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Assessment of the ecological structure of *Posidonia oceanica* (L.) Delile on the northern coast of Lazio, Italy (central Tyrrhenian, Mediterranean)

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Abstract

The ecological structure of *Posidonia oceanica* (L.) Delile meadows was evaluated on the northern coast of Lazio, Italy (central Tyrrhenian, Mediterranean sea). This is an infra-littoral zone with a wide range of anthropogenic activities and high geo-morphological variability, which reflects heterogeneity in shoot density, leaf morphology and biomass in fragmented patches. Genetic variability in populations corresponds to the formation of 3 sub-clusters, in the diverse impacted zones (north, centre and south), being correlated to the geographical distance between sites. AMOVA estimated a high genetic variation showing 43.05% individual differences within populations with a marked differentiation among the populations (56.9%) indicated by Fst value (0.57). These results revealed the role of the genetic structure of seagrasses for determining selectivity of fragmented habitat, in response to natural drivers. They showed that site-specific self-recruitment is related to biodiversity capacity and to the geo-morphological characteristic of the coast.

Keywords

AMOVA, Functional descriptors, Genetic variation, RAPD

Introduction

Coastal areas are characterized by environmental disturbances due to both natural process and anthropogenic activities, with consequent impacts on marine ecosystems (Benoit and Comeau 2005). *Posidonia oceanica* (L.) Delile meadows are considered as indicators of these impacts (Pergent et al. 1995; Pergent-Martini et al. 2005; Martinez-Grego et al. 2008; Lopez y Royo et al. 2011; Bennett et al. 2011; Personnic et al. 2014), which may influence their natural structural variability, causing a general decline of biomass, density and coverage (Duarte 2002; Orth et al. 2006; Boudouresque et al. 2009; Marbà et al. 2014). In the Mediterranean Sea, *P. oceanica* forms widespread ecosystems with high levels of biodiversity and productivity (Boudouresque et al. 1984; 2006; 2012) and, like other seagrasses, it is important from the ecological, geological and economic point of view (Costanza et al. 1997; Spalding et al. 2003; Vassallo et al. 2013). Moreover, this plant colonizes different types of substrates (e.g. sand, rocky, etc.) and generates meadows that occur in a wide range of morphotypes, ranging from continuous beds on the seafloor to fragmented patches of different shape and size (Molinier and Picard 1952; Den Hartog 1970; Semroud 1993; Boudouresque et al. 2012; Bonhomme et al. 2015). The monitoring of structural and functional descriptors of *P. oceanica* meadow health status (Buia et al. 2004) provides important information about the vitality and dynamic of meadows (Pergent-Martini et al. 2005), as well as the human influence on the environment (Montefalcone 2009). Recently, a new suite of descriptors has been proposed to assess the ecological status of *P. oceanica* meadows (Rotini et al. 2013), taking into account the physiological features of the plants by means of biochemical (Arnold et al. 2012) and genetic markers (Micheli et al. 2005, 2015; Procaccini et al. 2007; Macreadie et al. 2014) as standard indicators.

The objective of this work was to assess the ecological structure and genetic patterns of *P. oceanica* meadows along the northern coast of Lazio to contribute to the conservation of seagrass by future management activity. For this aim, we used functional descriptors (phenotypic variables, including biomass and density) and RAPD (Random Amplified Polymorphic DNA) molecular markers. The PCR-based RAPD marker technique was recently used in seagrasses for estimating the influence of environmental disturbances on phenotypic variables and genetic diversity of populations (Kim et al. 2019), and for distinguishing genetic variation of populations at individual level (Dilipan et al. 2017). At multiple spatial scales, RAPD analyses was conducted to assess the genetic variability of seagrass, evidencing genetic differences closely correlated with coastal currents (Jones et al. 2008). In previous studies, RAPD allowed us to examine the genetic structure in meadows located in the Ligurian Gulf (North Tyrrhenian coast) that showed a decrease in genetic diversity along an anthropogenic disturbance gradient at small scale (Micheli et al. 2005), revealing the role of currents (Micheli et al. 2010b; Rotini et al. 2013). Furthermore, we were also able to evaluate changes in genetic structure of the meadows and their resilience over a decade (Micheli et al. 2012).

Here we used RAPD to detect the genetic structure of *P. oceanica* meadows in the fragmented habitat of the northern coast of Lazio, in order to compare it to that of other Tyrrhenian populations previously studied. Such information was detected in an area where natural drivers occur at exceptional conditions and where no similar works have been carried out before.

Materials and methods

Study area

The study area between Marina di Tarquinia and Santa Severa (Lazio, Italy, Mediterranean Sea; Fig. 1) is located within two physiographic units, one extending from Monte Argentario to Capo Linaro, the other from Capo Linaro to Capo d' Anzio. Here the appearance of the coast is intimately related to the morphology of the seabed as the isobaths show a very uneven underwater sea-floor. In fact, according to Anselmi et al. (1978), different coastal geo-morphological types (coastal morpho-type) are present in the study area.

The northern part hosts the Mignone river floodplain, which is characterized by small sandy beaches and a rocky coastal terrace. From Civitavecchia to Santa Marinella, the coastline is dominated by the "Tolfa Mountains", which form a promontory characterizing the coastal morpho-type (terraces coasts). This promontory separates the southern physiographic unit from the northern one, and is crossed by small streams (e.g. Marangone stream) with local continental contributions. The southern part presents a small portion of coastal terraces and beaches with a prevalently sandy coast.

This coastal area is characterized by the presence of the littoral currents having a prevailing direction from south to north following a coastal local dynamic connected to high geo-morphological variability of the sea bottom, which can generate barriers to gene flow. In fact, in the study area the prevailing wind events come from to the southeast (data provided from the weather station of C-CEMS), inducing a sea current direction to north (Bonamano et al. 2015; 2016). However, *P. oceanica* flowers appeared in the meadows, and seeds were found in the central zone, near the Marangone stream, during November 2013, as was observed in other sites of the area studied (Gnisci 2014; Cognetti de Martiis 2016).

The area is also characterized by a very large port (Civitavecchia harbour), two important power plants located in the northern part of Civitavecchia, and a dense urban environment constituted by the municipalities of Civitavecchia and Santa Marinella, which altogether form a single urban aggregate (Fig. 1).

Field and sampling work

Field work activities were carried out during the late spring 2013, along 40 km of coastline. By SCUBA diving, shoots were collected into 18 sampling areas (6 shoots per sites, 3 sites per each station) from May 3rd to June 19th 2013 (Fig. 1, Table 1). For field work, we considered sufficient this temporal range as meteorological conditions

Table 1. Sampling sites, geographical coordinates, depth and three types of substrate of *Posidonia oceanica*. I = Rock, II = Rock+Sand, III = Sand+*Matte*.

Stations	Geographical coordinates	Depth (m)	Substrate	Type
st1	42°13'04.2"N, 11°41'25.2"E	10.0	Rock, Sand	II
St2	42°12'19.8"N, 11°42'16.2"E	9.5	Sand, Matte	III
St3	42°11'04.2"N, 11°42'25.8"E	13.4	Rock, Sand	II
St4	42°08'49.2"N, 11°43'52.8"E	10.3	Rock	I
St5	42°08'04.8"N, 11°44'25.8"E	5.5	Rock, Sand	II
St6	42°05'05.0"N, 11°47'37.2"E	4.9	Rock	I
St7	42°04'35.1"N, 11°47'57.2"E	7.5	Sand, Matte	III
St8	42°04'15.1"N, 11°48'06.4"E	12.0	Rock	I
St9	42°03'27.9"N, 11°48'35.9"E	10.0	Rock	I
St10	42°02'59.2"N, 11°48'57.8"E	10.3	Rock, Sand	II
St11	42°02'23.7"N, 11°48'59.8"E	11.0	Rock	I
St12	42°01'58.8"N, 11°48'55.8"E	8.9	Rock	I
St13	42°01'16.8"N, 11°50'40.8"E	10.9	Rock	I
St14	42°01'43.2"N, 11°51'16.2"E	10.0	Rock, Sand	II
St15	42°01'58.8"N, 11°52'36.0"E	13.0	Sand, Matte	III
St16	42°01'52.8"N, 11°54'52.8"E	13.2	Sand, Matte	III
St17	42°00'58.2"N, 11°56'40.8"E	9.4	Sand, Matte	III
St18	42°00'24.2"N, 11°55'00.7"E	13.4	Rock, Sand	II

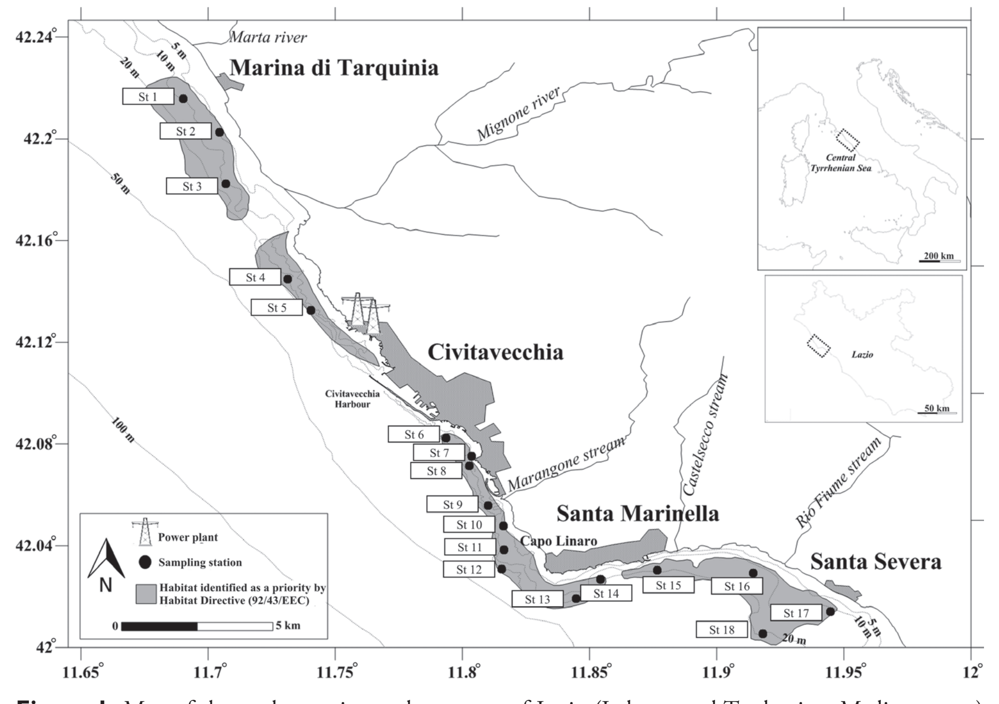

Figure 1. Map of the study area in northern coast of Lazio (Italy, central Tyrrhenian, Mediterranean) with the sampling sites of *Posidonia oceanica*.

were constant in the study area, and because *P. oceanica* meadows undergo changes in a larger time scales. In each station, three sites were selected to estimate density and coverage of the meadow. By hierarchical sampling design, shoot density was calculated as shoot number/m^2 counting the number of shoots in nine random squares (40 × 40 cm) (Buia et al. 2004; Panayotidis et al. 1981).

On the seafloor, the percentage in coverage of *P. oceanica* was estimated counting the number of sub-squares occupied by the plants in three gridded squares of 1 × 1 m (Boudouresque et al. 2007).

At the same time, eighteen shoots were randomly collected in each station and stored in sea-water at 4 °C, for laboratory analyses.

Morphological measures and biomass

In the laboratory, leaves of the shoots were washed in distilled water and biometric variables, such as number, length and width of juvenile, intermediate and adult leaves per shoot were measured in each station, according to Giraud's classification (Giraud 1977). Leaf Area Index (LAI) average was calculated according to Buia et al. (2004). Furthermore, the leaves were cleaned (by a razor blade to remove epiphytes) and dried at 80 °C for 72 hours, to obtain the dried weight, i.e. the dry biomass (g dm/shoot).

RAPD genetic analysis

Genetic analyses of *P. oceanica* populations were performed on the same shoots collected in each of the 18 sampled stations. According to Micheli et al. (2005), the young leaves were washed in distilled water, frozen in liquid nitrogen at -180 °C and stored at -80 °C before the extraction of genomic DNA, as reported in Dellaporta et al. (1983). Subsequently, DNA was amplified by TAQ Polymerase (Applied Biosystems), using PCR (Polymerase Chain Reaction) conditions similar to those described by Echt et al. (1992) with some modification involving reaction buffer (100 mM Tris-HCL, 500 mM KCL and 25 mM MgCl2). Amplification reactions were carried out in a thermal cycler (Perkin-Elmer) with the following temperature program: 5 min denaturation cycle at 94 °C and, subsequently, 40 cycles of 30 s at 37 °C annealing temperature and 6 min at 72 °C synthesis temperature. For each DNA (1 µg/µL) amplification, the AmpliTaq DNA Polymerase (0.4 µg/µL) and 10 different easily repeated oligonucleotides (10 mM) were used for their capacity to discriminate bands and scoring them as present/absent. Amplification products were separated by agarose gel electrophoresis (1.4%), stained with ethidium bromide, visualized on UV light and photographed. The different DNA fingerprints obtained were analyzed for the presence (1) or absence (0) of the bands, in order to determine the percentage of polymorphism calculated as the number of polymorphic bands out of the total number of bands.

Statistical analyses

Morphological and structural variables of *P. oceanica* meadows were statistically analyzed by means of PAST (Hammer et al. 2001) and R Development Core Team (2008) software. Three way Analysis of Variance (ANOVA) was employed to test the effect of three main factors, i.e. location, depth and substrate typology, on meadow structure parameters and leaf morphology. Furthermore the non-parametric Kruskal-Wallis test was performed to check the level of significance ($p < 0.05$, $p < 0.01$ or $p < 0.001$) of the main factors (location, depth and substrate typology) effect on number of juvenile, intermediate and adult leaves in each shoot, which data no present a normal distribution. The Mann-Whitney post-hoc pairwise comparison was performed to valuate significant differences ($p < 0.05$, $p < 0.01$, $p < 0.001$) among different sampling area (North, Centre and South). Intra- and inter-population genetic distance has been determined using the NTSYS 2.0 program (Rohlf 1993) generating a similarity matrix (Nei and Li 1979). Cluster analysis was performed on the similarity matrix with the SAHN program using UPGMA (Un-weighted Pair Group Method with Arithmetic Mean) generating the dendrogram. A cophenetic correlation has been used to measure goodness of fit for the cluster analysis (r) by comparing it with the original pairwise distance matrix (Euclidean squared distance) using a Mantel test (MXCOMP program).

Then, Principal Coordinate Analysis (PCoA, NT-SYS software; Rohlf 1993) was performed to elucidate the distribution of the samples by deriving genetic distances.

Subsequently AMOVA (Analysis of Molecular Variance) was performed with ARLEQUIN 3.5 program (Excoffier and Lischer 2010; http://cmpg.unibe.ch/software/arlequin3) to elucidate the genetic variation and relationships between individuals within and among populations. Using AMOVA, we estimated the number of genetically homogeneous groups of individuals based on their genotypes, at multiple loci, using the Bayesian approach. The method assumes a model in which there are K populations, each characterized by a set of allele frequencies at each locus. For each individual, the software computes the proportion of the genome that can be assigned to the inferred K populations with a high probability. Because RAPD markers are dominant, we assumed that each band represented the phenotype at a single biallelic locus (Williams et al. 1990). The heterogeneity of band frequencies across all populations was tested using the Fixation index (Fst) in ARLEQUIN software. Fst is a measure of population differentiation (Meirmans 2006), and represents the most frequently used method to analyze population structure concerning gene flow.

Results

Leaf morphology, biomass, density and coverage of the meadows

Results of leaf morphology (number of leaves/shoot, width and length), Leaf Area Index (LAI), biomass, shoot density and coverage of the plants collected in the 18 sampling stations, are reported in Table 2.

Table 2. Morphological measures of leaves (number, width, and length), Leaf Area Index (LAI), biomass, shoot density and coverage of *Posidonia oceanica* plants collected in each sampling site.

Stations	Leaf/Shoot (n°)	Leaf width (cm)	Leaf length (cm)	Leaf Area Index (LAI) (m^2/m^2)	Biomass (g dm/shoot)	Shoot Density (shoots/m^2)	Coverage (%)
St1	5.4 ± 1.8	0.90 ± 0.10	40.1 ± 15.3	3.1 ± 1.8	0.67 ± 0.39	173.6 ± 81.1	20.1 ± 6.4
St2	5.9 ± 1.1	0.91 ± 0.08	49.4 ± 17.1	4.3 ± 1.7	0.87 ± 0.27	172.9 ± 53.1	41.7 ± 25.3
St3	6.6 ± 1.7	0.86 ± 0.12	41.7 ± 19.3	5.0 ± 1.8	0.93 ± 0.46	242.7 ± 41.3	26 ± 4.4
St4	5.9 ± 1.5	0.92 ± 0.07	37.2 ± 14.7	5.2 ± 1.8	0.69 ± 0.29	281.2 ± 45.3	36.1 ±13.8
St5	6.9 ± 2.4	0.86 ± 0.09	24.3 ± 12.8	7.5 ± 4.3	0.39 ± 0.21	653.5 ±145.2	75 ± 9.5
St6	5.9 ± 1.2	0.86 ± 0.10	24.2 ± 14.2	4.0 ± 2.2	0.55 ± 0.29	325.7 ±82.3	22.2 ± 13.4
St7	6.1 ± 1.6	0.97 ± 0.09	34.9 ± 14.7	6.8 ± 2.5	1.03 ± 0.49	329.2 ± 98.1	93 ± 0.01
St8	6.7 ± 1.2	0.97 ± 0.09	33.2 ± 14.9	3.0 ± 1.5	0.95 ± 0.37	141.7 ± 62.9	12.5 ± 1.6
St9	5.7 ± 1.2	0.89 ± 0.08	40.5 ± 18.2	4.3 ± 1.8	0.66 ± 0.27	233.3 ± 56.3	63.3 ± 25.2
St10	5.9 ± 0.9	0.84 ± 0.14	31.9 ± 13.3	3.8 ± 1.7	0.83 ± 0.30	236.1 ± 65.1	26.6 ± 5.8
St11	6.2 ± 0.9	0.94 ± 0.08	35.9 ± 17.2	5.4 ± 2.2	0.89 ± 0.32	265.8 ± 78.8	44.4 ± 29.9
St12	5.3 ± 1.7	0.90 ± 0.23	31.0 ± 12.4	3.8 ± 1.2	0.49 ± 0.09	272.9 ± 78.6	18.7 ± 6.2
St13	5.9 ± 1.8	0.92 ± 0.09	30.5 ± 12.7	2.9 ± 1.4	0.62 ± 0.23	190.9 ± 78.6	11.1 ± 2.4
St14	5.2 ± 2.2	0.94 ± 0.08	43.8 ± 19.5	9.2 ± 3.4	0.77 ± 0.35	428.5 ±55.6	98.6 ± 1.2
St15	4.7 ± 1.5	0.90 ± 0.11	32.9 ± 13.4	2.5 ± 1.1	0.49 ± 0.20	179.2 ± 55.2	45.1 ± 17.7
St16	5.6 ± 1.9	0.80 ± 0.08	29.2 ± 11.3	1.8 ± 0.9	0.40 ± 0.11	156.2 ± 58.5	6.2 ± 0.01
St17	6.8 ± 2.1	0.88 ± 0.09	35.3 ± 15.7	7.0 ± 2.4	0.82 ± 0.23	365.9 ± 69.6	47.8 ± 8.4
St18	6.9 ± 0.9	0.91 ± 0.13	37.5 ± 17.7	4.7 ± 1.4	0.74 ± 0.21	228.5 ± 45.9	35.4 ± 25.2
Mean ± Standard Deviation (SD)	5.92 ± 1.03	0.90 ± 0.05	35.06 ± 7.30	4.50 ± 2.17	0.70 ± 0.21	276 ± 133	43.16 ± 31.27
Coefficient of variation	17.41	5.75	20.82	48.25	30.31	47.64	72.44

The presence of highly fragmented meadows (evidenced in Suppl. material 1: Fig. S1), in a large range of depths (from 4.9 m to 13.4 m. Table 1), was confirmed by the high variability of coverage found among stations, ranging from 6 to 98 % (St 16 and St 14 respectively), and by the coefficient of variation (72.4%) (Table 2).

Three-way ANOVA (Suppl. material 3: Table S1), was tested to detect significant factors in a multifactor model, in which there is one dependent variable (shoot density of *P. oceanica*) and three independent variables (depth, location and substrate typology).

The three way ANOVA showed differences in sea-bottom coverage ($P < 0.05$) due to different substrate types (Table 3). In all areas, the mean shoot density estimated was 276 ± 133 SD (number of shoot/m² ± Standard Deviation), ranging from 141 ± 62 SD to 653 ± 145 SD (St 8 and St 5, respectively). Biomass mean value 0.70 ± 0.213 SD (g dm/shoot) showed the highest values in the stations at intermediate depths, ranging from 1.03 ± 0.49 SD to 0.40 ± 0.11 SD.

All the shoots showed similar values in leaf number (5.92 ± 1.03 SD mean value) and width (0.9 ± 0.05 SD mean value).

Due to the differences in depth and water transparency of the 18 sites, we found a highly variable leaf length with values ranging from 24.24 ± 14.22 SD to 49.44 ± 17.11 SD (mean values of 35.05 ± 7.3 SD), showing statistically significant differences in the three populations (ANOVA, $P < 0.05$) (Table 2, Table 3, Suppl. material 3: Table S1).

In the Table 3, the multi-factors three-way ANOVA performed on shoot density of *P. oceanica*, showed no significant difference among the sites located in the north, central and south areas (ANOVA, $p = 0.1868$); on the contrary significant differences were found among stations located both on different depths (ANOVA, $p < 0.001$) and on different substrates (ANOVA, $p < 0.05$).

The non-parametric Kruskal-Wallis test was performed to verify the presence of significant differences in number of juvenile and intermediate leaves among the three sampling location (North, Centre and South). The test highlighted significant differences in the number of juvenile ($p < 0.001$) and intermediate ($p < 0.001$) leaves. Following Kruskal-Wallis results, the Mann-Whitney post-hoc pairwise comparison test was performed; it highlighted the lowest values of the juvenile leaf number, and the highest values of the intermediate leaf number in the central area compared to the other two locations. The adult leaves number showed no significant differences among the different locations (Kruskal-Wallis, $p = 0.0525$) (Suppl. material 2: Fig. S2).

Genetic variability of the population

By UPGMA dendrogram (Fig. 2), based on SAHN clustering of the data, the similarity coefficient (Nei's index) among the *P. oceanica* samples was 0.61 ± 0.01 based on 140 RAPD total bands (mono- and polymorphic) with fragments ranging in size from 0.3 kb to 3.8 kb. The percentage of polymorphism obtained in the population was 90.14% (Table 4).

Table 3. Three way Analysis of Variance (ANOVA) applied to three main factors (i.e. location, depth, and substrate type) on meadow structure parameters and leaf morphology.

	Sum Sq.	d.f.	Mean Sq.	F	Prob > F
Depth	226471	2	113235.5	12.56	**p < 0.001**
Location	31885.8	2	15942.9	1.77	0.1868
Substrates	76990.4	2	38495.2	4.27	**p < 0.05**
Error	288410	32	9012.8		
Total	896383.4	50			

Table 4. RAPD marker sequences, amplification range and total polymorphism detected in the studied *Posidonia oceanica* meadows.

Primer	Sequence	Amplification range	Fragment amplification		Tot	Polymorphism (%)
			polymorphic	monomorphic		
BY11	5'-ATCCACTGCA-3'	0.3–2.4 Kb	18	0	18	**100.00**
BY12	5'-GGTCGCAGGC-3'	0.3–3.8 Kb	12	2	14	**85.71**
BY13	5'-CCTTGACGCA-3'	0.5–3.8 Kb	13	2	15	**86.67**
BY15	5'-CTCACCGTCC-3'	0.73–2.8 Kb	11	1	12	**91.67**
DN4	5'-GTCGTGCTAT-3'	0.–2.4 Kb	9	2	11	**81.82**
DN5	5'-CCGACGGCAA-3'	0.3–1.75 Kb	22	0	22	**100.00**
DN6	5'-TGGACCGGTG-3'	0.5–3.0 Kb	8	1	9	**88.89**
UB24	5'-GGGTGAACCG-3'	0.75–2.25 Kb	12	0	12	**100.00**
UB26	5'-CGCCCCCAGT-3'	0.73–2.75 Kb	8	4	12	**66.67**
UB28	5'-GCTGGGCCGA-3'	0.5–1.85 Kb	15	0	15	**100.00**
			Average pergentage of polymorphism (%)			**90.14**

Mantel test, which compares Nei's distance and cophenetic matrices, returned statistically significant values, with a matrix correlation of $r = 0.95$ (normalized Mantel Statistic Z); $t = 25$ (Mantel T-test) and $p = 1.00000$ (Probability random $Z <$ observed Z).

PCoA analysis showed that the individuals sampled in the 3 different impacted zones fell into 3 distinct groups (north, centre and south populations) (Fig. 3). The first two axes accounted for 57.8% of variation, with axis 1 and 2 explaining 39.7 % and 18.1% of the variation, respectively. AMOVA (Suppl. material 4: Table S2) showed 43.05% individual differences within populations with a marked differentiation among the populations (56.9%) indicated by Fst value (0.57).

Discussion

In the meadows, the genetic structure of *P. oceanica* populations was clustered into three main groups located into three different zones (Fig. 2). The first population has been identified in the northern area, corresponding to sampling sites between Civitavecchia harbour and Marina di Tarquinia, an area mainly dominate by the presence of the Mignone river floodplain. As observed in UPGMA analysis, meadows located in this northern area are divided in two sub-populations, which are crossed by Mignone river. The second population (in the centre) corresponds to the sampling stations between Civitavecchia harbour and Capo Linaro with the presence of low cliffs and a very heterogeneous sea floor, with a prevalently rocky bottom. The third population, located in the southern part of the study area, from Capo Linaro to Santa Severa, is characterized by a prevalent sandy sea floor.

By AMOVA, a high level of genetic diversity was recognized within (43.05%) and among the populations (56.95%) and was confirmed by PCoA (Fig. 3) when the variation was applied to genetic distance among individuals (57.8%).

In this highly heterogeneous coastal area, we found 90.14% of total polymorphism ranging from 66.67 % to 100 % in the individuals analyzed (Table 4). This high percentage of polymorphism demonstrates the high variability displayed by each individual, which is also evidenced by the UPGMA cluster analysis (Figure 2) showing a low similarity value (0.52) within each population.

In the UPGMA cluster analysis, the 0.52 similarity value is lower than the one found for Monterosso meadow (0.66), where natural and anthropogenic pressure were low, and lower than the one found at the Mediterranean basin scale (0.81) (Micheli et al. 2005).

Moreover, in the same sub-cluster (Figure 2) are grouped the individuals of population with the same morphological features of the leaves linked to their genetic capacity to fit the same environment.

In the Table 2, the structural and functional descriptors have confirmed a high variability in all sampling areas, due to the different depth, which may particularly influence the morphology of leaves. According to other authors (Di Maida et al. 2013; Balestri et al. 2004; Pergent et al. 1995), the meadows that we found are fragmented, discontinuous and are characterized by a wide range of shoot density and substrate coverage which reflect a spatial heterogeneity of *P. oceanica* meadows, probably due to the complex nature of the seafloor (Tables 1, 2). Our results highlight the influence of natural drivers, as the geo-morphological features of the fragmented habitat, in the connectivity of seagrass populations. The heterogeneity patterns of the meadows that we found along the northern coast of Lazio, describe the ability of plants to respond to the environment. This depends on the availability of genetic variation improving plant growth, development and resilience (Hughes and Stachowicz 2004; Reusch et al. 2005). At this regard, Jahnke et al. (2015) suggested not only a greater resistance and resilience of individuals of higher genetic and genotypic diversity under disturbance, but also that the high diversity in high impacted sites reflects the mismatches with respect to pre-environmental impact conditions. especially because flowering and sexual recruitment are seldom observed. In fact, by the genetic diversity metrics study, they observed that the absence of low and medium levels of genetic variation in impacted locations were probably due to local extinctions of individuals that already exceeded their resistance capacity. Therefore, they suggested to use this valuable tool for restoration and mitigation projects, because the exceptional longevity of individuals (i.e. *P. oceanica* population) could create a temporal mismatch that may falsely suggest good meadow health status, while gradual deterioration of allelic diversity might go unnoticed (Jahnke et al. 2015).

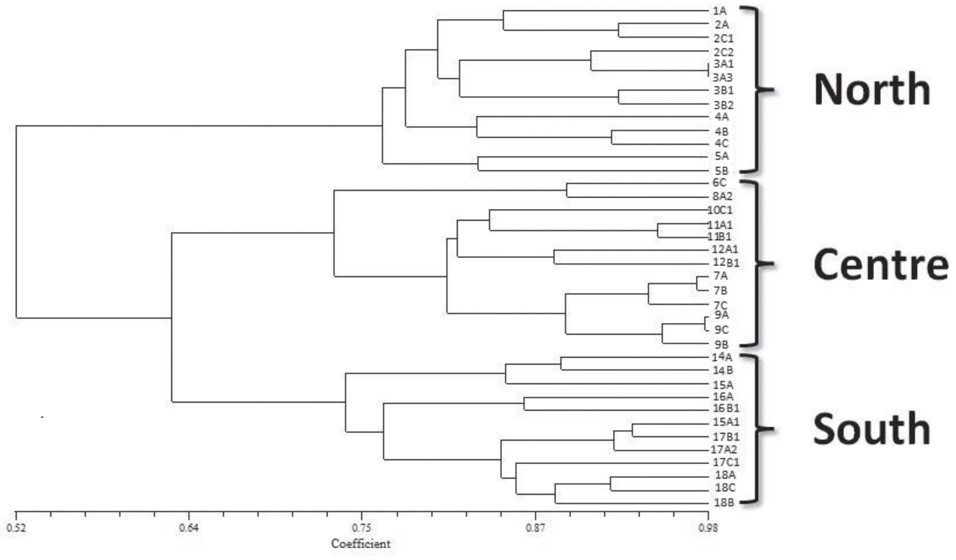

Figure 2. UPGMA analysis of *Posidonia oceanica* meadows.

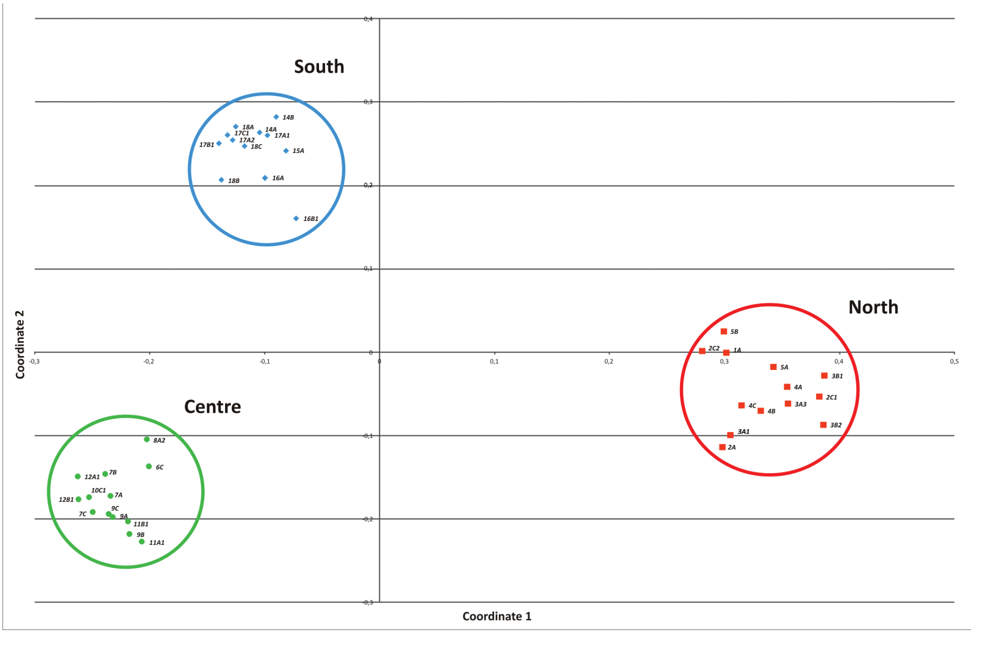

Figure 3. Principal Coordinate analyses (PCoA) based on 140 RAPD bands of XX individuals of *Posidonia oceanica*.

According to the above studies, our genetic data have highlighted the influence of different habitat conditions on plants found in the three different areas, which parallel the high variability of all structural and functional parameters (Table 2). The incidence of multiple environmental cues led plants to a more plastic response, differing among individuals, and the genetic distance between populations correlates to the distance between sites showing different environmental conditions (substrate, marine dynamic, nutrients, etc.) and subject to both natural drivers and different stressors.

Conclusion

The first investigation on the ecological/genetic structure of *P. oceanica* growing along the coasts of the northern Lazio has called the attention on the higher genetic variability of these meadows than others previously studied (Micheli et al. 2005; 2010b; 2012; Rotini et al. 2011; 2013). The observed genetic diversity and differentiation (Fst = 0.57) found among the *P. oceanica* populations suggest an adaptation capacity of the species to share different environments (rocky and sandy). This reflects in the formation of different local meadows with a spatial heterogeneity distribution along the studied area. UPGMA cluster of genetic distance revealed a high variability of seagrass population in the relatively close meadows as the result of a low level of gene flow among them. By using a dispersal simulation analysis, Serra et al. (2015) suggested that such pattern of genetic structure probably reflects historical events of recolonization from relict glacial areas and of past vicariance, which seems to persist because of the low connectivity among populations via marine currents. Whilst Jahnke et al. (2015) observed that the absence of low and medium levels of genetic variation in impacted locations are probably due to local extinctions of individuals that already exceeded their resistance capacity.

In the Mediterranean, *P. oceanica* plays a crucial role for the ecosystem productivity through favoring biodiversity, revealing a whole range of intra-specific levels of diversity from complete clonality to high variability (Ribeiro et al. 2016). In this littoral zone of the northern coast of Lazio, natural drivers like the prevailing current direction towards north (Bonamano et al. 2015; 2016) could affect seed transport favoring the colonization of new habitats whilst the incidence of multiple environmental impacts and the intra-meadow genotypic heterogeneity drive the plant to a more plastic response among individuals (Micheli et al. 2015; 2012).

Posidonia oceanica is considered a vulnerable species, largely susceptible to perturbations, and is thus included within Habitats Directive (92/43/EEC), which supports the Natura 2000 network of European protected areas. From a conservation perspective, and considering future increase in both anthropogenic and climatic pressures (Mannino 2018), the assessment and management of environmental quality require an adequate knowledge of the ecosystems that can be obtained only by multidisciplinary investigations (Cozza et al. 2019; Domina et al. 2018). Therefore further studies focused on the intra-variability of the meadows, by analyzing the allelic richness (Jahnke et al. 2015), are needed. These studies should include the changes of private (neutral) allelic in order to control the population demography vs genetic relationship stability necessary to reinforce their resilience as we have observed in other protected areas in the Mediterranean (Micheli et al. 2015; 2012). Finally, since seagrasses are globally declining, and their loss is often due to synergies among stressors (Ceccherelli et al. 2018), the ecological implication of the results obtained here, such as the genetic features and the environmental conditions, could be further aspects to be considered in the monitoring surveys.

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References

Anselmi B, Brondi A, Falchi G, Ferretti O (1978) Lineamenti granulometrici e mineralogici generali dei sedimenti fluviali e costieri del territorio italiano. Memorie della Società Geologica Italiana 19: 307–314.

Arnold T, Mealey C, Leahey H, Miller AW, Hall-Spencer JM, Milazzo M, Maers K (2012) Ocean acidification and the loss of phenolic substances in marine plants. PLOS One 7(4): e35107. https://doi.org/10.1371/journal.pone.0035107

Balestri E, Benedetti Cecchi L, Lardicci C (2004) Variability in patterns of growth and morphology of *Posidonia oceanica* exposed to urban and industrial wastes: contrasts with two reference locations. Journal of Experimental Marine Biology and Ecology 308: 1–21. https://doi.org/10.1016/j.jembe.2004.01.015

Bennett S, Roca G, Romero J, Alcoverro T (2011) Ecological status of seagrass ecosystems: an uncertainty analysis of meadow classification based on the *Posidonia oceanica* multivariate index (POMI). Marine Pollution Bulletin 62: 1616–1621. https://doi.org/10.1016/j.marpolbul.2011.06.016

Benoit G, Comeau A (2005) A sustainable future for the Mediterranean. In: The Blue Plan's Environment and Development Outlook. Earth scan, London, 450 pp.

Bonamano S, de Mendoz FP, Piermattei V, Martellucci R, Madonia A, Gnisci V, Mancini E, Fersini G, Burgio C, Marcelli M, Zappalà G (2015) Mathematical models supporting the monitoring of Civitavecchia harbour (Rome). WIT Transactions on Modelling and Simulation 59: 443–454. https://doi.org/10.2495/CMEM150401

Bonamano S, Piermattei V, Madonia A, de Mendoza FP, Pierattini A, Martellucci R, Stefanì C, Zappalà G, Caruso G, Marcelli M (2016) The Civitavecchia Coastal Environment Monitoring System (C-CEMS): a new tool to analyse the conflicts between coastal pressures and sensitivity areas. Ocean Science 12(1): 87–100. https://doi.org/10.5194/os-12-87-2016

Bonhomme D, Boudouresque CF, Astruch P, Bonhomme J, Bonhomme P, Goujard A, Thibaut T (2015) Typology of the reef formations of the Mediterranan seagrass *Posidonia oceanica*, and the discovery of extensive reefs in the Gulf of Hyères (Provence, Mediterranean). Scientific Report Port-Cros National Park 29: 41–73.

Boudouresque CF, Jeudy de Grissac A, Olivier J (1984) First International workshop on *Posidonia oceanica* Beds. GIS Posidonie, Marseille, France, 1–454.

Boudouresque CF, Bernard G, Bonhomme P, Charbonnel EG, Diviacco E, Meinesz A, Pergent G, Pergent-Martini C, Ruitton S, Tunesi L (2006) Préservation et Conservation des Herbiers à *Posidonia oceanica*. RaMoGe pub., Monaco, 200 pp.

Boudouresque CF, Bernard G, Bonhomme P, Charbonnel E, Le Diréach L, Ruitton S (2007) Monitoring methods for *Posidonia oceanica* seagrass meadows in Provence and the French Riviera. Scientific Report Port-Cros National Park 22: 17–38.

Boudouresque CF, Bernard G, Pergent G, Shili A, Verlaque M (2009) Regression of Mediterranean seagrasses caused by natural processes and anthropogenic disturbances and stress: a critical review. Botanica Marina 52: 395–418. https://doi.org/10.1515/BOT.2009.057

Boudouresque CF, Bernard G, Bonhomme P, Charbonnel E, Diviacco G, Meinesz A, Pergent G, Pergent-Martini C, Ruitton S, Tunesi L (2012) Protection and conservation of *Posidonia oceanica* meadows. RAMOGE and RAC/SPA publ., Tunis, 1–202.

Buia MC, Gambi MC, Dappiano M (2004) I sistemi a fanerogame marine. In: Gambi MC, Dappiano M (Eds) Manuale di metodologie di campionamento e studio del benthos marino Mediterraneo. Biologia Marina Mediterranea 11(suppl. 1): 133–183.

Ceccherelli G, Oliva S, Pinna S, Piazzi L, Procaccini G, Marin-Guirao L, Dattolo E, Gallia R, La Manna G, Gennaro P, Costa MM, Barrote I, Silva J, Bulleri F (2018) Seagrass collapse due to synergistic stressors is not anticipated by phenological changes. Oecologia. 186(4): 1137–1152. https://doi.org/10.1007/s00442-018-4075-9

Cognetti de Martiis S (2016) Studio della produzione primaria di *Posidonia oceanica* L. Delile, 1813 nel Lazio settentrionale PhD thesis. La Tuscia University http://hdl.handle.net/2067/2965.

Costanza R, d'Arge R, de Groot R, Farber S, Grasso M, Hannon B, Limburg K, Naeem S, O'Neill RV, Paruelo J, Raskin RG, Sutton P, van den Belt M (1997) The value of the world's ecosystem services and natural capital. Nature 387: 253–26. https://doi.org/10.1038/387253a0

Cozza R, Rende F, Ferrari M, Bruno L, Pacenza M, Dattola L, Bitonti MB (2019) Biomonitoring of *Posidonia oceanica* beds by a multiscale approach. Aquatic Botany 156: 14–24. https://doi.org/10.1016/j.aquabot.2019.04.002

Dellaporta SL, Wood J, Hicks JB (1983) A plant DNA mini preparation: version II. P.M.B.R. 1(4): 19–21. https://doi.org/10.1007/BF02712670

Den Hartog C (1970) The Seagrasses of the World. North Holland Publ. Co., Amsterdam.

Dilipan E, Papenbrock J, Thangaradjou T (2017) Random Amplified Polymorphic DNA (RAPD) fingerprints evidencing high genetic variability among marine angiosperms of India. Journal of the Marine Biological Association of the United Kingdom 97: 1307–1315. https://doi.org/10.1017/S0025315416000631

Di Maida G, Tomasello A, Sciandra M, Pirrotta M, Milazzo M, Calvo S (2013) Effect of different substrata on rhizomes growth, leaf biometry and shoot density of *Posidonia oceanica.* Marine Environment Research 87–88: 96–102. https://doi.org/10.1016/j.marenvres.2013.04.001

Domina G, Campisi P, Mannino AM, Sparacio I, Raimondo FM (2018) Environmental quality assessment of the Sicilian coast using a multi-disciplinary approach. Acta Zoologica Bulgarica, Suppl. 11: 11–18.

Duarte CM (2002) The future of seagrass meadows. Environmental Conservation 29: 192–206. https://doi.org/10.1017/S0376892902000127

Echt GS, Erdahl LA, McCoy TJ (1992) Genetic segregation of random amplified polymorphic DNA in diploid cultivated alfaalfa. Genome 35: 84–87. https://doi.org/10.1139/g92-014

Excoffier L, Lischer HEL (2010) Arlequin suite version 3.5: a new series of programs to perform population genetics analyses under Linux and Windows. Molecular Ecology Resources 10: 564–567. https://doi.org/10.1111/j.1755-0998.2010.02847.x

Giraud G (1977) Contribution à la description et à la phénologie quantitative des herbiers à *Posidonia oceanica* (L.) Delile. Thèse Doctorat 3^{éme} Cycle, Univ, Aix-Marseille II, 150. https://doi.org/10.1515/botm.1977.20.8.487

Gnisci V (2014) Spatial and temporal analysis of health status of meadows along Civitavecchia coast (Latium, Italy). PhD thesis. La Tuscia University. http://hdl.handle.net/2067/2645

Hammer Ø, Harper DAT, Ryan PD (2001) PAST: Paleontological statistics software package for education and data analysis. Palaeontologia Electronica 4(1): 1–9.

Hughes AR, Stachowicz JJ (2004) Genetic diversity enhances the resistance of a seagrass ecosystem to disturbance. Proceeding National Academy Science 101: 8998–9002. https://doi.org/10.1073/pnas.0402642101

Kim YK, Kim SH, Yi JM, Park SR, Lee KS (2019) Influence of environmental disturbances and reproductive strategy on genetic diversity and differentiation of *Zostera marina* populations on the southern coast of Korea. Marine Ecology 40: e12537. https://doi.org/10.1111/maec.12537

Jahnke M, Olsen JL, Procaccini G (2015) A meta-analysis reveals a positive correlation between genetic diversity metrics and environmental status in the long-lived seagrass *Posidonia oceanica*. Molecular Ecology 24(10): 2336–2348. https://doi.org/10.1111/mec.13174

Jones TC, Gemmill CEC, Pilditch CA (2008) Genetic variability of New Zealand seagrass (*Zostera muelleri*) assessed at multiple spatial scales. Aquatic Botany 88: 39–46. https://doi.org/10.1016/j.aquabot.2007.08.017

Lopez y Royo C, Pergent G, Alcoverro T, Buia MC, Casazza G, Martínez-Crego B, Pérez M, Silvestre F, Romero J (2011) The seagrass *Posidonia oceanica* as indicator of coastal water quality: experimental inter calibration of classification systems. Ecological Indicators 11: 557–563. https://doi.org/10.1016/j.ecolind.2010.07.012

Macreadie PI, Schliep MT, Rasheed MA, Chartrand KM, Ralph PJ (2014) Molecular indicators of chronic seagrass stress: A new era in the management of seagrass ecosystems? Ecological Indicators 38: 279–281. https://doi.org/10.1016/j.ecolind.2013.11.017

Mannino AM (2018) Human activities trigger change in marine landscape. Flora Mediterranea 28: 295–311 https://doi.org/10.7320/FlMedit28.295

Marbà N, Díaz-Almela E, Duarte CM (2014) Mediterranean seagrass (*Posidonia oceanica*) loss between 1842 and 2009. Biological Conservation 176: 183–190. https://doi.org/10.1016/j.biocon.2014.05.024

Martínez-Crego B, Vergés A, Alcoverro T, Romero J (2008) Selection of multiple seagrass indicators for environmental bio monitoring. Marine Ecology Progress Series 361: 93–109. https://doi.org/10.3354/meps07358

Meirmans PG (2006) Using the AMOVA framework to estimate a standardized genetic differentiation measure. Evolution 60: 2399–2402. https://doi.org/10.1554/05-631.1

Micheli C, Paganin P, Peirano A, Caye C, Meinesz A, Bianchi CN (2005) Genetic variability of *Posidonia oceanica* (L.) Delile in relation to local factors and biogeographic patterns. Aquatic Botany 82: 210–221. https://doi.org/10.1016/j.aquabot.2005.03.002

Micheli C, Spinosa F, Aliani S, Gasparini GP, Molcard A, Peirano A (2010b) Genetic input by *Posidonia oceanica* (L) Delile fruits dispersed by currents in the Ligurian Sea. Plant Biosystems 144: 333–339. https://doi.org/10.1080/11263501003764798

Micheli C, Cupido R, Lombardi C, Belmonte A, Peirano A (2012) Changes in genetic structure of *Posidonia oceanica* at Monterosso al Mare (Ligurian Sea) and its resilience over a decade (1998–2009). Environmental Management 50: 598–606. https://doi.org/10.1007/s00267-012-9917-3

Micheli C, D'Esposito D, Belmonte A, Peirano A, Valiante LM, Procaccini G (2015) Genetic diversity and structure in two protected *Posidonia oceanica* meadows. Marine Environmental Research 109: 124–131. https://doi.org/10.1016/j.marenvres.2015.06.016

Molinier R, Picard J (1952) Recherches sur les herbiers de phanérogames marines du littoral Méditerranéen français. Annales Institut Océanographique 27(3): 157–234.

Montefalcone M (2009) Ecosystem health assessment using the seagrass *Posidonia oceanica*: a review. Ecological Indicators 9: 595–604. https://doi.org/10.1016/j.ecolind.2008.09.013

Nei M, Li WH (1979) Mathematical model for studying genetic variation in terms of restriction endonucleases. Proceedings of the National Academy of Sciences, USA 76: 5269–5273. https://doi.org/10.1073/pnas.76.10.5269

Orth RJ, Carruthers TJB, Dennison WC, Duarte CM, Fourqurean JW, Heck KL, Hughes AR, Kendrick GA, Kenworthy WJ, Olyarnik S, Short F, Waycott M, Williams SL (2006) A global crisis for seagrass ecosystems. BioScience 56(12): 987–996. https://doi.org/10.1641/0006-3568(2006)56[987:AGCFSE]2.0.CO;2

Panayotidis P, Boudouresque CF, Marcot-Coqueugniol J (1981) Microstructure de l'herbier de *Posidonia oceanica* (L) Delile. Botanica Marina 24: 115–124. https://doi.org/10.1515/botm.1981.24.3.115

Pergent G, Pergent-Martini C, Boudouresque CF (1995) Utilisation de l'herbier à *Posidonia oceanica* comme indicateur biologique de la qualité du milieu littoral en Méditerranée: état de connaissances. Mésogée 54: 3–27.

Pergent-Martini C, Leoni V, Pasqualini V, Ardizzone GD, Balestri E, Bedini R, Belluscio A, Belsher T, Borg J, Boudouresque CF, Boumaza S, Bouquegneau JM, Buia MC, Calvo S, Cebrian J, Charbonnel E, Cinelli F, Cossu A, Di Maida G, Dural B, Francour P, Gobert S, Lepoint G, Meinesz A, Molenaar H, Mansour HM, Panayotidis P, Peirano A, Pergent G, Piazzi L, Pirrotta M, Relini G, Romero J, Sanchez-Lizaso JL, Semroud R, Shembri P, Shili A, Tomasello A, Velimirov B (2005) Descriptors of *Posidonia oceanica* meadows: use and application. Ecological Indicators 5: 213–230. https://doi.org/10.1016/j.ecolind.2005.02.004

Personnic S, Boudouresque CF, Astruch P, Ballesteros E, Blouet S, Bellan-Santini D, Bonhomme P, Thibault-Botha D, Feunteun E, Harmelin-Vivien M, Pergent G, Pergent-Martini C, Pastor J, Poggiale JC, Renaud F, Thibaut T, Ruitton S (2014) An ecosystem-based approach to assess the status of a Mediterranean ecosystem, the *Posidonia oceanica* seagrass meadow. PLOS One 9(6): 1–17 (e98994). https://doi.org/10.1371/journal.pone.0098994

Procaccini G, Piazzi L (2001) Genetic polymorphism and transplantation success in the Mediterranean seagrass *Posidonia oceanica*. Restoration Ecology 9: 332–338. https://doi.org/10.1046/j.1526-100x.2001.009003332.x

Procaccini G, Olsen JL, Reusch TBH (2007) Contribution of genetics and genomics to seagrass biology and conservation. Journal of Experimental Marine Biology and Ecology 350: 234–359. https://doi.org/10.1016/j.jembe.2007.05.035

R Development Core Team (2008) R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. http://www.R-project.org

Reusch TBH, Ehlers A, Hämmerli A, Worm B (2005) Ecosystem recovery after climatic extremes enhanced by genotypic diversity. Proceedings of the National Academy of Sciences of the United States of America102(8): 2826–2831. https://doi.org/10.1073/pnas.0500008102

Ribeiro AM, Foote AD, Kupczok A, Frazão B, Limborg MT, Piñeiro R, Abalde S, Rocha S, da Fonseca RR (2016) Marine genomics: News and views. Marine Genomics 31: 1–8. https://doi.org/10.1016/j.margen.2016.09.002

Rohlf FJ (1993) NTSYS- PC Numerical Taxonomy and Multivariate Analysis System. Exeter Software. Setauket, NY. www.exetersoftware.com/downloads/ntsysguide21

Rotini A, Micheli C, Valiante LM, Migliore L (2011) Assessment of *Posidonia oceanica* (L.) Delile conservation status by standard and putative approaches: the case study of Santa Marinella meadow (Italy, W Mediterranean). Open Journal of Ecology 1: 48–56. https://doi.org/10.4236/oje.2011.12006

Rotini A, Belmonte A, Barrote I, Micheli C, Peirano A, Santos RO, Silva J, Migliore L (2013) Effectiveness and consistency of a suite of descriptors for assessing the ecological status of seagrass meadows (*Posidonia oceanica* L. Delile). Estuarine, Coastal and Shelf Science 130: 252–259. https://doi.org/10.1016/j.ecss.2013.06.015

Semroud R (1993) Contribution à la connaissance de l'ecosysteme a *Posidonia oceanica* (L.) Delile dans la région d'Alger (Algérie): étude de quelques compartiments. PhD thesis.

Serra IA, Innocenti AM, Di Maida G, Calvo S, Migliaccio M, Zambianchi E, Pizzigalli C, Arnaud-Haond S, Duarte CM, Serrao A, Procaccini G (2015) A meta-analysis reveals a positive correlation between genetic diversity metrics and environmental status in the long-lived seagrass *Posidonia oceanica*. Molecular Ecology 24(10): 2336–2348. https://doi.org/10.1111/mec.13174

Spalding M, Taylor M, Ravilious C, Short F, Green E (2003) The distribution and status of seagrasses. In: Green EP, Short FT (Eds) World Atlas of Seagrass. University California Press, Berkeley CA, 5–26.

Vassallo P, Paoli C, Rovere A, Montefalcone M, Morri C, Bianchi CN (2013) The value of the seagrass *Posidonia oceanica*: a natural capital assessment. Marine Pollution Bulletin 75: 157–167. https://doi.org/10.1016/j.marpolbul.2013.07.044

Williams JGK, Kubelik AR, Livak J, Antoni Rafalski J, Tingey SV (1990) DNA polymorphisms amplified by arbitrary primers are useful as genetic markers. Nucleic Acid Research 18: 6531–6535. https://doi.org/10.1093/nar/18.22.6531

Supplementary material 1

Figure S1. Heterogeneous spatial distribution of seagrass population along the northern coast of Lazio (Italy), Central Tyrrhenian, Mediterranean

Authors: Valentina Gnisci, Selvaggia Cognetti de Martiis, Alessandro Belmonte, Carla Micheli, Viviana Piermattei, Simone Bonamano, Marco Marcelli

Data type: occurrence

Link: https://doi.org/10.3897/italianbotanist.9.46426.suppl1

Supplementary material 2

Figure S2. The non-parametric Kruskal-Wallis test

Authors: Valentina Gnisci, Selvaggia Cognetti de Martiis, Alessandro Belmonte, Carla Micheli, Viviana Piermattei, Simone Bonamano, Marco Marcelli

Data type: statistical data

Link: https://doi.org/10.3897/italianbotanist.9.46426.suppl2

Supplementary material 3

Table S1. ANOVA results

Authors: Valentina Gnisci, Selvaggia Cognetti de Martiis, Alessandro Belmonte, Carla Micheli, Viviana Piermattei, Simone Bonamano, Marco Marcelli

Data type: statistical data

Explanation note: Multifactor three-way ANOVA results to test the presence of significant differences in shoot density, leaf number, leaf length, leaf surface and LAI among the samples collected at different depth, location and substrate type.

Link: https://doi.org/10.3897/italianbotanist.9.46426.suppl3

Supplementary material 4

Table S2. AMOVA

Authors: Valentina Gnisci, Selvaggia Cognetti de Martiis, Alessandro Belmonte, Carla Micheli, Viviana Piermattei, Simone Bonamano, Marco Marcelli

Data type: statistical data

Link: https://doi.org/10.3897/italianbotanist.9.46426.suppl4

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RESEARCH ARTICLE

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Contribution to the bryological knowledge of the Tuscan-Emilian Apennines (Northern Italy)

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Abstract
The inventory of the bryophytes collected during the annual excursion of the Working Group for Bryology of the Italian Botanical Society is reported. This excursion was held in 2018 on the northern slope of the Tuscan-Emilian Apennines National Park, in the Administrative Region of Emilia-Romagna. The field work led to the finding of 113 taxa (24 liverworts and 89 mosses), including eight new records and seven confirmations for this Region. The occurrence of rare taxa for Italy (*Scapania uliginosa*, *Rhizomnium pseudopunctatum*, *Racomitrium fasciculare*, *Scorpidium cossonii*, *Grimmia lisae*, *Orthotrichum pulchellum*) is highlighted.

Keywords
Bryophytes, new floristic records, northern Apennines, regional flora

Introduction

The Tuscan-Emilian Apennines constitute the central sector of the northern Apennines, a mountain chain that crosses the Italian peninsula along the border between the Administrative Regions of Emilia-Romagna and Toscana.

The first knowledge on the bryophyte flora of the Tuscan-Emilian Apennines dates back to the end of the 19th century with the floristic contributions of Fiori (1886, 1892a, 1892b), Avetta (1897), Casali (1899a, 1899b), and Provasi (1938), regarding the moss and liverwort flora of the provinces of Modena, Reggio Emilia, and Parma. Other information is found in the papers published by Barsali (1907, 1914) and Bottini (1913, 1914, 1919); later, Raffaelli (1976) published a paper on the genus *Sphagnum* for the Tuscan-Emilian territory. More data can be drawn from the phytogeographic and phytosociological papers of Tomaselli and Gerdol (1984), Gerdol and Tomaselli (1988, 1993), Tomaselli (1991), and Petraglia and Tomaselli (2007). Recently, a study on the bryoflora of the gypsum outcrops (Aleffi et al. 2014) and a checklist of the bryophytes of Emilia-Romagna (Fariselli et al. 2019) were published. Nevertheless, knowledge on the bryophyte flora of the northern Apennines is not yet comprehensive; therefore, the annual excursion of the Working Group for Bryology of the Italian Botanical Society was organized in July 2018 in the National Park of the Tuscan-Emilian Apennines, where many different types of mountain habitats with an interesting bryophyte flora were investigated.

Study area

The Tuscan-Emilian Apennines represent the core district of the northern Apennines, a 250 km-long mountain barrier running in a NW-SE direction and separating the Po plain in the north from the rest of the Italian peninsula in the south (Fig. 1). The geological framework of the Tuscan-Emilian Apennines is mainly given by sandstones belonging to the Macigno Formation and by the Ligurian units, represented by successions characterized by helminthoid flysch deposits and sedimentary mélanges with blocks of ophiolite rocks (Bruni et al. 1994). Climatic features of the study area were obtained from the thermo-pluviometric data of six stations located above 1,000 m a.s.l. The mean annual precipitation is around 1500 mm, the mean annual temperature is about 5 °C with the mean monthly temperature ranging between 7 °C and 13 °C. July is the warmest month with a mean daily maximum of about 16 °C; February is the coldest one with a mean daily minimum of -2 °C.

The study area is located in the Emilian slope of the northern Apennines. It is characterized by a sub-Mediterranean vegetation belt dominated by xerophilous or mesophilous deciduous woodlands extending up to about 1,000 m a.s.l.; the montane belt is represented by different types of beech woodlands (Ubaldi et al. 1993). Its upper limit ranges between 1,600 and 1,700 m a.s.l., where it is strongly dependent upon geomorphological and land use conditions.

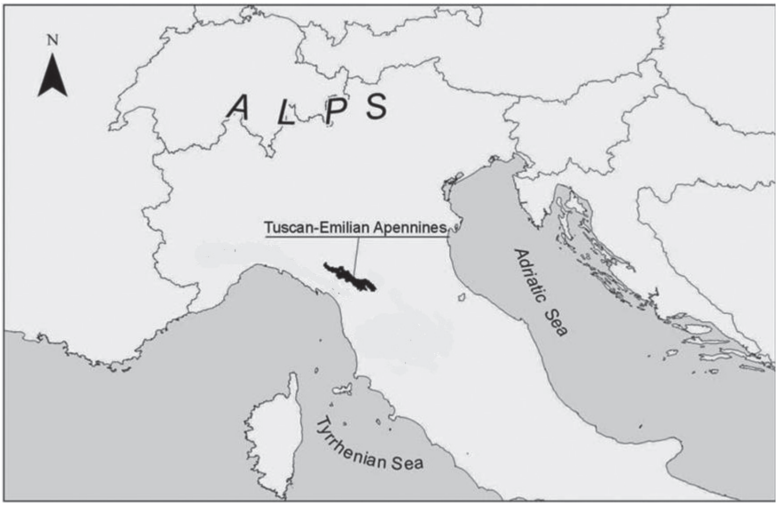

Figure 1. Schematic map of the study area.

Subalpine vegetation above the treeline is characterized by heathlands dominated by *Vaccinium* species (*V. myrtillus* L., *V. gaultherioides* Bigelow and *V. vitis-idaea* L.) and by *Empetrum hermaphroditum* Hagerup; they represent the most widespread vegetation type in the summit areas (Ferrari and Piccoli 1997). Intermixed with shrub heathlands and above the ridges and summits, a patchy mosaic of snow-beds (Petraglia and Tomaselli 2007), cryoxerophytic and mesophytic primary grasslands (Tomaselli et al. 2000), secondary grasslands (Gennai et al. 2014) and vegetation on rock faces and cliffs (Tomaselli et al. 2019) compose the landscape of the Tuscan-Emilian Apennines.

Materials and methods

The field work was carried out on 21–23 July, 2018 in areas falling in the Emilia-Romagna in the localities Passo della Scalucchia, Buca del Moro, Mt. Cavalbianco, Lago della Bargetana, and Mt. Prado, at altitudes between 1,350 and 2,056 m a.s.l. The collections were made from soil, rocks, rocky crevices, tree bark, and rotting stumps in different habitats (beech woods, heathlands with *Vaccinium* sp. pl., snow-beds, peat bogs, stream banks). The following 13 sites were investigated and sampled:

1 Passo della Scalucchia, beech wood, 1,350 m a.s.l., 44°21'25"N, 10°13'44"E
2 Buca del Moro, beech wood, 1,450 m a.s.l., 44°20'32"N, 10°12'59"E
3 Mt. Cavalbianco, beech wood, 1,575 m a.s.l., 44°17'10"N, 10°17'59"E
4 Mt. Cavalbianco, beech wood, 1,590 m a.s.l., 44°17'27"N, 10°17'55"E
5 Mt. Cavalbianco, beech wood, 1,600 m a.s.l., 44°17'38"N, 10°18'00"E
6 Mt. Cavalbianco, heathland, 1,650 m a.s.l., 44°18'05"N, 10°17'50"E

7 Mt. Cavalbianco, streams in the beech wood beyond the heathland, 1,450 m a.s.l. 44°18'24"N, 10°18'31"E
8 Lago della Bargetana, 1,740 m a.s.l., 44°15'28.9"N, 10°24'06.5"E
9 Lago della Bargetana, 1,750 m a.s.l., 44°15'18"N, 10°24'16"E
10 Lago della Bargetana, peat bog, 1,770 m a.s.l., 44°15'18"N, 10°24'17"E
11 Lago della Bargetana, peat bog, 1,780 m a.s.l., 44°15'18.6"N, 10°24'20"E
12 Lago della Bargetana, heatland, 1,820 m a.s.l., 44°15'09"N, 10°24'22"E
13 Mt. Prado, snow-beds, 2,056 m a.s.l., 44°14'58"N, 10°24'26"E

Taxa (genera and species) are arranged in alphabetical order mainly following the classification proposed by Goffinet et al. (2009). The nomenclature follows Ros et al. (2013), Plášek et al. (2015), and Lara et al. (2016) for mosses and Söderström et al. (2016) for liverworts.

The specimens are kept in CAME, CAG, SIENA, and in the personal herbaria of the authors.

Results

Floristic list

The bryophyte taxa collected in the investigated areas are listed below. The taxa followed by ** are new reports for Emilia-Romagna; the taxa followed by * are confirmations for the Region. For each taxon, the localities and habitat within the study area are reported.

MARCHANTIIDAE
JUNGERMANNIALES

Cephaloziaceae
Cephalozia bicuspidata (L.) Dumort. – Site 11: in the peat bog.

Cephaloziellaceae
Cephaloziella baumgartneri Schiffn. – Site 5: on soil and in rocky crevices in the beech wood.

Jungermanniaceae
Jungermannia atrovirens Dumort. – Site 5: on soil and in rocky crevices.

Lophocoleaceae
Chiloscyphus pallescens (Ehrh.) Dumort. – Site 12: on soil.
****Chiloscyphus polyanthos*** (L.) Corda – Site 8: on damp soil along a stream; site 10: in the peat bog.
Lophocolea heterophylla (Schrad.) Dumort. – Sites 1, 5: on rotting stumps in the beech wood.

Plagiochilaceae

Plagiochila asplenioides (L.) Dumort. – Site 1: on rocks.

Plagiochila porelloides (Torr. ex Nees) Lindenb. – Sites 3, 4: on soil in the beech wood, on bark of *Fagus sylvatica*; site 8: on peaty soil, along a stream.

Pseudolepicoleaceae

Blepharostoma trichophyllum (L.) Dumort. – Site 9: along a stream.

Scapaniaceae

Barbilophozia barbata (Schmidel ex Schreb.) Loeske – Site 6: on humus among boulders in the heathlands with *Vaccinium* sp. pl.

Barbilophozia hatcheri (A. Evans) Loeske – Site 8: in rocky crevices.

Barbilophozia lycopodioides (Wallr.) Loeske – Site 1: on rocks in the beech wood; site 6: on humus among boulders in the heathlands with *Vaccinium* sp. pl.

Lophozia ventricosa (Dicks.) Dumort. – Site 11: on peaty soil; Site 13: on soil in a snow-bed.

Lophozia wenzelii (Nees) Steph. – Site 8: on peaty soil.

Mesoptychia turbinata (Raddi) L.Söderstr. et Váňa – Sites 1,2: on soil; site 4: on humus among boulders in the heathlands with *Vaccinium* sp. pl.

*****Scapania irrigua*** (Nees) Nees – Site 5: on soil and rotting stumps in the beech wood.

******Scapania uliginosa*** (Lindenb.) Dumort. – Site 8: on peaty soil.

Trilophozia quinquedentata (Huds.) Bakalin – Site 12: on soil.

PORELLALES

Frullaniaceae

Frullania dilatata (L.) Dumort. – Site 4: on rotting stumps.

*****Frullania tamarisci*** (L.) Dumort. var. ***tamarisci*** – Site 4: on soil.

Porellaceae

Porella platyphylla (L.) Pfeiff. – Site 1: on soil at the edge of the beech wood; site 2: on rocks in the beech wood; site 3: on bark of *Fagus sylvatica*.

Radulaceae

Radula complanata (L.) Dumort. – Site 1: on bark of *Fagus sylvatica*; sites 3,4: on bark of *Fagus sylvatica*; site 7: along a stream.

Radula lindbergiana Gottschs ex C. Hartm. – Site 2: on rotting stumps in the beech wood.

METZGERIALES

Aneuraceae

Aneura pinguis (L.) Dumort. – Site 10: in the peat bog.

BRYIDAE
SPHAGNALES

Sphagnaceae

Sphagnum capillifolium (Ehrh.) Hedw. – Site 8,10: in the peat bog.

Sphagnum teres (Schimp.) Ångstr. – Site 8: in a swamp.

POLYTRICHALES

Polytrichaceae

Atrichum undulatum (Hedw.) P. Beauv. – Sites 3,4: on soil in the beech wood.

Pogonatum aloides (Hedw.) P.Beauv. – Site 4: on soil in the beech wood (forest path escarpment); site 13: in a snow-bed.

Pogonatum urnigerum P. Beauv. – Site 2: on soil in the beech wood.

Polytrichastrum alpinum (Hedw.) G.L.Sm. – Sites 1,2: on rocks and soil in the beech wood; site 3,4: on soil and rocky crevices in the beech wood; site 6: on humus among boulders in the heathlands with *Vaccinium* sp. pl.; site 8,9: in rocky crevices.

Polytrichum formosum Hedw. – Site 4: on soil in the beech wood; site 6: on humus among boulders in the heathlands with *Vaccinium* sp. pl.; site 9: on soil.

Polytrichum juniperinum Hedw. – Sites 5,6: on humus among boulders in the heathlands with *Vaccinium* sp. pl.

Polytrichum piliferum Hedw. – Site 1,5: on soil; site 4: on soil in the beech wood; site 6: on soil and humus among boulders in the heathlands with *Vaccinium* sp. pl.; site 13: on soil in a snow-bed.

BARTRAMIALES

Bartramiaceae

Philonotis calcarea (Bruch & Schimp.) Schimp. – Sites 8,9: on peaty soil; site 12: on soil in the heathland.

Philonotis fontana (Hedw.) Brid. – Site 8: along a stream edge; site 10: in the peat bog.

****Philonotis rigida*** Brid. – Site 12: on soil in the heathland.

Philonotis seriata Mitt. – Sites 8: on peaty soil; site 10: along a streamlet in the bog.

BRYALES

Bryaceae

Bryum schleicheri DC. – Site 10: along a streamlet in the bog; site 12: on soil in the heathland.

Bryum tenuisetum Limpr. – Site 13: on soil in a snow-bed.

Imbribryum mildeanum (Jur.) J.R. Spence – Site 13: on soil in a snow-bed.

Ptychostomum pallens (Sw.) J.R. Spance – Site 8: on peaty soil.

Ptychostomum pseudotriquetrum (Hedw.) J.R. Spence & H.P.Ramsay var. ***pseudotriquetrum*** – Site 8: on peaty soil.

Mniaceae

Mnium marginatum (Dicks.) P.Beauv. var. ***marginatum*** – Site 7: on damp soil.

Mnium spinulosum Bruch & Schimp. – Site 1: on soil; site 6: on humus among boulders in the heathlands with *Vaccinium* sp. pl.

Plagiomnium undulatum (Hedw.) T.J.Kop. var. ***undulatum*** – Site 7: on moist soil along streams.

Pohlia cruda (Hedw.) Lindb. – Site 7: on moist soil along streams.

*******Rhizomnium pseudopunctatum*** (Bruch & Schimp.) T.J.Kop. – Site 9: on moist soil.

Rhizomnium punctatum (Hedw.) T.J.Kop. – Site 5: on soil in the beech wood; site 7: on moist soil along streams.

DICRANALES

Dicranaceae

Dicranella heteromalla (Hedw.) Schimp. – Site 6: on humus among boulders in the heathlands with *Vaccinium* sp. pl.

Dicranella subulata (Hedw.) Schimp. – Site 9: in rocky crevices.

Dicranum majus Sm. – Site 9: on soil in the beech wood.

Dicranum scoparium Hedw. – Site 1: on soil; site 6: on humus among boulders in the heathlands with *Vaccinium* sp. pl.

Dicranum cfr. ***tauricum*** Sapjegin – Site 8: in rocky crevices.

Ditrichaceae

Ceratodon purpureus (Hedw.) Brid. – Site 1: on dry soil; site 2: on soil at the edge of the beech wood.

Fissidentaceae

* ***Fissidens pusillus*** (Wilson) Milde – Site 7: on soil along streams.

Rhabdoweisiaceae

Dicranoweisia cirrata (Hedw.) Lindb. – Site 6: on soil among boulders in the heathlands with *Vaccinium* sp. pl.

Hymenoloma crispulum (Hedw.) Ochyra – Site 6: on soil among boulders in the heathlands with *Vaccinium* sp. pl.

Kiaeria starkei (F.Weber & D.Mohr) I. Hagen – Site 9: in rocky crevices.

DIPHYSCIALES

Diphysciaceae

Diphyscium foliosum (Hedw.) D.Mohr – Sites 3,4: on soil in the beech wood.

GRIMMIALES

Grimmiaceae

****__*Grimmia lisae*__ De Not. – Site 1: on rocks in the beech wood.

__*Racomitrium elongatum*__ Ehrh. ex Frisvoll – Site 1: on soil in the beech wood.

****__*Racomitrium fasciculare*__ (Hedw.) Brid. – Site 6: on humus among boulders in the heathlands with *Vaccinium* sp. pl.; site 13: on soil in a snow-bed.

__*Racomitrium lanuginosum*__ (Hedw.) Brid. – Site 6: on humus among boulders and rocks in the heathlands with *Vaccinium* spp; site 9: on soil.

__*Schistidium apocarpum*__ (Hedw.) Bruch & Schimp. – Site 1: on rocks; site 6: among boulders in the heathlands with *Vaccinium* sp. pl.

HYPNALES

Amblystegiaceae

__*Campylium protensum*__ (Brid.) Kindb. – Site 12: on soil.

__*Campylium stellatum*__ (Hedw.) Lange & C.E.O. Jensen – Site 8: along a streamlet in the bog, on peaty soil; site11: on peaty soil.

__*Hygrohypnum luridum*__ (Hedw.) Jenn. – Site 8: on peaty soil.

__*Palustriella commutata*__ (Hedw.) Ochyra – Site 7: along a stream.

__*Palustriella falcata*__ (Brid.) Hedenäs – Site 11: in a peat bog.

__*Sanionia uncinata*__ (Hedw.) Loeske – Site 8: on peaty soil.

****__*Scorpidium cossonii*__ (Schimp.) Hedenäs – Site 8: on peaty soil.

Anomodontaceae

__*Anomodon attenuatus*__ (Hedw.) Huebener – Site 1: on soil in the beech wood.

Brachytheciaceae

__*Brachytheciastrum velutinum*__ (Hedw.) Ignatov & Huttunen var. __*velutinum*__ – Site 1: on soil in the beech wood.

__*Brachythecium campestre*__ (Müll. Hal.) Schimp. – Site 4: on soil in the beech wood.

__*Brachythecium rutabulum*__ (Hedw.) Schimp. – Site 4: on rotting stumps in the beech wood.

***__*Brachythecium cirrosum*__ (Schwägr.) Schimp. – Site 6: on humus among boulders in the heathlands with *Vaccinium* sp. pl.

__*Homalothecium sericeum*__ (Hedw.) Schimp. – Sites 1,3,4,5: on bark of *Fagus sylvatica*; Site 2: on soil in beech wood.

__*Kindbergia praelonga*__ (Hedw.) Ochyra – Sites 3,4: along streams.

__*Rhynchostegium confertum*__ (Dicks) Schimp. – Site 2: on bark at the base of *Fagus sylvatica*.

__*Rhynchostegium riparioides*__ (Hedw.) Cardot – Site 7: in a stream.

__*Scorpiurium circinatum*__ (Bruch) M.Fleisch. & Loeske – Site 4: on soil.

Calliergonaceae

__*Sarmentypnum exannulatum*__ (Schimp.) Hedenäs – Site 8: on peaty soil.

__*Straminergon stramineum*__ (Dicks. ex Brid.) Hedenäs – Site 8: in a bog.

Climaciaceae

Climacium dendroides (Hedw.) F.Weber & D.Mohr – Site 8: on peaty soil.

Hylocomiaceae

Hylocomium splendens (Hedw.) Schimp. – Site 8: on soil.

Rhytidiadelphus squarrosus (Hedw.) Warnst. – Site 6: on humus among boulders in the heathlands with *Vaccinium* sp.pl.

Rhytidiadelphus triquetrus (Hedw.) Warnst. – Site 6: on humus among boulders in the heathlands with *Vaccinium* sp. pl.

Hypnaceae

Campylophyllum halleri (Hedw.) M.Fleisch. – Sites 1,2: on rocks in the beech wood.

Herzogiella seligeri (Brid.) Z. Iwats – Site 4: on soil in the beech wood.

Hypnum cupressiforme Hedw. var. ***cupressiforme*** – Site 1: on bark of *Fagus sylvatica*, on soil and rocks in the beech wood; sites 3,4,5: on bark of *Fagus sylvatica*.

Leskeaceae

Lescuraea incurvata (Hedw.) E.Lawton – Site 5: on soil in the beech wood.

Lescuraea radicosa (Mitt.) Mönk. – Site 4: on rotting stumps.

*****Lescuraea saxicola*** (Schimp.) Molendo – Site 5: on rocks in the beech wood.

Pseudoleskeella nervosa (Brid.) Nyholm – Site 5: on soil in the beech wood.

Leucodontaceae

Leucodon sciuroides (Hedw.) Schwägr. – Sites 1,2: on bark of *Fagus sylvatica*.

Plagiotheciaceae

Plagiothecium denticulaum (Hedw.) Schimp. var. ***denticulatum*** – Sites 1,4,5: on rotting stumps in the beech wood.

Plagiothecium laetum Schimp. – Site 5: on rocks in the beech wood.

Pterigynandraceae

******Habrodon perpusillus*** (De Not.) Lindb. – Site 2: on rotting stumps in beech wood.

*****Heterocladium dimorphum*** (Brid.) Schimp. – Site 2: on humus among boulders in the heathlands with *Vaccinium* sp. pl.

Myurella julacea (Schwägr.) Schimp. – Site 6: on humus among boulders in the heathlands with *Vaccinium myrtillus*.

Myurella tenerrima (Brid.) Lindb. – Site 4: on soil in beech wood.

Pterigynandrum filiforme Hedw. – Site 1: on bark of *Fagus sylvatica*, on rotting stumps; sites 3,4,7: on bark of *Fagus sylvatica*, on soil; site 13: on soil in a snow-bed.

Thuidiaceae

Abietinella abietina (Hedw.) M.Fleisch. var. ***abietina*** – Sites 1,2: on soil in the beech wood.

Thuidium delicatulum (Hedw.) Schimp. – Site 7: on soil along streams.
Thuidium tamariscinum (Hedw.) Schimp. – Site 7: on soil.

ORTHOTRICHALES

Orthotrichaceae
Lewinskya affinis (Schrad. ex Brid.) F.Lara, Garilleti & Goffinet – Sites 3,4: on bark of *Fagus sylvatica*.
Pulvigera lyellii (Hook. & Taylor) Plášek, Sawicki & Ochyra – Sites 3,4: on bark of *Fagus sylvatica*.
*****Orthotrichum pulchellum*** Brunt. – Sites 3,4: on bark of *Fagus sylvatica*.
Orthotrichum striatum Hedw. – Sites 1,3,4: on bark of *Fagus sylvatica*.
Ortotrichum cfr. ***tenellum*** Bruch ex Brid. – Sites 3,5: on bark of *Fagus sylvatica*.

POTTIALES

Pottiaceae
Didymodon acutus (Brid.) K.Saito – Site 6: on humus among boulders in the heathlands with *Vaccinium myrtillus*.
Syntrichia ruralis (Hedw.) F.Weber & D.Mohr var. ***ruralis*** – Site 1: on rocks in the beech wood.
Tortula muralis Hedw. – Site 13: on soil in a snow-bed.

RHIZOGONIALES

Aulacomniaceae
Aulacomnium palustre (Hedw.) Schwägr. – Site 12: in a peat bog.

Discussion

The result of this survey is a checklist of 113 taxa (24 liverworts and 89 mosses), including eight records that, on the basis of data reported by Fariselli et al. (2019), are new for the Emilia-Romagna Region. Some of them are of phytogeographical interest and deserve a special protection over time. In particular, *Scapania uliginosa*, which is a circumpolar Arctic montane species very rare in Europe (Ros et al. 2007), is reported here for the first time in Emilia-Romagna. The new moss records for this Region are *Grimmia lisae*, *Habrodon perpusillus*, *Orthotrichum pulchellum*, *Philonotis rigida*, *Racomitrium fasciculare*, *Rhizomnium pseudopunctatum*, and *Scorpidium cossonii*. Amongst these, we highlight, for their rarity in Italy, *Rhizomnium pseudopunctatum*, *Racomitrium fasciculare*, and *Scorpidium cossonii*, reported only for few northern Regions (Aleffi et al. 2008). Particularly interesting is the finding of *Orthotrichum pulchellum*, which has been reported in Italy only from Lombardia, Calabria, and Sicilia (Aleffi et al. 2008). In addition to these interesting new records, the occurrence of seven species is confirmed for Emilia-Romagna: *Chiloscyphus polyanthos*, *Scapania irrigua*, and *Frullania tamarisci* among the liverworts, *Brachythecium cirrosum*, *Fissidens pusillus*, *Heterocladium dimorphum*, and *Lescuraea saxicola*, among the mosses. In particular, *Brachythecium cirrosum* deserves to be mentioned because it is an European bryophyte that is probably threatened by climate change; although it is not actually at risk, conservation measures for this taxon are recommended (Schnyder 2019). Overall, the most widespread species recorded by us are: *Plagiochila porelloides*, *Homalothecium sericeum*, *Hypnum cupressiforme* var. *cupressiforme*, *Polytrichastrum alpinum*, *Polytrichum piliferum*, and *Pterigynandrum filiforme*.

Based on the results of this survey, the bryophyte flora in the investigated area shows a liverwort/moss ratio of 0.269, with a scarce liverwort component, comparable with that of Monte Bondone (Trentino-Alto Adige), which is 0.256 (Privitera et al. 2010). Within mosses, the pleurocarpous/acrocarpous ratio is 0.87, a very high value considering the numerical superiority of the acrocarpous mosses. This is likely due to the occurrence, in the investigated sites (most of them within beech woods), of species that are well adapted to the forest ecosystem. Liverworts belong to 11 families, and mosses to 26; in particular, the most represented moss families are Brachytheciaceae (10.3%) Amblystegiaceae and Polytrichaceae (9.0% each one), followed by Mniaceae (6.8%) and then by Dicranaceae, Grimmiaceae, Orthotrichaceae and Pterygynandraceae (5.7% each). The scarce presence of the Pottiaceae (3.4%) is not surprising, since the family is widespread in Mediterranean territories (Privitera et al. 2015; Puglisi et al. 2015; Puglisi and Cataldo 2019).

As regards the phytogeographical analysis (Hill and Preston 1998), the boreal-temperate species prevail (30.7%), followed at a distance by boreal-arctic montane (16.2%), boreal-montane (11.7%), and temperate species (10.8%); the least represented categories are the Mediterranean (5.4%) and wide-temperate (2.7%).

In conclusion, this study reveals a rich bryophyte diversity in the investigated area, with a significant number of species that are rare for Italy. For this reason, and as previously highlighted for other mountain areas (Puglisi et al. 2013; Ellis et al. 2017), the Apennines can be considered an important site for biodiversity conservation, surely less affected by human disturbance, one of the most dangerous causes of biodiversity loss.

References

Aleffi M, Tacchi R, Cortini Pedrotti C (2008) Check-list of the Hornworts, Liverworts and Mosses of Italy. Bocconea 22: 1–256.

Aleffi M, Pellis G, Puglisi M (2014) The bryophyte flora of six gypsum outcrops in the Northern Apennines (Nature 2000 Network, Emilia-Romagna Region, Italy). Plant Biosystems 148(4): 825–836. https://doi.org/10.1080/11263504.2014.949331

Avetta C (1897) Flora crittogamica della Provincia di Parma. Malpighia 11: 181–197.

Barsali E (1907) Censimento delle epatiche toscane. Nuovo Giornale Botanico Italiano, n.s. 14: 5–49.

Barsali E (1914) Frammenti d'epaticologia italiana. Bullettino della Società Botanica Italiana 5: 41–44.

Bottini A (1913) Spigolature briologiche N. 2. Atti della Società Toscana di Scienze Naturali, Memorie, Pisa 22: 149–195.

Bottini A (1914) Spigolature briologiche N. 3. Atti della Società Toscana di Scienze Naturali, Memorie, Pisa 23: 37–43.

Bottini A (1919) Sfagnologia italiana. Mem. Accad.Lincei. 13: 1–87.

Bruni P, Cipriani N, Pandeli E (1994) New sedimentological and petrographical data on the Oligo-Miocene turbiditic formations of the Tuscan Domain. Memorie Società Geologica Italiana 48: 251–260.

Casali C (1899a) Aggiunte alla flora crittogamica del Reggiano. Bullettino della Società Botanica Italiana 5–6: 93–96.

Casali C (1899b) Le Briofite del Reggiano. Avellino, 35 pp.

Ellis LT, Afonina OM, Andriamiarisoa RL, Bednarek-Ochyra H, Cykowska-Marzencka B, Stryjak-Bogacka M, Bell NE, Boiko M, Callaghan DA, Campisi P, Dia MG, Marino ML, Provenzano F, Eckstein J, Enroth J, Erzberger P, Ezer T, Gargano ML, Ginzburg E, Górski P, Gradstein SR, Reeb C, Hannoire C, Infante M, Jukonienė I, Kushnevskaya EV, Lebouvier M, Nagy J, Opmanis A, Plášek V, Skoupá Z, Sabovljević MS, Sabovljević AD, Shevock R, Singh DK, Majumdar S, Skudnik M, Uselienė A, Venturella G, Węgrzyn M, Wietrzyk P, Yoon Y J, Kim JH ,Yücel E (2017) New national and regional bryophyte records, 53. Journal of Bryology, 39(4): 368–387. https://doi.org/10.1080/03736687.2017.1384204

Fariselli R, Aleffi M, Speranza M (2019) Check List delle Briofite dell'Emilia-Romagna. Alma Mater Studiorum, Università di Bologna, 168 pp.

Ferrari C, Piccoli F (1997) The ericaceous dwarf shrublands above the Northern Apennines timberline (Italy). Phytocoenologia 27: 53–76. https://doi.org/10.1127/phyto/27/1997/53

Fiori A (1886) Muschi del Modenese e del Reggiano. I[a] Contribuzione. Atti della Società dei Naturalisti di Modena, Memorie 5: 127–179.

Fiori A (1892a) Rivista statistica dell'Epaticologia Italiana. Primo elenco delle Epatiche del Modenese e Reggiano. Malpighia 6: 41–49.

Fiori A (1892b) Seconda contribuzione alla Briologia Emiliana. Malpighia 6: 564–570.

Gennai M, Foggi B, Viciani D, Carbognani M, Tomaselli M (2014) The *Nardus*-rich communities in the northern Apennines (N-Italy): a phytosociological, ecological and phytogeographical study. Phytocoenologia 44: 55–80. https://doi.org/10.1127/0340-269X/2014/0044-0574

Gerdol R, Tomaselli M (1988) Phytosociology and ecology of stream vegetation in the summit region of the northern Apennines. Bollettino del Museo di Storia Naturale della Lunigiana 6–7: 89–93.

Gerdol R, Tomaselli M (1993) The vegetation of wetlands in the northern Apennines (Italy). Phytocoenologia 21(4): 421–469. https://doi.org/10.1127/phyto/21/1993/421

Goffinet B, Buck WR, Shaw AJ (2009) Morphology, anatomy, and classification of the Bryophyta. In: Goffinet B, Shaw AJ (Eds) Bryophyte Biology, 2nd edn. Cambridge, Cambridge University Press, 55–138.

Hill MO, Preston CD (1998) The geographical relationship of British and Irish bryophytes. Journal of Bryology 20: 127–226. https://doi.org/10.1179/jbr.1998.20.1.127

Hodgetts NG (2015) Check list and Country status of European bryophytes – towards a new Red List for Europe. Irish Wildlife Manuals, No. 84. National Parks and Wildlife Service, Department of Arts, Heritage and the Gaeltacht, Ireland, 1–125.

Lara F, Garilleti R, Goffinet B, Draper I, Medina R, Vigalondo B, Mazimpaka V (2016) Lewinskya, a new genus to accommodate the phaneroporous and monoicous taxa of *Orthotrichum* (Bryophyta, Orthotrichaceae). Cryptogamie, Bryologie 37(4): 361–382. https://doi.org/10.7872/cryb/v37.iss4.2016.361

Petraglia A, Tomaselli M (2007) Phytosociological study of the snowbed vegetation in the Northern Apennines (Northern Italy). Phytocoenologia 37(1): 67–98. https://doi.org/10.1127/0340-269X/2007/0037-0067

Plášek V, Sawicki J, Ochyra R, Szczecińska M, Kulik T (2015) New taxonomical arrangement of the traditionally conceived genera *Orthotrichum* and *Ulota* (Orthotrichaceae, Bryophyta). Acta Musei Silesiae, Scientiae Naturales 64: 169–174. https://doi.org/10.1515/cszma-2015-0024

Privitera M, Aleffi M, Bertani G, Campisi P, Carratello A, Codogno M, Cogoni A, Miserere L, Perego S, Puglisi M, Sguazzin F, Tacchi R, Zimbone A (2010) Survey of the bryophyte diversity of the Carnic Alps, including some interesting records for the Italian bryoflora. Flora Mediterranea 20: 193–209.

Privitera M, Galesi R, Arato L, Puglisi M (2015) Bryophyte diversity in Augusta-Priolo territory (South-Eastern Sicily). Flora Mediterranea 25 (special issue): 115–126. https://doi.org/10.7320/FlMedit25SI.115

Provasi T (1938) Florula dei Laghetti dell'Appennino Parmense e Reggiano. Nuovo Giornale Botanico Italiano, n.s. 45(2). https://doi.org/10.1080/11263503809439757

Puglisi M, Campisi P, Aiello P, Dia MG, Privitera M (2015) Analysis of the bryophyte diversity of mountain ranges in Sicily. Nova Hedwigia 100(3–4): 391–405. https://doi.org/10.1127/nova_hedwigia/2015/0236

Puglisi M, Campisi P, Lakušić D, Surina B, Di Pietro R, Privitera M (2013) Notes on the bryophyte flora and vegetation of the central and south-western Balkans. Lazaroa 34: 107–116. https://doi.org/10.5209/rev_LAZA.2013.v34.n1.42334

Puglisi M, Cataldo D (2019) A comparative study on the bryophyte and lichen flora for monitoring the conservation status of protected areas of Sicily. Nova Hedwigia 109(3–4): 321–343. https://doi.org/10.1127/nova_hedwigia/2019/0550

Raffaelli M (1976) Gli Sfagni Tosco-Emiliani. Webbia 30(1): 159–175. https://doi.org/10.1080/00837792.1976.10670046

Smith AJE (2004) The Moss Flora of Britain and Ireland. Cambridge University Press, 1012 pp. https://doi.org/10.1017/CBO9780511541858

Ros RM, Mazimpaka V, Abou-Salama U, Aleffi M, Blockeel T-L, Brugués M, Cano MJ, Cros RM, Dia MG, Dirkse GM, El Saadawi W, Erdağ A, Ganeva A, Gonzalez-Mancebo JM, Herrnstadt I, Khalil K, Kürschner H, Lanfranco E, Losada-Lima A, Refai MS, Rodriguez-Nuñez S, Sabovijević M, Sérgio C, Shabbara H, Sim-Sim M, Söderström L (2007) Hepatics and Anthocerotes of the Mediterranean, an annotated checklist. Cryptogamie, Bryologie 28(4): 351–437.

Ros RM, Mazimpaka V, Abou-Salama U, Aleffi M, Blockeel TL, Brugués M, Cros RM, Dia MG, Dirkse GM, Draper I, El-Saadawi W, Erdağ A, Ganeva A, Gabriel R, González-Mancebo JM, Granger C, Herrnstadt I, Hugonnot V, Khalil K, Kürschner H, Losada-Lima A, Luís L, Mifsud S, Privitera M, Puglisi M, Sabovljević M, Sérgio C, Shabbara HM, Sim-Sim M, Sotiaux A, Tacchi R, Vanderpoorten A, Werner O (2013) Mosses of the Mediterranean, an annotated checklist. Cryptogamie, Bryologie 34: 99–283. https://doi.org/10.7872/cryb.v34.iss2.2013.99

Schnyder N (2019) *Brachythecium cirrosum*. The IUCN Red List of Threatened Species 2019: e.T88148732A88382488 [Downloaded on 13 November 2019]

Söderström L, Hagborg A, Von Konrat M, Bartholomew-Began S, Bell D, Briscoe L, Brown E, Cargill DC, Costa DP, Crandall-Stotler BJ, Cooper ED, Dauphin G, Engel JJ, Feldberg K, Glenny D, Gradstein SR, He X, Heinrichs J, Hentschel J, Ilkiu-Borges AL, Katagiri T, Konstantinova NA, Larraín J, Long DG, Nebel M, Pócs T, Puche F, Reiner-Drehwald E, Renner MAM, Sass-Gyarmati A, Schäfer-Verwimp A, Segarra Moragues JG, Stotler RE, Sukkharak P, Thiers BM, Uribe J, Váňa J, Villarreal JC, Wigginton M, Zhang L, Zhu R-L (2016) World checklist of hornworts and liverworts. Phytokeys 59: 1–828. https://doi.org/10.3897/phytokeys.59.6261

Tomaselli M (1991) The snow-bed vegetation in the Northern Apennines. Vegetatio 94: 177–189. https://doi.org/10.1007/BF00032630

Tomaselli M, Gerdol R (1984) Analisi e valutazione fitogeografico-ecologica della distribuzione di alcune orofite appartenenti alla flora igrofila dell'alto Appennino tosco-emiliano. Atti dell'Istituto Botanico e Laboratorio Crittogamico dell'Università di Pavia, Serie 7(2) (1983): 107–146.

Tomaselli M, Rossi G, Dowgiallo G (2000) Phytosociology and ecology of the *Festuca puccinellii*-grasslands in the northern Apennines (N-Italy). Botanica Helvetica 110(2): 125–149.

Tomaselli M, Foggi B, Carbognani M, Gennai M, Petraglia A (2019) The rock-face vegetation in the northern Apennines and neighbouring mountain areas, from the coast line to the highest summits. Phytocoenologia 49: 7–70. https://doi.org/10.1127/phyto/2018/0117

Ubaldi D, Zanotti AL, Puppi G (1993) Les paysages forestiers de l'Emilie-Romagne et leur signification bioclimatique. Colloques Phytosociologiques 21: 269–286.

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RESEARCH ARTICLE

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Notulae to the Italian flora of algae, bryophytes, fungi and lichens: 9

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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 *Encalypta*, *Grimmia*, and *Riccia*, for the fungal genera *Hericium*, *Inocybe*, *Inocutis*, *Pluteus*, and *Russula*, and for the lichen genera *Bryoria*, *Farnoldia*, *Hypocenomyce*, *Lecania*, *Paracollema, Peltigera*, *Sarcogyne*, and *Teloschistes*.

Keywords
Ascomycota, Basidiomycota, Bryidae, Jungermanniidae, Marchantiidae

How to contribute

The text of the records should be submitted electronically to: Cecilia Totti (c.totti@univpm.it) for algae, Marta Puglisi (mpuglisi@unict.it) for bryophytes, Alfredo Vizzini (alfredo.vizzini@unito.it) for fungi, Sonia Ravera (sonia.ravera@unipa.it) for lichens.

Floristic records

Bryophytes

Encalypta ciliata Hedw. (Encalyptaceae)

+ **VEN**: Il Castello, Livinallongo Val di Lana (Belluno) on rock in wet slit (UTM WGS84 32T 724444.5153886), 1720 m, 21 August 2016, *F. Sguazzin* (Bryophytorum Herbarium F. Sguazzin). – Species confirmed for the flora of Veneto.

Encalypta ciliata is a Circumpolar Boreal-montane floristic element (Dierßen 2001), recorded for several countries of the Mediterranean basin (Ros et al. 2013), but its range is subcosmopolitan (Smith 2004). According to Aleffi et al. (2008), this species is known in Italy for many Administrative Regions, including Veneto, where the records have not been confirmed over the last 50 years. According to Hodgetts (2015), *E. ciliata* is considered Endangered (EN) in Estonia; Vulnerable (VU) in Czech Republic, Hungary, Montenegro and Serbia; Critically Endangered (CR) in Ireland and Luxembourg; Data Deficient (DD) in Sardinia; Near Threatened (NT) in Sicily and Not Evaluated (NE) in Italy.

S. Poponessi, F. Sguazzin, M. Aleffi

Grimmia elongata Kaulf. (Grimmiaceae)

+ **EMR**: Monte Prado, Tuscan-Emilian Apennine National Park, Villa Minozzo (Reggio Emilia), on rocks (UTM WGS84: 32T 612458.4900639), 2095 m, 23 July 2018, *S. Poponessi* (PERU). – Species new for the flora of Emilia-Romagna.

Grimmia elongata is a Circumpolar Arctic-montane species with main distribution in the mountain areas of Europe, while it is very rare in southern Europe and in the Mediterranean countries (Ros et al. 2013; Hodgetts 2015). It is also known for North America, North Africa, and Asia (Muñoz and Pando 2000; Greven 2003; Ignatova and Muñoz 2004; Manju and Rajesh 2011). *Grimmia elongata* is a cryophytic, acidophytic species preferably growing on acidic sandstones, rocks and rocky crevices, north-facing outcrops and ledges. It is closely related to *Grimma donniana* Sm., from which it is distinguished for the reddish-brown colour of the cushions, muticous or short-awned leaves with only one margin recurved and dioecious sexuality. According to Aleffi et al. (2008), the species is known in Italy for Val d'Aosta, Piemonte, Lombardia, Trentino-Alto Adige, Campania, and Sicilia.

S. Poponessi, M. Puglisi

Riccia beyrichiana Hampe ex Lehm. (Ricciaceae)

+ **TOS**: Poggio alle Monache, Chiesanuova (Firenze), on wet paths in Mediterranean maquis (UTM 32T 676341.4842470), 224 m, 8 June 2019, *G. Pandeli* (SI); Collegramole Case Nuove Impruneta (Firenze), on soil in maquis with *Erica arborea* L. and *Arbutus unedo* L., (UTM WGS84 32T 676963.4842320), 198 m, 10 April 2017, *G. Pandeli* (SIENA); Poggio Valicaia Casignano Scandicci (Firenze), on wet paths in Mediterranean maquis (UTM WGS84 32T 637816.4983201), 360 m, 15 September 2019, *G. Pandeli* (SIENA). – Species new for the flora of Toscana.

Riccia beyrichiana grows on acidic soils and rocks in Mediterranean forests, on cliff tops, in wetlands and grasslands in exposed sites sometimes subjected to seasonal flooding. It is distinguished from the other species of *Riccia* for its large, channelled, long-persistent, shiny thallus with swollen margins. In Italy, it is reported for Piemonte, Lombardia, Trentino-Alto Adige, Umbria, Puglia, and Sardegna (Aleffi et al. 2008) and recently for Campania (Puglisi et al. 2015a, 2015b). Its global range includes Europe, SE Asia, N Africa, and N America (Ozenoglu Kiremit et al. 2016).

G. Pandeli, I. Bonini, M. Aleffi

Fungi

Hericium erinaceus (Bull.) Pers. (Hericiaceae)

+ **CAM**: Real Bosco di Capodimonte (Napoli), on living stem of *Quercus ilex* L. (UTM WGS 84: 33T 437027.4524498) 147 m, 28 November 2019, *M. Marziano* (NAP). – Species new for the flora of Campania.

Hericium erinaceus is considered as rare in Italy and is reported in the Red List as Endangered (Rossi et al. 2013), while it is widespread in America and Asia (Ginns 1985). Two specimens were found on the wounds of different stems of a living tree of *Quercus ilex* L. in a holm oaks forest in a historic royal park. This saprotrophic fungus produces white rot on living trees (Boddy et al. 2011). In Italy, it is known for Calabria (Siniscalco et al. 2018), Toscana (Corana et al. 2019), Sardegna, Emilia-Romagna, and Piemonte (Bernicchia and Padovan 1997). Other congener species found in Italy are *H. coralloides* (Scop.) Pers., *H. alpestre* Pers., and *H. cirrhatum* (Pers.) Nikol. (Saitta et al. 2011).

M. Marziano, C. Guarino

Inocybe pelargonium Kühner (Inocybaceae)

+ **LIG**: near Via S. Lorenzo di Casanova, Geminiano (Genova), on calcareous soil with *Quercus ilex* L., (UTM WGS 84: 32T 494157.4922117), 375 m, 19 October 2015, *F. Boccardo* (Herb. GDOR 3715). – Species new for the flora of Liguria.

Inocybe pelargonium is associated mainly with *Picea abies* (L.) H.Karst, *Fagus sylvatica* L. or *Quercus* L. (Bandini et al. 2019). *Inocybe pelargonium* is recognized by having strikingly distinctive characters: coppery-brownish, coppery-ochraceous to orange colours on pileus, typical smell like *Pelargonium* leaves or sweet fruits, when cut subspermatic, small spores (5.8–10.0 × 3.9–5.7 μm), and relatively short cystidia (28–65 μm) variable in shape, from sub-utriform, sub-fusiform to sub-clavate, generally crystalliferous at apex (Bandini et al. 2019).

F. Dovana, F. Boccardo

Inocutis levis (P.Karst.) Y.C.Dai (Hymenochaetaceae)

+ **ITALY** (**CAL**): Orto Botanico Università della Calabria, Rende (Cosenza), on the stem of 30-year-old declining poplar trees (*Populus nigra* and *Populus nigra* subsp. *italica*) (UTM WGS84: 33S 605990.4357046), 220 m, 11 October 2018, *G. Sicoli*, *G. Aloise*, *N.G. Passalacqua* (CLU No. F304). – Species new for the flora of Italy (Calabria).

Inocutis levis is a lignicolous fungus, showing sessile and pileate basidiomata, and a distinct granular core at the point of attachment to the plant tissues (Dai 2010). The maximum size we detected were 60 cm in width, 40 cm in projection, 4 and 10 cm in context and hymenial thickness, respectively. Spores are ellipsoid, yellowish and thick-walled, very similar to those produced by *Inocutis tamaricis* (Pat.) Fiasson & Niemelä, but differing from these because they remain cyanophilous even at maturity (Dai 2010; Sicoli and Mannarino 2017). The molecular comparison (nITS rDNA sequence) of our specimen with those available in GenBank (Boudagga et al. 2017; Hashemi et al. 2017) confirmed the identification. As far as we know, and despite a number of records for Asia and Africa (Karsten 1887; Salem and Michail 1980; Dai 2010; Ţura et al. 2010; Boudagga et al. 2017; Hashemi et al. 2017), no indication of this species for Europe has been reported, so far.

G. Sicoli, G. Aloise, N.G. Passalacqua

Pluteus semibulbosus **(Lasch) Quél. (Pluteaceae)**

+ **CAL**: Botanical Garden, University of Calabria, Rende (Cosenza), on a dead branch laying on the ground, reasonably belonging to *Quercus pubescens* Willd. (UTM WGS84: 33S 605956.4357271), 220 m, 14 October 2019, *G. Sicoli*, *A.B. De Giuseppe*, *N.G. Passalacqua* (CLU No. F309). – Species new for the flora of Calabria.

Pluteus semibulbosus is an agaricoid, lignicolous, saprotrophic fungus, showing pileate and stipitate basidiomata. The pileus, less than 3.0 cm in diameter, shows a whitish-cream to pale-skin translucent cuticle, darker in the centre, striate towards the margin. The stipe is central, white, cylindrical and more or less bulbous at the base, thus differing from the close *Pluteus plautus* (Weinm.) Gillet, which lacks the bulb. Caulocystidia are characteristically cylindrical to broadly clavate to broadly fusiform, whereas they are broadly clavate to pyriform or even ventricose in *P. plautus*. Moreover, pleurocystidia are broadly lageniform in contrast with the conical-fusiform, narrowly utriform to cylindrical pleurocystidia occurring in another close species, *Pluteus inquilinus* Romagn. (Kaigusuz et al. 2019).

G. Sicoli, A.B. De Giuseppe, N.G. Passalacqua

Russula nympharum **F.Hampe & Marxm. (Russulaceae)**

+ **ITALY** (**LIG**): Portofino Vetta (Genova), in *Quercus ilex* L. forest (UTM WGS84: 32T 513144.4908678), 30 October 2009, *R. Jon* (R Jon 0482); San Martino di Noceto (Genova), (UTM WGS84: 32T 513756.4911561), *Quercus* sp., 30 October 2009, *R. Jon* (R Jon 0483). – Species new for the flora of Italy (Liguria).

+ **ITALY** (**MAR**): Serrina S of Carpegna (Urbino), in *Quercus cerris* L. forest, (UTM WGS84: 33T 285363.4849414), 16 October 2004, leg. *A. Storgaard*, rev. *M. Vaneková* (C-F-91172). – Species new for the flora of Italy (Marche).

+ **ITALY** (**PIE**): Masserano (Biella), (UTM WGS84: 32T 439663.5049156), *Quercus* sp., 15 November 2009, *R. Jon* (R Jon 0501). – Species new for the flora of Italy (Piemonte)

+ **ITALY** (**TOS**): Marsiliana, Riserva Statale (Grosseto), forest with *Quercus suber* L. and *Q. ilex*, (UTM WGS84: 32T 646434.4763924), 8 November 2016, *L. Michelin* (SAV F-4887); 2 km SE of of the village, Frassine, Monterotondo Marittimo (Grosseto), forest with *Q. ilex* and *Q. cerris*, (UTM WGS84: 32T 646194.4775121), 10 November 2016, *M. Caboň* (SAV F-4992). – Species new for the flora of Italy (Toscana).

The original description of *Russula nympharum* (Adamčík et al. 2016) was based on four collections originating from France, Spain, and Belgium. This species is distinguished from its look-alike *Russula maculata* Quél. by lower spore ornamentation not exceeding 0.6 µm, more abundant pleurocystidia, mostly cylindrical terminal cells in pileipellis and broader, clavate pileocystidia near the pileus margin, on average wider than 7 µm. Our collections represent the first reports of *R. nympharum* from Italy. According to morphological and molecular (nITS rDNA) analysis of recently collected herbarium specimens, we identified five collections of *R. nympharum* originating from four Italian Regions. The studied collections are deposited in the herbarium of the Slovak Academy of Sciences (SAV) and in the Copenhagen Herbarium (C).

M. Caboň, S. Adamčík, R. Jon

Lichens

Bryoria furcellata (Fr.) Brodo & D.Hawksw. (Parmeliaceae)

+ **TAA**: Valle Aurina, tourist path 700 m N of Casere fraz. di Predoi (Bolzano), on bark of *Larix decidua* Mill. (UTM WGS84: 33T 281783.5215413), 1900 m, 19 July 2009, *J. Malíček* (Herb. Malíček no. 2323). – New for the flora of Trentino-Alto Adige.

Bryoria furcellata is a hair lichen usually 3–5(-12) cm long, showing regularly isotomic dichotomous branching, axils usually broad towards base and acute towards tips. It seems to be a well-delimited species characterized by lateral spinules, abundant, fissural soralia which develop tufts of spinules and by the presence of fumarprotocetraric acid (Gilbert and Hawksworth 2009). It has been reported in Italy so far only from Veneto (Nimis et al. 1991) and Friuli Venezia Giulia (Nimis 2016). It is a mainly boreal-montane, circumpolar lichen of the Northern Hemisphere, extending south to Mexico and Central America, apparently rare in the Alps (Nimis et al. 2018).

J. Malíček, S. Ravera

Farnoldia micropsis (A.Massal.) Hertel

+ **VEN**: Arabba (Belluno), near top of mountain 1 km S of Passo Pordoi, on dolomite rock (UTM WGS84: 32T 715995.5151106), 2400 m, 20 July 2009, leg. *J. Malíček*, det. *J. Hafellner* (Herb. Malíček no. 2326). – Species confirmed for the flora of Veneto.

Farnoldia micropsis is a crustose lichen with a white areolate thallus and black apothecia (up to 2 mm wide) adnate or between the areolae, characterized by I+ blue medulla. It is a circumpolar arctic-alpine species, widespread and common throughout the Alps (Nimis et al. 2018) on calcium-bearing rocks. Nevertheless, the only record from Veneto of *F. micropsis* dates back to the second half of the 19th century (Arnold 1876, Hertel 1967).

J. Malíček, S. Ravera

Hypocenomyce stoechadiana Abbassi Maaf & Cl.Roux (Ophioparmaceae)

+ **CAM**: Cratere degli Astroni (Napoli), on bark of *Quercus robur* L. (UTM WGS 84: 33T 428026.4521603) 19 m, 1 November 2016, *D. Puntillo* (CLU No. 17157, 17454, 17466, 17479, 17817, 17818, 17877, 17911). – Species new for the flora of Campania.

Hypocenomyce stoechadiana is a squamulose species with a Mediterranean-Macaronesic distribution, found on ancient specimens of *Olea* L., *Quercus ilex* L., and *Quercus virgiliana* (Ten.) Ten. in warm-humid areas. It has often sterile while at the collection site a large number of thalli is provided with fruiting bodies. According to Nimis and

Martellos (2017), this species shows an exclusively Tyrrhenian distribution in Italy, although in Calabria three populations have been found on the Ionian coast (CLU No. 5672, 5724, 17557). This lichen is classified in the Italian Red List of epiphytic lichens as "Vulnerable" (Nascimbene et al. 2013).

D. Puntillo, I. Catalano, S. Ravera

Lecania atrynoides **M.Knowles (Ramalinaceae)**

+ **TOS:** Cala San Quirico, Populonia (Livorno), on siliceous sandstone along the coast (UTM WGS84: 32T 621304.4759203), 3 m, 8 June 2018, *L. Paoli*, *Z. Fačkovcová* (SAV). – Species confirmed for the flora of Toscana.

Lecania atrynoides is a crustose Mediterranean-Atlantic species of siliceous rocks, generally growing in areas with a humid-warm climate, such as Tyrrhenian Italy. In Toscana it was reported only from the island of Capraia (Nimis et al. 1990). The identification of the new specimen from the area of Populonia has also been confirmed by sequencing of internal transcribed spacer (ITS) regions of ribosomal DNA (ITS1-5.8S-ITS2).

L. Paoli, Z. Fačkovcová, A. Guttová

Paracollema italicum **(B. de Lesd.) Otálora, P.M.Jørg. & Wedin (Collemataceae)**

+ **CAM**: Santuario S.S. Annunziata, Licusati frazione di Camerota (Salerno), on *Olea europaea* L. (UTM WGS84: 33T 530453.4434790), 410 m, 4 April 2010, *S. Ravera* (Herb. Ravera); 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). – Species new for the flora of Campania.

It is an epiphytic cyanolichen, which prefers trunks of *Olea*, *Ulmus*, *Quercus ilex* L., and *Quercus pubescens* Willd. in mesophytic woodland and exposed situations, not subjected to direct sunlight. It usually constitutes communities with *Normandina pulchella* (Borrer) Nyl. and several cyanolichens within it dominate (Degelius 1954). In Italy, it is rarely found in the Mediterranean belt. This species is presently known only for a few localities in Lazio (Ravera 2001) and in Puglia (Von Brackel 2011), while it has not been reconfirmed in its *locus classicus* in Genova (Ravera and Giordani 2008). *Paracollema italicum* is included in the Italian Red List of epiphytic lichens as "Endangered" (Nascimbene et al. 2013).

S. Ravera

Peltigera extenuata **(Vain.) Lojka (Peltigeraceae)**

+ **LOM**: Surroundings of Caruga, Valchiavenna (Sondrio), on a drystone wall covered by mosses (UTM WGS84: 32T 525689.5132912), 1240 m, September 2017, leg. *C. Vallese*, det. *R. Benesperi*, *C. Vallese* (Herb. Benesperi); Nasoncio, Gerola Alta (Sondrio), on a concrete wall covered with mosses at the edge of a secondary road (UTM WGS84: 32T

542796.5102441), 1087 m, 27 August 2019, leg. *G. Gheza*, det. *R. Benesperi*, *C. Vallese* (Herb. Nascimbene No. JN6789, Herb. Gheza). – Species new for the flora of Lombardia.

Peltigera extenuata is a foliose species characterized by a thallus with (mostly) rounded lobes and flocculent and pale rhizines becoming darker in the central part. The peculiar characteristic of this species is the presence of strictly laminal soredia (Goward et al. 1995). It is a terricolous species ,ecologically and morphologically similar to *Peltigera didactyla* (With.) J.R.Laundon, but it differs in having a KC+ red reaction of the medulla and soralia (Nimis 2016). In the past, it was often referred to *Peltigera didactyla* var. *extenuata* (Nyl. ex Vain.) Goffinet & Hastings, but according to Goffinet et al. (2003) this taxon is currently recognised as a species, which has been recently reported for Italy (Matteucci and Vanacore Falco 2015, Ravera et al. 2019).

C. Vallese, G. Gheza, L. Di Nuzzo

Sarcogyne praetermissa K.Knudsen & Kocourk. (Acarosporaceae)

+ **ITALY** (**ABR**): Gran Sasso Massif, pass between Santo Stefano di Sessanio and Campo Imperatore (L'Aquila), limestone, dolomite, Alpine grassland (UTM WGS84: 33T 389500.4693000), c. 1680 m, 6 April 1997, leg. *P.L. Nimis*, *M. Tretiach* (sub *Sarcogyne privigna*), rev. *P.L. Nimis*, 27 January 2020 (TSB No. 27188); Rocca Caramanico (Pescara), on limestone (UTM WGS84: 33T 418500.4661500), c. 1000 m, 12 August 1996, leg. *P.L. Nimis*, *M. Tretiach* (sub *Sarcogyne privigna* v. *calcicola*), rev. *P.L. Nimis*, 27 January 2020 (TSB No. 24943). – Species new for the flora of Italy (Abruzzo).

+ **ITALY** (**MAR**): Sibillini Mnts., Monte Vettore, near Valle Orsara (Ascoli Piceno), on calcareous boulders (UTM WGS84: 33T 362600.4743400), c. 1100 m, 7 August 1996, leg. *P.L. Nimis*, *M. Tretiach* (sub *Sarcogyne privigna*), rev. *P.L. Nimis*, 27 January 2020 (TSB No. 24064). – Species new for the flora of Italy (Marche).

+ **ITALY** (**MOL**): Below Lupara along river Biferno (Campobasso), dry calcareous rocks, cultivations (UTM WGS84: 33T 478566.4621312), c. 280 m, 4 April 1997, leg. *P.L. Nimis*, *M. Tretiach* (sub *Sarcogyne privigna*), rev. *P.L. Nimis*, 27 January 2020 (TSB No. 27080). – Species new for the flora of Italy (Molise).

Sarcogyne praetermissa is a recently-described species which was previously treated as a calcicolous morph of *Sarcogyne hypophaea* (Nyl.) Arnold (syn.: *Sarcogyne privigna* auct., see Nimis 2016), from which it differs in the unsegmented apothecial margins, the stouter paraphyses, and the growth on calcareous substrata (Knudsen and Kocourková 2018, see also Roux et al. 2019). This species, hitherto reported from central and northern Europe, and from Montenegro, seems to be particularly frequent on limestone outcrops along the Adriatic side of the Italian Peninsula, from the submediterranean to the upper montane belt, but is likely to be more widespread, and should be looked for elsewhere.

P.L. Nimis, E. Pittao

Teloschistes chrysophthalmus (L.) Th.Fr. (Teloschistaceae)

+ **PUG**: Bosco Cuturi, Manduria (Taranto) on *Phillyrea latifolia* L. and *Quercus ilex* L. (UTM WGS84: 33T 725580.4469003) and on *Pyrus amygdaliformis* Vill. (UTM

WGS84: 33T 725621.4468806), 93 m, 19 January 2020, *S. Gianfreda* (HERB GM); Bosco Rosamarina, Manduria (Taranto), on *Phillyrea angustifolia* L (UTM WGS84: 33T 726899.4468101), 86 m, 27 January 2020, *G. Matino* (HERB GM); near Sava (Taranto) on *Prunus dulcis* (Miller) D. A. Webb and *Pistacia lentiscus* L. (UTM WGS84: 33T 713504.4472856), 110 m, 28 January 2020, *S. Gianfreda* (HERB GM). – Species confirmed for the flora of Puglia.

Teloschistes chrysophthalmus is a fruticose lichen; it is quite showy due to lobes being orange-yellow to grey, mostly covered with numerous marginal fibrils which are also present around the pedicellate apothecia. This lichen is included in the Italian Red List of epiphytic lichens as "Near-threatened" (Nascimbene et al. 2013). It was much more common in the past and presently it is extinct in many Regions, especially in northern Italy (Nimis 2016). The last record in Puglia dates back to the late 19th century (Jatta 1889). We found some specimens in three localities on different substrates. These lichens grow on twigs of shrubs, on the terminal part, well exposed to the sun, and never found in undergrowth, in association with *Xanthoria parietina* (L.) Th.Fr., *Physcia adscendens* H.Olivier and *Parmotrema hypoleucinum* (J.Steiner) Hale. The density of *T. chrysophthalmus* seems to be extremely limited and its distribution is irregular, probably due to human interference (tree pruning, fires, use of herbicides and fertilizers).

S. Gianfreda, C. Matino

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References

Adamčík S, Caboň M, Eberhardt U, Saba M, Hampe F, Slovák M, Kleine J, Marxmuller H, Jančovičová S, Pfister DH, Khalid AN, Kolařík M, Marhold K, Verbeken A (2016) A molecular analysis reveals hidden species diversity within the current concept of *Russula maculata* (Russulaceae, Basidiomycota). Phytotaxa 270: 71–88. https://doi.org/10.11646/phytotaxa.270.2.1

Aleffi M, Tacchi R, Cortini Pedrotti C (2008) Check-list of the Hornworts, Liverworts and Mosses of Italy. Bocconea 22: 1–255.

Arnold F (1876) Lichenologische Ausflüge in Tirol: XVI. Ampezzo. Verhandlungen der Zoologisch-Botanischen Gesellschaft zu Wien 26: 389–414.

Bandini D, Oertel B, Ploch S, Ali T, Vauras J, Schneider A, Scholler M, Eberhardt U, Thines M (2019) Revision of some central European species of *Inocybe* (Fr.) Fr. subgenus *Inocybe*, with the description of five new species. Mycological Progress 18: 247–294. https://doi.org/10.1007/s11557-018-1439-9

Berlese AN (1896) Sulla struttura e sviluppo della *Pileolaria terebinthi*. Rivista di Patolgia Vegetale, Firenze: 287–294.

Bernicchia A, Padovan F (1997) Preliminary distributional data on Hericiaceae (Basidiomycetes) in Italy. Bocconea 5: 853–859.

Boddy L, Crockatt ME, Ainsworth AM (2011) Ecology of *Hericium cirrhatum*, *H. coralloides* and *H. erinaceus* in the UK. Fungal Ecology 4: 163–173. https://doi.org/10.1016/j.funeco.2010.10.001

Boudagga S, Ouali Z, Mersni M, Bouslama L, Gargano M, Venturella G, Jaouani (2017) Cultivation of some mushrooms species originating from Tunisia and exploration of their valuable metabolites. 9th International Medicinal Mushrooms Conference, Advances in Medicinal Mushroom Science: Building Bridges between Western and Eastern Medicine, September 24–28, 2017, Palermo, Italy, 131–132.

Corana F, Cesaroni V, Mannucci B, Baiguera RM, Picco AM, Savino E, Ratto D, Perini C, Kawagishi H, Girometta CE, Rossi P (2019) Array of Metabolites in Italian *Hericium erinaceus* Mycelium, Primordium, and Sporophore. Molecules 24: 1–3511. https://doi.org/10.3390/molecules24193511

Dai Y-C (2010) Hymenochaetaceae (Basidiomycota) in China. Fungal Diversity 45: 131–343. https://doi.org/10.1007/s13225-010-0066-9

Degelius G (1954) The Lichen Genus *Collema* in Europe. Morphology, Taxonomy, Ecology. Symbolae Botanicae Upsalenses 13: 277–280.

Dierßen K (2001) Distribution, ecological amplitude and phytosociological characterization of European bryophytes. Bryophytorum Bibliotheca 56: 1–289.

Gilbert OL, Hawksworth D (2009) *Bryoria* Brodo & D. Hawksw. (1977). In: Smith CW, Aptroot A, Coppins BJ, Fletcher A, Gilbert OL, James PW, Wolseley PA (Eds) The Lichens of Great Britain and Ireland. The British Lichen Society, Department of Botany, The Natural History Museum, Cromwell Road, London, 1046 pp.

Ginns J (1985) *Hericium* in North America: cultural characteristics and mating behaviour. Canadian Journal of Botany 63: 1551–1563. https://doi.org/10.1139/b85-215

Goffinet B, Miadlikowska J, Goward T (2003) Phylogenetic Inferences Based on nrDNASequences Support Five Morphospecies Within the *Peltigera didactyla* Complex (Lichenized Ascomycota). The Bryologist 106: 349–364. https://doi.org/10.1639/01

Goward T, Goffinet B, Vitikainen O (1995) Synopsis of the genus *Peltigera* (lichenized Ascomycetes) in British Columbia, with a key to the North American species. Canadian Journal of Botany 73: 91–111. https://doi.org/10.1139/b95-012

Greven HC (2003) Grimmias of the World. Backhuys Publishers, Leiden, 247 pp.

Hashemi H, Mohammadi H, Abdollahzadeh J (2017) Symptoms and fungi associated with elm trees decline in Iran. European Journal of Forest Research 136: 857–879. https://doi.org/10.1007/s10342-017-1075-y

Hertel H (1967) Revision einiger calciphiler Formenkreise der Flechtengattung *Lecidea*. Beihefte zur Nova Hedwigia 24: 92–96.

Hodgetts NG (2015) Checklist and country status of European bryophytes – towards a new Red List for Europe. Irish Wildlife Manuals, No. 84. National Parks and Wildlife Service, Department of Arts, Heritage and the Gaeltacht. Ireland, 130 pp.

Ignatova E, Muñoz J (2004) The genus *Grimmia* Hedw. (Grimmiaceae, Musci) in Russia. Arctoa 13: 101–182. https://doi.org/10.15298/arctoa.13.13

Jatta A (1889) Monographia Lichenum Italiae Meridionalis. Tip. Vecchi, Trani, 261 pp.

Karsten PA (1887) Fungi aliquot novi in Turkestania A Dre. Walther lecti. Hedwigia 26: 1–112.

Kaygusuz O, Türkekul I, Knudsen H, Çolak ÖF (2019) New records of *Pluteus* section *Hispidoderma* in Turkey Based on Morphological Characteristics and Molecular Data. Phytotaxa 413: 175–206. https://doi.org/10.11646/phytotaxa.413.3.1

Knudsen K, Kocourková J (2018) *Sarcogyne praetermissa* (Acarosporaceae), a new calcicolous lichen species from Europe, with a key to the European Sarcogyne species. Herzogia 31: 133–139. https://doi.org/10.13158/099.031.0109

Matteucci E, Vanacore Falco I (2015) The "Sereno Ameglio" Lichen collection: a virtual exploration of exsiccate conserved in the Aosta Valley Regional Natural Science Museum. Museologia scientifica 9: 57–61.

Manju CN, Rajesh KP (2011) *Grimmia funalis* (Schwägr.) Bruch & Schimp. (Grimmiaceae; Bryophyta) from India. Taiwania 56: 81–83.

Muñoz J, Pando F (2000) A world synopsis of the genus *Grimmia*. Monographs in Systematic Botany from the Missouri Botanical Garden 83: 1–133.

Nascimbene J, Nimis PL, Ravera S (2013) Evaluating the conservation status of epiphytic lichens of Italy: a red list. Plant Biosystems 147: 898–904. https://doi.org/10.1080/11263504.2012.748101

Nimis PL (2016) The Lichens of Italy – A second annotated catalogue. EUT Edizioni Università di Trieste, Trieste, 740 pp.

Nimis PL, Martellos S (2017) ITALIC – The Information System on Italian Lichens. Version 5.0. University of Trieste, Dept. of Biology, Trieste. http://dryades.units.it/italic

Nimis PL, Lazzarin G, Gasparo D (1991) Lichens as bioindicators of air pollution by SO_2 in the Veneto Region.

Nimis PL, Tretiach M, De Marchi A (1990) Contributions to lichen floristics in Italy. V. The lichens of the islands of Capraia (Tuscan Archipelago). Cryptogamie, Bryologie, Lichénologie 11: 1–30.

Nimis PL, Hafellner J, Roux C, Clerc P, Mayrhofer H, Martellos S, Bilovitz PO (2018) The lichens of the Alps – an annotated checklist. MycoKeys 31: 1–634. Studia Geobotanica. An international journal 11: 3–76. https://doi.org/10.3897/mycokeys.31.23568

Ozenoglu Kiremit H, Kirmaci M, Kiremit F (2016) New findings of *Riccia* species (Marchantiophyta), in Turkey and Southwest Asia. Cryptogamie, Bryologie 37: 1–8. https://doi.org/10.7872/cryb/v37.iss1.2016.19

Puglisi M, Campisi P, Dia MG, Privitera M (2015a) New or interesting regional bryophyte records for Italian bryoflora. Flora Mediterranea 25 (Special Issue): 193–198. https://doi.org/10.7320/FlMedit25SI.193

Puglisi M, Minissale P, Sciandrello S, Privitera M (2015b) The bryophyte vegetation of the Mediterranean temporary ponds in Italy. Plant Sociology 52: 69–78.

Ravera S (2001) Studia lichenologica in Central Italy. I. Interesting epiphytic species from Lazio (Latium Region). Allionia 38: 187–193.

Ravera S, Giordani P (2008) *Collema italicum* B. de Lesd. Informatore Botanico Italiano 40 suppl. 1: 143–145.

Ravera S, Puglisi M, Vizzini A, Totti C, Aleffi M, Barberis G, Benesperi R, Brackel W, Dagnino D, De Giuseppe AB, Fačkovcová Z, Gheza G, Giordani P, Guttová A, Mair P, Mayrhofer H, Nascimbene J, Nimis PL, Paoli L, Passalacqua NG, Pittao E, Poponessi S, Prosser F, Ottonello M, Puntillo D, Puntillo M, Sicoli G, Sguazzin F, Spitale D, Tratter W, Turcato C, Vallese C (2019) Notulae to the Italian flora of algae, bryophytes, fungi and lichens: 7. Italian Botanist 7: 69–91. https://doi.org/10.3897/italianbotanist.7.34285

Ros RM, Mazimpaka V, Abou-Salama U, Aleffi M, Blockeel TL, Brugués M, Cros RM, Dia MG, Dirkse GM, Draper I, El-Saadawi W, Erdag A, Ganeva A, Gabriel R, Gonzales-Mancebo JM, Granger C, Herrnstadt A, Hugonnot V, Khalil K, Kürschner H, Losada-Lima A, Luís L, Mifsus S, Privitera M, Puglisi M, Sabovlijević, Sèrgio C, Shabbara HM, Sim-Sim M, Sotiaux A, Tacchi R, Vanderpoorten A, Wernner O (2013) Mosses of the Mediterranean, an annotated checklist. Cryptogamie, Bryologie 34: 99–283. https://doi.org/10.7872/cryb.v34.iss2.2013.99

Rossi G, Montagnani C, Gargano D, Peruzzi L, Abeli T, Ravera S, Cogoni A, Fenu G, Magrini S, Gennai M, Foggi B, Wagensommer RP, Venturella G, Blasi C, Raimondo FM, Orsenigo S [Eds] (2013) Lista Rossa della Flora Italiana. 1. Policy Species e altre specie minacciate. Comitato Italiano IUCN e Ministero dell'Ambiente e della Tutela del Territorio e del Mare, 54 pp.

Roux C, Poumarat S, Gueidan C, Navarro-Rosinés P, Monnat J-Y, Houmeau J-M (2019) La Acarosporaceae de Okcidenta Eŭropo. Bulletin de la Société linnéenne de Provence 70: 107–167.

Saccardo PA (1872) Florula spontanea Horti Botanici Patavini. Nuovo Giornale botanico italiano 4: 212–220.

Saitta A, Bernicchia A, Gorjón SP, Altobelli E, Granito VM, Losi C, Lunghini D, Maggi O, Medardi G, Padovan F, Pecoraro L, Vizzini A, Persiani AM (2011) Biodiversity of wood-decay fungi in Italy. Plant Biosystems 145(4): 958–968. https://doi.org/10.1080/11263504.2011.633114

Salem MA, Michail SH (1980) *Inonotus pseudohispidus* on *Populus nigra* in Egypt. Transactions of the British Mycological Society 74: 107–110. https://doi.org/10.1016/S0007-1536(80)80015-5

Scalia G (1915) Rassegna dei casi fitopatologici, studiati nel Laboratorio di Patologia vegetale della Reale Scuola Enologica di Catania nel triennio 1910–1913: relazione del direttore prof. dott. Giuseppe Scalia. Monaco & Mollica, Catania, 40 pp.

Sicoli G, Mannarino D (2017) *Inocutis tamaricis*, ospite "balneare" nel comune di Amantea (CS). Rivista di Micologia 60: 71–78.

Siniscalco C, Bianco PM, Lavorato C, Rotella M, Parrettini GL, Marra E, Floccia F, Campana L (Eds.) (2018) Abbinamento delle componenti micologiche della Calabria ai sistemi di classificazione degli Habitat EUNIS e Natura 2000. Prima correlazione delle specie fungine delle foreste naturali. ISPRA, Manuali e linee guida n. 180/18, 206 pp.

Smith AJE (2004) The moss flora of Britain and Ireland. 2nd edn. Cambridge University Press, Cambridge, 1012 pp. https://doi.org/10.1017/CBO9780511541858

Trotter A (1908) Flora Italica Cryptogama. Pars I: Fungi. Uredinales: 40–41.

Ţura D, Zmitrovich IV, Wasser SP, Nevo E (2010) Checklist of Hymenomycetes (Aphyllophorales s.l.) and Heterobasidiomycetes in Israel. Mycobiology 38: 1–256. https://doi.org/10.4489/MYCO.2010.38.4.256

Von Brackel W (2011) Lichenicolous fungi and lichens from Puglia and Basilicata (southern Italy). Herzogia 24: 65–101. https://doi.org/10.13158/heia.24.1.2011.65

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RESEARCH ARTICLE

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Abstract
In this contribution, new data concerning the distribution of vascular flora alien to Italy are presented. It includes new records, confirmations, exclusions, and status changes for Italy or for Italian administrative regions. Furthermore, three new combinations are proposed. Nomenclatural and distribution updates published elsewhere are provided as Suppl. material 1.

Keywords
Alien species, 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 specimen along with its scan or photograph has to be sent to FI Herbarium: Museo di Storia Naturale (Botanica), Sistema Museale di Ateneo, 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 1,000 characters (spaces included).

Floristic records

***Acacia dealbata* Link subsp. *dealbata* (Fabaceae)**

+ (NAT) **CAL**: San Marco Argentano (Cosenza), fraz. Scalo Ferroviario, nei pressi dello svincolo autostradale (WGS84: 39.621743N, 16.222419E), margine strada, 120 m, 2 January 2020, *L. Peruzzi* (FI). – Naturalized alien subspecies new for the flora of Calabria.

Hundreds of ramets of heterogeneous size form a small dense wood, about 40 m long and 5 m thick, along a road. According to local people, one individual was planted in the area around 30 years ago, when there was not any road crossing this countryside, rich in olive groves and vineyards.

L. Peruzzi

***Aeonium arboreum* (L.) Webb & Berthel. (Crassulaceae)**

+ (CAS) **MOL**: Termoli (Campobasso), parete rocciosa del promontorio sul quale sorge il borgo antico (WGS84: 42.004633N, 14.998402E), parete rocciosa, ca. 5 m, SE, 14 July 2019, *N. Olivieri* (FI). – Casual alien species new for the flora of Molise.

Some individuals belonging to the cultivar Atropurpureum grow on a subvertical portion of a conglomerate calcareous rock wall.

N. Olivieri

Albizia julibrissin **Durazz. (Fabaceae)**

+ (CAS) **BAS**: Pisticci (Matera), Strada Provinciale Pozzitello-San Basilio (WGS84: 40.387222N, 16.572222E), bordo strada, 271 m, 3 November 2019, *C.M. Musarella* (FI, REGGIO); *ibidem* (WGS84: 40.385555N, 16.575553E), bordo strada, 228 m, 3 November 2019, *C.M. Musarella* (REGGIO). – Casual alien species new for the flora of Basilicata.

Several individuals at different growth stages were found along the way, probably born from seeds scattered from plants growing in nearby private areas.

C.M. Musarella

Amaranthus emarginatus **Salzm. ex Uline & W.L.Bray subsp.** ***emarginatus*** **(Amaranthaceae)**

+ (CAS) **MAR**: Ancona (Ancona), lungo Via Cardeto nei pressi della Caserma Villarey (WGS84: 43.62065N, 13.51668E), marciapiede, ca. 50 m, 9 July 2018, *N. Hofmann* (PESA); *ibidem*, lungo Via Volterra nei pressi dei giardini del Passetto (WGS84: 43.61569N, 13.53292E), marciapiede, 40 m, 21 October 2019, *N. Hofmann* (FI). – Casual alien subspecies new for the flora of Marche.

According to Iamonico (2015), the population can be referred to *Amaranthus emarginatus* var. *emarginatus*.

L. Gubellini, N. Hofmann, D. Iamonico

Amaranthus palmeri **S.Watson (Amaranthaceae)**

+ (NAT) **VEN**: Camposampiero (Padova), among the localities Cesere, Zanon and Ferro (WGS84: 45.554528N, 11.951444E), soybean field, 2 August 2018, leg. *A. Milani*, det. *A. Milani*, *D. Iamonico* (FI); Verona (Verona), stazione ferroviaria di Porta Vescovo (WGS84: 45.435721N, 11.016411E), decine di esemplari lungo i binari morti della stazione dei treni, 54 m, no exp., 17 October 2019, *A. Bertolli* (FI, ROV No. 74208). – Naturalized alien species new for the flora of Veneto.

Another population was found in a nearby soybean field (WGS84: 45.575639N, 11.912194E). According to ongoing research on herbicide-resistance (Milani et al. 2018), *A. palmeri* in Veneto is resistant to acetolactate inhibitors, allowing it to self-sustain and spread. At the train station "Verona Porta Vescovo", the population is represented by many fertile plants, which occupy an area of about 50 m in length.

A. Bertolli, D. Iamonico, A. Milani, R.R. Masin

Amaranthus viridis **L. (Amaranthaceae)**

+ (NAT) **LIG**: Pietra Ligure (Savona), Via F. Crispi (WGS84: 44.153079N, 8.285099E), margine stradale, 4 m, no exp., 11 August 2018, leg. *G. Galasso*, det. *G. Galasso, E. Banfi* (MSNM). – Status change from casual to naturalized alien for the flora of Liguria.

G. Galasso, E. Banfi

+ (CAS) **MAR**: Fano (Pesaro e Urbino), fraz. Caminate, lungo la Strada delle Caminate (WGS84: 43.779363N, 13.036444E), margine stradale, 90 m, 25 September 2019, *N. Hofmann* (FI, PESA). – Casual alien species new for the flora of Marche.

A small population of this species grows along a grassy roadside.

L. Gubellini, N. Hofmann

***Broussonetia papyrifera* (L.) Vent. (Moraceae)**

+ (CAS) **CAL**: Melito di Porto Salvo (Reggio Calabria), Via Pilati (WGS84: 37.920426N, 15.802819E), canale di scolo, 9 m, 5 October 2019, leg. *V.L.A. Laface*, det. *V.L.A. Laface, C.M. Musarella, G. Spampinato* (REGGIO); Montebello Jonico (Reggio Calabria), fraz. Saline Joniche, Borgata Sant'Elia (WGS84: 37.931162N, 15.740749E), bordo strada, 19 m, 11 October 2019, *V.L.A. Laface* (FI, REGGIO). – Casual alien species confirmed for the flora of Calabria.

This species was first reported by Pignatti (1982) for Calabria, and then recorded as not confirmed by Bernardo et al. (2009).

C.M. Musarella, V.L.A. Laface, G. Spampinato

***Buxus microphylla* Siebold & Zucc. (Buxaceae)**

+ (CAS) **ITALIA** (**TAA**): Stenico (Trento), fraz. Sclemo, Via della Breda 3 (WGS84: 46.054415N, 10.882023E), margine su terreno smosso, 757 m, SE, 14 March 2018, leg. *M. Merli*, det. *E. Banfi*, *G. Galasso* (FI, MSNM, *Herb. M. Merli*). – Casual alien species new for the flora of Italy (Trentino-Alto Adige).

This species was first described from Japan (Ohba 1999) based on a cultivar possibly corresponding today to the one named 'Faulkner'. In Japan, *B. microphylla* var. *japonica* (Müll.Arg.) Rehder & E.H.Wilson identifies the possible wild relative from which the main cultivated forms are derived.

M. Merli, E. Banfi, G. Galasso

***Canna indica* L. (Cannaceae)**

+ (CAS) **BAS**: Policoro (Matera), Via San Giusto (WGS84: 40.217961N, 16.690133E), canale di scolo, 10 m, 3 November 2019, *C.M. Musarella* (FI, REGGIO). – Casual alien species new for the flora of Basilicata.

This species was found in an area of about 2 m^2 along a water drainage channel.

C.M. Musarella

***Casuarina cunninghamiana* Miq. subsp. *cunninghamiana* (Casuarinaceae)**

+ (CAS) **LIG**: Pietra Ligure (Savona), Stazione FFSS di Pietra Ligure/Largo Veterani dello Sport (WGS84: 44.145790N, 8.277779E), nata spontaneamente da seme di *plantae cultae* poste nelle vicinanze, 6 m, no exp., 3 July 2016, *G. Galasso* (FI); *ibidem*, 28 July 2016, *G. Galasso* (FI, MSNM). – Casual alien subpecies new for the flora of Liguria.

G. Galasso, E. Banfi

Celosia argentea L. (Amaranthaceae)

+ (CAS) **CAL**: San Lucido (Cosenza), nel cimitero (WGS84: 39.308302N, 16.058392E), nelle fessure della pavimentazione, 157 m, 21 September 2019, *N.G. Passalacqua*, *M. Aversa* (FI, CLU). – Casual alien species new for the flora of Calabria.

Several individuals grow in between tiles, probably originating from cultivated plants in the neighborhood.

N.G. Passalacqua, M. Aversa, L. Bernardo

Cenchrus longisetus M.C.Johnst. (Poaceae)

+ (NAT) **LIG**: Sarzana (La Spezia), parcheggio lungo Via Sarzanello (WGS84: 44.105626N, 9.985910E), margine erboso, presenza continua lungo Via Sarzanello da 44.105325N, 9.985314E a 44.106434N, 9.987646E, 38 m, no exp., 28 October 2019, *D. Marchetti* (FI, MSNM). – Status change from casual to naturalized alien for the flora of Liguria.

E. Banfi, D. Marchetti, G. Galasso

Cenchrus longispinus (Hack.) Fernald (Poaceae)

+ (CAS) **LOM**: Milano (Milano), Stazione Milano-Centrale, binari e massicciata ferroviaria a sinistra del binario 1 (WGS84: ca. 45.490013N, 9.207040E), binari ferroviari, 130 m, no exp., 21 September 2018, leg. *G. Galasso*, det. *G. Galasso*, *E. Banfi* (FI, MSNM). – Casual alien species new for the flora of Lombardia.

E. Banfi, G. Galasso, R. Gentili, C. Toffolo

Ceratostigma plumbaginoides Bunge (Plumbaginaceae)

+ (CAS) **TOS**: Pontassieve (Firenze), fraz. Santa Brigida (WGS84: 43.852532N, 11.394439E), su un muro a secco, 400 m, 17 October 2019, *L. Pinzani* (FI, *Herb. L. Pinzani*). – Casual alien species new for the flora of Toscana.

A small population, likely derived from plants grown nearby as ornamentals.

L. Pinzani

Citrullus lanatus (Thunb.) Matsum. & Nakai subsp. *lanatus* (Cucurbitaceae)

+ (CAS) **LIG**: Sarzana (La Spezia), ZSC "IT1345101 Piana della Magra", spiaggia di Marinella di Sarzana (WGS84: 44.046169N, 10.017139E), spiaggia, 2 m, 29 September 2019, *C. Turcato* (FI, GE No. 1422). – Casual alien subspecies new for the flora of Liguria.

This taxon was found in the habitat of community interest Code 2120 “Shifting dunes along the shoreline with *Ammophila arenaria* (white dunes)”.

D. Dagnino, D. Longo, C. Turcato

+ (CAS) **CAL**: Rosarno (Reggio Calabria), Strada Consortile Melicucco “C.N. Eranov” (WGS84: 38.478225N, 15.979856E), bordo strada, 21 m, 13 September 2019, *C.M. Musarella* (FI, REGGIO); Trebisacce (Cosenza), lungo la linea ferroviaria (WGS84: 39.864318N, 16.531330E), ferrovia, 8 m, 27 October 2019, *C.M. Musarella* (REGGIO). – Casual alien subspecies new for the flora of Calabria.

C.M. Musarella

Clerodendrum trichotomum Thunb. (Lamiaceae)

+ (CAS) **CAM**: Pietradefusi (Avellino), SP50 (WGS84: 41.043000N, 14.883660E), fessure del marciapiede, 392 m, 13 October 2019, leg. *C. Villano*, det. *C. Villano*, *C.M. Musarella* (FI, REGGIO). – Casual alien species new for the flora of Campania.

A single individual was observed, probably originating from a nearby adult fruiting plant.

C.M. Musarella, C. Villano

Coix lacryma-jobi L. (Poaceae)

+ (CAS) **CAL**: Gerocarne (Vibo Valentia), fraz. Ariola (38.579422N, 16.261365E), incolto, 4 November 2015, *G. Spampinato* (FI); San Demetrio Corone (Cosenza), C.da Calamia (39.547517N, 16.372544E), giardino incolto, 5 November 2015, leg. *M. Zaretta*, det. *V.L.A. Laface*, *C.M. Musarella*, *G. Spampinato* (REGGIO). – Casual alien species new for the flora of Calabria.

C.M. Musarella, V.L.A. Laface, G. Spampinato

Cucurbita moschata Duchesne (Cucurbitaceae)

+ (CAS) **LIG**: Pietra Ligure (Savona), Torrente Scarincio (WGS84: 44.160524N, 8.278689E), greto ghiaioso, 10 m, no exp., 11 August 2018, leg. *G. Galasso*, det. *G. Galasso*, *E. Banfi* (FI). – Casual alien species new for the flora of Liguria.

In Pietra Ligure and neighboring territories, the cultivar Trombetta di Albenga is very common.

G. Galasso, E. Banfi

Cylindropuntia spinosior (Engelm.) F.M.Knuth (Cactaceae)

+ (CAS) **MAR**: Serra San Quirico (Ancona), presso le mura della città medievale (WGS84: 43.445366N, 13.017760E), pratello arido, 245 m, 5 August 2019, *G. Mei* (FI, ANC, *Herb. G. Mei*). – Casual alien species new for the flora of Marche.

We observed numerous individuals of different ages originating from seeds and rooting cladodes fallen to the ground. If confirmed in the coming years, this condition could allow the naturalization of the species.

G. Mei, A. Stinca, A. Ilari

Cyperus glomeratus L. (Cyperaceae)

+ (NAT) **LIG**. – Status change from casual to naturalized alien for the flora of Liguria.

In the past, this species was observed in the Trebbia (province of Genova) and Nervia (province of Imperia) valleys, according to the Ottone Penzig's handwritten notes found on a copy of De Notaris (1844). We found numerous small populations in gravelly and muddy banks of the Magra and Vara rivers (province of La Spezia), in the Special Area of Conservation "IT1343502 Parco della Magra-Vara".

D. Dagnino, M.G. Mariotti, C. Turcato

Dichondra micrantha Urb. (Convolvulaceae)

+ (NAT) **SAR**. – Status change from casual to naturalized alien for the flora of Sardegna.

Recently, this species has started a slow colonization in Sardegna, mainly in urban environments of Cagliari. Moreover, since 2018, it has been observed naturalized in the countryside of Oristano, in wet meadows of abandoned quarries.

G. Bacchetta, M. Fois, A. Lallai, L. Podda

Digitaria ciliaris (Retz.) Koeler (Poaceae)

+ (CAS) **SIC**: Giardini Naxos (Messina) (WGS84: 37.840427N, 15.276211E), lungo un corso d'acqua perenne, ca. 14 m, 22 September 2019, *G. Tavilla*, *S. Cambria*, *S. Sciandrello* (FI, CAT). – Casual alien species confirmed for the flora of Sicilia.

According to Galasso et al. (2018), *Digitaria ciliaris* does not occur in Sicilia, even though it was already reported by Wilhalm (2009).

G. Tavilla, S. Cambria, S. Sciandrello

Dimorphotheca ecklonis DC. (Asteraceae)

+ (CAS) **PUG**: Otranto (Lecce), muro presso la stazione ferroviaria (WGS84: 40.149166N, 18.481388E), muro in cemento e pietra calcarea, ca. 20 m, S, 21 August 2019, *N. Olivieri* (FI). – Casual alien species new for the flora of Puglia.

Some individuals of the species developed on an old sloping concrete and limestone wall, along with *Parietaria judaica* L.

N. Olivieri

Euphorbia marginata Pursh (Euphorbiaceae)

+ (CAS) **CAL**: Guardia Piemontese (Cosenza), fraz. Guardia Piemontese Marina (WGS84: 39.280614N, 15.584257E), fessure e margine di marciapiedi con accumulo di suolo e detriti, 30 m, 29 November 2019, *S. Fascetti, L. Rosati* (FI, HLUC). – Casual alien species new for the flora of Calabria.

S. Fascetti, L. Rosati

Fagopyrum esculentum Moench (Polygonaceae)

+ (CAS) **LIG**: Pietra Ligure (Savona), Torrente Maremola, presso la foce, subito a monte di Corso Italia (WGS84: 44.150564N, 8.286511E), greto, 1 m, no exp., 11 August 2018, *G. Galasso* (FI, MSNM). – Casual alien species confirmed for the flora of Liguria.

The presence of this species can be explained by the random dispersal of seeds, since they are frequently sold in food markets.

G. Galasso, E. Banfi

Ficus benjamina L. (Moraceae)

– **ITALIA** (**SAR**). – Alien species to be excluded from the flora of Italy (Sardegna).

An incomplete verification of literature sources generated mistaken reports of this cultivated species as casual alien in Sardegna. We argue that the record by Camarda et al. (2016) is due to a transcription mistake in the database supporting this work.

G. Bacchetta, G. Brundu, A. Lallai, L. Podda

Ficus elastica Roxb. ex Hornem. (Moraceae)

– **SAR**. – Alien species to be excluded from the flora of Sardegna.

This species was first reported for the island of La Maddalena (Sassari) by Bocchieri (1996). Later, it was indicated by several authors as a casual alien (Camarda et al. 2004; Bacchetta et al. 2009; Podda et al. 2012; Puddu et al. 2016). This is a misidentification with *Ficus macrophylla* Pers. subsp. *columnaris* (C.Moore) P.S.Green, only cultivated as ornamental.

G. Bacchetta, G. Brundu, A. Lallai, L. Podda

Ficus microcarpa L.f. (Moraceae)

+ (NAT) **SAR**. – Status change from casual to naturalized alien for the flora of Sardegna.

This species was introduced in the Botanical Gardens of Cagliari during the second half of the 19th century, and then cultivated as ornamental (Vannelli 1986). In recent years, many seedlings and saplings have been observed in different parts of Cagliari, often close to the parental trees (Puddu et al. 2016). We found propagules in fallow land, roadsides, and ruderal sites, growing as a lithophyte on walls and cliffs, and even as an epiphyte on *Phoenix canariensis* H.Wildpret and *Jacaranda mimosifolia* D.Don. In Sardinian botanical literature, *Ficus microcarpa* has been reported under some incorrect names (Gennari 1874; Cavara 1901; Chiappini 1967, 1985; Vannelli 1986; Podda et al. 2012), such as *F. retusa* L. or *F. benjamina* L.

G. Bacchetta, G. Brundu, A. Lallai, L. Podda

***Ficus retusa* L. (Moraceae)**

– **ITALIA** (**SAR**). – Alien species to be excluded from the flora of Italy (Sardegna).

The first report of *Ficus retusa* as a casual alien was by Podda et al. (2012). However, this record is due to a confusion with *F. microcarpa* L.f., the only naturalized *Ficus* in Sardegna.

G. Bacchetta, G. Brundu, A. Lallai, L. Podda

***Froelichia gracilis* (Hook.) Moq. (Amaranthaceae)**

+ (NAT) **ITALIA** (**PIE**): Trecate (Novara), Via Vigevano, all'esterno della raffineria SARPOM (WGS84: 45.26147N, 8.47086E), piazzale asfaltato a bordo strada, 131 m, 10 July 2019, leg. *S. Assini*, *F. Bracco*, *G. Gheza*, det. *N.M.G. Ardenghi* (FI); *ibidem*, 25 July 2019, leg. *S. Assini*, det. *N.M.G. Ardenghi* (FI). – Naturalized alien species new for the flora of Italy (Piemonte).

The Central American *Froelichia gracilis* has been recorded as an alien in eastern United States, Japan, Australia, and Hungary (Harden 2001; McCauley 2003, 2004; Balogh et al. 2004). The plants recorded for Italy were identified according to McCauley (2003, 2004) and Merkingler et al. (2014). They grow in cracks of the asphalt in two unloading sites close to a refinery where they form a dense, almost monospecific, vegetation.

S. Assini, F. Bracco, G. Gheza, N.M.G. Ardenghi

***Galinsoga parviflora* Cav. (Asteraceae)**

+ (INV) **SIC**. – Status change from naturalized to invasive alien for the flora of Sicilia.

Recent investigations on the urban flora of Palermo (Domina et al. 2019) revealed that this species grows abundantly in all anthropized sites of the city, such as flowerbeds and interstices.

F. Scafidi, E. Di Gristina

***Hedera algeriensis* Hibberd (Araliaceae)**

+ (NAT) **LIG**: Framura (La Spezia), ZSC "IT1343419 Monte Serro", loc. Fornaci (WGS84: 44.21469N, 9.52060E), sottobosco di lecceta, 14 m, 2 August 2019, *D. Dagnino*, *C. Turcato* (FI, GE No. 873). – Naturalized alien species new for the flora of Liguria.

We observed a small population of this species in the undergrowth of a holm oak wood (habitat of community interest Code 9340 "*Quercus ilex* and *Quercus rotundifolia* forests").

D. Dagnino, L. Minuto, C. Turcato

+ (CAS) **CAL**: Oriolo (Cosenza), sulle mura del centro storico presso Vico I San Giacomo (WGS84: 40.050482N, 16.450353E), muro in pietra, sfuggita a coltura, 400 m, 1 January 2020, *F. Roma-Marzio*, *P. Liguori* (FI). – Casual alien species new for the flora of Calabria.

Several plants originated from a nearby potted plant were found in the cavity of a wall.

F. Roma-Marzio

***Heuchera sanguinea* Engelm. (Saxifragaceae)**

+ (CAS) **ABR**: Campotosto (L'Aquila), fraz. Ortolano, SS80 del Gran Sasso (WGS84: 42.519680N, 13.424938E), muro sul bordo della strada, ca. 1020 m, 23 June 2019, *N. Olivieri* (FI). – Casual alien species new for the flora of Abruzzo.

Some individuals, probably originated from seeds produced by plants once cultivated as ornamentals nearby, have settled on a wall made of cement and limestone blocks.

N. Olivieri

***Hordeum vulgare* L. subsp. *vulgare* (Poaceae)**

+ (CAS) **LIG**: Serra Riccò (Genova), ZSC "IT1330893 Rio Ciaè", Valle del Rio Ciaè, pendici SE del Monte Pizzo, lungo la SP3 (WGS84: 44.50302N, 8.96627E), scarpata erbosa a bordo strada, 385 m, 13 October 2019, *G. Barberis*, *D. Dagnino*, *D. Longo*, *S. Peccenini* (FI, GE No. 1496). – Casual alien subspecies new for the flora of Liguria.

D. Dagnino, D. Longo

***Lamium galeobdolon* (L.) L. subsp. *argentatum* (Smejkal) J.Duvign. (Lamiaceae)**

+ (NAT) **VDA**: Aosta (Aosta), sentiero sotto il parcheggio lungo la Strada Regionale Roisan (WGS84: 45.754196N, 7.326396E), sottobosco di latifoglie, 696 m, W, 9 July 2017, leg. *G. Galasso*, det. *G. Galasso*, *E. Banfi* (FI, MSNM). – Naturalized alien subspecies new for the flora of Valle d'Aosta.

G. Galasso, E. Banfi

+ (CAS) **TOS**: Massa (Massa-Carrara), Via Capannelle, tra i Prati della Ciocca e Altagnana (WGS84: 44.052663N, 10,170231E), margine della strada che attraversa un castagneto, su scisti silicei, 260 m, 14 April 2003, *D. Marchetti* (FI, ROV No. 45056). – Casual alien subspecies new for the flora of Toscana.

D. Marchetti, F. Prosser

***Lantana camara* L. subsp. *aculeata* (L.) R.W.Sanders (Verbenaceae)**

+ (CAS) **LAZ**: Roma (Roma), area incolta situata presso la Via Tiburtina (WGS84: 41.908333N, 12.526150E), incolto, ca. 23 m, 25 July 2019, *N. Olivieri* (FI). – Casual alien subspecies new for the flora of Lazio.

Lantana camara is generically reported by Celesti-Grapow et al. (2013) and Galasso et al. (2018) for Lazio, without reference to the subspecies. Some fruiting individuals grow in an uncultivated degraded area.

N. Olivieri

***Lemna minuta* Kunth (Araceae)**

+ (INV) **BAS**: Bernalda (Matera), in un canale artificiale lungo Via Dompablo (WGS84: 40.379124N, 16.843067E), in acque a lento scorrimento, 0 m, 4 October 2019, *S. Ceschin*, *F. Mariani* (FI); *ibidem*, loc. Santa Palagina (WGS84: 40.374560N, 16.838382E), in acque a lento scorrimento, 0 m, 4 October 2019, *S. Ceschin*, *F. Mariani* (URT). – Invasive alien species new for the flora of Basilicata.

This species occurs in dense monospecific and multilayered free-floating mats of about one-cm thickness, suggesting an invasive behaviour.

S. Ceschin, F. Mariani

***Mazus pumilus* (Burm.f.) Steenis (Mazaceae)**

+ (NAT) **LOM**: Cremona (Cremona), Via Mercatello, di fronte al numero civico 27 e altrove nella via (WGS84: 45.134603N, 10.026109E), fessure della pavimentazione stradale (cubetti di porfido), 40 m, 19 May 2019, *A. Selvaggi* (MSNM). – Status change from casual to naturalized alien for the flora of Lombardia.

This new record combined with the presence and persistence also in other parts of the town leads us to consider this species as naturalized in Lombardia.

A. Selvaggi, F. Bonali

***Ocimum basilicum* L. (Lamiaceae)**

+ (CAS) **EMR**: Fontevivo (Parma), fraz. Ponte Taro, Fiume Taro (WGS84: 44.827128N, 10.225855E), greto fluviale, 55 m, 15 October 2019, *M. Adorni* (FI). – Casual alien species new for the flora of Emilia-Romagna.

A single flowering and fruiting individual was found in the gravel bed of the river Taro, probably born from seeds transported by water.

M. Adorni

***Oenothera lindheimeri* (Engelm. & A.Gray) W.L.Wagner & Hoch (Onagraceae)**

+ (CAS) **SAR**: Carbonia (Sud Sardegna), lungo la ciclabile a N di Via Lubiana (WGS84: 39.92800N, 8.30216E), incolti aridi, 70 m, 31 July 2019, *G. Calvia* (*Herb. G. Calvia*);

Sassari (Sassari), loc. Predda Niedda (WGS84: 40.737891N, 8.528253E), margine stradale ruderale, 153 m, 14 August 2019, *G. Brundu*, *V. Lozano* (FI, *Herb. UniSS Agraria*); Donori (Sud Sardegna), lungo la SP11 (WGS84: 39.2670N, 9.0822E), margine stradale, 150 m, 12 January 2020, *A. Lallai* (CAG). – Casual alien species new for the flora of Sardegna.

In Sardegna, this species is locally escaped in fallow land roadsides close to cultivation sites, as observed also in Florinas (Sassari) (WGS84: 40.651485N, 8.667238E, 350 m, 14 August 2019, *G. Brundu*).

G. Brundu, G. Calvia, A. Lallai, V. Lozano

Panicum barbipulvinatum Nash (Poaceae)

+ (INV) **FVG**: Venzone (Udine), Via A. Bidernuccio (WGS84: 46.3365N, 13.0891E), in the cracks of pavements, accompanied by *Eragrostis frankii*, 250 m, 6 October 2019, *G. Király*, *A. Király* (FI, BP); *ibidem*, 1.1 km SW of Pioverno on the left bank of river Tagliamento (WGS84: 46.3288N, 13.1219E), dry semi-ruderal grasslands, along with *Digitaria sanguinalis*, *Gypsophila repens*, *Sporobolus* spp., 234 m, 6 October 2019, *G. Király*, *A. Király* (FI, BP); Bordano (Udine), 0.2 km N of the village along the road Via Bordano (WGS: 46.3175N, 13.1122E), ruderal vegetation, along with *Artemisia verlotiorum*, *Panicum capillare*, *Oenothera* spp., 233 m, 6 October 2019, *G. Király, A. Király* (FI, BP). – Invasive alien species new for the flora of Friuli Venezia Giulia.

Panicum barbipulvinatum is a taxonomically critical species (Amarell et al. 2014; Király and Alegro 2015) that is quite common in the surroundings of Venzone, especially the Tagliamento valley. It was seen along several mountain roads of the area as well.

G. Király, A. Király

Panicum virgatum L. (Poaceae)

+ (CAS) **TOS**: Aulla (Massa-Carrara), stazione ferroviaria di Aulla, presso Via R. Accorsi (WGS84: 44.219659N, 9.978081E), incolto, 78 m, no exp., 16 October 2018, leg. *D. Marchetti*, det. *E. Banfi* (FI); *ibidem*, 17 September 2019, leg. *D. Marchetti*, det. *E. Banfi* (MSNM). – Casual alien species new for the flora of Toscana.

E. Banfi, D. Marchetti, G. Galasso

Passiflora morifolia Mast. (Passifloraceae)

+ (NAT) **ITALIA** (**SAR**): Assemini (Cagliari), fraz. Su Carroppu (WGS84: 39.298837N, 8.986744E), lungo le siepi e nei frutteti, 7 m, 23 October 2019, *G. Bacchetta*, *L. Onnis*, *L. Podda*, *M. Sarigu* (FI, CAG). – Naturalized alien species new for the flora of Italy (Sardegna).

The South American *Passiflora morifolia* (Miller 1997; Imig et al. 2018) has been recently introduced into Europe, mainly for ornamental purposes, similarly to other species of the genus *Passiflora*. In Assemini, its presence has been observed since 2006, close to the regional nursery "Is Bagantinus". Since then, this species has spread as far as about 2 km from there, colonizing orchards, walls, ruderal places, and fallow land.

G. Bacchetta, L. Onnis, L. Podda, M. Sarigu

Persicaria capitata (Buch.-Ham. ex D.Don.) H.Gross (Polygonaceae)

+ (CAS) **SAR**: Nuoro (Nuoro) (WGS84: 40.320602N, 9.336254E), bordi stradali, nelle fessure dei marciapiedi, 546 m, 13 September 2019, leg. *M. Manca*, det. *M. Manca*, *G. Brundu* (FI, *Herb. FoReSTAS Orgosolo*). – Casual alien species new for the flora of Sardegna.

M. Manca, G. Brundu

Phyllostachys aurea Carrière ex Rivière & C.Rivière (Poaceae)

+ (CAS) **PUG**: Galatina (Lecce), fraz. Collemeto, SS101 Salentina di Gallipoli (WGS84: 40.214713N, 18.099997E), bordo strada, 48 m, 25 August 2019, *C.M. Musarella* (FI, REGGIO). – Casual alien species new for the flora of Puglia.

Several individuals of the species were observed, probably escaped from a nearby garden.

C.M. Musarella

Platanus hispanica Mill. ex Münchh. (Platanaceae)

+ (NAT) **LIG**: Genova (Genova), quartiere Marassi, Torrente Bisagno, poco a monte dello stadio Luigi Ferraris (WGS84: 44.418133N, 8.948721E), greto del torrente, 16 m, 16 May 2019, *C. Turcato* (FI, GE No. 797); *ibidem*, 29 July 2019, *D. Dagnino*, *C.N. Macrì* (FI, GE No. 798); *ibidem*, quartiere Bolzaneto, Torrente Polcevera, presso Ponte Luigi Ratto (WGS84: 44.464201N, 8.898426E), greto, 46 m, 1 August 2019, *D. Dagnino* (FI, GE No. 568). – Naturalized alien species new for the flora of Liguria.

Both populations are large, showing well established individuals of several age classes, and possibly originated from old individuals of the nearby tree-lined avenues.

D. Dagnino, C. Turcato, D. Longo, L. Minuto

Platycladus orientalis (L.) Franco (Cupressaceae)

+ (CAS) **TOS**: Altopascio (Lucca), stazione ferroviaria, lungo i binari (WGS84: 43.817002N, 10.672046E), massicciata ferroviaria, 14 m, 23 October 2018, *M. Mugnai*, *L. Lazzaro*, *G. Ferretti* (FI). – Casual alien species new for the flora of Toscana.

Young individuals of *Platycladus orientalis* may present a notable leaf dimorphism in their juvenile leaves (Dörken 2013), possibly leading to misidentification as *Calocedrus decurrens* (Torr.) Florin.

M. Mugnai, L. Lazzaro, G. Ferretti

Pleuropterus multiflorus (Thunb.) Nakai (Polygonaceae)

+ (INV) **TOS**: Siena (Siena), Porta Tufi (WGS84: 43.313989N, 11.331430E), margine stradale, 340 m, 11 October 2017, leg. et det. *P. Castagnini*, *F. Serafino*, conf. *G. Galasso* 8 March 2019 (FI). – Invasive alien species new for the flora of Toscana.

G. Bonari, I. Bonini, P. Castagnini

+ (CAS) **MAR**: Ancona (Ancona), giardini del Passetto (WGS84: 43.615943N, 13.533277E), siepi, 40 m, 6 November 2019, *L. Gubellini*, *N. Hofmann* (FI, PESA). – Casual alien species new for the flora of Marche.

L. Gubellini, N. Hofmann

Pseudosasa japonica (Siebold & Zucc. ex Steud.) Makino ex Nakai (Poaceae)

+ (CAS) **TOS**: Siena (Siena), podere La Vigna, lungo il Fosso Ravacciano (WGS84: 43.3205681N, 11.3400000 E), margine di fosso, 250 m, 17 June 2019, leg. *M. Apruzzese*, det. *L. Pinzani* (FI, *Herb. L. Pinzani*). – Casual alien species new for the flora of Toscana.

The species grows in the city centre of Siena, along a river that crosses a relic forest (Bosco di Busseto), forming a dense population. Another small population has been observed nearby (Siena, Fonte di Follonica, WGS84: 43.3205117N, 11.3353871E, 285 m).

L. Pinzani, M. Apruzzese, C. Angiolini

Raphanus raphanistrum L. subsp. _sativus_ (L.) Schmalh. (Brassicaceae)

+ (CAS) **LIG**: Serra Riccò (Genova), ZSC "IT1330893 Rio Ciaè", Valle del Rio Ciaè, pendici SE del Monte Pizzo, lungo la SP3 (WGS84: 44.50468N, 8.96785E), bordo strada, al margine di ostrieto, 400 m, 13 October 2019, *G. Barberis*, *D. Dagnino*, *D. Longo*, *S. Peccenini* (FI, GE No. 1008). – Casual alien subspecies new for the flora of Liguria.

G. Barberis, D. Dagnino, D. Longo, S. Peccenini

Rhus coriaria L. (Anacardiaceae)

+ (CAS) **CAL**: Reggio Calabria (Reggio Calabria), fraz. Pellaro, SS106 Jonica (WGS84: 38.034271N, 15.658410E), scarpata stradale, 15 m, 9 August 2019, *C.M. Musarella* (REGGIO); *ibidem*, Via Eremo Pietrastorta (WGS84: 38.113496N, 15.673585E), bordo strada, giardino abbandonato, 537 m, 28 September 2019, *V.L.A. Laface* (REGGIO); *ibidem*, Cittadella Universitaria (WGS84: 38.121697N, 15.662514E), scarpata bordo strada, 72 m, 10 January 2020, leg. *V.L.A. Laface*, det. *V.L.A. Laface, C.M. Musarella*, *G. Spampinato* (REGGIO); Sant'Alessio in Aspromonte (Reggio Calabria), SS184 Gallico-Gambarie (WGS84: 38.170131N, 15.768870E), bordo strada, 537 m, 28 September 2019, *V.L.A. Laface* (FI, REGGIO). – Casual alien species confirmed for the flora of Calabria.

C.M. Musarella, V.L.A. Laface, G. Spampinato

Salvia abrotanoides (Kar.) Sytsma × _S. yangii_ B.T.Drew (Lamiaceae)

+ (CAS) **LAZ**: Bracciano (Roma), fraz. Vigna di Valle, presso l'Aeroporto di Vigna di Valle, di fronte all'hangar "Tricampate", sul Lago di Bracciano (WGS84: 42.084687N, 12.221944E), riva lacustre, su suolo sabbioso, 162 m, 19 September 2019, *S. Buono* (FI). – Casual alien nothospecies new for the flora of Lazio.

A single mature individual grows on sandy soil near the coasts of Lake Bracciano, along with other alien species such as *Amorpha fruticosa* L., *Datura stramonium* L., and *Xanthium italicum* Moretti.

S. Buono, S. Magrini

Salvia hispanica L. (Lamiaceae)

+ (CAS) **VEN**: San Martino Buon Albergo (Verona), sponda dx del Fiume Adige, subito a W di San Procolo, presso Zevio (WGS84: 45.3799085N, 11.1055010E), sponda sabbiosa, 3 esemplari, 30 m, 23 October 2015, leg. *F. Prosser*, *A. Bertolli*, *G. Tomasi*, *S. Andreatta*, det. *F. Prosser* (ROV No. 69728); Verona (Verona), sponda sx del Fiume Adige, 250 m a W del Ponte di San Pancrazio (WGS84: 45.4274692N, 11.0185053E), greto sassoso, 2 esemplari, 50 m, 11 November 2015, leg. *F. Prosser*, *A. Bertolli*, *S. Andreatta*, *G. Tomasi*, det. *F. Prosser* (ROV No. 69916); *ibidem*, ENE di Corte Garofalo, sull'isola presso la sponda dx del Fiume Adige (WGS84: 45.4060915N, 11.0282974E), greto sassoso, 3 esemplari, 44 m, 11 November 2015, leg. *F. Prosser*, *A. Bertolli*, *S. Andreatta*, *G. Tomasi*, det. *F. Prosser* (FI, ROV No. 71302). – Casual alien species new for the flora of Veneto.

Further data for the province of Verona are: river Adige, north of Perzacco (16 November 2015, 2 individuals); the creek known as Illasi, between Tregnago and Illasi (3 October 2019, 100 scattered individuals); Progno (creek) di Valpantena, between Grezzana and Quinto (17 October 2019, a dozen scattered individuals); Verona, river Adige, just downstream of the railway bridge (25 October 2019, one individual). All observations refer to sterile or budding plants. Along the Illasi creek, the plants reached full bloom in early November 2019, so that reproduction is possible.

F. Prosser, A. Bertolli, G. Tomasi, F. Menini

Sedum praealtum A.DC. (Crassulaceae)

+ (CAS) **MOL**: Termoli (Campobasso), versante orientale del promontorio sul quale sorge il borgo antico (WGS84: 42.004633N, 14.998402E), parete rocciosa assolata di natura conglomeratica, ca. 5 m, 14 July 2019, *N. Olivieri* (FI). – Casual alien species new for the flora of Molise.

N. Olivieri

***Setaria pumila* (Poir.) Roem. & Schult. subsp. *pallide-fusca* (Schumach.) B.K.Simon (Poaceae)**

+ (CAS) **ITALIA** (**TOS**): Aulla (Massa-Carrara), stazione ferroviaria di Aulla, presso Via R. Accorsi (WGS84: 44.219469N, 9.978091E), incolto, 78 m, no exp., 16 October 2018, leg. *D. Marchetti*, det. *E. Banfi* (FI, MSNM). – Casual alien subspecies new for the flora of Italy (Toscana).

This subspecies can be easily distinguished from the autonym by the smaller spikelets (2.0–2.5 mm) and the copper-reddish bristles (Rominger 2003). Some authors (e.g., Morrone et al. 2014) consider it as a synonym of *S. pumila*.

E. Banfi, D. Marchetti, G. Galasso

***Sporobolus indicus* (L.) R.Br. (Poaceae)**

+ (NAT) **UMB**: Magione (Perugia), fraz. San Feliciano, sul lungolago (WGS84: 43.117928N, 12.165532E), aiuola, 279 m, 29 September 2019, *N. Hofmann* (FI, PESA). – Naturalized alien species new for the flora of Umbria.

L. Gubellini, N. Hofmann

***Stachys byzantina* K.Koch (Lamiaceae)**

+ (CAS) **LIG**: Sant'Olcese (Genova), loc. Tullo, ZSC "IT1330893 Rio Ciaè", presso una carrareccia (WGS84: 44.493684N, 8.982430E), margine di prati aridi, 453 m, 8 July 2019, *A. Di Turi* (FI, GDOR, GE). – Casual alien species new for the flora of Liguria.

A cluster of well-developed individuals was found close to a cart track, next to arid grasslands.

A. Di Turi

***Thinopyrum obtusiflorum* (DC.) Banfi (Poaceae)**

+ (NAT) **TOS**: Aulla (Massa-Carrara), stazione ferroviaria di Aulla, presso Via R. Accorsi (WGS84: 44.219379N, 9.977977E), incolto, numerosi individui fino a 44.218973N, 9.977592E, 78 m, no exp., 16 October 2018, leg. *D. Marchetti*, det. *E. Banfi* (FI); *ibidem*, 17 September 2019, leg. *D. Marchetti*, det. *E. Banfi* (MSNM). – Naturalized alien species new for the flora of Toscana.

E. Banfi, D. Marchetti, G. Galasso

***Thuja plicata* Donn ex D.Don (Cupressaceae)**

+ (CAS) **ITALIA** (**PIE**): Meugliano (Torino), Lago di Meugliano, nei pressi della strada sterrata che percorre il crinale a S del lago (WGS84: 45.475116N, 7.790035E), boschi misti di latifoglie, 745 m, 8 May 2019, *M. Lonati*, *M. Pittarello*, *S. Ravetto Enri* (FI). – Casual alien species new for the flora of Italy (Piemonte).

This species was identified according to Chambers (1993), Schulz et al. (2005), and Tison and de Foucault (2014). It was introduced in the surroundings of Lake Meugliano in the 1930s for reforestation purposes. Offspring of this species is abundant near seed-bearing plants; some young individuals have also been found *ca*. 200 m away as the crow flies.

M. Lonati, M. Pittarello, S. Ravetto Enri

Tradescantia pallida (Rose) D.R.Hunt (Commelinaceae)

+ (CAS) **MOL**: Termoli (Campobasso), lungo Viale d'Italia (WGS84: 41.999713N, 14.990261E), bordo di chiusino per la raccolta delle acque piovane, ca. 35 m, 14 July 2019, *N. Olivieri* (FI). – Casual alien species new for the flora of Molise.

The observed individuals probably originated from fragments of plants cultivated as ornamentals in nearby houses.

N. Olivieri

Tradescantia virginiana L. (Commelinaceae)

+ (CAS) **FVG**: Paluzza (Udine), Via Nazionale (WSG84: 46.527719N, 13.013224E), prato incolto nei pressi del margine stradale, 605 m, 15 July 2019, *J. Lupoletti*, *A. Pica* (FI). – Casual alien species new for the flora of Friuli Venezia Giulia.

A small population occupying an area of approximately 5 m^2 was observed.

J. Lupoletti, A. Pica

Ulmus pumila L. (Ulmaceae)

+ (NAT) **LIG**: Vado Ligure (Savona), Via Trieste, in prossimità dei cantieri navali (WGS84: 44.267120N, 8.439779E), incolto, 4 m, 13 July 2019, *M. Lonati*, *A. Mainetti*, *S. Ravetto Enri* (FI); *ibidem*, Via Leon Pancaldo 158 (WGS84: 44.271611N, 8.438521E), aiuole prospicenti al lungomare, 10 m, 13 July 2019, *M. Lonati*, *A. Mainetti*, *S. Ravetto Enri* (FI). – Naturalized alien species new for the flora of Liguria.

This species has widely colonized uncultivated and abandoned areas and roadsides. Some individuals have reached big dimensions (6–7 m high) and are already fructifying. The documented risk of hybridization with the native *Ulmus* species (Cogolludo-Augustin et al. 2000; Brunet et al. 2013) suggests monitoring its spread in the region.

M. Lonati, A. Mainetti, S. Ravetto Enri

Verbena bonariensis L. (Verbenaceae)

+ (CAS) **VEN**: Legnaro (Padova), sul margine stradale di Via Orsaretto (WSG84: 45.343510N, 11.954306E), margine di campo coltivato a monocoltura di *Glycine max*, 10 m, 3 July 2019, *J. Lupoletti*, *A. Pica* (FI). – Casual alien species new for the flora of Veneto.

We found a single plant at the border of a soybean field.

J. Lupoletti, A. Pica

Washingtonia filifera (Linden ex André) H.Wendl. ex de Bary (Arecaceae)

+ (CAS) **LAZ**: Roma (Roma), nel giardino pubblico di Villa Lazzaroni (WGS84: 41.521909N, 12.312398E), aiuola, 46 m, 7 August 2019, *G. Buccomino* (FI). – Casual alien species new for the flora of Lazio.

In the site, there are three cultivated palms, two of which produce a large amount of seeds; some young seedlings were observed at their base.

G. Buccomino

Wisteria sinensis (Sims) DC. (Fabaceae)

+ (CAS) **PUG**: Arnesano (Lecce), SP119 (WGS84: 40.331384N, 18.090544E), bordo strada, 30 m, 24 August 2019, *C.M. Musarella* (FI, REGGIO). – Casual alien species new for the flora of Puglia.

Some young individuals were also found, maybe arisen *via* vegetative propagation.

C.M. Musarella

Nomenclatural novelties

Cenchrus americanus (L.) Morrone subsp. *chudeaui* (Maire & Trab.) Banfi & Galasso, comb. et stat. nov.

urn:lsid:ipni.org:names:77209604-1

Pennisetum chudeaui Maire & Trab., Bull. Mus. Natl. Hist. Nat. s. 2, 3(6): 523. 1931 [25 June 1931]

Recently Sosef (2019) published the new combination in *Cenchrus* L. for *Pennisetum chudeaui* Maire & Trab. subsp. *monodii* Maire, the progenitor of pearl millet, *Cenchrus americanus* (L.) Morrone subsp. *americanus* (Burgarella et al. 2018). However, the correct epithet at subspecific rank is '*chudeaui*' since '*monodii*', described simultaneously to the species (Maire 1931), is now considered a heterotypic synonym. Consequently, a new combination is required due to the priority of the autonym (Art. 11.6 of the ICN: Turland et al. 2018) that Maire automatically established when describing its subspecies (Art. 26.3 of the ICN).

E. Banfi, G. Galasso

***Cucumis sativus* L. subsp. *hardwickii* (Royle) Banfi & Galasso, comb. et stat. nov.**
urn:lsid:ipni.org:names:77209607-1

Cucumis hardwickii Royle, Ill. Bot. Himal. Mts. [Royle] 7: 220 (218, 219, pl. 47 fig. 3). 1835 [24 August 1835]

Molecular analyses (Sebastian et al. 2010; Qi et al. 2013; Liu et al. 2015) confirmed the exclusive role of the Indian wild cucumber *Cucumis hardwickii* in the genesis of the cultivated cucumber *C. sativus* (de Wilde and Duyfjes 2008). Regarding taxonomy, we have already emphasized (Galasso et al. 2018) that the rank of subspecies is preferable when distinguishing between a crop and its wild ancestor whenever domestication has proceeded linearly from the second to the first without any external genetic contribution.

E. Banfi, G. Galasso

***Rhaphiolepis bibas* (Lour.) Galasso & Banfi, comb. nov.**
urn:lsid:ipni.org:names:77209608-1

Crataegus bibas Lour., Fl. Cochinch. 1: 319. 1790 [September 1790]
Pyrus bibas (Lour.) M.F.Fay & Christenh., Global Fl. 4: 98. 2018 [9 February 2018]

Based on molecular, morphological, and geographic evidences, Liu et al. (2020) merged *Eriobotrya* Lindl. within *Rhaphiolepis* Lindl. For the loquat, *Eriobotrya japonica* (Thunb.) Lindl., the authors chose the replacement name *Rhaphiolepis loquata* B.B.Liu & J.Wen, because the epithet '*japonica*' was unavailable in *Rhaphiolepis* due to *Rhaphiolepi japonica* Siebold & Zucc. However, the new epithet is superfluous, although not illegitimate, in comparison with *Crataegus bibas*, also reported by the above-cited authors in synonymy, which holds priority at species level (Art. 11.4 of the ICN).

G. Galasso, E. Banfi

Nomenclatural and distribution updates from other literature sources

Nomenclatural, status, distribution updates, and corrections to Galasso et al. (2018) are provided in Suppl. material 1.

G. Galasso, F. Bartolucci

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References

Amarell U, Hoffer-Massard F, Röthlisberger J (2014) *Panicum barbipulvinatum* Nash (=*Panicum riparium* H. Scholz) – Eine übersehene Art in der Schweiz. Bauhinia 25: 59–68.

Bacchetta G, Mayoral O, Podda L (2009) Catálogo de la flora exótica de la isla de Cerdeña (Italia). Flora Montiberica 41: 35–61.

Balogh L, Dancza I, Király G (2004) A magyarországi neofitonok időszerű jegyzéke, és besorolásuk inváziós szempontból [Actual list of neophytes in Hungary and their classification according to their success]. In: Mihály B, Botta-Dukát Z (Eds) Biológiai Inváziók Magyarországon: Özönnövények [Biological invasions in Hungary: invasive plants]. A KvVM Természetvédelmi Hivatalának tanulmánykötetei 9. TermészetBÚVÁR Alapítvány Kiadó, Budapest, 61–92.

Bernardo L, Gangale C, Passalacqua NG, Uzunov D (2009) Regional experts: Calabria. In: Celesti-Grapow L, Pretto F, Brundu G, Carli E, Blasi C (Eds) A thematic contribution to the national biodiversity strategy. Plant invasion in Italy, an overview. Ministry for the Environment Land and Sea Protection, Nature Protection Directorate, Rome. [+ CD-Rom]

Bocchieri E (1996) L'esplorazione botanica e le principali conoscenze sulla flora dell'arcipelago della Maddalena (Sardegna nord-orientale). Rendiconti del Seminario della Facoltà di Scienze dell'Università di Cagliari 66(suppl.): 1–305.

Brunet J, Zalapa JE, Pecori F, Santini A (2013) Hybridization and introgression between the exotic Siberian elm, *Ulmus pumila*, and the native field elm, *Ulmus minor*, in Italy. Biological Invasions 15(12): 2717–2730. https://doi.org/10.1007/s10530-013-0486-z

Burgarella C, Cubry P, Kane NA, Varshney RK, Mariac C, Liu X, Shi C, Thudi M, Couderc M, Xu X, Chitikineni A, Scarcelli N, Barnaud A, Rhoné B, Dupuy C, François O, Berthouly-Salazar C, Vigouroux Y (2018) A western Sahara centre of domestication inferred from pearl millet genomes. Nature Ecology & Evolution 2(9): 1377–1380. https://doi.org/10.1038/s41559-018-0643-y

Camarda I, Brundu G, Carta L, Manca M, Satta V (2004) Invasive alien plants in the National Parks of Sardinia. In: Camarda I Manfredo MJ, Mulas F, Teel TL (Eds) Global Challenges of Parks and Protected Area Management. Proceedings of the 9th ISSRM. Carlo Delfino Ed., Sassari, 111–123.

Camarda I, Cossu TA, Carta L, Brunu A, Brundu G (2016) An updated inventory of the non-native flora of Sardinia (Italy). Plant Biosystems 150(5): 1106–1118. https://doi.org/10.1080/11263504.2015.1115438

Cavara F (1901) L'Orto Botanico di Cagliari come giardino di acclimatazione e come Istituto Scientifico. Nuovo Giornale Botanico Italiano n.s., 8(1): 28–48.

Celesti-Grapow L, Capotorti G, Del Vico E, Lattanzi E, Tilia A, Blasi C (2013) The vascular flora of Rome. Plant Biosystems 147(4): 1059–1087. https://doi.org/10.1080/11263504.2013.862315

Chambers KL (1993) *Thuja* L. Flora of North America Editorial Committee. Flora of North America North of Mexico (Vol. 2). Oxford University Press, New York, Oxford. http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=132902 [accessed 25.03.2020]

Chiappini M (1967) Acclimatation des plantes tropicales en Sardaigne. Morisia 1(1): 13–27.

Chiappini M (1985) Guida alla flora pratica della Sardegna. Carlo Delfino Ed., Sassari.

Cogolludo-Agustin MA, Agundez D, Gil L (2000) Identification of native and hybrid elms in Spain using isozyme gene markers. Heredity 85(2): 157–166. https://doi.org/10.1046/j.1365-2540.2000.00740.x

De Notaris J (1844) Repertorium florae Ligusticae. Ex Regio Typographeo, Taurini. https://doi.org/10.5962/bhl.title.6657

de Wilde WJJO, Duyfjes BEE (2008) The edible Cucurbitaceae of Thailand and Malesia and the wild forms of the cultivated ones. Sandakania 17: 43–91.

Domina G, Di Gristina E, Scafidi F, Calvo R, Venturella G, Gargano ML (2019) The urban vascular flora of Palermo (Sicily, Italy). Plant Biosystems. https://doi.org/10.1080/11263504.2019.1651787

Dörken VM (2013) Leaf dimorphism in *Thuja plicata* and *Platycladus orientalis* (thujoid Cupressaceae s. str., Coniferales): the changes in morphology and anatomy from juvenile needle leaves to mature scale leaves. Plant Systematics and Evolution 299(10): 1991–2001. https://doi.org/10.1007/s00606-013-0853-3

Galasso G, Conti F, Peruzzi L, Ardenghi NMG, Banfi E, Celesti-Grapow L, Albano A, Alessandrini A, Bacchetta G, Ballelli S, Bandini Mazzanti M, Barberis G, Bernardo L, Blasi C, Bouvet D, Bovio M, Cecchi L, Del Guacchio E, Domina G, Fascetti S, Gallo L, Gubellini L, Guiggi A, Iamonico D, Iberite M, Jiménez-Mejías P, Lattanzi E, Marchetti D, Martinetto E, Masin RR, Medagli P, Passalacqua NG, Peccenini S, Pennesi R, Pierini B, Podda L, Poldini L, Prosser F, Raimondo FM, Roma-Marzio F, Rosati L, Santangelo A, Scoppola A, Scortegagna S, Selvaggi A, Selvi F, Soldano A, Stinca A, Wagensommer RP, Wilhalm T, Bartolucci F (2018) An updated checklist of the vascular flora alien to Italy. Plant Biosystems 152(3): 556–592. https://doi.org/10.1080/11263504.2018.1441197

Gennari P (1874) Guida all'Orto Botanico della Regia Università di Cagliari. Tipografia Ed. dell'Avvenire di Sardegna, Cagliari.

Harden GJ (2001) Flora of New South Wales (Vol. 1). UNSW Press, Sydney.

Iamonico D (2015) Taxonomic revision of the genus *Amaranthus* (Amaranthaceae) in Italy. Phytotaxa 199(1): 1–84. https://doi.org/10.11646/phytotaxa.199.1.1

Imig DC, Milward-de-Azevedo MA, Cervi AC (2018) Passifloraceae sensu stricto de Minas Gerais, Brasil. Rodriguésia 69(4): 1701–1735. https://doi.org/10.1590/2175-7860201869415

Király G, Alegro A (2015) Re-evaluation of the *Panicum capillare* complex (Poaceae) in Croatia. Acta Botanica Croatica 74(1): 173–179. https://doi.org/10.1515/botcro-2015-0004

Liu B, Zhang D, Gao L-Z (2015) The complete chloroplast genome sequence of *Cucumis sativus* var. *hardwickii*, the wild progenitor of cultivated cucumber. Mitochondrial DNA Part 1 27(6)[2016]: 4627–4628. https://doi.org/10.3109/19401736.2015.1101588

Liu B-B, Liu G-N, Hong D-Y, Wen J (2020) *Eriobotrya* belongs to *Rhaphiolepis* (Maleae, Rosaceae): evidence from chloroplast genome and nuclear ribosomal DNA data. Frontiers in Plant Science 10(1731): 1–14. https://doi.org/10.3389/fpls.2019.01731

Maire R (1931) Mission Saharienne Augiéras-Draper, 1927–1928. Plantes du Sahara central. Bulletin du Muséum National d'Histoire Naturelle s. 2, 3(6): 521–538.

McCauley RA (2003) *Froelichia* Moench. Flora of North America Editorial Committee. Flora of North America North of Mexico (Vol. 4). Oxford University Press, New York, Oxford, 443–444.

McCauley RA (2004) New taxa and a new combination in the North American species of *Froelichia* (Amaranthaceae). Systematic Botany 29(1): 64–76. https://doi.org/10.1600/036364404772973997

Merkingler FF, Camara AA, Goudiaby A, Sonko A, Cheek M, Darbyshire I (2014) *Froelichia* (Amaranthaceae) – a new generic record and invasive weed for Africa. Kew Bulletin 69(4): 1–6. https://doi.org/10.1007/s12225-014-9538-5

Milani A, Scarabel L, Sattin M (2018) Complex *Amaranthus* spp. populations infesting soybean fields under ALS inhibitor selective pressare. In: Simončič A (Ed.) 18th European Weed Research Society symposium, EWRS 2018. 17–21 June 2018. Ljubljana, Slovenia. New approaches for smarter weed management. Book of abstracts. Kmetijski inštitut Slovenije, Ljubljana, 161 pp. http://www.asacim.org.ar/wp-content/uploads/2018/08/EWRS2018-Book-of-Abstracts.pdf [accessed: 15.04.2019]

Miller DM (1997) *Passiflora* Linnaeus. In: Cullen J, Alexander JCM, Brickell CD, Edmondson JR, Green PS, Heywood VH, Jørgensen P-M, Jury SL, Knees SG, Mattews VA, Maxwell HS, Miller DM, Nelson EC, Robson NKB, Walters SM, Yeo PF (Eds) The European Garden Flora (Vol. 5). Cambridge University Press, Cambridge, 258–262.

Morrone O, Aliscioni SS, Veldkamp JF, Pensiero JF, Zuloaga FO, Kellogg EA (2014) Revision of the Old World species of *Setaria* (Poaceae: Panicoideae: Paniceae). Systematic Botany Monographs 96: 1–153.

Ohba H (1999) Buxaceae. In: Iwatsuki K, Boufford DE, Ohba H (Eds) Flora of Japan (Vol. 2c). Kodansha Ltd., Tokyo, 106–108.

Pignatti S (1982) Flora d'Italia (Vol. 3). Edagricole, Bologna.

Podda L, Lazzeri V, Mascia F, Mayoral O, Bacchetta G (2012) The checklist of the Sardinian alien flora: an update. Notulae Botanicae Horti Agrobotanici Cluj-Napoca 40(2): 14–21. https://doi.org/10.15835/nbha4028225

Puddu S, Podda L, Mayoral O, Delage A, Hugot L, Petit Y, Bacchetta G (2016) Comparative analysis of the alien vascular flora of Sardinia and Corsica. Notulae Botanicae Horti Agrobotanici Cluj-Napoca 44(2): 337–346. https://doi.org/10.15835/nbha44210491

Qi J, Liu X, Shen D, Miao H, Xie B, Li X, Zeng P, Wang S, Shang Y, Gu X, Du Y, Li Y, Lin T, Yuan J, Yang X, Chen J, Chen H, Xiong X, Huang K, Fei Z, Mao L, Tian L, Städler T, Renner SS, Kamoun S, Lucas WJ, Zhang Z, Huang S (2013) A genomic variation map provides insights into the genetic basis of cucumber domestication and diversity. Nature Genetics 45(12): 1510–1515. https://doi.org/10.1038/ng.2801

Rominger JM (2003) *Setaria* P. Beauv. Flora of North America Editorial Committee. Flora of North America North of Mexico (Vol. 25). Oxford University Press, New York, Oxford, 539–558.

Schulz C, Knopf P, Stützel TH (2005) Identification key to the cypress family (Cupressaceae). Feddes Repertorium 116(1–2): 96–146. https://doi.org/10.1002/fedr.200411062

Sosef MSM (2019) Taxonomic novelties in central African grasses (Poaceae), Paniceae 2. Plant Ecology and Evolution 152(3): 554–560. https://doi.org/10.5091/plecevo.2019.1608

Tison J-M, de Foucault B (2014) Flora Gallica. Flore de France. Biotope Éditons, Mèze.

Turland NJ, Wiersema JH, Barrie FR, Greuter W, Hawksworth DL, Herendeen PS, Knapp S, Kusber W-H, Li D-Z, Marhold K, May TW, McNeill J, Monro AM, Prado J, Price MJ, Smith GF [Eds] (2018) International Code of Nomenclature for algae, fungi, and plants

(Shenzhen Code) adopted by the Nineteenth International Botanical Congress Shenzhen, China, July 2017. Regnum Vegetabile 159: 1–254. https://doi.org/10.12705/Code.2018
Vannelli S (1986) Il verde di Cagliari: guida alle piante e ai giardini della città. Janus Ed., Cagliari.
Wilhalm T (2009) *Digitaria ciliaris* in Europe. Willdenowia 39(2): 247–259. https://doi.org/10.3372/wi.39.39203

Supplementary material 1

Supplementary data

Authors: Gabriele Galasso, Fabrizio Bartolucci

Data type: species data

Explanation note: 1. Nomenclatural updates; 2. Note updates; 3. Distribution updates; 4. Synonyms, misapplied or included names.

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RESEARCH ARTICLE

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Notulae to the Italian native vascular flora: 9

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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, confirmations, exclusions, and status changes to the Italian administrative regions. Two new combinations are proposed. Nomenclatural and distribution updates, published elsewhere, and corrigenda are provided as Suppl. material 1.

Keywords
Endemic, Floristic data, Italy, 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 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 1,000 characters (spaces included).

Floristic records

Alchemilla filicaulis Buser (Rosaceae)

+ **ABR**: Rocca S. Maria (Teramo), Fosso di Valle Castellana pascoli verso la testata del Fosso della Morricana (WGS84: 42.659739N; 13.409204E), suolo marnoso-arenaceo, 1780 m, 28 June 2008, leg. *G. Tondi*, *F. Minutillo*, det. *G. Tondi* (FI); Lucoli frazione di Casamaina (Aquila), Monte Ocre, loc. La Faina (WGS84: 42.256784N; 13.425853E), pascolo sassoso su suolo calcareo, 1900 m, 1 July 2015, leg. *G. Tondi*, *F. Minutillo*, *E. De Santis*, det. *G. Tondi* (*Herb. Tondi* Nos. 1174, 1181); Rivisondoli (Aquila), loc. via di Monte Pratello (WGS84: 41.863745N; 14.040567E), prato umido su suolo calcareo, 1240 m, 15 June 2019, leg. *G. Tondi*, *F. Minutillo*, det. *G. Tondi* (*Herb. Tondi* Nos. 1894, 1895, 1896); Villavallelonga (Aquila) loc. Prati d'Angro (WGS84: 41.492363N; 13.412422E), prato pascolo al margine di faggeta esposto prevalentemente a Nord, 1083 m, 14 July 2019, leg. *G. Buccomino*, det. *F. Festi* (FI). – Species confirmed for the flora of Abruzzo.

This species was recorded by Conti et al. (2008) based on an old specimen collected on Monte Corno and kept in NAP. The collected plants can be referred to *Alchemilla filicaulis* var. *vestita* (Buser) Buser ex H.J.Coste (Pignatti et al. 2017).

G. Tondi, F. Festi, G. Buccomino

Alyssoides utriculata (L.) Medik. subsp. *utriculata* (Brassicaceae)

+ **CAL**: Morano Calabro (Cosenza), Vallone del Rago (UTM WGS84: 39.880921N; 16.129481E), rupi calcaree esposte a SW, 925 m s.l.m., 8 August 2019, *L. Peruzzi* (PI026078); Morano Calabro (Cosenza), Vallone del Rago (WGS84: 39.879379N; 16.124443E), rupi calcare esposte a NE, 935 m s.l.m., 8 August 2019, *L. Peruzzi* (FI). – Species new for the flora of Calabria.

This Mediterranean species occurs all across the Italian peninsula, from the north-west to the south-east, but its range was, until now, known to end in Basilicata (Bartolucci et al. 2018), on the northern slopes of the Pollino Massif. The population of Vallone del Rago, consisting of hundreds of individuals scattered over an area of about 1 km, is found, on the contrary, on Pollino's southern slopes.

L. Peruzzi

Andrachne telephioides L. (Phyllanthaceae)

+ (CAS) **VEN**: Verona Porta Vescovo (Verona), incolto in via Porto San Michele (WGS84: 45.43509049N; 11.02568835E), alcuni esemplari in frutto in un piazzale di ditta dismessa, 56 m, no esp., 17 October 2019, *A. Bertolli* (FI, ROV No. 74207). – Casual regional alien species new for the flora of Veneto.

A. Bertolli

***Anisantha rubens* (L.) Nevski (Poaceae)**

+ (CAS) **LOM**: Milano (Milano), deposito ferroviario di Milano-San Rocco (c/o Stazione di Milano-Porta Garibaldi), binari abbandonati e massicciata ferroviaria all'estremo sudorientale (WGS84: tra 45.491230N; 9.172140E e 45.490830N; 9.174037E), binari abbandonati e massicciata ferroviaria, 125 m, no exp., 31 May 2018, *G. Galasso*, det. *G. Galasso*, *E. Banfi* (FI, MSNM). – Casual regional alien species new for the flora of Lombardia.

E. Banfi, G. Galasso, R. Gentili, C. Toffolo

***Avena clauda* Durieu (Poaceae)**

+ **PUG**: Santeramo (Bari), via per Matera (WGS84: 40.748895N; 16.702143E), fallow lands, 374 m, 17 May 2019, *G. Silletti*, *V. Tomaselli* (BI, FI). – Species confirmed for the flora of Puglia.

This species was mentioned for "Mte. Gargano Manfredonia" (Puglia) by Baum (1977; see also Licht 2018), but reported as doubtfully occurring by Bartolucci et al. (2018). We confirm the presence of this species in a different locality within the province of Bari.

G. Silletti, V. Tomaselli

***Biarum tenuifolium* (L.) Schott subsp. *tenuifolium* (Araceae)**

+ C **MAR**: Camerino (Macerata), via Pontoni 5 (WGS84: 43.136972N; 13.071119E), garden of the School of Biosciences and Veterinary Medicine, 623 m, 11 September 2019, *S. Ballelli*, *R. Pennesi* (FI). – Cryptogenic species new for the flora of Marche.

This species was found in the natural grassland environment of a small academic garden. This finding would represent, if the native status will be confirmed, the new northern limit in Italy.

S. Ballelli, R. Pennesi

***Bromopsis stenophylla* (Link) LazzerI (Poaceae)**

+ **LIG**: Framura (La Spezia), western slope of M. di S. Agata (WGS84: 44.22375N; 9.57397E), thermophilous shrubs and meadows, 345 m, 12 May 2018, *Barberis G.*, *Cibei C. Dagnino D. Di Turi A.*, *Longo D.*, *Marchetti D.*, *Mariotti M.G.*, *Menozzi B.I.*, *Peccenini S.*, *Turcato C.* (FI; GE No. 646); Savignone (Genova), eastern slope of M. Moro (WGS84: 44.57264N; 9.00778E), shrubs and meadows along the trail, 830 m, 27 July 2019, *Dagnino D.* (FI; GE No. 796); Savignone (Genova), southwestern slope of M. Brughea, between Castello Nero and Castello Rosso (WGS84: 44.56772N; 8.99264E), xerophytic grasslands and garigues, 597 m, 3 August 2019, *Barberis G.*, *Briozzo I.*, *Dagnino D.*, *Leone M.*, *Longo D.* (FI; GE No. 753). – Species new for the flora of Liguria.

Bromopsis stenophylla was found in shrubby-herbaceous xerophytic and thermophilous plant communities, under sub-Mediterranean and sub-continental climates. This species occurs in two Special Areas of Conservation: "IT1343415 Guaitarola" (GE 646) and "IT1330213 Conglomerato di Vobbia". The fragmented distribution in Italy and the recent findings (Lazzeri 2014) suggest that the distribution of this taxon is incompletely known, mainly because of confusions with closely related taxa.

D. Dagnino, D. Longo, E. Banfi, G. Barberis

Camphorosma monspeliaca L. subsp. _monspeliaca_ (Chenopodiaceae)

+ **LIG**: Pietra Ligure (Savona), Rocca delle Fene, presso la vetta (WGS84: 44.154034N; 8.275008E), margine di lecceta, 185 m, S, 12 August 2017, *G. Galasso* (MSNM); *ibidem*, 16 August 2018, *G. Galasso*, det. *G. Galasso*, *E. Banfi* (FI, MSNM). – Subspecies confirmed for the flora of Liguria.

Camphorosma monspeliaca was mentioned for Liguria by Penzig (1897) and Gismondi (1949). However, in the past, Liguria included also the Nice area (now Provence, France), from which all the previous reports originated (Bertoloni 1833). Consequently, Bartolucci et al. (2018) believed that the indication for the current Liguria administrative region was a mistake. Instead, the species certainly occurs in this region, on clayey soils along the sloping coastal strip of the western part (e.g., Borghetto Santo Spirito, Pietra Ligure, Finale Ligure).

G. Galasso, E. Banfi

Centranthus calcitrapae (L.) Dufr. subsp. _calcitrapae_ (Valerianaceae)

+ (CAS) **LOM**: Milano (Milano), Stazione Milano-Lambrate, binari e massicciata ferroviaria sul lato orientale (WGS84: tra 45.485009N; 9.237874E e 45.482575N; 9.238616E), binari ferroviari, 124 m, no exp., 21 May 2018, *G. Galasso*, det. *G. Galasso*, *E. Banfi* (FI, MSNM). – Casual regional alien subspecies new for the flora of Lombardia.

G. Galasso, E. Banfi, R. Gentili, C. Toffolo

Cirsium vulgare (Savi) Ten. subsp. _silvaticum_ (Tausch) Arènes (Asteraceae)

+ **LIG**: Serra Riccò (Genova), tra Crocetta d'Orero e Costa Fontana (WGS84: 44.518017N; 8.983647E), scarpata erbosa a bordo strada, 470 m, 13 October 2019, *G. Barberis*, *D. Dagnino*, *D. Longo*, *S. Peccenini* (FI, GE No. 1478); Torriglia (Genova), sopra Garaventa (WGS84: 44.539264; 9.177251), margine prato da sfalcio, 923 m, 4 October 2019, *S. Macciò* (GE No. 1501); Torriglia (Genova), sopra Bavastrelli (WGS84: 44.559594; 9.175368), prato-pascolo, 950 m, 4 October 2019, *S. Macciò* (GE No. 1502). – Subspecies new for the flora of Liguria.

This taxon grows in different types of herbaceous plant communities (i.e., edge of grasslands, meadows, and ruderal grassy banks along roadsides).

D. Dagnino, G. Barberis, D. Longo

Cirsium vulgare (Savi) Ten. subsp. _vulgare_ (Asteraceae)

+ **LIG**: Savignone (Genova), IT1330213 "Conglomerato di Vobbia" M. Pianetto, pendici W (WGS84: 44.57487N; 8.97936E), castagneto ceduo, 634 m, 3 August 2019, *G. Barberis*, *I. Briozzo*, *D. Dagnino*, *M. Leone*, *D. Longo* (FI, GE No. 1132). – Subspecies new for the flora of Liguria.

This taxon was found at the edge of a dirt road crossing a chestnut coppice forest within a Special Area of Conservation "IT1330213 - Conglomerato di Vobbia".

D. Dagnino, I. Briozzo, G. Barberis, D. Longo

Crepis bursifolia L. (Asteraceae)

+ **MAR**: Campofilone (Fermo), in the flower beds of the Q8 petrol station along the A14 highway (WGS84: 43.075479N; 13.844311E), 37 m, no exp., 18 July 2014, *S. Ballelli* (CAME); Fermo, in the meadows of the Athletics Sports Center (WGS84: 43.168261N; 13.737924E), 160 m, sandstone substrate, no exp., 09 June 2019, *S. Ballelli* (CAME, FI); Camerino (Macerata), Viale G. Leopardi 19, in a flowerbed along the sidewalk (WGS84: 43.136993N; 13.071453E), 618 m, no exp., 17 June 2019, *S. Ballelli*, *R. Pennesi* (CAME); Fermo, Via Bore di Tenna 53, uncultivated fields (WGS84: 43.173320N; 13.704779E), 252 m, no exp., 02 July 2019, *A. Crisanti* (CAME); Castelraimondo (Macerata), Via Papa Giovanni XIII, in the pavement of the church (WGS84: 43.206735N; 13.055021E), 313 m, no exp., 08 August 2019, *S. Ballelli* (CAME). – Species new for the flora of Marche.

S. Ballelli, R. Pennesi, A. Crisanti

Delphinium pubescens DC. (Ranunculaceae)

+ **CAM**: Castellammare di Stabia (Napoli), località Botteghelle (WGS84: 40.689858N; 14.480595E), fessure della pavimentazione, 84 m, 28 June 2014, *A. Stinca* (FI). – Species new for the flora of Campania.

A. Stinca, G. Chianese, A. Esposito

Galium mollugo L. (Rubiaceae)

+ **BAS**: Carbone (Potenza), Bosco Vaccarizzo (WGS84: 40.126850N; 16.051211E), lungo la strada sterrata che attraversa il bosco, 957 m s.l.m., 04 July 2019, *N.G. Passalacqua*, *L. Bernardo* (FI, CLU). – Species new for the flora of Basilicata.
+ **CAL**: Laino Borgo (Cosenza), Azienda Agrituristica "Al Verneto", sentiero ad ovest dell'abitazione, sotto c.le Maurianni (WGS84: 39.942302N; 15.929936E), cespuglieti e radure con roccia affiorante, ca. 660 m s.l.m., 17 June 2005, *L. Bernardo*, *R. Odoguardi* (FI). – Species confirmed for the flora of Calabria.

N.G. Passalacqua, L. Bernardo

Gelasia villosa (Scop.) Cass. subsp. _columnae_ (Guss.) Bartolucci, Galasso & F.Conti (Asteraceae)

+ **MOL**: Colletorto (Campobasso), Valle del Fortore, Vallone S. Maria, Masseria Bernardo (WGS84: 41.668330N; 15.015833E), 259 m, 20 April 1995, leg. *F. Lucchese*, det. *F. Conti*, *F. Lucchese*, *F. Bartolucci* (URT); Guardialfiera (Campobasso), Valle del Biferno, M. Peloso (WGS84: 41.819440N; 14.826388E), 410 m, 4 May 1992, leg. *F. Lucchese*, det. *F. Conti*, *F. Lucchese*, *F. Bartolucci* (URT). – Subspecies new for the flora of Molise.

F. Conti, F. Lucchese, F. Bartolucci

Gelasia villosa (Scop.) Cass. subsp. _villosa_ (Asteraceae)

– **MOL**. – Subspecies to be excluded from the flora of Molise.

This taxon was reported as occurring in Molise by Lucchese (1995), Fanelli et al. (2001), and Bartolucci et al. (2018). An accurate revision of specimens preserved in URT (Università di Roma Tre) collected by F. Lucchese, led us to attribute them to *S. villosa* Scop. subsp. *columnae* (Guss.) Nyman. The nomenclature follows Bartolucci et al. (2020).

F. Conti, F. Lucchese, F. Bartolucci

Genista monspessulana (L.) L.A.S.Johnson (Fabaceae)

+ **BAS**: San Severino Lucano (Potenza), Bosco Magnano (WGS84: 40.04223N, 16.11472E), margine di cerreta termofila, 737 m s.l.m., esp. Sud, 5 June 2019, *A. Scoppola* (FI, UTV No. 38283). – Species new for the flora of Basilicata.

In Bosco Magnano, *Genista monspessulana* was found on a trail along the border of oak forest; this population fills a distribution gap along the southern Tyrrhenian coast.

M. Pellegrino, A. Scoppola

Hieracium pseudolaggeri (Zahn) Prain (Asteraceae)

+ **ITALIA** (VDA): Brusson (Aosta), sentiero per Raccard, in destra orografica del torrente Messuère (WGS84: 45.761527N, 7.740618E ± 50 m), 1485 m s.l.m., pineta di Pino silvestre, 19 June 2019, leg. *M. Bovio*, *M. Broglio* et *G. Jacquemet*, det. *G. Gottschlich* (FI, AO, *Herb. Gottschlich*). – Species new for the flora of Italia (Valle d'Aosta).

Hieracium pseudolaggeri was hitherto only known from the Valais in Switzerland (Gottschlich 2007).

G. Gottschlich, M. Bovio

Hypericum hirsutum L. (Hypericaceae)

+ **CAL**: Oriolo (Cosenza), in loc. Scifi lungo la SP154, a ESE della chiesa della Madonna della Neve (WGS84: 39.972495N; 16.442806E), margine di bosco mesofilo, 820 m s.l.m., 11 August 2019, *F. Roma-Marzio*, *P. Liguori* (FI). – Species confirmed for the flora of Calabria.

Hypericum hirsutum was reported in Calabria as doubtfully occurring (Bartolucci et al. 2018) based on several records in the so-called area of Alto Ionio Cosentino, published by Vita and D'Errico (1981) and Vita (1989). We confirm the presence of this species in one of these localities.

F. Roma-Marzio

Jacobaea erucifolia (L.) G.Gaertn., B.Mey. & Scherb. subsp. _erucifolia_ (Asteraceae)

+ **LIG**: Crocefieschi (Genova), "IT1330213 – Conglomerato di Vobbia", Monte Castello (WGS84: 44.58979N; 9.02079E), bosco misto di latifoglie, 935 m, 7 September 2019, *A. Baroni*, *F. Baroni*, *D. Dagnino*, *G. Gatto*, *D. Longo* (FI). – Subspecies new for the flora of Liguria.

This taxon was found in a mixed deciduous broadleaf forest in a mountain area, within the Special Area of Conservation "IT1330213 – Conglomerato di Vobbia".

D. Dagnino, C. Cibei

Leontodon hispidus L. subsp. _hyoseroides_ (Welw. ex Rchb.) Murr (Asteraceae)

+ **TOS**: Seravezza (Lucca), Alpi Apuane, M. Pelato, sopra le Gobbie, lungo la via delle cave (WGS84: 44.062371N; 10.231210E), pendii rupestri su marmo, 1110 m, 28 June 2016, *F. Conti*, *F. Bartolucci*, *D. Marchetti* (FI, APP Nos. 62876, 62877); Seravezza (Lucca), Alpi Apuane, sopra le Gobbie, nel versante settentrionale del M. Altissimo (WGS84: 44.058955N; 10.23097E), su terra e detriti di marmo, 1130 m, 23 August 2006, *D. Marchetti* (APP No. 34144); Stazzema (Lucca), Alpi Apuane, fra Tre Fiumi e Isola Santa, sopra la Turrite Secca (WGS84: 44.061741N; 10.284954E), su marmo, 705 m, 7 September 1997, *D. Marchetti* (APP No. 50323). – Species confirmed for the flora of Toscana.

We confirm the presence of this taxon in the Alpi Apuane, where it was recorded in the past by Fiori (1927). We also observed it in other localities, such as Foce di Pianza, above Carrara (Massa-Carrara); summit ridge of Mt. Pelato, in the group of Mt. Altissimo (Massa-Carrara, Lucca); close to le Gobbie, up to the Passo del Vestito, in the group of Mt. Altissimo (Lucca). As stated by Zidorn (2012), both glabrous and hairy plants sometimes co-occur in some populations.

F. Conti, F. Bartolucci, D. Marchetti

Najas minor All. (Hydrocharitaceae)

+ **SAR**: Viddalba (Sassari), Fiume Coghinas (WGS84: 40.919625N; 8.869938E), 3 m, 22 July 2019, leg. *G. Orrù*, *R. Angius*, *M. Copez*, *S. Fanni*, *M.C. Locci*, *M.L. Pala* et *G. Pirastru*, det. *G. Orrù* et *R. Angius* (FI). – Species new for the flora of Sardegna.

G. Orrù, R. Angius, M. Copez, S. Fanni, M.C. Locci, M.L. Pala, G. Pirastru

Osyris alba L. (Santalaceae)

+ **PIE**: Alto (Cuneo), sotto Strada provinciale 216, boscaglia a roverella (WGS84: 44.110359N; 7.994390E), ca. 720 m, 12 January 2020, *D. Barberis*, *S. Ravetto Enri*, *M. Lonati* (FI). – Species new for the flora of Piemonte.

Osyris alba is an euri-mediterranean species, previously known in NW Italy only for Liguria (Bartolucci et al. 2018). This species is widespread on the south-facing slopes of the Pennavaire valley over an area of about 0.2 km^2.

D. Barberis, S. Ravetto Enri, M. Lonati

Persicaria lapathifolia (L.) Delarbre subsp. _lapathifolia_ (Polygonaceae)

+ **LIG**: Carrodano (La Spezia), "IT1343502 Parco della Magra – Vara", Fiume Vara a NW di Ca' di Vara (WGS84: 44.250635N; 9.680426E), greto, 132 m, 23 August 2019, *C. Turcato*, *D. Dagnino* (FI, GE No. 909). – Subspecies new for the flora of Liguria.

D. Dagnino, C. Turcato

Pinus halepensis Mill. subsp. _halepensis_ (Pinaceae)

+ **SAR**. – Status change from naturalized to native for the flora of Sardegna.

The first mention of *Pinus halepensis* in Sardegna dates back to the explorer Agostino Tagliafico, in 1736 (Arrigoni 1967). Later, Moris (1827) reported the presence of this species, followed by Angius (1851). More recently, Arrigoni (1967) reviewed several historical records supporting the hypothesis of a natural presence of this species in Sardegna. Many other authors considered this taxon native to Sardegna (Arrigoni 2006; Bacchetta 2006; Camarda and Valsecchi 2008), also supported by Pleistocenic fossil pine pollen records (Del Rio and Pittau 1974; Buosi et al. 2016), and by archaeobotanical studies on several Neolithic to Bronze Age (6000–1200 BCE) settlements (Pittau et al. 2012; De Rita and Melis 2013; Buosi et al. 2015; Melis et al. 2017; Pittau et al. 2018). Given this evidence, we support the status change from introduced to native species in Sardegna.

G. Calvia, G. Bacchetta, G. Bonari

Plantago argentea Chaix subsp. _liburnica_ Ravnik (Plantaginaceae)

+ **TOS**: Massa (Massa-Carrara), "Parco delle Alpi Apuane", Cava di Valsora, Pendici NW di Monte Pelato, presso Passo del Vestito (WGS84: 44.06619N; 10.221078E), gariga, 898 m, 4 June 2019, *C. Turcato* (FI, GE No. 923). – Subspecies new for the flora of Toscana.

D. Dagnino, C. Turcato

Poa palustris L. subsp. _palustris_ (Poaceae)

+ **PUG**: Altamura (Bari), loc. San Giuseppe (WGS84: 40.926022N; 16.440731E), flooded soils along the edges of a pond, 503 m, 17 May 2019, *G. Silletti*, *V. Tomaselli* (BI, FI). – Species confirmed for the flora of Puglia.

This taxon was recorded for "Bosco Isola" (Lesina, Foggia) by Forte et al. (2002), but then as doubtfully occurring by Bartolucci et al. (2018). The presence of a specimen in the BI Herbarium [Lesina (Foggia), 5 May 1999, leg. *F. Pantaleo*, det. *F. Pantaleo*, *L. Forte* (BI No. 31492)], along with this new finding near Altamura, confirm the presence of this taxon in Puglia.

G. Silletti, V. Tomaselli, L. Forte

Polygonum bellardii All. (Polygonaceae)

+ **LIG**: Serra Riccò (Genova), tra Crocetta d'Orero e Costa Fontana (WGS84: 44.518017N; 8.983647E), scarpata erbosa a bordo strada, 470 m, 13 October 2019, *G. Barberis*, *D. Dagnino*, *D. Longo*, *S. Peccenini* (GE No. 1480). – Species confirmed for the flora of Liguria.

In Liguria, this species was no longer recorded, despite several historical reports (Bertoloni 1839–41; De Notaris 1844; Raffaelli 1979). The lack of recent records is probably because of confusion with similar common species belonging to the *P. aviculare* L. group.

D. Dagnino, G. Barberis, D. Longo

Potamogeton nodosus Poir. (Potamogetonaceae)

+ **LIG**: Sarzana (La Spezia), "IT 1345101 Piana del Magra", Bozi di Saudino (WGS84: 44.09816N; 9.96347E), lago eutrofico artificiale, 4 m, 1 April 2019, *I. Briozzo*, *D. Dagnino*, *C. Turcato* (GE No. 972). – Species confirmed for the flora of Liguria.

In Liguria, this species was no longer recorded, despite a historical report, i.e., Ottone Penzig's handwritten notes found on a copy of De Notaris (1844) stored in the library of the University of Genoa. We found *P. nodosus* inside an artificial lake (Habitat of Community Interest code 3150 "Natural euthrophic lakes with Magnopotamion or Hydrocharition-type vegetation") within a Special Area of Conservation (IT 1345101 Piana del Magra).

D. Dagnino, L. Minuto, C. Turcato

Potamogeton perfoliatus L. (Potamogetonaceae)

+ **SAR**: Viddalba (Sassari), Fiume Coghinas (WGS84: 40.919942N; 8.870379E), 3 m, 22 July 2019, leg. *G. Orrù*, *R. Angius*, *M. Copez*, *S. Fanni*, *M.C. Locci*, *M.L. Pala*, *G. Pirastru*, det. *G. Orrù et R. Angius* (FI). – Species new for the flora of Sardegna.

G. Orrù, R. Angius, M. Copez, S. Fanni, M.C. Locci, M.L. Pala, G. Pirastru

Rosa nitidula Besser (Rosaceae)

+ **CAL**: Oriolo (Cosenza), C.da Serra Salice verso Timpa Caporosso (WGS84 40.049099N; 16.424548E), boscaglia mesofila, 700 m, 17 August 2019, *F. Roma-Marzio & P. Liguori* (FI). – Species new for the flora of Calabria.

Rosa nititula belongs to the *R. canina* L. group (Klastersky 1968). In the past, several authors considered this rose as a variety of *R. canina* and in the recent checklist of the vascular flora native to Italy it is considered as a taxonomically doubtful taxon (Bartolucci et al. 2008).

F. Roma-Marzio, P. Liguori, E. Lattanzi

***Ruppia maritima* L. (Ruppiaceae)**

+ **LIG**: Sarzana (La Spezia), "IT1343502 Parco della Magra – Vara", Loc. Pallodola (WGS84: 44.076177N; 9.977878E), estuario, 0 m, 30 August 2019, *C. Turcato*, *D. Dagnino* (GE No. 825). – Species confirmed for the flora of Liguria.

In Liguria, this species was no longer recorded, despite a historical report, i.e., Ottone Penzig's handwritten notes found on a copy of De Notaris (1844) stored in the library of the University of Genoa. *Ruppia maritima* was found in the estuary of the Magra river (Habitat of Community Interest code 1130 "Estuaries"), inside the Special Area of Conservation "IT1343502 Parco della Magra – Vara". An old specimen (dated 1856) in GDOR Herbarium attests the long-term occurrence of this species in La Spezia area.

D. Dagnino, M.G. Mariotti, C. Turcato

***Salvia nemorosa* L. (Lamiaceae)**

+ (CAS) **VEN**: Tregnago (Verona), al bivio con la strada per il paese di Centro (WGS84: 45.51917525N; 11.14306809E), ai bordi di un prato falciato, 520 m slm, 27 June 2019, *F. Menini*, *M. Trenchi* (FI, VER). – Casual regional alien species new for the flora of Veneto.

This species was first collected in Veneto by M. Trenchi and F. Festi in 2012 in a fertilized grassland at Morini di Marcenigo, Tregnago, Verona (ROV). New surveys in 2016 and 2017 by F. Menini and M. Trenchi confirm the constant presence of *Salvia nemorosa* in different localities of the same municipality.

S. Andreatta, F. Menini, M. Trenchi

***Seseli tortuosum* L. subsp. *tortuosum* (Apiaceae)**

+ (CAS) **VEN**: Ca Nova S. Lucia (Verona), lungo la tangenziale tra interporto e casello Verona nord (WGS84: 45.42051091N; 10.91500121E), una ventina di esemplari in fiore e frutto in due nuclei distanti circa un centinaio di metri nell'incolto erboso lungo la strada, 76 m, no esp., 25 October 2019, *A. Bertolli*, *F. Prosser* (FI, ROV No. 74206, VER). – Casual regional alien species new for the flora of Veneto.

A. Bertolli, F. Prosser

***Staphylea pinnata* L. (Staphyleaceae)**

+ **UMB**: Scheggia e Pascelupo (Perugia), Monte Cucco, presso l'Eremo di San Girolamo (WGS84 43.392318N; 12.744308E), orno-ostrieto ceduo su versante con esposizione NE, substrato carbonatico, presenza di rocciosità e pietrosità, 682 m s.l.m., 28 September 2019, *A. Di Filippo* (UTV No. 38197). – Species confirmed for the flora of Umbria.

Staphylea pinnata is reported as "doubtfully occurring" in Umbria (Bartolucci et al. 2018). This species was found on the western slope of the Apennines dividing Umbria and Marche on ravines at 600 m a.s.l. near Sigillo within the province of Perugia (Biondi et al. 2002).

A. Di Filippo, G. Russo, A. Scoppola

Trigonella wojciechowskii **Coulot & Rabaute (Fabaceae)**

+ (CAS) **LOM**: Milano (Milano), deposito ferroviario di Milano-San Rocco (c/o Stazione di Milano-Porta Garibaldi), binari abbandonati e massicciata ferroviaria all'estremo sudorientale (WGS84: tra 45.491230N; 9.172140E e 45.490830N; 9.174037E), binari abbandonati e massicciata ferroviaria, 125 m, no exp., 31 May 2018, *G. Galasso*, det. *G. Galasso*, *E. Banfi* (FI, MSNM). – Casual regional alien species new for the flora of Lombardia.

Previous reports by Rota (1853) for Sarnico (Province of Bergamo), followed by others, including those of Pignatti (1982) and Pignatti et al. (2017), are erroneous (Bartolucci et al. 2018) and should be referred to *Trigonella sulcata* (Desf.) Coulot & Rabaute (Martini et al. 2012).

G. Galasso, E. Banfi, R. Gentili, C. Toffolo

Zannichellia peltata **Bertol. (Potamogetonaceae)**

+ **TOS**: Montebonello (Pontassieve), vicino alla sponda destra del fiume Sieve, in prossimità del ponte, (WGS84: 43.830270N; 11.486550E), 110 m s.l.m., 31 July 2019, *L. Pinzani* (FI). – Species new for the flora of Toscana.

L. Pinzani

Nomenclatural novelties

Galatella tripolium **(L.) Galasso, Bartolucci & Ardenghi, comb. nov.**
urn:lsid:ipni.org:names:77209610-1

≡ *Aster tripolium* L., Sp. Pl. 2: 872(–873). 1753 [1 May 1753]
≡ *Tripolium pannonicum* (Jacq.) Dobrocz. subsp. *tripolium* (L.) Greuter, Willdenowia 33(1): 47. 2003 [29 August 2003]
≡ *Galatella pannonica* (Jacq.) Galasso, Bartolucci & Ardenghi subsp. *tripolium* (L.) Galasso, Bartolucci & Ardenghi, Ital. Botanist 3: 34. 2017 [5 May 2017]

Galatella tripolium **(L.) Galasso, Bartolucci & Ardenghi subsp.** ***pannonica*** **(Jacq.) Galasso, Bartolucci & Ardenghi, comb. nov.**
urn:lsid:ipni.org:names:77209611-1

≡ *Aster pannonicus* Jacq., Hort. Bot. Vindob. 1(1): 3 (pl. 8). 1770
≡ *Tripolium vulgare* Nees var. *pannonicum* (Jacq.) Schur, Enum. Pl. Transsilv.: 304. 1866 [April–June 1866]
≡ *Tripolium pannonicum* (Jacq.) Dobrocz., Fl. URSR 11: 63. 1962
≡ *Galatella pannonica* (Jacq.) Galasso, Bartolucci & Ardenghi, Ital. Botanist 3: 34. 2017 [5 May 2017]

When transferred to *Tripolium* Nees, *Aster tripolium* L. [1753] is unavailable because the use of the Linnaean epithet in *Tripolium* would result in a tautonym (Art. 23.4 of the ICN; Turland et al. 2018), but the epithet *tripolium* becomes again available in the genus *Galatella* Cass. Unfortunately, Galasso et al. in Bartolucci et al. (2017) forgot to consider this point, so that the combinations are corrected here.

G. Galasso, F. Bartolucci, N.M.G. Ardenghi

Nomenclatural and distribution updates from other literature sources, and corrigenda

Nomenclatural and distribution updates, and corrigenda to Bartolucci et al. (2018) are provided in Suppl. material 1.

F. Bartolucci, G. Galasso

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References

Angius V (1851) Geografia, storia e statistica dell'Isola di Sardegna, voll. XVIII bis, XVIII ter, XVIII quater. In: Casalis G (Ed.) Dizionario geografico-storico-statistico-commerciale degli Stati di S.M. il Re di Sardegna. Maspero e Marzorati, Torino.

Arrigoni PV (1967) Ricerca sulla distribuzione del *Pinus halepensis* Mill. e del *Pinus pinea* L. in Sardegna. Webbia 22(2): 405–417. https://doi.org/10.1080/00837792.1967.10669869

Arrigoni PV (2006) Flora dell'Isola di Sardegna (Vol. 1). Carlo Delfino Editore, Sassari.

Bacchetta G (2006) Flora vascolare del Sulcis (Sardegna Sud-Occidentale, Italia). Guineana 12: 1–369.

Bartolucci F, Galasso G, Conti F (2020) Nomenclatural novelties and typification of names in *Scorzonera* sensu lato (Asteraceae, Cichorieae) for the Italian vascular flora. Phytotaxa 437(5): 279–290. https://doi.org/10.11646/phytotaxa.437.5.2

Bartolucci F, Domina G, Adorni M, Alessandrini A, Ardenghi NMG, Banfi E, Baragliu GA, Bernardo L, Bertolli A, Biondi E, Carotenuto L, Casavecchia S, Cauzzi P, Conti F, Crisanti MA, D'Amico FS, Di Cecco V, Di Martino L, Faggi G, Falcinelli F, Forte L, Galasso G, Gasparri R, Ghillani L, Gottschlich G, Guzzon F, Harpke D, Lastrucci L, Lattanzi E, Maiorca G, Marchetti D, Medagli P, Olivieri N, Pascale M, Passalacqua NG, Peruzzi L, Picollo S, Prosser F, Ricciardi M, Salerno G, Stinca A, Terzi M, Viciani D, Wagensommer RP, Nepi C (2017) Notulae to the Italian native vascular flora: 3. Italian Botanist 3: 29–48. https://doi.org/10.3897/italianbotanist.3.13200

Bartolucci F, Peruzzi L, Galasso G, Albano A, Alessandrini A, Ardenghi NMG, Astuti G, Bacchetta G, Ballelli S, Banfi E, Barberis G, Bernardo L, Bouvet D, Bovio M, Cecchi L, Di Pietro R, Domina G, Fascetti S, Fenu G, Festi F, Foggi B, Gallo L, Gottschlich G, Gubellini L, Iamonico D, Iberite M, Jiménez-Mejías P, Lattanzi E, Marchetti D, Martinetto E, Masin RR, Medagli P, Passalacqua NG, Peccenini S, Pennesi R, Pierini B, Poldini L, Prosser F, Raimondo FM, Roma-Marzio F, Rosati L, Santangelo A, Scoppola A, Scortegagna S, Selvaggi A, Selvi F, Soldano A, Stinca A, Wagensommer RP, Wilhalm T, Conti F (2018) An updated checklist of the vascular flora native to Italy. Plant Biosystems 152(2): 179–303. https://doi.org/10.1080/11263504.2017.1419996

Baum BR (1977) Oats: wild and cultivated. Biosystematics Research Institute, Canada, Department of Agriculture Ottawa, Monograph No. 14, Ontario, 463 pp.

Bertoloni A (1833) Flora italica (Vol. 1). Ex Typographaeo Haeredum Richardi Masii, Bononiae [Bologna], 768 pp.

Bertoloni A (1839–1841) Flora italica (Vol.4). Ex Typographaeo Haeredum Richardi Masii, Bononiae [Bologna], 799 pp.

Biondi E, Casavecchia S, Pinzi M, Allegrezza M, Baldoni M (2002) The syntaxonomy of the mesophilous woods of the Central and Northern Apennines (Italy). Fitosociologia 39(2): 71–93.

Buosi C, Pittau P, Paglietti G, Scanu GG, Serra M, Ucchesu M, Tanda G (2015) A human occupation cave during the bronze age: archaeological and palynological applications of a case study in Sardinia (western Mediterranean). Archaeometry 57(S1): 212–231. https://doi.org/10.1111/arcm.12132

Buosi C, Pittau P, Scanu GG (2016) Flora del Pleistocene della Sardegna – The Pleistocene flora of Sardinia. In: Kustatscher E, Roghi G, Bertini A, Miola A (Eds) Storia delle piante fossili in Italia. Paleobotany in Italy. Museo di Scienze Naturali dell'Alto Adige: 342–343.

Camarda I, Valsecchi F (2008) Alberi e arbusti spontanei della Sardegna. Carlo Delfino Ed., Sassari.

Conti F, Bartolucci F, Manzi A, Miglio M, Tinti D (2008) Aggiunte alla Flora d'Abruzzo: III contributo. Annali dei Musei Civici-Rovereto. Sezione Archeologia, Storia, Scienze Naturali 14 23(2007): 127–140.

De Notaris G (1844) Repertorium florae ligusticae. Ex Regia Typographia, Taurini [Torino], 495 pp. https://doi.org/10.5962/bhl.title.6657

De Rita F, Melis RT (2013) The cultural landscape near the ancient city of Tharros (central West Sardinia): vegetation changes and human impact. Journal of Archaeological Science 40: 4271–4282. https://doi.org/10.1016/j.jas.2013.06.027

Del Rio M, Pittau P (1974) Analisi palinologica di un livello argilloso delle dune di Fontanamare. Morisia 4: 3–8.

Fanelli G, Lucchese F, Paura B (2001) Le praterie a *Stipa austroitalica* di due settori adriatici meridionali (Basso Molise e Gargano). Fitosociologia 38(2): 25–36.

Fiori A (1927) Nuova Flora Analitica d'Italia (Vol. 2(5)). Tipografia M. Ricci, Firenze, 641–800.

Forte L, Cavallaro V, Pantaleo F, D'Amico FS, Macchia F (2002) The vascular Flora of the "Bosco Isola" at Lesina (Foggia-Apulia). Flora Mediterranea 12: 33–92.

Gottschlich G (2007) Die Gattung *Hieracium* L. (Compositae) im Herbarium Rupert Huter (Vinzentinum Brixen, BRIX). Kommentiertes Verzeichnis mit taxonomischen und nomenklatorischen Ergänzungen unter besonderer Berücksichtigung der Typus-Belege. Veröffentlichungen des Tiroler Landesmuseums Ferdinandeum 86: 5–416.

Gismondi A (1949) Prospetto della flora ligustica. Guida botanica della Liguria: descrizione succinta disposta in chiavi analitiche di tutte le piante vascolari che crescono spontaneamente sul suolo ligure, o vi si incontrano subspontanee o naturalizzate, oppure vi sono estesamente coltivate. Scia, Genova.

Klastersky I (1968) *Rosa* L. In: Tutin TG, Burges NA, Chater AO, Edmondson JR, Heywood VH, Moore DM, Valentine DH, Walters SM, Webb DA (Eds) Flora Europaea. 2. Cambridge University Press, 25–32.

Lazzeri V (2014) Note floristiche tosco-sarde III: novità per le regioni Toscana e Sardegna. *Quaderni del Museo di Storia Naturale di Livorno* 25(2013–2014): 67–77.

Licht W (2018) Conspectus florae garganicae praecursor, 479 pp. https://plants1.iome.uni-mainz.de/files/2019/05/Conspectus.pdf [accessed 18.04.2020]

Lucchese F (1995) Elenco preliminare della flora spontanea del Molise. Annali di Botanica (Roma) 53, Suppl. 12: 85–86.

Martini F, Bona E, Federici G, Fenaroli F, Perico G (2012) Flora vascolare della Lombardia centro-orientale (Vol. 1). Lint Editoriale, Trieste.

Melis RT, Depalmas A, Di Rita F, Montis F, Vacchi M (2017) Mid to late environmental changes along the coast of western Sardinia (Mediterranean Sea). Global and planetary change 155: 29–41. https://doi.org/10.1016/j.gloplacha.2017.06.001

Moris GG (1827) Stirpium sardoarum elenchus 1. Ex Typiis Regis, Calari [Cagliari], 55 pp.

Penzig O (1897) Florae ligusticae synopsis. Annali del Museo Civico di Storia Naturale di Genova s. 2., 18: 423–531.

Pignatti S (1982) Flora d'Italia (Vol. 1). Edagricole, Bologna.

Pignatti S, Guarino R, La Rosa M (2017) Flora d'Italia (Ed. 2, Vol. 2). Edagricole, Bologna.

Pittau P, Buosi C, Scanu GG (2018) Past environments of Sardinian archaeological sites (Italy, West Mediterranean Sea), based on palynofacies characterization. Acta Palaeobotanica 58(1): 73–93. https://doi.org/10.2478/acpa-2018-0003

Pittau P, Lugliè C, Buosi C, Sanna I, Del Rio M (2012) Palynological interpretation of the Early Neolithic coastal open-air site at Sa Punta (central-western Sardinia, Italy). Journal of Archaeological Science 39: 1260–1270. https://doi.org/10.1016/j.jas.2012.01.014

Raffaelli M (1979) Contributi alla conoscenza del genere *Polygonum* L. 2. *Polygonum bellardii* All. Webbia 33(2): 327–342. https://doi.org/10.1080/00837792.1979.10670126

Rota L (1853) Prospetto della flora della della provincia di Bergamo. Tipografia Mazzoleni, Bergamo.

Turland NJ, Wiersema JH, Barrie FR, Greuter W, Hawksworth DL, Herendeen PS, Knapp S, Kusber W-H, Li D-Z, Marhold K, May TW, McNeill J, Monro AM, Prado J, Price MJ, Smith GF [Eds] (2018) International Code of Nomenclature for algae, fungi, and plants (Shenzhen Code) adopted by the Nineteenth International Botanical Congress Shenzhen, China, July 2017. Regnum Vegetabile 159: 1–254. https://doi.org/10.12705/Code.2018

Vita F (1989) Analisi della vegetazione spontanea del bosco «Farne Grandi» presso Farneta, frazione di Castroregio (Cosenza). Monti e Boschi 40(3): 55–59.

Vita F, D'Errico P (1981) I boschi dei comuni di Castroregio e Oriolo (Calabria): ricerche fitogeografiche e vegetazionali; proposte per l'intervento e verifica di rimboschimenti l'arboricoltura da legno. Annali della Facoltà di Agraria dell'Università di Bari 32: 677–706.

Zidorn C (2012) *Leontodon* and *Scorzoneroides* (Asteraceae, Cichorieae) in Italy. Plant Biosystems 146(suppl.1): 41–51. https://doi.org/10.1080/11263504.2012.710272

Supplementary material 1

Supplementary data

Authors: Fabrizio Bartolucci, Gabriele Galasso

Data type: species data

Explanation note: 1. Nomenclatural updates. 2. Distribution updates. 3. Synonyms, misapplied or included names. 4. Notes to Notulae to the Italian native vascular flora: 8 (Bartolucci et al. 2019).

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RESEARCH ARTICLE

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

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Abstract

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

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

Keywords

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

Introduction

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

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

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

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

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

Study area

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

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

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

Geology

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

Climate

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

Vegetation types

The vegetation is mainly composed of forests, shrublands, and grasslands (Francalancia 1976; Venanzoni and Kwiatowski 1994; Venanzoni et al. 1999; Borfecchia et al. 2003; Gafta 2006; Suppl. material 1: 1.3). Forest communities cover the slopes of the lower Val di Tazza. *Ostrya carpinifolia* Scop. forests and mixed forests with *O. carpinifolia* and *Quercus pubescens* Willd. are widespread up to about 1,000 m in north-facing and south-facing slopes, respectively; *Fagus sylvatica* L. forests extend over about 1,000 m a.s.l. Grasslands are widespread on the slopes and semi-flat lands of the upper Val di Tazza, interrupted by beech copses and shrubland communities characterised by *Cytisophyllum sessilifolium* (L.) O.Lang, *Spartium junceum* L., and *Prunus spinosa* L. The main grassland types are characterized by *Bromopsis erecta* (Huds.) Fourr. on the south-facing slopes, *Sesleria nitida* Ten. on the driest and steepest slopes with shallow soils, *B. erecta* and *Briza media* L. on north-facing slopes and semi-flat lands of the mountain tops, *Brachypodium rupestre* (Host) Roem. & Schult., on deeper soil conditions. There are *Cynosurus cristatus* L. dominated hay meadows, mown in July and then open to cattle grazing, in a small area of the upper Val di Tazza. Other habitats include rocky walls and gorges with *Quercus ilex* L. shrubs and chasmophytic vegetation, nitrophilous and hygro-nitrophilous communities, ruderal environments, and some springs and small depressions with stagnant water.

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

Materials and methods

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

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

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

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

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

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

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

Results

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

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

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

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

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

Discussion

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

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

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

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

Conclusions

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

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

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

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

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References

Aeschimann D, Lauber K, Moser DM, Theurillat JP (2004) Flora alpina, Vols. 1–3. Zanichelli, Bologna.

Ardenghi NMG, Galasso G, Banfi E, Zoccola A, Foggi B, Lastrucci L (2014) A taxonomic survey of the genus *Vitis* L. (Vitaceae) in Italy, with special reference to Elba Island (Tuscan Archipelago). Phytotaxa 166(3): 163–198. https://doi.org/10.11646/phytotaxa.166.3.1

Ardenghi NMG, Banfi E, Galasso G (2015a) A taxonomic survey of the genus *Vitis* L. (Vitaceae) in Italy, part II: the 'Euro-American' hybrids. Phytotaxa 224(3): 232–246. https://doi.org/10.11646/phytotaxa.224.3.2

Ardenghi NMG, Galasso G, Banfi E, Cauzzi P (2015b) *Vitis* × *novae-angliae* (Vitaceae): systematics, distribution and history of an "illegal" alien grape in Europe. Willdenowia 45(2): 197–207. https://doi.org/10.3372/wi.45.45206

Arnelas I, Devesa J A (2011) Revisión taxonómica de *Centaurea* sect. *Jacea* (Mill.) Pers. (Asteraceae) en la Península Ibérica. Acta Botanica Malacitana 36(1): 33–88. https://doi.org/10.24310/abm.v36i1.2775

Arrigoni PV (2014) Revisione tassonomica e corologica del genere *Poygala* in Italia. Informatore Botanico Italiano 46(2): 235–263.

Ballelli S, Francalancia C (1982) La flora della Riserva naturale di Torricchio. La Riserva Naturale di Torricchio 5: 3–73.

Ballelli S, Francalancia C (1987) Dati aggiuntivi alla flora di Torricchio. La Riserva Naturale di Torricchio 7: 3–13.

Bartolelli K, Dell'Uomo A, Torrisi MC (2003) Inventario delle alghe della Riserva naturale di Torricchio. In AA.VV. Università degli Studi di Camerino, Trentennale della Riserva naturale di Torricchio (1970–2000). La Riserva Naturale di Torricchio 11: 415–426.

Bartolucci F, Domina G, Ardenghi NMG, Bacchetta G, Bernardo L, Buccomino G, Buono S, Caldararo F, Calvia G, Carruggio F, Cavagna A, D'Amico FS, Di Carlo F, Festi F, Forte L, Galasso G, Gargano D, Gottschlich G, Lazzaro L, Magrini S, Maiorca G, Medagli P, Mei G, Mennini F, Mereu G, Miserocchi D, Olivieri N, Passalacqua NG, Pazienza G, Peruzzi L, Prosser F, Rempicci M, Roma-Marzio F, Ruggero A, Sani A, Saulle D, Steffanini C, Stinca A, Terzi M, Tondi G, Trenchi M, Viciani D, Wagensommer RP, Nepi C (2018a) Notulae to the Italian native vascular flora: 6. Italian Botanist 6: 45–64. https://doi.org/10.3897/italianbotanist.6.30575

Bartolucci F, Domina G, Ardenghi NMG, Banfi E, Bernardo L, Bonari G, Buccomino G, Calvia G, Carruggio F, Cavallaro V, Chianese G, Conti F, Facioni L, Del Vico E, Di Gristina E, Falcinelli, F, Forte L, Gargano D, Mantino F, Martino M, Mei G, Mereu G, Olivieri N, Passalacqua NG, Pazienza G, Peruzzi L, Roma-Marzio F, Scafidi F, Scoppola A, Stinca A, Nepi C (2018b) Notulae to the Italian native vascular flora: 5. Italian Botanist 5: 71–81. https://doi.org/10.3897/italianbotanist.5.25892

Bartolucci F, Peruzzi L, Galasso G, Albano A, Alessandrini A, Ardenghi NMG, Astuti G, Bacchetta G, Ballelli S, Banfi E, Barberis G, Bernardo L, Bouvet D, Bovio M, Cecchi L, Di Pietro R, Domina G, Fascetti S, Fenu G, Festi F, Foggi B, Gallo L, Gottschlich G, Gubellini L, Iamonico D, Iberite M, Jiménez-Mejías P, Lattanzi E, Marchetti D, Martinetto E, Masin RR, Medagli P, Passalacqua NG, Peccenini S, Pennesi R, Pierini B, Poldini L, Prosser F, Raimondo FM, Roma-Marzio F, Rosati L, Santangelo A, Scoppola A, Scortegagna S, Selvaggi A, Selvi F, Soldano A, Stinca A, Wagensommer RP, Wilhalm T, Conti F (2018c) An updated checklist of the vascular flora native to Italy. Plant Biosystems 152(2): 179–303. https://doi.org/10.1080/11263504.2017.1419996

Bartolucci F, Domina G, Alessandrini A, Angiolini C, Ardenghi NMG, Bacchetta G, Banfi E, Bolpagni R, Bonari G, Bräuchler C, Calvia G, Cancellieri L, Cannucci S, Carruggio F, Conti F, Cavallaro V, Fanfarillo E, Ferretti G, Festi F, Fiaschi T, Foggi B, Forte L, Fröhner SE, Galasso G, Gestri G, Gottschlich G, Labadessa R, Lastrucci L, Lazzaro L, Mereu G, Morabito A, Mugnai M, Musarella CM, Orsenigo S, Pazienza G, Pennesi R, Peruzzi L, Pierini B, Podda L, Prosser F, Rossi G, Scoppola A, Spampinato G, Stinca A, Tomaselli V, Zangari G, Nepi C (2019a) Notulae to the Italian native vascular flora: 7. Italian Botanist 7: 125–148. https://doi.org/10.3897/italianbotanist.7.36148

Bartolucci F, Domina G, Ardenghi NMG, Bacaro G, Bacchetta G, Ballarin F, Banfi E, Barberis G, Beccarisi L, Bernardo L, Bonari G, Bonini F, Brullo S, Buono S, Buono V, Calbi M, Caldararo F, Calvia G, Cancellieri L, Cannavò S, Dagnino D, Esposito A, Fascetti S, Filibeck G, Fiorini G, Forte L, Galasso G, Gestri G, Gigante D, Gottschlich G, Gubellini L, Hofmann N, Lastrucci L, Lonati M, Lorenz R, Lunardi L, Magrini S, Mainetti A, Maiorca G, Mereu G, Messa Ballarin RT, Minuto L, Mossini S, Musarella CM, Nimis PL, Passalacqua NG, Peccenini S, Petriglia B, Podda L, Potenza G, Ravetto Enri S, Roma-Marzio F, Rosati L, Ruggero A, Spampinato G, Stinca A, Tiburtini M, Tietto C, Tomaselli V, Turcato C, Viciani D, Wagensommer RP, Nepi C (2019b) Notulae to the Italian native vascular flora: 8. Italian Botanist 8: 95–116. https://doi.org/10.3897/italianbotanist.8.48626

Bartolucci F, Galasso G, Conti F (2020) Nomenclatural novelties and typification of names in *Scorzonera* sensu lato (Asteraceae, Cichorieae) for the Italian vascular flora. Phytotaxa 437(5): 279–290. https://doi.org/10.11646/phytotaxa.437.5.2

Borfecchia F, De Cecco L, Dibari C, Iannetta M, Martini S, Pedrotti F, Schino G (2003) Carta della vegetazione reale della "Riserva Naturale di Torricchio" ottenuta mediante elaborazione di immagini satellitari multispettrali. La Riserva Naturale di Torricchio 11: 359–369.

Bracchetti L, Carotenuto L, Catorci A (2012) Land-cover changes in a remote area of central Apennines (Italy) and management directions. Landscape and Urban Planning 104(2): 157–170. https://doi.org/10.1016/j.landurbplan.2011.09.005

Brilli-Cattarini AJB, Ballelli S, Gubellini L, Taffetani F (2005) Aggiornamento sullo stato delle conoscenze floristiche delle Marche. In: Scoppola A, Blasi C (Eds) Stato delle Conoscenze sulla Flora Vascolare d'Italia. Palombi & Partener S.r.l., Roma: 147–150.

Brullo S, Giusso Del Galdo GP, Minissale P (2009) Taxonomic revision of the *Koeleria splendens* C. Presl group (Poaceae) in Italy based on morphological characters. Plant Biosystems 143(1): 140–161. https://doi.org/10.1080/11263500802709764

Canullo R, Venanzoni R (1989) Studio preliminare della struttura di una popolazione di *Cytisus sessilifolius* L. nella Riserva Naturale di Torricchio Appennino centrale, Italia. Società Italiana di Ecologia Atti 7: 761–766.

Canullo R, Spada F (1996) La memoria di un paesaggio scomparso nel comportamento di arbusti invasivi. In: Ingegnoli V, Pignatti S (Eds) L'ecologia del paesaggio in Italia. Città Studi Edizioni, Milano, 131–143.

Castroviejo S, Aedo C, Ciruiano S, Lainz M, Montserrat P, Morales R, Muñoz Garmendia F, Navarro C, Paiva J, Soriano C (1986–2019) Flora Iberica. Real Jardìn Botanico, CSIC, Madrid.

Catorci A, Foglia M, Tardella FM, Vitanzi A, Sparvoli D, Gatti R, Galli P, Paradisi L (2012a) Map of changes in landscape naturalness in the Fiastra and Salino catchment basins (central Italy). Journal of Maps 8(1): 97–106. https://doi.org/10.1080/17445647.2012.668769

Catorci A, Gatti R, Cesaretti S (2012b) Effect of sheep and horse grazing on species and functional composition of sub-Mediterranean grasslands. Applied Vegetation Science 15(4): 459–469. https://doi.org/10.1111/j.1654-109X.2012.01197.x

Cervellini M, Fiorini S, Cavicchi A, Campetella G, Simonetti E, Chelli S, Canullo R, Gimona A (2017) Relationships between understory specialist species and local management practices in coppiced forests – Evidence from the Italian Apennines. Forest ecology and management 385: 35–45. https://doi.org/10.1016/j.foreco.2016.11.027

Chelli S, Canullo R, Campetella G, Schmitt AO, Bartha S, Cervellini M, Wellstein C (2016) The response of sub-Mediterranean grasslands to rainfall variation is influenced by early season precipitation. Applied Vegetation Science 19(4): 611–619. https://doi.org/10.1111/avsc.12247

Chelli S, Simonetti E, Campetella G, Chiarucci A, Cervellini M, Tardella FM, Tomasella M, Canullo R (2019) Plant diversity changes in a nature reserve: a probabilistic sampling method for quantitative assessments. Nature Conservation 34: 145–161. https://doi.org/10.3897/natureconservation.34.30043

Chrtekjun J (1992) Taxonomical remarks on the *Stachys recta* group. Folia Geobotanica et Phytotaxonomica 27(2): 177–183. https://doi.org/10.1007/BF02856248

Conti F, Proietti E, Chidozie Ogwu M, Gubellini L, Bartolucci F (2019) Re-evaluation of *Senecio apenninus* (Asteraceae, Senecioneae). Willdenowia 49(3): 329–341. https://doi.org/10.3372/wi.49.49304

Deiana G, Pieruccini U (1976) Geologia e geomorfologia della Montagna di Torricchio. La Riserva Naturale di Torricchio 1: 27–76.

Del Carratore F, Garbari F, Jarvis C (1998) The application of the Linnaean names *Salvia pratensis*, *S. agrestis*, *S. haematodes*, *S. verbenaca* and *S. clandestina* (Lamiaceae). Plant Biosystems 132(2): 169–176. https://doi.org/10.1080/11263504.1998.10654201

Fiori A (1923–1929) Nuova Flora Analitica d'Italia, Vols. 1–3. Tipografia M. Ricci, Firenze.

Francalancia C (1976) Carta della vegetazione della Riserva Naturale di Torricchio. La Riserva Naturale di Torricchio 1: 77–98.

Francalancia C, Galli P, Paradisi L (1995) Variazioni nella composizione floristica dei prati a *Cynosurus cristatus* L. delle alte Valli di Tazza e di Fematre (Appennino marchigiano), in rapporto alle pratiche colturali. Fitosociologia 29(1): 89–93.

Gafta D (2006) Vegetation landscape patterns in the Torricchio Natural Reserve: implication for biological conservation. La Riserva Naturale di Torricchio 12: 61–80.

Galasso G, Conti F, Peruzzi L, Ardenghi NMG, Banfi E, Celesti-Grapow L, Albano A, Alessandrini A, Bacchetta G, Ballelli S, Bandini Mazzanti M, Barberis G, Bernardo L, Blasi C, Bouvet D, Bovio M, Cecchi L, Del Guacchio E, Domina G, Fascetti S, Gallo L, Gubellini L, Guiggi A, Iamonico D, Iberite M, Jiménez-Mejías P, Lattanzi E, Marchetti D, Martinetto E, Masin RR, Medagli P, Passalacqua NG, Peccenini S, Pennesi R, Pierini B, Podda L, Poldini L, Prosser F, Raimondo FM, Roma-Marzio F, Rosati L, Santangelo A, Scoppola A, Scortegagna S, Selvaggi A, Selvi F, Soldano A, Stinca A, Wagensommer RP, Wilhalm T, Bartolucci F (2018a) An updated checklist of the vascular flora alien to Italy. Plant Biosystems 152(3): 556–592. https://doi.org/10.1080/11263504.2018.1441197

Galasso G, Domina G, Adorni M, Ardenghi NMG, Bonari G, Buono S, Cancellieri L, Chianese G, Ferretti G, Fiaschi T, Forte L, Guarino R, Labadessa R, Lastrucci L, Lazzaro L, Magrini S, Minuto L, Mossini S, Olivieri N, Scoppola A, Stinca A, Turcato C, Nepi C (2018b) Notulae to the Italian alien vascular flora: 5. Italian Botanist 5: 45–56. https://doi.org/10.3897/ib.5.25910

Galasso G, Domina G, Alessandrini A, Ardenghi NMG, Bacchetta G, Ballelli S, Bartolucci F, Brundu G, Buono S, Busnardo G, Calvia G, Capece P, D'Antraccoli M, Di Nuzzo L, Fanfarillo E, Ferretti G, Guarino R, Iamonico D, Iberite M, Latini M, Lazzaro L, Lonati M, Lozano V, Magrini S, Mei G, Mereu G, Moro A, Mugnai M, Nicolella G, Nimis PL, Olivieri H, Pennesi R, Peruzzi L, Podda L, Probo M, Prosser F, Ravetto Enri S, Roma-Marzio F, Ruggero A, Scafidi F, Stinca A, Nepi C (2018c) Notulae to the Italian alien vascular flora: 6. Italian Botanist 6: 65–90. https://doi.org/10.3897/italianbotanist.6.30560

Galasso G, Domina G, Andreatta S, Angiolini C, Ardenghi NMG, Aristarchi C, Arnoul M, Azzella MM, Bacchetta G, Bartolucci F, Bodino S, Bommartini G, Bonari G, Buono S, Buono V, Caldarella O, Calvia G, Corti E, D'Antraccoli M, De Luca R, De Mattia F, Di Natale S, Di Turi A, Esposito A, Ferretti G, Fiaschi T, Fogu MC, Forte L, Frigerio J, Gubellini L, Guzzetti L, Hofmann N, Laface VLA, Laghetti G, Lallai A, La Rosa A, Lazzaro L, Lodetti S, Lonati M, Luchino F, Magrini S, Mainetti A, Marignani M, Maruca G, Medagli P, Mei G, Menini F, Mezzasalma V, Misuri A, Mossini S, Mugnai M, Musarella CM, Nota G, Olivieri N, Padula A, Pascale M, Pasquini F, Peruzzi L, Picella G, Pinzani L, Pirani S, Pittarello M, Podda L, Ravetto Enri S, Rifici CD, Roma-Marzio F, Romano R, Rosati L, Scafidi F, Scarici E, Scarici M, Spampinato G, Stinca A, Wagensommer RP, Zanoni G, Nepi C (2019a) Notulae to the Italian alien vascular flora: 8. Italian Botanist 8: 63–93. https://doi.org/10.3897/italianbotanist.8.48621

Galasso G, Domina G, Ardenghi NMG, Aristarchi C, Bacchetta G, Bartolucci F, Bonari G, Bouvet D, Brundu G, Buono S, Caldarella O, Calvia G, Cano-Ortiz A, Corti E, D'Amico FS, D'Antraccoli M, Di Turi A, Dutto M, Fanfarillo E, Ferretti G, Fiaschi T, Ganz C, Guarino R, Iberite M, Laface VLA, La Rosa A, Lastrucci L, Latini M, Lazzaro L, Lonati M, Lozano V, Luchino F, Magrini S, Mainetti A, Manca M, Mugnai M, Musarella CM, Nicolella G, Olivieri N, Orrù I, Pazienza G, Peruzzi L, Podda L, Prosser F, Ravetto Enri S, Restivo S, Roma-Marzio F, Ruggero A, Scoppola A, Selvi F, Spampinato G, Stinca A, Terzi M, Tiburtini M, Tornatore E, Vetromile R, Nepi C (2019b) Notulae to the Italian alien vascular flora: 7. Italian Botanist 7: 157–182. https://doi.org/10.3897/italianbotanist.7.36386

Garbari F, Giovannini A, Marchetti D (2003) Biosystematics, taxonomy and phytogeography of the Pterodological Flora of the Monte Pisano (NW Tuscany, Italy). Bocconea 16: 41–53. http://www.herbmedit.org/bocconea/16-0041.pdf

Garbari F, Bedini G, Ansaldi M, Marchetti D (2007) Fitogeografia apuana. Aggiornamenti biosistematici, tassonomici e corologici sulle Spermatophyta endemiche, relitte e critiche. Biogeographia 28(1): 177–204. https://doi.org/10.21426/B6110043

Grau J (1970) Cytotaxonomische bearbeitung der gattung Myosotis L. IV Erganzende Studien. Mitteilungen der Botanischen Staatssammlung München VIII: 127–136.

Ivan D, Donita N, Gafta D, Canullo R (1994) La struttura dei pascoli a *Sesleria nitida* nella Riserva Naturale di Torricchio. La Riserva Naturale di Torricchio 9: 41–70.

Kwiatkowski W, Venanzoni R (1994) Carta dei Suoli della Riserva naturale di Torricchio (Appennino centrale). La Riserva Naturale di Torricchio 9: 15–21.

Malatesta L, Tardella FM, Tavoloni M, Postiglione N, Piermarteri K, Catorci A (2019) Land use change in the high mountain belts of the central Apennines led to marked changes of the grassland mosaic. Applied Vegetation Science 22(2): 243–255. https://doi.org/10.1111/avsc.12416

Malavasi M, Acosta A, Carranza ML, Bartolozzi L, Basset A, Bassignana M, Campanaro A, Canullo R, Carruggio F, Cavallaro V, Cianferoni F, Cindolo C, Cocciuffa C, Corriero G, D'Amico FS, Forte L, Freppaz M, Mantino F, Matteucci G, Pierri C, Stanisci A, Colangelo P (2018) Plant invasions in Italy: An integrative approach using the European LifeWatch infrastructure database. Ecological Indicators 91: 182–188. https://doi.org/10.1016/j.ecolind.2018.03.038

Orsenigo S, Montagnani C, Fenu G, Gargano D, Peruzzi L, Abeli T, Alessandrini A, Bacchetta G, Bartolucci F, Bovio M, Brullo C, Brullo S, Carta A, Castello M, Cogoni D, Conti F, Domina G, Foggi B, Gennai M, Gigante D, Iberite M, Lasen C, Magrini S, Perrino EV, Prosser F, Santangelo A, Selvaggi A, Stinca A, Vagge I, Villani MC, Wagensommer RP, Wilhalm T, Tartaglini N, Duprè E, Blasi C, Rossi G (2018) Red Listing plants under full national responsibility: extinction risks and threats in the vascular flora endemic to Italy. Biological Conservation 224: 213–222. https://doi.org/10.1016/j.biocon.2018.05.030

Orsenigo S, Fenu G, Gargano D, Montagnani C, Abeli T, Alessandrini A, Bacchetta G, Bartolucci F, Carta A, Castello M, Cogoni D, Conti F, Domina G, Foggi B, Gennai M, Gigante D, Iberite M, Peruzzi L, Pinna MS, Prosser F, Santangelo A, Selvaggi A, Stinca A, Villani M, Wagensommer RP, Tartaglini N, Duprè E, Blasi C, Rossi G (2020) Red list of threatened vascular plants in Italy. Plant Biosystems [e-published 26 Mar 2020]. https://doi.org/10.1080/11263504.2020.1739165

Orsomando E, Catorci A, Pitzalis M, Raponi M (2000) The phytoclimate of Umbria. Parlatorea 4: 5–24.

Panfili M (2003) Flora lichenica della Riserva naturale "Montagna di Torricchio". In AA.VV. Università degli Studi di Camerino, Trentennale della Riserva naturale di Torricchio (1970–2000). La Riserva Naturale di Torricchio 11: 427–436.

Paolucci L (1890) Flora marchigiana. Tip. Federici, Pesaro, 656 pp.

Pedrotti F (1978) Einige bemerkungen über die Entwicklung der Vegetation im Naturreservat von Torricchio. Phytocenosis 7: 11–19.

Pedrotti F (1981) La Riserva Naturale di Torricchio dal 1977 al 1981. La Riserva Naturale di Torricchio 4: 3–21.

Pedrotti F (1994) La Riserva Naturale di Torricchio dal 1982 al 1994. La Riserva Naturale di Torricchio 8: 3–18.

Pedrotti F (2010) La Riserva Naturale di Torricchio 1970–2010. Temi Editrice, Trento, 516 pp.

Peruzzi L, Bartolucci F, Frignani F, Minutillo F (2007) *Gagea tisoniana*, a new species of *Gagea* Salisb. sect. *Gagea* (Liliaceae) from central Italy. Botanical Journal of the Linnean Society 155(3): 337–347. https://doi.org/10.1111/j.1095-8339.2007.00710.x

Peruzzi L, Conti F, Bartolucci F (2014) An inventory of vascular plants endemic to Italy. Phytotaxa 168: 1–75. https://doi.org/10.11646/phytotaxa.168.1.1

Peruzzi L, Domina G, Bartolucci F, Galasso G, Peccenini S, Raimondo FM, Albano A, Alessandrini A, Banfi E, Barberis G, Bernardo L, Bovio M, Brullo S, Brundu G, Brunu A, Camarda I, Conti F, Croce A, Iamonico D, Iberite M, Iiriti G, Longo D, Manca A, Marsili S, Medagli P, Pistarino A, Salmeri C, Santangelo A, Scassellati E, Selvi F, Soldano A, Stinca A, Vacca G, Villani MC, Wagensommer RP, Passalacqua NG (2015) An inventory of the names of vascular plants endemic to Italy, their loci classici and types. Phytotaxa 196: 1–217. https://doi.org/10.11646/phytotaxa.196.1.1

Pesaresi S, Biondi E, Casavecchia S (2017) Bioclimates of Italy. Journal of maps 13(2): 955–960. https://doi.org/10.1080/17445647.2017.1413017

Pichi-Sermolli REG (1948) Flora e vegetazione delle serpentine e delle altre ofioliti dell’alta Valle del Tevere (Toscana). Webbia 6(1): 3–378. https://doi.org/10.1080/00837792.1948.10669585

Pignatti S (1982) Flora d’Italia, Vols. 1–3. Edagricole, Bologna.

Pignatti S, Guarino R, La Rosa M (2017a) Flora d’Italia. Ed. 2, Vol. 1. Edagricole, Bologna, 1064 pp.

Pignatti S, Guarino R, La Rosa M (2017b) Flora d’Italia. Ed. 2, Vol. 2. Edagricole, Bologna, 1178 pp.

Pignatti S, Guarino R, La Rosa M (2018) Flora d’Italia. Ed. 2, Vol. 3. Edagricole, Bologna, 1287 pp.

Pignatti S, Guarino R, La Rosa M (2019) Flora d’Italia. Ed. 2, Vol. 4. Edagricole, Bologna, 1054 pp.

Pinzi M (1995) I pascoli della Riserva Naturale di Torricchio. Tesi sperimentale in Ecologia Vegetale, Scienze Naturali, Università di Camerino.

Puppi G, Cristofolini G (1996) Systematic of the Complex *Pulmonaria saccharata-P. vallarsae* and Related Species (Boraginaceae). Webbia 51(1): 1–20. https://doi.org/10.1080/00837792.1996.10670611

Rizzi G, Giordani P (2010) Contributo alla conoscenza della flora lichenica della Riserva Naturale di Torricchio. La Riserva Naturale di Torricchio 13: 147–154.

Rogora M, Frate L, Carranza M.L, Freppaz M, Stanisci A, Bertani I, Bottarin R, Brambilla A, Canullo R, Carbognani M, Cerrato C, Chelli S, Cremonese E, Cutini M, Di Musciano M, Erschbamer B, Godone D, Iocchi M, Isabellon M, Magnani A, Mazzola L, Morra di Cella U, Pauli H, Petey M, Petriccione B, Porro F, Psenner R, Rossetti G, Scotti A, Sommaruga R, Tappeiner U, Theurillat J.-P, Tomaselli M, Viglietti D, Viterbi R, Vittoz P, Winkler M, Matteucci G (2018) Assessment of climate change effects on mountain ecosystems through a cross-site analysis in the Alps and Apennines. Science of the Total Environment 624: 1429–1442. https://doi.org/10.1016/j.scitotenv.2017.12.155

Roma-Marzio F, Astuti G, Peruzzi L (2015) Taxonomy, typification and karyology of *Crepis lacera* (Asteraceae). Phytotaxa 208(1): 45–54. https://doi.org/10.11646/phytotaxa.208.1.4

Roma-Marzio F, Najar B, Alessandri J, Pistelli L, Peruzzi L (2017) Taxonomy of prickly juniper (*Juniperus oxycedrus* group): A phytochemical–morphometric combined approach at the contact zone of two cryptospecies. Phytochemistry 141: 48–60. https://doi.org/10.1016/j.phytochem.2017.05.008

Rossi G, Montagnani C, Gargano D, Peruzzi L, Abeli T, Ravera S, Cogoni A, Fenu G, Magrini S, Gennai M, Foggi B, Wagensommer RP, Venturella G, Blasi C, Raimondo FM, Orsenigo S (2013) Lista Rossa della Flora Italiana. 1. Policy Species e altre specie minacciate. Comitato Italiano IUCN e Ministero dell’Ambiente e della Tutela del Territorio e del Mare, 1–58.

Staffolani L, Hruska K (2008) Ricerche sulla flora allergenica dell’Appennino centrale: l’esempio della Riserva naturale di Torricchio. L’Uomo e l’Ambiente 50: 1–29.

Tacchi R, Cortini Pedrotti C, Aleffi M (2006) Flora briologica della Riserva Naturale “Montagna di Torricchio”. La Riserva Naturale di Torricchio 12: 25–59.

Tardella FM, Catorci A (2015) Context-dependent effects of abandonment vs. grazing on functional composition and diversity of sub-Mediterranean grasslands. Community Ecology 16(2): 254–266. https://doi.org/10.1556/168.2015.16.2.13

Tison J-M, de Foucault B (2014) Flora Gallica. Flore de France. Biotope Éditions, Mèze, 1195 pp.

Tornadore N, Garbari F (1979) Il genere *Ornithogalum* L. (Liliaceae) in Italia. 3. Contributo alla revisione citotassonomica. Webbia 33(2): 379–423. https://doi.org/10.1080/00837792.1979.10670128

Troiani N, Tardella FM, Malatesta L, Corazza M, Ferrari C, Catorci A (2016) Long-term cropland abandonment does not lead per se to the recovery of semi-natural herb communities deemed habitats of community interest. Acta Botanica Croatica 75(2): 226–235. https://hrcak.srce.hr/166906

Tutin TG, Burges NA, Chater AO, Edmondson JR, Heywood VH, Moore DM, Valentine DH, Walters SM, Webb DA (1993) Flora Europaea, Vol. 1. 2nd Ed. Cambridge, University Press, Cambridge.

Tutin TG, Heywood VH, Burges NA, Moore DM, Valentine DH, Walters SM, Webb DA (Eds) (1964–80) Flora Europaea, Vols. 1–5. 1st Ed. Cambridge University Press, Cambridge.

Venanzoni R (2003) Prime valutazioni dei dati climatici della Riserva naturale di Torricchio. La Riserva Naturale di Torricchio 11: 437–444.

Venanzoni R, Kwiatowski W (1994) Carta delle serie di vegetazione della Riserva Naturale di Torricchio (Appennino centrale). La Riserva Naturale di Torricchio 9: 23–30.

Venanzoni R, Kwiatkowski W, Kaomocki A (1999) The geographic information system as a tool to archive field and cartographic data in the "Montagna di Torricchio" Natural Reserve (Central Italy). Phytocoenosis (Suppl Cart Geobot) 11: 191–197.

Wellstein C, Campetella G, Spada F, Chelli S, Mucina L, Canullo R, Bartha S (2014) Context-dependent assembly rules and the role of dominating grasses in semi-natural abandoned sub-Mediterranean grasslands. Agriculture, ecosystems & environment 182: 113–122. https://doi.org/10.1016/j.agee.2013.12.016

Zangheri P (1976) Flora italica, Vols 1–2. Cedam, Padova.

Supplementary material 1

Supplementary materials

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RESEARCH ARTICLE

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Chromosome numbers for the Italian flora: 9

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Abstract

In this contribution, new chromosome data obtained on material collected in Italy are presented. It includes counts from six populations of three taxa within the genus *Pulmonaria*, two of which are endemic to Italy (*P. vallarsae* subsp. *apennina* and *P. vallarsae* subsp. *vallarsae*); the other is the widespread European *P. officinalis*. In addition, two counts from *Potentilla detommasii* and *Stachys thirkei*, two eastern Mediterranean species, are also reported.

Keywords

cytogeography, cytotaxonomy, Emilia-Romagna, Friuli Venezia Giulia, Marche, Toscana, Trentino-Alto Adige

How to contribute

Texts concerning new chromosome data should be submitted electronically to Giovanni Astuti (gastuti@biologia.unipi.it), including indications on voucher specimens and methods used.

Chromosome counts

Boraginaceae

Pulmonaria vallarsae A.Kern. subsp. *apennina* (Cristof. & Puppi) Cecchi & Selvi

Chromosome number. 2*n* = 22 (Figs 1a, 2)

Voucher specimen. Italy. Toscana. Molino del Pallone (Sambuca Pistoiese, Pistoia), sulla sponda toscana del fiume Reno (WGS84: 44.100658N, 10.962573E), margine di bosco, ca. 500 m s.l.m., 5 April 2019, *L. Liu & G. Astuti* (PI n° 034194–034202); Passo del Muraglione (San Godenzo, Firenze), sulla SS67 scendendo verso San Benedetto in Alpe (WG84: 43.935302N, 11.658088E), ca. 900 m s.l.m., 9 April 2019, *L. Liu & G. Astuti* (PI n° 034203–034214).

Chromosome number. 2*n* = 28 (Fig. 1b)

Voucher specimen. Italy. Toscana. Molino del Pallone (Sambuca Pistoiese, Pistoia), sulla sponda toscana del fiume Reno (WGS84: 44.100658N, 10.962573E), margine di bosco, ca. 500 m s.l.m., May 2015, *P. Pupillo* (plant only temporarily cultivated at the Botanic Garden of Pisa University).

Method. Squash preparations were made on root tips obtained from potted plants. 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. The overall morphology of these plants is congruent with *P. vallarsae* subsp. *apennina*, a subspecies endemic to peninsular Italy (Cecchi and Selvi 2015). In the population from Molino del Pallone we found ten individuals showing 2*n* = 22 (Fig. 1a) and one individual with 2*n* = 28 chromosomes (Fig. 1b). Vosa and Pistolesi (2004) found a few individuals with an intermediate chromosome number (2*n* = 26)

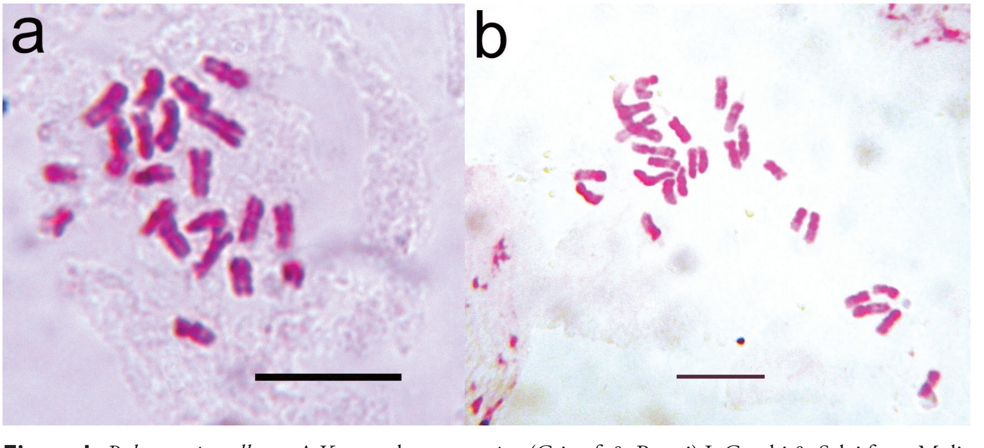

Figure 1. *Pulmonaria vallarsae* A.Kern. subsp. *apennina* (Cristof. & Puppi) L.Cecchi & Selvi from Molino del Pallone (Sambuca Pistoiese, Pistoia), 2*n* = 22 (**a**) and 2*n* = 28 (**b**). Scale bar: 10 μm.

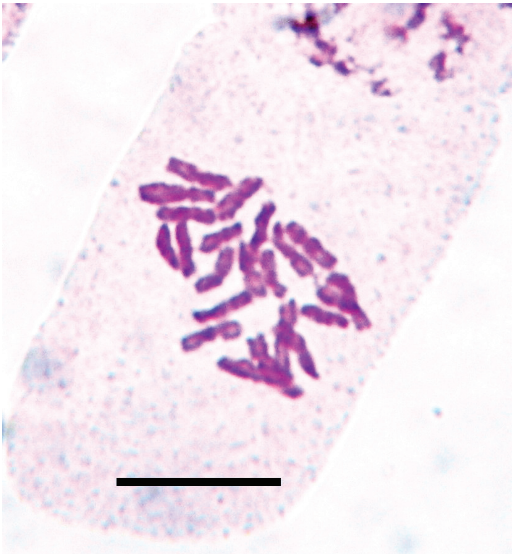

Figure 2. *Pulmonaria vallarsae* A.Kern. subsp. *apennina* (Cristof. & Puppi) L.Cecchi & Selvi from Passo del Muraglione (San Godenzo, Firenze), $2n = 22$. Scale bar: 10 μm.

among plants showing $2n = 22$ chromosomes at Passo del Muraglione. However, in the present study, we found there only plants with $2n = 22$ chromosomes (12 individuals studied). In both cases, we highlight the rarity of chromosome numbers different from $2n = 22$, which is typical of *P. vallarsae* subsp. *apennina*, although a population showing $2n = 26$ chromosomes has been recently recorded from Abruzzo (Astuti et al. 2019).

Pulmonaria vallarsae A.Kern. subsp. *vallarsae*

Chromosome number. $2n = 22$ (Figs 3, 4)

Voucher specimen. Italy. Trentino-Alto Adige. Pian delle Fugazze (Vallarsa, Trento) (WGS84: 45.760208N, 11.171882E), ca. 1160 m s.l.m., 17 April 2019, *L. Liu & G. Astuti* (PI n° 034215–034219); Alla sorgente del Cop, Bellaria di Cei (Villa Lagarina, Trento) (WGS84: 45.96022N, 11.04163E), ca. 900 m s.l.m., 17 July 2019, *L. Liu & G. Astuti* (PI n° 034220–034222).

Method. Squash preparations were made on root tips obtained from potted plants. 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. *Pulmonaria vallarsae* subsp. *vallarsae* is endemic to Trentino-Alto Adige and Veneto (Cecchi and Selvi 2015), and it was described by Kerner (1878) on plants occurring in Vallarsa, the valley of the river Leno situated southeast of Rovereto, which is the *locus classicus* for this species (Puppi and Cristofolini 1996). Pian delle Fugazze, the northern summit of the valley, is among the localities cited in the protologue.

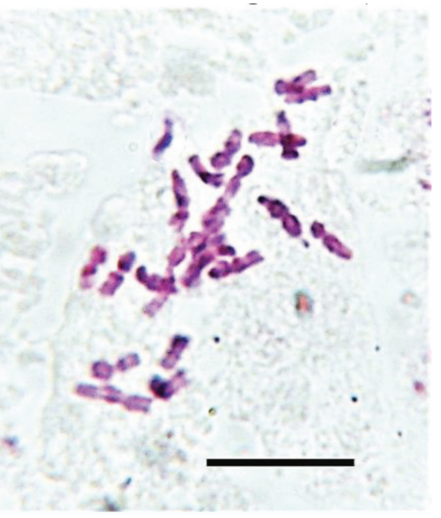

Figure 3. *Pulmonaria vallarsae* A.Kern. subsp. *vallarsae* from Pian delle Fugazze (Vallarsa, Trento), 2*n* = 22. Scale bar: 10 µm.

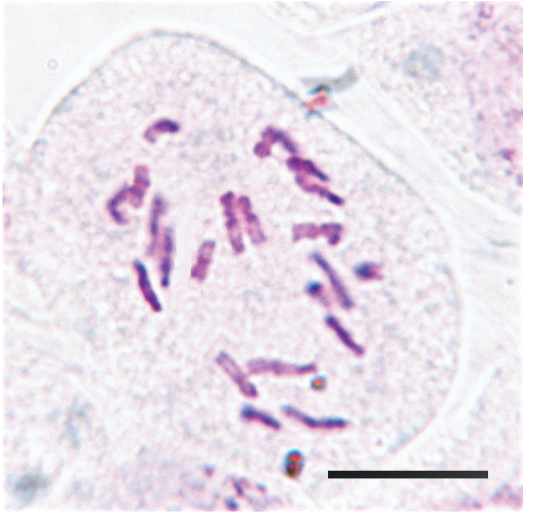

Figure 4. *Pulmonaria vallarsae* A.Kern. subsp. *vallarsae* from Bellaria di Cei (Villa Lagarina, Trento), 2*n* = 22. Scale bar: 10 µm.

All the five individuals sampled here displayed the typical chromosome number of *P. vallarsae* (including *P. vallarsae* subsp. *apennina*), 2*n* = 22, without any variation. This chromosome number was also found in the three individuals sampled in the other population at Bellaria di Cei, which is ca. 40 km far from the *locus classicus* of this species.

Pulmonaria hirta L.

Chromosome number. $2n$ = 28 (Fig. 5)

Voucher specimen. Italy. Emilia-Romagna. Parco di Monte Paderno (Bologna) (WGS84: 44.452272N, 11.320769E), ca. 280 m s.l.m., 3 April 2019, *L. Liu & G. Astuti* (PI n° 034223–034226).

Chromosome number. $2n$ = 22 (Fig. 6)

Voucher specimen. Italy. Emilia-Romagna. Parco di Monte Paderno (Bologna) (WGS84: 44.452272N, 11.320769E), ca. 280 m s.l.m., 3 April 2019, *L. Liu & G. Astuti* (PI n° 034227–034228).

Method. Squash preparations were made on root tips obtained from potted plants. 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. These plants display intermediate morphological features between the typical *P. hirta* and the typical *P. vallarsae* subsp. *apennina* (Puppi and Cristofolini 1996; Cecchi and Selvi 2015), although showing a closer resemblance to the former species, whose range spreads from SE France to C Italy (Cecchi and Selvi 2015). Four out of six samples in this population were found to have $2n$ = 28 chromosomes, which is typical for *P. hirta* (Astuti et al. 2019; Pupillo et al. 2019), whereas the remaining two individuals were found to have $2n$ = 22 chromosomes. Plants with $2n$ = 22 and 28 chromosomes grow together and do not show any pattern relating chromosome number to a specific morphological syndrome, as already observed by Vosa and Pistolesi (2004) for other populations.

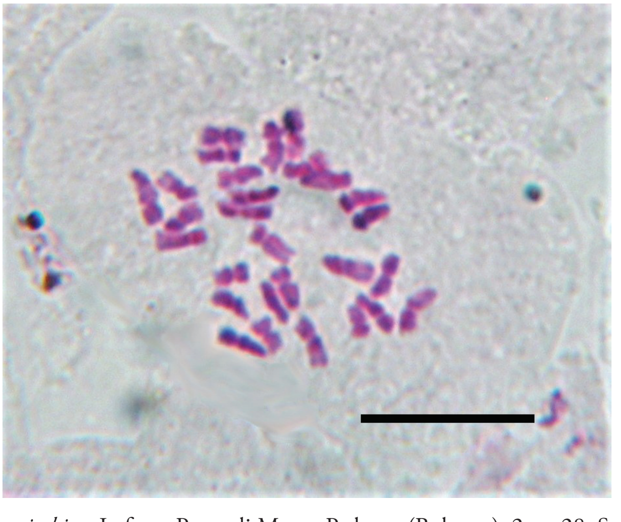

Figure 5. *Pulmonaria hirta* L. from Parco di Monte Paderno (Bologna), $2n$ = 28. Scale bar: 10 µm.

Figure 6. *Pulmonaria hirta* L. from Parco di Monte Paderno (Bologna), $2n = 22$. Scale bar: 10 μm.

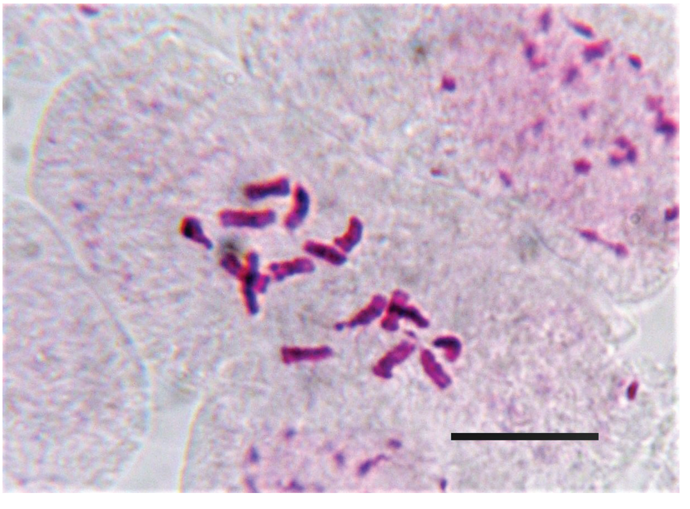

Figure 7. *Pulmonaria officinalis* L. subsp. *officinalis* from Castelmonte (Prepotto, Udine), $2n = 16$. Scale bar: 10 μm.

Pulmonaria officinalis L. subsp. *officinalis*

Chromosome number. $2n = 16$ (Fig. 7)

Voucher specimen. Italy. Friuli Venezia Giulia. Lungo la SP31 sotto il santuario di Castelmonte (Prepotto, Udine), (WGS84: 46.092828N, 13.516041E), ca. 580 m s.l.m., 21 March 2019, *L. Liu & G. Astuti* (PI n° 034229–034237).

Observations. Plants in this population show some morphological features that are intermediate between *P. officinalis* and *P. vallarsae*, especially in terms of leaf shape and maculation. However, the cordate leaf base and the presence of *aculeoli* (very short conical hairs) clearly place these plants within *P. officinalis* subsp. *officinalis* (Bolliger 1982), a taxon that is widespread in Europe. This is also confirmed by the chromosome number $2n$ = 16, found in all nine individuals studied, which is typical of *P. officinalis* (Sauer 1975; Bolliger 1982). Because of the faint maculation of most of the plants, these plants resemble *P. officinalis* subsp. *marzolae* G.Astuti, Peruzzi, Cristof. & P.Pupillo, known so far for Trentino-Alto Adige only. However, the presence of *aculeoli* in the population studied here does not match with their absence in *P. officinalis* subsp. *marzolae* (Astuti et al. 2014). Therefore, these plants could be safely ascribed to a faintly spotted form of *P. officinalis*.

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Rosaceae

***Potentilla detommasii* Ten.**

Chromosome number. $2n$ = 14 (Fig. 8)

Voucher specimen. Italy. Basilicata. Belvedere del Malvento (Viggianello, Potenza), (WGS84: 39.902987N, 16.136537E), ca. 1620 m s.l.m., 13 August 2018, *L. Peruzzi* (seeds collected in the field and stored at the Seed Bank of the Department of Biology, University of Pisa).

Method. Squash preparations were made on root tips obtained from germinating seeds. 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. This species spreads from peninsular Italy to Turkey, but it is not recorded for Croatia and Montenegro (Kurtto 2009). Here we report the first chromosome count for *P. detommasii* from Italy, which agrees with the only other count available for this species (Markowa 1971), confirming its diploid status.

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Figure 8. *Potentilla detommasii* Ten. from Belvedere del Malvento (Viggianello, Potenza), $2n$ = 14. Scale bar: 10 µm.

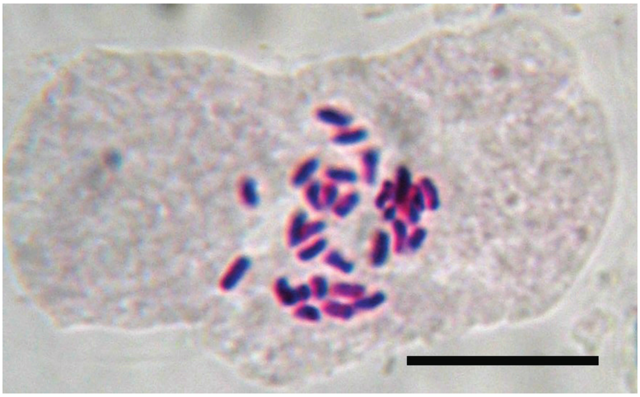

Figure 9. *Stachys thirkei* K.Koch, 2*n* = 30 from Monte Rosato (Fermo). Scale bar: 10 µm.

Lamiaceae

Stachys thirkei K.Koch

Chromosome number. 2*n* = 30 (Fig. 9)

Voucher specimen. Italy. Marche. Monte Rosato (Fermo) (WGS84: 43.129556N, 13.702611E), prato arido a sud del bosco su substrato argilloso, 88 m, 6 June 2015, *M. Tiburtini* (FI).

Method. Squash preparations were made on root tips obtained from cultivated plants. Root tips were pre-treated with 0.4% colchicine for 4 h and then fixed in Carnoy solution for 1 h. After hydrolysis in 1N HCl at 60 °C, the tips were stained with leuco-basic fuchsine.

Observations. This species grows in the eastern Mediterranean, showing a main distribution range in the Balkans, but extending eastwards to Turkey and westwards to Italy (Ball 1972). This species has been recorded for Marche (Bartolucci et al. 2019), where it has been found in only two localities. The specimen investigated here comes from one of these localities, and our count agrees with a previous report for Italy (Falciani and Fiorini 1996). This chromosome number is also typical of all the species belonging to *Salvia* sect. *Eriostomum* (Hoffmans. & Link) Dumort. (Falciani 1997).

G. Astuti, M. Tiburtini

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References

Astuti G, Liu L, Peruzzi L (2019) Chromosome numbers for the Italian flora: 7. Italian Botanist 7: 183–187. https://doi.org/10.3897/italianbotanist.7.36004

Astuti G, Cristofolini G, Peruzzi L, Pupillo P (2014) A new subspecies of *Pulmonaria officinalis* (Boraginaceae) from the southern Alps. Phytotaxa 186(3): 148–157. https://doi.org/10.11646/phytotaxa.186.3.3

Ball LW (1972) *Stachys* L. In: Tutin TG, Heywood VH, Burges NA, Moore DM, Valentine DH, Walters SM, Webb DA (Eds) Flora Europaea 3, Cambridge University Press, Cambridge, 151–157.

Bartolucci F, Peruzzi L, Galasso G, Albano A, Alessandrini A, Ardenghi NMG, Astuti G, Bacchetta G, Ballelli S, Banfi E, Barberis G, Bernardo L, Bouvet D, Bovio M, Cecchi L, Di Pietro R, Domina G, Fascetti S, Fenu G, Festi F, Foggi B, Gallo L, Gottschlich G, Gubellini L, Iamonico D, Iberite M, Jiménez-Mejías P, Lattanzi E, Marchetti D, Martinetto E, Masin RR, Medagli P, Passalacqua NG, Peccenini S, Pennesi R, Pierini B, Poldini L, Prosser F, Raimondo FM, Roma-Marzio F, Rosati L, Santangelo A, Scoppola A, Scortegagna S, Selvaggi A, Selvi F, Soldano A, Stinca A, Wagensommer RP, Wilhalm T, Conti F (2018) An updated checklist of the vascular flora native to Italy. Plant Biosystems 152(2): 179–303. https://doi.org/10.1080/11263504.2017.1419996

Bartolucci F, Domina G, Ardenghi NMG, Bacaro G, Bacchetta G, Ballarin F, Banfi E, Barberis G, Beccarisi L, Bernardo L, Bonari G, Bonini F, Brullo S, Buono S, Buono V, Calbi M, Caldararo F, Calvia G, Cancellieri L, Cannavò S, Dagnino D, Esposito A, Fascetti S, Filibeck G, Fiorini G, Forte L, Galasso G, Gestri G, Gigante D, Gottschlich G, Gubellini L, Hofmann L, Lastrucci L, Lonati M, Lorenz R, Lunardi L, Magrini S, Mainetti A, Maiorca G, Mereu G, Messa Ballarin RT, Minuto L, Mossini S, Musarella CM, Nimis PG, Passalacqua NG, Peccenini S, Petriglia B, Podda L, Potenza G, Ravetto Enri S, Roma-Marzio F, Rosati L, Ruggero A, Spampinato G, Stinca A, Tiburtini M, Tietto C, Tomaselli V, Turcato C, Viciani D, Wagensommer RP, Nepi C (2019) Notulae to the Italian native vascular flora: 8. Italian Botanist 8: 95–116. https://doi.org/10.3897/italianbotanist.8.48626

Bolliger M (1982) Die Gattung *Pulmonaria* in Westeuropa. J. Cramer, Vaduz, Schweiz, 215 pp.

Cecchi L, Selvi F (2015) Boraginaceae in Italy – II. Plant Biosystems 149: 630–677. https://doi.org/10.1080/11263504.2015.1057261

Falciani L (1997) Systematic revision of *Stachys* sect. *Eriostomum* (Hoffmans. & Link) Dumort. in Italy. Lagascalia 19(1–2): 187–238.

Falciani L, Fiorini G (1996) Reports: 679–682. In: Kamari G, Felber F, Garbari F (Eds) Mediterranean chromosome number reports: 6. Flora Mediterranea 6: 223–337.

Kerner A (1878) Monographia Pulmonariarum. Sumptibu Librariae Academicae Wagnerianae, Oeniponte, 52 pp.

Kurtto A (2009) Rosaceae (pro parte majore). Euro+Med Plantbase – the information resource for Euro-Mediterranean plant diversity. http://ww2.bgbm.org/EuroPlusMed/ [accessed 12 May 2020]

Markowa M (1971) *Potentilla detommasi* Ten. In: Löve A (Ed.) IOPB Chromosome Number Reports: XXXIII. Taxon 20: 609–614. https://doi.org/10.1002/j.1996-8175.1971.tb03184.x

Puppi G, Cristofolini G (1996) Systematics of the complex *Pulmonaria saccharata*, *Pulmonaria vallarsae* and related species (Boraginaceae). Webbia 51: 1–20. https://doi.org/10.1080/00837792.1996.10670611

Pupillo P, Marconi G, Peruzzi L, Astuti G (2019) The genus *Pulmonaria* (Boraginaceae) in the province of Bologna. Quaderni del Museo Civico di Storia Naturale di Ferrara 7: 19–26.

Sauer F (1975) Karyo-systematische Untersuchungen an der Gattung *Pulmonaria* (Boraginaceae). Bibliotheca Botanica 131: 1–85.

Vosa CG, Pistolesi G (2004) Chromosome numbers and distribution of the genus *Pulmonaria* (Boraginaceae) in Tuscany and neighbouring areas. Caryologia 57(1): 121–126. https://doi.org/10.1080/00087114.2004.10589380

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RESEARCH ARTICLE

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Abstract
In this contribution, the conservation status assessment of three vascular plants according to IUCN categories and criteria are presented. It includes the assessment of *Soldanella calabrella* Kress at global level, and the regional assessment of *Luzula pindica* (Hausskn.) Chrtek & Křísa and *Romulea variicolor* Mifsud (Italy).

Keywords
conservation, extinction risk, IUCN protocol, threats

How to contribute

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

Red List assessments

Luzula pindica (Hausskn.) Chrtek & Křísa

Regional assessment (Italy)
Taxonomy and nomenclature
Order: Poales *Family:* Juncaceae

Luzula pindica (Hausskn.) Chrtek & Křísa Webbia 19: 6 (1964) ≡ *Luzula spicata* (L.) DC. var. *pindica* Hausskn., Mitth. Thüring. Bot. Vereins, n.f., 13–14: 33 (1899)

Common name*:* Erba lucciola del M. Pindo (It), Pindus woodrush (En).

Geographic distribution range: The main range of *Luzula pindica* (Fig. 1) includes the mountain areas of the Balkan region, but this species reaches its western distribution limit in southern Italy (Chrtek and Křísa 1980). In the context of the species' range, the Italian populations define a striking disjunction. Accordingly, this plant represents one of the most remarkable examples of Amphi-Adriatic taxa within the Italian vascular flora. As found for other taxa with a similar geographical pattern (e.g., *Gentianella crispata* (Vis.) Holub: Gargano et al. 2009), in Italy *L. pindica* is confined to a small area at the southern extreme of the Apennine chain. Indeed, some historical records (from the beginning of the 20th century or earlier) reporting the presence of this species on Mt. Volturino and the Sila mountains (Chrte and Křísa 1964) were not later confirmed. Therefore, the ascertained Italian range of *L. pindica* currently includes just a few localities in a restricted area of the massif of Mt. Pollino (Fig. 2) that falls within the Administrative Regions of Basilicata and Calabria (Bernardo et al. 2014).

Distribution: Countries of occurrence: Albania, Bulgaria, Greece, Italy, and North Macedonia.

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

Flowering time: From June to July.

Reproduction: *Luzula* is mostly wind-pollinated, while seed dispersal generally relies on myrmecochory (e.g., Oostermeijer 1989).

Habitat and ecology: *Luzula pindica* grows on limestone, within high-mountain grasslands established close or above the treeline. Accordingly, this species is associated to the *Ranunculo-Nardion* vegetation (Tomaselli et al. 2003), which includes the mesophilous grasslands and the fragments of snowbed vegetation of the S-Apennines (Gargano et al. 2010).

Population information: Since 2016, this species is included in a monitoring program focused on the oro-Mediterranean herbaceous communities of the Pollino National Park. The demographical data obtained from permanent sampling areas indicate that flowering rates of *L. pindica* range from 19.7 to 2.7 flowering stalks/m^2. To date, it is difficult to deduce a clear demographic trend. However, data related to different periods of the blooming seasons show that the species is subjected to intense grazing; indeed, during the four years of observation, the percent of grazed flowering stalks ranged from 87.5 to 100%.

Figure 1. *Luzula pindica* at Piani di Pollino (Terranova di Pollino, Potenza, Basilicata), a locality included in the Pollino National Park. Photograph by Liliana Bernardo.

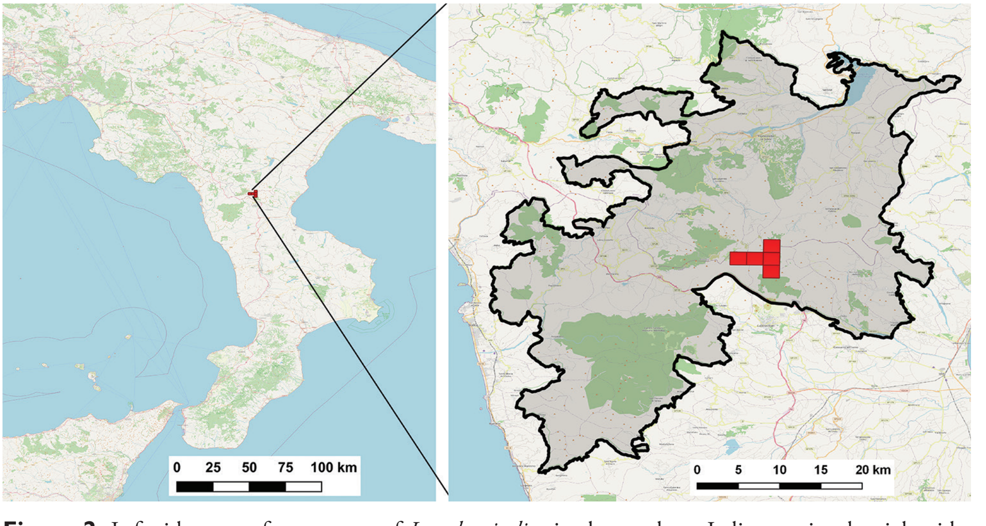

Figure 2. Left side: area of occupancy of *Luzula pindica* in the southern Italian peninsula; right side: location of the AOO cells with respect to the boundaries of the Pollino National Park (light shaded area).

Threats: *2.3. Livestock and farming and ranching:* the grasslands hosting this species are subjected to over-grazing pressure during the flowering season. Trampling due to nomadic domestic animals reduces the soil quality by promoting erosion and nitrification; the excessive grazing rate represents a severe limitation to sexual recruitment in all known populations of *L. pindica*.

CRITERIA APPLIED:
Criterion B: **EOO:** 20 km^2.
AOO: 20 km^2 calculated with a 2 × 2 km fixed cell grid (Gargano 2011).
a) Number of locations: all the populations occur in a restricted area; the growth contexts are highly homogeneous and show a comparable regime of over-grazing. For these reasons, *L. pindica* is believed to occupy a unique location in Italy.
b) Due to over-grazing, the habitat quality (iii) is declining in many sites, as well as the number of mature individuals (v). Since the plant was no longer observed in some historical sites of its regional range, a reduction of EOO and AOO may have also affected the species in Italy, but this is difficult to prove and quantify.

Red List category and Criteria (Regional Assessment)

CR	**Critically Endangered**	**B1ab(iii,v)**

Rationale for the assessment: In Italy, *L. pindica* is confined to a few sites within a small mountain area of the peninsula. The current regional distribution accounts for an EOO and AOO of only 20 km^2. This species is threatened by excessive grazing pressure, which can alter the quality of the habitat and reduce the rate of reproductive success. Due to the contiguity of the inhabited sites, and their homogeneous sensitivity to the prevalent threat, *L. pindica* occurs in a single location. The absence of recent records for some historical sites suggests a historical reduction of the regional range. Currently, due to the marked geographical rarity, the occurrence in a single location, and the effect of over-grazing on habitat quality and on the population's reproductive processes, this taxon qualifies as Critically Endangered (CR) at the regional level. Because geographical isolation makes any contribution of the populations occurring in Eastern Europe to the conservation status of the Italian ones unlikely, there is no reason for up- or down-grading the risk category resulting from this assessment procedure.

Previous assessment: This taxon is Not Evaluated (NE) at the global level (IUCN 2020), while it is as Endangered (EN) in the Red List of the Italian vascular flora (Orsenigo et al. 2020).

Conservation actions: All known Italian populations of *L. pindica* occur within the Pollino National Park.

Conservation actions needed: It is necessary to improve the site management in order to reduce the impact of grazing on this species during the flowering period. This would allow to enhance the quality of the growth context and to improve the rates of sexual recruitment. Seed banking would be also an effective way to preserve the species' genetic resources and support future reinforcement trials.

Domenico Gargano, Nicodemo G. Passalacqua, Liliana Bernardo

Romulea variicolor Mifsud

Regional assessment (Italy)
Taxonomy and nomenclature
Order: Asparagales *Family*: Iridaceae

Romulea variicolor Mifsud, Webbia 70: 257 (2015) – *Romulea melitensis* auct. Fl. Ital. et Malta

Common name: Zafferanetto maltese, Romulea maltese (It); Maltese Sand Crocus (En).

Geographic distribution range: *Romulea variicolor* (Fig. 3) is native to Malta and Sicily (Italy). Previously, it was reported by some authors (Haslam et al. 1977; Frignani and Iiriti 2001) as *Romulea melitensis* Béguinot. However, Mifsud (2015) suggested that this taxonomic treatment should be considered as ambiguous, describing the new name *R. variicolor*. This species was reported for the first time in Sicily by Brullo et al. (2009) and later confirmed by Mifsud (2015). Its Italian distribution is restricted to a small coastal stretch between Cava d'Aliga and Marina di Modica (Ragusa, Sicily) (Fig. 4).

Distribution: *Countries of occurrence:* Italy (Sicily), Malta.

Biology: *Plant growth form:* perennial (bulbous geophyte).

Flowering and fruiting time: Flowering from February to March and fruiting from March to April.

Reproduction: No detailed information is available on the pollination system and seed dispersal mechanism.

Habitat and ecology: *Romulea variicolor* grows on sandstones and Miocene limestones (0–100 m a.s.l.), within the lower upper semiarid thermomediterranean bioclimatic belt (Bazan et al. 2015). From a phytosociological point of view, in the Maltese Islands this plant was considered by Brullo et al. (2020) as a differential species of the *Romuleo melitensis-Ranunculetum bullati*, an association framed within the *Leontondonto tuberosi-Bellidion sylvestris* Biondi, Filigheddu and Farris 2001 (*Lygeo sparti-Stipetea tenacissimae* Rivas-Martinez 1978). In Sicily, it shows similar ecological requirements, colonizing small flat surfaces among the low shrubs of coastal garrigues or halophilous communities with *Limonium hyblaeum* Brullo (Brullo et al. 2009). From a biogeographical perspective, the population of *Romulea variicolor* falls within the Camarino-Pachinense district (Brullo et al. 1995).

Population information: In Sicily, *R. variicolor* is represented by few groups of individuals circumscribed to the south-eastern coast of the island, in the province of Ra-

Figure 3. *Romulea variicolor* in the rocky coast near Sampieri (Ragusa, Sicily). Photograph by S. Cambria.

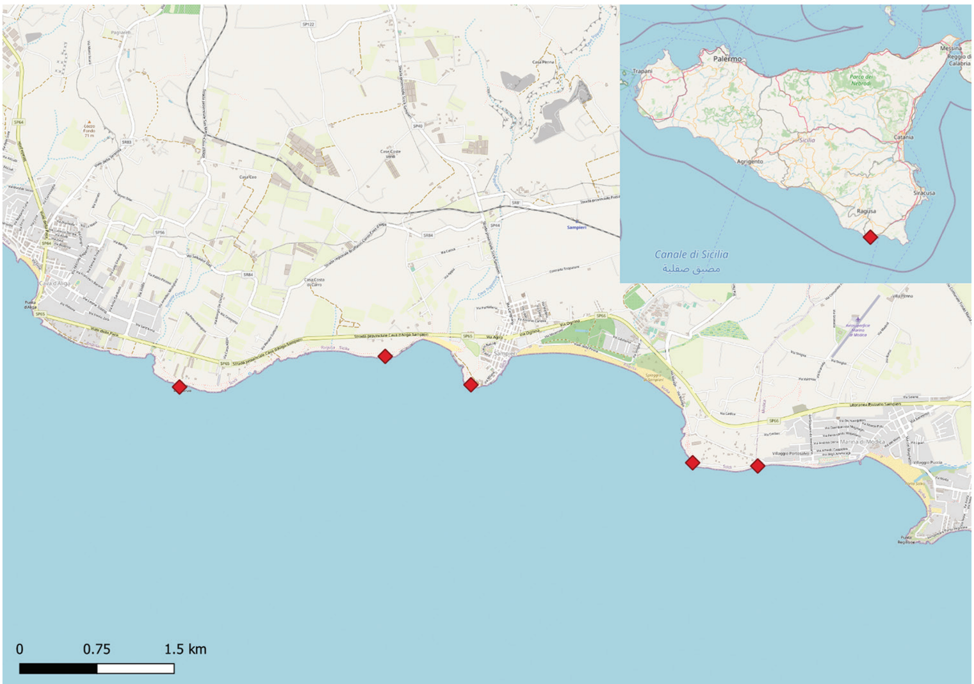

Figure 4. Geographical range and distribution map of *Romulea variicolor* Mifsud in Sicily.

gusa. This species shows an extremely scattered distribution with few isolated patches, where it is sometimes locally abundant for an estimated total number of a few hundred individuals. Mifsud (2018) reported a stable population trend, while direct observations of the Sicilian population indicate a slight regression and thus its progressive decline.

Threats: *1.1 Housing & Urban Areas:* the modifications of urban areas impact on the habitat of this species.

8.1 Invasive Non-Native/Alien Species/Diseases: the species' range can be reduced by invasive alien plants, such as *Carpobrotus edulis* (L.) N.E.Br.

1.3 Tourism & Recreation Areas: the coastal area is strongly subject to tourist activities during the summer season.

7.3. Other ecosystems modifications: many of the stands are subject to coastal erosion.

CRITERIA APPLIED

Criterion B: **AOO**: 16 km^2 calculated with GeoCAT (Geospatial Conservation Assessment Tool) software (Bachman et al. 2011).
a) Number of locations: we identified five locations based on urbanization that represents the main threat affecting the species.
b) Decline observed in (iii) area, extent and/or quality of habitat; (v) number of mature individuals.

Red List category and Criteria (Global Assessment)

EN	**Endangered**	**B2ab(iii,v)**

Rationale for the assessment: *Romulea variicolor* is a geophyte endemic of the Maltese islands and south-eastern Sicily. In Italy, this species shows a localized distribution in Sicily, being limited to a small coastal area strongly affected mainly by urbanization, tourism and other risk factors. Populations are represented by scattered groups with few individuals, clearly subject to a decline, particularly for locations closest to urban centers and tourist sites. The regional distribution range consists in an AOO of 16 km^2. Considering the exiguous number of stands and the presence of several threats, this taxon can be classified as Endangered (EN).

Previous assessment: *Romulea variicolor* was evaluated as Least Concern (LC) at a global level (Mifsud 2018) and, more recently, as Data Deficient (DD) in Italy (Orsenigo et al. 2020).

Conservation actions: *Romulea variicolor* is unprotected by international, national and regional specific laws. The Sicilian population partly falls within the SAC ITA080008 'Contrada Religione'. Moreover, the area at issue has been identified as an Important Plant Area (IPA), essential for the conservation of plant biodiversity, indicated as "Costa di Sampieri (SIC 16)".

Conservation actions needed: Research activities (e.g., demographic, eco-physiological, etc.) are advisable and an improved quality of the habitat is necessary for *in situ* conservation.

Salvatore Cambria, Gianmarco Tavilla

Soldanella calabrella Kress

Global Assessment

Taxonomy and nomenclature

Order: Ericales *Family*: Primulaceae

Soldanella calabrella Kress, Primulac.-Stud. 8: 24 (1988) – *Soldanella hungarica* auct. Fl. Ital.

Common name: Soldanella calabrese (It), Calabrian Soldanella (En).

Geographic distribution range: *Soldanella calabrella* Kress (Fig. 5) is endemic to Calabria (Fig. 6), and its distribution consists of two disjunct populations in Sila and Aspromonte. Cristofolini and Pignatti (1962) attributed the Calabrian populations to *S. hungarica* Simonk., underlining their significant disjunction concerning the main distribution area. Later, Pignatti (1982) reported for Sila and Apromonte the presence of *S. hungarica*, stating in a note that the Calabrian *Soldanella* could represent an as yet unreported species. Finally, Kress (1988) classified the Calabrian plants as *Soldanella calabrella*. Zhang et al. (2001), in their review of the genus *Soldanella* L., confirmed the autonomy of this species.

Distribution: Country of occurrence: Italy.

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

Flowering and fruiting time: Flowering from May to June and fruiting from June to August.

Reproduction: *Soldanella calabrella* is an insect-pollinated species. Dispersal mechanisms are barochory and hydrochory (for long-distance dissemination). No information on seed germination is available.

Habitat and ecology: *Soldanella calabrella* grows near springs or on shady and damp walls subject to dripping along the mountain streams with permanent, weakly flowing and well-oxygenated waters. This habitat is located within deciduous mesophilous forests of *Fagus sylvatica* L. often associated with *Abies alba* Mill. on acid crystalline rocks of the mountain belt. The altitude range falls between 1,200 and 1,900 m a.s.l., in upper supratemperate or lower orotemperate bioclimate (Brullo et al. 2001). *Soldanella calabrella* is a characteristic species of the *Adenostylo-Soldanelletum calabrellae* Signorello 1986 *corr.* Brullo, Scelsi and Spampinato 2001, an association of the *Caricion remotae* Kästner 1941 alliance (Brullo et al. 2001).

Population information: this species shows a highly fragmented and disjunct distribution, with two macro distribution areas, the Sila mountains (where it is further fragmented into two sub-areas: Sila Grande and Sila Piccola) and the Aspromonte massif. A total of 25 localities was confirmed in 2019 (10 in Aspromonte, 7 in Sila Grande, and 8 in Sila Piccola). Four of the past sites of occurrence documented in the literature (Brullo et al. 2001, Spampinato et al. 2008) were not confirmed by recent surveys carried out in 2019. Due to ecological factors and habitat threats, populations range from several hundred up to a few individuals limited to very small areas.

Figure 5. *Soldanella calabrella* Kress, at Materazzelli (Cosoleto, Reggio Calabria). Photograph by V.L.A. Laface.

Threats: *2.3.1 Nomadic grazing*: many grazing animals, in particular, cows (*Bos taurus*) and wild boar (*Sus scrofa*), drink in the streams and springs where the species grows, damaging the habitat.

5.3 Logging & wood harvesting: the localities at lower altitudes are located in areas subject to forestry uses that severely modify the habitat. The threat is still present, therefore a further drop in the number of individuals and habitat quality can be expected.

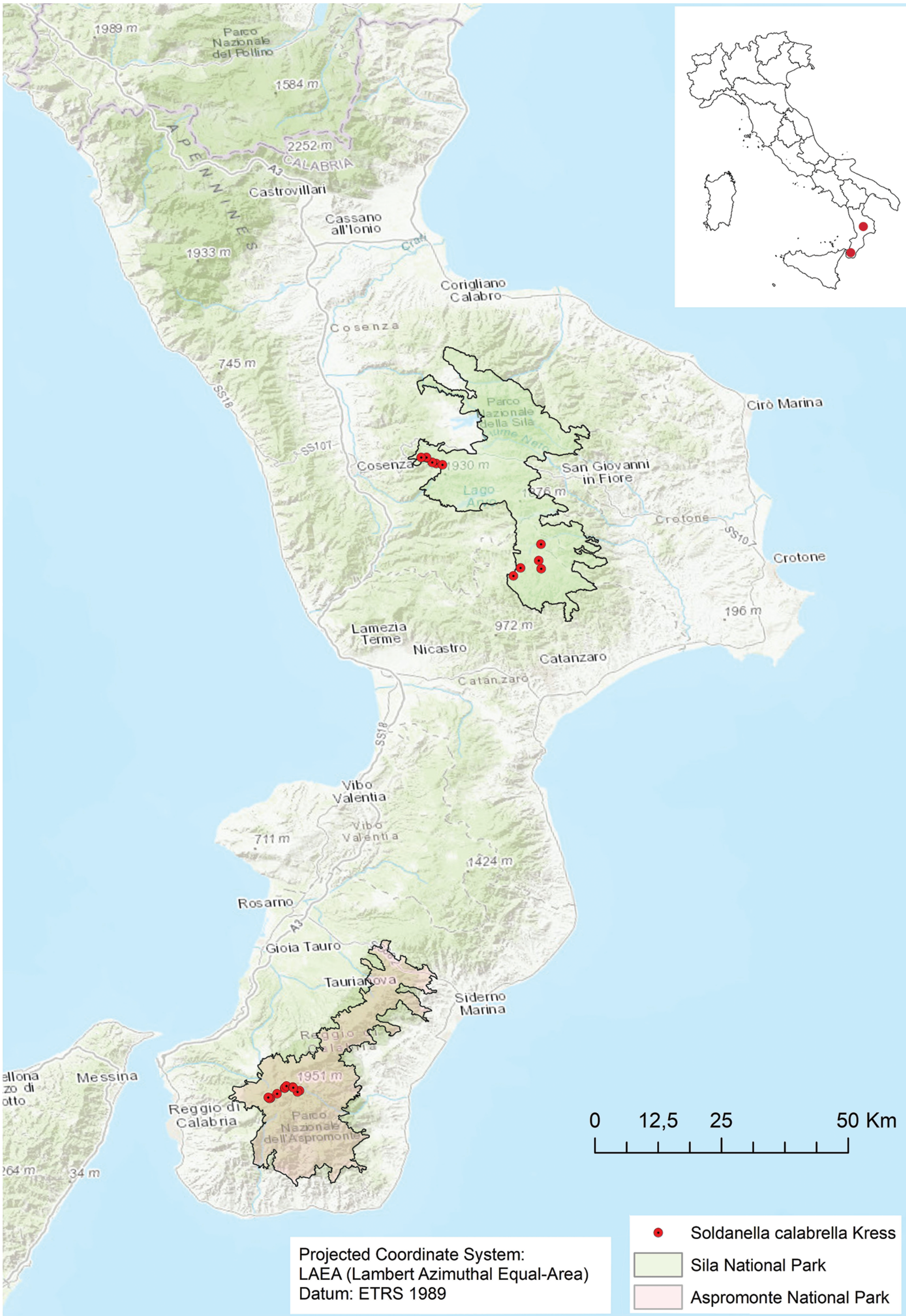

Figure 6. Geographical range and distribution map of *Soldanella calabrella* Kress.

11.1 Habitat shifting & alteration: field surveys show that the lower-altitude stations are the most threatened by the natural evolution of habitats due to climate change. This species is restricted to the microclimate occurring in streams and springs of the mountain belt.

11.2 Drought: the survival of *S. calabrella* is tied to peculiar wet habitats; drought, therefore, causes the rapid disappearance of the species.

11.4 Storms and floods: they cause landslides, collapses, erosion or sediment deposition, causing the loss of suitable species habitat.

CRITERIA APPLIED:

Criterion B: **EOO:** 2,203 km^2 calculated with minimum convex hull polygon using ArcMap10.4.

AOO: 44 km^2 calculated with 2 × 2 km cell fixed grid in the ArcMap10.4.

a) number of locations >5

b) Habitat extent and quality (iii) are declining, as well as the number of mature individuals (v). A reduction of AOO (ii) is likely to have affected the species.

Criterion A2: reduction in the estimated population as a function of an AOO reduction >30% in 10 years, which continues today due to declining habitat quality and habitat destruction.

c) documented decline in AOO and habitat quality, according to threats 11.1, 11.2,11.4, and 2.3.1

Red List category and Criteria (Global Assessment)

VU	**Vulnerable**	**A2c + B1ab(ii,iii,v) + 2ab(ii,iii.v)**

Rationale for the assessment: The populations are scattered as a consequence of its peculiar habitat: shady and damp walls subject to dripping near springs or along the perennial streams of the mountain belt. A decline in population size is documented by a continuous and significant reduction in AOO. The AOO decreased from 64 km^2 to 44 km^2 in the last 10 years, due to the fore-mentioned threats that affect the extent and quality of the habitat. The individuals located at lower altitudes are the most threatened by the anthropic impact (logging, water abstraction, and grazing) and by climate change, which have already led to the extinction of some populations in the last decades. Based on new data that document a decline in AOO, quality of habitat, and number of mature individuals, *S. calabrella* can be considered "Vulnerable (VU)" at global level according to IUCN criteria (IUCN 2012).

Previous assessment: the species was previously assessed as "Endagered (EN)" at global level (Orsenigo et al. 2018).

Conservation actions: *Soldanella calabrella* is unprotected by regional, national or international laws. The current localities of this species fall within the Aspromonte and Sila National Park.

Conservation actions needed: Monitoring and research activities are needed to evaluate population dynamics and trends. Specific control and protection measures must be taken to preserve the habitat and the species.

Valentina Lucia Astrid Laface, Carmelo Maria Musarella, Giovanni Spampinato

References

Bachman S, Moat J, Hill AW, Torre J de la, Scott B (2011) Supporting Red List threat assessments with GeoCAT: geospatial conservation assessment tool. In: Smith V, Penev L (Eds) E-Infrastructures for data publishing in biodiversity science. ZooKeys 150: 117–126. https://doi.org/10.3897/zookeys.150.2109 [Version BETA]

Bazan G, Marino P, Guarino R, Domina G, Schicchi S (2015) Bioclimatology and Vegetation Series in Sicily: A geostatistical approach. Annales Botanici Fennici 52(1–2): 1–18. https://doi.org/10.5735/085.052.0202

Bernardo L, Passalacqua NG, Peruzzi L (2014) *Luzula pindica* (Hausskn.) Chrtek & Křísa (Juncaceae). In: Barberis G, Nepi C, Peruzzi L, Peccenini S (Eds) Notulae alla checklist della flora vascolare italiana 18 (2071–2099). Informatore Botanico Italiano 46(2): 1–276.

Brullo S, Brullo C, Cambria S, Giusso del Galdo G (2020) The Vegetation of Maltese Islands. Geobotany Studies, Springer. https://doi.org/10.1007/978-3-030-34525-9

Brullo C, Brullo S, Giusso del Galdo G (2009) Notes on the occurrence of *Romulea melitensis* (Iridaceae) in Sicily – a critical species of the Mediterranean flora. In: Peccenini S, Domina G (Eds) Gruppi Critici della Flora d'Italia, Comunicazioni. 30–31 ottobre 2009, Roma.

Brullo S, Minissale P, Spampinato G (1995) Considerazioni fitogeografiche sulla flora della Sicilia. Ecolologia Mediterranea 21(1–2): 99–117. https://doi.org/10.3406/ecmed.1995.1759

Brullo S, Scelsi F, Spampinato G (2001) La vegetazione dell'Aspromonte. Studio fitosociologico. Laruffa Editore, Reggio Calabria, 368 pp.

Chrtek J, Křísa B (1964) On the problem of the species *Luzula spicata* (L.) DC. in Italy. Webbia 19: 1–10. https://doi.org/10.1080/00837792.1964.10669801

Chrtek J, Křísa B (1980) *Luzula* DC. In: Tutin TG, Heywood VH, Burges NA, Moore DM, Valentine DH, Walters SM, Webb DA (Eds) Flora Europaea 5, Cambridge University Press, Cambridge.

Cristofolini G, Pignatti S (1962) Revisione delle forme Italiane del genere *Soldanella* L. Webbia 16: 443–475. https://doi.org/10.1080/00837792.1962.10669727

Frignani F, Iiriti G (2001) The genus *Romulea* in Italy: taxonomy, ecology and intraspecific variation in relation to the flora of Western Mediterranean islands. Fitosociologia 48(2) suppl. 1: 13–20.

Gargano D (2011) Toward a New List of the Italian Flora: a standard grid for estimating the area of occupancy (AOO). Informatore Botanico Italiano 43(2): 455–458.

Gargano D, Bellusci F, Pellegrino G, Palermo AM, Bernardo L, Musacchio A (2009) The conservation perspectives and value of small and isolated plant populations: preliminary clues for *Gentianella crispata* (Gentianaceae) at the western border of its range. Annales Botanici Fennici 46: 115–124. https://doi.org/10.5735/085.046.0206

Gargano D, Vecchio G, Bernardo L (2010) Plant soils relationships in fragments of Mediterranean snow-beds: ecological and conservation implications. Plant Ecology 207: 175–189. https://doi.org/10.1007/s11258-009-9663-7

Haslam SM, Sell PD, Wolseley PA (1977) A Flora of the Maltese Islands. Malta University Press, Msida.

IUCN (2012) IUCN Red List Categories and Criteria: Version 3.1. Second Edition. IUCN Species Survival Commission. IUCN, Gland, Switzerland and Cambridge, 32pp.

IUCN (2020) The IUCN Red List of Threatened Species vers. 2020-1. http://www.iucnredlist.org

Kress A (1988) Primulaceen-Studien 8: Der Formenkreis um *Soldanella chrysosticta*. Gröbenzell bei München.

Mifsud S (2015) A review of *Romulea* Maratti (Iridaceae) in the Maltese Islands. Webbia 70(2): 247–287. https://doi.org/10.1080/00837792.2015.1071910

Mifsud S (2018) *Romulea variicolor*. The IUCN Red List of Threatened Species 2018: e.T87637491A87637638. https://doi.org/10.2305/IUCN.UK.2018-1.RLTS.T87637491A87637638.en

Oostermeijer JGB (1989) Myrmecochory in *Polygala vulgaris* L., *Luzula campestris* (L.) DC. and *Viola curtisii* Forster in a Dutch dune area. Oecologia 78: 302–311. https://doi.org/10.1007/BF00379102

Orsenigo S, Fenu G, Gargano D, Montagnani C, Abeli T, Alessandrini A, Bacchetta G, Bartolucci F, Carta A, Castello M, Cogoni D, Conti F, Domina G, Foggi B, Gennai M, Gigante D, Iberite M, Peruzzi L, Pinna MS, Prosser F, Santangelo A, Selvaggi A, Stinca A, Villani M, Wagensommer RP, Tartaglini N, Duprè E, Blasi C, Rossi G (2020) Red List of threatened vascular plants in Italy. Plant Biosystems. https://doi.org/10.1080/11263504.2020.1739165

Orsenigo S, Montagnani C, Fenu G, Gargano D, Peruzzi L, Abeli T, Alessandrini A, Bacchetta G, Bartolucci F, Bovio M, Brullo C, Brullo S, Carta A, Castello M, Cogoni D, Conti F, Domina G, Foggi B, Gennai M, Gigante D, Iberite M, Lasen C, Magrini S, PerrinoEV, Prosser F, Santangelo A, Selvaggi A, Stinca A, Vagge I, Villani M, Wagensommer RP, Wilhalm T, Tartaglini N, Duprè E, Blasi C, Rossi G (2018) Red Listing plants under full national responsibility: Extinction risk and threats in the vascular flora endemic to Italy. Biological Conservation 224: 213–222. https://doi.org/10.1016/j.biocon.2018.05.030

Pignatti S (1982) Flora d'Italia 2: 285–286. Edagricole, Bologna.

Spampinato G, Cameriere P, Crisafulli A, Caridi D (2008) Carta della biodiversità vegetale del Parco Nazionale dell'Aspromonte. Quaderni di Botanica Ambientale e Applicata 19: 3–36.

Tomaselli M, Bernardo L, Passalacqua NG (2003) The vegetation of the Ranunculo-Nardion in the Southern Apennines (S-Italy). Phyton (Horn) 43: 39–57.

Zhang LB, Comes HP, Kadereit JW (2001) Phylogeny and Quaternary history of the European montane/alpine endemic *Soldanella* (Primulaceae) based on ITS and AFLP variation. American Journal of Botany 88: 2331–2345. https://doi.org/10.2307/3558393