (Figure 2) in the cells reaches 51 species on the Alburni Mountains and is relatively high. This is also the situation in the cells corresponding to areas studied over a long period such as Capri Island or with a special attention paid to the Orchid flora as Lattari Mountains and the Taburno-Camposauro complex.

Observations

Observations account for 11017 records from more than 30 different contributors (academic researchers, scholars working on bachelor/PhD theses, postdoctoral research-

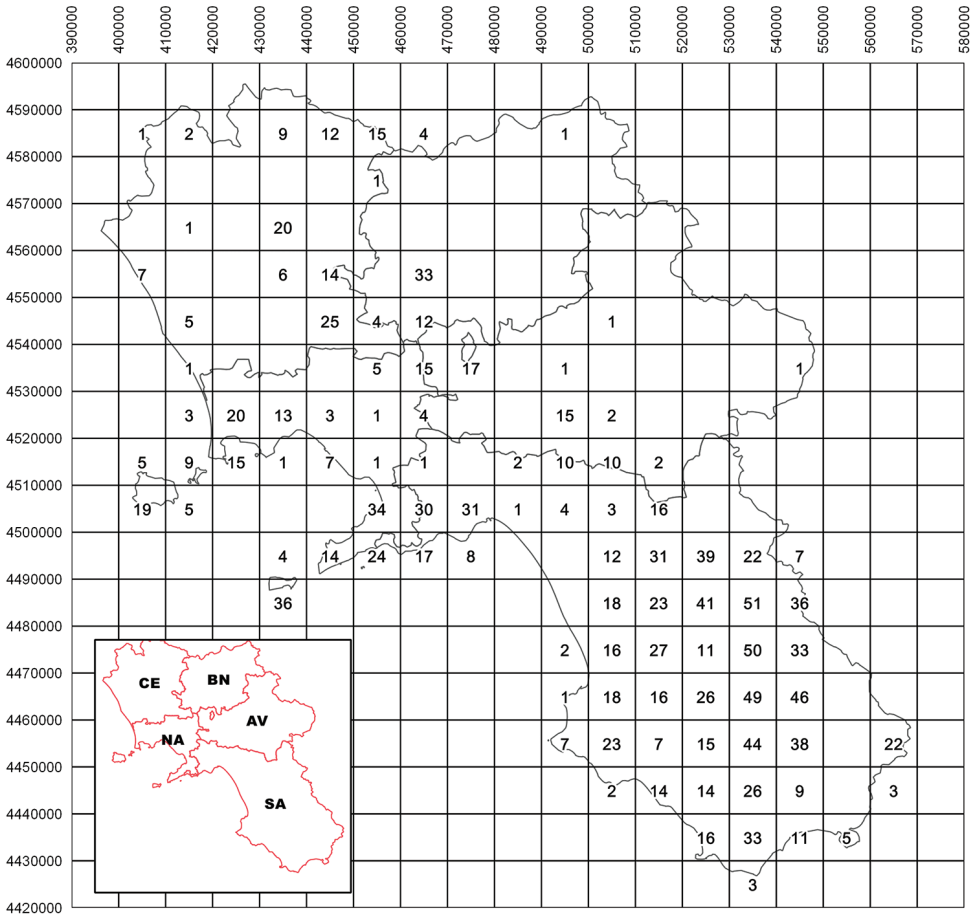

Figure 2. Richness of taxa based on literature data. The number includes hybrids but also species *sensu lato*. Coordinates are expressed in metres, UTM WGS84 33N. Province abbreviations: AV = Avellino, BN = Benevento, CE = Caserta, NA = Naples, SA = Salerno.

ers, members of naturalistic associations and regular or occasional volunteer contributors). The quality of the observation data is very good since 99.3% are "punctual" type data even if they sometimes lack some important features: the number of plants is missing in the 31.7% of the total observations while on the opposites the full date, very important to validate the correct identification of some species (e.g. *Ophrys* taxa), for the monitoring activities or to describe the phenology of the species, is present in the 95.5% of the records.

A total of 110 taxa have been observed and 33 of them are hybrids (Suppl. material 2). The most observed species are *Orchis italica*, *Anacamptis morio* and *Dactylorhiza maculata* subsp. *saccifera*.

Out of the 183 grid cells covering the Campania region, 109 cells have at least one observation (Figure 3). In these cells, the number of records varies from 1 to 2228, with

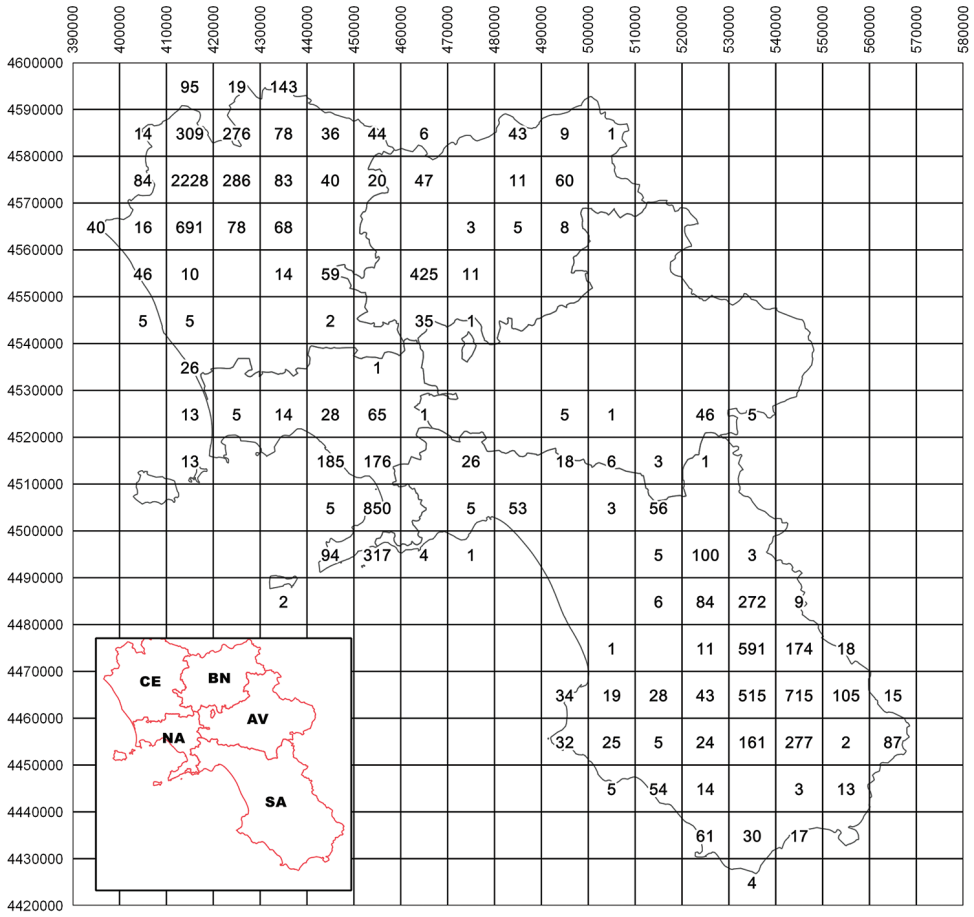

Figure 3. number of field data (observations) in the 10 km × 10 km cells of the grid on 31 December 2016. Coordinates are expressed in metres, UTM WGS84 33N. Province abbreviations: AV = Avellino, BN = Benevento, CE = Caserta, NA = Naples, SA = Salerno.

a mean of 101.3 and there is a high number of cells with less than 10 records. The most widespread species, according to their distribution in the grid cells are *Orchis italica*, *Serapias vomeracea* subsp. *vomeracea*, *Anacamptis morio* and *Anacamptis pyramidalis.*

The richness of the cells is higher in many cells for which no data was available in literature and reaches maximum values of 63 entities, including hybrids (Figure 4).

Study efforts and bias

Looking at the collecting effort over time, observations are very heterogeneously distributed (Figure 5) with a peak in 2001 – 2002. The impact of the volunteer contributors (citizen science projects) is always significant and account for the 39% of the total

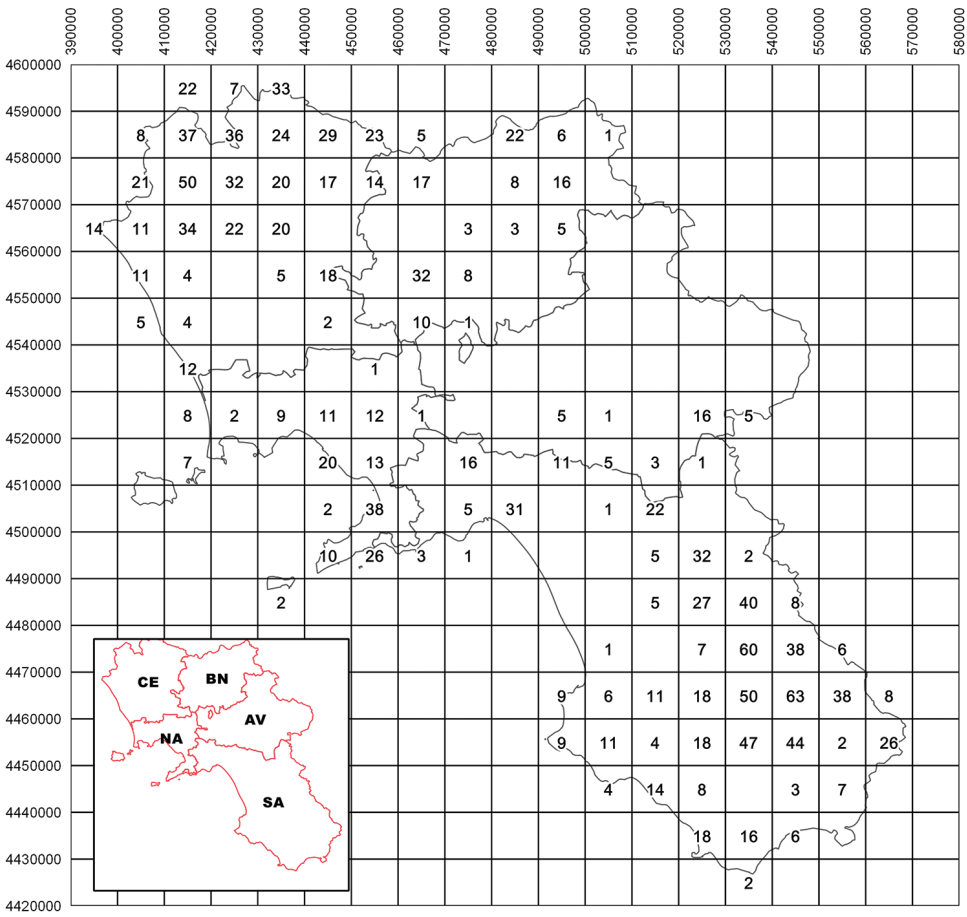

Figure 4. Richness of taxa based on field data (observations). The number includes hybrids. Coordinates are expressed in metres, UTM WGS84 33N. Province abbreviations: AV = Avellino, BN = Benevento, CE = Caserta, NA = Naples, SA = Salerno.

field records. The spatial distribution is also biased since the records are heterogeneously distributed in the five provinces (Tab 1). More than 75% of the observations fall in the Caserta and Salerno provinces. This is mainly due to the presence of important study areas (Matese Mountains, Roccamonfina volcano and Cilento-Vallo di Diano National Park) but when the extensions of the provinces are considered, surprisingly the province of Salerno is still not sufficiently explored, with less than one record per square kilometre. Conversely, for the small province of Naples, there is an average of 1.51 records/km^2. The bias in the spatial distribution of the data can also be a consequence of the well known "botanist effect" phenomenon (Moerman and Estabrook 2006) since the most explored provinces are also the most inhabited and where most contributors to the project actually live.

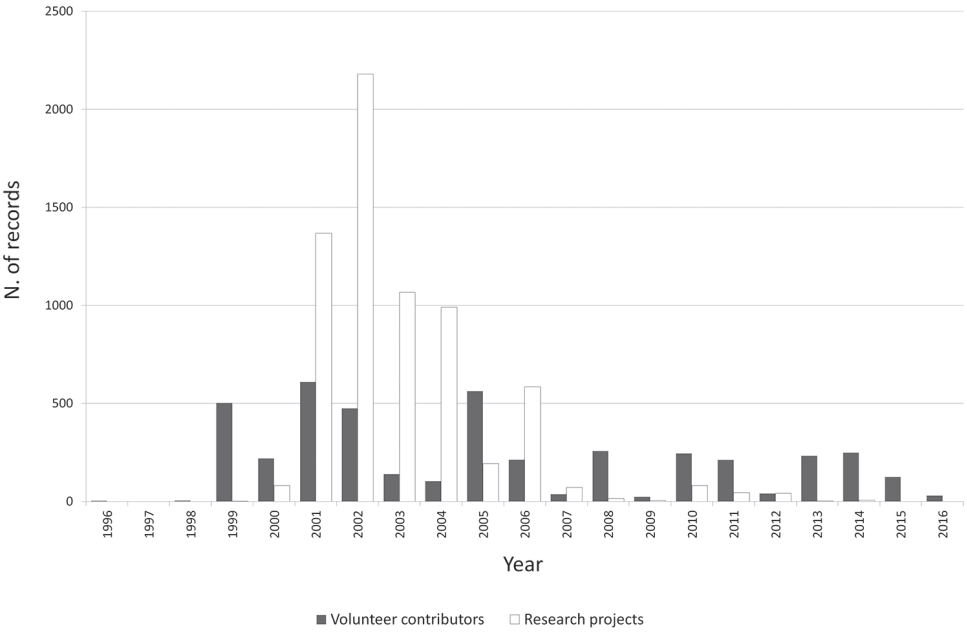

Figure 5. Distribution of the observations over time, collected in research projects or by volunteer contributors.

The observation records were clumped in 4037 different localities (points with different coordinates) and the same number of points was randomly generated using the QGIS random point tool. The distribution of actual localities was biased since 67% of them fell inside 27% of the region included in protected areas (χ^2 = 1973.65, *DF* = 1, p<0.001; Figure 6). On the other hand, less than 26% of the records were located inside the 2 km wide buffer around the main roads (Figure 7). The value of χ^2 (83.25, *DF* = 1, p<0.001) confirmed that the observation localities were preferably distributed far from the highways and there was not a clear "highway effect". On the other hand, the "roadside effect" was an important bias since the number of observations near roads was greater than the number expected from a spatially random distribution (Table 2). The differences were very significant in the buffer 0–100 m (χ^2 = 19.72, *DF* = 1, p<0,001). The Kolmogorov-Smirnov test confirmed this bias since the observed distribution was significatively different from the random distribution (*D* = 0.044, p<0.001).

The online atlas

The database information has been used to produce an online atlas (http://www.floracampana.unina.it/Orchidee/index.html) which includes the distribution maps on a UTM grid with 10 km × 10 km cells, some photographs and other information about

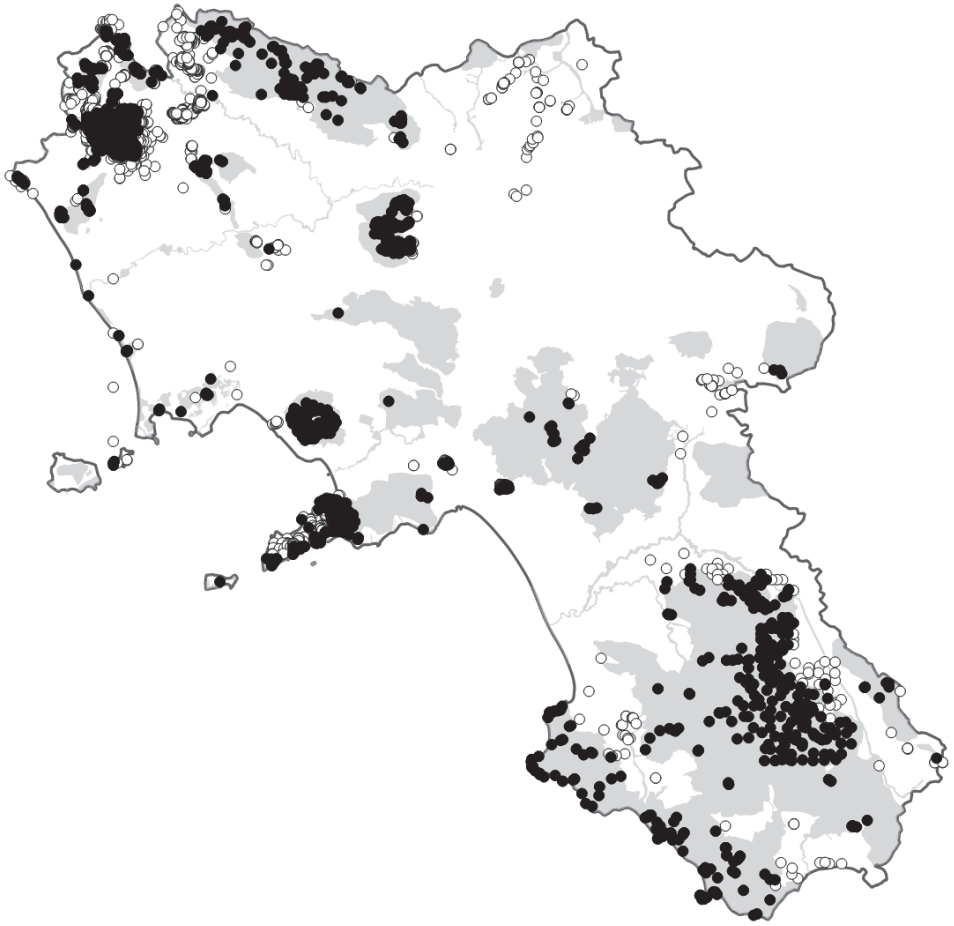

Figure 6. Distribution of the localities of the observations (punctual type) inside (black circles) and outside (open circles) protected areas (grey areas).

the presence of native orchids in Campania. The sites are periodically updated and, at present, it considers 75 entities observed at least one time and 2 others whose presence is reported for the region in literature but there are no records in the database i.e. *Orchis patens* (Del Guacchio 2010) and *Epipactis meridionalis* (Acta Plantarum 2007, GIROS 2016).

Conclusions

The database and the online atlas are intended as a means for promoting the aggregation between people interested in nature and avoiding (or limiting) the dispersion of distribution data on orchids. These will also represent a useful tool for the scien-

Figure 7. Distribution of the localities of the observations (punctual type) inside (black circles) and outside (open circles) a 2 km buffer around the main roads (bands).

Table 2. Number of actual observation localities and randomly placed localities (null model) falling inside the buffers around the road and the calculated chi square value. *** p<0.001

Buffer width (m)	Actual localities	Random points	Chi square
100	1077	957	15.0***
200	1690	1612	3.8
300	2156	2159	0.0
400	2420	2498	2.4
500	2691	2757	1.6
1000	3462	3450	0.0
2000	3919	3872	0.6
3000	4007	4001	0.0
>4000	4037	4037	0.0

tific community. Nowadays, admittedly, the knowledge on orchid distribution in the Campania region is far from being satisfactory since large areas (or cell grids) remain unexplored. However, this database and the related atlas may represent the first step towards the increase in fine-scale knowledge of orchid distribution in this important Mediterranean region.

Unifying the large amount of data collected in research projects, with the numerous but sporadic contributions from volunteers, may contribute to the avoidance of data dispersion and may place information in a wider time and geographic context.

Nevertheless, the project has so far generated some criticism which should be resolved in the future because there may be a source of bias in the data. Many records are incomplete although more structured research projects for Vesuvius, Roccamonfina or Cilento used a protocol for data collection (e.g. Perazza 1994). Volunteer contributions, as a matter of fact, often miss important data about ecologic or conservation features (habitat, number of plants, phenology etc.). Sharing of the progress and the analysis results could be a significative contribution to the volunteers' awareness about the importance of recording complete data. The bias analysis performed on the data spatial distribution could give important directions about where (and when) to sample. Actually, the distribution of the localities for observations is highly biased and the question whether the "biodiversity hotspots" are really the richer in species or simply the richer in observations still needs an answer. Contributors tend to sample inside the protected areas but often not too far from their car. So sampling is easier and faster but biased. Finally the systematic scheme can be a source of conflict since there is not a unique and dominant point of view. For this reason and to allow an easy switch from one scheme to another, the documentation of the observations (i.e. photographs and, secondarily, accurate descriptions of the plants) is essential for the correct identification or re-identification of the records.

In addition to the intrinsic value of distribution data, the following potential of the project can be highlighted:

– the development of a naturalistic and scientific culture;

– the implementation of the knowledge of rare and protected species and the use of orchids as environmental indicators;

– referring also to the previous point, the coordinates collected with high precision and accuracy can be useful in the monitoring activities required for the species listed in the Annexes of the Habitat Directive (Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora). Amongst the plant species listed, *Himantoglossum adriaticum* has a very widespread distribution throughout Italy and would require significant monitoring efforts (Gargano et al. 2016, Ercole et al. 2017)

– the networking of people sharing their interest towards orchid family and nature can be a model for a sustainable use of the landscape;

– a structured database can be integrated into other collections of data both in "horizontal" networks (e.g. floristic or biodiversity databases) and in "vertical" networks (e.g. national and international orchid databases).

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Supplementary material 1

Relations between the 4 tables of the MS Access database used to store the data of the project and respective fields

Authors: Antonio Croce, Roberto Nazzaro

Data type: Image

Explanation note: Relations between the 4 tables of the MS Access database used to store the data of the project and respective fields. Primary keys are underlined. Information requested from the volunteer contributors are marked by an asterisk. Formats of the fields are given as abbreviations in brackets: N= Number, T= Text; Y/N = Yes/No.

Link: https://doi.org/10.3897/italianbotanist.4.14916.suppl1

Supplementary material 2

Checklist of the taxa recorded in the database

Authors: Antonio Croce, Roberto Nazzaro

Data type: Table

Explanation note: Checklist of the taxa recorded in the database, in alphabetical order. The first two columns report the number of citations and the number of observation per taxa. The third column reports the total number of records. The fourth and the fifth columns report the number of 10 km x10 km cells of the used grid where the taxon has been recorded in literature and as field observation respectively.

Link: https://doi.org/10.3897/italianbotanist.4.14916.suppl2

Supplementary material 3

References considered for the bibliographic records

Authors: Antonio Croce, Roberto Nazzaro

Data type: (measurement/occurence/multimedia/etc.)

Explanation note: References considered for the bibliographic records, in alphabetical order.

Link: https://doi.org/10.3897/italianbotanist.4.14916.suppl3

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RESEARCH ARTICLE

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Notulae to the Italian alien vascular flora: 4

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Abstract

In this contribution, new data concerning the Italian distribution of alien vascular flora are presented. It includes new records and exclusions for Italy or for Italian administrative regions of taxa in the genera *Cedrus*, *Cenchrus*, *Citrus*, *Cyrtomium*, *Diospyros*, *Elaeagnus*, *Erigeron*, *Iris*, *Oenothera*, *Pavonia*, *Phytolacca*, *Styphnolobium*, and *Verbena*. Furthermore, a new combination in the genus *Amaranthus* is proposed.

Keywords

Floristic data, Italy, new combination, nomenclature

How to contribute

The text for the new records should be submitted electronically to Chiara Nepi (chiara.nepi@unifi.it). The corresponding specimen along with its scan or photograph has to be sent to FI Herbarium: Sezione di Botanica Filippo Parlatore del Museo di Storia Naturale, Via G. La Pira 4, 50121 Firenze (Italy). Those texts concerning nomenclatural novelties (typifications only for accepted names), status changes, exclusions, and confirmations should be submitted electronically to: Gabriele Galasso (gabriele.galasso@comune.milano.it). Each text should be within 2,000 characters (spaces included).

Floristic records

Amaranthus hybridus L. subsp. *caudatus* (L.) Iamonico & Galasso, comb. nov. (Amaranthaceae)
urn:lsid:ipni.org:names:77167023-1

≡ *Amaranthus caudatus* L., Sp. Pl. 2: 990. 1753 [1.V.1753].

The aggregate of *Amaranthus hybridus* L. includes the grain amaranths and forms a critical group from a taxonomical point of view. The evolutionary origin of grain taxa is still unclear, and two hypotheses were suggested, i.e., monophyletic and polyphyletic (e.g., Xu and Sun 2001, Iamonico 2015). A recent study by Stetter and Schmid (2017) showed that different and separated populations of wild *A. hybridus* subsp. *hybridus* appear to be the ancestor of the three cultivated grain species (i.e., *A. caudatus* L., *A. cruentus* L., and *A. hypochondriacus* L.); *A. hybridus* subsp. *quitensis* (Kunth) Costea & Carretero might be additionally involved in the origin of *A. caudatus*. On the contrary, the similar wild *A. powellii* S.Watson is related to *A. retroflexus* L. with which it forms a well separated clade. Accordingly, Stetter and Schmid (2017) strongly support a monophyletic status for these taxa. Since the subspecific rank is considered suitable for representing taxonomic relationships between a domesticated crop and its direct wild relative (Harlan and de Wet 1971) (see e.g., Bartolucci et al. 2017, Galasso et al. 2017), a new combination is proposed here for the grain crop *A. caudatus*.

D. Iamonico, G. Galasso

Cedrus atlantica (Endl.) G.Manetti ex Carrière (Pinaceae)

+ (CAS) **TOS**: Sesto Fiorentino (Firenze), Monte Morello in loc. Ceppeto, lungo il sentiero CAI 06l (WGS84: 43.85862°N; 11.25914°E), rimboschimento di conifere miste, 575 m, 11 March 2017, *F. Roma-Marzio, L. Peruzzi* (FI, PI, *Herb. F. Roma-Marzio*). – Casual alien species new for the flora of Toscana.

In the area of Monte Morello this species, as well as other conifers, has been frequently planted (Gestri and Peruzzi 2016). However, a spontaneous regeneration of *C. atlantica* was never reported before in Toscana (Roma-Marzio et al. 2016). Several small plants and plantlets, certainly originating from seeds, were found under mature planted trees.

F. Roma-Marzio, L. Peruzzi

Cenchrus incertus M.A.Curtis (Poaceae)

– **CAM**. – Alien species to be excluded from the flora of Campania.

Cenchrus incertus was recorded as new for the flora of Campania by Astolfi and Nazzaro (1993), based on specimens collected at the mouth of the Sele River in the Province of Salerno. After the revision of those specimens by Verloove and Sánchez Gullón (2012), the Sele population has been attributed to the closely related *C. longispinus* (Hack.) Fernald. Recently, *C. incertus* was also indicated by Stinca et al. (2013) for Sessa Aurunca at the mouth of the Garigliano River (Caserta Province) (PORUN). However, this *exsiccatum* was recently revised by one of us (AS) and identified as *C. longispinus*. Therefore, as already proposed by Del Guacchio and La Valva (2017), *C. incertus* is to be excluded from the flora of Campania.

A. Stinca, G. Chianese

Cenchrus longisetus M.C.Johnst. (Poaceae)

+ (CAS) **ABR**: Teramo (Teramo), bordo stradale lungo Via Po (WGS84: 42.665786°N; 13.720375°E), margine stradale, ca. 230 m, SE, 5 July 2017, *N. Olivieri* (FI). – Casual alien species new for the flora of Abruzzo.

This species occurs with some individuals along the edge of the paved road, at the border of an artificial urban lawn, occasionally mulled and subjected to anthropic disturbance, on a sandy, dry and shallow, silt soil. *Cenchrus longisetus* is cultivated as ornamental in a flowerbed nearby the opposite side of the road.

N. Olivieri

Citrus ×*aurantium* L. (Rutaceae)

= *C.* ×*sinensis* (L.) Osbeck (*C. maxima* (Burnm.) Merr. × *C. reticulata* Blanco)

+ (CAS) **ABR**: San Vito Chietino (Chieti), loc. Marina (WGS84: 42.305277°N; 14.447947°E), margine di coltivazione di agrumi parzialmente abbandonata, ca. 50 m, SE, 3 July 2017, *N. Olivieri* (FI). – Casual alien nothospecies new for the flora of Abruzzo.

A young individual of this hybrid grows at the margins of a cultivation of sweet oranges and olives in partial abandonment, along with young specimens of *Pittosporum tobira* (Thunb.) W.T.Aiton. The area is located on a hilly, fresh and partially shaded slope, on sandy soil. According to Mabberley (1999), sweet orange [*Citrus* ×*sinensis* (L.) Osbeck] is a heterotypic synonym of bitter orange (*C.* ×*aurantium*).

N. Olivieri

Cyrtomium falcatum (L.f.) C.Presl (Dryopteridaceae)

+ (NAT) **TAA**: Riva del Garda (Trento), nelle fessure della banchina del Lungolago Marinai d'Italia (WGS84: 45.883853°N; 10.841031°E), banchina in cemento, 65 m, 2 July 2017, *F. Roma-Marzio, P. Liguori* (FI, PI). – Naturalized alien species new for the flora of Trentino-Alto Adige.

The fern *Cyrtomium falcatum* is native to China, Japan, Korea, and Polynesia (Zhang and Barrington 2013). In Trentino-Alto Adige, Prosser (1995) reported the occurrence of the related *C. fortunei* J.Sm. that mainly differs from *C. falcatum* in the shape and thickness of lateral pinnae: lanceolate and papery in *C. fortunei*, ovate-lanceolate and leathery in *C. falcatum* (Zhang and Barrington 2013, Tison et al. 2014). About ten tufts or single fronds, originated from cultivated plants in the surrounding flowerbeds, were found in several places of the quay.

F. Roma-Marzio

Diospyros virginiana L. (Ebenaceae)

+ (NAT) **ITALIA** (**TOS**): Isola d'Elba, Campo nell'Elba (Livorno), San Piero in Campo, tra il campo sportivo e le cave di granito (WGS84: 42.750440°N; 10.202823°E), 230 m, 10 June 2017, *G. Frangini, G. Cortesi, B. Pierini, L. Peruzzi* (FI). – Naturalized alien species new for the flora of Italy (Toscana).

The plants were identified by using the keys reported by Li et al. (1996) and Eckenwalder (2009). *Diospyros virginiana* is native to the eastern USA (Eckenwalder 2009) and it has been occasionally used as rootstock for *D. kaki* Thunb. (Cohen et al. 1991). This is possibly the reason for the original introduction of *D. virginiana* on the island of Elba. The observed populations are able to self-propagate and form small, dense, monospecific woods not only in the area cited above, but also in a nearby more south-western locality (WGS84: 42.747865°N; 10.200290°E), in Fetovaia (WGS84: 42.735374°N; 10.153356°E) and in Colle di Palombaia (WGS84: 42.738525°N; 10.208502°E).

G. Frangini, G. Cortesi, B. Pierini, L. Peruzzi

Elaeagnus ×*ebbingei* Door. (Elaeagnaceae)

(*E. macrophylla* Thunb. × *E. pungens* Thunb.)

+ (CAS) **CAM**: Pozzuoli (Napoli), presso il porto (WGS84: 40.829347°N; 14.114121°E), sabbie marittime al margine di una formazione ad *Arundo donax*, 1 m, 20 April 2017, *A. Stinca* (FI, PORUN). – Casual alien nothospecies new for the flora of Campania.

This hybrid was recorded for the first time in Italy by Gallo (2010) in Piemonte and more recently in Abruzzo (Galasso et al. 2017). The individuals observed in Campania have spread by seeds of cultivated plants probably carried by the sea.

A. Stinca

Erigeron karvinskianus DC. (Asteraceae)

+ (CAS) **PUG**: Bari (Bari), zona sudorientale della città, nel centro del quartiere Carbonara (WGS84: 41.073501°N; 16.873610°E), lungo la parete ombreggiata di una casa, 54 m, 24 April 2017, *V. Tomaselli, G. Veronico* (FI). – Casual alien species new for the flora of Puglia.

It tends to spread out very rapidly, growing usually on walls or rocky places.

G. Veronico, V. Tomaselli

Iris albicans Lange (Iridaceae)

+ (NAT) **MAR**: Fabriano (Ancona), lungo la SS76 in loc. C.se le Balzette, circa 3 km a SW di Fabriano (WGS84: 43.31752°N; 12.87186°E), prato a bordo strada, 404 m, 16 April 2017, *F. Roma-Marzio, P. Liguori* (FI). – Naturalized alien species new for the flora of Marche.

Several shoots were observed for about one kilometre along the edge of the road.

F. Roma-Marzio

Oenothera adriatica Soldano (Onagraceae)

+ (CAS) **EMR**: Ravenna (Ravenna), Marina di Ravenna, zona industriale (WGS84: 44.443633°N; 12.226668°E), margine stradale, 1 m, no exp., 24 June 2015, *G. Bonari* (FI). – Casual alien species new for the flora of Emilia-Romagna.

In the industrial area, a few individuals grow scattered in the cracks of the sidewalk.

G. Bonari, A. Soldano

Pavonia hastata Cav. (Malvaceae)

+ (CAS) **ITALIA** (**LAZ**): Bracciano (Roma), Vigna di Valle, Museo Storico dell'Aeronautica Militare presso l'Aeroporto di Vigna di Valle, sulla sponda del Lago di Bracciano (WGS84: 42.085353°N; 12.218744°E), sponda lacustre, 158 m, 28 June 2017, *S. Buono* (FI). – Casual alien species new for the flora of Italy (Lazio).

Pavonia Cav. is a genus of more than 200 species from the tropics and subtropics and a member of the tribe Malvavisceae C.Presl, which is characterized by the number of styles corresponding to twice the number of carpels (Bird 1997, Fryxell 1999). *Pavonia hastata* is native to tropical South America where it occurs in woodlands and open forests in both damp and dry habitats; it is naturalized in Australia (Australian Native Plants Society 2017), southern USA (Bird 1997, Fryxell and Hill 2015, Plants Database 2017), Africa (Ulbrich 1920–1921, Fryxell 1999) and Portugal (Domingues de Almeida and Freitas 2012). This species usually forms a spreading shrub to about 1 m in height; leaf blades are ovate-triangular to hastate-oblong; inflorescences are axillary with solitary flowers, which are typically *Hibiscus*-like in shape, light pink or white with a red throat, appearing in summer and autumn; fruits are schizocarps with five mericarps (Fryxell 1999, Fryxell and Hill 2015, Australian Native Plants Society 2017). *P. hastata* is commonly cultivated as an ornamental plant (Bird 1997). In the location reported here, the species grows on sandy soil together with *Abutilon theophrasti* Medik., *Ludwigia peploides* (Kunth) P.H.Raven subsp. *montevidensis* (Spreng.) P.H.Raven, *Portulaca oleracea* L. aggr., *Solanum nigrum* L. and others. To date, a single individual regularly develops flowers and fruits. It was not observed, so far, in other locations along the lakeshore.

S. Buono, A. Scoppola

Phytolacca dioica L. (Phytolaccaceae)

+ (CAS) **TOS**: Isola d'Elba, Rio nell'Elba (Livorno), parte interna del Golfo di Nisporto (WGS84: 42.823821°N; 10.381158°E), 5 m, 10 June 2017, *G. Frangini, B. Pierini* (FI). – Casual alien species new for the flora of Toscana.

Five old trees occur in the site, showing abundant vegetative propagation.

G. Frangini, B. Pierini

Styphnolobium japonicum (L.) Schott (Fabaceae)

+ (CAS) **MOL**: Termoli (Campobasso), presso Via Madonna delle Grazie (WGS84: 41.998469°N; 14.989163°E), margine stradale, ca. 36 m, 15 July 2017, *N. Olivieri* (FI). – Casual alien species new for the flora of Molise.

Some young individuals grow along the roadside, in the narrow space between a wall and a kerb, as well as at the edge of a parking lot where some trees of the species were planted.

N. Olivieri

Verbena bonariensis L. (Verbenaceae)

+ (CAS) **LAZ**: Roma (Roma), pressi della stazione ferroviaria Tiburtina (WGS84: 41.893872°N; 12.530000°E), bordi di aiuole, ca. 20 m, 12 July 2017, *N. Olivieri* (FI). – Casual alien species new for the flora of Lazio.

Some individuals of this species grow at the edge of some irrigated flowerbeds. The plants originated from seeds produced by some individuals planted in neighbouring flowerbeds.

N. Olivieri

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RESEARCH ARTICLE

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Notulae to the Italian native vascular flora: 4

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Abstract

In this contribution new data concerning the distribution of native vascular flora in Italy are presented. It includes new records, exclusion, extinction and confirmations to the Italian administrative regions for taxa in the genera *Androsace*, *Artemisia*, *Fragaria*, *Melampyrum*, *Myosotis*, *Petrorhagia*, *Phillyrea*, *Rosa*, *Rumex*, *Spiranthes*, *Trifolium*, and *Vicia*. Furthermore, a new combination in the genus *Omalotheca* is proposed.

Keywords

Floristic data, Italy, new combinations, nomenclature

How to contribute

The text for the new records should be submitted electronically to Chiara Nepi (chiara.nepi@unifi.it). The corresponding specimens along with its scan or photograph have to be sent to FI Herbarium: Sezione di Botanica "Filippo Parlatore" del Museo di Storia Naturale, Via G. La Pira 4, 50121 Firenze (Italy). Those texts concerning nomenclatural novelties (typifications only for accepted names), status changes, exclusions, and confirmations should be submitted electronically to: Fabrizio Bartolucci (fabrizio.bartolucci@gmail.com). Each text should be within 2,000 characters (spaces included).

Floristic records

Androsace mathildae Levier (Primulaceae)

– **CAM.** Species to be excluded from the flora of Campania.

This species is doubtfully reported for Campania by Lacaita (1921), Moggi (1955, 2001) and Conti et al. (2005), on the basis of an improperly interpreted indication of Briganti (1816, sub *Aretia alpina*). Briganti (1816), describing the new species *Campanula alburnica* V.Brig. (= *Asyneuma trichocalycinum* [Ten.] K.Malý) for Mt. Alburno, generically quotes some plants for the Apennines without indicating any locality; among these plants, he listed also *Aretia alpina*. In the Briganti collection preserved in the *Herbarium Porticense* (PORUN), there is currently only one specimen of *A. alpina* lacking collection date and locality. Accordingly, this species presently occurs only in Abruzzo (Peruzzi et al. 2015) and should be excluded from Campania.

A. Stinca, G. Chianese

Artemisia campestris L. subsp. *variabilis* (Ten.) Greuter (Asteraceae)

+ **PUG**: Chieuti (Foggia), loc. Marina di Chieuti, vegetazione retrodunale presso la foce del torrente Saccione (WGS84: 41.925116°N; 15.137822°E), ca. 5 m, 28 June 2017, *N. Olivieri* (FI). – Subpecies confirmed for the flora of Puglia.

This subspecies was not recorded in Puglia by Conti et al. (2005), albeit it had been indicated previously by Forte et al. (2002).

N. Olivieri

Fragaria viridis Weston subsp. *viridis* (Rosaceae)

+ **UMB:** Castel Giorgio (Terni), loc. Casa Perazza (WGS84: 42.680235°N; 12.019837°E), margine di cespuglieto, al sole, al bordo di sterrato adibito ad area di sosta, 580 m, 15 April 2017, *A. Scoppola* (FI, UTV Nos. 35211, 35213). – Species confirmed for the flora of Umbria.

This species was reported by Barsali (1931, sub *Fragaria vesca* var. *viridis* (Duch.) Fiori), in woody and grassy sites together with *F. vesca* L. var. *vesca*, albeit less frequently. According to Pignatti (1982) it is present, but rare, throughout mainland Italy, but Conti et al. (2005) consider its occurrence in Umbria doubtful. In its area of occurrence, the population consists of a few plants in a very restricted space, due to the progressive expansion of shrubs.

J. López Tirado, A. Scoppola

Melampyrum variegatum (Porta & Rigo) Huter (Orobanchaceae)

+ **LAZ:** Ascrea (Rieti), Monte Filone (WGS84: 42.198666°N; 13.008821°E), pendii sassosi, 800 m, 19 June 2004, *F. Bartolucci* (FI, APP No. 57782). – Species confirmed for the flora of Lazio.

Melampyrum variegatum is reported for Lazio (Conti et al. 2005), but not confirmed in the regional flora recently published by Anzalone et al. (2010).

F. Bartolucci, F. Conti

Myosotis graui Selvi (Boraginaceae)

+ **UMB:** Parco Naturale Regionale del Monte Cucco, Sigillo (Perugia), versante SW del M. Testagrossa (WGS84 43.34081°N; 12.77901°E), pascolo su suolo calcareo, 960 m, 16 April 2017, *F. Roma-Marzio et P. Liguori* (FI, *Herb. Roma-Marzio*). – Species confirmed for the flora of Umbria.

After the typification of the name *Myosotis ambigens* (Bég.) Grau, this unit turned out to be a heterotypic synonym of *M. alpestris* F.W.Schmidt (Selvi and Cecchi 2009). However, plants from the central and southern Apennines are morphologically different from those occurring in the Alps and northern Apennines. For this reason, *Myosotis graui* was described as a new Italian endemic species (Selvi and Cecchi 2009). The known distribution

range of *M. graui* goes from Marche to Calabria along the Apennines, whereas in Umbria its occurrence is considered doubtful (Peruzzi et al. 2014). In the flora of Monte Cucco (Menghini and De Capite 1974), the occurrence of *M. alpestris* was reported; more recently, Biondi et al. (2004) reported the co-occurrence of *M. alpestris* and *M. ambigens* for the same place. In our collection area, *M. graui* is very common in rocky calcareous pastures.

F. Roma-Marzio, L. Cecchi, F. Selvi

Omalotheca diminuta (Braun-Blanq.) Bartolucci & Galasso, comb. nov. (Asteraceae)

≡ *Gnaphalium diminutum* Braun-Blanq., Vierteljahrsschr. Naturf. Ges. Zürich 62(2): 618. 1917 [31.XII.1917].

= *Gnaphalium supinum* L. var. *hoppeanum* (W.D.J.Koch) Fiori f. *magellense* Fiori, Fl. Italia [Fiori, Béguinot & Paoletti] 3(2): 279(–280). 1904 [IV.1904] ≡ *Gnaphalium hoppeanum* W.D.J.Koch subsp. *magellense* (Fiori) Strid, Mountain Fl. Greece [Strid] 2: 411. 1991 ≡ *Omalotheca hoppeana* (W.D.J.Koch) Sch.Bip. & F.W.Schultz subsp. *magellensis* (Fiori) Holub, Preslia 70(2): 108. 1998 [21.VI.1998].

According to molecular analyses conducted by Nie et al. (2016), *Omalotheca* Cass. is recognized as an independent genus from *Gnaphalium* L. The list of taxa recognized for the Italian flora (Conti et al. 2005) belonging to this genus, besides the necessary new combination proposed here, is as follows: *O. norvegica* (Gunnerus) Sch.Bip. & F.W.Schultz [≡ *Gnaphalium norvegicum* Gunnerus], *O. hoppeana* (W.D.J.Koch) Sch. Bip. & F.W.Schultz (≡ *Gnaphalium hoppeanum* W.D.J.Koch), *O. supina* (L.) DC. (≡ *Gnaphalium supinum* L.), *O. sylvatica* (L.) Sch.Bip. & F.W.Schultz (≡ *Gnaphalium sylvaticum* L.).

F. Bartolucci, G. Galasso

Petrorhagia dubia (Raf.) G. López & Romo (Caryophyllaceae)

0 **EMR:** Bologna, Monte Sabbione, 11 June 1873, *Marchesetti* (FI); A Sassuolo presso Modena, 27 June 1898, *s.coll.* (FI). – Species not confirmed for the flora of Emilia-Romagna.

Petrorhagia dubia (Raf.) G.López & Romo is a southern Mediterranean species. In Italy, it occurs in Veneto (casual), Sardegna and from Toscana to Sicilia, whereas it is not confirmed in Friuli Venezia Giulia (Conti et al. 2005, Masin and Scortegana 2012). Although this species was never reported for Emilia-Romagna, we found two sheets bearing *P. dubia*, mixed with *P. prolifera* (L.) P.W.Ball & Heywood in FI herbarium, as already annotated by P.W. Ball and R. Corradi on the herbarium sheets, and confirmed by us.

M. D'Antraccoli, F. Roma-Marzio

Phillyrea angustifolia L. (Oleaceae)

+ **MOL**: Termoli (Campobasso), versante meridionale del Vallone del Riovivo (WGS84: 41.994680°N; 14.995916°E), ca. 25 m, 28 June 2017, *N.Olivieri* (FI). – Species new for the flora of Molise.

N. Olivieri

Rosa deseglisei Boreau (Rosaceae)

+ **EMR**: Brunelli di Borgo Val di Taro (Parma), lungo una siepe tra due case (WGS84: 44.506207°N; 9.764378°E), 540 m, 13 June 2016 Leg. *L. Ghillani*, Det. *L. Ghillani*, *M. Adorni*, *E. Lattanzi* (FI). – Species confirmed for the flora of Emilia-Romagna.

Rosa deseglisei is reported only for Piemonte, Trentino-Alto Adige and Lazio (Conti et al. 2005). It was subsequently reported also for Toscana (Venturi 2006, Ricceri 2013), Lombardia (Martini et al. 2012, under the name *R. corymbifera* subsp. *deseglisei*), and Puglia (Wagensommer et al. 2014). This species has been previously reported only for Emilia-Romagna (under the name *R. dumetorum* var. *deseglisei*) by Caldesi (1880) for several sites in the Province of Ravenna: "*S. Biagio in collina, Urbiano, Poggio, M. della Bicocca, Celle, Pergola*". We found a single plant.

L. Ghillani, M. Adorni

Rumex acetosella L. subsp. *multifidus* (L.) Schübl. & G.Martens (Polygonaceae)

+ **PUG:** Brindisi, at Saline di Punta della Contessa saltworks in a wide marginal area between a cultivated field and the dune belt (WGS84: 40.602538°N; 18.033729°E), less than 1 m a.s.l., 20 May 2015, *V. Tomaselli, G. Veronico* (FI). – Subspecies new for the flora of Puglia.

Rumex acetosella L. is widespread throughout the Italian territory (Conti et al. 2005), while *R. acetosella* subsp. *multifidus* is recorded only for Abruzzo, Campania, Basilicata, Calabria, and Sicilia. This subspecies prefers sandy environments with a certain degree of soil acidity (Stopps et al. 2011). The population was found in a meadow dominated by *Agrostis pourretii* Willd..

G. Veronico, V. Tomaselli

Spiranthes aestivalis (Poir.) Rich. (Orchidaceae)

0 **LAZ.** – Species extinct from the flora of Lazio.

Ettore Rolli discovered this species in 1870 in the marshes (which have now disappeared) of Fiumicino. Over one century later, in June 1988, *S. aestivalis* was found again near the Riserva Naturale Tevere-Farfa (Giardini 1988). In this locality, the only one known at that time in Lazio, *S. aestivalis* was observed for several years, and in 1992 some specimens were collected for chromosome counting (Capineri and Giardini 1994). In 1999, works for the enlargement of the A1 motorway started, which impacted the area with *Spiranthes*. These road construction works changed the water regime so that the site that once hosted this orchid no longer has the amount of water needed for the survival of this species. During the inspections carried out over the last decade, from the summer of 2006 to 2016, *S. aestivalis* has never been observed again. This species should, therefore, be considered as locally extinct in Lazio.

M. Giardini

Trifolium hirtum All. (Fabaceae)

+ **LIG:** Cairo Montenotte (Savona), Loc. S. Anna, Langhe Orientali (WGS84 44.392838°N; 8.268630°E), scarpatella arida al bordo di strada sterrata, 415 m, 27 May 2017, *A. Scoppola* (FI, UTV No. 35207, 35208). – Species confirmed for the flora of Liguria.

This species was recently reported for Umbria (Bartolucci et al. 2016). It was historically known for Liguria (Conti et al. 2005), based on a finding by F. Vignolo-Lutati dating back to 1924 (*exsiccatum* in TO-HP). This collector, showing great foresight, attached a topographic map of the site and the precise location of the population to the herbarium sheet. After more than 90 years, these details allowed us to re-find the same population. Presently, it consists of a few individuals growing in a small dry grassland among meadows, country houses, and the nearby land.

A. Scoppola, L. Guglielmone

Vicia johannis Tamamsch. (Fabaceae)

+ **EMR:** Monte del Gesso di Vezzano sul Crostolo (Reggio Emilia) (WGS84: 44.595992°N; 10.529490°E), prato steppico al margine di siepe, 320 m, 16 May 2008, *V. Morelli, S. Sturloni* (*Herb. Branchetti*); Ca' Sana di Terenzo (Parma) (WGS84: 44.619535°N; 10.151032°E), prateria arida arbustata, 390 m, 25 March 2016, *M. Adorni* (FI); Stadirano di Lesignano de' Bagni (Parma) (WGS84: 44.637292°N; 10.291043°E), margine arido di siepe, 280 m, 3 April 2016, *M. Adorni* (FI); Ca' del Parmigiano di Fornovo di Taro (Parma) (WGS84: 44.678709°N; 10.129904°E), cresta di calanco argilloso, 320 m, 3 May 2016, *M. Adorni* (FI). – Species new for the flora of Emilia-Romagna.

Vicia johannis is a species with Mediterranean distribution (Tison and de Focault 2014). This species is not reported by Pignatti (1982) and it is listed in Conti et al. (2005) without a precise distribution. Its occurrence in Veneto was recently reported by Alessandrini et al. (2017), while its occurrence in Emilia-Romagna appeared in Acta Plantarum Forum (http://www.actaplantarum.org/floraitaliae/viewtopic.php?t=85449). Previously, the populations from Ca' del Parmigiano and Monte del Gesso di Vezzano were wrongly recorded as *V. narbonensis* L. (Adorni et al. 2012, Alessandrini et al. 2012).

M. Adorni, V. Morelli, S. Sturloni

Vicia melanops Sm. (Fabaceae)

+ **UMB:** Orvieto (Terni), SP 13, strada sterrata verso il confine con la Prov. di Viterbo (WGS84: 42.657744°N; 12.016411°E), margine incolto di arbusteto lungo stradello tra i campi, 595 m, 14 April 2017, A. Scoppola (FI, UTV No. 35209). – Species confirmed for the flora of Umbria.

The species occurs frequently in southern Italy and Sicilia, and sporadically in northern Tyrrhenian areas (Pignatti 1982). It is very rare in central Italy, occurring in Toscana, Lazio and Abruzzo, where it reaches the northern limit of its range along the Adriatic side (Conti et al. 2017). According to Conti et al. (2005), the species doubtfully occurs in Umbria, where it was previously reported through unpublished observations by S. Ballelli. The population reported here grows close to the regional borders, within the herbaceous vegetation settled on the edge of a minor road.

J. López Tirado, A. Scoppola

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RESEARCH ARTICLE

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Chromosome numbers for the Italian flora: 4

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Abstract

In this contribution new chromosome data obtained on material collected in Italy are presented. It includes 9 chromosome counts for *Polygala* (Polygalaceae), *Dianthus* and *Silene* (Caryophyllaceae).

Keywords

Cytogeography, cytotaxonomy, karyotype

How to contribute

Texts concerning new chromosome data should be submitted electronically to Lorenzo Peruzzi (lorenzo.peruzzi@unipi.it), including indications of voucher specimens and methods used.

Chromosome counts

Polygala flavescens DC. subsp. *flavescens* (Polygalaceae)

Chromosome number. $2n = 22$ (Fig. 1)

Voucher specimen. ITALY. Toscana. Cerbaie (Pisa) (WGS84: 43.751228 N, 10.719234 E), 55 m, 7 May 2015, *D. Dolci* (PI n. 000455, 000456, 000457, 000458).

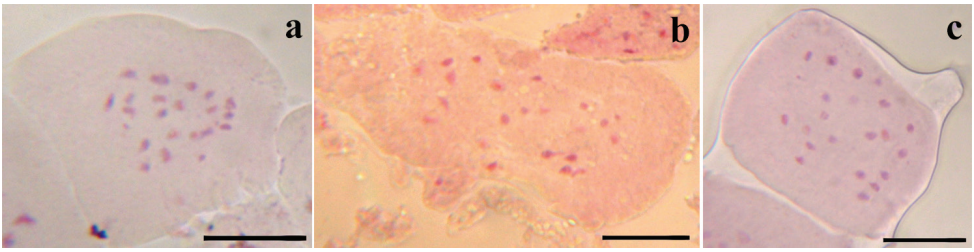

Figure 1. *Polygala flavescens* DC. subsp. *flavescens*, 2*n* = 22 from Cerbaie, Tuscany (**a**), Torano, Lazio (**b**), and Vallerotonda, Lazio (**c**). Scale bar: 10 μm.

Lazio. Torano (Rieti) (WGS84: 42.157098 N, 13.270760 E), 760 m, 30 April 2015, *D. Dolci* (PI n. 000453, 000454); Vallerotonda (Frosinone) (WGS84: 41.588942 N, 14.007237 E), 765 m, 3 May 2015, *D. Dolci* (PI n. 000459, 000460).

Method. Squash preparations were made on root-tips taken from plants cultivated in the Botanical Garden of Pisa and obtained from germinating seeds collected in the field. Root-tips were pre-treated with 0.4% colchicine for 3 hours and then fixed in Carnoy fixative solution for 1 hour. After hydrolysis in HCl 1N at 60° C, the tips were stained in leuco-basic fuchsine.

Observations. *Polygala flavescens* subsp. *flavescens* is an Italian endemic taxon, described from central Italy and currently recorded from Emilia Romagna to Basilicata (Conti et al. 2005, Del Guacchio 2010). These are the first chromosome counts for this species (Bedini et al. 2010 onwards), and they also represent the first records of 2*n* = 22 cytotypes in the genus *Polygala* L. (Rice et al. 2014).

Polygala flavescens DC. subsp. *maremmana* (Fiori) Arrigoni (Polygalaceae)

Chromosome number. 2*n* = 22 (Fig. 2)

Voucher specimen. ITALY. Toscana. Monte Argentario (Grosseto) (WGS84: 42.421952 N, 11.140779 E), 130 m, 6 May 2015, *D. Dolci* (PI n. 000466, 000467, 000468, 000469).

Method. Squash preparations were made on root-tips taken from plants cultivated in the Botanical Garden of Pisa and obtained from germinating seeds collected in the field. Root-tips were pre-treated with 0.4% colchicine for 3 hours and then fixed in Carnoy fixative solution for 1 hour. After hydrolysis in HCl 1N at 60° C, the tips were stained in leuco-basic fuchsine.

Observations. *Polygala flavescens* subsp. *maremana* is an Italian endemic, originally described as a form based on plants from Mt. Argentario (Peruzzi et al. 2015). Currently, it is recorded from the coasts of southern Tuscany, from San Vincenzo (Leghorn) to Capalbio (Grosseto) (Arrigoni 2014). Our chromosome count, performed on plants from the *locus classicus*, is the first for this subspecies (Bedini et al. 2010 onwards), and it agrees with the chromosome number reported above for *P. flavescens* subsp. *flavescens*.

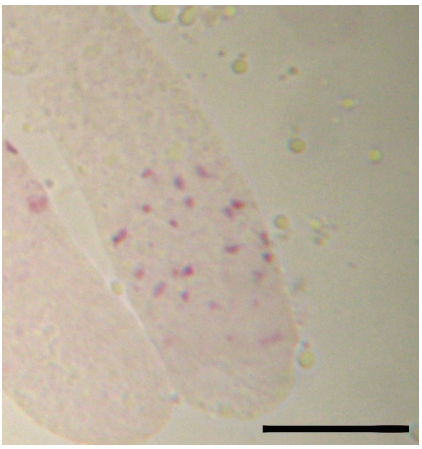

Figure 2. *Polygala flavescens* subsp. *maremmana* (Fiori) Arrigoni, 2*n* = 22. Scale bar: 10 μm.

Polygala flavescens DC. subsp. *pisaurensis* (Caldesi) Arcang. (Polygalaceae)

Chromosome number. 2*n* = 22 (Fig. 3)

Voucher specimen. ITALY. Marche. Fano (Pesaro e Urbino) (WGS84: 43.864231 N, 12.984113 E), 25 m, 24 April 2015, *D. Dolci* (PI n. 000461, 000462).

Method. Squash preparations were made on root-tips taken from plants cultivated in the Botanical Garden of Pisa and obtained from germinating seeds collected in the field. Root-tips were pre-treated with 0.4% colchicine for 3 hours and then fixed in Carnoy fixative solution for 1 hour. After hydrolysis in HCl 1N at 60° C, the tips were stained in leuco-basic fuchsine.

Observations. *Polygala flavescens* subsp. *pisaurensis* is an Italian endemic, originally described as a species based on plants from Pesaro (Peruzzi et al. 2015). Currently, it is recorded for coastal hills of Emilia-Romagna and Marche (Arrigoni 2014). Our chromosome count, performed on plants from the *locus classicus* area, is the first for this subspecies (Bedini et al. 2010 onwards), and it agrees with the chromosome numbers reported above for *P. flavescens* subsp. *flavescens* and *P. flavescens* subsp. *maremmana*.

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Dianthus brutius Brullo, Scelsi & Spamp. subsp. *brutius* (Caryophyllaceae)

Chromosome number. 2*n* = 30 (Fig. 4)

Voucher specimen. ITALY. Calabria. Aspromonte, Roccaforte del Greco (Reggio Calabria), near the Menta's artificial basin (WGS84: 38.12427 N, 15.90080 E), metamorphic rock outcrops along the road, 1400 m, 21 August 2017, *L. Peruzzi & K.F. Caparelli* (seeds collected in the field and stored in the Germplasm Bank of Department of Biology, Pisa, under acc. n. PI-20170073).

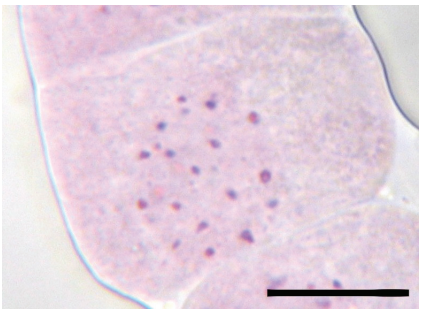

Figure 3. *Polygala flavescens* subsp. *pisaurensis* (Caldesi) Arcang., 2*n* = 22. Scale bar: 10 μm.

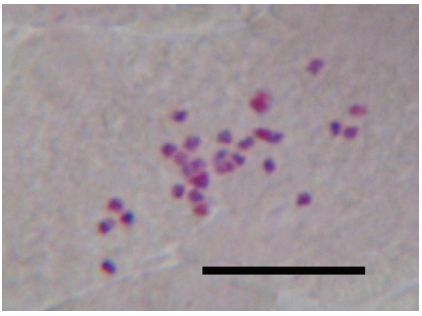

Figure 4. *Dianthus brutius* Brullo, Scelsi & Spamp. subsp. *brutius*, 2*n* = 30. Scale bar: 10 μm.

Method. Squash preparations were made on root-tips obtained from germinating seeds collected in the field. Root-tips were pre-treated with 0.4% colchicine for 3 hours and then fixed in Carnoy fixative solution for 1 hour. After hydrolysis in 1N HCl at 60° C, the tips were stained in leuco-basic fuchsine.

Observations. *Dianthus brutius* subsp. *brutius* is endemic to Calabria (Peruzzi et al. 2014), occurring in the mountain part of the Aspromonte area, and it belongs to *D. vulturius* Guss. & Ten. group (Brullo et al. 2000). This is the first chromosome count for this species, and the number is consistent with the basic chromosome number (*x* = 15) typical for the genus *Dianthus* L. (Bedini et al. 2010 onwards; Rice et al. 2014).

Dianthus brutius Brullo, Scelsi & Spamp. subsp. *pentadactyli* Brullo, Scelsi & Spamp. (Caryophyllaceae)

Chromosome number. 2*n* = 30 (Fig. 5)

Voucher specimen. ITALY. Calabria. Melito di Porto Salvo (Reggio Calabria), Pentidattilo (WGS84: 37.95946 N; 15.76115 E), conglomerate cliffs, 300 m, 21 August 2017, *L. Peruzzi & K.F. Caparelli* (seeds collected in the field and stored in the Germplasm Bank of Department of Biology, Pisa, under acc. n. PI-20170072).

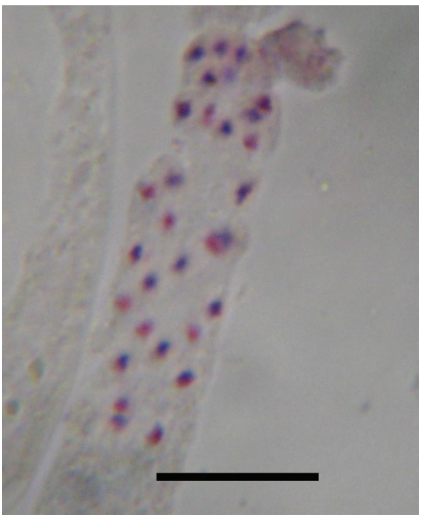

Figure 5. *Dianthus brutius* subsp. *pentadactyli* Brullo, Scelsi & Spamp., 2*n* = 30. Scale bar: 10 μm.

Method. Squash preparations were made on root-tips obtained from germinating seeds collected in the field. Root-tips were pre-treated with 0.4% colchicine for 3 hours and then fixed in Carnoy fixative solution for 1 hour. After hydrolysis in 1N HCl at 60° C, the tips were stained in leuco-basic fuchsine.

Observations. *Dianthus brutius* subsp. *pentadactyli* is endemic to Calabria (Peruzzi et al. 2014), occurring in the lowest part of the Ionian slope of Aspromonte area (Brullo et al. 2000). This is the first chromosome count for this subspecies (Bedini et al. 2010 onwards), and it agrees with the chromosome number reported above for *D. brutius* subsp. *brutius*.

Dianthus vulturius Guss. & Ten. subsp. *aspromontanus* Brullo, Scelsi & Spamp. (Caryophyllaceae)

Chromosome number. 2*n* = 30 (Fig. 6)

Voucher specimen. ITALY. Calabria. Montebello Jonico (Reggio Calabria), along the road to Masella (WGS84: 37.97780 N, 15.75978 E), cliffs, 320 m a.s.l., 21 August 2017, *L. Peruzzi* & *K.F. Caparelli* (PI).

Method. Squash preparations were made on root-tips obtained from germinating seeds collected in the field. Root-tips were pre-treated with 0.4% colchicine for 3 hours and then fixed in Carnoy fixative solution for 1 hour. After hydrolysis in 1N HCl at 60° C, the tips were stained in leuco-basic fuchsine.

Observations. *Dianthus vulturius* subsp. *aspromontanus* is endemic to Calabria (Peruzzi et al. 2014). It is distributed only in a small area of southern Aspromonte, growing as a chasmophyte (Brullo et al. 2000). This is the first chromosome count for this species, and it is consistent with chromosome numbers reported above for the related *D. brutius* subsp. *brutius* and *D. brutius* subsp. *pentadactyli*.

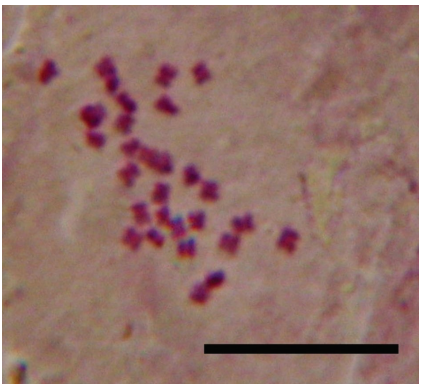

Figure 6. *Dianthus vulturius* Guss. & Ten. subsp. *aspromontanus* Brullo, Scelsi & Spamp., 2*n* = 30. Scale bar: 10 μm.

Figure 7. *Silene calabra* Brullo, Scelsi & Spamp., 2*n* = 24. Scale bar: 10 μm.

Silene calabra Brullo, Scelsi & Spamp. (Caryophyllaceae)

Chromosome number. 2*n* = 24 (Fig. 7)

Voucher specimen. ITALY. Calabria. Melito di Porto Salvo (Reggio Calabria), Pentidattilo (WGS84: 37.95278 N, 15.76156 E), cliffs along the road, 255 m a.s.l., 21 August 2017, *Lorenzo Peruzzi* & *K.F. Caparelli* (seeds collected in the field and stored in the Germplasm Bank of Department of Biology, Pisa, under acc. n. PI-20170071).

Method. Squash preparations were made on root-tips obtained from germinating seeds collected in the field. Root-tips were pre-treated with 0.4% colchicine for 3 hours and then fixed in Carnoy fixative solution for 1 hour. After hydrolysis in 1N HCl at 60° C, the tips were stained in leuco-basic fuchsine.

Observations. *Silene calabra* is endemic to Calabria (Peruzzi et al. 2014). According to Brullo et al. (1997), this species belongs to *S.* sect. *Siphonomorpha* Otth., and

it shows a close morphological relationship mainly with taxa of the *S. mollissima* (L.) Pers. group. This is the first chromosome count reported for this species, and it agrees with that reported for the closely related *S. oenotriae* Brullo (Peruzzi et al. 2007), and with those reported for other taxa within *S.* sect. *Siphonomorpha* (Naciri et al. 2017, and literature cited therein).

R.B. Chiavegatto, M. D'Antraccoli, F. Roma-Marzio, L. Peruzzi

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RESEARCH ARTICLE

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Global and Regional IUCN Red List Assessments: 4

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Abstract

In this contribution, the conservation status assessments of three vascular plants are presented following to IUCN categories and criteria. It includes the assessment at global level of *Saxifraga caprariae* Mannocci, Ferretti, Mazzoncini & Viciani and *S. montis-christi* Mannocci, Ferretti, Mazzoncini & Viciani and the regional assessment of *Halocnemum cruciatum* (Forssk.) Tod. (Spain).

Keywords

Conservation, extinction risk, IUCN protocol, threats

How to contribute

The text of the global and regional assessment should be submitted electronically to Simone Orsenigo (simone.orsenigo@unimi.it) or to Giuseppe Fenu (gfenu@unica.it); text up to 8000 characters in length (space included) must include a distribution map and a picture of the assessed species.

Red List assessments

Saxifraga caprariae Mannocci, Ferretti, Mazzoncini & Viciani

Global Assessment
Taxonomy and nomenclature
Order: Saxifragales **Family:** Saxifragaceae

Saxifraga caprariae Mannocci, Ferretti, Mazzoncini & Viciani, Phytotaxa 284: 122. 2016.

Common name: Sassifraga di Capraia (It); Saxifrage of Capraia (En).

Geographic distribution range: *S. caprariae* (Fig. 1) is endemic to Capraia, a small island in the Tuscan Archipelago, Italy (Fig. 2; Mannocci et al. 2016). The species was found in three separate sites: "Fondo" Spring, below "Sella dell'Acciatore"; upper northern part of "Vado della Peraiola", below "gli Stagnoli" near "Fosso del Calacone"; and on the northern slopes of Mt. Pontica, towards "Vado della Fenicia". In the *Herbariun Centrale Italicum* (FI) there are herbarium specimens collected in 1896 from Mt. Castello, another site on the island. *Saxifraga caprariae* appears to be not confirmed at Mt. Castello, since repeated field surveys have failed to find it, however it is possible that this subpopulation persists.

Distribution: Country of occurrence: Italy

Biology: *Plant growth form*: perennial (hemicryptophyte)

Flowering time: Early spring (March to April)

Reproduction: No information on pollination, dispersal strategy and seed germination is available.

Habitat and Ecology: *Saxifraga caprariae* grows on volcanic rocks, on cliffs mainly exposed northwards between 250 and 350 m a.s.l. Soil is often thin, scarce or almost nonexistent, with a vegetation mainly consisting of mosses, lichens and small ferns (Mannocci et al. 2016), belonging to the alliance *Linarion caprariae* Foggi et al. 2006 (Habitat Directive: 8220 "Siliceous rocky slopes with chasmophytic vegetation").

Population information: A rough count in the three subpopulations on Capraia in 2015 gave totals of around 400 mature plants, however the number of individuals could be underestimated, because the areas where the individuals grow are not easily accessible and the species was only recently described. There is no detailed information available on population dynamics and trends.

Figure 1. *Saxifraga caprariae* in "Fondo" Spring, below "Sella dell'Acciatore"; Capraia Island (Tuscan Archipelago). Photograph by M. Mannocci.

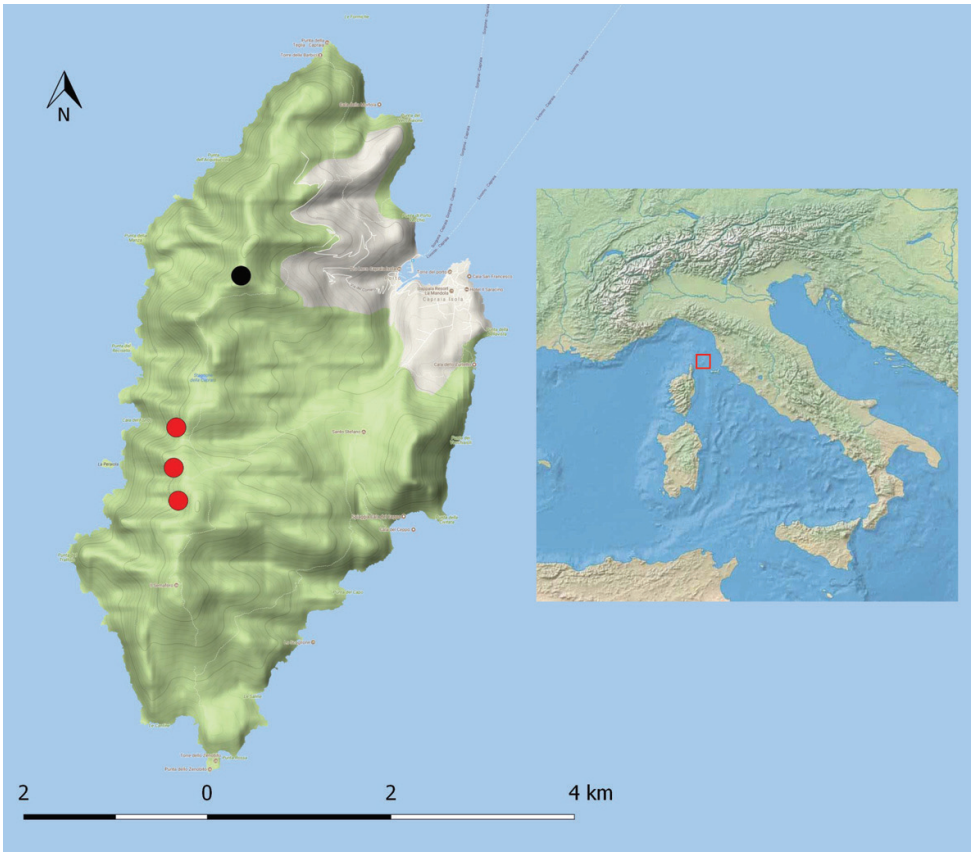

Figure 2. Geographic range and distribution map of *Saxifraga caprariae*. The red points in the map mark the current localities of occurrence, while the black one indicates an historical site.

Threats: 11.4 *Storms & Flooding*. Sporadic events of strong rainfalls could represent a threat, causing exceptional floods and landslides in the valleys where the species occurs.

CRITERIA APPLIED:

Criterion B: **EOO:** 4 km^2 calculated with minimum convex hull in QGis 2.14
AOO: 4 km^2 calculated with a 2 × 2 km cell fixed grid

a) The only plausible threat could be the sporadic events of exceptional rainfalls (more and more frequent due to climate change) causing floods and landslides with possible impacts on the subpopulations. Something similar could explain the reason why the species was not confirmed in the historical site of Mt. Castello.

b) The threat of sporadic heavy rainfall is not sufficient to expect a decline in AOO (ii), number of subpopulations (iv) or number of mature individuals (v).

Criterion D: Number of mature individuals: < 1000

Red List category and Criteria (Global Assessment)

VU	**Vulnerable**	D1

Rationale for the assessment: *Saxifraga caprariae* is an Italian endemic found only on Capraia Island. It occurs in three small sites on rocky volcanic cliffs. Although it has a restricted AOO and EOO, this plant is relatively well protected. The population comprises fewer than 1000 mature individuals. Based on the population size the species qualifies for listing as Vulnerable D1.

Previous assessment: *Saxifraga caprariae* was not evaluated (NE) previously (IUCN 2017).

Conservation actions: *Saxifraga caprariae* is not protected at regional, national or international level, due to the fact it was recently described (Mannocci et al. 2016). All the sites are included in the Capraia Island SAC (IT5160006 "Isola di Capraia"), which is also part of the Tuscan Archipelago National Park.

Conservation actions needed: further monitoring and research are recommended in order to better understand the population trends of the species.

Daniele Viciani, Giulio Ferretti, Matilde Gennai

Saxifraga montis-christi Mannocci, Ferretti, Mazzoncini & Viciani

Global Assessment

Taxonomy and nomenclature

Order: Saxifragales *Family:* Saxifragaceae

Saxifraga montis-christi Mannocci, Ferretti, Mazzoncini & Viciani, Phytotaxa 284: 123. 2016

Figure 3. *Saxifraga montis-christi* in "Collo dei Lecci" Valley, Montecristo Island (Tuscan Archipelago). Photograph by L. Lazzaro.

Common name: Sassifraga di Montecristo (It); Saxifrage of Montecristo (En).

Geographic distribution range: *Saxifraga montis-christi* (Fig. 3) is endemic to Montecristo, a small island in the Tuscan Archipelago, Italy (Fig. 4; Mannocci *et al.* 2016), where it is known from two sites, "Collo dei Lecci" Valley and "Collo di Fondo" Valley. In the *Herbariun Centrale Italicum* (FI) there are specimens collected in 1965 from another site on the island, between "Convento" and "Monte della Fortezza". Recent field surveys have failed to find the species in the latter site, but we cannot exclude the possibility that it may persist there.

Distribution: Country of occurrence: Italy

Biology: *Plant growth form:* perennial (hemicryptophyte)

Flowering time: Early spring (March to April)

Reproduction: No information on pollination, dispersal strategy and seed germination is available.

Habitat and ecology: *Saxifraga montis-christi* grows on acid igneous rocks, on cliffs mainly exposed northwards between 200 and 550 m a.s.l. Soil is often thin, scarce or almost nonexistent, with a vegetation mainly consisting of mosses, lichens and small ferns (Mannocci et al. 2016), belonging to the alliance *Linarion caprariae* Foggi et al. 2006 (Habitat Directive: 8220 "Siliceous rocky slopes with chasmophytic vegetation").

Population information: The species occurs on steep cliffs which are difficult to access. The total population is estimated to be fewer than 1,000 mature individuals. There is no detailed information available on population dynamics and trends.

Threats: 11.4 *Storms & Flooding*. It is possible to hypothesize that sporadic heavy rainfall events could lead to high flow in streams, resulting in landslides, in the small

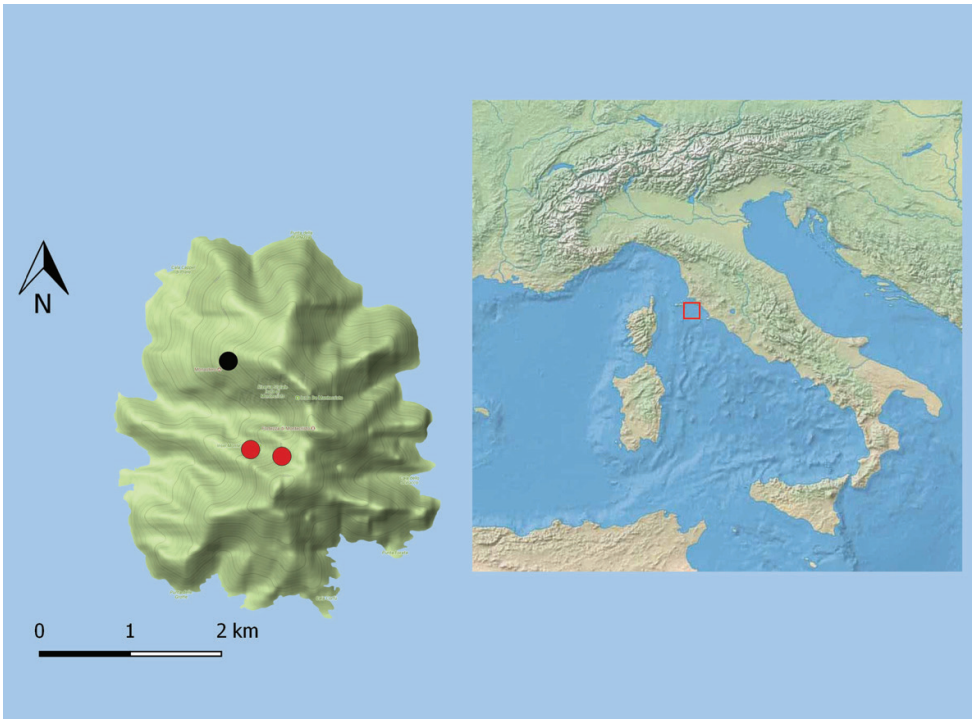

Figure 4. Geographic range and distribution map of *Saxifraga montis-christi*. The red points mark the current localities of occurrence; the black point indicate the historical sites.

narrow valleys where this species occurs and this could constitute a threat to some subpopulations.

CRITERIA APPLIED:

Criterion B: **AOO:** 4 km^2 calculated with a 2 × 2 km cell fixed grid

a) The species occurs on the largely inaccessible cliffs, inside a protected area, therefore the only plausible threat could be the sporadic events of exceptional rainfalls (more and more frequent due to climate change) causing floods and landslides with possible impacts on the subpopulations. Something similar could explain the reason why the species was not confirmed in the historical site between "Convento" and "Monte della Fortezza".

b) The threat of the sporadic heavy rainfall events is not sufficient to expect a decline in AOO (ii), number of subpopulations (iv) or number of mature individuals (v).

Criterion D: Number of mature individuals: < 1000

Red List category and Criteria (Global Assessment)

VU	**Vulnerable**	D1

Rationale for the assessment: *Saxifraga montis-christi* is an Italian endemic species that is known only on Montecristo Island in the Tuscan Archipelago. It occurs in two

small barely accessible sites on volcanic rocky cliffs in an uninhabited island, inside a National Park. The total number of mature individuals is fewer than 1,000. It is therefore assessed as Vulnerable D1.

Previous assessment: *Saxifraga montis-christi* was not evaluated (NE) previously (IUCN 2017).

Conservation actions: As it was only recently described (Mannocci et al. 2016), *Saxifraga montis-christi* is not protected either at the regional, national or international level. Montecristo Island is an Integral Natural Reserve within the Tuscan Archipelago National Park. All the sites are included in the Montecristo Island SAC (IT5160014 "Isola di Montecristo").

Conservation actions needed: Further monitoring and research are recommended in order to better understand the population trends of the species.

Daniele Viciani, Giulio Ferretti, Matilde Gennai

Halocnemum cruciatum (Forssk.) Tod.

Regional assessment (Spain)

Taxonomy and nomenclature

Order: Caryophyllales *Family:* Amaranthaceae

Halocnemum cruciatum (Forssk.) Tod. in Nuovo Giorn. Bot. Ital. 5(3): 159 (1873)
≡ *Salicornia cruciata* Forssk., Fl. Aegypt.-Arab.: 2 (1775) ≡ *H. strobilaceum* var. *cruciatum* (Forssk.) Moq. in DC., Prodr. 13(2): 149 (1849)
= *H. strobilaceum* auct. non (Pall.) M. Bieb., Fl. Taur.-Caucas. 3: 3 (1819)

Common name: Garbancillo (Sp), Hamd jointed glasswort (En), رمحأ بطح، منادغ (منادّغ) (Ar).

Geographic distribution range: *Halocnemum cruciatum* (Fig. 5) is distributed throughout the Mediterranean Basin and Arabian Peninsula. The Spanish population is divided into three areas in the semi-arid provinces of SE Spain (Fig. 6). It was first collected in the province of Almeria by Losa & Rivas-Goday (1968) and it still occurs at two sites on the coastal salt marshes in San Juan de los Terreros and Pozo del Esparto, which are separated by 3.5 km. Two additional subpopulations persist in Murcia, one in Calarreona, very close to the Almeria populations (4.5 km), and another in Saladares del Guadalentin. In El Almarjal and Cabo de Palos, where it was discovered by Jiménez Munuera (1909), this plant was considered extinct. There are recent introductions in the salt marshes in Lo Poyo and Cotorrillo in San Pedro del Pinatar. In Alicante, Rigual (1968) cited it in Saladares de Albatera, Balsares del Altet, El Hondo de Crevillente, Salinas de La Marina and the surroundings of Pantano de Elche and the Vinalopo riverbed. Currently, it only exists in El Hondo and Salinas de Santa Pola; it has also disappeared from Clot de Galvany (Serra 2007).

Figure 5. *Halocnemum cruciatum* photographed in San Juan de los Terreros (Almería, Spain, photograph by A. Lahora, on the left) and in El Hondo (Alicante, Spain, photograph by L. Serra, on the right).

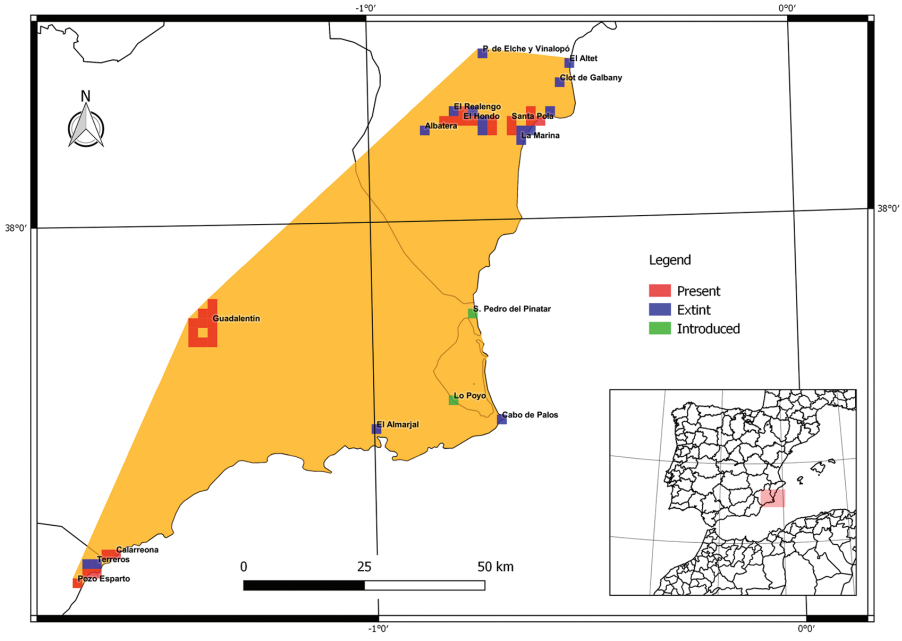

Figure 6. Extent of Occurrence (orange) and Area of Occupancy (2 × 2 km cell grid) of *Halocnemum cruciatum* in Spain.

Distribution: Countries of occurrence: Algeria, Cyprus, Egypt, Israel, Italy, Jordan, Lebanon, Libya, Morocco, Saudi Arabia, Spain, Syria, Tunisia, Turkey and United Arab Emirates.

Biology: *Plant growth form:* perennial (nanophanerophyte).

Flowering and fruiting time: Flowering from August to September, fruiting from September to November.

Reproduction: By seed and vegetative propagation. Wind-pollinated. Seeds have no dispersal structures and germinate in the wet season (Pujol et al. 2001, Estrelles et al. 2015).

Habitat and Ecology: Xerohalophyte (hyper-halophyte), growing on the margins of coastal and inland thermophilic salt marshes, on soils with high salt concentrations of the *Frankenio corymbosae-Halocnemetum cruciati* association (Biondi et al. 2013).

Population information: In Almeria, 2,455 mature individuals were counted in 2004; the number declined to 220 and 201 individuals in 2006 and 2015, respectively, due to habitat destruction. In Murcia, the counts conducted in Calarreona in 2006 showed an approximate number of 1,500 individuals, even though there has been a continuous regression due to a loss of habitat quality related to the watertable increase; thus, the species only survives on the wetland margins. In the Guadalentin subpopulation, a direct count was made in 2015, with a total of 5,789 individuals; however, much of the original area was degraded and occupied by agricultural activities. In Alicante, the total number of individuals is much higher, although it has a scattered distribution and many patches have been lost due to habitat transformation for crops, urbanization or infrastructure. It has even been affected within protected natural areas by an increase in the duration of flood irrigation to favour the presence of birds. In Murcia, translocations and plantations have been carried out, with a survival rate higher than 90%.

Threats: *1.1 Housing & Urban areas*: there is strong urban pressure on the coast.

1.2 Commercial & Industrial Areas: in Guadalentin and Albatera the habitat has been occupied by industrial estates.

1.3 Tourism & recreation areas: part of the coastal populations has been affected by resorts, golf courses, car parks and camping areas.

2.1 Annual & Perennial Non-Timber Crops: in Guadalentin and El Hondo, agriculture has occupied part of the species' habitat.

2.3 Livestock Farming & Ranching: the Guadalentin subpopulation is affected by cattle trampling.

4.1 Roads & Railroads: all the subpopulations are located alongside roads or highways.

6.1. Recreational activities: tourism damages coastal populations, especially in the summer.

7.2 Dams & Water Management/Use: The *Halocnemum* halophytic vegetation has been replaced in some areas by formations of *Phragmites*, *Sarcocornia*, etc., due to changes in water flow patterns from their natural range.

9.4 Garbage & Solid Waste: There is dumping of debris and garbage in the salt marshes.

CRITERIA APPLIED:

Criterion A: There has been a more than 80% decrease in population size over the last 30 years which continues today. Both AOO and EOO have been reduced with destruction and loss of habitat quality.

Red List category and Criteria (Regional Assessment)

Critically Endangered	**CR A2ac**

Rationale for the assessment: In Spain, *Halocnemum cruciatum* is restricted to three severely fragmented subpopulations. There has been a continuous decrease in population size, which currently continues, a reduction of AOO, and EOO and a loss of suitable habitats. Generation time is estimated at 10-12 years. The EOO (calculated with minimum convex polygon in QGIS 2.18) has declined from 4,480 km^2 to 3,614 km^2. The AOO (calculated with a 2 × 2 km cell fixed grid) has decreased from 180 km^2 to 112 km^2 in the last 30 years. Populations are threatened by urban, residential and industrial developments, roads, agriculture and cattle. Some patches are also affected by modification of flooded areas and waste dumping. For this reason, this plant is considered as Critically Endangered at a regional level (Spain).

Previous assessment: Critically Endangered [CR A2ac; B1ab(i,ii,iii,iv,v)+2ab(i,ii, iii,iv,v); C2a(ii)b] in Moreno Saiz (2009) at a national level (Spain).

Conservation actions: *Halocnemum cruciatum* is protected at the regional level in Andalusia (23/2012 Decree), Murcia Region (50/2003 Decree) and Valencian Community (6/2013 Order). The *Halocnemum* vegetation is included in Annex I of the Habitats Directive, Mediterranean and thermo-Atlantic halophilous scrubs (code 1420). Much of Murcia's and Alicante's subpopulations are within natural protected areas.

Conservation actions needed: Protection of the patches in Andalusia. Habitat management and restoration. Seed collection and conservation in botanical gardens. Population reinforcement and reintroduction.

Notes: Recent taxonomic investigations confirm that *H. cruciatum* is a separate species from *H. strobilaceum* (Pall.) M.Bieb. (Piirainen et al. 2017).

Lahora Agustín, Mendoza-Fernández Antonio J., Robles Jesús, Serra Lluís, Schwarzer Hedwig, Sánchez-Gómez Pedro, Mota Juan.

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RESEARCH ARTICLE

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Notulae to the Italian flora of algae, bryophytes, fungi and lichens: 4

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Abstract

In this contribution, new data concerning bryophytes, fungi and lichens of the Italian flora are presented. It includes new records and confirmations for the bryophyte genera *Campylopus*, *Paludella*, *Tortula*, and *Conocephalum*, the fungal genera *Agonimia*, *Buelliella*, *Entorrhiza*, *Filicupula*, *Poronia*, and *Sporisorium*, the lichen genera *Cladonia*, *Dibaeis*, *Lasallia*, and *Rhizocarpon*.

Keywords

Ascomycota, Basidiomycota, Bryidae, Marchantiidae, floristic data

How to contribute

The text of the records should be submitted electronically to: Cecilia Totti (c.totti@univpm.it) for algae, Annalena Cogoni (cogoni@unica.it) for bryophytes, Alfredo Vizzini (alfredo.vizzini@unito.it) for fungi, Sonia Ravera (sonia.ravera@unimol.it) for lichens.

Floristic records

Bryophytes

Campylopus introflexus (Hedw.) Brid. (Leucobryaceae)

+ **TAA**: Predacava, tra Lisignago e Masen (Trento) (UTM WGS84: 32T 668435.5115211), 685 m, 11 March 2017, *F. Prosser* (Herb. Prosser No. 00701); Laghetti di Marco (Trento), along the itinerary in the proximity of the Laghetto Nord (UTM WGS84: 32T 656576.5079954), 175 m, 7 April 2017, *F. Prosser* (Herb. Prosser No. 00722). – Species new for the flora of Trentino-Alto Adige.

The species has a wide distribution in the southern Hemisphere and is invasive in North America and Europe (Priede and Mežaka 2016). In Italy, it was reported by Puglisi et al. (2015) and Scortegagna (2016). The two populations recorded here are situated along paths, a usual habitat for this species (see Puglisi et al. 2015). Both populations are small,covering a few square decimeters. At Laghetti di Marco, a biotope of limestone boulders, this acidophilous species grows on soil originated from rotting *Pinus nigra* J.F.Arnold wood.

F. Prosser

Conocephalum salebrosum Szweyk., Buczkowska & Odrzykoski (Conocephalaceae)

+ **TOS**: San Pellegrino al Cassero, Sambuca Pistoiese (Pistoia), on vertical stillicidious sandstone wall along the street, accessed through the stone bridge on SS64 towards the

locality of Pianezzi (UTM WGS84: 32T 657799.4880866), 660 m, 8 August 2017; ibidem, upstream, on stillicidious escarpment of sandstone rocks (UTM WGS84: 32T 658160.4880536), 808 m, 8 August 2017, *F. Cheli* (SIENA; Herb. Cheli). Species new for the flora of Toscana.

This species was described by Szweykowski et al. (2005) who defined the diagnostic features to distinguish between *Conocephalum salebrosum* and *C. conicum*, which, before this study, could be distinguished only genetically. Both occur in mostly shaded and usually calcareous habitats. *C. salebrosum* appears to be more tolerant to xeric habitats than *C. conicum*. *C. salebrosum* is widespread in Europe and, on the basis of the diagnostic differences between the two species, a review of other Italian specimens from herbaria would be appropriate in order to define their real occurrence on the Italian territory (Poponessi et al. 2014). In Toscana, it has been found in association with *Palustriella commutata* (Hedw.) Ochyra var. *commutata*, *Didymodon tophaceus* (Brid.) Lisa, and *Pellia endiviifolia* (Dicks.) Dumort. in Habitat 7220 "Petrifying springs with tufa formation (*Cratoneurion commutati*)" according to the Habitat Directive (Council Directive 92/43/EEC). It has been found sharing the habitat with *C. conicum* in both the recorded areas where a conspicuous spring waterflow is present all year round, even in summer (2015–2017 monitoring).

F. Cheli, I. Bonini

Paludella squarrosa (Hedw.) Brid. (Meesiaceae)

+ **TAA**: Klapfbergtal (a side-valley of the Val d'Ultimo), nearby the Klapferalm (Bolzano), on a moist and peaty slope with emerging rocks and percolating water (UTM WGS84: 32T 646331.5146651), 1945-1960 m, 27 June 2017, *F. Sguazzin*, *G. Bergamo Decarli*, *D. Rigotti* (Bryophytorum Herbarium F. Sguazzin). – Species new for the flora of Trentino-Alto Adige.

Paludella squarrosa is an Arctic species considered as a glacial relict (Dierβen 2001). According to Aleffi et al. (2008), the presence in Italy of *P. squarrosa* in restricted to a few mountain localities of Lombardia and Trentino-Alto Adige, while the presence in Piemonte has not been confirmed in the last 50 years. Associated bryophyte species include *Cladopodiella fluitans* (Nees) H.Bruch, *Aulacomnium palustre* (Hedw.) Schwägr., *Campylium stellatum* (Hedw.) Lange & C.E.O.Jensen, *Dichodontium palustre* (Dicks.) M.Stech, *Philonotis fontana* (Hedw.) Brid., *Pleurozium schreberi* (Willd. ex Brid.) Mitt., *Ptychostomum pseudotriquetrum* (Hedw.) J.R.Spence & H.P.Ramsay, *Rhizomnium pseudopunctatum* (Bruch & Schimp.) T.J.Kop., *Sanionia uncinata* (Hedw.) Loeske, *Scorpidium cossonii* (Schimp.) Hedenäs, *S. revolvens* (Sw. ex anon.) Rubers, *Sphagnum russowii* Warnst., *S. warnstorfii* Russow, *Straminergon stramineum* (Dicks. ex Brid.) Hedenäs, and *Tomentypnum nitens* (Hedw.) Loeske. In Europe, *P. squarrosa* is classified as follows: Endangered (EN) in Italy, Austria, Latvia, Czech Republic, Slo-

vakia, Romania, and Ukraine; Critically Endangered (CR) in Ireland and Germany; Vulnerable (VU) in Switzerland; Near Threatened (NT) in Estonia; Regional Extinct (RE) in Great Britain and Netherlands; Extinct (E) in Poland (Hodgetts 2015).

F. Sguazzin, G. Bergamo Decarli, D. Rigotti

Tortula protobryoides R.H.Zander (Pottiaceae)

+ **EMR**: Parco Regionale dei Gessi Bolognesi e Calanchi dell'Abbadessa (Bologna) on arid outcrops (UTM WGS84: 32T 690641.49222865), ca. 570 m, 22 April 2017, *S. Poponessi*, *A. Cogoni* (BPERU). – Species confirmed for Emilia-Romagna.

This taxon has been found on gypsum outcrops in dry and sunny stations associated with *Tortella squarrosa* (Brid.) Limpr., *Syntrichia ruralis* (Hedw.) F.Weber & D.Mohr var. *ruralis* and *Didymodon luridus* Hornsch. The collected samples show cleistocarpous capsules. *Tortula protobryoides* has been recorded twice with recent reports in Marche and Sardegna, while its occurrence in Emilia-Romagna has not been confirmed over the last 50 years (Aleffi et al. 2008; Poponessi et al. 2014). The genus *Protrobryum* is accepted by Hill et al. (2006) for the single species *Protrobryum bryoides* (Dicks.) J.Guerra & M.J.Cano. Ros et al. (2013) include this species in the genus *Tortula* as proposed by Zander (1993) and subsequently confirmed by Werner et al. (2002, 2004) on the basis of molecular data. In Europe, this species is located in central and eastern regions; it becomes much rarer in the north and south. However, it does occur in Hungary, Croatia, Greece, Spain, Portugal, Italy, and Macaronesia. This taxon has been assigned to the European Temperate geographic element (Smith 2004). *Tortula protobryoides* is considered Critically Endangered (CR) in Switzerland, Endangered (EN) in Bulgaria, Vulnerable (VU) in Estonia, Regional Extinct (RE) in Ireland and Nothern Ireland and Bedreigd Endangered (BE) in Netherlands in terms of Netherlands-specific categories (Hodgetts 2015).

S. Poponessi, A. Cogoni, M. Aleffi, R. Venanzoni

FUNGI

Buelliella poetschii Hafellner (Dothideales)

+ **LAZ**: Civita di Bagnoregio (Viterbo), on *Endocarpon* sp. (UTM WGS84: 33T 263304.4723472), 406 m, 17 January 2017, *L. Gavrylenko* (KHER No. 10527). – Species new for the flora of Italy (Lazio).

This species grows on squamules of *Endocarpon* species. It is characterized by immersed apothecia-like pseudothecia, dark brown exciple and brown 1-septate ascospores 15.5–17.5 × 7.0–8.0 µm (Hafellner et al. 2008). There are two *Buelliella* spe-

cies reported from Italy – *B. minimula* (Tuck.) Fink on thallus of *Pertusaria pertusa* (L.) Tuck. (Brackel 2015) and *B. physciicola* Poelt & Hafellner on the thallus of *Phaeophyscia sciastra* (Ach.) Moberg (Hafellner 1979). *Buelliella poetschii* was recently reported from Austria (Hafellner et al. 2008), Belgium (Diederich et al. 2009), Bolivia (Flakus and Kukwa 2012), Peru (Etayo 2010a), Spain (Etayo 2010b), Switzerland (Hafellner et al. 2008), Russia (Urbanavichus and Urbanavichene 2011), the Netherlands (Diederich et al. 2009), Turkey (Yazıcı and Etayo 2013), Ukraine (Khodosovtsev et al. 2009), and USA (Hafellner et al. 2008).

V. Darmostuk, L. Gavrylenko

Entorrhiza aschersoniana (Magnus) Lagerh. (Entorrhizaceae)

+ **CAL**: Orto Botanico, Arcavacata (Cosenza), on roots of *Juncus bufonius* L. (UTM WGS84: 33S 605886.4357371), m 203, 8 May 2007, *D. Puntillo* (CLU No. 66). New species for the flora of southern Italy (Calabria).

The genus *Entorrhiza* was established by Weber (1884) to accommodate fungi inducing galls on root tips of members of the Cyperaceae and Juncaceae. Magnus (1888) placed this species in the genus *Schinzia* Nägeli nom. illeg. Weber (1884) after a detailed investigation of the fungus in roots of *Juncus bufonius*; he considered the species as belonging to the Ustilaginales, erected the genus *Entorrhiza* and described the anatomy of the galls with illustrations of the fungus in the host cells. *Entorrhiza aschersoniana* is so far known from Europe, Central America and New Zealand (Vánky 2012). The phylogenetic position of *Entorrhiza* has long been debated (Begerow et al. 2006, Matheny et al. 2006, Hibbett et al. 2007). Recently, Bauer et al. (2015) proposed to include the genus in the new fungal phylum *Entorrhizomycota*. An extensive study of the genus *Entorrhiza* was carried out by Fineran (1973) in a doctoral thesis. Concerning Italy, there is an old record for Tirolo (Ciferri 1938) and a recent record for Friuli (Tomasi 2014).

D. Puntillo, A. Vizzini

Filicupula suboperculata (Döbbeler & P. James) Y.J. Yao & Spooner (Pyronemataceae)

+ **ITALIA** (**CAL**): Serra San Bruno (Vibo Valentia), Bosco di Santa Maria (UTM WGS84: 33T 614186.4268013), 820 m, 3 May 2015, *W. v. Brackel*, *D. Puntillo* (CLU No. 41). – New species for the flora of Italy (Calabria).

This species was originally described as *Pseudonectria* by Döbbeler and James (Döbbeler 1978) as the ascomata were interpreted as perithecia. Later, it was segregated into the genus *Octosporella* by Döbbeler (1979), and finally accommodated in the genus *Filicupula* by Yao and Spooner (1996), because the ascomata were interpreted as apothecia and not perithecia. *Filicupula suboperculata* grows on phyllodia of members

of the liverwort genus *Frullania*, where it causes no visible damage. Until now it was reported only from *Frullania tamarisci* (L.) Dumort., while we found it on *Frullania dilatata* (L.) Dumort. The species was known only from the type locality in Scotland and from Bavaria/Germany (Brackel 2011). In Calabria it was collected on *F. dilatata* growing on bark of *Abies alba* Mill. in a site with oceanic climate.

W. v. Brackel, D. Puntillo

Poronia punctata (L.) Fr. (Xylariaceae)

+ **CAL**: Monte Manfriana, Pollino National Park (Cosenza), on horse dung (UTM WGS84: 33S 606809.4414729), 1867 m, 19 November 2016, *D. Puntillo* (CLU No. 62).

+ **SAR**: Altopiano dei Cavalli, Codoleddu, Maracalagonis (Cagliari), on horse dung in marshy pasture (UTM WGS84: 32S 533856.4345064), 710 m, 11 April 2017, *D. Puddu* (CAG No. P.31–59/1.1b); ibidem, on horse dung, at the edge of wet meadows and Mediterranean temporary ponds (UTM WGS84: 32S 533914.4344777), 710 m, 17 May 2017, leg. *G. Calvia*, det. *A. Vizzini* (CAG. No. P.31–59/1.1a). – Species new for the flora of Sardegna and South Italy (Calabria).

Described by Linnaeus as *Peziza punctata* (1753) and then included in the genus *Poronia* by Fries (1846), this species is recognizable for the white, pezizoid and stipitate stromata with black immersed perithecia growing on equine dung. It is considered an endangered rare species and has been considered extinct in many countries (Ing 1993). It is also part of the Red List of the Italian flora (Rossi et al. 2013) as a Vulnerable species (VU). The (+)-isoepoxydon produced by the fungus has been identified as an intermediate in the biosynthesis of patulin, a mycotoxin inhibiting the growth of other fimicolous fungi (Gloer and Truckenbrod 1988). In Italy, it was recorded by Micheli (1729) and Traverso (1907), while Saccardo (1882) recorded it from Croatia (Dalmatia). Recently, it was reported from the Simbruini mountains (Lazio) by Granito and Lunghini (2006), from the Natural Reserve "Bosco della Favara e Bosco Granza" (Sicilia) by Venturella and Saitta (2009), and from the Regional Park of Monte Cucco (Umbria) by Minciarelli (2013). Owing to the large population of horses still living in the wild in some areas of the Pollino National Park and Codoleddu, this species is fairly widespread in these areas.

D. Puntillo, D. Puddu, A. Tatti

Sporisorium schweinfurthianum (Thüm.) Karatygin (Ustilaginaceae)

+ **CAL**: Deuda (Paola, Cosenza), sores in the ovaries of *Imperata cylindrica* (L.) Raeusch. (33S 589831.4353616) 8 m, 4 August 2013, *D. Puntillo* (CLU No. 70). – Species confirmed for the flora of Calabria.

This very rare species was described by Thümen (1877) and accommodated in the genus *Ustilago*. Saccardo (1908) put it in the genus *Sphacelotheca*. Vánky (1983) then segregated this species in the genus *Sporisororium*, but with an invalid name. Finally, Karatygin in Karatygin and Azbukina (1989) validly combined it into *Sporisorium*. *Sporisorium schweinfurthianum* is distributed in S-E Europe, Africa and Asia (Denčev 1991; Wood et al. 2009; Vánky 2012). In Italy, this species is known from Sicilia (Palermo) and Calabria (Cosenza) (Ciferri 1938).

D. Puntillo

Lichens

Agonimia opuntiella (Buschardt & Poelt) Vězda (Verrucariaceae)

+ **CAM**: Pisciotta (Salerno), on *Olea europaea* L. (UTM WGS84: 33T 519127.4440793), 230 m, 22 February 2011, leg. *S. Ravera, G. Brunialti*, det. *S. Ravera* (Herb. Ravera); Marina di Pisciotta (Salerno), on *Olea europaea* L. (UTM WGS84: 33T 519798.4439244), 40 m, 22 February 2011, leg. *S. Ravera*, *G. Brunialti*, det. *S. Ravera* (Herb. Ravera); Sacco Vecchia (Salerno), on *Quercus ilex* Willd. (UTM WGS84: 33T 531309.4470725), 600 m, 11 April 2011, leg. *S. Ravera, G. Brunialti,* det. *S. Ravera* (Herb. Ravera). – Species new for the flora of southern Italy (Campania).

Agonimia opuntiella is an epiphytic microlichen with squamulose thallus showing minutely papillate and hairy surface. This species grows on basal parts of old trees, usually on bark among mosses; it is overlooked in the field and often confused with young specimens of *Phaeophyscia hirsuta* (Mereschk.) Essl for the hairy surface.

These records confirm the scarce poleotolerance (Nimis 2016) of this species: both of the sites in the area of Pisciotta include undisturbed centenary trees in an olive orchard, and Sacco vecchia is an abandoned village at the foot of Mount Motola in the upper Cilento valley. *Agonimia octospora* is included in the national red list of epiphytic lichens as "Least Concern" (Nascimbene et al. 2013).

S. Ravera

Cladonia humilis (With.) J.R.Laundon (Cladoniaceae)

+ **LOM**: Malpaga (Bergamo), on sandy-pebbly calcareous soil in a dry grassland (UTM WGS84: 32T 558079.5051190), 183 m, 23 June 2016, *G. Gheza* (Herb. Gheza); Basella (Bergamo), on sandy-pebbly calcareous soil in a dry grassland (UTM WGS84: 32T 557803.5050480), 176 m, 21 June 2016, *G. Gheza* (Herb. Gheza). – Species confirmed for the flora of Lombardia.

Cladonia humilis is a terricolous species with a mainly Thyrrenian distribution in Italy (Nimis 2016). The two localities reported here are located in the nature reserve of Malpaga-Basella, within the Serio Regional Park, in wide calcareous dry grasslands near the rivercourse. The specimens analysed by thin layer chromatography always contained fumarprotocetraric acid and atranorin.

G. Gheza, H. Mayrhofer, J. Nascimbene

Cladonia strepsilis (Ach.) Grognot (Cladoniaceae)

+ **PIE**: Tenuta Bornago, Cameri (Novara), on sandy-pebbly soil in a dry *Corynephorus* grassland (UTM WGS84: 32T 476694.5044401), 171 m, 17 June 2016, *G. Gheza* (Herb. Gheza). – Species confirmed for the flora of Piemonte.

+ **LOM**: Ansa di Castelnovate, Vizzola Ticino (Varese), on sandy-pebbly soil in a dry *Corynephorus* grassland (UTM WGS84: 32T 473961.5052563), 164 m, 16 June 2016, *G. Gheza* (Herb. Gheza); "La Promessa", Lonate Pozzolo (Varese), on sandy-pebbly soil in a small open *Calluna* heathland, (UTM WGS84: 32T 478604.5046292), 188 m, 15 March 2017, *G. Gheza* (Herb. Gheza). – Species confirmed for the flora of Lombardia.

Cladonia strepsilis is a terricolous species, which was considered restricted to the Alps in Italy (Nimis 2016). These new records show that, like other *Cladonia* species with a montane-alpine distribution in Italy (see Gheza 2015), *C. strepsilis* reaches the planitial belt following the rivercourse of the Ticino river. It was found associated with *Cladonia foliacea* (Huds.) Willd. or *Cladonia cervicornis* (Ach.) Flot. and, sometimes, also with *Cladonia polycarpoides* Nyl., in the *Cladonietum foliaceae* Klement, 1953 emend. Drehwald, 1993 and in the *Pycnothelio-Cladonietum cervicornis* Paus, 1997. The specimens analysed by thin layer chromatography always contained baeomycesic acid, squamatic acid and strepsilin.

G. Gheza, H. Mayrhofer, J. Nascimbene

Dibaeis baeomyces (L.f.) Rambold & Hertel (Icmadophilaceae)

+ **PIE**: "Vauda" of Vauda Canavese (Torino), on bare clayey soil among *Calluna vulgaris* shrubs, in a dry *Calluna* heathland (UTM WGS84: 32T 388776.5013995), 434 m, 8 March 2016, *G. Gheza*, *S. Assini* (Herb. Gheza); "Vauda" of San Carlo Canavese (Torino), on bare clayey soil among *Calluna vulgaris* shrubs, in a dry *Calluna* heathland (UTM WGS84: 32T 392345.5012651), 370 m, 8 March 2016, *G. Gheza*, *S. Assini* (Herb. Gheza); Verrone (Biella), on bare clayey soil at the edge of a trail, in a dry *Calluna* heathland (UTM WGS84: 32T 431668.5036758), 250 m, 3 April 2017, *G. Gheza*, *S. Assini* (Herb. Gheza); Baraggione di Candelo near Cascina Bravetta, Massazza (Biella), on bare clayey soil among *Calluna vulgaris* shrubs, in a dry *Calluna*

heathland (UTM WGS84: 32T 435996.5037555), 245 m, 7 July 2017, *G. Gheza* (Herb. Gheza). – Species confirmed for the flora of Piemonte.

+ **LOM**: Brughiera di Tornavento, Lonate Pozzolo (Varese), on bare soil among *Polytrichum* sp., at the edge of a dry *Calluna* heathland (UTM WGS84: 32T 478357.5049083), 202 m, 9 June 2017, *G. Gheza* (Herb. Gheza). – Species confirmed for the flora of Lombardia.

Dibaeis baeomyces is a terricolous species typical of pioneer and, often, disturbed areas (Nimis 2016). It has been always reported for montane-alpine localities in both Piemonte and Lombardia (see literature cited by Nimis 1993, 2016). Therefore, the records reported here are important to show that the species still exists in the Po Plain where well-preserved *Calluna* heathlands, which are one its main habitats (Nimis 2016), are still found. The record from the Brughiera di Tornavento confirms its occurrence in the area a long time after the last record by Cozzi (1917). It was always found sterile.

G. Gheza, J. Nascimbene, S. Assini

Gallowayella aphrodites (Kalb, Poelt & S.Y.Kondr.) S.Y.Kondr., Fedorenko, S.Stenroos, Kärnefelt, Elix, Hur & A.Thell (Teloschistaceae)

+ **BAS**: Rotonda (Potenza) in front of head office of Pollino National Park, m. 626, on bark of *Tilia* sp. (UTM WGS84: 33S 589202.4421804), 19 October 2015, *D. Puntillo* (CLU No. 16033). New species for the flora of Basilicata.

Originally described as *Xanthoria aphrodites* by Kalb et al. (Kondratyuk and Poelt 1997), this species was transferred to the genus *Xanthomendoza* by Søchting et al. (2002), then to the genus *Oxneria* by Kondratyuk and Kärnefelt (2003) and, finally, to the genus *Gallowayella* by Kondratyuk et al. (2012). In Italy, it is known only from Calabria (Puntillo and Puntillo 2015). *Gallowayella aphrodites* is easily confused with *Xanthoria parietina* (L.) Th.Fr., with which it is often found co-occurring in the same areas.

G. Potenza, D. Puntillo

Lasallia pustulata (L.) Mérat (Umbilicariaceae)

+ **TOS**: Valle del Crevole, close to the path Sentiero delle Miniere, Miniere di Murlo (Siena), on a vertical jasper outcrop, N. slope (UTM WGS84: 32T 693556.4779090), 218 m, 16 April 2014, *A. Guttová*, *L. Paoli* (SIENA); Valle del Crevole, close to the path Sentiero delle Miniere, Miniere di Murlo (Siena), on a horizontal jasper outcrop (UTM WGS84: 32T 693561.4779091), 218 m, 27 August 2016, *L. Paoli, Z. Fačkovcová*. – Species confirmed for the flora of Toscana.

The species has a pustulate upper surface with black clusters of coralloid isidia. It generally grows on siliceous rocks, standing stones and boulders. The presently

described locality hosts a small population consisting of a few dozen thalli, growing both on horizontal and vertical outcrops. In 2015, two populations of *L. pustulata* were described on similar jasper outcrops in "Botro del Diavolo", in a remote hilly area SE of Livorno (Pasquinelli and Puccini 2016). A previously published record for Toscana refers to the Elba Island, where *L. pustulata* was observed on a granitic boulder on the E slope of Mt. Capanne (300 m a.s.l.), together with *Anaptychia runcinata* (With.) Laund. and *Cladonia rangiformis* Hoffm. (on soil) (Pišút 1997). Another record from Elba is available through a herbarium specimen collected by E. Albertshofer in 1965 and conserved at the Santa Barbara Botanic Garden Lichen Herbarium. The species was also reported on siliceous rocks on Capraia Island (Nimis et al. 1990). Herbarium specimens in TSB attest to its recent presence on Mt. Amiata, chiefly on siliceous rocks in Località Acquapassante (by M. Tretiach in 1992 and 2001) and Vivo d'Orcia (by M. Tretiach in 1992). A sample in SIENA (by J. Nascimbene in 1995) was collected on trachyte from Mt. Amiata. A publication by Feige et al. (1990) reported the use of *L. pustulata* from Mt. Amiata for the identification of radioactive contamination. Other herbarium specimens (SIENA) collected in 1993 (by Sforzi) and 2000 (by Casini) attest to the presence of *L. pustulata* in "Val di Farma" (Località La Pietra), between the provinces of Grosseto and Siena. In the past, this species was also found on Monte Pisano (by C. Bicchi in 1858, TSB) and in Vallombrosa (Mori 1883). Other records available in Toscana are prior to 1900; for a summary, see Nimis (1993).

L. Paoli, Z. Fačkovcová, A. Guttová

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