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Itineraries of the Working Group for Vegetation Science of the Italian Botanical Society – 1 (2022): Excursion to the Egadi Islands, Mount San Giuliano and Mount Cofano (Trapani, western Sicily, Italy)

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Abstract

The results of the annual excursion of the Working Group for Vegetation Science of the Italian Botanical Society, held in the Egadi Islands, Mount San Giuliano and Mount Cofano (W Sicily) on April 23–27 2022, are presented. This paper includes: (1) general information on the visited sites; (2) geology and geomorphology; (3) climatology and bioclimatology with tables of climatic data; (4) description of the following five geobotanical itineraries – accompanied by 29 original vegetation relevés and 11 synthetic relevés, proceeding from different bibliographic references: (a) Mount San Giuliano; (b) Marettimo Island: coastal and subcoastal stretch of the southern part, between Punta Bassana and Contrada Chiappera; (c) Marettimo Island: Case Romane, Mount Pizzo Falcone and the north-western coastal stretch; (d) Island of Levanzo; (e) Mount Cofano – with catenal pictograms of the vegetation, surveys and description of the plant communities and related syntaxonomic scheme; (5) list of the surveyed plant taxa, collected specimens and herbaria in which they are deposited. A new syntaxon is also described (*Catapodio pauciflori-Moraeetum sisyrinchii* ass. nova), referring to an ephemeral dry grassland located along the north-western coastal stretch of Marettimo. The new association is framed in the *Plantagini-Catapodion balearici*, alliance of the *Stipo-Bupleuretalia semicompositi* order of the class *Stipo-Trachynietea distachyae* (order *Stipo-Bupleuretalia semicompositi*, alliance *Plantagini-Catapodion balearici*). An original synoptic table, regarding 17 different plant communities with high frequency of *Moraea sisyrinchium*, provides a comparative framework of the new association with allied vegetation units so far described throughout the Mediterranean region. Syntaxonomical and nomenclatural remarks regarding the Mediterranean vegetation occurring in this territory are also given throughout the text. Some floristic updates for the study sites are also reported, including the discovery for the first time in Sicily of *Lysimachia loeflingii*.

Keywords

Egadi Island, Phytogeography, Syntaxonomy, Vascular flora, Vegetation, Western Sicily

Introduction

This paper was inspired by the numerous vegetation studies carried out, mainly in the Iberian countries, by Salvador Rivas-Martínez (July 16, 1935–August 27, 2020) and his collaborators and published in the series "Itinera Geobotanica" edited by the Asociación Española de Fitosociología (AEFA). In the present contribution, results of the surveys carried out during an excursion of the Working Group for Vegetation Science of the Italian Botanical Society are presented. The aim is to provide information on the plant communities encountered, as well as on the environmental characteristics of the inspected stands. In particular, representative biotopes have been selected in order to provide opportunities for a critical and comparative study with similar vegetation

aspects occurring in nearby territories. It should be emphasized that one of the main scientific activities envisaged by this Working Group is to improve knowledge on Italian vegetation through field surveys, which allow for the increment of data relating to the syntaxa and their floristic set. Moreover, the phytosociological approach, based on floristic, ecological, structural, and phytogeographic analyses, furthers our knowledge of the correlations within the syndynamic processes that determine a natural evolution of the phytocoenoses.

In the 2022 excursion, which took place from 23 to 27 April, the object of the geobotanical investigation was the extreme western sector of Sicily (Figs 1–3), with guided tours focused on two important and isolated mountain reliefs located along the coast (Mt. San Giuliano and Mt. Cofano), as well as the islands of Marettimo and Levanzo, in the Egadi Archipelago.

Previously, these areas of Sicily were targeted in various phytosociological investigations concerning above all Mt. Cofano (Barbagallo et al. 1979, 1980; Gianguzzi and Ottonello 2000; Gianguzzi and La Mantia 2008) and Marettimo (Brullo and Marcenò 1983) or extended to the whole Province of Trapani (Scuderi 2006) or to Sicily (Brullo et al. 2008; Gianguzzi et al. 2016a; Guarino and Pasta 2017). Further important contributions concern monographic studies on the woody vegetation (Brullo and Marcenò 1985a; Brullo et al. 2008; Marino et al. 2012), the chasmophilous vegetation (Brullo and Marcenò 1979; Brullo et al. 2004), the perennial dry grasslands (Minissale 1995; Brullo et al. 2006, 2010), the coastal rocky vegetation (Bartolo et al. 1992), and the synanthropic vegetation (Brullo and Marcenò 1980, 1985b; Brullo 1985; Brullo et al. 2007).

Concerning the flora, apart from the classic floristic studies by Gussone (1832–34, 1842–45) and Lojacono-Pojero (1888–1909), more recent contributions were made by Giardina et al. (2006) and Brullo et al. (2020), as well as those on Marettimo (Francini and Messeri 1956; Gianguzzi et al. 2006), Levanzo (Di Martino and Trapani 1968; Romano et al. 2006), and Mt. Cofano (Barbagallo et al. 1979, 1980; Gianguzzi et al. 2005). Further data are available from the Province of Trapani (Raimondo et al. 1986, 1990, 1992; Scuderi 2006; Aleo et al. 2013), related floristic reports (e.g. Catanzaro 1984; Brullo and Marcenò 1985b; Ottonello and Catanzaro 1986; Raffaelli and Ricceri 1988; Lorenz and Lorenz 2002; La Rosa et al. 2021; etc.) or descriptions of new species (e.g. Raimondo and Bancheva 2004; Brullo C. et al. 2009; Brullo et al. 2016; Domina et al. 2017, etc.).

The present contribution aims to summarize, in the form of a geobotanical report, the knowledge and critical issues concerning the plant communities identified during the aforementioned annual excursion of our Working Group. Furthermore, syntaxonomic and phytogeographic considerations, that fueled the debate during this field trip in one of the richest biodiversity hotspots of the Mediterranean basin (Médail and Quezel 1999), are reported.

Study area

Mount San Giuliano (791 m a.s.l.) – on the summit of which the town of Erice rises – and Mount Cofano (659 m a.s.l.), located further to the north-east (Munici-

pality of Custonaci), are two important landmarks in NW Sicily. Geologically, they consist of carbonate rocks dating back to the Mesozoic, interspersed with calcarenite substrates originating from Pleistocene bioclastic and aeolian processes (Abate et al. 1993; Lentini and Carbone 2014). As regards the islands of Marettimo (12.3 km^2) and Levanzo (5.6 km2), they are part of the Egadi archipelago, together with Favignana Formica and Maraone, which emerged during the early Miocene, in the period known as the "Egadi Range" (Catalano et al. 1985; Catalano 1986). In particular, Marettimo, dominated by Pizzo Falcone (686 m a.s.l.), is made up of dolomite, marl and limestone dating back to the period between the Middle Trias and the Lower Lias with pelagic and reef facies (Abate et al. 1999; Gasparo Morticelli et al. 2016). Instead, the island of Levanzo is dominated by carbonate and clastic-terrigenous substrates dating back to the Mesozoic and Tertiary, with Plio-Pleistocene and Holocene depositions (Abate et al. 1995).

According to the biogeographical classification proposed by Rivas-Martínez et al. (2004), the study area falls within the Mediterranean Region, West Mediterranean Sub-Region, Italo-Tyrrhenian Province, Sicilian Sector, Western Sub-Sector and Aegadian district (Brullo et al. 1995).

All visited sites belong to the Natura 2000 network as Special Areas of Conservation (SACs), with the following codes: ITA010010 – Mt. San Giuliano; ITA010016

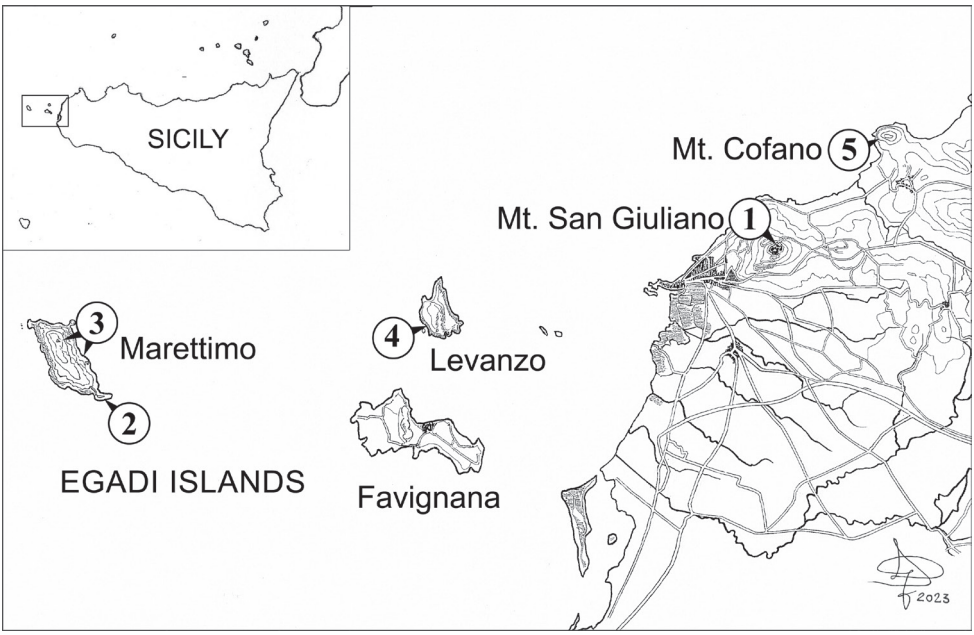

Figure 1. Map of the itineraries of the 2022 annual excursion of the Working Group for Vegetation Science of the Italian Botanical Society, numbered in chronological order. Arrows correspond to the precise location of the sites depicted in Fig. 2.

– Mt. Cofano and its coastline; ITA010002 – Marettimo; ITA010003 – Levanzo. These are also included in the following Special Protection Areas (SPAs): ITA010027 – Egadi Archipelago; ITA010029 – Mount Cofano, Mount San Vito and Mount Sparagio. The area of Mount Cofano is also a Nature Reserve of the Region of Sicily, while the seacoast of Marettimo and Levanzo is part of the "Egadi Islands" Marine Nature Reserve.

Bioclimatology

Due to the lack of meteorological stations in the Egadi archipelago, the climatic records in the area are based on data collected by the Ministry of Public Works (1978–1996) from the thermo-pluviometric or pluviometric stations installed in Capo San Vito (6 m a.s.l.), Trapani (15 m a.s.l.), Sant'Andrea Bonagia (48 m a.s.l.), Lentina (125 m a.s.l.), Specchia (140 m a.s.l.), and Erice (756 m a.s.l.). All these stations are located along the coast, within a radius of 50 km from the center of the study area.

Table 1 reports the annual averages of max. and min. temperatures (in °C), daily temperature ranges, and absolute max. and min. temperatures recorded at the weather stations of Trapani, Capo S. Vito, and Erice. Table 2 shows the average monthly and annual rainfall recorded in the period 1926–1985 of all the aforementioned stations (Duro et al. 1996). The climate throughout the study area is characterized by a rainfall regime of Mediterranean type, with markedly dry summers and mild winters. In particular, Marettimo is rainier than Levanzo, and so is Mt. San Giuliano compared to Mt. Cofano, since fogs and hidden precipitations are frequent on its top. Average annual temperatures vary between 18.1 and 19 °C, gradually decreasing to 14.5 °C on the summit of Mt. San Giuliano. Overall, the proximity of the sea affects significantly the temperatures of the whole area, mitigating the climatic extremes.

Based on the bioclimatic classification proposed by Rivas-Martínez (2004), the study areas are arranged in the following units:

1. Mt. San Giuliano – From thermo-Mediterranean with lower sub-humid ombroclimate (coastal plain) to Meso-Mediterranean with upper sub-humid ombroclimate on the top (Gianguzzi and La Mantia 2008).
2. Mt. Cofano – From thermo-Mediterranean with lower sub-humid ombroclimate (coastal plain) to Meso-Mediterranean with upper sub-humid ombroclimate on the top (Gianguzzi and La Mantia 2008);
3. Marettimo – From thermo-Mediterranean with dry/sub-humid ombroclimate to Meso-Mediterranean with sub-humid ombroclimate above 400–550 m altitude (Gianguzzi et al. 2006);
4. Levanzo – Thermo-Mediterranean with upper dry ombroclimate (Romano et al. 2006).

Table 1. Annual averages of max., min. and diurnal temperatures (in °C), daily temperature range, absolute max. and min. temperatures recorded at the weather stations of Trapani (15 m a.s.l.), Capo S. Vito (15 m a.s.l.) (Duro et al. 1996) and Erice (759 m a.s.l.) (Ministero dei LL. PP. 1978–1996).

Station	Av. max.	Av. min	Av. diurnal	Daily range	Absolute max.	Absolute min.
Trapani	21.7	14.4	18.1	7.3	41.8	0.1
Capo S. Vito	22.4	15.5	19.0	6.9	43.0	2.4
Erice	17.5	11.9	14.5	5.6	41.0	-2.7

Table 2. Average monthly and annual rainfall and number of rainy days (r.d.) recorded at the weather stations of Trapani, Capo San Vito, Sant'Andrea Bonagia, Lentina, Specchia (1926–1985; after Duro et al. 1996) and Erice (1978–1996; after Ministero dei LL. PP. 1978–1996).

Month	Trapani (15 m a.s.l.)		Capo S. Vito (6 m a.s.l.)		S. Andrea B. (48 m a.s.l.)		Lentina (125 m a.s.l.)		Specchia (140 m a.s.l.)		Erice (756 m a.s.l.)	
	mm	r.d.	mm	r.d.	mm	r.d.	mm	r.d.	mm	r.d.	mm	r.d.
January	64.2	10	68.4	9	75.0	10	88.6	11	80.3	11	81.7	10
February	50.8	8	58.6	8	65.6	9	77.6	10	71.6	10	61.8	10
March	44.1	7	42.8	6	60.0	8	56.7	8	49.8	8	71.9	10
April	34.4	5	35.1	5	42.2	6	44.4	6	36.2	5	72.6	8
May	19.2	3	18.1	2	22.6	3	24.6	3	18.5	3	35.2	5
June	8.0	1	5.6	1	8.9	1	6.7	1	7.6	1	6.5	2
July	1.7	–	3.2	–	2.6	-	1.8	–	2.3	–	4.0	–
August	9.5	1	9.1	1	15.1	1	9.4	1	10.5	1	10.0	1
September	35.3	3	41.6	3	55.7	4	47.2	4	41.3	4	49.3	4
October	71.1	7	71.2	7	89.3	7	90.0	8	83.3	8	90.6	7
November	69.6	8	66.7	8	85.1	9	95.3	9	75.1	8	86.4	10
December	75.1	11	82.0	10	78.6	11	96.5	12	83.3	11	82.0	11
Year	**483**	**64**	**502.4**	**60**	**602.7**	**69**	**637.8**	**73**	**559.8**	**70**	**651.3**	**78**

Materials and methods

Bioclimatic units are based on Rivas-Martínez's classification (2004); indices were calculated on data extracted from Drago et al. (2005) and Duro et al. (1996). Reference was made also to Gianguzzi and La Mantia (2008), Bazan et al. (2015), and Gianguzzi et al. (2016b).

Following the phytosociological approach (Braun-Blanquet 1964), 29 original relevés and 11 synthetic relevés, elaborated from different bibliographic references regarding the study area, were carried out. The syntaxonomic classification refers to different contributions cited throughout the text.

The floristic lists of collected or observed taxa from Mt. San Giuliano, Marettimo, Levanzo, and Mt. Cofano are reported in Suppl. materials 1, 2, 3, and 4, respectively. New floristic records are highlighted with a note in the tables provided in the Suppl. materials 1–4.

The collected plant material is preserved in public (FI, HFLA, HLUC, IS, IT, the acronyms follow Thiers 2023), or private herbaria (Herb. G. Mei). The identification of the plant specimens was based on Pignatti et al. (2017–2019). Taxonomic nomenclature follows the checklists of the Italian vascular flora (Bartolucci et al. 2018;

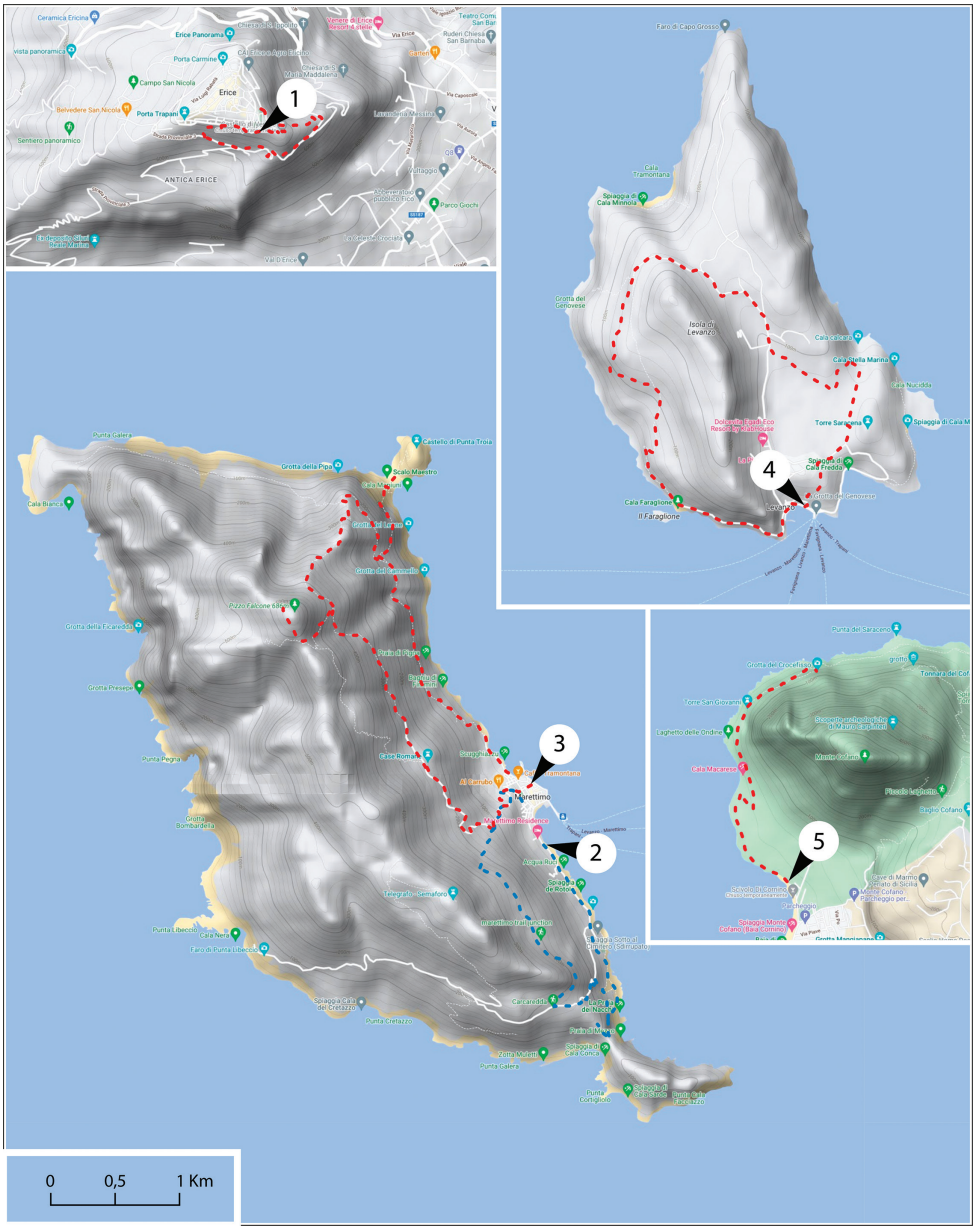

Figure 2. Tracks of the itineraries of excursions to Mount San Giuliano (**1**), Marettimo island (**2, 3**), Levanzo island (**4**), and Mount Cofano (**5**). All maps have the same cartographic scale (basemap provided by Google Terrain).

Galasso et al. 2018) and their updates available on the Portal to the Flora of Italy (2023), apart from: *Coronilla valentina* L. subsp. *glauca* (L.) Batt., *Hyoseris baetica* Sch. Bip. ex Nyman, *Reichardia picroides* (L.) Roth var. *maritima* (Boiss.) Fiori [Pignatti et al. 2017–2019; Gianguzzi et al. 2006], *Senecio aegadensis* C. Brullo et Brullo

(Brullo and Brullo 2020) [= *Senecio leucanthemifolius* Poir. subsp. *leucanthemifolius*], *Helichrysum panormitanum* Tineo ex Guss. subsp. *messeriae* (Pignatti) C. Brullo et Brullo and subsp. *brulloi* Iamonico et Pignatti (Iamonico et al. 2016; Brullo and Brullo 2020), and *Lysimachia loeflingii* (Jiménez-Lopez et al. 2022). For the taxa not belonging to the flora of Italy, cited in Table 4, the World Flora Online (2023) was followed.

Excursion to Mount San Giuliano (23 April 2022): Erice, Venus Castle, trail surrounding the castle

Mt. San Giuliano (786 m a.s.l.) is located near Trapani; it has an almost triangular shape, with rather steep southern and eastern slopes and a less abrupt morphology on north and north-western flanks, which are interrupted by stepped faults (Lentini and Carbone 2014). Despite the anthropic pressure exerted on it since ancient times, this mountain has a high naturalistic value and is often mentioned as one of the biotopes with the highest biodiversity in Sicily.

Land use – Erice, on the summit of Mt. San Giuliano, is an ancient town founded by the Elymians, which dominates a landscape now altered by various anthropic disturbances. In particular, the higher areas are covered by extensive reforestation with conifers, which are periodically subject to fires, while the rest of the area is characterized by low secondary shrublands, represented by maquis (dominated by *Chamaerops humilis* or *Cytisus infestus*) and garrigues (dominated by *Thymbra capitata*, and *Erica multiflora*), by steppic grasslands with *Hyparrhenia hirta* subsp. *hirta* or *Ampelodesmos mauritanicus*, and by ephemeral meadows, usually interspersed with rocky outcrops colonized by several endemic chasmophytes. Limited patches of woody vegetation dominated by holm oak or laurel occur in cooler microclimate stands of the northern slope.

Series and microgeoseries – The basal xeric belt of Mt. San Giuliano is mainly represented by maquis with lentisk and dwarf palm (*Pistacio lentisci-Chamaeropo humilis* sigmetum), lithophilous climatic vegetation linked to very sunny and arid stands especially with southern exposure. In conditions of marked edaphic xerity, as in the more rocky stands, it is sometimes replaced by an oleaster series ascribed to *Ruto chalepensis-Oleo sylvestris* sigmetum, which shows a scattered distribution and can be traced back to remains of ancient olive groves long since abandoned and now gone wild, which were saved from fires and cuts. This plant community is here represented by the *Ruto chalepensis-Oleetum sylvestris* subass. *euphorbietosum bivonae* (Gianguzzi and Bazan 2020a, 2020b). The semi-rupestrian rock outcrops are usually colonized by the *Euphorbia dendroides* maquis, which must be considered as an edapho-xerophilous community in contact with chasmophilous associations. Among the secondary plant communities occurring in this belt, xeric grasslands with *Hyparrhenia hirta* subsp. *hirta* (*Hyparrhenietum hirto-pubescentis* s. l.) and therophytic meadows of the class *Stipo-Trachynietea distachyae* must be mentioned.

The holm oak series (*Pistacio lentisci-Querco ilicis* sigmetum) develops within the upper belt, influenced by the Thermo- to Meso-Mediterranean subhumid bioclimate.

Figure 3. a Participants to the escursion (Erice, 23 April 2022) **b** view of the northern summit of Mt. San Giuliano, next to Torretta Pepoli, with stands of rupestrian and forest vegetation **c** the local endemic *Centaurea erycina*, character species of *Scabioso creticae-Centauretum ucriae* subass. *brassicetosum drepanensis* **d** view of the village of Marettimo surrounded by formerly terraced fields and by the rugged landscape of the island **e** view of the *Erico multiflorae-Pinetum halepensis*, with Punta Bassana in the background **f** vegetation of *Limonietum tenuiculi*, fringing the rocky shore of Marettimo.

It is represented by the following vegetation units: climatophilous woodland with *Quercus ilex* and *Pistacia lentiscus* (*Pistacio lentisci-Quercetum ilicis*); scrub with *Chamaerops humilis* (*Pistacio-Chamaeropetum humilis*) and/or *Cytisus infestus* (*Pyro amygdaliformis-Calicotometum infestae*); garrigue with *Erica multiflora* (*Micromerio fruticulosae-Ericetum multiflorae* corr. = *Erico-Micromerietum fruticulosae*); perennial dry grassland with *Ampelodesmos mauritanicus* (*Helictotricho convoluti-Ampelodesmetum mauritanici*); nitrophilous hemicryptophytic vegetation (*Carlino siculae-Feruletum communis*); therophytic meadow with *Stipellula capensis* (*Ononido breviflorae-Stipetum capensis*).

In this belt, other more circumscribed series occur, such as that of the chestnut oak series (*Oleo-Querco virgilianae* sigmetum, see Brullo and Marcenò 1985a; Brullo et al. 2008; Di Pietro et al. 2020a, 2020b) on deep and evolved soils, mainly represented by secondary plant communities on abandoned cropland, as well as the laurel series (*Acantho-Lauro nobilis* sigmetum), on cooler stands, such as gorges with a northern exposure. Lastly, the microgeosigmetum of cliffs, with associations of the alliance *Dianthion-rupicolae* (*Asplenietea trichomanis*), must be mentioned. The intricate issue regarding the taxonomic identity of the thermophilous pubescent white oaks of Sicily and southern Italy has been addressed by several authors (Brullo et al. 1999; Guarino et al. 2015; Wellstein and Spada 2015; Di Pietro et al. 2016; Pasta et al. 2016; Musarella et al. 2018; Di Pietro et al. 2020a, 2020b, 2021).

Endemic and rare species – Several endemic taxa thrive on Mt. San Giuliano, such as *Dianthus rupicola* subsp. *rupicola* (Tyrrhenian endemic) and *Micromeria graeca* subsp. *fruticulosa* (endemic to western Sicily, the island of Capri, and the Sorrento peninsula). Mt. San Giuliano is the locus classicus of *Brassica villosa* subsp. *drepanensis*, with a few other stands on Mt. Cofano and Capo San Vito, *Centaurea erycina* (Fig. 3c), (Raimondo and Bancheva 2004), and *Silene nefelites* (Brullo et al. 2014). A few other rare, non-endemic, species, namely *Simethis mattiazzi* a Mediterranean-Atlantic species (Gianguzzi et al. 2012), *Chamaeiris foetidissima*, *Vinca major*, and *Prunus mahaleb*, were recorded in the upper part of Mt. San Giuliano, where they take advantage of the humidity due to moisture condensation and frequent fogs rising from the sea.

Sampled plant communities

The first stopover was in the town of Erice, where it was possible to observe *Silene nefelites*, an endemic therophyte widespread along the roadside, as well as the chasmophytic vegetation colonizing the walls of the Castle of Venus and the nearby carbonate rocky outcrops. This chasmophytic community is referred to the Sicilian-Tyrrhenian association of the *Dianthion rupicolae*, *Scabioso creticae-Centauretum ucriae* subass. *brassicetosum drepanensis* (see Brullo et al. 2004), a relevé of which is reported below.

Scabioso creticae-Centauretum ucriae* subass. *brassicetosum drepanensis – Erice (38°02'25"N, 12°35'27"E): 627 m, 80°, N, 100 m². Diagnostic species: *Lomelosia cretica* 2, *Brassica villosa* subsp. *drepanensis* 2, *Centaurea erycina* 1. Characteristics of alliance, order and class: *Dianthus rupicola* subsp. *rupicola* 1, *Silene fruticosa* 2. Other species: *Athamanta sicula* +, *Sedum dasyphyllum* subsp. *glanduliferum* +,

Umbilicus rupestris +, *Asplenium ceterach* +, *Polypodium cambricum* 1, *Hypochoeris laevigata* 1, *Micromeria graeca* subsp. *fruticulosa* +, *Hyoseris radiata* +, *Campanula erinus* +, *Sedum caeruleum* +, *Muscari commutatum* +, *Veronica cymbalaria* +.

The *Scabioso creticae-Centauretum ucriae* is widespread on the cliffs of the mountains forming the north-western strip of the coast of Trapani. However, the stands observed in Erice differ from the typical ones for the lack of some endemic species, such as *Iberis semperflorens* and *Seseli bocconei*.

Paucispecific, subnitrophilous and sciaphilous wall vegetation, characterized by hemicryptophytes such as *Parietaria judaica* and *Athamanta sicula* is frequent on the old walls of Erice. It can be referred to *Athamanto siculae-Parietarietum*, an association of the alliance *Parietarion judaicae*, described from Monte Pellegrino (Palermo) by Gianguzzi and Bazan (2020c), which is quite frequent along the coasts of western Sicily. A relevé, sampled in the town of Erice, is reported below.

Athamanto siculae-Parietarietum judaicae – Erice, north-eastern city walls (38°02'12"N, 12°35'25"E): 740 m, 90°, E, 8 m². Diagnostic species: *Parietaria judaica* 3, *Atamantha sicula* 2, *Campanula erinus* +. Characteristics of alliance, order and class: *Sedum dasyphyllum* subsp. *glanduliferum* 1, *Umbilicus rupestris* +, *Cymbalaria muralis* +. Other species: *Hypochoeris laevigata* +, bryophytes (+).

Along the north-eastern side of Erice, near the Torre Pepoli, a path descends all around the cliff on which the Castello di Venere is built (Figs 2, 3b). In this place, patches of pre-forest vegetation with *Laurus nobilis*, referred to the association *Acantho mollis-Lauretum nobilis* (Gianguzzi et al. 2010), were observed. It is a vegetation linked to cool and shady places within the Meso-Mediterranean sub-humid bioclimatic belt. The relevé reported below was sampled on a steep slope, with a clay-limestone matrix, next to the cliffs, in an area that is highly exposed to moisture condensation.

Acantho mollis-Lauretum nobilis – Erice, below the cliffs near Torretta Pepoli (38°02'08"N, 12°35'29"E): 726 m, 80°, N, 100 m². Diagnostic species: *Laurus nobilis* 4, *Hedera helix* 3, *Acanthus mollis* 2, *Orobanche hederae* +, *Cyclamen hederifolium* +. Characteristics of alliance, order and class: *Rubia peregrina* 1, *Asparagus acutifolius* 1, *Rosa sempervirens* 2, *Ruscus aculeatus* 1, *Euphorbia characias* +, *Lonicera etrusca* 1, *Chamaeiris foetidissima* 2, *Clematis vitalba* 1, *Fraxinus ornus* 2, *Allium subhirsutum* 1. Other species: *Rubus ulmifolius* 2, *Crataegus monogyna* 1, *Ficaria verna* 1, *Arum italicum* 1, *Smyrnium olusatrum* 1, *Parietaria judaica* + (Gianguzzi et al. 2016a).

Syntaxonomical note – The association *Acantho mollis-Lauretum nobilis* belongs to the alliance *Asparago acutifolii-Laurion nobilis*; it is locally characterized by *Ficus carica*, *Celtis australis*, *Asparagus acutifolius*, *Clematis vitalba*, *Cyclamen hederifolium*, *Ulmus minor*, and *Orobanche hederae*. This association was described by Gianguzzi et al. (2016a) to define the micro-woods rich in laurel, widespread in Italy and in the large central-Mediterranean islands. Compared to the alliance *Arbuto unedonis-Laurion nobilis*, described for the Iberian Peninsula by Rivas-Martinez et al. (2001, 2002), framed in the order *Pistacio-Rhamnetalia alaterni*, the *Asparago acutifolii-Laurion nobilis* is more mesophilous and, therefore, it can be included in the order *Quercetalia ilicis* (Gianguzzi et al. 2016a; Rivieccio et al. 2021).

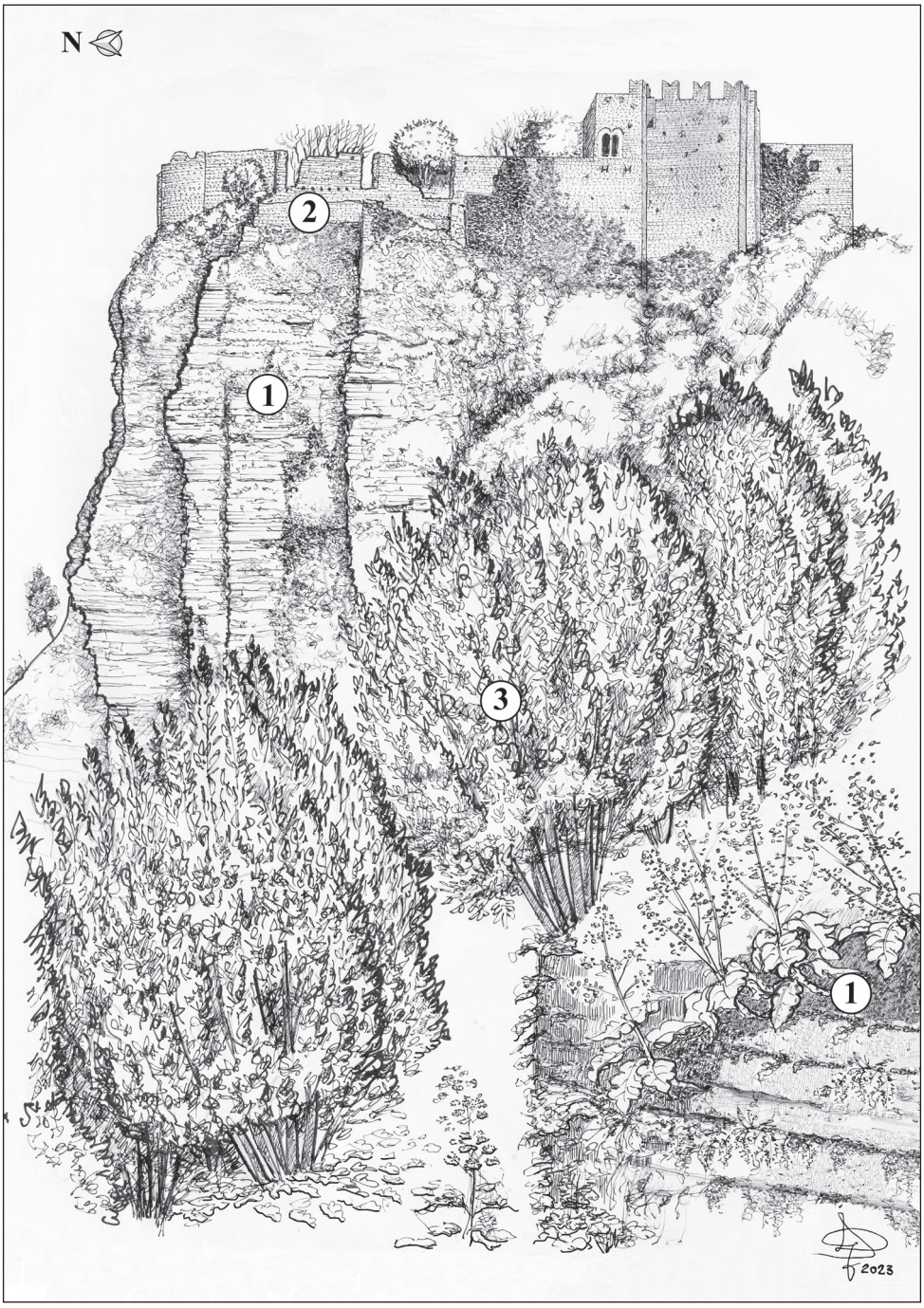

Figure 4. Mount San Giuliano: vegetation near Torretta Pepoli (38°02'08"N, 12°35'29"E; 730 m a.s.l.); in the background the Castle of Venus (Erice) – **1** *Scabioso creticae-Centauretum ucriae* subass. *brassicetosum drepanensis*; **2** subnitrophilous and subsciaphilous wall vegetation (*Athamanto siculae-Parietarietum judaicae*); **3** *Acantho mollis-Lauretum nobilis*.

Excursion to Marettimo Island I (24 April 2022): coastal and sub-coastal stretch of the southern part of the island, between Punta Bassana and Contrada Chiappera

The island of Marettimo (Fig. 2) – as seen from the hydrofoil arriving from Trapani (Fig. 3d) – appears as a rather rugged and uneven ridge, with Pizzo Falcone (686 m a.s.l.) towering on a system of other peaks sloping both northwards [Pizzo delle Fragole (538 m a.s.l.) and Capo Bianco (470 m a.s.l.)] and southwards [Pizzo del Capraio (626 m a.s.l.), Punta Campana (629 m a.s.l.), Punta Anzine (493 m a.s.l.) and Pizzo Nido Falcone (490 m a.s.l.)]. The steep slopes of the island are interrupted by torrential incisions and by imposing rock walls scattered all along the island's ridge, as well as in the localities named Libbano, Bassano, Orru Chiàppara, etc.

The island is characterized by very peculiar plant communities, which host many taxa of phytogeographic relevance, some of which endemic to the island. This is explained by its long geographical isolation, positioned at the extreme western limit of the Egadi archipelago and ca. 35 km from the Sicilian coasts, with isobaths between -100 and -350. Besides, during the last glacial maximum (20–18.00 years ago) it remained isolated from Sicily, unlike the other islands of the archipelago, which were, instead, united with Sicily (Agnesi et al. 1993). Therefore, Marettimo can be considered as a refuge area for numerous taxa missing in Sicily and in the rest of the archipelago.

On the other hand, some species that are quite frequent in Sicily are missing in Marettimo, such as *Rubus ulmifolius* Schott and other shrubs of the class *Crataego-Prunetea*, as well as species typical of dry grasslands, such as *Stipellula capensis*, which is represented on the island by very few individuals, probably of recent anthropogenic introduction. From a phytogeographical point of view, it is important to underline the possible connections with the African coast through a submerged ridge whose depth never goes below 350 m (Hofrichter 2001). Therefore, Marettimo probably acted as a stepping stone for various North African species that spread into the central part of the Mediterranean basin since the Messinian salinity crisis.

Land use – The agro-silvo-pastoral activities that existed until recently on the island have gradually led to the disappearance or rarefaction of the woodlands that previously covered its slopes. However, it should be noted that Marettimo, unlike other Mediterranean territories, does not seem to have suffered the devastating impact of periodical fires, with positive consequences on the natural vegetation. Furthermore, the activity of woodcutters, quite widespread on the island until 60 years ago, has now disappeared, and agricultural and pastoral activities have been gradually abandoned during the last decades. In the past, the whole island was exploited for the production of wood; deforestation and clearing was carried out on a large scale, with timber and fagots transported downstream using cableways, loaded directly onto boats and sold as firewood in the nearby coastal town of Trapani. Overall, the interruption of human activities and the absence of fires has brought about a significant advance in the evolution of the natural landscape.

The recent land-use change has led to both qualitative and quantitative variations in floristic and phytocoenotic diversity, through the progressive rarefaction, and sometimes disappearance, of species linked to crop and rural activities, once consisting of small peach orchards, olive groves and – to a lesser extent – vineyards, or ash groves, as well as wheat or leguminous crops (*Vicia faba* L., *Cicer arietinum* L., etc.). This is countered by the recent random introduction of allochthonous species, particularly in the proximity of the village and tourist infrastructure (Gianguzzi et al. 2006).

Series and microgeoseries – On south-exposed coastal slopes, frequently affected by the sirocco wind, the infra-Mediterranean edapho-xerophilous series of *Periploco-Euphorbio dendroidis* sigmetum is recognisable. On cracked rocky slopes and clastic substrates, within the thermo-Mediterranean Dry bioclimate, especially on the western and southwestern slopes of the island, the *Ruto chalepensis-Oleo sylvestris rhamno oleoidis* sigmetosum replaces the previously mentioned series. The head of the series is a maquis referred to the *Ruto chalepensis-Oleetum sylvestris* subass. *rhamnetosum oleoidis* (Gianguzzi and Bazan 2020a, 2020b); secondary aspects are represented by a low shrubland with *Euphorbia dendroides* and *Rhamnus lycioides* subsp. *oleoides* (*Rhamno alaterni-Euphorbietum dendroidis* subass. *rhamnetosum oleoidis*), as well as xerophilous grassland with *Hyparrhenia hirta* subsp. *hirta* (*Hyparrhenietum hirto-pubescentis* s.l.) and therophytic grasslands of the class *Stipo-Trachynietea distachyae*. The thermo-Mediterranean Dry to Subhumid belt is, however, dominated by the *Erico multiflorae-Pino halepensis* sigmetum, a pine forest series linked to more or less consolidated talus slopes at the base of the rocky cliffs. Upwards, within the Meso-Mediterranean Sub-humid bioclimatic belt, the holm oak series of the *Pistacio lentisci-Querco ilicis* / *Daphno sericeae-Querco ilicis* sigmetum occurs (see further on in the text for further explanations on the intricate question of the syntaxonomy of the holm oak woods of Marettimo). Currently, the limited residual patches of these woodlands are located in impervious stands near Pizzo Campana, as well as between Mt. Falcone and Pizzo delle Fragole, where the evolutionary processes of recolonization are clearly recovering, after the extensive deforestation implemented in the past (Gianguzzi et al. 2003a, b).

Among the secondary vegetation units, the garrigue with *Salvia rosmarinus* and *Erica multiflora*, ascribed to the association *Micromerio fruticulosae-Ericetum multiflorae* (Brullo and Marcenò 1983), is dominant throughout the island. It occupies large areas up to the highest parts of the island, interfering with the different vegetation series present there, with some local floristic variants, depending on particular ecological conditions. In fact, in addition to the subassociation *typicum*, other variants can be recognised, characterized by *Coronilla valentina* subsp. *glauca* and *Globularia alypum*, or by *Thymbra capitata*, or by *Cistus monspeliensis* and *Cistus salviifolius*. Along the ravines to the north of the village, there are shrublands with *Myrtus communis*, indicating a certain edaphic humidity. In the higher stands, a shrubby vegetation characterized by two rare relict taxa, *Daphne sericea* and *Thymelaea tartonraira*, occurs. These two species are completely missing from the rest of the Sicilian territories. In Marettimo, *Salvia rosmarinus* also reaches elevations that are quite unusual in Sicily, where this species is

limited to small residual sites near the coastline. This is probably due to isolation of the island even during the last glacial maxima, thus preserving it from climate change-related plant migrations.

The chasmophilous vegetation of *Bupleuro dianthifolii-Scabiosetum limonifoliae* is also rich in endemic or rare species, as well as the plant communities occurring on the rocky coasts, represented by the *Limonietum tenuiculi*, *Senecioni bicoloris-Helichrysetum messerii* and *Agropyro scirpei-Inuletum crithmoidis*.

Endemic and rare species – According to literature data (Gianguzzi et al. 2006; Scuderi 2008; Brullo C. et al. 2009), the vascular flora of Marettimo consists of 499 taxa. There are eight species endemic to the island, three of which are palaeoendemic (*Oncostema ughii*, *Bupleurum dianthifolium*, *Thymus richardii* subsp. *nitidus*) and five schizoendemic (*Allium franciniae*, *Helichrysum panormitanum* subsp. *messeriae*, *Limonium tenuiculum*, *Prospero hierae* and *Senecio aegadensis*). In addition, another narrow-ranging paleoendemic species limited to the islands of Marettimo and Favignana, *Brassica macrocarpa*, occurs. Other endemic species with a distribution including the Sicilian territory are: *Hexaphylla rupestris*, *Bellevalia dubia*, *Carlina sicula*, *Euphorbia papillaris*, *Plantago afra* subsp. *zwierleinii*, *Pseudoscabiosa limonifolia*, *Ranunculus spicatus* subsp. *rupestris*, *Jacobaea maritima* subsp. *sicula*, and *Seseli bocconei*. Some other endemics have a wider Tyrrhenian range, such as *Crocus longiflorus*, *Daucus carota* subsp. *drepanensis*, *Dianthus rupicola* subsp. *rupicola*, *Iberis semperflorens*, *Glandora rosmarinifolia*, *Pimpinella anisoides*, *Micromeria graeca* subsp. *fruticulosa*, *Anthemis secundiramea*, etc. The island also hosts species of biogeographical interest, that are either completely absent or very rare in the rest of Sicily, such as *Aristolochia navicularis*, *Daphne sericea*, *Erodium maritimum*, *Lagurus ovatus* subsp. *vestitus*, *Periploca angustifolia*, *Reichardia tingitana*, *Simethis mattiazzi*, *Thymelaea tartonraira*, and others.

Sampled plant communities

Moving from the town of Marettimo towards the southern part of the island, there is a relatively flat stretch of coastline, which is very different from the rest of the island, characterised by cliffs and crags that are rather steep and not always accessible (Fig. 5). Along this coast, it is possible to observe halophilous and scattered vegetation, represented towards the sea by the *Limonietum tenuiculi*, widespread throughout the island, both on low coasts and sea-facing cliffs (Fig. 3f).

Limonietum tenuiculi (After Brullo and Marcenò 1983: tab. 1, rels 1–13) – Diagnostic species: *Limonium tenuiculum* V, *Senecio aegadensis* IV, Characteristics of alliance, order and class: *Crithmum maritimum* V, *Daucus carota* subsp. *drepanensis* V, *Lotus cytisoides* V, *Silene sedoides* V, *Reichardia picroides* var. *maritima* V, *Plantago macrorhiza* III, *Jacobaea maritima* subsp. *sicula* III, *Frankenia hirsuta* III. Other species: *Catapodium pauciflorum* IV, *Anthemis secundiramea* IV, *Hyoseris radiata* III, *Parapholis incurva* II, *Limbarda crithmoides* subsp. *longifolia* II, *Euphorbia segetalis* II, *Bellis annua* II, *Ranunculus paludosus* II, *Sagina maritima* II, *Hornungia procumbens* II, *Plantago coronopus* I, *Trifolium scabrum* I, *Arthrocaulon meridionale* I.

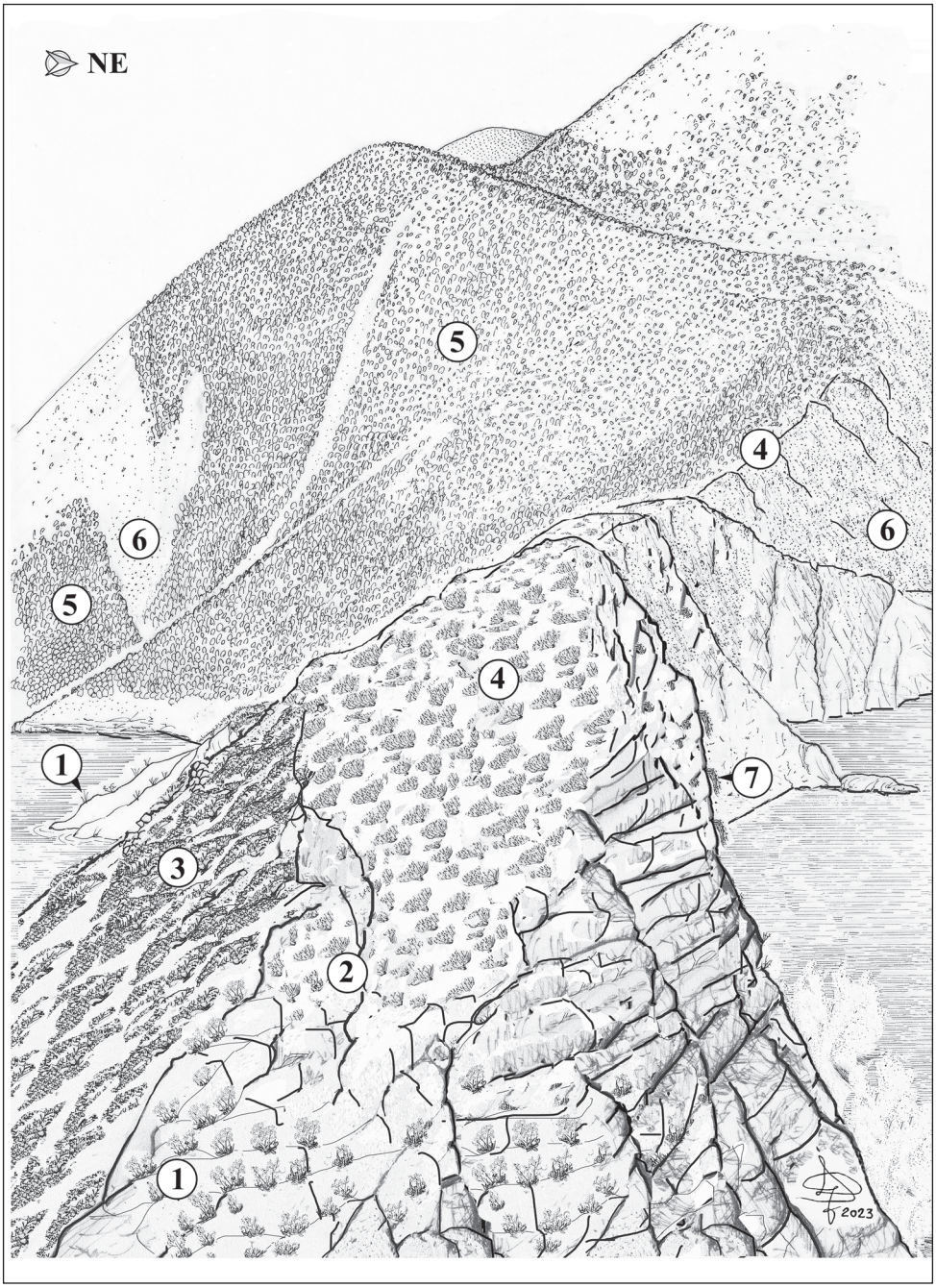

Figure 5. Vegetation along the slopes of Marettimo (southern cape) between Punta Bassana and Pizzo Spirone (37°56'52"N, 12°05'25"E; 53 m a.s.l.) – **1** *Limonietum tenuiculi*; **2** *Senecioni bicoloris-Helichrysetum messerii*; **3** *Periploco angustifoliae-Euphorbietum dendroidis*; **4** *Micromerio fruticulosae-Ericetum multiflorae* var. *typicum*; **5** *Erico multiflorae-Pinetum halepensis*; **6** *Oleo sylvestris-Pistacietum lentisci*; **7** *Bupleuro dianthifolii-Scabiosetum limonifoliae*.

Along the landward gradient, the *Limonietum tenuiculi* is replaced by *Senecioni bicoloris-Helichrysetum messerii* is found next, characterized by the silvery cushions of the dominant species. This plant community is more frequent along the north-east facing coast, in the upper part of the coastal cliffs, forming an ecotone between the halo-tolerant vegetation and the coastal garrigue or other inland vegetation.

Senecioni bicoloris-Helichrysetum messerii (After Brullo and Marcenò 1983: tab. 2, rels 1–10) – Marettimo, a little beyond the cemetery: 10 m., 8°, NE, 50 m². Diagnostic species: *Helichrysum panormitanum* subsp. *messeriae* V, *Jacobaea maritima* subsp. *sicula* V, *Polycarpon tetraphyllum* subsp. *alsinifolium* V. Characteristics of alliance, order and class: *Daucus carota* subsp. *drepanensis* V, *Crithmum maritimum* V, *Lotus cytisoides* V, *Reichardia picroides* var. *maritima* IV, *Catapodium balearicum* IV, *Plantago macrorhiza* V, *Limonium tenuiculum* IV, *Anthemis secundiramea* IV, *Senecio aegadensis* IV, *Silene sedoides* III, *Thymelaea hirsuta* I. Other species: *Dactylis glomerata* subsp. *hispanica* V, *Hyoseris radiata* V, *Euphorbia segetalis* IV, *Catapodium balearicum* IV, *Trifolium scabrum* III, *Brachypodium distachyon* III, *Stachys romana* III, *Parapholis incurva* II, *Erica multiflora* III, *Catapodium rigidum* III, *Romulea bulbocodium* II, *Linum strictum* II, *Carlina sicula* II, *Pallenis spinosa* I, *Coronilla valentina* subsp. *glauca* I, *Euphorbia dendroides* I, *Limbarda crithmoides* subsp. *longifolia* II, *Bellis annua* II, *Pistacia lentiscus* I.

The southern slopes of Punta Bassana, characterised by clay-limestone substrates, are rather xeric and strongly affected by dry southerly winds, particularly the sirocco. These are colonized by a low scrub dominated by *Periploca angustifolia* and *Euphorbia dendroides*, accompanied by a few other species of the order *Pistacio-Rhamnetalia alaterni* and of the class *Quercetea ilicis*, as shown in the relevé below.

Periploco angustifoliae-Euphorbietum dendroidis – Punta Bassana (37°57'01"N, 12°04'50"E): 81 m, 30°, S, 40%, 100 m². Diagnostic species: *Periploca angustifolia* 3, *Euphorbia dendroides* 2. Characteristics of alliance, order and class: *Teucrium fruticans* 1, *Olea europaea* var. *sylvestris* 1, *Clematis cirrhosa* +, *Ruta chalepensis* +. Other species: *Salvia rosmarinus* 2, *Erica multiflora* 2, *Micromeria graeca* subsp. *fruticulosa* +, *Dactylis glomerata* subsp. *hispanica* +, *Squilla pancration* +.

An aspect of degradation of the above-mentioned maquis is represented by a thinned garrigue, which can be ascribed to the *Micromerio fruticulosae-Ericetum multiflorae* (Fig. 8e); a relevé of this vegetation is reported below.

Micromerio fruticulosae-Ericetum multiflorae* var. *typicum – Ridge of Punta Bassana (37°57'04"N, 12°04'49"E): 86 m, 30°, SSE, 40%, 40 m². Diagnostic species: *Salvia rosmarinus* 3, *Erica multiflora* 2, *Micromeria graeca* subsp. *fruticulosa* +, Characteristics of alliance, order and class: *Fumana thymifolia* 1, *Cuscuta epithymum* +, *Phagnalon rupestre* +. Other species: *Pistacia lentiscus* 1, *Glandora rosmarinifolia* +.

Moving along the path that leads from Punta Bassana towards Carcaredda (180 m a.s.l.) and proceeding along the base of Pizzo Spirone (333 m a.s.l.) towards Contrada Chiappera, it is possible to observe some *Pinus halepensis* woods. This forest vegetation grows on rather steep slopes, essentially consisting of partially consolidated, frequently eroded, carbonatic screes. It develops mainly within the thermo-Mediterranean dry

to subhumid bioclimatic belt and falls within the series of *Erico multiflorae-Pineto halepensis* sigmetum, whose more mature aspect is represented by *Erico multiflorae-Pinetum halepensis*, an association renamed by Pesaresi et al. (2017), which was previously attributed by Brullo et al. (2008) to *Pistacio lentisci-Pinetum halepensis* De Marco et Caneva 1985. It is a basiphilous pine forest, rich in *Pistacia lentiscus* in the undergrowth. Small nuclei of this association that survived the deforestation are currently located in the north-eastern part of the island, encompassing Pigna and Spartivalle districts. However, most of the vegetation dominated by *Pinus halepensis* can be traced back to forest plantations carried out in the 1970s. These artificial forests turned into mature, self-reproducing naturalised woods, as can be seen along the aforesaid trails. Indeed, these reforestations show a relatively rapid recovery of *P. halepensis*, favoured by the intense dissemination that has gradually brought about its advancement in the garigues and maquis belonging to the same vegetation series.

Erico multiflorae-Pinetum halepensis (After Scuderi 2002, tab. 11, rels 1–5 sub *Pistacio lentisci-Pinetum halepensis*) – Diagnostic species: *Pinus halepensis* V, *Salvia rosmarinus* V. *Erica multiflora* IV, *Globularia alypum* V, Other species: *Pistacia lentiscus* IV, *Cistus creticus* subsp. *creticus* IV, *Coronilla valentina* subsp. *glauca* IV, *Arisarum vulgare* IV. *Carex hallerana* III, *Ruta chalepensis* I, *Daphne gnidium* I, *Micromeria graeca* subsp. *fruticulosa* I, *Leontodon tuberosus* III, *Ophrys* gr. *fusca* I, *Orchis italica* I, *Hexaphylla rupestris* I, *Colchicum cupani* I.

Syntaxonomical note – According to Pesaresi et al. (2017) and Bonari et al. (2021), the *Erico multiflorae-Pinetum halepensis* must be arranged in the order *Pinetalia halepensis* of the class *Pinetea halepensis*. It includes the vegetation dominated by *Pinus halepensis* of several localities of the Italian territory, such as Pantelleria (Brullo et al. 1977; Gianguzzi 1999a, 1999b), south-eastern Sicily (Bartolo et al. 1978, 1985), Apulia (De Marco et al. 1985), and Sardinia at Porto Pino (De Marco et al. 1985). The class-level classification of Mediterranean pine forests is still a matter of debate. An official proposal for the addition of the class *Pinetea halepensis* Bonari et Chytrý in Bonari et al. (2021) to the syntaxonomic scheme of the EuroVegChecklist (from now on EVC) (Mucina et al. 2016) was officially advanced in 2021.

Among the main reasons why the authors of the proposal consider it appropriate to place Mediterranean pine forests in a different class from *Quercetea ilicis* is that there would be a better match in remote sensing of vegetation and land-cover classifications leading to a better correspondence with the broadly used systems of habitats or forest types, which usually, in the first place distinguish between broadleaved and coniferous forests. This proposal was critically evaluated by a panel of experts selected by the European Vegetation Classification Committee who have highlighted some critical issues in the research paper (Bonari et al. 2021) where the new class *Pinetea halepensis* was proposed. Among the weak points, which according to the Commission require further study and a broader discussion within the EVC, we mention the following: i) the lack of true diagnostic species in the new class that are not already classified as characteristic species of other classes or orders, especially *Quercetea ilicis* and *Pistacio-Rhamnetalia alaterni*; ii) the inclusion in the statistical analysis of both natural pine forests and

putative old anthropogenic pine plantations, which would, at least partially, contravene the very concept of "plant community" composed of species ecologically coherent with the site where they live and distributed in the arrangement they themselves established; iii) a too broad tree layer coverage range (>15%) which in fact would lead to include different macro-vegetation types, such as forests, shrublands and (wooded) grasslands and garrigues in the same syntaxonomic class; iv) a lack of homogeneity with the current EVC framework where there are already other alliances and orders related to conifer forests that are currently classified within classes dominated by broad-leaved tree species (evergreen or deciduous). The final decision on this proposal via a vote will take place during 2023. To date, both Biondi et al. (2014) and Mucina et al. (2016) classify the *Pinus halepensis* forests characterized by a rich *Pistacio-Rhamnetalia* evergreen sclerophyllous understorey in the order *Pinetalia halepensis* and in the class *Quercetea ilicis*, due to the occurrence of several sclerophyllous shrubs of this class in the undergrowth of pine forests. Given the almost total absence on Marettimo of species of the class *Crataego-Prunetea* – as well as of *Cytisus infestus*, often dominant in the Sicilian coasts – the pine forest edge is formed by garrigues of *Micromerio fruticulosae-Ericetum multiflorae*, which are represented not only in their typical aspect, but also in the variants with *Thymbra capitata*, *Cistus monspeliensis* and *Ampelodesmos mauritanicus* framed in the alliance *Polygalo preslii-Ericion multiflorae* (class *Ononido-Rosmarinetea*). In addition to the typical stands (with *Globularia alypum* and *Coronilla valentina* subsp. *glauca*), linked precisely to the *Pinus halepensis* vegetation series – a relevé of which is reported below – a number of other variants occur on the island, in particular those with *Thymbra capitata*, *Cistus monspeliensis*, and *Ampelodesmos mauritanicus*.

Micromerio fruticulosae-Ericetum multiflorae* var. *typicum – Marettimo, Contrada Carcaredda (37°57'14"N, 12°04'34"E): 189 m, 25°, SSE, 80 m². Diagnostic species: *Salvia rosmarinus* 4, *Micromeria graeca* subsp. *fruticulosa* 1, *Erica multiflora* +, *Globularia alypum* 1, *Coronilla valentina* subsp. *glauca* +. Characteristics of alliance, order and class: *Ononis minutissima* +, *Cistus monspeliensis* 1, *Phagnalon saxatile* +, *Cistus creticus* subsp. *creticus* +. Other species: *Pistacia lentiscus* 2, *Hyparrhenia hirta* subsp. *hirta* 2, *Brachypodum retusum* 2, *Avena barbata* 2, *Scorpiurus subvillosus* 1, *Ruta chalepensis* +, *Euphorbia dendroides* +, *Catapodium rigidum* +, *Carex hallerana* +, *Coronilla scorpioides* +, *Trachynia distachya* +, *Leontodon tuberosum* +, *Linum strictum* +, *Arisarum vulgare* +, *Hypochoeris achyrophorus* +, *Melica minuta* +, *Lysimachia loeflingii* +, *Allium ampeloprasum* r, *Gladiolus byzantinus* r.

Another forest edge vegetation related to the *P. halepensis* series is represented by a low scrub of oleaster and *Pistacia lentiscus*, of which two relevés are reported below.

Oleo sylvestris-Pistacietum lentisci s.l. – Marettimo, Contrada Chiappera (37°57'33"N, 12°04'24"E): 220 m, 15°, E, 100 m². Diagnostic species: *Pistacia lentiscus* 4, Characteristics of alliance, order and class: *Euphorbia dendroides 2*, *Daphne gnidium* +, *Ruta chalepensis* +, *Arisarum vulgare* 1, *Stachys major* +, *Rubia peregrina* +, *Carex hallerana* +, Other species: *Erica multiflora* 3, *Cistus creticus* subsp. *creticus* 2, *Melica minuta* 2, *Coronilla valentina* 1, *Cistus monspeliensis* 1, *Allium subhirsutum* 1, *Salvia rosmarinus* +, *Phagnalon saxatile* +, *Ferula communis* +, *Daucus carota* +,

Sonchus tenerrimus +, *Jacobaea maritima* subsp. *sicula* +, *Poterium sanguisorba* subsp. *balearicum* +, *Ampelodesmos mauritanicus* +, *Lysimachia arvensis* r, *Dactylis glomerata* subsp. *hispanica* r, *Centranthus calcitrapae* r, *Anemone hortenis* r, *Ononis mitissima* r.

Oleo sylvestris-Pistacietum lentisci s.l. – Marettimo, near the cemetery (37°57'32"N, 12°04'40"E): 52 m, 50°, NE, 40 m². Diagnostic species: *Pistacia lentiscus* 5, Characteristics of alliance, order and class: *Euphorbia dendroides* 1, *Ruta chalepensis* 1, *Arisarum vulgare* +, *Rubia peregrina* 1. Other species: *Erica multiflora* +, *Coronilla valentina* 2, *Ferula communis* +, *Sonchus tenerrimus* +, *Jacobaea maritima* subsp. *sicula* 1, *Magydaris pastinacea* 2, *Clinopodium nepeta* +, *Brachypodium retusum* +, *Reichardia picroides* +, *Phagnalon saxatile* +, *Sonchus bulbosus* +, *Dactylis glomerata* subsp. *hispanica* +, *Galactites tomentosus* +, *Galium murale* +, *Cynoglossum creticum* +, *Melica minuta* +.

Syntaxonomical note – The maquis with *P. lentiscus* is quite widespread in the Mediterranean region, where various associations are reported, such as *Oleo-Pistacietum lentisci* Molinier 1954, *Cneoro-Pistacietum lentisci* O. Bolos et R. Molinier (1969) 1984, and *Myrto-Pistacietum lentisci* (Molinier 1954 em. O. Bolos 1962) Rivas-Martinez 1975, the latter occurring also on Marettimo.

Excursion to Marettimo II (25 April 2022): Case Romane, Mt. Falcone and north-eastern coastal stretch

Above the village of Marettimo, along the initial part of a paved track leading to the locality named Case Romane, there are compact limestone outcrops colonized by a sparse garrigue dominated by *Thymbra capitata*. This vegetation can be considered a variant of the *Micromerio fruticulosae-Ericetum multiflorae*, a relevé of which is reported below.

Micromerio fruticulosae-Ericetum multiflorae **var. with *Thymbra capitata*** – Slightly above the Marettimo village (37°58'04"N, 12°04'14"E): 47 m, 25°, NE, 85 m². Diagnostic species: *Thymbra capitata* 4, *Erica multiflora* 1, *Salvia rosmarinus* +, *Micromeria graeca* subsp. *fruticulosa* +. Characteristics of alliance, order and class: *Globularia alypum* 1, *Coronilla valentina* subsp. *glauca* +, *Phagnalon saxatile* +. Other species: *Pistacia lentiscus* 2, *Stachys major* 1, *Arisarum vulgare* 1, *Bituminaria bituminosa* 1, *Carlina sicula* 1, *Brachypodium distachyon* 1, *Euphorbia dendroides* +, *Jacobaea maritima* subsp. *sicula* +, *Lonicera implexa* +, *Ruta chalepensis* +, *Leontodon tuberosum* +, *Anemone hortensis* +, *Fedia graciliflora* +, *Hypochoeris achyrophorus* +, *Linum strictum* +, *Linum usitatissimum* subsp. *angustifolium* +, *Rubia peregrina* +, *Euphorbia peplis* +, *Valerianella dentata* +, *Macrobriza maxima* +, *Anthyllis vulneraria* subsp. *maura* +, *Reichardia picroides* +, *Lysimachia arvensis* +, *Daphne gnidium* +, *Olea europaea* var. *sylvestris* pl. +, *Ampelodesmos mauritanicus* +, *Poterium sanguisorba* subsp. *balearicum* +, *Ferula communis* +, *Orchis italica* +, *Pallenis spinosa* +.

Up to Case Romane (37°58'13"N, 12°03'51"E), an archaeological site where the main freshwater spring of the island gushes out, the vegetation can be referred to the *P. halepensis* forest series described in the previous itinerary. Further up, at 450–500 m a.s.l., whitin the Meso-Mediterranean sub-humid bioclimatic belt, the holm oak series

(*Pistacio lentisci-Querco ilicis* sigmetum) develops on carbonatic soils. The head of the series is represented by residual nuclei of holm oak woods (*Pistacio lentisci-Quercetum ilicis*), remnants of the intense deforestation that occurred in the past (Fig. 8d). These small forest patches, occurring also at Pianoro della Craparizza, Pizzo delle Fragole and between the localities Stincazzi and Scaturro, represent relict flaps of the primary forest, exploited in the past (up to the 1960s) for charcoal production. One of these nuclei was observed along the path, on the slope to the east of Pizzo Campana. It can be ascribed to the subassociation *arbutetosum unedonis* – one of the two recorded from the island – a relevé of which is reported below.

Pistacio lentisci-Quercetum ilicis* subass. *arbutetosum unedonis – Below Pizzo Campana (37°58'20"N, 12°03'30"E): 455 m, 25°, NE, 100 m². Diagnostic species: *Quercus ilex* 4, *Pistacia lentiscus* 1, *Arbutus unedo* 1. Characteristics of alliance, order and class: *Dapne gnidium* 1, *Carex hallerana* 1, *Cyclamen repandum* +, *Ruta chalepensis* +, *Rubia peregrina* +. Other species: *Erica multiflora* 4, *Salvia rosmarinus* 1, *Micromeria graeca* subsp. *fruticulosa* +, *Cistus creticus* subsp. *creticus* 1, *Jacobaea maritima* subsp. *sicula* +, *Selaginella denticulata* +, *Hypochoeris laevigata* +.

Aspects of holm oak woods with *Arbutus unedo* referred to the above-mentioned subassociation are also sporadically recorded in Sicily on leached carbonatic soils, as in the case of the cacuminal part of Monte Cofano (Gianguzzi and La Mantia 2008). On Marettimo, these holm oak woods are fringed by scrubland dominated by *P. lentiscus*, through degradation replaced by the *Cistus salviifolius* variant of the garrigue *Micromerio fruticulosae-Ericetum multiflorae*. A relevé of this garrigue, widespread over large areas in the upper part of Marettimo, is reported below.

Micromerio fruticulosae-Ericetum multiflorae* var. with *Cistus salviifolius – Below Pizzo Campana (37°58'33"N, 12°03'26"E): 480 m, 20°, NE, 85 m². Diagnostic species: *Cistus salviifolius* 3, *Erica multiflora* 3, *Salvia rosmarinus* 4, *Micromeria graeca* subsp. *fruticulosa* +. Characteristics of alliance, order and class: *Globularia alypum* 1, *Cistus creticus* subsp. *creticus* 1, *Fumana thymifolia* +. Other species: *Pistacia lentiscus* 1, *Arisarum vulgare* +, *Trachynia distachya* 1, *Brachypodium retusum* 1, *Allium franciniae* +, *Carex halleriana* +, *Valantia muralis* +, *Leontodon tuberosum* +, *Anemone hortensis* +, *Fedia graciliflora* +, *Hypochoeris achyrophorus* +, *Colchicum bivonae* +.

This garrigue is often compenetrated with a hemicryptophic vegetation dominated by *Brachypodium retusum*, particularly on steep stony slopes, that are covered by a vegetation similar to the one described as *Brachypodio ramosi-Cistetum cretici* from the Mt. Cofano area (Gianguzzi and La Mantia 2008; Gianguzzi et al. 2015).

In higher stands, near Pizzo Falcone, there is a holm-oak wood differentiated by the occurrence of *Daphne sericea*, a small shrub that is completely absent in Sicily, having on Marettimo the western limit of its range (Di Pietro 2001). This vegetation was described by Brullo and Marcenò (1983) as *Daphno sericeae-Quercetum ilicis* and considered the potential forest vegetation in the upper part of the island, which is linked to a regular moisture condensation regime, testified by frequent fogs. A relevé is reported below.

Daphno sericeae-Quercetum ilicis – Pizzo Falcone (37°58'41"N, 12°03'18"E): 544 m, 25°, N, 100 m². Diagnostic species: *Quercus ilex* 3, *Daphne sericea* 1. Characteristics

of alliance, order and class: *Pistacia lentiscus* 1, *Daphne gnidium* +, *Carex hallerana* 1, *Cyclamen repandum* 1. Other species: *Erica multiflora* 2, *Salvia rosmarinus* 1, *Cistus creticus* subsp. *creticus* 1, *Jacobaea maritima* subsp. *sicula* +, *Anemone hortensis* +.

Syntaxonomic notes – The syntaxonomic arrangement of the holm oak woodlands of the island of Marettimo represents a still unresolved problem from a nomenclatural point of view. Brullo and Marcenò (1983) validly described the association *Daphno sericeae-Quercetum ilicis*, typical of the highest areas of Marettimo, where *Quercus ilex* took advantage of the frequent occurrence of fog and westerly humid winds. Two years later, the same authors in their fundamental work on the class *Quercetea ilicis* in Sicily (Brullo and Marcenò 1985b), described for western and southern Sicily a new thermophilous association of holm oak wood named *Pistacio lentisci-Quercetum ilicis*. In this paper, the authors included the *Daphno sericeae-Quercetum ilicis* that they had previously described for Marettimo in the ecological range of *Pistacio lentisci-Quercetum ilicis*, considering the latter association as a simple variant of the newly described *Pistacio lentisci-Quercetum ilicis*. In nomenclatural terms however, this kind of downgrading is not allowed by the code of phytosociological nomenclature (ICPN, Theurillat et al. 2020). In fact, the name *Daphno sericeae-Quercetum ilicis* Brullo et Marcenò 1983 has nomenclatural priority over *Pistacio lentisci-Quercetum ilicis* Brullo et Marcenò 1985 as it was published two years earlier (principle IV of ICPN).

Clearly, the peculiar distribution range of *Daphne sericea* does not support the use of the name *Daphno-Quercetum ilicis* to represent the holm-oak woods of the whole of Sicily. In fact this species occurs on Marettimo but is missing in the rest of Sicily and in most of southern Italy. It then reappears further north along the Tyrrhenian coast from northern Campania to southern Tuscany as well as in Puglia (Gargano) and inland areas of Abruzzo and (sporadically) Molise. However, since the authors of these associations clearly stated that these two communities represent, in fact, different aspects of the same association, the name *Pistacio lentisci-Quercetum ilicis* automatically becomes the type of the earliest legitimate name (Art. 29c) that in this case is *Daphno sericeae-Quercetum ilicis*. For this reason, the name *Pistacio lentisci-Quercetum ilicis* should be considered superfluous (Art. 18b). Brullo et al. (2008) tried to resolve the issue by describing the new subassociation *Pistacio lentisci-Quercetum ilicis* subass. *daphnetosum sericeae* exclusively for the island of Marettimo. However, also in this case, since the authors chose, as nomenclatural type of the new subassociation *daphneetosum sericeae*, the same relevé (rel. 2 of tab. 6) already used by Brullo and Marcenò (1983) to typify the *Daphno sericeae-Quercetum ilicis*, there is once again a reunion of syntaxa at the same rank (*Pistacio-Quercetum* vs. *Daphno-Quercetum*), with nomenclatural priority for *Daphno sericeae-Quercetum ilicis* for the above reasons. The possible solutions to this question are essentially two. The first leads to consider the *Daphno-Quercetum ilicis* as restricted solely to Marettimo by virtue of the particular bioclimatic and biogeographic conditions that characterize this island and to separate it from the *Pistacio-Quercetum ilicis*, which is widespread in the whole of Sicily and probably in other areas of southern Italy. The second solution is to refer to Art. 52 of the 4th edition of the ICPN and to propose to the Committee for Change and Conservation of Names (CCCN) the adop-

tion of *Pistacio lentisci-Quercetum ilicis* as *nomen conservandum* over its earlier heterotypic name (syntaxonomic synonym) *Daphno sericeae-Quercetum ilicis*. While waiting for this proposal to be officially advanced and for the whole process of acceptance to be completed, the only possible syntaxonomic reference for this paper, in agreement with the ICPN, is the name *Daphno sericeae-Quercetum ilicis* Brullo et Marcenò 1984.

The summit of Pizzo Falcone (Fig. 6), sloping steeply towards the coast, dominates the whole island. The imposing cliffs on the northern side host a luxuriant rupicolous vegetation, which is also well represented elsewhere on the island (Pizzo del Capraro, Pizzo Lisandro, as well as the areas of Libbano, Bassano, Orru Chiàppara, etc.). These cliffs, especially those facing north and north-east, are rich in endemites and species of relevant taxonomic and phytogeographic value. The chasmophytic vegetation of Marettimo was referred by Brullo and Marcenò (1979) to the *Bupleuro-Scabosetum limonifoliae*, association framed into the alliance *Dianthion rupicolae* (*Asplenietalia glandulosi*, *Asplenietea trichomanis*).

Bupleuro dianthifolii-Scabiosetum limonifoliae (After Brullo and Marcenò 1983: tab. 7, rels 1–16) – Diagnostic species: *Bupleurum dianthifolium* V, *Helichrysum panormitanum* subsp. *messeriae* V, *Oncostema ughii* V, *Thymus richardii* subsp. *nitidus* II. Characteristics of alliance, order and class: *Seseli bocconei* V, *Iberis semperflorens* V, *Hexaphylla rupestris* V, *Pseudoscabiosa limonifolia* IV, *Glandora rosmarinifolia* IV, *Dianthus rupicola* subsp. *rupicola* IV, *Brassica macrocarpa* II, *Melica minuta* II, *Parietaria lusitanica* II, *Atamantha sicula* I. *Hypochoeris laevigata* IV, *Polypodium cambricum* II, *Asplenium ceterach* II, *Sedum dasyphyllum* s.l. II, *Umbilicus rupestris* I, *Ranunculus spicatus* subsp. *rupestris* I. Other species: *Erica multiflora* V, *Jacobaea maritima* subsp. *sicula* VI, *Micromeria graeca* subsp. *fruticulosa* IV, *Salvia rosmarinus* III, *Lonicera implexa* II, *Euphorbia dendroides* II, *Allium subhirsutum* II, *Hyoseris radiata* I, *Valantia muralis* I, *Cistus creticus* subsp. *eriocephalus* I, *Carex halleriana* I, *Selaginella denticulata* I, *Pistacia lentiscus* I, *Petrosedum sediforme* I, *Lagurus ovatus* subsp. *vestitus* I, *Quercus ilex* I, *Daphne sericea* I, *Lobularia maritima* I, *Galium corrudifolium* I.

Just below the summit of Pizzo Falcone (Fig. 8c), a branch of the main downhill path (37°58'41"N, 12° 03'17"E; 543 m) leads to Punta Troia (Fig. 8a). Here there are dense garrigues referable to *Micromerio fruticulosae-Ericetum multiflorae*, sometimes mixed with *Brachypodium retusum* grassland, differentiated by the occurrence of *Coronilla valentina* subsp. *glauca*, belonging to the *Coronillo glaucae-Brachypodietum retusi* (Brullo et al. 2010).

Coronillo glaucae-Brachypodietum retusi (After Brullo et al. 2010: tab. 15, rels 1–2) – Diagnostic species: *Coronilla valentina* subsp. *Glauca* 2, *Brachypodium retusum* 2. Characteristics of alliance, order and class: *Ferula communis* 2, *Ampelodesmos mauritanicus* 1, *Hyoseris radiata* 1, *Phagnalon saxatile* 1, *Hyparrthenia hirta* subsp. hirta 1, *Dactylis glomerata* subsp. *hispanica* 2, *Carlina sicula* 1. Other species: *Avena barbata* 1, *Ruta chalepensis* 1, *Cistus creticus* subsp. *eriocephalus* 2, *Micromeria fruticulosa* 2, *Arisarum vulgare* 2.

These are secondary vegetation units pertaining to the holm oak series (*Pistacio-Querco ilicis* sigmetum), as well as lower down to the *Pinus halepensis* series (*Erico multiflorae-Pino halepensis* sigmetum). While proceeding towards Contrada Rumurale, the

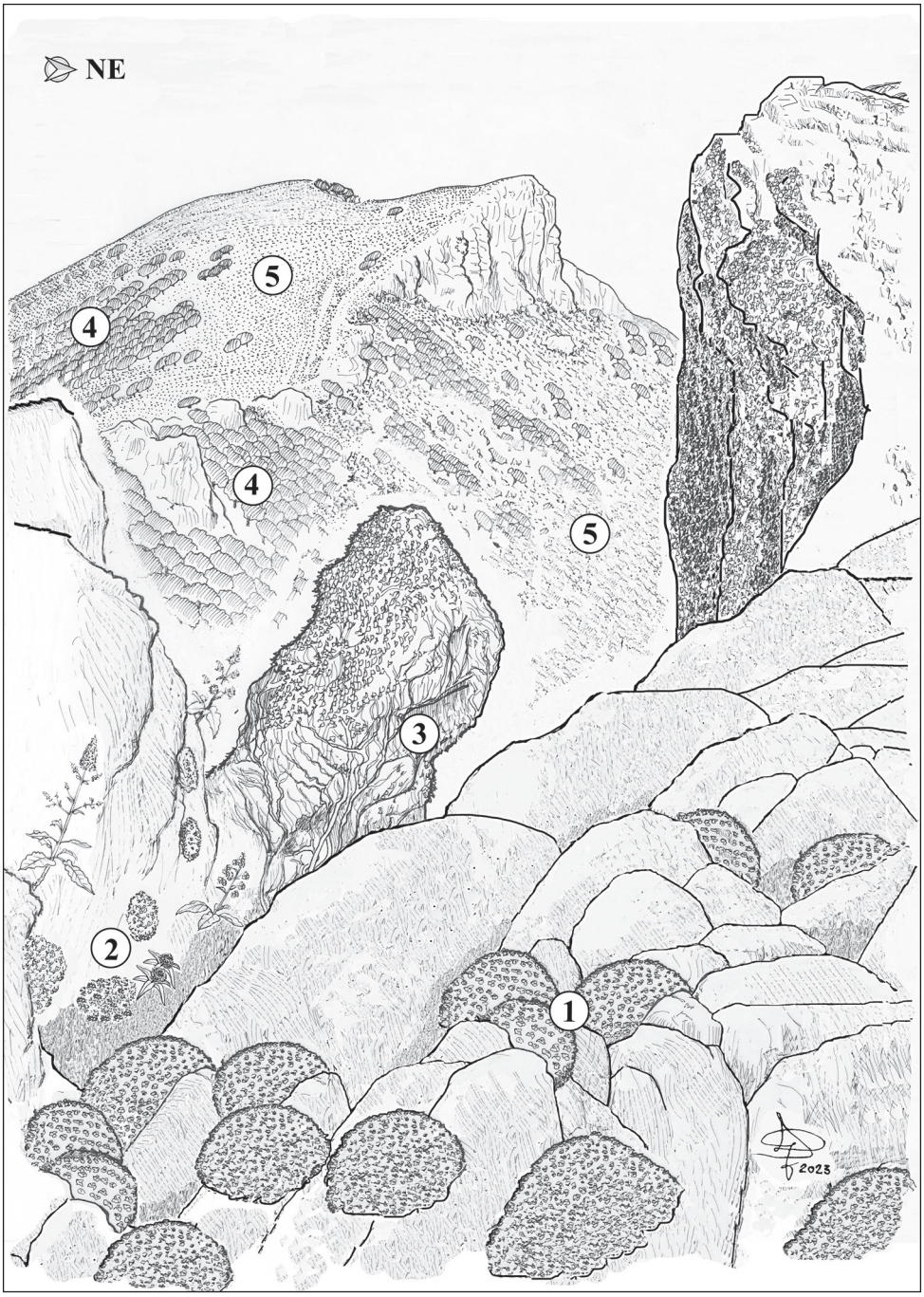

Figure 6. Marettimo Island: vegetation near the top of Monte Falcone (37°58'51"N, 12°03'06"E; 632 m a.s.l.) – **1** *Euphorbia dendroides* community; **2** *Bupleuro dianthifolii-Scabiosetum limonifoliae*; **3** *Hedera helix* community; **4** *Daphno sericeae-Quercetum ilicis* subass. *arbutetosum unedonis*; **5** *Micromerio fruticulosae-Ericetum multiflorae* var. with *Cistus salviifolius*.

path crosses the valley of the Ficarello stream, overlooked by the rocky walls of Pizzo Falcone. This scenic route leads along the ridges of Pizzo Madonnuzza and descends to Contrada Libbano, where it is possible to observe very interesting stands of chasmophytic vegetation, belonging to *Bupleuro dianthifolii-Scabiosetum limonifoliae*, notably rich in endemic species, such as *Bupleurum dianthifolium*, *Oncostema ughii* (Fig. 8b), *Thymus reichardii* subsp. *nitidus*, *Helichrysum panormitanum* subsp. *messeriae*, *Brassica macrocarpa*, *Pseudoscabiosa limonifolia*, *Hexaphylla rupestris*, *Seseli bocconei*, *Dianthus rupicola*, *Iberis semperflorens*, *and Glandora rosmarinifolia* among others.

Along the coast, the route returning to the town crosses a maquis dominated by *Euphorbia dendroides*, that can be referred to *Rhamno alaterni-Euphorbietum dendroidis* subass. *rhamnetosum oleoidis* (Fig. 7). A relevé of this vegetation is reported below.

Rhamno alaterni-Euphorbietum dendroidis* subass. *rhamnetosum oleoidis – Along the northeastern coast of Marettimo (37°58'23"N, 12°04'06"E): 27 m a.s.l., slope 18° NE, 40%, 100 m². Diagnostic species: *Euphorbia dendroides* 4, *Olea europaea* var. *sylvestris* 1, *Rhamnus lycioides* subsp. *Oleoides* 1. Characteristics of alliance, order and class: *Pistacia lentiscus* 3, *Lonicera implexa* 1, *Ruta chalepensis* 1, *Stachys major* +, *Arisarum vulgare* +. Other species: *Erica multiflora* 2, *Ampelodesmos mauritanicus* 2, *Allium subhirsutum* 2, *Jacobaea maritima* subsp. *sicula 2*, *Micromeria graeca* subsp. *fruticulosa* +, *Phagnalon saxatile* +, *Leontodon tuberosus* +, *Clinopodium nepeta* +, *Dactylis glomerata* subsp. *hispanica* +, *Squilla pancration* +.

Towards the sea, within halo-subhalophilous associations, such as *Limonietum tenuiculi* and *Senecioni bicoloris-Helichrysetum messerii*, an interesting ephemeral vegetation dominated by *Moraea sisyrinchium* was in full bloom at the time of our visit. Based on the relevés carried out in these stands (Table 4), it is to be referred to a new association, proposed as *Catapodio pauciflori-Moraeetum sisyrinchii* Gianguzzi, Di Pietro, Fortini, Guarino, Mei, Rosati, Spampinato, Stinca *ass. nov. hoc loco* (holotypus: Table 3, rel. 6, hoc loco), which belongs to the *Plantagini-Catapodium balearici*, an alliance of the class *Stipo-Trachynetea distachyae*. This coastal association, usually linked to outcrops of carbonate rock with shallow red soils, can be considered a geographic vicariant of the *Anthemido-Desmazerietum siculae* Brullo 1985, from north-western Sicily, and of the *Anthemido-Allietum lehmannii* Brullo et Scelsi 1998 from southern Sicily.

Catapodio pauciflori-Moraeetum sisyrinchii Gianguzzi, Di Pietro, Fortini, Guarino, Mei, Rosati, Spampinato, Stinca *ass. nov. hoc loco* (holosyntypus: Table 3, rel. 6, here designated).

Syntaxonomic framework – Class: *Stipo-Trachynietea distachyae*, order: *Stipo-Bupleuretalia semicompositi*, alliance: *Plantagini-Catapodion balearici*.

Diagnostic species – *Moraea sisyrinchium* (dom.), *Catapodium pauciflorum*, *Hyoseris baetica*, *Prospero hierae*.

Structure and ecology – Thermophilous coastal vegetation with an early spring optimum, physiognomically dominated by *Moraea sisyrinchium*, growing together with various ephemeral herbaceous plants such as *Anthemis secundiramea*, *Plantago coronopus*, *Catapodium pauciflorum*, *Bellis annua*, *Silene colorata*, *Hedypnois rhagadioloides*, *Medicago truncatula*, *Hypochoeris achyrophorus*, *Filago pygmaea*, *Plantago lagopus*,

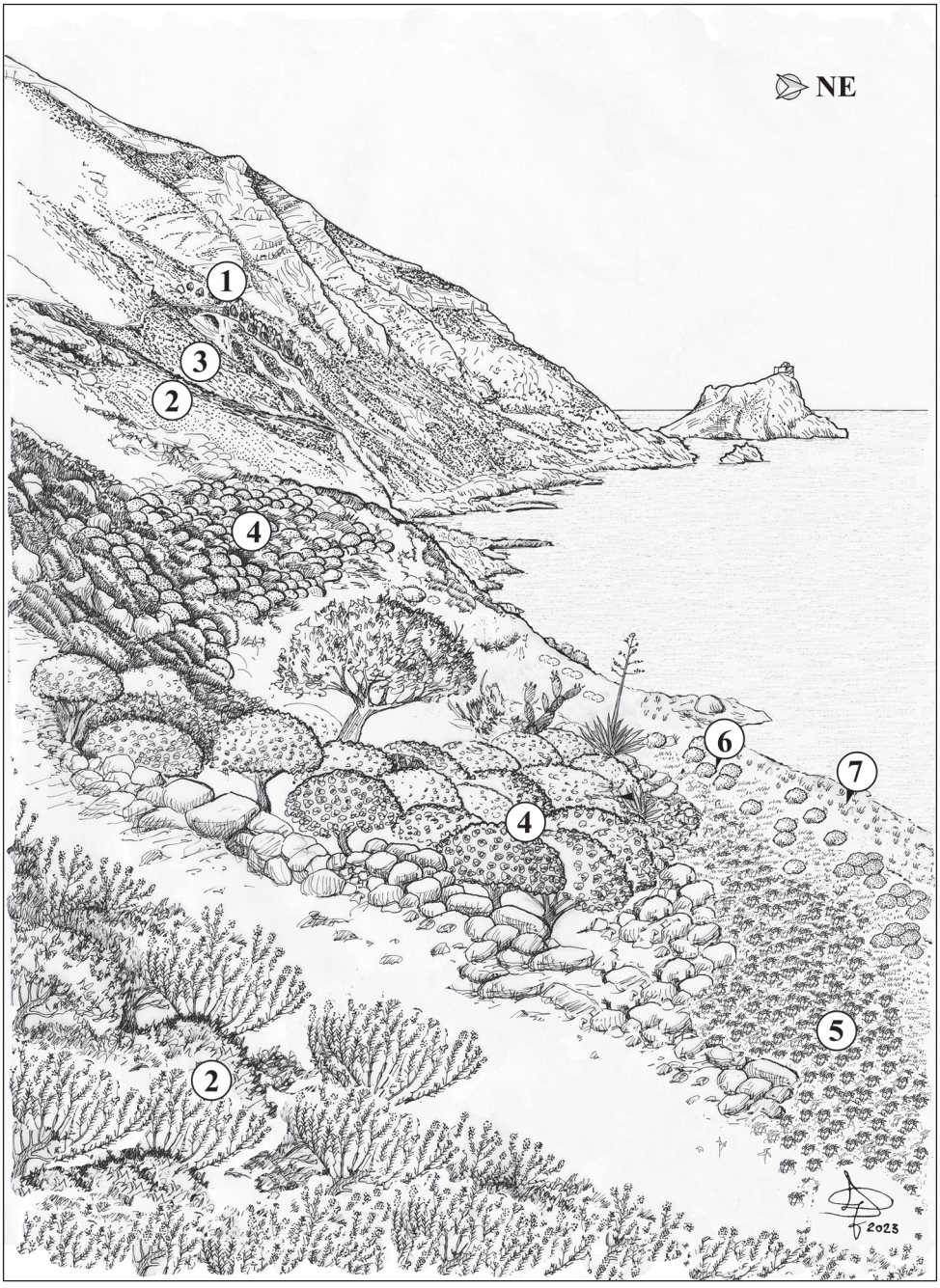

Figure 7. Marettimo Island: vegetation along the north-eastern coast, next to Case Martorana (37°58'22"N, 12°03'07"E; 21 m a.s.l.). – **1** *Erico multiflorae-Pinetum halepensis*; **2** *Coronillo glaucae-Brachypodietum retusi*; **3** *Micromerio fruticulosae-Ericetum multiflorae* var. *typicum*; **4** *Rhamno alaterni-Euphorbietum dendroidis* subass. *rhamnetosum oleoidis*; **5** *Catapodio pauciflori-Moraeetum sisyrinchii* ass. nova; **6** *Senecioni bicoloris-Helichrysetum messerii*; **7** *Limonietum tenuiculi*.

Stachys romana, *Trifolium scabrum*, *Valantia muralis*. It develops in the gaps of the sub-halophilous vegetation *Senecioni bicoloris-Helichrysetum messerii* and of the coastal garrigue, on rocky outcrops covered with shallow red soil.

Bioclimate – Dry thermo-Mediterranean.

Distribution – Marettimo, along the coast.

Syntaxonomic notes – *Moraea sisyrinchium* is a typical south Mediterranean species, widespread from the coastal territory of the Middle East to Spain. In Italy, this species occurs in southern regions and goes up along the Italian peninsula only on its western side, i.e., along the Tyrrhenian coasts of Campania, Lazio, and Tuscany. From a phytosociological point of view, Biondi et al. (2001) considered *Moraea sisyrinchium* a diagnostic species of the order *Brachypodio-Dactyletalia hispanicae* occurring as co-dominant species in the *Anthyllido vulnerariae-Kundmannietum siculae* and in the *Loto cytisoidis-Dactylidetum hispanicae* subass. *iridetosum sisyrinchi*, described from northern Sardinia. The latter exhibits a certain ecological similarity to our *Catapodio pauciflorae-Moraeetum sisyrinchii*, being both associations typical of marine terraces no longer dominated by halophilous species. However, the Sardinian association exhibits an absolute dominance of *Dactylis glomerata* subsp. *hispanica*, which is instead extremely sporadic in the communities of Marettimo. *Morea sisyrinchium* is also described as co-dominant species in the *Sileno sedoidis-Hymenolobetum revelieri*, an association referred to the ephemeral communities of *Saginetea maritimae* (*Frankenion pulverulentae*) occurring along the Ionian rocky coasts of Puglia on silty-sandy substrates and in spatial contiguity with *Crithmo-Limonietea* communities (Brullo and Giusso del Galdo 2003). The occurrence of *Silene sedoides*, *Valantia muralis* and *Parapholis incurva* and the physiognomical importance of *Plantago coronopus* and *Morea sisyrinchium* (Figs 7 and 8f) highlight similarities with the association of Marettimo, although the latter exhibits a much higher floristic richness probably due to a lower occurrence of chloride salts in the soil. Finally, *Moraea sisyrinchium* is a highly frequent species in various associations described in Sicilian coastal areas and is currently included in the alliance *Plantagini-Catapodion balearici* (order: *Stipo-Bupleuretalia semicompositi*; class: *Stipo-Trachynietea distachyae*). As regards the phytosociological classification of *Moraea sisyrinchium* in other Mediterranean countries, it must be pointed out that the association *Irido sisyrinchii-Stipetum capensis* Bolós et Molinier 1958 described for the Balearic Islands is the last stage of degradation of the Mediterranean maquis in coastal south-facing slopes affected by the moderating influence of the sea nearby (Bolós and Molinier 1958). In the southern part of the Iberian Peninsula, *Moraea sisyrinchium* is a high- frequency species in the *Spergulo fallacis-Plantaginetum ovatae* (Dana-Sanchez et al. 1999). These last two associations are framed in the alliance *Stipion retortae* (order: *Brachypodietalia distachyi*; class: *Stipo-Trachynietea distachyae*). However, *Moraea sisyrinchium* is a high-frequency species also in the *Poo bulbosae-Onobrychidetum eriophorae* Rivas Goday, Ladero et C. Rivas in Rivas Goday et Ladero 1970 and in the *Trifolio subterranei-Plantaginetum serrariae* Martín et Galán in Galán, Morales et Vicente 2000, both classified in the class *Poetea bulbosae* (Rivas-Martinez et al. 2001). In Cyprus, *Moraea sisyrinchium* occurs abundantly in the open phrygana dominated by *Sarcopoterium spinosum* (Rikli 1946).

Table 3. *Catapodio pauciflorae-Moraeetum sisyrinchii* (rel 1–6 exiting the village towards Punta Troia; rel 7–10 near the cemetery).

Relevé No.	01	02	03	04	05	06	07	08	09	10
Altitude (m a.s.l.)	12	12	12	10	10	10	5	7	8	10
Slope (%)	10	1	8	8	25	20	5	7	8	10
Aspect	N	E	E	E	N	E	N	E	E	E
Area (m^2)	4	4	4	4	4	4	4	3	4	3
Total cover (%)	50	85	95	90	90	90	90	95	85	80
Average vegetation height (cm)	9	10	13	10	12	13	10	12	12	12
Char. association										
Moraea sisyrinchium	3	4	4	4	4	4	4	4	4	3
Hyoseris baetica	+	+	1	1	1	+	+	+	+	+
Prospero hierae	+		+			+				
Char. all. *Plantagini-Catapodion balearici*										
Plantago coronopus	+	3	3	2	.	2	+	1	3	+
Catapodium pauciflorum	1	+	+	+	+	+	1	+	+	+
Bellis annua	.	.	+	+	+	.	.	+	.	+
Char. ord. *Stipo-Bupleuretalia semicompositi* and cl. *Stipo-Trachynietea distachyae*										
Silene colorata	.	1	+	1	+	1	1	1	2	+
Hedypnois rhagadioloides	1	1	.	+	1	+	+	.	+	+
Medicago truncatula	+	+	.	.	+	1	2	1	1	3
Anthemis secundiramea	.	1	+	3	+	+	1	.	+	.
Hypochoeris achyrophorus	1	.	.	.	+	+	+	1	.	+
Filago pygmaea	.	.	+	1	+	1	.	+	+	+
Trifolium scabrum	+	+	+	+	+	1	.	.	.	.
Stachys romana	+	.	+	+	+	+	.	+	.	.
Plantago lagopus	.	.	+	.	2	.	2	2	+	1
Valantia muralis	+	.	+	+	+	+	.	.	.	.
Lotus edulis	.	.	.	.	1	.	+	+		+
Trisetaria aurea	.	2	.	+	.	+	.	.	.	.
Convolvolus lineatus	.	.	.		.	.	3	2	2	
Linum strictum	+	.	.	+	.	.	.	.	.	.
Linaria reflexa	.	.	.	+	+	.	.	.	.	.
Trachynia distachya	2	.	.	.	.	.	.	.	.	.
Coronilla scorpioides	1	.	.	.	.	.	.	.	.	.
Linum usitatissimum subsp. *angustifolium*	+	.	.	.	.	.	.	.	.	.
Asteriscus aquaticus	+	.	.	.	.	.	.	.	.	.
Rumex bucephalophorus s.l.	.	.	.	.	.	+	.	.	.	.
Companions										
Triticum neglectum	1	+	1	2	1	2	+	2	1	+
Lotus cytisoides	1	2	1	+	2	2	1	.	.	1
Lolium rigidum s.l.	.	+	+	1	+	+	+	1	.	+
Daucus carota subsp. *drepanensis*	.	.	1	+	2	+	1	1	1	.
Euphorbia peplus	1	+	+	+	+	+	.	.	.	.
Reichardia picroides	.	.	1	+	1	+	+	.	.	.
Sonchus tenerrimus	.	.	.	+		+	.	+	+	+
Euphorbia segetalis	.	.	.	+	+	+	.	.	.	+
Carlina sicula	.	.	.	.	+	+	.	.	+	1
Anisantha madritensis	+	.	.	+	+	.	.	.	.	.
Lobularia maritima	.	.	.	+	+	.	+	.	.	.
Cuscuta sp.	.	.	.	.	.	.	+	+	+	.
Silene sedoides	+	.	.	.	.	.	+	.	.	.
Parapholis incurva	.	.	+	+	.	.	.	.	.	.

Relevé No.	01	02	03	04	05	06	07	08	09	10
Convolvolus althaeoides	.	.	.	.	+	.	.	.	+	.
Salvia clandestina	.	.	.	.	+	.	.	.	.	+
Dactylis glomerata subsp. *hispanica*	1	.	.	.		.	.	.	.	.
Bituminaria bituminosa	+	.	.	.	.	.	.	.	.	.
Avena barbata	+	.	.	.	.	.	.	.	.	.
Leontodon tuberosum	+	.	.	.	.	.	.	.	.	.
Lysimachia loeflingii	+	.	.	.	.	.	.	.	.	.
Orobanche minor	.	.	.	+	.	.	.	.	.	.
Medicago polymorpha	.	.	.	.	+	.	.	.	.	.
Carduus pycnocephalus	.	.	.	.	+	.	.	.	.	.
Carduus argyroa	.	.	.	.	.	.	.	.	+	.
Erodium cicutarium	.	.	.	.	.	.	.	.	.	+

Therefore, a wide range of possible interpretations for the classification of the *Catapodio pauciflorae-Moraeetum sisyrinchii* is available (see synoptic Table 4). On the other hand, this community represents a peculiar syntaxonomic issue, since, as far as we know, associations with absolute dominance of *Moraea sisyrinchium* have not been described to date.

In our opinion, the syntaxonomic classification of *Catapodio pauciflorae-Moraeetum sisyrinchii* at the class rank cannot ignore the life form spectrum of all the species that compose this association (Table 3). Therophytes prevail based on simple presence and frequency, whereas perennial species are dominant in the spectrum based on cover values. Obviously, *Moraea sisyrinchium* plays a major role in determining the largely prevailing perennial life form based on cover values. However, this dominance would be maintained (albeit only slightly) even if *Moraea sisyrinchium* had a cover-abundance index of "1" (instead of "3" or "4") testifying a non secondary role of perennial species in the community. Accordingly, the most plausible syntaxonomic solution would be to consider the *Catapodio pauciflorae-Moraeetum sisyrinchii* as putatively assignable to a class characterized by perennial communities. Having this in mind and following the EuroVegChecklist (EVC) framework (Mucina et al. 2016), we should classify this association in the class *Lygeo sparti-Stipetea tenacissimae* Rivas-Mart. 1978, in the order *Cymbopogoni-Brachypodietalia ramosi* Horvatic 1963 and in the alliance *Reichardio maritimae-Dactylidion hispanicae* Biondi et al. 2001. The latter alliance is indeed defined as including thermo-Mediterranean subhalophilous perennial grasslands in wind-swept habitats on calcareous soils of the Tyrrhenian and Ionian seas. This classification shares the one proposed by Biondi et al. (2001) for northern Sardinia where this alliance was included in the *Brachypodio-Dactylidetalia hispanicae* (syn. of *Cymbopogoni-Brachypodietalia* in EVC) but in the class *Artemisietea vulgaris*. However, the latter classification, especially if considered at the order and class ranks, would seem more appropriate for perennial communities (or mixed annual-perennial communities) dominated by cespitose hemicryptophytes (e.g., *Hyparrhenia hirta* subsp. *hirta*, *Brachypodium retusum*, *Dactylis glomerata* subsp. *hispanica*). This does not appear to be the case in Marettimo. On the other hand, the classification in the *Poetea bulbosae* does not seem plausible, at least at the biogeographic level, as this class is centered in the Iberian Peninsula. Moreover, the previously mentioned Spanish communities currently ascribed to this class are not limited to coastal districts but are widespread also in

Table 4. Simplified synoptic table of plant communities with high frequency of *Moraea sisyrinchium* from the Mediterranean region (species occurring in less than three columns are omitted, unless characteristic of the association). Cl. ***Stipo-Trachynietea*** [ord. ***Stipo-Bupleuretalia semicompositi*****,** all. ***Plantagini-Catapodium marini*** (1–8) and. ***Onobrychido-Ptilostemion stellati*** Brullo, Scelsi et Spampinato 2001 (9–10)]: 1) *Catapodio pauciflorae-Moraeetum sisyrinchii* ass. nova (Table 3, hoc loco); 2) *Anthemido secundirameae-Desmazerietum siculae* Brullo 1985 (after Barbagallo et al. 1979 – Sicily: Mount Cofano, sub aggr. a *A. secundiramea* and *Desmazeria sicula*); 3) *Antemido secundirameae-Allietum lehmannii* Brullo et Scelsi 1996 (after Brullo and Scelsi 1996, tab. 5, – Sicily: Vendicari and Sampieri); 4) *Onobrychido-Psiluretum incurvi* Brullo et Scelsi 1996 (after Brullo and Scelsi 1996, tab. 6 – Sicily: Vittoria, Nipitella and Castelluccio); 5) *Filagini-Daucetum lopadusani* Bartolo, Brullo, Minissale et Spampinato, 1988 (after Bartolo et al. 1988, tab. 20 – Sicily: Lampedusa Island); 6) *Allietum lojaconoi* Brullo 1985 (after Brullo 1985, tab. 9, Malta and Gozo); 7) *Allietum lojaconoi* Brullo 1985 subass. *typicum*, subass. *anthemidetosum urvilleanae* and subass. *linetosum tryginum* Brullo et al. 2020 (after Brullo et al. 2020, tab. 14.4 – Malta and Gozo); 8) *Silenetum melitensis* Brullo, Brullo, Cambria et Giusso del Galdo 2020 (after Brullo et al. 2020, tab. 14.1 – Malta, Gozo and Comino); 9) *Ptilostemono-Bupleuretum gracilis* Brullo, Scelsi et Spampinato 2001 (after Brullo et al. 2001, tab. 107 – Calabria: Aspromonte); 10) *Parapholido incurvae-Aizoetum hispanicae* Brullo, Scelsi et Spampinato 2001 (after Brullo et al. 2001, tab. 111 – Calabria: Aspromonte). Cl. ***Stipo-Trachynietea*** [ord. ***Trachynetalia distachiae*** Rivas-Martínez 1978, all. ***Trachynion distachyae*** Rivas-Mart. 1978 (11–12) and ***Stipion retortae*** O. de Bolòs 1957 (13–14)]: 11) *Vulpio ligusticae-Trisetarietum aureae* Brullo 1975 (after Brullo et al. 2020, tab. 14.2 – Malta and Gozo); 12) *Thero-Sedetum coerulei* subass. *sedetosum caespitosi* Brullo 1975 (after Brullo et al. 2020, tab. 14.1, rel. 1–14 – Gozo and Comino); 13) *Irido-Stipetum retortae* [after O. Bolòs and Molinier 1958 tab. 11 – Maiorca Island (= *Irido sisyrinchii-Stipetum capensis* O. Bolòs et Molinier 1958)]; 14) *Spergulo fallacis-Plantaginetum ovatae* Dana Sanchez, Rodriguez-Tamayo et Mota Poveda 1999 (after Dana Sanchez et al. 1999 tab. 11 – Spain: Almeria). Cl. ***Poetea bulbosae*** Rivas Goday et Rivas-Mart. in Rivas-Mart. 1978 (ord. ***Poetalia bulbosae*** Rivas Goday et Rivas-Mart. in Rivas Goday et Ladero 1970, all. ***Trifolio subterranei-Periballion minutae*** Rivas Goday 1964): 15) *Poo bulbosae-Trifolietum subterranei* subass. *plantaginetosum serrariae* Sciandrello, D'Agostino. et Minissale 2013 (after Sciandrello et al. 2013, tab. 4, rel. 20–28 – Sicily: Taormina). Cl. ***Saginetea maritimae*** Westhoff et al. 1962 (ord. ***Frankenietalia pulverulentae*** Rivas-Mart. ex Castroviejo et Porta 1976, all. ***Frankenion pulverulentae*** Rivas-Mart. ex Castroviejo et Porta 1976): 16) *Sileno sedoidis-Hymenolobetum revelieri* Brullo et Giusso 2003 (after Brullo and Giusso 2003, tab. 1 rel.1–9 – Puglia: Taranto, Lido Gandoli). Cl. ***Artemisietea vulgaris*** Lohmeyer et al. in Tx. ex von Rochow1951 (ord. ***Brachypodio ramosi-Dactyletalia hispanicae*** Biondi, Filigheddu et Farris 2001, all. ***Thero-Brachypodion ramosi*** Br.-Bl. 1925): 17) *Loto cytisoidis-Dactyletum hispanicae* subass. *dactyletosum hispanicae* Biondi, Filigheddu et Farris 2001 and subass. *iridetosum sisyrinchii* Biondi, Filigheddu et Farris 2001 (after Biondi et al. 2001, tab. 46 – Sardinia: Nurra); 18) *Anthyllido vulnerariae-Kundmannietum siculae* Biondi, Filigheddu et Farris 2001 (after Biondi et al. 2001 tab. 45 – Sardinia: Nurra).

Column number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Number of relevés	10	5	15	6	20	6	22	10	8	14	8	14	3	15	10	9	8	5
Guide species																		
Moraea sisyrinchium	100	100	100	100	55	100	100	100	75	71	100	73	66	52	100	100	62	80
Characteristic species of association																		
Hyoseris lucida subsp. *taurina*	100	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Prospero hierae	30	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Desmazeria sicula	.	100	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Daucus carota subsp. *drepanensis*	.	100	.	.	100	.	.	.	.	.	.	.	.	.	.	.	.	.

Column number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Number of relevés	**10**	**5**	**15**	**6**	**20**	**6**	**22**	**10**	**8**	**14**	**8**	**14**	**3**	**15**	**10**	**9**	**8**	**5**
Lonas annua	.	100	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Allium lehmannii	.	100	100	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Anthemis secundiramea	70	100	100	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Onobrychis caput-galli	.	.	20	100	.	.	.	.	5	42	.	.	.	.	.	.	.	.
Festuca incurva	.	.	.	100	.	.	.	.			.	.	.	.	.	.	.	.
Logfia lojaconoi	.	.	.	.	95	.	.	.	.	.	.	.	.	.	.	.	.	.
Diplotaxis scaposa	.	.	.	.	90	.	.	.	.	.	.	.	.	.	.	.	.	.
Linaria reflexa subsp. *lubbockii*	.	.	.	.	75	.	.	.	.	.	.	.	.	.	.	.	.	.
Allium lojaconoi	.	.	.	.		100	100	.	.	.	.	.	.	.	.	.	.	.
Linum trigynum	.	.	.	.		.	23	.	.	.	.	.	.	.	.	.	.	.
Silene melitensis	.	.	.	.		.	.	100	.	.	.	.	.	.	.	.	.	.
Bupleurum semicompositum	.	.	.	.	.	.	.	.	100	7	.	.	.	.	.	.	.	.
Aizoanthemopsis hispanicum	.	.	.	.	.	.	.	.	.	100	.	.	.	.	.	.	.	.
Festuca danthonii subsp. *danthonii*	.	.	.	100	.	.	.	.	25	.	100	.	.	.	.	.	.	.
Trisetaria aurea	30	.	.	.	.	49	23	.	.	.	100	27	.	.	.	.	.	.
Sedum caeruleum	.	.	.	.	.	.	.	.	.	.	.	100	.	.	.	.	.	.
Sedum caespitosum	.	.	.	.	.	.	.	.	.	.	.	47	.	.	.	.	.	.
Spergularia flaccida	.	.	.	.	.	.	.	.	.	.	.	.	.	100	.	.	.	.
Plantago ovata	.	.	.	.	.	.	.	.	.	.	.	.	.	73	.	.	.	.
Herniaria cinerea	.	.	.	.	.	.	.	.	.	.	.	.	.	73	.	.	.	.
Spergularia diandra	.	.	.	.	5	.	.	.	.	.	.	.	.	73	.	.	.	.
Poa bulbosa	.	40	.	.	.	.	27	.	25	.	50	53	.	.	100	.	.	.
Plantago serraria	.	.	.	.	.	49	54	.	.	.	.	.	.	.	100	.	.	.
Trifolium subterraneum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	100	.	.	.
Onobrychis aequidentata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	100	.	.	.
Hornungia procumbens subsp. *revelierei*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	100	.	.
Silene sedoides subsp. *sedoides*	20	.	.	.	.	.	.	.	.	.	.	.	.	.	.	100	.	.
Gaudinia fragilis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	75	.
Carex flacca subsp. *erythrostachys*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	50	80
Pancratium illyricum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	25	20
Crocus minimus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	62	.
Kundmannia sicula	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	100
Anthyllis vulneraria	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	100
Char. All. *Onobrychido-Ptilostemion stellati* (*) *Plantagini-Catapodion balearicae* (°) and Ord. *Stipo-Bupleuretalia semicompositi*																		
Medicago littoralis	.	80	92	.	60	100	91	100	25	92	38	27	33	26	.	.	25	.
Anisantha fasciculata subsp. *fasciculata*	.	80	59	100	60	83	62	50	100	92	.	.	.	.	20	.	.	.
Bellis annua°	50	80	59	.	.	49	45	50	.	.	25	53	33	.	.	.	.	.
Asteriscus aquaticus	10	20	92	100	100	100	49	.	.	.	.	20		19	.	.	.	.
Lagurus ovatus subsp. *vestitus°*	100	60	.	.	40	49	27	60	.	.	.	27	.	.	.	.	62	.
Catapodium balearicum°	.	100	92	.	100	100	100	100	.	.	.	100	.	.	.	100	.	.
Convolvulus lineatus	30	20	.	.	85	83	59	.	.	.	.	.	.	.	.	.	.	.
Crupina crupinastrum	.	60	.	83	.	49	14	.	.	.	.	.	33	.	.	.	.	.
Atractylis cancellata	.	100	.	.	.	.	.	.	88	28	.	.	100	32	.	.	.	.
Romulea variicolor°	.	.	.	.	.	.	91	100	.	.	50	87	.	.	.	.	.	.
Echium parviflorum	.	60	.	.	35	.	32	.	.	.	.	.	.	.	.	.	.	.
Anthemis secundiramea	.	.	.	.	.	.	36	100	.	.	.	20	.	.	.	.	.	.
Spergularia marina	.	.	.	.	.	.	14	50	.	.	.	.	.	.	.	.	.	.
*Filago eriocephala**	.	.	.	.	.	.	.	.	100	14	.	.	.	.	.	.	.	.
*Ptilostemon stellatus**	.	.	.	.	.	.	.	.	12	49	.	.	.	.	.	.	.	.

Column number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Number of relevés	**10**	**5**	**15**	**6**	**20**	**6**	**22**	**10**	**8**	**14**	**8**	**14**	**3**	**15**	**10**	**9**	**8**	**5**
Char. Cl. *Stipo-Trachynietea distachyae*																		
Brachypodium distachyon	10	100	.	49	100	100	75	40	88	71	100	53	100	6	40	.	.	.
Hypochaeris achyrophorus	60	60	79	66	75	66	49	90	38	.	62	27	100	.	70	.	.	.
Linum strictum	20	20	53	83	70	66	32	30	100	14	75	40	100	.	.	.	.	.
Euphorbia exigua subsp. *exigua*	.	40	86	83	85	49	49	.	12	14	75	47	100	6	50	.	.	.
Hedypnois rhagadioloides	.	100	66	.	50	100	62	80	12	.	25	27	33	52	20	.	.	.
Catapodium rigidum	.	80	72	.	40	100	41	40	62	14	62	53	100	.	40	.	.	.
Stipellula capensis	.	100	.	100	25	83	59	100	12	.	100	20	100	46	30	.	.	.
Trifolium scabrum	60	80	53	83	20	100	62	.	88	.	62	67	.	.	70	.	.	.
Valantia muralis	40	100	100	.	20	66	36	.	.	.	38	40	100	.	.	40	.	.
Filago pygmaea	70	100	92	.	95	49	75	.	.	.	75	73	.	.	.	10	.	.
Hyoseris scabra	.	.	13	66	55	17	36	.	12	.	50	47	.	.	70	.	.	.
Lotus edulis	40	40	.	66	45	.	32	.	12	.	50	.	33	.	.	.	.	.
Medicago minima	.	40	.	.	.	49	36	.	25	.	50	40	33	.	70	.	.	.
Plantago lagopus	60	.	.	.	.	33	27	.	.	.	88	.	33	52	20	.	.	.
Anisantha rubens	.	60	66	66	40	49	14	.	.	.	.	.	.	39	.	.	.	.
Trifolium stellatum	.	60	.	100		49	32	.	38	.	62	.	.	.	80	.	.	.
Stachys romana	60	60	.	.	70	.	18	.	.	.	.	.	66	.	50	.	.	.
Plantago afra	.	10	.	66	65	.	.	.	.	.	62	27	66	.	.	.	.	.
Medicago monspeliaca	.	.	.	.	50	17	23	.	.	.	12	47	.	19	.	.	.	.
Sedum rubens	.	60	40	.	.	49	18	.	.	.		47	.	.	.	.	.	.
Filago pyramidata	.	60	.	.	.	83	23	.	.	.	.	.	33	46	.	.	.	.
Medicago truncatula	80	.	.	.	.	66	32	.	.	.	.	47	.	.	.	.	.	.
Helianthemum salicifolium	.	80	79	.	.	.	.	.	.	.	.	.	.	13	100	.	.	.
Arenaria leptoclados subsp. *leptoclados*	.	.	.	.	.	66	18	.	.	.	12	47	.	.	.	.	.	.
Silene colorata	90	.	.	.	.	.	23	.	.	.	62	.	.	.	.	.	.	.
Rumex bucephalophorus s.l.	10	.	.	.	.	.	18	.	.	.	.	.	.	.	.	.	12	.
Ononis ornithopodioides	.	60	.	.	.	49	14	.	.	.	.	.	.	.	.	.	.	.
Sulla spinosissima	.	.	66	.	5	66		.	.	.	.	.	.	.	.	.	.	.
Char. Cl. *Saginetea maritimae*																		
Parapholis incurva	20	100	86	.	60	100	87	50	100	85	25	47	100	.	.	.	.	.
Plantago coronopus	90	100	100	.	100	100	87	100	.	.	.	53	70	26	.	.	.	.
Char. Cl. *Artemisietea vulgaris* and ord. *Brachypodio ramosi-Dactyletalia hispanicae*																		
Reichardia picroides	50	80	.	.	75	49	41	.	.	.	.	.	33	.	.	.	100	40
Dactylis glomerata subsp. *hispanica*	10	40	.	.		49	27	30	.	.	.	.	.	.	.	.	100	100
Lotus cytisoides	80	60	.	.	20	.	.	.	.	.	.	.	.	.	.	.	88	100
Convolvulus althaeoides	20	.	.	.		.	.	.	.	.	.	.	33	.	.	.	38	.
Daucus carota s.l.	.	.	.	.		49	18	.	.	.	.	.	.	.	.	.	100	.
Companions																		
Lysimachia arvensis	.	.	.	33	25	.	18	.	25	21	.	.	100	26	70	.	.	.
Triticum neglectum	100	.	.	.	.	100	23	.	.	.	25	.	.	19	60	.	.	.
Centaurium pulchellum subsp. *pulchellum*	.	80	47	.	.	83	.	30	12	.	.	.	.	.	.	.	.	.
Scorpiurus muricatus	.	.	.	.	25	17	27	.	.	.	25	.	.	6	.	.	.	.
Medicago polymorpha	10	.	.	.	.	49	14	.	.	.	38	.	.	.	.	.	.	.
Avena barbata	10	.	.	.	.	33	14	.	.	.	.	.	.	.	50	.	.	.
Lolium rigidum s.l.	80	80	.	.	.	.	.	40	12		.	.	.	.	.	.	.	.
Trigonella sulcata	.	40	.	.	.	.	.	.	62	21	12	.	.	.	.	.	.	.
Salvia verbenaca	.	.	.	49	40	.	.	.	.	.	12	.	.	6	.	.	.	.
Rostraria cristata	.	.	.	.		49	32	.	.	.	25	33	.	.	.	.	.	.
Micromeria microphylla	.	.	.	.	.	33	14	.	.	.	.	.	.	19	.	.	.	.
Arisarum vulgare subsp. *vulgare*	.	.	.	.	.		.	.	.	.	.	.	33	.	.	.	12	100

inland areas. More convincing is the choice of the alliance *Plantagini-Catapodion* and of the order *Stipo-Bupleuretalia semicompositi*. On the other hand, some critical aspects linked to the heterogeneous coenological pattern of the *Stipo-Bupleuretalia* and their inclusion in *Stipo-Trachynietea* have already been reported by Di Pietro et al. (2021) and in the same EVC the displacement of the *Stipo-Bupleuretalia* in the class *Saginetea maritimae* is suggested. However, in our opinion, the possibility to include the order *Stipo-Bupleuretalia* and related alliances in the class *Saginetea maritimae* deserves to be discussed further. As a matter of fact, a proper high-rank syntaxon to accommodate the Mediterranean plant communities dominated by small perennial species in an overall floristic context mainly characterized by therophytes is still lacking.

Excursion to Levanzo Island (26 April 2022): Levanzo, Baglio Florio, Cala Calcara, Contrada La Fossa, Pietre Varate.

The island of Levanzo (5.6 k m^2) is 12 km away from Trapani and about 4 km from Favignana. It has a morphological structure defined by faults separating two north-south trending limestone ridges, culminating respectively in the peaks named Pizzo del Monaco (278 m a.s.l.) and Pizzo del Corvo (201 m a.s.l.). Between these two peaks there is a wide depression known as La Fossa (69 m a.s.l.), once extensively cultivated. The coastline is not easily accessible, except on the north-western and south-eastern sides. Compared to the island of Marettimo, Levanzo is characterized by much drier overall environmental conditions. An intense agro-silvo-pastoral land use, performed until a few decades ago, has led to a general involution of the climactic series, partly altered by the introduction of allochthonous floristic elements.

Land use – The landscape, somewhat impoverished in its climactic vegetation, is largely dominated by open areas covered by low scrub, garrigue and grasslands, sometimes punctuated by small patches of coniferous reforestation.

Series and microgeoseries – Secondary plant communities related to the Sicilian coastal, basiphilous, infra-thermo-Mediterranean dry series (*Ruto chalepensis-Oleo sylvestris periploco angustifoliae* sigmetosum) predominate. To these aspects, some microsigmeta relating to the rocky coasts and cliffs can be added.

Endemic and rare species – The vascular flora of the island consists of 468 taxa (Romano et al. 2006). The endemic flora consists of 15 taxa, none of which is exclusive to the island, such as *Euphorbia papillaris*, *Logfia lojaconoi*, *Limonium bocconei*, *Limonium lojaconoi*, *Limonium ponzoi*, *Romulea linaresii*, *Carlina sicula* subsp. *sicula*, *Helichrysum panormitanum* subsp. *messeriae*, *Neotinea tridentata*, *Seseli bocconei*, *Dianthus rupicola* subsp. *rupicola*, *Iberis semperflorens*, *Matthiola incana* subsp. *rupestris*, *Ophrys apulica* and *Jacobaea maritima* subsp. *sicula*. Other species of phytogeographical interest include some taxa that are completely missing from Sicily (e.g., *Periploca angustifolia* and *Aristolochia navicularis*), as well as *Crocus longiflorus*, here at the westernmost limit of its distribution range. Other rare elements, occurring also in the neighbouring Trapani coast (e.g., *Rhamnus lycioides* subsp. *oleoides*, *Hypericum pubescens*), are present in the flora of Levanzo.

Figure 8. a View of the north-eastern side of Marettimo Island, with Punta Troia in the background **b** vegetation with *Oncostema ughii*, a paleoendemic species exclusively found on Marettimo **c** north-facing cliffs of Pizzo Falcone **d** residual stands of the pristine holm oak forest (*Pistacio lentisci-Quercetum ilicis*) on the slopes of Pizzo delle Fragole **e** the garrigue *Micromerio fruticulosae-Ericetum multiflorae*, widespread throughout the island **f** *Morea sisyrinchium* characterizing the *Catapodio pauciflorae-Moraeetum sisyrinchii* ass. nova.

Sampled plant communities

From the village of Levanzo, near the post office, a path leads towards Cala Fredda across a synanthropic vegetation characterized by *Agave sisalana* (Fig. 10a), a remainder of ancient plantations locally used for fibre production, that nowadays tends to be recolonised by the local maquis. Later the Baglio Florio is reached, that is a farmhouse built by the Florio family, overlooking the broad plain known as 'La Fossa', once cultivated with vineyards (Fig. 10b). From here an old path descends to the bay of Cala Calcara, crossing a wintergreen low maquis attributable to the *Periploco-Euphorbietum dendroidis* (Fig. 10c). This coenosis (of which two relevés are given below) is widespread throughout the island, and represents the climatophilous vegetation of the low and windy coasts of all the islands of the Channel of Sicily, including the Maltese Islands.

Periploco angustifoliae-Euphorbietum dendroidis – Rel. 1, La Fossa, on limestone outcrops (37°59'27"N, 12°20'37"E): 63 m, 2°, S, 100%, 100 m². Diagnostic species: *Pistacia lentiscus* 4, *Periploca angustifolia* 3, *Euphorbia dendroides* 1. Characteristics of alliance, order and class: *Stachys major* 2, *Olea europaea* var. *sylvestris* 1, *Rubia peregrina* +, *Rhamnus lycioides* subsp. *oleoides* +. Other species: *Oloptum miliaceum* 1, *Ferula communis* +, *Asphodelus ramosus* +, *Hyparrhenia hirta* subsp. *hirta* +, *Galactites tomentosus* +, *Allium subhirsutum* +. *Lobularia maritima* +.

Rel. 2, behind Isola, on limestone outcrops: 170 m, 5°, NNW, 100%, 100 m². Diagnostic species: *Pistacia lentiscus* 4, *Periploca angustifolia* 2, *Euphorbia dendroides* 3. Characteristics of alliance, order and class: *Phillyrea latifolia* 1, *Stachys major* 3, *Asparagus acutifolius* 1, *Rubia peregrina* 1, *Rhamnus lycioides* subsp. *oleoides* +, *Melica minuta* subsp. *latifolia* 2, *Arisarum vulgare* 1. Other species: *Erica multiflora* 2, *Gladiolus byzantinus* +, *Allium subhirsutum* +, *Magydaris pastinacea* +, *Squilla pancration* +, *Brachypodium retusum* 1, *Asphodelus ramosus* 1, *Dactylis glomerata* subsp. *hispanica* +, *Ammoides pusilla* +, *Jacobaea delphiniifolia* +, *Lotus edulis* +, *Crepis vesicaria* +, *Tapsia garganica* +.

Due to degradation processes, the maquis is usually replaced by a xero-thermophilous grassland attributable to *Hyparrhenietum hirto-pubescentis*, of which a relevé is reported below.

Hyparrhenietum hirto-pubescentis – Above Cala Calcara (37°59'46"N, 12°20'43"E): 58 m, 2°, S, 100%, 80 m². Diagnostic species: *Hyparrhenia hirta* subsp. *hirta* 5. Characteristics of alliance, order and class: *Brachypodium retusum* 3, *Squilla pancration* 1, *Convolvolus altheoides* 1, *Asphodelus ramosus* 1, *Ferula communis* +, *Mandragora autumnalis* +, *Tapsia garganica* +, *Loncomelos narbonense* +, *Magydaris pastinacea* +, *Aristolochia navicularis* +. Other species: *Smyrnium olusatrum* 2, *Trachynia distachya* 1, *Galactites tomentosus* 1, *Carlina sicula* +, *Fedia graciliflora* +, *Avena barbata* +, *Tripodion tetraphyllum* +, *Sonchus bulbosus* +, *Oxalis pes-caprae* +, *Urospermum dalechampii* +, *Scorpiurus subvillosus* +, *Sonchus tenerrimus* r, *Pistacia lentiscus* r, *Linum strictum* r, *Allium commutatum* r.

In these xeric habitats, ephemeral meadows dominated by *Stipellula capensis* are quite frequent, mainly in stands with very superficial and eroded soils. A relevé of this vegetation, belonging to the class *Stipo-Trachynetea distachyae*, is given below.

Stipelluletum s.l. – Above Cala Calcara (37°59'46"N, 12°20'42"E): 59 m, 2°, S, 95%, 80 m². Diagnostic species: *Stipellula capensis* 5, Characteristics of alliance, order and class: *Trachynia distachya* 1, *Trifolium stellatum* +, *Lotus edulis* +, *Hypochaeris achyrophorus* +, *Tripolium tetraphyllum* +, *Stachys romana* +, *Plantago lagopus* +, *Trifolum cherleri* r, *Linum strictum* r, *Trifolium campestre* r. Other species: *Avena sterilis* 1, *Avena barbata* 2, *Hyparrhenia hirta* subsp. *hirta* 1, *Plantago afra* 1, *Galactites tomentosus* 1, *Medicago polymorpha* 1, *Carlina sicula* subsp. *sicula* +, *Crepis vesicaria* +, *Glebionis coronaria* +, *Erodium cicutarium* +, *Scorpiurus subvillosus* r, *Nigella damascena* r, *Linum usitatissimum* subsp. *angustifolium* r, *Diplotaxis viminea* r, *Lotus corniculatus* r, *Convolvulus althaeoides* r, *Sonchus tenerrimus* r.

After crossing Piana della Fossa, the path leads to the northern part of the island, with scenic views over Cala Tramontana and Capo Grosso. In the lower part of Pizzo Monaco, all along the western slope of the island, the *Periploco-Euphorbietum dendroidis* is well represented, sometimes mixed with small reforestations of *Pinus halepensis* and xerophilous grasslands. Along this itinerary (Fig. 2), a trail descends to the famous "Grotta del Genovese", which was inhabited between 10,000 and 6,000 B.C. offering wonderfully preserved paintings and engravings dating back to the Upper Palaeolithic period. Back on the main trail, along the coastal stretch between Pietre Varate and the urban centre, it is possible to observe halophytic vegetation attributable to *Limonietum bocconei* (Fig. 9).

Excursion along the coastline of Mount Cofano (27 April 2022)

Mt. Cofano (659 m a.s.l.) is a coastal promontory with a rugged profile made up of carbonate rock, rising on the Trapani coastline, between the Cornino and Macari plains. The area falls within a Site of Community Interest and is also a Regional Nature Reserve. The area is geologically related to the Monte Sparacio-Monte Cofano and Monte Speziale-Monte Palatimone units, dating back to the Mesozoic, to which bioclastic calcarenites and conglomerates with a prevalent arenitic matrix are marginally added. It represents one of the most interesting biotopes in the western sector of Sicily, characterised by the occurrence of many naturalistic-environmental attractions. The effects of an intense anthropic pressure and wildfires have determined a deep degradation of the climactic series characterising this mountain.

Land use – The first archaeological evidence of human presence on Mt. Cofano dates back to the Upper Palaeolithic, between 14,000 and 12,000 years ago (Tusa 2001, Romano et al. 2021). Deforestation was probably an ongoing activity already in prehistoric times, leading to the current landscape physiognomy, dominated by secondary plant communities. This is the case of the low maquis dominated by *Chamaerops humilis* (locally known as 'giummarra') and the perennial dry grassland dominated by *Ampelodesmos mauritanicus* (locally known as 'disa'), both of which are typical pyrophytes, among the best adapted to the fires that, nearly every year, burn the slopes of this mountain, especially in summer (Fig. 10d). Forest rarefaction has led to the disappearance of some of the woody species recorded in the past, as in the case of *Quercus coccifera*, reported from the area by Ponzo (1900) and no longer found.

Figure 9. Levanzo Island: vegetation along the southern coast, near Cala Faraglione (37°59'12"N, 12°19'51"E; 12 m a.s.l.); in the background, Marettimo Island – **1** *Periploco angustifoliae-Euphorbietum dendroidis*; **2** *Hyparrhenietum hirto-pubescentis*; **3** *Stipelluletum* s.l.; **4** *Senecioni bicoloris-Helichrysetum messerii*; **5** *Limonietum bocconei*.

Figure 10. a *Agave sisalana* and *Selenicereus undatus*, two exotic species naturalized in the scrub near the village of Levanzo **b** view of the vegetation landscape on the island of Levanzo, between Contrada La Fossa and Pizzo Monaco **c** *Periploco-Euphorbietum dendroidis* scrub, on the western slopes of Levanzo **d** *Pistacio lentisci-Chamaeropetum humilis*, along the southwestern slope of Mt. Cofano **e** *Erica sicula*, an interesting paleoendemite exclusive to the cliffs of Mt. Cofano **f** view of the south-facing slopes of Mt. Cofano, with *Pistacio lentisci-Chamaeropetum humilis* in the foreground.

Series and microgeoseries – the series of the dwarf palm (*Pistacio lentisci-Chamaeropo humilis* sigmetum) develops along the coast of Mt. Cofano, in catenal contact with the halophytic vegetation of the alliance *Crithmo-Limonion*. Along the landward gradient, the series of the holm oak and European ash (*Rhamno alaterni-Querco ilicis pistacieto terebinthi* sigmetosum) settles on the talus slopes fringing the calcareous-dolomitic rocky faces, especially with northern orientation. The *Quercus coccifera* series (*Chamaeropo humilis-Querco calliprini* sigmetum) develops on calcarenite substrates. On compact limestone substrates with southern exposure, the dry infra-thermo-Mediterranean basiphilous series of the wild olive tree (*Ruto chalepensis-Oleo sylvestris euphorbio bivonae* sigmetosum) develops. The series of the holm oak with lentisk (*Pistacio lentisci-Querco ilicis* sigmetum) is represented on compact limestone in the highest and coolest part of Mt. Cofano, within the meso-Mediterranean subhumid bioclimate. Particularly interesting are the microgeosigmeta of the rocky coasts and cliffs, rich in endemic species which represented a main interest of this excursion.

Endemic and rare species – The vascular flora of Mt. Cofano consists of 651 taxa (Gianguzzi et al. 2006; Brullo et al. 2016), with 48 endemic taxa, three of which are exclusive, i.e., *Erica sicula* subsp. *sicula* (Fig. 10e), *Helichrysum panormitanum* subsp. *brulloi*, and *Limonium cophanense*. Other very rare endemic taxa are *Hieracium cophanense* (recorded also from Mount Passo del Lupo, within the Zingaro Nature Reserve) and *Pseudoscabiosa limonifolia* (recorded also from Marettimo Island and along the north-western promontories of Sicily, up to Palermo). Among the north-western Sicilian endemics, the following were recorded: *Brassica villosa* subsp. *drepanensis*, *Centaurea panormitana*, *C. tyrrhena*, *Limonium bocconei*, *L. ponzoi*, *Matthiola incana* subsp. *rupestris*, *Klasea flavescens* subsp. *mucronata*, etc. Several Sicilian endemics are also present, such as *Ranunculus spicatus* subsp. *rupestris*, *Seseli bocconei*, *Convolvulus cneorum var*, *cneorum*, *Eryngium tricuspidatum*, *Odontites bocconei* subsp. *bocconei*, *Neotinea commutata*, *Ophrys lacaitae*, *O. lunulata*, *O. oxyrrhynchos*, *Senecio squalidus* subsp. *microglossus* (= *S. siculus* All.). Other endemics ranging beyond the Sicilian territory include: *Orchis brancifortii*, *Antirrhinum siculum*, *Bellevalia dubia*, *Dianthus rupicola* subsp. *rupicola*, *D. siculus*, *Iberis semperflorens*, etc. Finally, some species of remarkable phytogeographical interest also occur in Mt. Cofano, such as *Glandora rosmarinifolia*, *Lonas annua*, *Rhamnus lycioides* subsp. *oleoides*, *Ranunculus baudotii*, etc.

Sampled plant communities

The itinerary starts from Contrada Macari (Fig. 2), in the south-eastern part of the Nature Reserve, up to the cliffs near the Grotta del Crocifisso (38°06'43"N, 12°39'54"E), offering numerous points of historical and natural interest (Fig. 11). Along the rocky coast, the halophilous vegetation of *Limonietum bocconei* is widespread.

Limonietum bocconei* subass. *typicum (After Gianguzzi and La Mantia 2008: tab. 6, rels 1–6) – Diagnostic species: *Limonium bocconei* V, Characteristics of alliance, order and class: *Crithmum maritimum* V, *Lotus cytisoides* V, *Pallenis maritima* V, *Silene sedoides* V, *Plantago macrorhiza IV*, *Daucus carota* subsp. *drepanensis* IV, *Senecio leucan-*

themifolius IV, *Reichardia picroides* var. *maritima* IV, *Frankenia hirsuta* III, *Arthrocaulon meridionale* I, *Limonium ponzoi* I. Other species: *Desmazeria sicula* IV, *Silene vulgaris* IV, *Anthemis secundiramea* III, *Parapholis incurva* III, *Beta vulgaris* subsp. *maritima* III, *Moraea sisyrinchium* II, *Hyoseris radiata* II, *Capparis sicula* II, *Sporobolus virginicus* II, *Dactylis glomerata* subsp. *hispanica* I, *Thymelaea hirsuta* I, *Brachypodium retusum* I, *Romulea columnae* I, *Petrosedum sediforme* I, *Catapodium balearicum* I, *Stachys romana* I, *Chamaerops humilis* I, *Dianthus rupicola* subsp. rupicola I, *Spergularia marina* I, *Medicago littoralis* I.

Another variant of the previous association is found on the imposing detrital conoids located on the northern slope of Mt. Cofano, characterized by the silvery cushions of *Helichrysum panormitanum* subsp. *brulloi*, a rupicolous species endemic to this coastal stretch. This vegetation is treated as subass. *helichrysetosum brulloi* of the *Limonietum bocconei*. It colonizes the partially eroded arid escarpments of the seaward slopes, markedly exposed to the influence of sea winds.

***Limonietum bocconei* subass. *helichrysetosum brulloi* corr.** (After Gianguzzi and La Mantia 2008: tab. 6, rels 7–12) – Diagnostic species: *Limonium bocconei* V, *Helichrysum panormitanum* subsp. *Brulloi*. Characteristics of alliance, order and class: *Crithmum maritimum* V, *Lotus cytisoides* V, *Pallenis maritima* V, *Plantago macrorhiza* V, *Daucus carota* subsp. *drepanensis* V, *Reichardia picroides* var. *maritima* V, *Frankenia hirsuta* II. Other species: *Dactylis glomerata* subsp. *hispanica* V, *Seseli bocconei* V *Silene vulgaris* V, *Thymelaea hirsuta* IV, *Hyoseris radiata* IV, *Anthemis secundiramea* III, *Brachypodium retusum* III, *Catapodium balearicum* II, *Moraea sisyrinchium* I, *Ampelodesmos mauritanicus* I, *Cytisus infestus* I, *Dactylis glomerata* subsp. *hispanica* I, *Romulea columnae* III, *Asparagus acutifolius* III, *Petrosedum sediforme* II, *Catapodium balearicum* I, *Stachys romana* II, *Arthrocaulon meridionale* II, *Chamaerops humilis* I, *Dianthus rupicola* subsp. *rupicola* I, *Erica multiflora* I, *Euphorbia segetalis* I.

The aforesaid vegetation represents the transitional aspect between the *Limonietum bocconei typicum* and the low maquis with *Chamaerops humilis* (Fig. 7), ascribed to the *Pistacio-Chamaeropetum humilis* (Fig. 10f). The latter occurs mainly on calcareous and calcarenite substrates near the coast. From these primary stands, it tends to climb along the steep talus slopes fringing the calcareous cliffs. Here it behaves as a pioneer vegetation, facilitated by the erosion of the superficial soil layers, as well as by frequent fires, that block competition with other woody species, allowing the dwarf palm to dominate the landscape. Several other thermophilous elements of the class *Quercetea ilicis* make up this coenosis, as shown in the synthetic relevé reported below.

Pistacio lentisci-Chamaeropetum humilis (After Gianguzzi and La Mantia 2008: tab. 10 rels. 1–10) – Diagnostic species: *Chamaerops humilis* V, *Pistacia lentiscus* V. Characteristics of alliance, order and class: *Asparagus albus* V, *Teucrium fruticans* IV, *Euphorbia dendroides* IV, *Stachys major* IV, *Osyris alba* III, *Rhamnus alaternus* III, *Olea europaea* var. *sylvestris* II, *Daphne gnidium* II, *Rubia peregrina* II, *Cytisus infestus* V, *Arisarum vulgare* V, *Smilax aspera* V, *Asparagus acutifolius* II, *Pistacia terebinthus* II, *Phillyrea latifolia* I. Other species: *Hyparrhenia hirta* subsp. *hirta* V, *Asphodelus ramosus* V, *Micromeria graeca* subsp. *fruticulosa* IV, *Dactylis glomerata* subsp. *hispanica* IV, *Cachrys libanotis* IV, *Reichardia pic-*

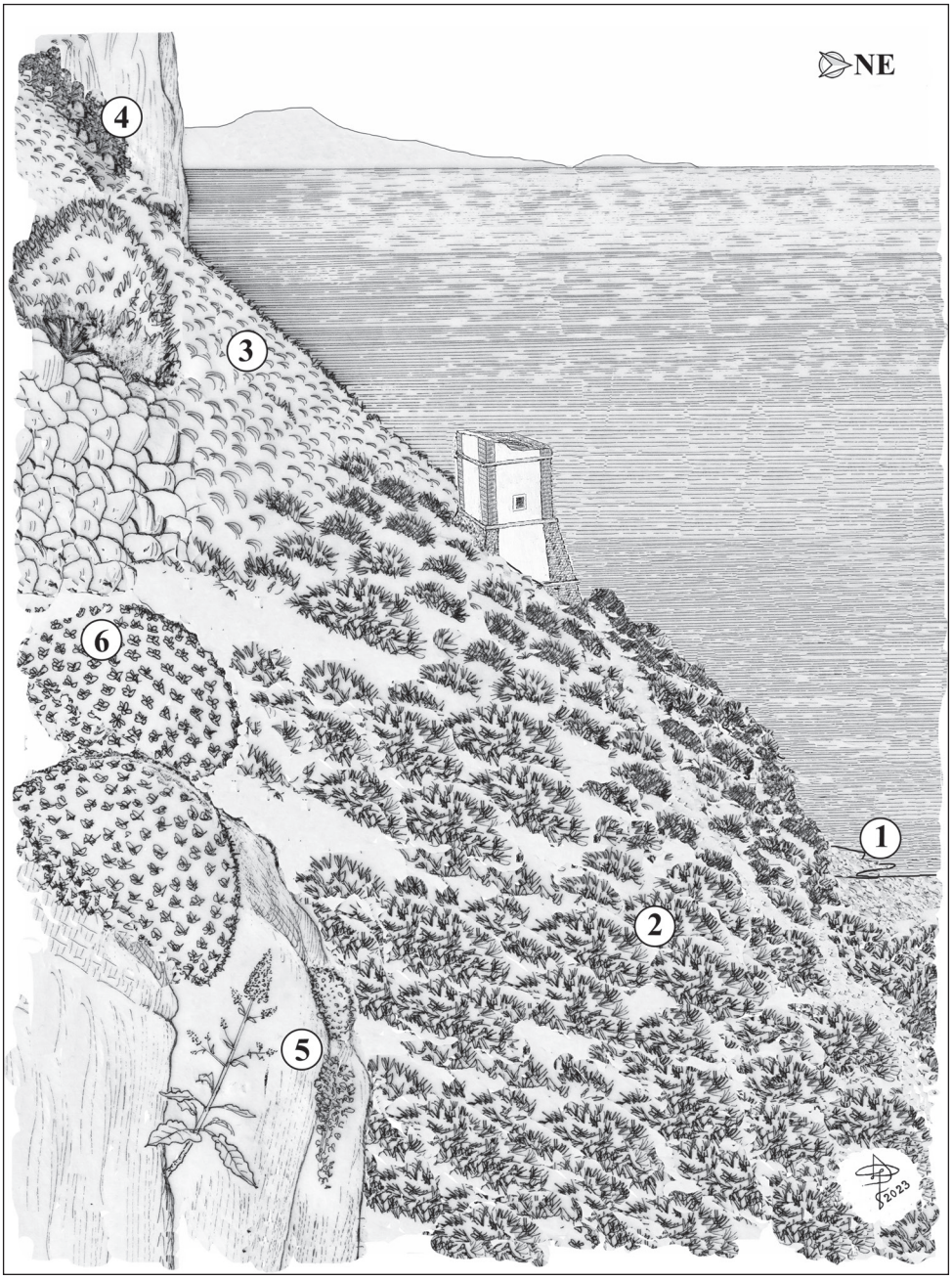

Figure 11. Vegetation along the north-western coast of Mount Cofano, next to Torre S. Giovanni (38°06'35"N, 12°39'33"E; 39 m a.s.l.); in the background, Mount San Giuliano and Levanzo Island. **1** *Limonietum bocconei*. **2** *Pistacio lentisci-Chamaeropetum humilis*; **3** *Helictotricho convoluti-Ampelodesmetum mauritanici*; **4** *Rhamno alaterni-Quercetum ilicis* subass. *pistacietosum terebinthi*; **5** *Scabioso creticae-Centauretum ucriae* subass. *typicum* and subass. *ericetosum siculae*; **6** *Rhamno-Euphorbietum dendroides* subass. *euphorbietosum bivonae*.

roides IV, *Brachypodium retusum* III, *Ampelodesmos mauritanicus* III, *Carlina gummifera* III, *Lotus citysoides* III, *Convolvolus cantabrica* III, *Pallenis spinosa* III, *Thymelaea hirsuta* III, *Petrosedum sediforme* II, *Squilla pancration* II, *Bituminaria bituminosa* II, *Pallenis maritima* II, *Anthyllis vulneraria* subsp. *maura* II, *Salvia verbenaca* II, *Oloptum miliaceum* II, *Anethum foeniculum* II, *Lobularia maritima* II, *Ambrosinia bassii* II, *Romulea columnae* II, *Lotus tetragonolobus* II, *Helichrysum panormitanum* subsp. *brulloi* I, *Carex flacca* subsp. *erythrostachys* I, *Cynodon dactylon* I, *Daucus carota* subsp. *hispanicus* I, *Eryngium campestre* I, *Biscutella maritima* I, *Convolvolus altheoides* I, *Rubus ulmifolius* I, *Carlina sicula* I, *Moraea sisyrinchium* I, *Thapsia garganica* I, *Urospermum picroides* I, *Kundmannia sicula* I.

The clastic slopes developing at the base of the cliffs of Mt. Cofano, especially near the rocky outcrops, in relatively cooler and shadier conditions, belong to the holm oak series with manna ash (*Rhamno alaterni-Querco ilicis pistacietosum terebinthi* sigmetum). Frequent fires have led to the almost total disappearance of the more evolved forest aspects of this series, leaving room for secondary aspects and, in particular, for the perennial grassland dominated by *Ampelodesmos mauritanicus*, here represented by the *Helictotricho convoluti-Ampelodesmetum mauritanici*.

Helictotricho convoluti-Ampelodesmetum mauritanici (After Gianguzzi and La Mantia 2008: tab. 20, rels. 1–8) – Diagnostic species: *Ampelodesmos mauritanicus* V, *Klasea flavescens* subsp. *mucronata* III, *Eryngium tricuspidatum* subsp. *bocconei* III, *Helictochloa cincinnata* III, *Delphinium emarginatum* III, *Helminthotheca aculeata* III, *Dianthus siculus* II, *Gelasia villosa* subsp. *columnae* I, *Pimpinella anisoides* I. Characteristics of alliance, order and class: *Hyparrhenia hirta* s.l. V, *Dactylis glomerata* subsp. *hispanica* V; *Asphodelus ramosus* V, *Andropogon distachyus* IV, *Convolvolus altheoides* IV, *Bituminaria bituminosa* IV, *Kundmannia sicula* III. *Reichardia picroides* II, *Hyoseris radiata* II, *Lathyrus clymenum* II, *Anethum piperitum*, *Micromeria graeca* II, *Anthyllis vulneraria* subsp. *maura* II, *Lobularia maritima* II, *Convolvolus cantabrica* II, *Verbascum sinuatum* II, *Phagnalon saxatile* II, *Ferula communis* I, *Thapsia garganica* I, *Pallenis spinosa* I, *Scolymus grandiflora* I, *Poterium sanguisorba* subsp. *balearicum* I. Other species: *Chamaerops humili* subsp. *humilis* V, *Carlina sicula* V, *Pistacia lentiscus* IV, *Stachys major* IV, *Brachypodium retusum* IV, *Micromeria graeca* subsp. *fruticulosa* IV, *Cytisus infestus* III, *Asparagus albus* III, *Stachys romana* III, *Urospermum dalechampii* III, *Melica minuta* III, *Macrobriza maxima* III, *Linum trigynum* III, *Erica multiflora* II, *Carlina gummifera* II, *Hypericum perfoliatum* II, *Linum strictum* II, *Daucus carota* II, *Fumana thymifolia* II, *Pistacia terebinthus* II, *Teucrium fruticans* I, *Asparagus acutifolius* I, *Squilla pancration* I, *Lotus cytisoides* I, *Scorpiurus subvillosus* I, *Hyoseris radiata* I.

The most structured seral stage occurring on the slopes near the cliffs must be referred to a holm oak wood, in which two deciduous trees, *Fraxinus ornus* and *Pistacia terebinthus*, play an important physiognomic role, as differential species of the *Rhamno alaterni-Quercetum ilicis pistacietosum terebinthi*, a woodland nowadays represented by small residual patches.

Rhamno alaterni-Quercetum ilicis* subass. *pistacietosum terebinthi (After Gianguzzi and La Mantia 2008: tab. 13, rels. 1–7) – Diagnostic species: *Quercus ilex* V, *Pistacia terebinthus* V, *Fraxinus ornus* V, *Rhamnus alaternus* V, *Rhus coriaria* II. Characteristics

Table 5. Syntaxonomic scheme.

CRITHMO-LIMONIETEA Br.-Bl.1947 in Br.-Bl., Roussine et Nègre 1952
- CRITHMO-LIMONIETALIA Molinier 1934
  - Crithmo-Limonion Molinier 1934
    - *Limonietum bocconei* Barbagallo, Brullo et Guglielmo 1979 subass. *typicum*
    - subass. *helichrysetosum cophanense* Gianguzzi et La Mantia 2008
    - *Limonietum tenuiculi* Brullo et Marcenò 1983
  - Plantagini-Thymelaeion hirsutae Bartolo et Brullo in Bartolo et al. 1992
  - Anthyllidion barbae-jovis Brullo et De Marco 1989
    - *Senecioni bicoloris-Helichrysetum messerii* Brullo et Marcenò 1983

SALICORNIETEA FRUTICOSAE Br.-Bl. et Tx. ex A. Bolòs y Vayreda et O. de Bolòs in A. Bolòs y Vayreda 1950
- SARCOCORNIETALIA FRUTICOSAE Br.-Bl.1933
  - Juncion maritimi Br.-Bl. ex Horvatic 1934
    - *Agropyro scirpei-Inuletum crithmoidis* Brullo in Brullo et al.1988

ASPLENIETEA TRICHOMANIS (Br.-Bl. in Meier et Br.-Bl. 1934) Oberd. 1977
- ASPLENIETALIA GLANDULOSI Br.-Bl. in Meier et Br.-Bl. 1934
  - Dianthion rupicolae Brullo et Marcenò 1979
    - *Scabioso creticae-Centauretum ucriae* Brullo et Marcenò 1979
      - – subass. *typicum* Brullo et Marcenò 1979
      - – subass. *ericetosum siculae* Brullo et Marcenò 1979
    - *Bupleuro dianthifolii-Scabiosetum limonifoliae* Brullo et Marcenò 1979

CYMBALARIO-PARIETARIETEA JUDAICAE Oberd. 1969
- TORTULO-CYMBALARIETALIA Segal 1969
  - Parietarion judaicae Segal 1969
    - *Athamanto siculae-Parietarietum judaicae* Gianguzzi et Bazan 2020

PINETEA HALEPENSIS Bonari et Chytrý in Bonari et al. 2021
(currently sub-judice by the European Vegetation Classification Committee)
- PINETALIA HALEPENSIS Biondi, Blasi, Galdenzi, Pesaresi et Vagge in Biondi et al. 2014
  - Pistacio lentisci-Pinion halepensis Biondi, Blasi, Galdenzi, Pesaresi et Vagge in Biondi et al. 2014
    - *Erico multiflorae-Pinetum halepensis* (Brullo, Di Martino et Marcenò 1977) Biondi et Pesaresi 2017 in Biondi et al. 2017(= *Pistacio lentisci-Pinetum halepensis* De Marco et Caneva 1985)

QUERCETEA ILICIS Br.-Bl.1947
- QUERCETALIA ILICIS Br.-Bl.1936 em. Rivas-Martínez 1975
  - Fraxino orni-Quercion ilicis Biondi, Casavecchia et Gigante in Biondi et al. 2013
    - *Rhamno alaterni-Quercetum ilicis* Brullo et Marcenò 1985
    - subass. *pistacietosum terebinthi* Gianguzzi, Ilardi et Raimondo 1996
    - *Pistacio lentisci-Quercetum ilicis* Brullo et Marcenò 1985 subass. *typicum*
    - subass. *arbutetosum unedonis* Gianguzzi et La Mantia 2008
    - *Daphno sericeae-Quercetum ilicis* Brullo et Marcenò 1984
  - Asparago acutifolii-Laurion nobilis Gianguzzi, P. Cuttonaro, Cusimano et Romano. 2016
    - *Acantho mollis-Lauretum nobilis* Gianguzzi, D'Amico et Romano 2010
- PISTACIO LENTISCI-RHAMNETALIA ALATERNI Rivas-Martínez 1975
  - Oleo sylvestris-Ceratonion siliquae Br.-Bl. 1936 em. Rivas-Martínez 1975
    - *Pistacio lentisci-Chamaeropetum humilis* Brullo et Marcenò 1985
    - *Periploco angustifoliae-Euphorbietum dendroidis* Brullo, Di Martino et Marcenò 1977
    - *Rhamno alaterni-Euphorbietum dendroidis* Géhu et Biondi 1997
      - subass. *rhamnetosum oleoidis* (Brullo et Marcenò 1985) Gianguzzi, Cutton, Cusim. et Romano 2016
      - subass. *euphorbietosum bivonae* (Gianguzzi, Ilardi et Raimondo 1996) Gianguzzi, Cutton., Cusim. et Romano 2016
    - *Pyro amygdaliformis-Calicotometum infestae* Gianguzzi et La Mantia 2008
    - *Ruto chalepensis-Oleetum sylvestris* Gianguzzi et Bazan 2020
      - subass. *euphorbietosum bivonae* Gianguzzi et Bazan 2020

subass. *rhamnetosum oleoidis* Gianguzzi et Bazan 2020
subass. *periplocetosum angustifoliae* Gianguzzi et Bazan 2020
CRATAEGO-PRUNETEA Tüxen 1962
PYRO-SPINOSAE-RUBETALIA ULMIFOLII Biondi, Blasi et Casavecchia in Blasi et al. 2014
Pruno spinosae.Rubion ulmifolii O.Bolòs 1954
Clematido cirrhosae-Rubetum ulmifolii Gianguzzi et La Mantia 2008
ONONIDO-ROSMARINETEA Br.-Bl. in A. Bolòs y Vayreda 1950
ROSMARINETALIA OFFICINALIS Br.-Bl. ex Molinier 1934
Poligalo preslii-Ericion multiflorae Guarino et Pasta 2017
Micromerio fruticulosae-Ericetum multiflorae Brullo et Marcenò 1983
Brachypodio ramosi-Cistetum creticae Gianguzzi et La Mantia 2008
LYGEO SPARTI-STIPETEA TENACISSIMAE Rivas-Martínez 1978
CYMBOPOGONO-BRACHYPODIETALIA RAMOSI Horvatić1963
Phlomido lychnitidis-Brachypodion retusi Mateo ex Theurillat et Mucina 2016
Coronillo glaucae-Brachypodietum retusi C. et S. Brullo, Giusso et Tomaselli 2006
Helminthotheco aculeatae-Brachypodietum retusi C. et S. Brullo, Giusso et Tomaselli 2006
HYPARRHENIETALIA HIRTO-PUBESCENTIS Rivas-Martínez 1978
Saturejo-Hyparrhenion hirtae O. de Bolòs 1961
Hyparrhenietum hirto-pubescentis s.l. A.et O. de Bolòs et Br.-Bl. 1950
Avenulo-Ampelodesmion mauritanici Minissale 1995
Helictotricho convoluti-Ampelodesmetum mauritanici Minissale 1995
ONOPORDETEA ACANTHII Br.-Bl. 1964
CARTHAMETALIA LANATI Brullo in Brullo et Marcenò 1985
Onopordion illyrici Oberd. 1954
Carlino siculae-Feruletum communis Gianguzzi, Ilardi et Raimondo 1996
GALIO-URTICETEA Passarge ex Kopecky 1969
GALIO APARINES-ALLIARIETALIA PETIOLATAE Görs et Müller 1969
Galio-Alliarion petiolatae Oberdorfer et Lohmeyer in Oberd., Görs, Korneck, Lohm., Müller, Philippi et Seibert 1967
Smyrnienion olusatri Rivas Goday ex Rivas-Martinez, Fernàndez-Gonzàlez et Loidi 1999
Acantho-Smyrnietum olusatri Brullo et Marcenò 1985
STIPO-TRACHYNIETEA DISTACHYAE Brullo in Brullo, Scelsi et Spampinato 1998
TRACHYNETALIA DISTACHYAE Rivas-Martinez 1978
Trachynion distachyae Rivas-Martínez 1978 Brullo in Brullo et al. 2020
Thero-Sedetum caerulei Brullo 1975
Stipion retortae O. de Bolòs 1957
Ononido breviflorae-Stipetum capensis Brullo, Guarino et Ronsisvalle 1998
STIPO-BUPLEURETALIA SEMICOMPOSITI Brullo in Brullo, Scelsi et Spampinato 2001
Plantagini-Catapodion balearici Brullo 1985 corr. Guarino et Pignatti 2019
Anthemido intermediae-Desmazerietum siculae Brullo 1985
Catapodio pauciflorae-Moraeetum sisyrinchii ass. nova hoc loco

of alliance, order and class: *Cyclamen hederifolium* V, *Allium subhirsutum* V, *Asparagus acutifolius* V, *Smilax aspera* IV, *Rubia peregrina* IV, *Clematis cirrhosa* IV, *Rosa sempervirens* IV, *Euphorbia characias* III, *Asplenium onopteris* II, *Ruta chalepensis* II, *Daphne gnidium* I, *Teucrium flavum* V, *Euphorbia dendroides* II, *Stachys major* II, *Osyris alba* II, *Arisarum vulgare* IV, *Carex distachya* II, *Ruscus aculeatus* II, *Phillyrea latifolia* II, *Hedera helix* V. Other species: *Acanthus mollis* V, *Rubus ulmifolius* IV, *Arum italicum* IV, *Polypodium cambricum* IV, *Anthriscus nemorosa* IV, *Ampelodesmos mauritanicus* III, *Geranium lucidum* III,

Helminthotheca aculeata III, *Oxalis pes-caprae* II, *Brachypodium retusum* II, *Centranthus ruber* II, *Clinopodium nepeta* II, *Athamanta sicula* II, *Lathyrus oleraceus* subsp. *biflorus* I, *Dryopteris villarii* subsp. *pallida* I, *Galium aparine* I, *Umbilicus horizontalis* I, *Theligonum cynocrambe* I, *Crataegus monogyna* I. *Carex divisa* I, *Anemone hortensis* I, *Convolvulus silvaticus* I, *Hypericum perfoliatum* I, *Geranium purpureum* I. *Thapsia asclepium* I.

The rupestrian habitat is particularly well represented in the Mt. Cofano area, especially along the northern slopes, where the calcareous cliffs are more than 300 m high. On these cliffs, chasmophytic vegetation of the *Scabioso-Centauretum ucriae* subass. *typicum* and subass. *ericetosum siculae*, as well as comophilous, therophytic and bryophytic communities occur.

Scabioso creticae Centauretum ucriae (After Gianguzzi and La Mantia 2008: tab. 7, rels. 1–10) – Diagnostic species subass. *typicum*: *Centaurea panormitana* V, *Brassica villosa* subsp. *bivoniana* V, *Matthiola incana* subsp. *rupestris* V, *Convolvulus cneorum* II, *Brassica villosa* subsp. *drepanensis* I. Diagnostic species subass. *ericetosum siculae*: *Helichrysum panormitanum* subsp. *brulloi* V, *Erica sicula* II, *Pseudoscabiosa limonifolia* II, *Hieracium cophanense* II, *Phagnalon rupestre* I. Characteristics of alliance, order and class: *Silene fruticosa* V, *Seseli bocconei* V, *Dianthus rupicola* subsp. *rupicola* V, *Iberis semperflorens* IV, *Hexaphylla rupestris* IV, *Euphorbia bivonae* III, *Glandora rosmarinifolia* II, *Pimpinella anisoides* I, *Antirrhinum siculum* I, *Odontites bocconei* subsp. *bocconei* I, *Lomelosia cretica* IV, *Polypodium cambricum* III, *Melica minuta* III, *Asplenium ceterach* III, *Athamanta sicula* II, *Hypochoeris laevigata* II, *Sedum dasyphyllum* II. *Pseudodictamnus hispanicus* II, *Capparis orientalis* II, *Umbilicus horizontalis* II, *Parietaria lusitanica* I, *Asplenium trichomanes* subsp. *quadrivalens* I, *Ranunculus spicatus* subsp. *rupestris* I, *Teucrium flavum* I. Other species: *Euphorbia dendroides* III, *Stachys major* II, *Ruta chalepensis* II, *Ampelodesmos mauritanicus* II, *Chamaerops humilis* II, *Asparagus albus* II, *Ephedra* sp. I, *Micromeria graeca* subsp. *fruticulosa* V, *Galium lucidum* IV, *Coronilla valentina* subsp. *glauca* III, *Brachypodium retusum* III, *Hyoseris radiata* III, *Erica multiflora* II, *Lotus cytisoides* II, *Lobularia maritima* II, *Petrosedum sediforme* II, *Centranthus ruber* I, *Malva arborea* I, *Oloptum miliaceum* I, *Phagnalon rupestre* I.

Floristic remarks

The research led to the identification of 423 taxa of vascular plants, of which 100 in Mt. San Giuliano (including 53 taxa documented by herbarium specimens: Suppl. material 1), 201 in Marettimo Island (including 93 taxa documented by herbarium specimens: Suppl. material 2), 137 in Levanzo Island (including 79 taxa documented by herbarium specimens; Suppl. material 3), and 220 in Mt. Cofano (including 77 taxa documented by herbarium specimens, Suppl. material 4). In all the aforementioned study areas, the Asteraceae was the most represented family with 12, 27, 26 and 32 taxa, respectively.

With regards to Marettimo, four taxa were found to be new floristic records: *Ervum pubescens*, *Fumana laevis*, *Kalanchoë* ×*houghtonii*, *Lysimachia loeflingii* and *Medicago littoralis*. In particular, *L. loeflingii*, a species recently described and known in Italy only for

Sardinia (Jiménez-López et al. 2022), is recorded for the first time in Sicily. Our discovery of *M. littoralis* is a confirmation for the flora of the island as it was formerly reported by Francini and Messeri (1956), but not subsequently confirmed (Gianguzzi et al. 2006). A potential threat to the native flora of the island is the finding of *K.* ×*houghtonii*, an artificial hybrid created in the 1930s in the USA by experimental crossings between *K. daigremontiana* Raym.-Hamet & H.Perrier and *K. delagoënsis* Eckl. & Zeyh., considered one of the most rapidly expanding invasive plants in recent times (Herrando-Moraira et al. 2020). For example, in Italy it was recently indicated as invasive in Calabria (Stinca et al. 2022). Moreover, further four taxa were found by us for the first time in Levanzo (i.e., *Avena sterilis* subsp. *sterilis*, *Blackstonia perfoliata* subsp. *intermedia*, *Catapodium rigidum* subsp. *majus*, *Hyparrhenia sinaica*, *Oxalis corniculata*, *Phagnalon rupestre* subsp. *rupestre* and *Scorpiurus subvillosus*) and three new taxa in Mt. Cofano (i.e., *Blackstonia grandiflora*, *Carex divulsa* and *Galium lucidum* subsp. *venustum*). Among these taxa, very interesting is the discovery of *H. sinaica*, a SW-Steno-Mediterranean species very similar to *H. hirta* subsp. *hirta* from which it is distinguished by a few characters concerning the peduncles and the bracts of the inflorescences (Pignatti et al. 2017–2019).

In agreement with the results achieved by other Working Groups of the Italian Botanical Society in southern Italy (e.g., Rosati et al. 2017, Stinca et al. 2019), data obtained during this study, confirmed the important role of a collaborative approach among botanists, especially among specialists in vascular flora and vegetation, aimed at the analysis of the plant diversity of the Italian territory.

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References

Abate B, Di Maggio C, Incandela A, Renda P (1993) Carta Geologica dei Monti di Capo San Vito (scala 1/25000). Dipartimento di Geologia e Geodesia, Palermo.

Abate B, Ferruzza G, Incandela A, Renda P (1995) Tettonica trascorrente nelle Isole Egadi (Sicilia occidentale). Studi Geologici (2, Vol. Speciale): 9–14.

Abate, B, Incandela, A, Renda, P (1999) Geologia dell'Isola di Marettimo. Il Naturalista Siciliano 23(1–2), 3–41.

Agnesi V, Macaluso T, Orrù P, Ulzega A (1993) Paleogeografia dell'Arcipelago delle Egadi (Sicilia) nel Pleistocene Sup.-Olocene. Il Naturalista Siciliano 17(1–2): 3–22.

Aleo M, Bazan G, Quattrocchi U (2013) Le piante vascolari del litorale trapanese: da Ronciglio a Capo San Vito. Quaderni di botanica ambientale e applicata 22: 101–116.

Barbagallo C, Brullo S, Guglielmo A (1979) Lineamenti della vegetazione di Monte Cofano (Sicilia occidentale). Pubblicazioni Istituto di Botanica Università di Catania.

Barbagallo C, Brullo S, Guglielmo A (1980) Carta della vegetazione di Monte Cofano (Sicilia occidentale). Collana del Progr. Finalizzato "Promoz. Sulla Qualità dell'Ambiente", s. AQ\1\39. C.N.R, Roma.

Bartolo G, Brullo S, Lo Cicero E, Marcenò C, Piccione V (1978) Osservazioni fitosociologiche sulla pineta a *Pinus halepensis* di Vittoria (Sicilia meridionale). Archivio Botanico e Biogeografico Italiano 54(3–4): 137–154.

Bartolo G, Brullo S, Minissale P, Spampinato G (1985) Osservazioni fitosociologiche sulle pinete a *Pinus halepensis* Miller del bacino del fiume Tellaro (Sicilia sud-orientale). Bollettino dell'Accademia Gioenia di Scienze naturali 18: 255–270.

Bartolo G, Brullo S, Signorello P (1992) La classe *Crithmo-Limonietea* nella penisola italiana. Colloques Phytosociologiques 19(1989): 55–82.

Bartolo G, Brullo S, Minissale P, Spampinato G (1988) Flora e vegetazione dell'Isola di Lampedusa. Bollettino dell'Accademia Gioenia di Scienze Naturali di Catania 21(344): 119–225.

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

Bazan G, Marino P, Guarino R, Domina G, Schicchi R (2015) Bioclimatology and vegetation series in Sicily: a geostatistical approach. Annales Botanici Fennici 52: 1–18. https://doi.org/10.5735/085.052.0202

Biondi E, Blasi C, Allegrezza M, Anzellotti I, Azzella MM, Carli E, Casavecchia S, Copiz R, Del Vico E, Facioni L, Galdenzi D, Gasparri R, Lasen C, Pesaresi C, Poldini L, Sburlino G, Taffetani F, Vagge I, Zitti S, Zivkovic L. (2014) Plant communities of Italy: The Vegetation Prodrome, Plant Biosystems – An International Journal Dealing with all Aspects of Plant Biology, 148(4): 728–814. https://doi.org/10.1080/11263504.2014.948527

Biondi E, Filigheddu R, Farris E (2001) Il paesaggio vegetale della Nurra. Fitosociologia 38(2) (suppl. 2): 3–105.

Bolòs O, Molinier R (1958) Recherches phytosociologiques dans l'Ile de Majorque. Collectanea Botanica 5(34): 699–865.

Bonari G, Fernández-González F, Çoban S, Monteiro-Henriques T, Bergmeier E, Didukh YP, Xystrakis F, Angiolini C, Chytrý K, Acosta ATR, Agrillo E, Costa JC, Danihelka J, Hennekens SM, Kavgacı A, Knollová I, Neto CS, Sağlam C, Škvorc Z, Tichý L, Chytrý M

(2021) Classification of the Mediterranean lowland to submontane pine forest vegetation. Applied Vegetation Science 24(1): e12544. https://doi.org/10.1111/avsc.12544

Braun-Blanquet J (1964) Pflanzensoziologie, Grundzüge der Vegetationskunde (3rd Edn). Springer, Wien. https://doi.org/10.1007/978-3-7091-8110-2

Brullo S (1985) Contributo alla conoscenza della vegetazione nitrofila della Sicilia. Colloques Phytosociologiques 12: 23–148.

Brullo S, Brullo C (2020) Flora endemica illustrata della Sicilia. Laruffa editore, 1–448.

Brullo C, Brullo S, Cambria S, Giusso Del Galdo G, Ilardi V (2016) *Limonium cophanense* (Plumbaginaceae), a new species from Sicily. Phytotaxa 255(2): 153–159. https://doi.org/10.11646/phytotaxa.255.2.4

Brullo C, Brullo S, Giusso del Galdo G, Guarino R, Minissale P, Scuderi L, Siracusa G, Sciandrello S, Spampinato G (2010) The *Lygeo-Stipetea* class in Sicily. Annali di Botanica (0): 57–84.

Brullo C, Brullo S, Giusso del Galdo G, Ilardi V (2014) *Silene nefelites* (Caryophyllaceae), a new annual species from Sicily. Phyton-Annales rei botanicae 54(2): 223–232.

Brullo C, Brullo S, Giusso del Galdo G, Pavone P, Salmeri C (2009) *Prospero hierae* (Hyacinthaceae), a new species from Marettimo Island (Sicily). Phyton 49(1): 93–104.

Brullo C, Brullo S, Giusso del Galdo G, Tomaselli V (2006) Contributo alla conoscenza delle praterie a *Brachypodium retusum* del Mediterraneo centro-orientale. Quaderni di Botanica Ambientale e Applicata 17(2): 49–64.

Brullo S, Brullo C, Cambria S, Giusso del Galdo G (2020) The vegetation of the Maltese Islands. Springer International Publishing. https://doi.org/10.1007/978-3-030-34525-9

Brullo S, Di Martino A, Marcenò C (1977) La vegetazione di Pantelleria (Studio fitosociologico). Pubblicazioni Istituto di Botanica. Università di Catania. Catania, 111 pp.

Brullo S, Gianguzzi L, La Mantia A, Siracusa G (2008) La classe *Quercetea ilicis* in Sicilia. Bollettino dell'Accademia Gioenia di Scienze naturali 41(369): 1–77.

Brullo S, Giusso del Galdo G (2003) La classe *Saginetea maritimae* in Italia. Fitosociologia 40(2): 29–41.

Brullo S, Giusso del Galdo G, Guarino R, Minissale P, Spampinato G (2007) A survey of the weedy communities of Sicily. Annali di Botanica 7(n.s.): 127–161.

Brullo S, Guarino R, Siracusa G (1999) Taxonomical revision about the deciduous oaks of Sicily. Webbia 54(1): 1–72. https://doi.org/10.1080/00837792.1999.10670670

Brullo S, Marcenò C (1979) *Dianthion rupicolae* nouvelle alliance sudtyrrhenienne des *Asplenietalia glandulosi*. Documents Phytosociologiques 4: 131–146.

Brullo S, Marcenò C (1980) Il *Diplotaxion erucoidis* in Sicilia, con considerazioni sulla sintassonomia e distribuzione. Notiziario Fitosociologico 15(1978): 27–44.

Brullo S, Marcenò C (1983) Osservazioni fitosociologiche sull'Isola di Marettimo (Arcipelago delle Egadi). Bollettino dell'Accademia Gioenia di Scienze Naturali di Catania 15(320): 201–228.

Brullo S, Marcenò C (1985a) Contributo alla conoscenza della classe *Quercetea ilicis* in Sicilia. Notiziario Fitosociologico 19(1): 183–229.

Brullo S, Marcenò C (1985b) Contributo alla conoscenza della vegetazione nitrofila della Sicilia. Colloques Phytosociologiques 12: 23–148.

Brullo S, Marcenò C, Siracusa G (2004) La classe *Asplenietea trichomanis* in Sicilia. Colloques Phytosociologiques 27: 467–538.

Brullo S, Minissale P, Spampinato G (1995) Considerazioni fitogeografiche sulla flora della Sicilia. Ecologia Mediterranea 21(1/2): 99–117. https://doi.org/10.3406/ecmed.1995.1759

Brullo S, Scelsi F (1996) Contributo alla conoscenza della vegetazione terofitica costiera del territorio ibleo. Bollettino dell'Accademia Gioenia di Scienze Naturali di Catania 29(352): 151–168.

Brullo S, Scelsi F, Spampinato G (2001) La vegetazione dell'Aspromonte. Laruffa, 370 pp.

Catalano R (1986) Northeastern Sicily straits. Stratigraphy and structures from seismic reflection profiles. – Rendiconti della Società Geologica Italiana 9: 103–112.

Catalano R, D'Argenio B, Montanari L, Borlotti E, Torelli L (1985) Marine geology of the N-W Sicily offshore (Sardinia Channel) and its relationships with mainland structures. Bollettino della Società Geologica Italiana 104: 207–215.

Catanzaro F (1984) Contributo alla flora dell'isola di Marettimo (Egadi). Il Naturalista siciliano 8: 27–34.

Dana Sánchez E, Rodríguez-Tamayo L, Mola Poveda JE (1999) Los pastizales anuales semiónidos del secror Almeriense: *Spergulo fallacis-Plantaginetum ovatae*, una nueva comunidad endémica. Lazaroa 20: 49–53.

De Marco G, Dinelli A, Caneva G (1985) Analisi sintassonomica e fitogeografica comparata delle boscaglie a *Juniperus phoenicea* L. in Sardegna. Notiziario Fitosociologico 22: 39–48.

Di Martino A, Trapani S (1968) Flora e vegetazione delle isole di Favignana e Levanzo nell'Arcipelago delle Egadi. II. Levanzo. Lavori dell'Istituto Botanico e del Giardino Coloniale di Palermo, 23: 37–152.

Di Pietro R (2001) Aspetti cenologici e distributivi di *Daphne sericea* Vahl nel Lazio. Fitosociologia 38 (2): 45–61.

Di Pietro R, Conte AL, Di Marzio P, Gianguzzi L, Spampinato G, Caldarella O, Fortini P (2020a) A multivariate morphometric analysis of diagnostic traits in southern Italy and Sicily pubescent oaks. Folia Geobotanica 55(3): 163–183. https://doi.org/10.1007/s12224-020-09378-0

Di Pietro R, Conte AL, Di Marzio P, Fortini P, Farris E, Gianguzzi L, Muller M, Rosati L, Spampinato G, Gailing O (2021) Does the genetic diversity among pubescent white oaks in southern Italy, Sicily and Sardinia islands support the current taxonomic classifcation? European Journal of Forest Research 140: 355–371. https://doi.org/10.1007/s10342-020-01334-z

Di Pietro R, Di Marzio P, Antonecchia G, Conte AL, Fortini P (2020b) Preliminary characterization of the *Quercus pubescens* complex in southern Italy using molecular markers. Acta Botanica Croatica 79(1): 15–25. https://doi.org/10.37427/botcro-2020-002

Di Pietro R, Di Marzio P, Medagli P, Misano G, Silletti GN, Wagensommer RP, Fortini P (2016) Evidence from multivariate morphometric study of the *Quercus pubescens* complex in southeast Italy. Botanica Serbica 40: 83–10.

Di Pietro R, Fortini P, Misano G, Terzi M (2021) Phytosociology of *Atractylis cancellata* and *Micromeria microphylla* communities in southern Italy with insights on the xerothermic steno-Mediterranean grasslands high-rank syntaxa. Plant Sociology 58(1): 133–155. https://doi.org/10.3897/pls2021581/07

Domina G, Greuter W, Raimondo FM (2017) A taxonomic reassessment of the *Centaurea busambarensis* complex (Compositae, Cardueae), with description of a new species from the Egadi Islands (W Sicily). Israel Journal of Plant Sciences 64(1–2): 48–56.

Drago A, Cartabellotta D, Lo Bianco B, Lombardo M (2000) Atlante climatologico della Sicilia. Regione Siciliana, Assessorato Agricoltura e Foreste, Servizi allo Sviluppo, Unità Operativa di Agrometeorologia, Palermo.

Duro A, Piccione V, Scalia C, Zampino S (1996) Precipitazioni e temperature medie mensili in Sicilia relative al sessantennio 1926–1985. Atti 5° Workshop Progr. Strat. C.N.R. 'Clima Ambiente e Territorio nel Mezzogiorno d'Italia 1: 17–109.

Francini E, Messeri A (1956) L'Isola di Marettimo nelle Egadi e la sua vegetazione. Webbia 11: 607–846. https://doi.org/10.1080/00837792.1956.10669652

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 A, Selvaggi A, Selvi F, Soldano A, Stinca A, Wagensommer R.P, Wilhalm T, Bartolucci F (2018) An updated checklist of the vascular flora alien to Italy. Plant Biosystems 152(3): 556–592. https://doi.org/10.1080/11263504.2018.1441197

Gasparo Morticelli M, Sulli A, Agate M (2016) Sea-land geology of Marettimo (Egadi Islands, central Mediterranean sea). Journal of Maps 12(5): 1093–1103. https://doi.org/10.1080/17445647.2015.1127858

Gianguzzi L (1999a) Vegetazione e bioclimatologia dell'Isola di Pantelleria (Canale di Sicilia) con annessa Carta della vegetazione dell'Isola di Pantelleria (Canale di Sicilia). Braun-Blanquetia 20: 1–74.

Gianguzzi L (1999b) Il paesaggio vegetale dell'Isola di Pantelleria. Collana Sicilia Foreste 8, Azienda Foreste Demaniali della Regione Siciliana, Palermo, 1–192.

Gianguzzi L, Bazan G (2020a) A phytosociological analysis of the *Olea europaea* L. var. *sylvestris* (Mill.) Lehr. forests in Sicily. Plant Biosystems 154(5): 705–725. https://doi.org/10.1080/11263504.2019.1681532

Gianguzzi L, Bazan G (2020b) The *Olea europaea* L. var. *sylvestris* (Mill.) Lehr. forests in the Mediterranean area. Plant Sociology 56 (2): 3–34. https://doi.org/10.7338/pls2019562/01

Gianguzzi L, Bazan G (2020c) The vegetation of a historic road system in the suburban area of Monte Pellegrino (Palermo, Sicily). Plant Sociology 57(2): 71–103. https://doi.org/10.3897/pls2020572/02

Gianguzzi L, Cusimano D, Bonventre V, Romano S, Ilardi V (2012) Bio-ecological, phytosociological and conservation aspects of relictual and disjointed populations of *Simethis mattiazzi* (Vandelli) Sacc. (Xanthorrhoeaceae) in the Channel of Sicily. Acta Botanica Gallica 159(3): 303–318. https://doi.org/10.1080/12538078.2012.737141

Gianguzzi L, Cusimano D, Cuttonaro P, Romano S (2016a) Contribution to the phytosociological characterisation of the forest vegetation of the Sicani Mountains (inland of the north-western Sicily). Plant Sociology 53(1): 5–42. http://doi.org/10.7338/pls2016531/02

Gianguzzi L, Cusimano D, Ilardi V, Romano S (2015) Phytosociological analysis of the *Genista* sp. pl. garrigues of the *Cisto-Lavanduletea* and *Rosmarinetea officinalis* classes in the South-Tyrrhenian area (Mediterranean Region). Plant Biosystems 149(3): 574–588. https://doi.org/10.1080/11263504.2014.1000425

Gianguzzi L, D'Amico A, Romano S (2010) Phytosociological remarks on residual woodlands of *Laurus nobilis* in Sicily. Lazaroa 31: 67–84. https://doi.org/10.5209/rev_LAZA.2010.v31.4

Gianguzzi L, La Mantia A (2008) Contributo alla conoscenza della vegetazione e del paesaggio vegetale della Riserva Naturale "Monte Cofano" (Sicilia occidentale) (con allegata Carta sinfitosociologica della vegetazione, scala 1:20.000). Fitosociologia 45(1) (suppl. 1): 1–55.

Gianguzzi L, La Mantia A, Ottonello D, Romano S (2005) La flora vascolare della Riserva naturale di Monte Cofano (Sicilia occidentale). Il Naturalista Siciliano 29(3–4): 107–152.

Gianguzzi L, Ottonello D (2000) La Riserva di Monte Cofano (Sicilia nord-occidentale). Aspetti geomorfologici, naturalistici ed etnoantropologici. Collana Sicilia Foreste 8, Azienda Foreste Demaniali della Regione Siciliana. Palermo, 1–257.

Gianguzzi L, Papini F, Cusimano D (2016b) Phytosociological survey vegetation map of Sicily (Mediterranean region). Journal of Maps 12(5): 845–851. https://doi.org/10.1080/17445647.2015.1094969

Gianguzzi L, Scuderi L, La Mantia A (2003a) Dati preliminari per una caratterizzazione sinfitosociologica e cartografica del paesaggio vegetale dell'Isola di Marettimo (Arcipelago delle Egadi, Canale di Sicilia). – Congr. Soc. Ital. Fitosoc. "Fitosociologia Applicata" (Venezia 12–14 Febbraio 2003). Riassunti: 32.

Gianguzzi L, Scuderi L, La Mantia A (2003b) Fitosociologia applicata alla conservazione delle aree protette in Sicilia: la Carta della vegetazione dell'Isola di Marettimo (Arcipelago delle Egadi). Atti del 98° Congresso Società Botanica Italiana. Riassunti. Catania 24–26 Settembre 2003, 297.

Gianguzzi L, Scuderi L, Pasta S (2006) La flora vascolare dell'Isola di Marettimo (Arcipelago delle Egadi, Canale di Sicilia): aggiornamento ed analisi fitogeografica. Webbia 61(2): 359–402. https://doi.org/10.1080/00837792.2006.10670810

Giardina G, Raimondo FM, Spadaro V (2007) A catalogue of plants growing in Sicily. Bocconea 20: 5–582.

Guarino R, Bazan G, Paura B (2015) Downy oak woods of Italy: phytogeographical remarks on a controversial taxonomic and ecological issue in: Warm-Temperate Deciduous Forests around the Northern Hemisphere. Springer International Publishing. https://doi.org/10.1007/978-3-319-01261-2_7

Guarino R, Pasta S (2017) Botanical Excursions in Central and Western Sicily. Field Guide for the 60th IAVS Symposium (Palermo, 20–24 June 2017). Palermo University Press, Palermo, 1–606. https://www.academia.edu/35613890/Botanical_Escursions_in_Central_and_Western_Sicily

Gussone G (1832–1834) Supplementum ad Florae Siculae Prodromum, quod et specimen florae insularum Siciliae ulteriori adjacentium. Fasciculi 2 Ex Regia Typographia, Neapoli.

Gussone G (1842–1845) Florae Siculae Synopsis exhibens plantas vasculares in Sicilia insulisque adjacentibus hucusque detectas secundum systema Linneanum dispositas. 3 vols. Typ. Tramater, Neapoli. https://doi.org/10.5962/bhl.title.50455

Herrando-Moraira S, Vitales D, Nualart N, Gómez-Bellver C, Ibáñez N, Massó S, Cachón-Ferrero P, González-Gutiérrez PA, Guillot D, Herrera I, Shaw D, Stinca A, Wang Z, López-Pujol J (2020) Global distribution patterns and niche modelling of the invasive *Kalanchoe* × *houghtonii* (Crassulaceae). Scientific Reports 10: 3143. https://doi.org/10.1038/s41598-020-60079-2

Hofrichter R (2001) Das Mittelmeer: Flora, Fauna, Ökologie. Spektrum, Heidelberg.

Iamonico D, Guarino R, Ilardi V, Pignatti S (2016) A revision of *Helichrysum panormitanum* s.l. (Asteraceae) in the Italian and Maltese floras. Phytotaxa 286(3): 207–210.

Jiménez-López FJ, Viruel J, Arista M, Ortiz PL, Talavera M (2022) Molecular approaches reveal speciation between red-and blue-flowered plants in the Mediterranean *Lysimachia arvensis* and *L. monelli* (Primulaceae). Botanical Journal of the Linnean Society 199(2): 557–577. https://doi.org/10.1093/botlinnean/boab081

La Rosa A, Gianguzzi L, Salluzzo G, Scuderi L, Pasta S (2021) Last tesserae of a fading mosaic: floristic census and forest vegetation survey at Parche di Bilello (south-western Sicily, Italy), a site needing urgent protection measures. Plant Sociology 58(1): 55–74. https://doi.org/10.3897/pls2020581/04

Lentini F, Carbone S (2014) Geologia della Sicilia-geology of Sicily. Memorie Descr. Carta Geologica d'Italia 95: 7–414.

Lojacono-Pojero M (1888–1909) Flora Sicula o descrizione delle piante spontanee o indigenate in Sicilia. Palermo, 5 voll.

Lorenz R, Lorenz K (2002) Zur Orchideenflora zirkumsizilianischer Inseln. Jber. naturwiss. Ver. Wuppertal 55: 100–162. https://doi.org/10.2307/3072695

Marino P, Guarino R, Bazan G (2012) The Sicilian taxa of *Genista* sect. *Voglera* and their phytosociological framework. Flora Mediterranea 22: 169–190. https://doi.org/10.7320/FlMedit22.169

Médail F, Quezel P (1999) Biodiversity hotspots in the Mediterranean Basin: setting global conservation priorities. Conservation biology 13(6): 1510–1513. https://doi.org/10.1046/j.1523-1739.1999.98467.x

Minissale P (1995) Studio fitosociologico delle praterie ad *Ampelodesmos mauritanicus* della Sicilia. Colloques phytosociologiques 21: 615–652.

Ministero dei LL. PP (1978–1996) Annali idrologici. Palermo.

Mucina L, Bültman H, Dierssen K, Theurillat J-P, Dengler J, Čarni A, Šumberová K, Raus T, Di Pietro R, Iakushenko D, et al. (2016) Vegetation of Europe: Hierarchical floristic classification system of plant, lichen, and algal communities. Applied Vegetation Science. 19(Suppl. 1): 3–264. https://doi.org/10.1111/avsc.12257

Musarella CM, Cano Ortiz A, Piñar Fuentes JC, Navas Ureña J, Pinto Gomes CJ, Quinto Canas R, Spampinato G, Cano E (2018) Similarity analysis between species in the *Quercus* genus in southern Italy based on the fractal dimension. PhytoKeys 113: 79–95. https://doi.org/10.3897/phytokeys.113.30330

Ottonello D, Catanzaro F (1986) Contributo alla flora del Trapanese. Il Naturalista siciliano 9(1–4): 89–99.

Pasta S, De Rigo D, Caudullo G (2016) *Quercus pubescens* in Europe: distribution. habitat. usage and threats. In: San-Miguel-Ayanz. J, De Rigo D, Caudullo G, Houston Durrant T, Mauri A (Eds) European Atlas of Forest Tree Species. Publications Office of the European Union. Luxembourg, e01493b+.

Pesaresi S, Biondi E, Vagge I, Galdenzi D, Casavecchia S (2017) The *Pinus halepensis* Mill. forests in the central-eastern European Mediterranean basin. Plant Biosystems 151(3): 512–529. https://doi.org/10.1080/11263504.2017.1302514

Pignatti S, Guarino R, La Rosa M (2017–2019) Flora d'Italia, 2nd edn. Media Business – Edagricole, Milano – Bologna, 4 vols.

Ponzo A (1900) La flora trapanese. Tipografia Puccio, Palermo, 140 pp.

Portal to the Flora of Italy (2023) Portale della Flora d'Italia / Portal to the Flora of Italy. http:/dryades.units.it/floritaly [Accessed 10.03.2023]

Raffaelli M, Ricceri C (1988) Su alcune specie mediterranee del genere *Euphorbia* L.: *E. bivonae* Steud., *E. papillaris* (Boiss.) Raffaelli et Ricceri, stat. nov, *E. melitensis* Parl. Webbia 42(1): 1–13. https://doi.org/10.1080/00837792.1988.10670423

Raimondo FM, Fici S, Gianguzzi L, Lentini F, Mazzola P, Miceli G, Not R, Ottonello D, Romano S, Schicchi R (1986) Atlante iconografico delle piante endemiche o rare della Riserva naturale orientata dello Zingaro (Sicilia). Dipartimento di Scienze Botaniche, Azienda Freste Demaniali della Regione Siciliana, STASS, Palermo, 1–84.

Raimondo FM, Gianguzzi L, Ilardi V (1992) Inventari delle specie "a rischio" nella flora vascolare nativa della Sicilia. Quaderni di Botanica Ambientale Applicata 3: 65–132.

Raimondo FM, Gianguzzi L, Venturella G, Lo Valvo M (1990) Indagine preliminare sul patrimonio biologico-ambientale delle coste siciliane. Quaderni di Botanica Ambientale Applicata 1: 131–182.

Raimondo FM, Bancheva ST (2004) *Centaurea erycina* (Asteraceae), a new species from NW-Sicily. Bocconea 17: 299–306.

Rikli M (1946) Das Pflanzenkleid der Mittelmeerländer, Bd. 2. Huber, Bern.

Rivas-Martínez S (1994) Bases para una nueva classificacion bioclimatica de la Tierra. Folia Botanica Madritensis 10: 1–23.

Rivas-Martìnez S, Diaz TE, Fernàndez-Gonzàlez F, Izco J, Lousa M, Penas A (2002) Vascular plant communities of Spain and Portugal. Addenda to the syntaxonomical checklist of 2001. Itinera Geobotanica 15(2): 433–922.

Rivas-Martìnez S, Fernàndez-Gonzàlez F, Loidi J, Lousa M, Penas A (2001) Syntaxonomical checklist of vascular plant communities of Spain and Portugal to association level. Itinera Geobotanica 14(2): 5–341.

Rivas-Martìnez, S, Penas, A, Dıaz, TE (2004) Biogeographic map of Europe. León, Spain: Cartographic Service, University of León.

Rivieccio G, Aleffi M, Angiolini C, Bagella S, Bazan G, Bonini F, Caria MC, Casavecchia S, Castello M, Dagnino G, De Francesco M.C, Farris E, Fanfarillo E, Fiaschi T, Forte L, Gianguzzi L, Landucci F, Maneli F, Mantino F, Mariotti M, Pirone G, Poldini L, Poponessi S, Praleskouskaya S, Stanisci A, Tomaselli V, Tozzi FP, Turcato C, Venanzoni R, Gigante D (2021) New national and regional Annex I Habitat records: from #26 to #36. Plant Sociology 58(2): 77–98. https://doi.org/10.3897/pls2021582/07

Romano S, Tobia G, Gianguzzi L (2006) Rassegna della flora vascolare dell'Isola di Levanzo (Arcipelago delle Egadi, Canale di Sicilia). Informatore Botanico Italiano 38(2): 481–502.

Romano V, Catalano G, Bazan G, Calì F, Sineo L (2021) Archaeogenetics and Landscape Dynamics in Sicily during the Holocene: A Review. Sustainability 13(17): 9469. https://doi.org/10.3390/su13179469

Rosati L, Romano V, Bartolucci F, Bernardo L, Bouvet D, Cancellieri L, Caruso G, Conti F, Faraoni F, Banfi E, Galasso G, Lattanzi E, Lavezzo P, Peccenini S, Perrino EV, Salerno G, Sciandra A, Soldano A, Stinca A, Totta C, Fascetti S (2017) Contribution to the floristic knowledge of the Maddalena Mountains (Basilicata and Campania, southern Italy). Italian Botanist 3: 73–82. https://doi.org/10.3897/ib.3.12519

Sciandrello S, D'Agostino S, Minissale P (2013) Vegetation analysis of the Taormina Region in Sicily: a plant landscape characterized by geomorphology variability and both ancient and recent anthropogenic influences. Lazaroa 34: 151–190. https://doi.org/10.5209/rev_LAZA.2013.v34.n1.41434

Scuderi L (2002) Caratterizzazione tipologica e cartografica del paesaggio vegetale dell'Isola di Marettimo (Isole Egadi). Corso di Laurea in Scienze Forestali ed Ambientali. Facoltà di Agraria. Università degli Studi di Palermo (A.A. 2001–2002).

Scuderi L (2006) Flora e vegetazione della provincia di Trapani (Sicilia). Tesi di Dottorato in Scienze Ambientali I – Fitogeografia dei Territori Mediterranei (XIX Ciclo), Università degli Studi di Catania, Catania, 1–541.

Scuderi L (2008) Nuovo contributo alla flora vascolare di Marettimo (Isole Egadi, Sicilia occidentale). Il Naturalista Siciliano 2(3–4): 484–485.

Stinca A, Chianese G, D'Auria G, Fascetti S, Ravo M, Romano VA, Salerno G, Astuti G, Bartolucci F, Bernardo L, Bonari G, Bouvet D, Cancellieri L, Carli E, Caruso G, Catalano I, Cennamo GD, Ciaschetti G, Conti F, Di Pietro R, Fortini P, Gangale C, Lapenna MR, Lattanzi E, Marcucci R, Peccenini S, Pennesi R, Perrino EV, Peruzzi L, Roma-Marzio F, Scoppola A, Tilia A, Villani M, Rosati L (2019) Contribution to the floristic knowledge of eastern Irpinia and Vulture-Melfese area (Campania and Basilicata, southern Italy). Italian Botanist 8: 1–16. https://doi.org/10.3897/italianbotanist.8.37818

Stinca A, Musarella CM, Rosati L, Laface VLA, Licht W, Fanfarillo E, Wagensommer RP, Galasso G, Fascetti S, Esposito A, Fiaschi T, Nicolella G, Chianese G, Ciaschetti G, Salerno G, Fortini P, Di Pietro R, Perrino EV, Angiolini C, De Simone L, Mei G (2021) Italian Vascular Flora: New Findings, Updates and Exploration of Floristic Similarities between Regions. Diversity 13(11): 600. https://doi.org/10.3390/d13110600

Theurillat JP, Willner W, Fernández-González F, Bültmann H, Čarni A, Gigante D, Mucina L, Weber H (2021) International Code of Phytosociological Nomenclature. 4th edn. Applied Vegetation Science 24: e12491. https://doi.org/10.1111/avsc.12491

Thiers B (2023) Index Herbariorum: A Global Directory of Public Herbaria. New York Botanical Garden's Virtual Herbarium. https://sweetgum.nybg.org/science/ih [Accessed on 5 March 2023]

Tusa S (2000) Evidenze archeologiche. In: Gianguzzi L and Ottonello D (Eds) La Riserva di Monte Cofano (Sicilia nord-occidentale). Aspetti geomorfologici, naturalistici ed etnoantropologici. Collana Sicilia Foreste 8, Azienda Foreste Demaniali della Regione Siciliana, Palermo, 223–237.

Wellstein C, Spada F (2015) The status of *Quercus pubescens* Willd. In Europe. In: Box EO, Fujiwara K (Eds) Warm-temperate deciduous forests around the Northern Hemisphere. Springer, Cham, 153–163. https://doi.org/10.1007/978-3-319-01261-2_8

WFO (2003) World Flora Online. http://www.worldfloraonline.org/ [Accessed 10.03.2023]

Supplementary material 1

List of collected specimens (*) from Mt. San Giuliano and/or taxa quoted in the text
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Supplementary material 2

List of collected specimens (*) from Marettimo Island and/or taxa quoted in the text
Authors: Lorenzo Gianguzzi, Riccardo Guarino, Giuseppe Bazan, Romeo Di Pietro, Alicia Teresa Rosario Acosta, Enrico Bajona, Peter Bolliger, Costantino Bonomi, Adriano Camuffo, Carlo Console, Simonetta Fascetti, Paola Fortini, Annarita Frattaroli, Giacomo Mei, Fabio Mondello, Silvia Olivari, Masin Rizzieri, Leonardo Rosati, Simona Sarmati, Leonardo Scuderi, Marco Simonazzi, Giovanni Spampinato, Lucia Viegi, Adriano Stinca
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Supplementary material 3

List of collected specimens (*) from Levanzo Insland and/or taxa quoted in the text
Authors: Lorenzo Gianguzzi, Riccardo Guarino, Giuseppe Bazan, Romeo Di Pietro, Alicia Teresa Rosario Acosta, Enrico Bajona, Peter Bolliger, Costantino Bonomi, Adriano Camuffo, Carlo Console, Simonetta Fascetti, Paola Fortini, Annarita Frattaroli, Giacomo Mei, Fabio Mondello, Silvia Olivari, Masin Rizzieri, Leonardo Rosati, Simona Sarmati, Leonardo Scuderi, Marco Simonazzi, Giovanni Spampinato, Lucia Viegi, Adriano Stinca
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Supplementary material 4

List of collected specimens (*) from Mt. Cofano and/or taxa quoted in the text
Authors: Lorenzo Gianguzzi, Riccardo Guarino, Giuseppe Bazan, Romeo Di Pietro, Alicia Teresa Rosario Acosta, Enrico Bajona, Peter Bolliger, Costantino Bonomi, Adriano Camuffo, Carlo Console, Simonetta Fascetti, Paola Fortini, Annarita Frattaroli, Giacomo Mei, Fabio Mondello, Silvia Olivari, Masin Rizzieri, Leonardo Rosati, Simona Sarmati, Leonardo Scuderi, Marco Simonazzi, Giovanni Spampinato, Lucia Viegi, Adriano Stinca
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Supplementary material 5

Taxa with authors' names listed in Table 4

Authors: Lorenzo Gianguzzi, Riccardo Guarino, Giuseppe Bazan, Romeo Di Pietro, Alicia Teresa Rosario Acosta, Enrico Bajona, Peter Bolliger, Costantino Bonomi, Adriano Camuffo, Carlo Console, Simonetta Fascetti, Paola Fortini, Annarita Frattaroli, Giacomo Mei, Fabio Mondello, Silvia Olivari, Masin Rizzieri, Leonardo Rosati, Simona Sarmati, Leonardo Scuderi, Marco Simonazzi, Giovanni Spampinato, Lucia Viegi, Adriano Stinca

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RESEARCH ARTICLE

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Contribution to the floristic knowledge of Lipari and Panarea Islands (Sicilia, Italy)

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Abstract

The inventory of the taxa collected in 2022 during the annual field trip of the Working Group for Floristics, Systematics and Evolution of the Italian Botanical Society is reported. The field trip was held from 19th to 22th April in the islands of Lipari and Panarea (Aeolian Islands, Sicilia). Overall, 1,664 herbarium specimens were deposited in public and private herbaria. The flora documented for the studied area amounts to 386 specific and subspecific taxa, belonging to 241 genera and 74 families. *Centaurea aeolica*, *Helichrysum litoreum* (Asteraceae), and *Dianthus rupicola* subsp. *aeolicus* (Caryophyllaceae) were the

only three Italian endemics found in the study area, whereas 48 alien taxa were recorded. *Dimorphotheca ecklonis* (Asteraceae), *Nassella tenuissima* (Poaceae), *Solanum torvum* (Solanaceae), and *Viola wittrockiana* (Violaceae) are casual alien species new to Sicilia, whereas *Oenothera odorata* (Onagraceae) is a new naturalized alien species for the Italian vascular flora.

Keywords
Aeolian islands, alien species, biodiversity, endemics, floristic novelties, vascular flora

Introduction

The Working Group for Floristics, Systematics and Evolution of the Italian Botanical Society (SBI) has been active in increasing the floristic knowledge of Italy by organizing, since 20 years, floristic excursions dedicated to poorly explored areas and publishing the results (e.g., Conti et al. 2006; Bartolucci et al. 2019; Stinca et al. 2019; Roma-Marzio et al. 2020 and literature cited therein). The selection of the territories to be investigated is usually based on the low number of published floristic studies, as summarized in the map of floristic knowledge of Italy (Scoppola and Blasi 2005). Herein, we present the results of the field trip held in 2022 in Lipari and Panarea, two Aeolian islands investigated by botanists since the first half of the 19th century, but for which complete and updated floristic data are lacking.

Indeed, Giovanni Gussone reported in his Florae Siculae Prodromus (Gussone 1827–1834) and Florae Siculae Synopsis (Gussone 1842–1845) several plant records from all the seven main Aeolian islands. Michele Lojacono-Pojero in 1877 and in 1902 explored the islands of Salina, Lipari, Vulcano, Panarea (and its surrounding islets) and Stromboli (Lojacono-Pojero 1878, 1904). Giuseppe Zodda visited the same islands in 1902 (Zodda 1904). Although outdated, comprehensive lists of the flora and vegetation for the islands of Alicudi, Vulcano and Stromboli (Ferro and Furnari 1968a, b, 1970; Di Benedetto 1973) are available; a map of the vegetation of Filicudi with an annexed floristic list was published by Longhitano (1983). A summary of punctual contributions on individual areas, taxonomic groups or floristic notes is also available in Lo Cascio (2017a).

Gioachino Ferro, from the University of Catania (Sicily), dedicated a large part of his life to the study of the flora and vegetation of this archipelago but his passing away stopped the publication of the summary of his research. Several analyses based on data regarding the flora of this archipelago have been published (Pasta and La Mantia 2013; Celesti-Grapow et al. 2016; Zannini et al. 2018; Pasta et al. 2019; Chiarucci et al. 2021) but any without providing accessible floristic lists. Actually, the floras of Lipari, Salina and Panarea are still unpublished. The Wikiplantbase #Sicilia database (Domina et al. 2016 [onwards]) hosts only 262 and 107 floristic records for Lipari and Panarea, respectively. In 2022, with the aim of improving the knowledge on the flora of the islands of Lipari and Panarea, an excursion of the Working Group for Floristics, Systematics and Evolution of the SBI was organized on these islands.

Materials and methods

There were 18 active participants: Enrico Bajona, Giulio Barone, Fabrizio Bartolucci, Laura Cancellieri, Giuseppe Caruso, Fabio Conti, Alessandro Crisafulli, Giannantonio Domina, Simonetta Fascetti, Jacopo Franzoni, Antonio Giacò, Valentina L.A. Laface, Lorenzo Pinzani, Leonardo Rosati, Anna Scoppola, Adriano Stinca, Agnese Tilia, and Daniele Viciani and six guests (Suppl. material 1).

Study area

Lipari and Panarea are currently two quiescent volcanic islands although there is a weak hydrothermal activity in the western part of Lipari and active submarine fumaroles about 2.5 km east of the coast of Panarea. Both islands fall within the thermo-Mediterranean belt with a dry-humid climate (Bazan et al. 2015). There are prehistoric remains that place the first phase of human colonization of the Aeolian Archipelago starting from the 5th millennium BP (Lo Cascio 2017b). The first profound modifications of the territory occurred during the Greek and Roman colonization. Until the early 20th century, most of the islands' surface was cultivated. In the mid-nineteenth century, the Aeolian Islands had about 21,000 inhabitants, almost double the current residents, and agriculture was the main activity (Cavallaro 1987). Today the cultivated area is around 15% in Lipari and 5% in Panarea, also including the ornamental greenery and the small, cultivated areas in and around the settlements (data obtained from aerial images). A gradual recolonization of natural vegetation has begun in the abandoned lands. The potential vegetation, where the soil is deeper, is represented by *Quercus ilex* L. woods with the presence of *Erica arborea* L. The remains of this vegetation are very limited. Small strips of deciduous oak woods are also present. Anthropic action has determined regression processes of the vegetation favouring the development of maquis with *Erica arborea* and *Arbutus unedo* L. and garrigues with *Cistus* sp. pl. and *Genista tyrrhena* Vals. subsp. *tyrrhena*. The maquis with *Euphorbia dendroides* L. occurs on the lithosols. On sunny slopes, prairies with *Hyparrhenia sinaica* (Delile) Llauradó ex G.López or *H. hirta* (L.) Stapf subsp. *hirta* and, scattered, *Genista tyrrhena* dominates. On the cooler slopes, prairies with *Brachypodium retusum* (Pers.) P.Beauv. are dominant. The coasts are mainly rocky, while beaches are localized and of modest extension. During the excursions, we crossed synanthropic vegetation near inhabited centres, cultivated fields in agricultural areas for collecting weeds and semi-natural vegetation of prairie, garrigue and scrub in non-cultivated lands.

Lipari is the largest of the Aeolian Islands (37.2 km^2) and, like the others, it is made up of various volcanic formations composed of a large variety of volcanic rock types (Forni et al. 2013). It reaches 594 m a.s.l. on Mount Sant'Angelo. The most common soils are ever-changing regosols and lithosols. More than 660 taxa are documented for the island, 14% of which are alien to the Italian territory (Chiarucci et al. 2021). Panarea extends for 3.3 km^2 and reaches a height of 420 m a.s.l. It is composed of andesitic to dacitic as well as of rhyolitic rocks (Stanulla et al. 2017). Almost 440 taxa are known for the island, 12% of which are alien to Italy (Chiarucci et al. 2021).

Data collection

With the aim of optimizing the sampling, five excursions were planned in order to: (a) maximise the environmental heterogeneity among sampling sites, (b) explore areas of scarce floristic knowledge, and (c) include the area of high naturalistic value (Lo Cascio and Pasta 2004) (Table 1). Three excursions were performed in the southern, western and northern parts of Lipari and one in the southern part of Panarea; the village of Lipari and its surroundings were investigated during the last day (Fig. 1, Table 1).

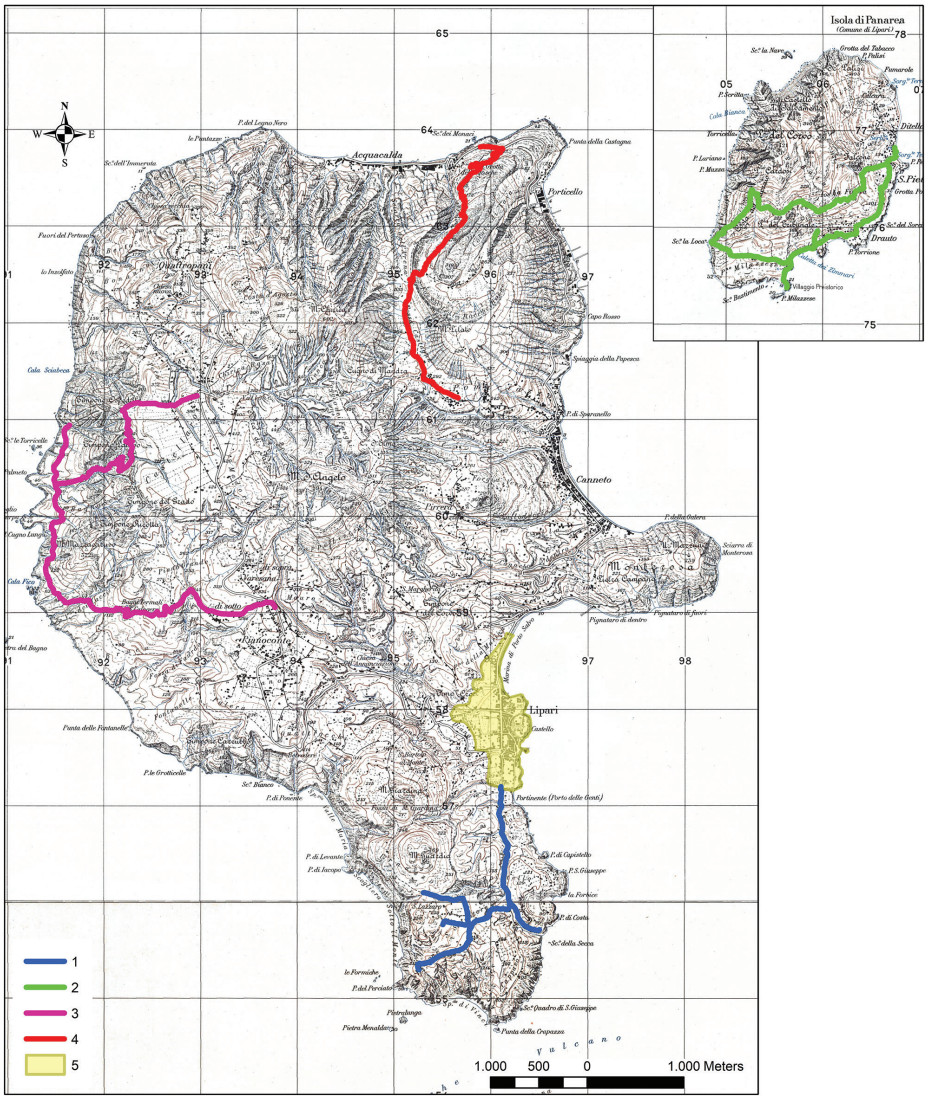

Figure 1. Study areas and localization of the excursion itineraries. For details on the sample sites, see Table 1.

Table 1. List of sampling sites, with reference number, locality name, geographic coordinates, altitude range, main habitats, and date of collection.

ID	Locality name	Start point (WGS84)	End point (WGS84)	Length (km)	Altitudinal range (m a.s.l.)	Main habitats	Date
1	Lipari, southern part of the island	38.460829°N, 14.954650°E	38.443654°N, 14.945286°E	3.9	5–220	dry stone walls, maquis, roadside, uncultivated land, trail	19 April 2022
2	Panarea, southern part of the island	38.637883°N, 15.077146°E	38.634164°N, 15.059745°E	5.6	0–260	inhabited area, dry stone walls, uncultivated land, uncultivated sandy land, cliff, cliff facing the sea, beach, trail	20 April 2022
3	Lipari, western part of the island	38.497938°N, 14.918653°E	38.477423°N, 14.928274°E	6.8	50–380	dry stone walls, trail, escarpment, uncultivated land, olive grove, roadside	21 April 2022
4	Lipari, northern part of the island	38.521090°N, 14.952329°E	38.497234°N, 14.950102°E	3.8	50–350	dry stone walls, wet ground, maquis, uncultivated, cultivated, slope, roadside	22 April 2022
5	Lipari, village	38.474946°N, 14.955492°	38.460829°N, 14.954650°E	≈ 4.0	0–30	flower beds, sidewalk, dry stone walls, concrete walls, roadside, uncultivated land	22 April 2022

Plant identification

Herbarium specimens prepared are deposited in public and private herbaria (Suppl. material 2). Each participant drafted a list of the species collected during the excursions and later identified. As done during previous excursions, the coordinator of the Working Group merged the floristic lists and organized a workshop to revise critical collections and unidentified specimens at the Herbarium Mediterraneum Panormitanum of the University of Palermo on February 22th–24th 2023.

The nomenclature of taxa mainly follows the updated checklists of the vascular flora native (Bartolucci et al. 2018) and alien (Galasso et al. 2018) to Italy and subsequent updates summarised in the Portal to the Flora of Italy (2023, see also Martellos et al. 2020). The exceptions are commented in the floristic list (Suppl. material 3). In the floristic list, families are divided into "Ferns and Fern allies", "Gymnosperms", "Angiosperms, Dicots", "Angiosperms, Monocots" and ordered alphabetically; genera, species and subspecies are ordered alphabetically. For each taxon, the following information is reported: endemic, cryptogenic or alien status, sampling locality, herbarium in which the collection is preserved (Suppl. material 2). Abbreviations or symbols used in the floristic list are: **E** = Italian endemic (according to Peruzzi et al. 2014; Bartolucci et al. 2018; Portal to the Flora of Italy 2023); **A** = Alien taxon and its status in the observed localities: **CAS** (casual), **NAT** (naturalized), **INV** (invasive); **C** = Cryptogenic taxon (doubtfully native taxon, whose origin of occurrence in Italy is unknown); **N =** New record for the flora of Sicilia.

A list of species new to Lipari and Panarea is not provided due to the lack of updated and specific floristic lists for these two islands.

Results

After the field trips a total of 1,664 herbarium specimens were prepared and identified, belonging to 386 species and subspecies, 241 genera, and 74 families (Suppl. material 3, 4).

Centaurea aeolica Guss. ex Lojac., *Helichrysum litoreum* Guss. and *Dianthus rupicola* Biv. subsp. *aeolicus* (Lojac.) Brullo & Miniss. were the only three Italian endemics found in the study area.

A total of 48 alien taxa were recorded (12.4%), 20 of which are casual, 26 naturalized and two invasive (i.e. *Ailanthus altissima* (Mill.) Swingle and *Oxalis pes-caprae* L.). Noteworthy is the discovery of *Oenothera odorata* Jacq. (Onagraceae) (Fig. 2A), a naturalized species new to Italy, as well as, *Dimorphotheca ecklonis* DC. (Asteraceae) (Fig. 2B), *Nassella tenuissima* (Trin.) Barkworth (Poaceae) (Fig. 2C), *Solanum torvum* Sw. (Solanaceae) (Fig. 2D), and *Viola wittrockiana* Gams ex Nauenb. & Buttler (Violaceae) new to Sicilia.

Figure 2. A *Oenothera odorata* from site 1 **B** *Dimorphotheca ecklonis* from site 1 **C** *Nassella tenuissima* from site 3 **D** *Solanum torvum* from site 4. For details on the sample sites, see Table 1. Photographs by G. Domina.

Discussion

Among the 386 species and subspecies identified in this work, only *Centaurea aeolica* is exclusive of the Aeolian archipelago. Concerning the other two endemics, *Dianthus rupicola* subsp. *aeolicus* also occurs on the promontory of Capo Milazzo, *Helichrysum litoreum* occurs in some other Tyrrhenian Italian regions and both are included in the Red List of the Italian endemic flora (Orsenigo et al. 2020) as LC ("Least Concern").

This research also highlighted a high number of alien species (48) among the taxa sampled. Despite a recent study conducted by Stinca and co-workers (2021) in which it was stated that the introduction of alien species does not alter the ability to distinguish the Italian administrative regions on the basis of their total flora, the spread of invasive species poses a particular environmental threat on small islands of the Mediterranean Basin, which are hotspots of biodiversity and contain rare habitats and endemic species (Celesti-Grapow et al. 2016).

Nassella tenuissima has recently been planted for ornamental purposes near a winery and is spreading, probably by wind dissemination, to surrounding areas. It is strongly recommended to remove this species before it becomes naturalized on the island.

Gamochaeta pensylvanica (Willd.) Cabrera is a North American neophyte with increasing distribution in Italy. It was probably introduced as a weed by plant nurseries and was collected for the first time in Italy in 1980, and in Sicilia in 2015 (Ardenghi and Cauzzi 2015).

Oenothera odorata Jacq. (Onagraceae) is a naturalized species new to Italy. The population of Lipari was previously identified as *Oenothera stricta* Ledeb. ex Link subsp. *stricta* (Domina and Mazzola 2008). The current identification is based on a careful study of collected specimens according to Dietrich (1977) and has been confirmed by comparison with original material of *O. stricta* and *O. odorata*. The other Italian records currently referred to *Oenothera stricta* subsp. *stricta*, on our opinion, need to be verified.

Phyllostachys aurea Carrière ex Rivière & C.Rivière is being used as a living plant fence around a villa in Panarea and has started to reproduce vegetatively in the surrounding area.

Serapias nurrica Corrias subsp. *nurrica* is not reported in Pasta et al. (1999) and in the other available sources. It was found in Panarea, in the centre on the island, within old abandoned agricultural terraces and in Lipari on wasteland in the southern and western parts of the island.

Wahlenbergia lobeliodes (L.f.) Link subsp. *nutabunda* (Guss.) Murb. (Primulaceae) was newly found in Panarea on the Costa del Capraro about 120 years after the record by Lojacono-Pojero (1903) and about 40 years after the record by Brullo from Cala dei Zimmari (Brullo and Grillo 1985). This ephemeral taxon, occurring also in Sardegna and Calabria, has a very short vegetative cycle which makes it rarely reported.

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References

Ardenghi NMG, Cauzzi P (2015) *Gnaphalium pensylvanicum*. In: Raab-Straube E von, Raus T (Ed.) Euro+Med-Checklist Notulae, 5 [Notulae ad floram euro-mediterraneam pertinentes 34]. Willdenowia 45(3): 449–464. https://doi.org/10.3372/wi.45.45312

Bartolucci F, Cancellieri L, Conti F, Banfi E, Bouvet D, Celestini M, Ciaschetti G, Di Pietro R, Falcinelli F, Fascetti S, Galasso G, Lattanzi E, Masin RR, Pennesi R, Rosati L, Stinca A, Tilia A, Forte TGW, Scoppola A (2019) Contribution to the floristic knowledge of Velino and Aterno valleys (Lazio-Abruzzo, central Italy). Italian Botanist 7: 93–100. https://doi.org/10.3897/italianbotanist.7.34697

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

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

Brullo S, Grillo M (1985) Le associazioni psammofile effimere dei *Malcomietalia* rinvenute in Sicilia. Bollettino dell'Accademia Gioenia di Scienze Natutali 18(325): 271–282.

Cavallaro C [Ed.] (1987) Sistema territoriale arcipelago Eolie. Analisi e riassetto di alcuni elementi: turismo istruzione sanità territorio. SAGEP, Genova.

Celesti-Grapow L, Bassi L, Brundu G, Camarda I, Carli E, D'Auria G, Del Guacchio E, Domina G, Ferretti G, Foggi B, Lazzaro L, Mazzola P, Peccenini S, Pretto F, Stinca A, Blasi C (2016) Plant invasions on small Mediterranean islands: an overview. Plant Biosystems 150(5): 1119–1133. https://doi.org/10.1080/11263504.2016.1218974

Conti F, Angiolini C, Bernardo L, Costalonga S, Di Pietro R, Fascetti S, Giardina G, Giovi E, Gubellini L, Lattanzi E, Lavezzo P, Peccenini S, Salerno G, Scoppola A, Tinti D, Turrisi R (2006) Contributo alla conoscenza floristica della Basilicata: resoconto dell'escursione del gruppo di floristica (S.B.I.) nel 2003. Informatore Botanico Italiano 38(2): 383–409.

Chiarucci A, Guarino R, Pasta S, La Rosa A, Lo Cascio P, Médail F, Pavon D, Fernández-Palacios JM, Zannini P (2021) Species–area relationship and small-island effect of vascular plant diversity in a young volcanic archipelago. Journal of Biogeography 48(11): 2919–2931. https://doi.org/10.1111/jbi.14253

Di Benedetto L (1973) Flora di Alicudi (Isole Eolie). Archivio Botanico e Biogeografico Italiano 49(3–4): 135–162.

Dietrich W (1977) The South American species of *Oenothera* sect. *Oenothera* (*Raimannia*, *Renneria*; Onagraceae). Annals of the Missouri Botanical Garden 64(3): 425–626. https://doi.org/10.2307/2395257

Domina G, Mazzola P (2008) Flora ornamentale delle isole circumsiciliane. Quaderni di Botanica Ambientale e Applicata 19: 107–119.

Domina G, Peruzzi L, Bedini G [Eds] (2016 [onwards]) Wikiplantbase #Sicilia. http://bot.biologia.unipi.it/wpb/sicilia [Accessed 25.09. 2023]

Ehrendorfer F (1976) *Galium*. In: Tutin TG, Heywood VH Bruges NA, Moore DM, Valentine DH, Walters SM, Webb DA (Eds) Flora Europaea, Vol. 4. Cambridge University Press, Cambridge, 14–36.

Ferro G, Furnari F (1968a) Flora e vegetazione di Stromboli (Isole Eolie). Archivio Botanico e Biografico Italiano 44(1–2): 21–45.

Ferro G, Furnari F (1968b) Flora e vegetazione di Stromboli (Isole Eolie) (Continuazione dal fascicolo precedente). Archivio Botanico e Biografico Italiano 44(3): 59–87.

Ferro G, Furnari F (1970) Flora e vegetazione di Vulcano (Isole Eolie). Pubblicazioni dell'Istituto Botanico dell'Università di Catania, Catania.

Forni F, Lucchi F, Peccerillo A, Tranne CA, Rossi PL, Frezzotti ML (2013) Stratigraphy and geological evolution of the Lipari volcanic complex (central Aeolian archipelago). Chapter 10. In: Lucchi F, Peccerillo A, Keller J, Tranne CA, Rossi PL (Eds) The Aeolian Islands volcanoes. Geological Society, London, Memoirs 37: 213–279. https://doi.org/10.1144/M37.10

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

Gussone G (1827–1834) Florae Siculae Prodromus, Vols 1–2, Suppl. Regia Typographia, Napoli.

Gussone G (1842–1845) Florae Siculae Synopsis, Vols 1–2, Add. Tramater, Napoli.

Lo Cascio P (2017a) Biological bibliography of the Aeolian Islands. http://www.nesos.org/docs/references.pdf [Accessed 1.9.2023]

Lo Cascio P (2017b) Le isole Eolie. Ed. Danaus, Palermo.

Lo Cascio P, Pasta S (2004) Il patrimonio biologico delle isole Eolie: dalla conoscenza alla conservazione. Il Naturalista Siciliano, s. 4 28(1): 457–476.

Lojacono-Pojero M (1878) Le Isole Eolie e la loro vegetazione con enumerazione delle piante spontanee vascolari. Tip. G. Lorsnaider, Palermo.

Lojacono-Pojero M (1903) Flora Sicula, Vol. 2(1). S. Bizzarrilli, Palermo.

Lojacono-Pojero M (1904) Otto giorni alle Eolie. Sicula, Rivista bimestrale del Club Alpino Siciliano 9(1–2): 11–18.

Longhitano N (1983) Carta della vegetazione dell'Isola di Filicudi (Isole Eolie). Archivio botanico e biogeografico italiano, 58(1–2): 89–105.

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 plant species in Italy. Plant Biosystems 155(2)[2021]: 310–335. https://doi.org/10.1080/11263504.2020.1739165

Martellos S, Bartolucci F, Conti F, Galasso G, Moro A, Pennesi R, Peruzzi L, Pittao E, Nimis PL (2020) FlorItaly – the portal to the Flora of Italy. PhytoKeys 156: 55–71. https://doi.org/10.3897/phytokeys.156.54023

Pasta S, La Mantia T (2013) Plant species richness, biogeographic and conservation interest of the vascular flora of the satellite islands of Sicily: patterns, driving forces and threats. In: Cardona Pons E, Estaun Clariso I, Comas Casademont M, Fraga, Arguimbau P (Eds) Proceedings and abstracts of the 2nd Botanical Conference in Menorca Islands and plants: preservation and understanding of flora on Mediterranean Islands, Es Mercadal, 26–30 April 2011. Institut Menorquí d'Estudis, Consell Insular de Menorca, Maó, 201–240.

Pasta S, La Rosa A, Pavon D, Lo Cascio P, Médail F (2019) Tentamen Florae Aeolicae: a critical checklist of the vascular plants of the Aeolian Islands (Sicily, Italy). In: Bareka P, Domina G, Kamari G (Eds) XVI OPTIMA Meeting 2–5 October 2019, Agricultural University of Athens, Greece, Abstracts. Oral Presentations, E-posters. Palermo, 71–71.

Pasta S, Lo Cascio P, Pancioli V (1999) Sull'effettiva consistenza numerica e distribuzione delle Orchidaceae nell'arcipleago Eoliano. Il Naturalista Siciliano, s. 4 23(3–4): 467–484.

Peruzzi L, Conti F, Bartolucci F (2014) An inventory of vascular plants endemic to Italy. Phytotaxa 168(1): 1–75. https://doi.org/10.11646/phytotaxa.168.1.1

Pignatti S, Guarino R, La Rosa M (2017–2019) Flora d'Italia. 2nd edn., Vol. 1–4 & Flora Digitale. Edagricole, New Business Media, Milano.

Portal to the Flora of Italy (2023) Portale della Flora d'Italia/Portal to the Flora of Italy. 2023.1. http://dryades.units.it/floritaly/ [Accessed 25.9.2023]

Roma-Marzio F, D'Antraccoli M, Angeloni D, Bartolucci F, Bernardo L, Cancellieri L, Caruso G, Conti F, Dolci D, Gestri G, Gubellini L, Hofmann N, Laface VLA, Lattanzi E, Lavezzo P, Maiorca G, Montepaone G, Musarella CM, Noto D, Perrino EV, Proietti E, Masin RR, Scoppola A, Stinca A, Tiburtini M, Tilia A, Peruzzi L (2020) Contribution to the floristic knowledge of Sillaro, Santerno, and Senio high valleys (Toscana, Italy). Italian Botanist 10: 101–111. https://doi.org/10.3897/italianbotanist.10.60118

Scoppola A, Blasi C [Eds] (2005) Stato delle conoscenze sulla flora vascolare d'Italia. Palombi Editori, Roma.

Stanulla R, Pohl T, Müller C, Engel J, Hoyer M, Merkel B (2017) Structural and mineralogical study of active and inactive hydrothermal fluid discharges in Panarea, Italy. Environmental Earth Sciences 76: 404. https://doi.org/10.1007/s12665-017-6714-6

Stinca A, Chianese G, D'Auria G, Fascetti S., Ravo M, Romano VA, Salerno G, Astuti G, Bartolucci F, Bernardo L, Bonari G, Bouvet D, Cancellieri L, Carli E, Caruso G, Catalano I, Cennamo GD, Ciaschetti G, Conti F, Di Pietro R, Fortini P, Gangale C, Lapenna MR, Lattanzi E, Marcucci R, Peccenini S, Pennesi R, Perrino EV, Peruzzi L, Roma-Marzio F, Scoppola A, Tilia A, Villani M, Rosati L (2019) Contribution to the floristic knowledge of eastern Irpinia and Vulture-Melfese area (Campania and Basilicata, southern Italy). Italian Botanist 8: 1–16. https://doi.org/10.3897/italianbotanist.8.37818

Stinca A, Musarella CM, Rosati L, Laface VLA, Licht W, Fanfarillo E, Wagensommer RP, Galasso G, Fascetti S, Esposito A, Fiaschi T, Nicolella G, Chianese G, Ciaschetti G, Salerno G, Fortini P, Di Pietro R, Perrino EV, Angiolini C, De Simone L, Mei G (2021) Italian vascular flora: new findings, updates and exploration of floristic similarities between regions. Diversity 13(11): 600. https://doi.org/10.3390/d13110600

Zannini P, Pasta S, Guarino R, Chiarucci A (2018) The Aeolian archipelago as a model system for Island Biogeography Theory. In: AaV (Eds) The Mediterranean. 113° Congresso della Società Botanica Italiana, Fisciano (SA), 12–15 September 2018. Abstracts. Società Botanica Italiana, Firenze, C40–C40.

Zodda G (1904) Una gita alle isole Eolie. Atti della Reale Accademia Peloritana 19(1): 73–108.

Supplementary material 1

Participants to the field trip

Authors: Giulio Barone, Enrico Bajona, Fabrizio Bartolucci, Laura Cancellieri, Giuseppe Caruso, Fabio Conti, Gianniantonio Domina, Simonetta Fascetti, Jacopo Franzoni, Valentina L.A. Laface, Lorenzo Pinzani, Leonardo Rosati, Anna Scoppola, Adriano Stinca, Agnese Tilia, Alessandro Crisafulli

Data type: pdf

Explanation note: Participants to the field trip of the Working Group for Floristics, Systematics and Evolution of the Italian Botanical Society (April 19th–22th 2022).

Link: https://doi.org/10.3897/italianbotanist.16.113415.suppl1

Supplementary material 2

Public and private herbaria in which the collected specimens are kept

Authors: Giulio Barone, Enrico Bajona, Fabrizio Bartolucci, Laura Cancellieri, Giuseppe Caruso, Fabio Conti, Gianniantonio Domina, Simonetta Fascetti, Jacopo Franzoni, Valentina L.A. Laface, Lorenzo Pinzani, Leonardo Rosati, Anna Scoppola, Adriano Stinca, Agnese Tilia, Alessandro Crisafulli

Data type: pdf

Link: https://doi.org/10.3897/italianbotanist.16.113415.suppl2

Supplementary material 3

Inventory of the taxa collected or photographed during the field trip

Authors: Giulio Barone, Enrico Bajona, Fabrizio Bartolucci, Laura Cancellieri, Giuseppe Caruso, Fabio Conti, Gianniantonio Domina, Simonetta Fascetti, Jacopo Franzoni, Valentina L.A. Laface, Lorenzo Pinzani, Leonardo Rosati, Anna Scoppola, Adriano Stinca, Agnese Tilia, Alessandro Crisafulli

Data type: pdf

Explanation note: Field trip held in April 2022 in the islands of Lipari and Panarea (Aeolian Archipelago, Sicilia).

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Supplementary material 4

Selected photographs of taxa and landscapes shot

Authors: Giulio Barone, Enrico Bajona, Fabrizio Bartolucci, Laura Cancellieri, Giuseppe Caruso, Fabio Conti, Gianniantonio Domina, Simonetta Fascetti, Jacopo Franzoni, Valentina L.A. Laface, Lorenzo Pinzani, Leonardo Rosati, Anna Scoppola, Adriano Stinca, Agnese Tilia, Alessandro Crisafulli

Data type: pdf

Explanation note: Field trip held in April 2022 in the islands of Lipari and Panarea (Aeolian Archipelago, Sicilia).

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RESEARCH ARTICLE

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Notulae to the Italian alien vascular flora: 16

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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 and status changes from casual to naturalized for Italy or for Italian administrative regions. Nomenclatural and distribution updates, published elsewhere, and corrections are provided as supplementary material.

Keywords

Alien species, floristic data, Italy, nomenclature

How to contribute

The text for the new records, status changes from casual to naturalized or invasive, exclusions, and confirmations should be submitted electronically to Lorenzo Lastrucci (lorenzo.lastrucci@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 and typifications (only for accepted names) should be submitted electronically to Gabriele Galasso (gabriele.galasso@comune.milano.it). Each text should be within 1,000 characters (spaces included).

Floristic records

Acer negundo L. (Sapindaceae)

\+ (NAT) **SIC**: Palermo (Palermo), Piazza D. Dolci (WGS84: 38.114604°N, 13.350172°E), negli interstizi dei marciapiedi, 32 m, 31 May 2023, *E. Di Gristina* (FI, SAF No. 100119). – Naturalized alien species new for the flora of Sicilia.

Several young individuals have been found in the interstices of the sidewalks. Other plants have been recorded in the city center and residential areas of Palermo (Via C. Lascaris, Via P. Ranzano, Via Marco Polo, Via Contessa Adelasia, and Via Ausonia).

E. Di Gristina, G. Barone

***Achillea filipendulina* Lam. (Asteraceae)**

+ (CAS) **TOS**: Cortona (Arezzo), loc. Riccio (WGS84: 43.222485°N, 12.003922°E), fossi al bordo della strada, 276 m, 8 June 2022, leg. *L. Baccheschi*, det. *L. Baccheschi*, *C. Angiolini* (FI). – Casual alien species new for the flora of Toscana.

L. Baccheschi, C. Angiolini

***Alternanthera pungens* Kunth (Amaranthaceae)**

+ (CAS) **SAR**: Cagliari (Cagliari), Pineta di Su Siccu, zona Bonaria (WGS84: 39.206061°N, 9.124077°E), spontaneizzata nei pressi di alcuni esemplari di *Washingtonia robusta*, 0 m, 25 November 2022, *S. Costantini*, *G. Bacchetta* (FI, CAG). – Casual alien species new for the flora of Sardegna.

About ten flowering individuals occur spontaneously in a meadow, occupying an area of approximately 100 m^2. The species was probably accidentally introduced with garden soil.

S. Costantini, G. Bacchetta

***Anredera cordifolia* (Ten.) Steenis (Basellaceae)**

+ (NAT) **ABR**: Chieti (Chieti), loc. Tricalle (WGS84: 42.367821°N, 14.170778°E), margine stradale, 228 m, 10 June 2021, *A. Pica*, *J. Lupoletti* (FI). – Status change from casual to naturalized alien for the flora of Abruzzo.

In Abruzzo, *Anredera cordifolia* is reported as a casual alien for the provinces of Chieti and L'Aquila (Olivieri 2010; Conti et al. 2016). In addition to the above reported locality, covering an area of approximately 20 m^2, in 2022–2023 we observed two further stable nuclei of nearly 10 m^2 within a radius of 1 km. All three localities are along roadsides in ruderal environments and are in rapid expansion, gradually replacing the native flora over the years.

A. Pica, J. Lupoletti

***Campanula poscharskyana* Degen (Campanulaceae)**

+ (NAT) **PIE**: Cellio con Breia (Vercelli), fraz. Breia, presso la Chiesa di San Giovanni (WGS84: 45.764462°N, 8.307049°E), muretto a secco, 807 m, 23 June 2023, *M. Lonati*, *G. Nota* (FI). – Status change from casual to naturalized alien for the flora of Piemonte.

In Piemonte, this species was first recorded in 2020 as a casual alien in the province of Torino (Maglioni and Selvaggi 2020). A new population was found in Breia (Vercelli province), in the Insubrian area, where *Campanula poscharskyana* is widespread and colonizes walls and road margins, even forming dense populations with *Erigeron karvinskianus* DC. We, therefore, propose its status change from casual to naturalized.

M. Lonati, G. Nota

***Celtis occidentalis* L. (Cannabaceae)**

+ (NAT) **LOM**: Milano (Milano), Via del Ricordo, Cimitero dismesso di Crescenzago (WGS84: 45.509488°N, 9.239759°E), boscaglia di neoformazione, 127 m, no exp., 5 May 2023, *G. Galasso* (MSNM barcodes MSNM52449, MSNM52450); *ibidem* (WGS84: 45.509196°N, 9.239834°E), boscaglia di neoformazione, 127 m, no exp., 4 June 2023, *G. Galasso* (FI, MSNM barcode MSNM52551). – Status change from casual to naturalized alien for the flora of Lombardia.

Inside the Crescenzago Cemetery, decommissioned and abandoned in the 1960s, *Celtis occidentalis* forms an uneven-aged newly formed forest of *ca.* 4,200 m^2 with regularly fruiting plants.

G. Galasso

***Cryptomeria japonica* (L.f.) D.Don (Cupressaceae)**

+ (CAS) **CAL**: Condofuri (Reggio Calabria), loc. Scafi (WGS84: 38.031610°N, 15.873680°E), impianto di *Pinus* sp. pl. percorso dal fuoco, 1079 m, 9 November 2022, leg. *L.M. Manti*, det. *V.L.A. Laface*, *L.M. Manti*, *C.M. Musarella*, *G. Spampinato* (FI, REGGIO). – Casual alien species new for the flora of Calabria.

The observed individuals derived from seeds of mature plants in the nearby area, used in a garden border for wind protection.

L.M. Manti, V.L.A. Laface

***Elaeagnus pungens* Thunb. (Elaeagnaceae)**

+ (CAS) **MAR**: Osimo (Ancona), loc. Santo Stefano (WGS84: 43.514864°N, 13.459450°E), vegetazione pioniera in *gully erosion morphology* (profonda morfologia di incisione dovuta a forte erosione superficiale) in area agricola, 143 m, 16 October 2019, leg. *G. Mei*, det. *G. Mei*, *A. Stinca* (FI, *Herb. G. Mei*). – Casual alien species new for the flora of Marche.

G. Mei, A. Stinca

***Gazania rigens* (L.) Gaertn. (Asteraceae)**

+ (CAS) **MAR**: Grottammare (Ascoli Piceno), Lungomare della Repubblica (WGS84: 42.988611°N, 13.871602°E), margine di aiuola presso il litorale, ca. 3 m, 6 August 2022, *N. Olivieri* (FI). – Casual alien species new for the flora of Marche.

N. Olivieri

***Glandularia hybrida* (Groenland & Rümpler) G.L.Nesom & Pruski (Verbenaceae)**

+ (CAS) **CAL**: Cirò (Crotone), loc. Palombello, lungo la mulattiera a ca. 700 m dalla strada SP10 (WGS84: 39.372540°N, 17.049235°E), margine di campi, substrato

argilloso, 115 m, 4 July 2022, leg. *G. De Fine*, det. *N.G. Passalacqua* (FI). – Casual alien species new for the flora of Calabria.

N.G. Passalacqua, G. De Fine

***Hesperocyparis glabra* (Sudw.) Bartel (Cupressaceae)**

+ (NAT) **PIE**: Torino (Torino), Parco della Maddalena, sentiero a ovest del Faro della Vittoria (WGS84: 45.031151°N, 7.720302°E), bosco artificiale di conifere, 697 m, 26 December 2022, *S. Pirani*, *S. Ravetto Enri* (FI). – Naturalized alien species new for the flora of Piemonte.

The Parco della Rimembranza, commonly knowns as Parco della Maddalena, is an artificial plantation dating from the 1920s mainly composed of alien conifers, many of which are successfully reproducing. Some young *Hesperocyparis glabra* trees were observed in a dense group of individuals with varying heights, some of which also carrying mature cones.

S. Pirani, S. Ravetto Enri

***Jasminum nudiflorum* Lindl. (Oleaceae)**

+ (CAS) **TOS**: Fiesole (Firenze), loc. Vincigliata, sotto il castello nei pressi del Parco Avventura (WGS84: 47.792868°N, 11.312394°E), bosco termofilo, 210 m, 12 March 2022, *L. Pinzani* (FI, *Herb. L. Pinzani*). – Casual alien species new for the flora of Toscana.

L. Pinzani

***Kalanchoë ×houghtonii* D.B.Ward (Crassulaceae)**

+ (NAT) **SAR**: Pula (Cagliari), loc. Santa Margherita, Via Flumendosa (WGS84: 38.956650°N, 8.966953°E), margini stradali e cunette presso il litorale, depositi alluvionali poligenici, 5 m, 30 September 2023, *A. Lallai*, *M. Sarigu* (FI, CAG). – Status change from casual to naturalized alien for the flora of Sardegna.

In Sardegna, *Kalanchoë ×houghtonii* was introduced as ornamental a long time ago and reported as a casual alien since 2012 (Podda et al. 2012). Its vegetative reproduction mode through leaf propagules (Smith 2020) has allowed it to form stable populations on the edges of roads or in areas showing marked human disturbance.

A. Lallai, M. Sarigu

***Lantana camara* L. subsp. *camara* (Verbenaceae)**

+ (CAS) **TOS**: Siena (Siena), Via G. Gigli (WGS84: 43.314299°N, 11.342025°E), margine stradale, 278 m, 12 September 2022, *T. Fiaschi*, *E. Fanfarillo* (FI, SIENA). – Casual alien subspecies new for the flora of Toscana.

T. Fiaschi, E. Fanfarillo

***Lonicera fragrantissima* Lindl. & Paxton (Caprifoliaceae)**

+ (CAS) **LOM**: Cassano Magnago (Varese), vasche di laminazione dei torrenti Rile e Tenore (WGS84: 45.64159°N, 8.83220°E), boscaglia ripariale, 240 m, 27 May 2022, *M. Adorni* (FI). – Casual alien species new for the flora of Lombardia.

Only two individuals were found.

M. Adorni

***Lupinus albus* L. subsp. *albus* (Fabaceae)**

+ (NAT) **SIC**: Cefalù (Palermo), C.da San Biagio (WGS84: 38.003835°N, 14.005445°E), uncultivated land, 340 m, 1 May 2023, leg. *G. Domina*, det. *G. Domina*, *E. Di Gristina*, *G. Barone* (FI, SAF No. 100135). – Status change from casual to naturalized alien for the flora of Italy (Sicilia).

Lupinus albus subsp. *albus*, actually considered a casual alien (Giardina et al. 2007), has not been commonly cultivated for over thirty years but currently forms stable populations in the basal belt of the Madonie Mountains, in the municipality of Cefalù, in San Biagio, Rocca Stefana, and Sant'Ambrogio.

E. Di Gristina, G. Barone

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

+ (NAT) **TAA**: Trento (Trento), nel parcheggio di Trento Expo (CFCE: 9932/2) (WGS84: 46.063807°N, 11.116756°E), selciato con bolognini, due gruppi di ca. 1 m^2 ciascuno, 192 m, 23 May 2021, *F. Prosser* (FI, ROV No. 80110). – Naturalized alien species new for the flora of Trentino-Alto Adige.

Mazus pumilus was found also in Trento (Piazza Duomo, WGS84: 46.067121°N, 11.121309°E, abundant, 5 June 2022), Arco (WGS84: 45.916275°N, 10.879655°E, in one point, 21 May 2023), and in the square of Villa Lagarina (WGS84: 45.917141°N, 11.030945°E, abundant, 25 June 2023).

F. Prosser

***Nicotiana tabacum* L. (Solanaceae)**

+ (CAS) **ABR**: Rocca San Giovanni (Chieti), loc. Piano dei Marchi (WGS84: 42.279444°N, 14.482222°E), bordo di canale asciutto nei pressi di una pineta di impianto artificiale, ca. 105 m, 3 September 2022, *N. Olivieri* (FI). – Casual alien species new for the flora of Abruzzo.

Only one individual of the species, close to flowering was found. The area is partially occupied by an artificial forest of *Pinus halepensis* Mill. subsp. *halepensis*, which was affected by a fire in August 2021.

N. Olivieri

***Parthenocissus tricuspidata* (Siebold & Zucc.) Planch. (Vitaceae)**

+ (CAS) **SAR**: Cagliari (Cagliari), Asse Mediano (WGS84: 39.240395°N, 9.118457°E), margini stradali, 21 m, 2 September 2022, *M. Fois*, *A. Cuena-Lombraña* (FI, CAG). – Casual alien species new for the flora of Sardegna.

M. Fois, A. Cuena-Lombraña

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

+ (NAT) **SAR**: Oschiri (Sassari), Rizzolu 'e Curadore in loc. Pegurone (WGS84: 40.794427°N, 9.050850°E), lungo le sponde del torrente, 277 m, 16 October 2022, *G. Calvia*, *A. Ruggero* (FI, CAG). – Naturalized alien species new for the flora of Sardegna.

In Sardegna, this species has been confused with *Bambusa vulgaris* Schrad. ex J.C.Wendl., which was reported in several works (Camarda et al. 2016; Galasso et al. 2018; Calvia and Ruggero 2020). More recent surveys from Gallura, Logudoro, Sassarese, Campidano di Cagliari, Sulcis-Iglesiente, and other areas, revealed that all the populations previously attributed to *B. vulgaris* were to be assigned to this species that, at the current state of knowledge, is the only bamboo cultivated and then naturalized on the island.

G. Calvia, A. Ruggero

***Plumbago auriculata* Lam. (Plumbaginaceae)**

+ (NAT) **CAM**: Napoli (Napoli), Centro Direzionale, sottopassaggio di Viale della Costituzione (WGS84: 40.857025°N, 14.284956°E), base dei muri in cemento armato ai margini del piano stradale, in ambiente ombroso e stagionalmente umido, 15 September 2022, *E. Del Guacchio* (FI, NAP). – Status change from casual to naturalized alien for the flora of Campania.

The species has been reported as an alien for a long time in Campania and is now widespread, even in scarcely disturbed environments (Del Guacchio and La Valva 2017). In the above reported locality, it is well represented by a stable and growing population (Stinca et al. 2016; E. Del Guacchio, pers. obs.). It is notable that it thrives better than the individuals cultivated or escaped in the overhanging gardens, especially in summer.

E. Del Guacchio, G. Galasso

***Portulaca umbraticola* Kunth (Portulacaceae)**

+ (CAS) **MAR**: Grottammare (Ascoli Piceno), Lungomare della Repubblica (WGS84: 42.988611°N, 13.871388°E), base di fioriera in cemento, presso il litorale, ca. 3 m, 6 August 2022, *N. Olivieri* (FI). – Casual alien species new for the flora of Marche.

N. Olivieri

***Sedum multiceps* Coss. & Durieu (Crassulaceae)**

+ (CAS) **ABR**: Teramo (Teramo), Via A. De Gasperi (WGS84: 42.662777°N, 13.708055°E), fessure di un muro in cemento presso la strada, ca. 251 m, 21 January 2023, *N. Olivieri* (FI). – Casual alien species new for the flora of Abruzzo.

N. Olivieri

***Sparaxis bulbifera* (L.) Ker Gawl. (Iridaceae)**

+ (NAT) **ITALIA** (**SIC**): Cefalù (Palermo), Gibilmanna, C.da Colombo (WGS84: 38.002785°N, 14.025698°E), frutteto tradizionale, 590 m, 30 April 2023, *G. Domina* (FI, SAF No. 100116). – Status change from casual to naturalized alien for the flora of Italy; naturalized alien species new for the flora of Sicilia.

A population of several hundred individuals of *Sparaxis bulbifera* was found among orchards and on uncultivated land.

E. Di Gristina, G. Barone

***Tagetes minuta* L. (Asteraceae)**

+ (CAS) **SAR**: Sanluri (Sud Sardegna), loc. Riu Piras (WGS84: 39.570372°N, 8.909956°E), margini stradali, 146 m, 2 June 2022, *F. Mascia*, *L. Podda*, *G. Bacchetta* (FI, CAG). – Casual alien species new for the flora of Sardegna.

F. Mascia, L. Podda

***Zantedeschia aethiopica* (L.) Spreng. (Araceae)**

+ (NAT) **MOL**: Campomarino (Campobasso), presso la strada SS16 "Adriatica" (WGS84: 41.959166°N, 15.036666°E), area acquitrinosa disturbata, ca. 3 m, 12 April 2023, *N. Olivieri* (FI). – Naturalized alien species new for the flora of Molise.

Many individuals of the species flower and bear fruit and are, therefore, actively propagating. The infructescences, formed by orange berries that probably attract birds, tend to bend with their peduncle downwards as they ripen, perhaps allowing seeds to be disseminated also by water.

N. Olivieri

Nomenclatural and distribution updates from other literature sources

Nomenclatural, status, and distribution updates according to Becherer (1936), Rey (2002), She et al. (2005), Ward (2005), Ezcurra and Daniel (2007), Giardina et al. (2007), Persson (2007), Belyaeva (2009), Banfi and Galasso (2010), Eckenwalder (2010), Licitra and Napoli (2011), Verloove and Sánchez Gullón (2012), Gestri and Peruzzi (2013), Ardenghi and Polani (2016), Murrell and Ponedexter (2016), Del Guacchio and La Valva (2017),

Peruzzi et al. (2017), Turland et al. (2018), Buccheri et al. (2019), Lucas et al. (2019), Mutke et al. (2019), Prosser et al. (2019), Tzvelev and Probatova (2019), Bruschi and Pulverelli (2020), Bugni et al. (2020), Calvia and Ruggero (2020), Levin and Sagun (2021), Nepal and Purintun (2021), Semprini (2021), Wei et al. (2021), Filice and Nicolella (2022), Gubellini (2022), Lazzeri and Palermo (2022), Marchenko and Kuzovkina (2022), Prosser et al. (2022), Sadler et al. (2022), Alessandrini et al. (2023), Antonietti et al. (2023a, 2023b), Applequist (2023), Barone et al. (2023), Buldrini et al. (2023), Capuano and Caruso (2023), Castaldi et al. (2023), Conti et al. (2023a, 2023b), Info Flora (2023 [onwards]), Knapp et al. (2023), Laghi (2023), Lazzeri et al. (2023), Longo et al. (2023a, 2023b), Marcenò et al. (2023), Marfella et al. (2023), Martínez et al. (2023), Nicolella et al. (2023a, 2023b), Palazzolo et al. (2023), POWO (2023a [onwards], 2023b [onwards]), Roma-Marzio et al. (2023), Selvaggi et al. (2023), Smith (2023), Soldano and Minuzzo (2023), Trotta et al. (2023), Weakley et al. (2023), Yang et al. (2023), Zepigi et al. (2023), and corrections to Galasso et al. (2018) and subsequent updates summarised in the Portal to the Flora of Italy (2023) are provided in Suppl. material 1.

G. Galasso, F. Bartolucci

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References

Alessandrini A, Montanari S, Ardenghi NMG, Banfi E, Bruschi T, Ceroni P, Coli M, De Vivo R, Faggi G, Federici A, Fenaroli F, Fornasari L, Frascari M, Gobbato M, Gottschlich G, Grillini P, Lazzeri V, Longo D, Lorenzini G, Morelli V, Morolli S, Ottonello M, Polverelli L, Romani E, Rossetti G, Sirotti M, Uhlich H, Zambrini A (2023) Terza rassegna di novità per la flora dell'Emilia-Romagna segnalate nel forum Acta Plantarum, con una entità da eliminare. ActaPlantarum Notes 9: 66–79.

Antonietti A, Dellavedova R, Marchetti D (2023a) Nota n. 1225. *Selaginella kraussiana* (Kunze) A.Braun (Selaginellaceae). In: Selvaggi A, Soldano A, Pascale M, Dellavedova R (Eds) Note floristiche piemontesi n. 1181–1242. Rivista Piemontese di Storia Naturale 44: 241–242.

Antonietti A, Dellavedova R, Zuffi E, Selvaggi A (2023b) Nota n. 1224. *Ludwigia hexapetala* (Hook. & Arn.) Zardini, H.Y.Gu & P.H.Raven (Onagraceae). In: Selvaggi A, Soldano A, Pascale M, Dellavedova R (Eds) Note floristiche piemontesi n. 1181–1242. Rivista Piemontese di Storia Naturale 44: 241.

Applequist WL (2023) Report of the Nomenclature Committee for Vascular Plants: 74. Taxon 72(4): 908–922. https://doi.org/10.1002/tax.12993

Ardenghi NMG, Polani F (2016) La flora della provincia di Pavia (Lombardia, Italia settentrionale). 1. L'Oltrepò Pavese. Natural History Sciences 3(2): 51–79. https://doi.org/10.4081/nhs.2016.269

Banfi E, Galasso G [Eds] (2010) La flora esotica lombarda. Museo di Storia Naturale di Milano, Milano.

Barone G, Bajona E, Bartolucci F, Cancellieri L, Caruso G, Conti F, Domina G, Fascetti S, Franzoni J, Laface VLA, Pinzani L, Rosati L, Scoppola A, Stinca A, Tilia A, Crisafulli A (2023) Contribution to the floristic knowledge of Lipari and Panarea Islands (Sicilia, Italy). Italian Botanist 16: 59–71. https://doi.org/10.3897/italianbotanist.16.113415

Becherer A (1936) Fortschritte in der Systematik und Floristik der Schweizerflora (Gefässpflanzen) in den Jahren 1934 und 1935. Berichte der Schweizerischen Botanischen Gesellschaft 45: 248–296.

Belyaeva I (2009) Nomenclature of *Salix fragilis* L. and a new species, *S. euxina* (Salicaceae). Taxon 58(4): 1344–1348. https://doi.org/10.1002/tax.584021

Bruschi T, Pulverelli L (2020) La flora dei Tausani (San Leo, RN). Quaderno di Studi e Notizie di Storia Naturale della Romagna 51: 41–94.

Buccheri M, Boscutti F, Pellegrini E, Martini F (2019) La flora aliena nel Friuli Venezia Giulia. Gortania. Botanica, Zoologia 40[2018]: 7–78.

Bugni E, Faggi G, Lazzari G, Montanari S, Saiani D, Semprini F, Sirotti M (2020) Flora Forlì urbana e suburbana. Quadrante CFCE 1738-3. Quaderni dell'IBIS 9: 1–58.

Buldrini F, Gianaroli I, Bosi G, Alessandrini A, Santini C (2023) Spontaneous vascular flora of the historical monumental cemetery of Modena (N-Italy). Italian Botanist 15: 111–136. https://doi.org/10.3897/italianbotanist.15.102589

Calvia G, Ruggero A (2020) The vascular flora of Mount Limbara (northern Sardinia): from a troubled past towards an uncertain future. Flora Mediterranea 30: 293–313. https://doi.org/10.7320/FlMedit30.293

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

Capuano A, Caruso G (2023) New records for the alien vascular flora of Calabria (S-Italy). Research Journal of Ecology and Environmental Sciences 3(2): 1–35. https://doi.org/10.31586/rjees.2023.723

Castaldi V, Bellino A, Baldantoni D (2023) The ecology of bladderworts: the unique hunting-gathering-farming strategy in plants. Food Webs 35: e00273. https://doi.org/10.1016/j.fooweb.2023.e00273

Conti F, Bartolucci F, Manzi A, Paolucci M, Santucci B, Petriccione B, Miglio M, Ciaschetti G, Stinca A (2016) Integrazioni alla flora vascolare dell'Italia centrale. Atti della Società Toscana di Scienze Naturali, Memorie, Serie B 122[2015]: 33–42. https://doi.org/10.2424/ASTSN.M.2015.05

Conti F, Cangelmi G, Da Valle J, De Santis E, Giacanelli V, Gubellini G, Hofmann N, Masin R, Miglio M, Palermo D, Santucci B, Bartolucci F (2023a) Additions to the vascular flora of Italy. Flora Mediterranea 33: 177–191. https://doi.org/10.7320/FlMedit33.177

Conti F, Palermo D, Santucci B, Miglio M, Paolucci M, De Santis E, Giacanelli V, Bartolucci F (2023b) Additions to the vascular flora of the central and southern Italy. Flora Mediterranea 33: 83–89. https://doi.org/10.7320/FlMedit33.083

Del Guacchio E, La Valva V (2017) The non-native vascular flora of Campania (southern Italy). Plant Biosystems 152(4)[2018]: 767–779. https://doi.org/10.1080/11263504.2017.1338626

Eckenwalder JE (2010) *Populus* Linnaeus. In: Flora of North America Editorial Committee (Ed.) Flora of North America North of Mexico, Vol. 7. Oxford University Press, New York, Oxford, 5–22.

Ezcurra C, Daniel TF (2007) *Ruellia simplex*, an older and overlooked name for *Ruellia tweediana* and *Ruellia coerulea* (Acanthaceae). Darwiniana 45(2): 201–203. https://doi.org/10.14522/darwiniana.2014.452.92

Filice C, Nicolella G (2022) Noterella 0376: *Nassella neesiana* (Trin. & Rupr.) Barkworth. In: Buono V, Canzonieri A, Di Gregorio B, Longo D, Nicolella G (Eds) Noterelle 0341–0393. Acta Plantarum Notes 8: 194.

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

Gestri G, Peruzzi L (2013) I fiori di Leonardo. La flora vascolare del Montalbano in Toscana. Aracne editrice, Roma.

Giardina G, Raimondo FM, Spadaro V (2007) A catalogue of plants growing in Sicily. Bocconea 20: 5–582.

Gubellini L (2022) Gli alberi e gli arbusti delle Marche. Guida al riconoscimento. Ed. Fondazione Cassa di Risparmio di Fano, Fano (Pesaro e Urbino).

Info Flora (2023 [onwards]) *Geranium sibiricum* L. In: Info Flora. The national data and information center on the Swiss flora. https://www.infoflora.ch/it/flora/geranium-sibiricum.html [accessed 30.10.2023]

Knapp S, Särkinen T, Barboza GE (2023) A revision of the South American species of the Morelloid clade (*Solanum* L., Solanaceae). PhytoKeys 231: 1–342. https://doi.org/10.3897/phytokeys.231.100894

Laghi P (2023) Segnalazioni floristiche n. 165–166. Quaderno di Studi e Notizie di Storia Naturale della Romagna 57: 253–254.

Lazzeri V, Palermo D (2022) *Opuntia puberula* Pfeiff. In: Raab-Straube E von, Raus T (Eds) Euro+Med-Checklist Notulae, 15. Willdenowia 52(2): 276–278. https://doi.org/10.3372/wi.52.52205

Lazzeri V, Campus G, Cardini A, Gestri G, Nicolella G, Tognazzi F (2023) Note floristiche toscosarde V: novità regionali per le regioni Toscana e Sardegna. ActaPlantarum Notes 9: 94–103.

Levin GA, Sagun VG (2021) (2808) Proposal to reject the name *Acalypha supera* (Euphorbiaceae). Taxon 70(2): 436–437. https://doi.org/10.1002/tax.12483

Licitra G, Napoli M (2011) Flora spontanea della città di Ragusa. Bollettino dell'Accademia Gioenia di Scienze Naturali 44(373): 227–278.

Longo D, Airale A, Bellone G, Faggi G, Gottschlich G, Lazzeri V, Ottonello M, Prosser F, Tison J-M (2023a) Rassegna di segnalazioni notevoli per il Piemonte e Valle d'Aosta comparse nel forum Acta Plantarum III. ActaPlantarum Notes 9: 18–30.

Longo D, Ardenghi NMG, Banfi E, Blanca M, Ferrando U, Gottschlich G, Ottonello M, Pavone S (2023b) Rassegna di segnalazioni notevoli per la Liguria comparse nel forum Acta Plantarum III. ActaPlantarum Notes 9: 9–17.

Lucas EJ, Holst B, Sobral M, Mazine FF, Nic Lughadha EM, Barnes Proença CE, Ribeiro da Costa I, Vasconcelos TNC (2019) A new subtribal classification of tribe Myrteae (Myrtaceae). Systematic Botany 44(3): 560–569. https://doi.org/10.1600/036364419X15620113920608

Maglioni G, Selvaggi A (2020) Nota n. 1004. *Campanula poscharskyana* Degen (Campanulaceae). In: Selvaggi A, Soldano A, Pascale M, Dellavedova R (Eds) Note floristiche piemontesi n. 951–1013. Rivista Piemontese di Storia Naturale 41: 213–214.

Marcenò C, Iamonico D, Venanzoni R, Boschi I, Guarino R (2023) First finding of an unusual population of *Alternanthera* in Sicily and considerations on its morphological peculiarities, ecological requirements, and potential invasiveness. Mediterranean Botany Online first: 1–9. https://doi.org/10.5209/mbot.84939

Marchenko AM, Kuzovkina YA (2022) Notes on the nomenclature and taxonomy of *Salix fragilis* (Salicaceae). Taxon 71(4): 721–732. https://doi.org/10.1002/tax.12685

Marfella L, Rufino F, Glanville HC, Mastrocicco M, Strumia S (2023) Distribution of the invasive alien species *Cotula coronopifolia* L. (Asteraceae) relating to water halinity and sodicity in the Variconi wetland (Campania, southern Italy). Hydrobiologia 850(7): 1653–1668. https://doi.org/10.1007/s10750-023-05175-w

Martínez M, Vargas-Ponce O, Zamora-Tavares P (2023) Taxonomic revision of *Physalis* in Mexico. Frontiers in Genetics 14: 1080176. https://doi.org/10.3389/fgene.2023.1080176

Murrell ZK, Ponedexter DB (2016) Cornaceae Berchtold & J. Presl. In: Flora of North America Editorial Committee (Ed.) Flora of North America North of Mexico, Vol. 12. Oxford University Press, New York, Oxford, 443–457.

Mutke S, Vendramin G, Fady B, Bagnoli F, González-Martínez SC (2019) Molecular and quantitative genetics of stone pine (*Pinus pinea*). In: Nandwani D (Ed.) Genetic diversity in horticultural plants. Sustainable development and biodiversity, Vol. 22. Springer, Cham, 61–84. https://doi.org/10.1007/978-3-319-96454-6_3

Nepal MP, Purintun JM (2021) Systematics of the genus *Morus* L. (Moraceae). Taxonomy, phylogeny and potential responses to climate change. In: Razdan MK, Thomas D (Eds) Mulberry. Genetic improvement in context of climate change. Taylor & Francis Group, Boca Raton 1: 2–20. https://doi.org/10.1201/9780429399237-2

Nicolella G, Alessandrini A, Buono V, Canzoneri A, Longo D, Zepigi M [Eds] (2023a) Noterelle 0394–0425. Novità per la flora italiana e segnalazioni floristiche regionali. ActaPlantarum Notes 9: 222–139.

Nicolella N, Ardenghi NMG, Antonini M, Bamonte R, De Santis E, Iamonico D, Ottonello M, Palermo D, Palmieri M, Rossi F (2023b) Rassegna di segnalazioni notevoli riguardanti alcune regioni dell'Italia centro-meridionale comparse nel forum Acta Plantarum II. Acta-Plantarum Notes 9: 31–43.

Olivieri N (2010) Notulae: 50–53. In: Nepi C, Peccenini S, Peruzzi L (Eds) Notulae alla flora esotica d'Italia: 3 (38–53). Informatore Botanico Italiano 42(2): 534–535.

Palazzolo P, Soldano A, Selvaggi A, Galasso G, Antonietti A, Dellavedova (2023) Nota n. 1222. *Acer saccharinum* L. subsp. *saccharinum* (Sapindaceae). In: Selvaggi A, Soldano A, Pascale M, Dellavedova R (Eds) Note floristiche piemontesi n. 1181–1242. Rivista Piemontese di Storia Naturale 44: 239–240.

Persson K (2007) Nomenclatural synopsis of the genus *Colchicum* (Colchicaceae), with some new species and combinations. Botanische Jahrbücher für Systematik, Pflanzengeschichte und Pflanzengeographie 127(2): 165–242. https://doi.org/10.1127/0006-8152/2007/0127-0165

Peruzzi L, Viciani D, Angiolini C, Astuti G, Banfi E, Benocci A, Bonari G, Bruni G, Caramante P, Caré M, Carta A, Castagnini P, Cheli A, Ciampolini F, D'antraccoli M, Ferretti G, Ferruzzi S, Fiaschi T, Foggi B, Fontana D, Galasso G, Gallo L, Galvani D, Gestri G, Grazzini A, Lastrucci L, Lazzaro L, Loppi S, Manganelli G, Mugnai M, Piazzini S, Pierini B, Roma-Marzio F, Sani A, Selvi F, Soldano A, Stinca A, Bedini G (2017) Contributi per una flora vascolare di Toscana. IX (507–605). Atti della Società Toscana di Scienze Naturali, Memorie, Serie B 124: 73–86. https://doi.org/10.2424/ASTSN.M.2017.07

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

Portal to the Flora of Italy (2023) Portale della Flora d'Italia/Portal to the Flora of Italy. 2023.1. https://dryades.units.it/floritaly/ [accessed 05.10.2023]

POWO (2023a [onwards]) *Avena fatua* L. In: Plants of the World Online. Facilitated by the Royal Botanic Gardens, Kew. https://powo.science.kew.org/taxon/urn:lsid:ipni.org:names:391443-1 [accessed 04.07.2023]

POWO (2023b [onwards]) *Paspalum paucispicatum* Vasey. In: Plants of the World Online. Facilitated by the Royal Botanic Gardens, Kew. https://powo.science.kew.org/taxon/urn:lsid:ipni.org:names:184541-2 [accessed 23.10.2023]

Prosser F, Bertolli A, Festi F, Perazza G (2019) Flora del Trentino. Fondazione Museo Civico di Rovereto, Edizioni Osiride, Rovereto (Trento).

Prosser F, Bertolli A, Festi F, Tomasi G, Andreatta S, Costantini L, Dal Corso G, Di Carlo F, Menini F, Ovatoli M, Pighi E, Scortegagna S, Trenchi M (2022) Segnalazioni floristiche veronesi III. Bollettino del Museo Civico di Storia Naturale di Verona. Botanica Zoologia 46: 5–28.

Rey C (2002) Le géranium de Sibérie (*Geranium sibiricum* L.), indigène dans l'Arc alpin: approche biologique et microclimatique. Les Cahiers de Sciences Naturelles 6: 1–53.

Roma-Marzio F, Luchino F, Giardini M, Bonari G, Millan MY, Meneguzzo E, Ardenghi NMG, Iamonico D, Crosato M, Pica A, Lupoletti J, Lonati M, Nota G, Banfi E, Galasso G, Ghitti L, Pirani S, Ravetto Enri S, Gennaio R, Crucitti P, Montaldi A, Capotorti G,

Villani M, Munaretto I, Casalini R, Pinzani L, Nigro S, Del Vico E, Lastrucci L (2023) Nuove segnalazioni floristiche italiane 15 (138–169). Notiziario della Società Botanica Italiana 7: 1–10.

Sadler R, Parker T, Verboom GA, Ellis AG, Jackson M, van Zyld J, Manning J, Berg NG (2022) A molecular phylogeny of Calenduleae (Asteraceae) supports the transfer of *Dimorphotheca polyptera* DC. to *Osteospermum* L. South African Journal of Botany 151(A): 234–245. https://doi.org/10.1016/j.sajb.2022.09.001

Selvaggi A, Dellavedova R, Soldano A (2023) Nota n. 1221. *Datura wrightii* Regel (Solanaceae). In: Selvaggi A, Soldano A, Pascale M, Dellavedova R (Eds) Note floristiche piemontesi n. 1181–1242. Rivista Piemontese di Storia Naturale 44: 239.

Semprini F (2021) Taxa di un certo interesse o poco segnalati presenti in un erbario amatoriale del territorio romagnolo. Quaderno di Studi e Notizie di Storia Naturale della Romagna 54: 47–53.

She M, Pu F, Pan Z, Watson M, Cannon JFM, Holmes-Smith I, Kljuykov EV, Phillippe LR, Pimenov MG (2005) Apiaceae (Umbelliferae). In: Wu ZY, Raven PH, Hong DY (Eds) Flora of China, Vol. 14. Science Press, Beijing, Missouri Botanical Garden Press, St. Louis, 1–205.

Smith GF (2020) Notes on *Kalanchoe* ×*houghtonii* (Crassulaceae subfam. Kalanchooideae), an early hybrid between two species of *K.* subg. *Bryophyllum*. Haseltonia 2019(26): 78–85, https://doi.org/10.2985/026.026.0111

Smith GF (2023) A review of exotic *Kalanchoe* taxa (Crassulaceae subfam. Kalanchooideae) naturalised and cultivated in Africa and the Gulf of Guinea islands, with their nomenclature updated. Phytotaxa 613(1): 1–28. https://doi.org/10.11646/phytotaxa.613.1.1

Soldano A, Minuzzo C (2023) Nota n. 1228. *Phacelia tanacetifolia* Benth. (Boraginaceae). In: Selvaggi A, Soldano A, Pascale M, Dellavedova R (Eds) Note floristiche piemontesi n. 1181–1242. Rivista Piemontese di Storia Naturale 44: 244.

Stinca A, Croce A, D'Auria G, Salerno G, Santangelo A, Rosati L, Motti R. (2016) Nuovi dati sulla flora vascolare aliena della Campania (Sud Italia). Atti della Società Toscana di Scienze Naturali di Pisa, Memorie, Serie B 122[2015]: 89–110. https://doi.org/10.2424/ASTSN.M.2015.09

Trotta G, Castello M, Petruzzellis F, Pischedda S, Boscutti F (2023) First record of naturalization of *Erechtites hieraciifolius* (L.) Raf. ex DC. (Asteraceae) in Italy. Natural History Sciences 10(2): 77–79. https://doi.org/10.4081/nhs.2023.716

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

Tzvelev NN, Probatova NS (2019) Zlaki Rossii / Grasses of Russia. KMK Scientific Press, Moscow.

Verloove F, Sánchez Gullón E (2012) A taxonomic revision of non-native *Cenchrus* s.str. (Paniceae, Poaceae) in the Mediterranean area. Willdenowia 42(1): 67–75. https://doi.org/10.3372/wi.42.42107

Ward DB (2005) A case of disputed orthography: is it *Echinochloa colona*; or is it *Echinochloa colonum* (Gramineae). Sida, Contributions to Botany 21(4): 2171–2183.

Weakley AS, Kees JC, Sorrie BA, Ward SG, Poindexter DB, Brock M, Estes LD, Bridges EL, Orzell SL, Levin GA, McClelland RKS, Schmidt RJ, Namestnik SA (2023) Studies in the vascular flora of the southeastern United States. IX. Journal of the Botanical Research Institute of Texas 17(1): 191–257. https://doi.org/10.17348/jbrit.v17.i1.1293

Wei T, van Treuren R, Liu X, Zhang Z, Chen J, Liu Y, Dong S, Sun P, Yang T, Lan T, Wang X, Xiong Z, Liu Y, Wei J, Lu H, Han S, Chen JC, Ni X, Wang J, Yang H, Xu X, Kuang H, van Hintum T, Liu X, Liu H (2021) Whole-genome resequencing of 445 *Lactuca* accessions reveals the domestication history of cultivated lettuce. Nature Genetics 53(5): 752–760. https://doi.org/10.1038/s41588-021-00831-0

Yang C-X, Liu S-Y, Zerega NJC, Stull GW, Gardner EM, Tian Q, Gu W, Lu Q, Folk RA, Kates HR, Guralnick RP, Soltis DE, Soltis PS, Wang Y-H, Yi T-S (2023) Phylogeny and biogeography of *Morus* (Moraceae). Agronomy 13(8): 2021. https://doi.org/10.3390/agronomy13082021

Zepigi M, Ardenghi NMG, Bellio R, Colombo S, Federici A, Ferrando U, Galasso G, Giordana F, Lazzeri V, Leoni G, Maggioni L, Mazzi G, Mazzoli A, Menini F, Merli M, Parrino N, Perino P, Siega Vignut P, Truzzi A (2023) Rassegna di segnalazioni notevoli per alcune regioni del nord Italia comparse nel forum Acta Plantarum. ActaPlantarum Notes 9: 113–121.

Supplementary material 1

Categories concerning the occurrence status of taxa

Authors: Gabriele Galasso, Fabrizio Bartolucci

Data type: pdf

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: 16

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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, and exclusions to the Italian administrative regions. Nomenclatural and distribution updates, published elsewhere, and corrigenda are provided as supplementary material.

Keywords

Endemic taxa, Floristic data, Italy

How to contribute

The text for the new records, exclusions, and confirmations should be submitted electronically to Lorenzo Lastrucci (lorenzo.lastrucci@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 and typifications (only for accepted names) should be submitted electronically to: Fabrizio Bartolucci (fabrizio.bartolucci@gmail.com). Each text should be within 1,000 characters (spaces included).

Floristic records of native taxa

Alchemilla effusa Buser (Rosaceae)

+ **UMB**: Castelluccio di Norcia (Norcia, Perugia) (WGS84: 42.781561°N, 13.195514°E), Piano Grande, prato pingue presso i Mergani; suolo calcareo, 1272 m, 7 July 2021, leg. *F. Falcinelli*, det. *F. Festi* (FI, Herb. Tondi). – Species new for the flora of Umbria.

F. Falcinelli, F. Festi, G. Tondi

***Alchemilla marsica* Buser (Rosaceae)**

+ **MOL**: Capracotta (Isernia) (WGS84: 41.830136°N, 14.293988°E), Habitat 6210*, prateria semi-mesofila secondaria polispecifica perenne, copertura 100%, a dominanza di *Bromopsis erecta* (Huds.) Fourr., *Carex flacca* Schreb. subsp. *erythrostachys* (Hoppe) Holub, *Brachypodium rupestre* (Host) Roem. & Schult., 1332 m s.l.m. esposizione sud sud-est, 6 June 2021, leg. *P. Fortini*, det. *G. Tondi* (FI, IS). – Species new for the flora of Molise.

P. Fortini, G. Tondi

***Alchemilla reniformis* Buser (Rosaceae)**

+ **UMB**: Monte Coscerno (S. Anatolia di Narco, Perugia) (WGS84: 42.718762°N, 12.885913°E), pascolo, versante N; suolo calcareo, 1635 m, 15 July 2021, leg. *F. Falcinelli*, det. *G. Tondi*, rev. *F. Festi* (FI, Herb. Tondi). – Species new for the flora of Umbria.

F. Falcinelli, F. Festi, G. Tondi

***Anemone hortensis* L. subsp. *hortensis* (Ranunculaceae)**

+ **PIE**: Gavi (Alessandria), calanchi dello Scrivia (sponda sinistra) (WGS84: 40.090440°N, 53.303100°E), 483 m, 3 March 2022, *E. Repetto* (FI). – Species new for the flora of Piemonte.

We observed this species in a dry grassland of a badland on the left bank of the Scrivia River. The species grows together with *Brachypodium rupestre* (Host) Roem. & Schult., *Carex caryophyllea* Latourr., *Globularia bisnagarica* L., and *Lotus dorycnium* L.

E. Repetto, S. Assini

***Cornus sanguinea* L. subsp. *hungarica* (Kárpáti) Soó (Cornaceae)**

+ **MOL**: Pesche (Isernia), (WGS84: 41.602233°N, 14.271280°E), cespuglieto. 695 m s.l.m. esposizione sud sud-est, 17 May 2023, *P. Fortini*, *L. Quaranta* (IS). – Subspecies new for the flora of Molise.

P. Fortini, L. Quaranta

***Crassula tillaea* Lest.-Garl. (Crassulaceae)**

+ **PIE**: Trecate (Novara), (WGS84: 45.4372860°N, 8.8065930°E), pratello arido acidofilo del Ticino (sponda destra), 135 m, 26 April 2023, leg. *S. Assini*, det. *P. Palazzolo* (FI). – Species new for the flora of Piemonte.

This species was reported for Piemonte as "recorded by mistake" (Bartolucci et al. 2018), but we observed large populations occurring in pioneer siliceous dry grasslands, located between the Polo Industriale San Martino and the right bank of the Ticino River. This species grows together with *Aira caryophyllea* L., *Tuberaria guttata* (L.) Fourr., *Spergularia rubra* (L.) J.Presl & C.Presl, *Carex caryophyllea* Latourr., and *Aphanes arvensis* L.

S. Assini, P. Palazzolo

***Desmazeria sicula* (Jacq.) Dumort. (Poaceae)**

+ **PUG**: Lesina (Foggia), l'Isola, tra Cauto e Santa Maria, (WGS84: 41.906388°N, 15.497954°E), pratello terofitico su suolo sabbioso, 4 m s.l.m., 30 May 2023, leg. *V. Tomaselli*, *F. Carruggio*, det. *V. Tomaselli*, *F. Carruggio*, *E. Genduso*, (FI, BI Nos 57968, 57969). − Species new for the flora of Puglia.

E. Genduso, F. Carruggio

***Euphorbia palustris* L. (Euphorbiaceae)**

+ **PUG**: Chieuti (Foggia), Marina di Fantina, (WGS84: 41.916602°N, 15.215413°E), fragmiteto in pineta costiera (rimboschimento a *Pinus halepensis* Mill.), 3 m s.l.m., 22 April 2023, leg. *E. Costanzo*, *E. Genduso*, det. *V. Tomaselli*, *F. Carruggio*, *E. Genduso* (FI, BI Nos 58007). − Species confirmed for the flora of Puglia.

Formerly reported by Fiori (1926) in the area of "Golfo di Taranto lungo il fiume Lato nelle Menasciole", but its presence was never confirmed.

E. Genduso, V. Tomaselli

***Festuca sicula* C.Presl (Poaceae)**

+ **MOL**: Carovilli (Isernia) (WGS84: 41.665589°N, 14.274823°E), prato da sfalcio mesofilo, 986 m s.l.m., 20 June 2022, *P. Fortini*, *L. Quaranta* (IS). – Species new for the flora of Molise.

P. Fortini, L. Quaranta

***Festuca stricta* Host subsp. *trachyphylla* (Hack.) Patzke ex Pils (Poaceae)**

+ **MOL**: Pescopennataro (Isernia), (WGS84: 41.5157755°N, 14.193816°E), prateria mesofila continua su suolo profondo, 955 m s.l.m., 15 June 2022, *P. Fortini*, *L. Quaranta* (FI, IS). – Subspecies new for the flora of Molise.

P. Fortini, L. Quaranta

***Hieracium diaphanoides* Lindeb. subsp. *pseudumbrosum* Zahn (Asteraceae)**

+ **EMR**: Tizzano Val Parma (Parma), pendici di Monte Fuso sopra Rusino (WGS84: 44.50554°N, 10.26450°E), bosco misto mesofilo, 1080 m, 26 June 2013, leg. *M. Adorni*, *L. Ghillani*, det. *G. Gottschlich* (FI). – Subspecies new for the flora of Emilia-Romagna.

M. Adorni, L. Ghillani, G. Gottschlich

***Hieracium tenuiflorum* Arv.-Touv. subsp. *tenuiflorum* (Asteraceae)**

+ **MAR**: Rotella (Ascoli Piceno), Monte Ascensione (WGS84: 42.926439°N, 13.553891°E), margini di bosco, 700−1100 m, 7 May 2008, leg. *C. D'Angeli*, *F. Conti*, det. *G. Gottschlich* (APP No. 39706). − Subspecies new for the flora of Marche.

Hieracium tenuiflorum was recently recorded for Marche without indication of the subspecies (Canzoneri et al. 2022).

G. Gottschlich, F. Conti

***Lysimachia loeflingii* F.J.Jiménez-López & M.Talavera (Primulaceae)**

+ **PUG**: Bari, Campus Università degli studi di Bari Aldo Moro (WGS84: 41.109738°N, 16.882152°E) vegetazione sinantropica mesofila degli incolti e delle aree prative e ruderali in prossimità delle aree di cantiere 12 m, 3 April 2023, leg. *G. Mei*, det. *G. Mei*, *A. Stinca* (FI, *Herb. G. Mei*); Bari, Istituto di Selvicoltura ed ecologia Forestale (WGS84: 41.111358°N, 16.882177°E) vegetazione degli incolti nelle aree più fresche e in prossimità dei passaggi pedonali 15 m, 3 April 2023, leg. *G. Mei*, det. *G. Mei*, *A. Stinca* (*Herb. G. Mei*). – Species confirmed for the flora of Puglia.

This finding confirms the only historical report for the Italian peninsula; in fact the presence of *L. loeflingii* in Italy is known for Sardegna, and Sicilia (Barone et al. 2023; Gianguzzi et al. 2023), while it was reported as doubtfully occurring in Puglia (Bartolucci et al. 2018, 2022).

G. Mei, A. Stinca

***Melomphis arabica* (L.) Raf. (Asparagaceae)**

+ **CAL**: San Ferdinando (Reggio Calabria), Località Torre, (WGS84: 38.495195°N, 15.920087°E), a bordo strada e nei terreni incolti circostanti, 5 m, 6 May 2023, *V.L.A. Laface*, *G. Tavilla* (REGGIO, CAT). – Species confirmed for the flora of Calabria.

During fieldwork around the Metropolitan City of Reggio Calabria, we discovered a well-established population of the species near the village of San Ferdinando on uncultivated land.

V.L.A. Laface, G. Tavilla

***Montia arvensis* Wallr. (Montiaceae)**

+ **PUG**: Gravina in Puglia (Bari), "Bosco Difesa Grande", Lago Matera, (WGS84: 40.753235°N, 16.382895°E), prati umidi terofitici con *Ranunculus sardous* e *Lotus parviflorus*, 438 m s.l.m., 17 March 2023, leg. *V. Tomaselli*, det. *V. Tomaselli*, *G. Pazienza*, (BI No. 57778). – Species confirmed for the flora of Puglia.

V. Tomaselli, G. Pazienza

***Najas major* All. (Hydrocharitaceae)**

+ **BAS**: Pignola (Potenza), loc. Lago Pantano (WGS84:, 40.587943°N, 15.751694°E), in the lake, 760 m a.s.m., 12 August 2022, *L. Rosati*, *G. Potenza* (FI). – Species new for the flora of Basilicata.

During the monitoring of macrophyte vegetation at Lake Pantano, we detected several small patches of a *Najas major*-dominated community, at a depth of 0,6–1,3 m, close to the shore.

G. Potenza, L. Rosati

***Narcissus tazetta* L. subsp. *italicus* (Ker Gawl.) Baker (Amaryllidaceae)**

+ **SAR**: Curcuris (Oristano), loc. Riu canali, prati umidi ai margini del Corso d'acqua (WGS84: 39.756013°N, 8.824960°E), 141 m s.l.m., 16 January 2023, *F. Mascia* (CAG); Siliqua (Sud Sardegna), loc. Su tidili, Margini e capezzagne di coltivi, prati umidi (WGS84: 39.284911°N, 8.795614°E), 66 m s.l.m., 13 February 2023, *G. Secci & Mascia* (FI, CAG); loc. Tzinnigas, incolti umidi (WGS84: 39.251558°N, 8.767128°E), 144 m s.l.m., 13 February 2023 *G. Secci*; Villanovaforru (Sud Sardegna), loc. Funtana Iannus, radure umide ai margini della lecceta, margini di sentieri (WGS84: 39.636856°N, 8.859135°E), 318 m s.l.m.,15 January 2023, *F. Mascia* (CAG). – Subspecies confirmed for the flora of Sardegna.

The first records for Sardegna refer to material collected in Jerzu by Bornemann (Barbey 1884) and by Bonomi (*sine loco*, 1895, FI). These records were never confirmed thereafter.

F. Mascia, G. Secci

***Sagina alexandrae* Iamonico (Caryophyllaceae)**

+ **PIE**: Trecate (Novara), prati aridi del Ticino (sponda destra) (WGS84: 45.440868°N, 8.805930°E), 112 m, 26 April 2023, leg. *I. Brugellis*, det. *S. Assini* (FI). – Species confirmed for the flora of Piemonte.

We observed the species occurring in a siliceous dry grassland, which can be classified as Habitat 6210*, located between the Polo Industriale San Martino and the right bank of the Ticino River.

S. Assini, I. Brugellis

***Salsola tragus* L. (Amaranthaceae)**

+ **LAZ**: Tarquinia (Viterbo), Riserva Naturale Statale Saline di Tarquinia (WGS84: 42.210163°N, 11.708960°E), dune, 2 m, 6 November 2022, *G. Buccomino*, *D. Iamonico* (FI); Roma, Tenuta Presidenziale di Castel Porziano, litorale interno, November 1987, *B. Anzalone*, rev. *D. Iamonico* 1 June 2023 (RO-HA); Latina, Isola di Ponza, 26 June 1966, *B. Anzalone*, rev. *D. Iamonico* 1 June 2023 (RO-HA); Latina, Isola di Ponza, pressi di Ponza, 16–19 October 1966, *B. Anzalone*, rev. *D. Iamonico* 1 June 2023 (RO-HA). – Species new for the flora of Lazio.

In addition to our findings, we found three further specimens collected by B. Anzalone in the provinces of Rome and Latina and previously identified as *Salsola kali* L. (see also Anzalone et al. 2010: 265). Further specimens annotated as *S. kali* are preserved at RO, but they cannot be surely identified as they are lacking mature fruits.

D. Iamonico, G. Buccomino

***Sisymbrium austriacum* Jacq. subsp. *austriacum* (Brassicaceae)**

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

The indications of *Sisymbrium austriacum* for Campania and Molise, i.e., Montevergine (province of Avellino) and Matese massif (Campania and Molise) (e.g., Fiori 1924; Pignatti 1982; Lucchese 1995) apparently rely only on Tenore (1831) and were never confirmed (cf. also Santangelo et al. 2008). However, due to the incomplete material, Tenore himself (1835–1836, under the name *S. pannonicum* Jacq. var. "*Jacobaeefolium*") questioned whether it could instead represent a variety of *S. altissimum* L. or even a new species. The only pertinent material in Tenore's herbarium (NAP, barcode NAP0001829!) consists of a few fruiting scapes apparently collected in Abruzzo by Cecchetti (see Tenore 1831). The label, handwritten by Tenore, reports his aforementioned doubts. In any case, this material was already identified by L. Grande as *S. orientale* L., which makes the reports for Campania and Molise unreliable.

E. Del Guacchio

***Tragopogon eriospermus* Ten. (Asteraceae)**

+ **PUG**: Laterza (Taranto), Fontana Imperatore, (WGS84: 40.669799°N, 16.755913°E), prateria a *Lolium arundinaceum* (Schreb.) Darbysh. subsp. *arundinaceum*, *Phalaris paradoxa* L. e *Poa palustris* L, 350 m s.l.m., 4 June 2023, leg. *G. Silletti*, *E. Costanzo*, det. *G. Silletti*, *V. Tomaselli* (FI, BI Nos 58198-58206). – Species confirmed for the flora of Puglia.

This species had been historically reported by Tenore (1831) for the "Tavoliere".

G.N. Silletti, E. Costanzo, V. Tomaselli

***Trigonella infesta* (Guss.) Coulot & Rabaute (Fabaceae)**

+ **PUG**: Ginosa (Taranto), Gravina di Ginosa (WGS84: 40.582500°N, 16.760556°E), incolto arido pietroso, 200 m, 9 June 2023, leg. *G. Pellegrino*, det. *G. Pellegrino*, *L. Forte* (BI No. 58194). – Species new for the flora of Puglia.

This is a western Mediterranean species (Coulot and Rabaute 2013), which reaches the Ionian Islands in Greece to the east (Dimopoulos et al. 2013). For southern peninsular Italy, the species was reported with certainty only for Basilicata (Portal to the Flora of Italy 2023).

G. Pellegrino, L. Forte

***Vicia melanops* Sm. (Fabaceae)**

+ **EMR**: San Lazzaro di Savena (Bologna), Parco dei Gessi Bolognesi (WGS84: 44.444876°N, 11.375468°E), prato su affioramenti gessosi, 205 m, 24 April 2022, leg. *L. Fontanabona*, det. *L. Fontanabona*, *F. Santi.*, *A. Zarantonello* (FI). − Species confirmed for the flora of Emilia-Romagna.

This species was already reported in Emilia-Romagna by Mattei (1886), who cites a record by Odoardo Beccari dating back to 1864 for the hills surrounding Bologna. The same record is also reported in Betti (1909).

L. Fontanabona, F. Santi

***Vicia pannonica* Crantz subsp. *striata* (M.Bieb.) Nyman (Fabaceae)**

+ **BAS**: Pignola (Potenza), Pantano (WGS84: 40.588492°N, 15.741264°E), margine seminativo di grano, 785 m, 27 May 2023, leg. *G. Potenza*, *L. Rosati*; det. *G. Potenza*, *L. Rosati* (FI). – Subspecies new for the flora of Basilicata.

In the southern Italian peninsula, this taxon has been previously reported only for Puglia (Bartolucci et al. 2018). It is a Mediterranean element considered as a segetal species (Fanfarillo et al. 2020) but also observed in shrublands and forest edges Pignatti (1982). In the NE Italian administrative regions it is considered as an alien taxon.

G. Potenza, L. Rosati

Floristic records of regional alien taxa

***Viburnum tinus* L. subsp. *tinus* (Viburnaceae)**

+ (NAT) **PIE**: Comune di Torino (TO), collina di Torino presso il Colle della Maddalena (WGS84: 45.030988°N, 7.720587°E), versante termofilo a *Quercus pubescens* e *Q. cerris*, 704 m s.l.m., 14 April 2023, *M. Lonati*, *G. Nota* (FI). – Naturalized regional alien taxon new for the flora of Piemonte.

In the area where *V. tinus* was found, this species forms a small population with specimens in the reproductive stage and many young seedlings, probably originating from the older plants.

G. Nota, M. Lonati

Nomenclatural and distribution updates from other literature sources

Nomenclatural and distribution updates, and corrigenda to Bartolucci et al. (2018) and subsequent updates summarised in the Portal to the Flora of Italy (2023) according to Bacchetta et al. (2007), Bracchi and Romani (2010), Fici (2014), Gristina et

al. (2014), Hernández-Ledesma et al. (2015), Banasiak et al. (2016), Kadereit et al. (2016), Bartolucci et al. (2020, 2023a, 2023b), Kreutz et al. (2020), Maglio (2021), Conti and Bartolucci (2022), Gestri et al. (2022, 2023), Joffard et al. (2022), Prosser et al. (2022), Selvaggi et al. (2022, 2023), Stace (2022), Bovio (2022), Brusa (2022), Aedo (2023), Alessandrini et al. (2023), Applequist (2023), Böhnert and Del Guacchio (2023), Brullo et al. (2023), Buldrini et al. (2023), Conti et al. (2023a, 2023b, 2023c, 2023d), De Santis (2023), Fraser-Jenkins et al. (2023), Gargano et al. (2023), Gianguzzi et al. (2023), Gregor et al. (2023), Iamonico et al. (2023a, 2023b), Laghi and Pica (2023), Lazzeri et al. (2023), Longo (2023); Longo and Ottonello (2023), Longo et al. (2023a, 2023b), Maglio and Roccia (2023), Manni et al. (2023), Nicolella et al. (2023a, 2023b), Pica and Laghi (2023), Pica et al. (2023), Romero Zarco (2023), Sciuto et al. (2023), Skubic et al. (2023), Tiburtini et al. (2023), Zepigi et al. (2023) are provided in Suppl. material 1.

F. Bartolucci, G. Galasso

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References

Aedo C (2023) A Monograph of the genus *Geranium* L. (Geraniaceae). Consejo Superior de Investigaciones Científicas, Madrid, 898 pp.

Alessandrini A, Montanari S, Ardenghi NMG, Banfi E, Bruschi T, Ceroni P, Coli M, De Vivo R, Faggi G, Federici A, Fenaroli F, Fornasari L, Frascari M, Gobbato M, Gottschlich G, Grillini P, Lazzeri V, Longo D, Lorenzini G, Morelli V, Morolli S, Ottonello M, Polverelli L, Romani E, Rossetti G, Sirotti M, Uhlich H, Zambrini A (2023) Terza rassegna di novità per la flora dell'Emilia-Romagna segnalate nel forum Acta Plantarum, con una entità da eliminare. ActaPlantarum Notes 9: 66–79.

Anzalone B, Iberite M, Lattanzi E (2010) La Flora vascolare del Lazio. Informatore Botanico Italiano 42(1): 187–317.

Applequist WL (2023) Report of the Nomenclature Committee for Vascular Plants: 74. Taxon 72(4): 908–922. https://doi.org/10.1002/tax.12993

Bacchetta G, Pontecorvo C, Vacca R (2007) The flora of Monte Arcuentu (SW Sardinia). Webbia 62(2): 175–204. https://doi.org/10.1080/00837792.2007.10670822

Banasiak Ł, Wojewódzka A, Baczyński J, Reduron J, Piwczyński M, Kurzyna-Młynik R, Gutaker R, Czarnocka-Cieciura A, Kosmala-Grzechnik S, Spalik K (2016) Phylogeny of Apiaceae subtribe Daucinae and the taxonomic delineation of its genera. Taxon 65(3): 563–585. https://doi.org/10.12705/653.8

Barbey W (1884) Florae Sardoae Compendium. Georges Bridel Editeur, Lousanne.

Barone G, Bajona E, Bartolucci F, Cancellieri L, Caruso G, Conti F, Domina G, Fascetti S, Franzoni, Laface VLA, Pinzani L, Rosati L, Scoppola A, Stinca A, Tilia A, Crisafulli A (2023) Contribution to the floristic knowledge of Lipari and Panarea Islands (Sicilia, Italy). Italian Botanist 16: 59–71. https://doi.org/10.3897/italianbotanist.16.113415

Bartolucci F, Domina G, Bagella S, Barberis G, Briozzo I, Calbi M, Caria MC, Cavallaro V, Chianese G, Cibei C, Conti F, Dagnino D, Esposito A, Galasso G, Giacanelli V, Forte L, Gottschlich G, Lattanzi E, Longo D, Mei G, Merli M, Orsenigo S, Pau GB, Pazienza G, Peccenini S, Pisanu S, Rivieccio G, Roma-Marzio F, Scafidi F, Selvi F, Stinca A, Turcato C, Nepi C (2020) Notulae to the Italian native vascular flora: 10. Italian Botanist 10: 47–55. https://doi.org/10.3897/italianbotanist.10.60743

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, Andreatta S, Argenti C, Astuti G, Ballelli S, Ballestrin S, Banfi E, Barberis D, Bernardo L, Bertolli A, Bonali F, Bonini F, Bruschi T, Buccomino G, Caldarella O, Cancellieri L, Caputo P, Conti F, Crisanti A, Del Guacchio E, Falcinelli F, Festi F, Ferri V, Filibeck G, Galasso G, Gestri G, Gigante D, Gubellini L, Gottschlich G, Guarino R, Hofmann N, Király G, Laghi P, Lazzeri V, Lonati M, Luchino F, Lupoletti J, Mei G, Merli M, Pagitz K, Paura B, Pennesi R, Perrino EV, Pica A, Pierini B, Pinzani L, Pittarello M, Praleskouskaya S, Prosser F, Roma-Marzio F, Santi F, Saiani D, Sebellin A, Soldano A, Spilli T, Stinca A, Terzi M, Tiburtini M, Tomasi G, Venanzoni R, Lastrucci L (2022) Notulae to the Italian native vascular flora: 13. Italian Botanist 13: 67–84. https://doi.org/10.3897/italianbotanist.13.86403

Bartolucci F, Domina G, Adorni M, Bacchetta G, Bajona E, Banfi E, Barbadoro F, Biscotti N, Bonsanto D, Conti F, Da Pozzo M, Dagnino D, De Fine G, Del Guacchio E, Forte L, Di Gristina E, Galasso G, Ghillani L, Gottschlich G, Gubellini L, Laface VLA, Lasen C, Lonati M, Mainetti A, Mascia F, Mazzacuva G, Musarella CM, Orsenigo S, Passalacqua NG, Pazienza G, Pinzani L, Rodi ES, Santi F, Sáez L, Selvaggi A, Tomaselli V, Torino L, Zidorn C, Lastrucci L (2023a) Notulae to the Italian native vascular flora: 15. Italian Botanist 15: 91–109. https://doi.org/10.3897/italianbotanist.15.105796

Bartolucci F, Domina G, Conti F (2023b) (2979) Proposal to conserve the name *Ranunculus isthmicus* against *R. schowii* (Ranunculaceae). Taxon 72(4): 941–942. https://doi.org/10.1002/tax.13012

Betti S (1909) Supplemento alla Flora Bolognese. Rivista Italiana di Scienze Naturali (Siena), 20: 15–19, 30–32, 56–58, 109–117.

Böhnert T, Del Guacchio E (2023) The type and correct authorship of the name *Muscari neglectum* (Asparagaceae). Taxon. https://doi.org/10.1002/tax.13025

Bovio M (Ed.) (2022) Note di aggiornamento al volume Flora vascolare della Valle d'Aosta – 8. Revue Valdotaine d'Histoire Naturelle 76: 89–98.

Bracchi G, Romani E (2010) Checklist aggiornata e commentata della flora della Provincia di Piacenza. Museo Civico di Storia Naturale di Piacenza, Piacenza.

Brullo S, Brullo C, Cambria S, Tomaselli V, Crisafulli A, Siracusa G, Minissale P, Giusso del Galdo G (2023) Taxonomic and ecological remarks on *Solenopsis bivonae* species complex (Campanulaceae). PhytoKeys 229: 77–111. https://doi.org/10.3897/phytokeys.229.104324

Brusa G (2022) Contributo all'incremento delle conoscenze floristiche in Valle d'Aosta. Revue Valdôtaine d'Histoire Naturelle 76: 55–68.

Buldrini F, Gianaroli I, Bosi G, Alessandrini A, Santini C (2023) Spontaneous vascular flora of the historical monumental cemetery of Modena (N-Italy). Italian Botanist 15: 111–136. https://doi.org/10.3897/italianbotanist.15.102589

Canzoneri A, Carbini D, Domina G, Faggi G, Giovannini G, Gottschlich G, Lazzeri V, Ottonello M, Paganelli G, Peccenini S, Sassi D (2022) Rassegna di segnalazioni notevoli riguardanti le Marche comparse nel forum Acta Plantarum. Acta Plantarum Notes 8: 166–169.

Conti F, Bartolucci F (2022) La Flora vascolare del Parco Nazionale d'Abruzzo, Lazio e Molise. Edizioni del Parco, FastEdit (Acquaviva Picena, Ascoli Piceno).

Conti F, Oberprieler C, Dorfner M, Schabel E, Bartolucci F (2023a) *Pedicularis rostratospicata* subsp. *marsica* (P. Sect. Rostratae, Orobanchaceae), a new subspecies from the Central Apennines (Italy). Plants 12: 2614. https://doi.org/10.3390/plants12142614

Conti F, Falcinelli F, Giacanelli V, Santucci B, Miglio M, Manzi A, Bartolucci F (2023b) New floristic data of vascular plants from central Italy. Natural History Sciences 10(1): 51–56. https://doi.org/10.4081/nhs.2023.636

Conti F, Palermo D, Santucci B, Miglio M, Paolucci M, De Santis E, Giacanelli V, Bartolucci F (2023c) Additions to the vascular flora of the central and southern Italy. Flora Mediterranea 33: 83–89. https://doi.org/10.7320/FlMedit33.083

Conti F, Cangelmi G, Da Valle J, De Santis E, Giacanelli V, Gubellini L, Hofmann N, Masin R, Miglio M, Palermo D, Santucci B, Bartolucci F (2023d) Additions to the vascular flora of Italy. Flora Mediterranea 33: 177–191. https://doi.org/10.7320/FlMedit33.177

Coulot P, Rabaute P (2013) Monographie des Leguminosae de France. Tome 3. Tribù des Trifolieae Société Botanique du Centre-Ouest, Jarnac, 760 pp.

De Santis E (2023) La Flora del Monte Campitelli (Anagni, FR). Contributo alla conoscenza della Flora vascolare dei Monti Ernici. ActaPlantarum Notes 9: 80–88.

Dimopoulos P, Raus Th, Bergmeier E, Constantinidis Th, Iatrou G, Kokkini S, Strid A, Tzanoudakis D (2013) Vascular plants of Greece: an annotated checklist. Berlin; Athens: Botanic Garden and Botanical Museum Berlin-Dahlem; Hellenic Botanical Society.

Fanfarillo E, Latini M, Iberite M, Bonari G, Nicolella G, Rosati L, Salerno G, Abbate A (2020) The segetal flora of winter cereals and allied crops in Italy: species inventory with chorological, structural and ecological features. Plant Biosystems 154(6): 935–946. https://doi.org/10.1080/11263504.2020.1739164

Fici S (2014) A taxonomic revision of the *Capparis spinosa* group (Capparaceae) from the Mediterranean to Central Asia. Phytotaxa 174(1): 1–24. http://dx.doi.org/10.11646/phytotaxa.174.1.1

Fiori A (1924) Nuova flora analitica d'Italia, vol. 1(4). Tipografia di M. Ricci, Firenze.

Fiori A (1926) Nuova flora analitica d'Italia, vol. 2(2). Tipografia di M. Ricci, Firenze.

Fraser-Jenkins CR, Gibby M, Rumsey FJ, Ekrt L, Evans AJ, Boudrie M, Pigott AC, Golding R (2023) (2957) Proposal to conserve the name *Dryopteris affinis* (Lowe) Fraser-Jenk. against *D. affinis* Kinahan (Pteridophyta: Dryopteridaceae). Taxon 72(3): 665–666. https://doi.org/10.1002/tax.12966

Gargano D, Franzoni J, Luqman H, Fior S, Rovito S, Peruzzi L (2023) Phenotypic correlates of genetic divergence suggest at least three species in the complex of *Dianthus virgineus* (Caryophyllaceae). Taxon. https://doi.org/10.1002/tax.13073

Gestri G, Pierini B, Peruzzi L, Festi F (2022) Aggiornamento sulla distribuzione del genere *Alchemilla* L. (Rosaceae) in Toscana (Italia centrale). Atti della Società Toscana di Scienze Naturali di Pisa, Memorie Serie B 129: 47–51.

Gestri G, Pierini B, D'Antraccoli M, Bernardini A, Peruzzi L (2023) An updated inventory of the vascular flora of the Cerbaie hills (Tuscany, Italy). Italian Botanist 15: 165–175. https://doi.org/10.3897/italianbotanist.15.105302

Gianguzzi L, Guarino R, Bazan G, Di Pietro R, Acosta ATR, Bajona E, Bolliger P, Bonomi C, Camuffo A, Console C, Fascetti S, Fortini P, Frattaroli A, Mei G, Mondello F, Olivari S, Rizzieri M, Rosati L, Sarmati S, Scuderi L, Simonazzi M, Spampinato G, Viegi L, Stinca A (2023) Itineraries of the Working Group for Vegetation Science of the Italian Botanical Society – 1 (2022): Excursion to the Egadi Islands, Mount San Giuliano and Mount Cofano (Trapani, western Sicily, Italy). Italian Botanist 16: 1–57. https://doi.org/10.3897/italianbotanist.16.103989

Gregor T, Kasperek G, Raabe U (2023) *Festuca guestfalica* ein westfälischer Lokalendemit oder eine in Mittel- und Westeuropa weit verbreitete Sippe? Kochia 16: 109–119. https://doi.org/10.21248/kochia.v16.168

Gristina AS, Fici S, Siragusa M, Fontana I, Garfì G, Carimi F (2014) Hybridization in *Capparis spinosa* L.: Molecular and morphological evidence from a Mediterranean island complex. Flora 209(12): 733–741. https://doi.org/10.1016/j.flora.2014.09.002

Hernández-Ledesma P, Berendsohn WG, Borsch T, von Mering S, Akhani H, Arias S, Castañeda-Noa I, Eggli U, Eriksson R, Flores-Olvera H, Fuentes-Bazán S, Kadereit G, Klak C, Korotkova N, Nyffeler R, Ocampo G, Ochoterena H, Oxelman B, Rabeler RK, Sanchez A, Schlumpberger BO, Uotila P (2015) A taxonomic backbone for the global synthesis of FlorItaly 69 species diversity in the angiosperm order Caryophyllales. Willdenowia 45(3): 281–383. https://doi.org/10.3372/wi.45.45301

Iamonico D, Domina G, Conti F (2023a) On the identity of *Rumex uliginosus* and the occurrence of *R. dentatus* in Italy (Polygonaceae). Phytotaxa 619(1): 105–110. https://doi.org/10.11646/phytotaxa.619.1.6

Iamonico D, Guglielmone L, Del Guacchio E (2023b) The genus *Sagina* (Caryophyllaceae) in Italy: nomenclatural remarks. Plants 12: 3169. https://doi.org/10.3390/plants12173169

Joffard N, Buatois B, Arnal V, Véla E, Montgelard C, Schatz B (2022) Delimiting species in the taxonomically challenging orchid section *Pseudophrys*: Bayesian analyses of genetic and phenotypic data. Frontiers in Ecology and Evolution 10: 1058550. https://doi.org/10.3389/fevo.2022.1058550

Kadereit JW, Albach DC, Ehrendorfer F, Galbany-Casals M, Garcia-Jacas N, Gehrke B, Kadereit G, Kilian N, Klein JT, Koch MA, Kropf M, Oberprieler C, Pirie MD, Ritz CM, Röser M, Spalik K, Susanna A, Weigend M, Welk E, Wesche K, Zhang L-B, Dillenberger MS (2016) Which changes are needed to render all genera of the German flora monophyletic? Willdenowia 46(1): 39–91. https://doi.org/10.3372/wi.46.46105

Kreutz K, Klaver JMI, Bioagioli M (2020) *Ophrys metaurensis*, a new species from the Marche region (Central Italy). GIROS Orchidee Spontanee d'Europa 63(1): 137–151.

Laghi P, Pica A (2023) Segnalazioni floristiche (n. 165–167): 167. *Epipactis purpurata* Sm. Quaderno di Studi e Notizie di Storia Naturale della Romagna 57: 255.

Lazzeri V, Campus G, Cardini A, Gestri G, Nicolella G, Tognazzi F (2023) Note floristiche toscosarde V: novità regionali per le regioni Toscana e Sardegna. ActaPlantarum Notes 9: 94–103.

Longo D (2023) Alpi Liguri 2022 - Il XIII° Raduno Annuale di Acta Plantarum. ActaPlantarum Notes 9: 44–65.

Longo D, Ottonello M (2023) *Narcissus pseudonarcissus* L. subsp. *provincialis* (Pugsley) J.-M. Tison: conferma della presenza in Italia e in Liguria. ActaPlantarum Notes 9: 89–93.

Longo D, Airale A, Bellone G, Faggi G, Gottschlich G, Lazzeri V, Ottonello M, Prosser F, Tison J-M (2023a) Rassegna di segnalazioni notevoli per il Piemonte e Valle d'Aosta comparse nel forum Acta Plantarum III. ActaPlantarum Notes 9: 18–30.

Longo D, Ardenghi NMG, Banfi E, Blanca M, Ferrando U, Gottschlich G, Ottonello M, Pavone S (2023b) Rassegna di segnalazioni notevoli per la Liguria comparse nel forum Acta Plantarum III. ActaPlantarum Notes 9: 9–17.

Lucchese F (1995) Elenco preliminare della flora spontanea del Molise. Annali di Botanica (Rome) 53, Suppl. 12: 1–386.

Mattei GE (1886) Aggiunte alla flora bolognese. Tip. Azzoguidi, Bologna.

Maglio M (2021) Contribution à la connaissance de *Pinguicula arvetii* Genty (Lentibulariaceae) dans les Alpes sud-occidentales italiennes. Bulletin Mensuel de la Société Linnéenne de Lyon 90 (3–4) : 79–93.

Maglio M, Roccia A (2023) Typification des noms *Pinguicula variegata* Arv.-Touv. et *Pinguicula arvetii* Genty (Lentibulariaceae) et observations sur les récoltes de Casimir Arvet-Touvet. Bulletin Mensuel de la Société Linnéenne de Lyon 92 (5–6) : 148–164.

Manni QG, Gennaio R, Pellegrino G (2023) An overview on the presence of *Iris unguicularis* (Iridaceae) in Salento (Apulia, southern Italy) and a new record of *Iris unguicularis* subsp. *carica* for the Italian vascular flora. Plant Biosystems 157(4): 890–898. https://doi.org/10.1080/11263504.2023.2229849

Nicolella G, Alessandrini A, Buono V, Canzoneri A, Longo D, Zepigi M [Eds] (2023a) Noterelle 0394–0425. Novità per la Flora Italiana e segnalazioni floristiche regionali. Acta Plantarum Notes 9: 222–139.

Nicolella N, Ardenghi NMG, Antonini M, Bamonte R, De Santis E, Iamonico D, Ottonello M, Palermo D, Palmieri M, Rossi F (2023b) Rassegna di segnalazioni notevoli riguardanti alcune regioni dell'Italia centro-meridionale comparse nel forum Acta Plantarum II. ActaPlantarum Notes 9: 31–43.

Pica A, Laghi P (2023) Atlante delle Orchidee del Parco Nazionale delle Foreste Casentinesi, Monte Falterona e Campigna. Guida alle specie e chiavi di riconoscimento. P. N. delle

Foreste Casentinesi, Monte Falterona e Campigna. Premiato Stabilimento Tipografico dei Comuni, Santa Sofia (FC), 356 pp.

Pica A, Berardi D, Ciaschetti G (2023) Prime segnalazioni di *Anacamptis berica* in Abruzzo e in Molise. GIROS Orchidee Spontanee d'Europa 66(1): 78–85.

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

Portal to the Flora of Italy (2023) Portale della Flora d'Italia/Portal to the Flora of Italy. 2023.1. https://dryades.units.it/floritaly/ [accessed 03.08.2023 and 09.08.2023]

POWO (2023) Plants of the World Online. Facilitated by the Royal Botanic Gardens, Kew. http://www.plantsoftheworldonline.org/ [Accessed 13.10.2023]

Prosser F, Bertolli A, Festi F, Tomasi G, Andreatta S, Costantini L, Dal Corso G, Di Carlo F, Menini F, Ovatoli M, Pighi E, Scortegagna S, Trenchi M (2022) Segnalazioni Floristiche veronesi III. Bollettino del Museo Civico di Storia Naturale di Verona. Botanica Zoologia 46: 5–28.

Romero Zarco C (2023) *Bromus cincinnatus* (Poaceae): perennial oat-grass or annual brome-grass? Mediterranean Botany 44: e84748. https://doi.org/10.5209/mbot.84748

Santangelo A, Bronzo E, Croce A, Salvati C, Strumia S (2008) Base di dati per le ricerche floristiche: un esempio per il Matese campano. Informatore Botanico Italiano 40(1): 59–71.

Selvaggi A, Soldano A, Pascale M, Dellavedova R [Eds] (2022) Note floristiche piemontesi n. 1082–1180. Rivista Piemontese di Storia Naturale 43: 175–209.

Selvaggi A, Soldano A, Pascale M, Dellavedova R [Eds] (2023) Note floristiche piemontesi n. 1181–1242. Rivista Piemontese di Storia Naturale 44: 227–252.

Sciuto K, Wolf MA, Sfriso A, Brancaleoni L, Iberite M, Iamonico D (2023) Molecular and morphometric update on italian *Salicornia* (Chenopodiaceae), with a focus on the species *S. procumbens* s.l. Plants 12: 375. https://doi.org/10.3390/plants12020375

Skubic M, Záveská E, Frajman B (2023) Meeting in Liguria: Hybridisation between Apennine endemic *Euphorbia barrelieri* and western Mediterranean *E. nicaeensis* led to the allopolyploid origin of *E. ligustica*. Molecular Phylogenetics and Evolution 185: 107805. https://doi.org/10.1016/j.ympev.2023.107805.

Stace CA (2022) Conspectus of and key to the world's species of *Vulpia* C.C. Gmel. (Poaceae: Loliinae) and seven related genera. British & Irish Botany 4(2): 74–94. https://doi.org/10.33928/bib.2022.04.074

Tenore M (1831) Sylloge plantarum vascularium florae neapolitanae. Ex Typographia Fibreni, Neapoli.

Tenore M (1835–1836) Flora napolitana, vol. 5. Dalla Stamperia e Cartiera del Fibreno, Napoli.

Tiburtini M, Bacchetta G, Sarigu M, Cambria S, Caputo P, De Luca D, Domina G, Turini A, Peruzzi L (2023) Integrative taxonomy of *Armeria* taxa (Plumbaginaceae) endemic to Sardinia and Corsica. Plants 12: 2229. https://doi.org/10.3390/plants12112229

Zepigi M, Ardenghi NMG, Bellio R, Colombo S, Federici A, Ferrando U, Galasso G, Giordana F, Lazzeri V, Leoni G, Maggioni L, Mazzi G, Mazzoli A, Menini F, Merli M, Parrino N, Perino P, Siega Vignut P, Truzzi A (2023) Rassegna di segnalazioni notevoli per alcune regioni del nord Italia comparse nel forum Acta Plantarum. ActaPlantarum Notes 9: 113–121.

Supplementary material 1

Categories concerning the occurrence status of taxa follow Bartolucci et al. (2018)
Authors: Fabrizio Bartolucci, Gabriele Galasso
Data type: pdf
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 flora of algae, bryophtes, fungi and lichens: 16

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Abstract

In this contribution, new data concerning algae, bryophytes, fungi and lichens of the Italian flora are presented. It includes new records and confirmations for the algal genera *Acetabularia*, *Nitella*, and *Nitellopsis* for the bryophyte genera *Drepanocladus*, *Fissidens*, *Hookeria*, and *Weissia*, the fungal genera *Alnicola*, *Arthonia*, *Cortinarius, Inocybe*, *Leucoagaricus*, *Neohygrocybe*, and *Puccinia* and the lichen genera *Bacidina*, *Chaenotheca*, *Flavoplaca*, *Gyalecta*, *Heterodermia*, *Rinodina*, *Scytinium*, and *Squamarina*.

Keywords

Ascomycota, Basidiomycota, Bryidae, Charophyceae, Ulvophyceae

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. Each text should be within 1,000 characters (spaces included).

Floristic records

Algae

Acetabularia caliculus J.V.Lamoroux (Polyphysaceae)

+ **ITA** (**SAR**): Porto Pozzo, Palau (Sassari) (UTM WGS84: 32T 523455.4560060), shoals with fine sediments, -3 m, 30 August 2023, leg. *S. Rossi*, det. *E. Trainito*, *G. Calvia* (FI). – Species confirmed for Italy (Sardegna).

This species was found growing densely in a rather small (not more than 30 m^2) shoal, close to the entrance of a small gulf and a lagoon, on very fine sediments. It is characterised by the presence of a stalk (white or green) with a terminal concave cup (brilliant green) formed by free segments. *Acetabularia caliculus* is distinguished from *A. acetabulum* L. primarily by having a generally longer axis, a darker green color of the terminal disc with a significantly lower number of rays (55–90 in *A. acetabulum*, 22–35 in *A. calyculus*), and the upper crown formed by segments that are not fused together (Rodríguez-Prieto et al. 2010). First described from Western Australia, in the Mediterranean Sea it has been previously recorded only from the Balearic Islands (Valet 1968; Ribera Siguán and Gómez Garreta 1985; Gallardo et al. 1993) and the north-western coast of Spain (Pérez-Ruzafa and Honrubia 1984; Gallardo et al. 1985; Pérez-Ruzafa 1990; Gallardo et al. 1993, 2016; Pérez-Ruzafa et al. 2008).

S. Rossi, G. Calvia, E. Trainito

***Nitella opaca* (C.Agardh ex Bruzelius) C.Agardh (Characeae)**

+ **ABR**: Lago della Montagna Spaccata, Alfedena (L'Aquila) (WGS 84: 33T 417533 4619146), lake bottom between 0 and 7 m depth, 1060 m, 22 August 2023, leg. *L. Rosati*, *G. Filibeck*, det. *L. Rosati*, *M.M. Azzella* (UTV, HLUC); Lago di Scanno, Scanno (L'Aquila) (WGS 84: 33T 405937 4641877), lake bottom between 3 and 6 m depth, 922 m, 9 September 2023, leg. *L. Rosati*, *G. Filibeck*, det. *L. Rosati*, *M.M. Azzella* (UTV, HLUC); Lago di Campotosto, Parco Nazionale del Gran Sasso e Monti della Laga, Campotosto (L'Aquila) (WGS 84: 33T 367533 4711315), lake bottom between 5 and 14 m depth, 1300 m, 19 September 2023, leg. *L. Rosati*, *L. Cancellieri*, det. *L. Rosati*, *M.M. Azzella* (UTV, HLUC). – Species new to Abruzzo.

This species was recorded in Italy for Trentino-Alto Adige, Lombardia, Veneto, Lazio and Sardegna (Bazzichelli and Abdelahad 2009). In Abruzzo, it currently dominates the submerged vegetation of the Montagna Spaccata reservoir; it covers also large areas in the Campotosto reservoir, while it is less abundant in the natural lake of Scanno. *Nitella opaca* is similar to *N. flexilis* (L.) C.Agardh, from which it differs for being dioecious. In general, *N. opaca* colonizes high-conductivity waters, rich in calcium content, and occurs at varying depths (Kairesalo et al. 1992; Trajanovska et al. 2012; Azzella 2014; Auderset Joye and Boissezon 2018); it requires relatively cold water (optimal temperature 12–15 °C) (Mouronval et al. 2015).

L. Rosati, L. Cancellieri, G. Filibeck

***Nitella gracilis* (Smith) C.Agardh (Characeae)**

+ **ABR**: Lago di Barrea, Parco Nazionale d'Abruzzo Lazio e Molise, Civitella Alfedena (L'Aquila) (WGS 84: 33T 413176 4624275), lake bottom between 0 and 3 m depth, 975 m, 21 August 2023, leg. *L. Rosati*, *G. Filibeck*, det. *L. Rosati*, *M.M. Azzella* (UTV, HLUC); Lago di Campotosto, Parco Nazionale del Gran Sasso e Monti della Laga, Campotosto (L'Aquila) (WGS 84: 33T 366045 4712141), lake bottom between 5

and 10 m depth, 1300 m, 10 September 2023, leg. *L. Rosati*, *G. Filibeck*, det. *L. Rosati*, *M.M. Azzella* (UTV, HLUC); Lago della Montagna Spaccata, Alfedena (L'Aquila) (WGS 84: 33T 417518 4619153), lake bottom at 4 m depth, 1060 m, 22 August 2023, leg. *L. Rosati*, *G. Filibeck*, det. *L. Rosati*, *M.M. Azzella* (UTV, HLUC). – Species new to Abruzzo.

This species was recorded in Lombardia, Friuli-Venezia Giulia, Veneto and Lazio (Bazzichelli and Abdelahad 2009). We found it in very small quantities, within the mats of dominant Characeae such as *N. opaca* (C.Agardh ex Bruzelius) C.Agardh or *Chara vulgaris* L., in the submerged vegetation of three reservoir lakes. It is impossible to confuse it with any other species of the genus. *N. gracilis* is a rare and endangered species: it is extinct in Denmark and endangered in the Balkans, Sweden and Switzerland (Azzella 2014). Its optimum seems to point to low-calcium waters (Auderset Joye and Boissezon 2018), thus the finding in association with calciophilous *N. opaca* requires further ecological investigation.

L. Rosati, G. Filibeck, M.M. Azella

***Nitellopsis obtusa* (Desv.) J.Groves (Characeae)**

+ **ABR**: Lago di Campotosto, Parco Nazionale del Gran Sasso e Monti della Laga, Campotosto (L'Aquila) (WGS 84: 33T 367428 4711205), lake bottom between 9 and 14 m depth, 1300 m, 19 September 2023, leg. *L. Rosati*, *L. Cancellieri*, det. *L. Rosati*, *M.M. Azzella* (UTV, HLUC). – Species new to Abruzzo.

This widespread species is recorded in Italy for Veneto, Emilia-Romagna, Toscana, Lazio, Puglia and Basilicata (Bazzichelli and Abdelahad 2009). *Nitellopsis obtusa* is the only extant member of the genus; it is a dioecious species, usually colonizing carbonate-rich waters, often reaching deeper waters than other Charophytes (Bolpagni et al. 2013; Azzella 2014). This species is of conservation concern in much of its native European range (Azzella 2014) but is classified as an invasive species in North America (Larkin et al. 2018). We found that *N. obtusa* is the dominant species in the deepest vegetation belt of the reservoir Lake of Campotosto; the lake bottom lies on a former mire within a sandstone-marl basin.

L. Rosati, L. Cancellieri, M.M. Azzella

***Nitellopsis obtusa* (Desv.) J.Groves (Characeae)**

+ **BAS**: Lago Pantano, Pignola (Potenza) (WGS 84: 33T 563204 4493157), lake bottom at 1.3 m depth, 764 m, 12 August 2022, leg. *L. Rosati*, *G. Potenza*, det. *L. Rosati* (HLUC). – Species confirmed for Basilicata.

The only record of this species for Basilicata dates to more than a century ago, in Monticchio lakes (Trotter 1908, sub *Tolypellopsis ulvoides*). A recent work found that it was extinct from these lakes (Azzella 2012). We have re-discovered it at a different location, Lago Pantano - where Characeae are very rare, only occurring interspersed within the *Ceratophyllum demersum* L.-dominated vegetation.

G. Potenza, L. Rosati

Bryophytes

Drepanocladus turgescens (T.Jensen) Broth. (Amblystegiaceae)

+ **TAA**: Sella Group, near the path Rif. Pordoi-Rif. Boè (Trento) (UTM WGS84: 32T 716173.5153708), water flow on dolomite, 2812 m, 3 September 2019, *F. Prosser* (ROV 03847); Brenta Group, below the NW face of Cima Grostè (Trento) (UTM WGS84: 32T 646605.5118202), on wet dolomite steps, 2585 m, 31 July 2020, *F. Prosser* (ROV 05509); Pale di S. Martino, on the plateau (Trento) (UTM WGS84: 32T 719507.5127871), wetland on dolomite, 2473 m, 12 August 2020, *F. Prosser* (ROV FP 05208). – Species confirmed for Trentino-Alto Adige.

Drepanocladus turgescens is a moss with a mainly subarctic-alpine distribution in Europe (Krajewski 2017), rare in the Mediterranean (Ros et al. 2013). In Italy it is reported only from some northern administrative regions, such as Piemonte, Friuli-Venezia Giulia, Veneto, and Trentino-Alto Adige, in the latter two with old records (Aleffi et al. 2020). In Trentino-Alto Adige, *D. turgescens* was previously signalled by Dalla Torre and Sarnthein (1904) for Passo di Resia, where it is not confirmed (FloraFaunaSüdtirol 2023).

F. Prosser

Fissidens fontanus (Bach.Pyl.) Steud. (Fissidentaceae)

+ **TAA**: Sarca river, between Torbole and Arco (UTM WGS84: 32T 646077.5082938), 72 m, 8 June 2023, *D. Spitale* (ROV 7000). – Species new to Trentino-Alto Adige.

Fissidens fontanus differs from the other species of the genus by missing a central strand in the stem and in the sheathing laminae reaching only 1/4–1/3 of the total leaf length (Privitera and Puglisi 1994). In Italy, the species is signalled with old records for Piemonte, Lombardia and Veneto, while more recent data (after 1968) are available for Friuli-Venezia Giulia, Toscana, Sardegna, and Sicilia (Aleffi et al. 2020); it is also recorded for Liguria and Lazio without precise collection data or locality. In the new locality the species was found growing on stones at depth of 10–30 cm.

D. Spitale, M. Cantonati

Hookeria lucens (Hedw.) Sm. (Hookeriaceae)

+ **TAA**: Val di Daone, along the Chiese stream just above Pracul (Trento) (UTM WGS84: 32T 619161.5092964), humid wooded place on granite, 980 m, 14 May 2023, *F. Prosser* (ROV BR06971). – Species new to Trentino-Alto Adige.

Hookeria lucens is a species of shaded, moist, humid sites, reported in Italy from some northern and central regions (Piemonte, Lombardia, Veneto, Friuli-Venezia Giulia, Toscana, and Lazio) and with old reports from Puglia (Aleffi et al. 2020). In the new locality of Trentino-Alto Adige, it was found a few meters from the eastern bank of the Chiese river in a limited settlement of a few square decimetres in an area scarcely accessible and partially explored.

F. Prosser

***Weissia angustifolia* (Baumgartner) D.A.Callaghan (Pottiaceae)**

+ **ITA** (**TOS**): Villamarina Hospital, Piombino (Livorno) (UTM WGS84: 32T 623451.4755326), on sunny and exposed flowerbeds with dry bare soil, consisting of more or less cemented quartzose-carbonate sand, 103 m, 14 January 2021, *G. Pandeli* (SIENA); Talamone (Grosseto) (UTM WGS84: 32T 675060.4714755), Mediterranean garrigue dominated by *Salvia rosmarinus* Spenn. on calcareous substrate, 38 m, 26 January 2021, *G. Pandeli* (SIENA). – Species new to Italy (Toscana).

Weissia angustifolia was previously reported as a variety of *W. longifolia* Mitt., and only recently recognized at species level by Callaghan et al. (2019). According to these authors, it differs from other taxa of the genus by the tightly involute margins along the distal half of perichaetial leaves, short seta and the presence of an abscission zone at the junction of the operculum and urn, a combination that is unique amongst European species belonging to *Weissia* Hedw. subg. *Astomum* Hampe.

G. Pandeli, I. Bonini, A. Battaglini

Fungi

***Alnicola macrospora* J.Favre (Hymenogastraceae)**

+ **CAL**: Botanical Garden, University of Calabria, Rende (Cosenza) (UTM WGS84: 33S 605982.4357356), on the ground at the edge of an artificial carr, under *Populus* and *Salix* prevailing growing woody plant genera, 200 m, 7 October 2022, *N.G. Passalacqua*, *A.B. De Giuseppe*, *G. Sicoli* (CLU F324). – Species new to Calabria.

A group of about 20 gregarious basidiomata referable to the genus *Alnicola* Kühner [=*Naucoria* (Fr.) P.Kummer] was detected on the ground in a marshy area surrounding an artificial pond colonised by young poplars and willow trees. Very recently, the macro- and micro-characteristics of our specimens were found referable to the description of *Alnicola macrospora* J.Favre given by Consiglio and Marchetti (2022). Two detections of this fungus are available for Italy, i.e., from Sardegna in 2008 (Consiglio and Marchetti 2022) and from Lombardia in 2010 (https://www.funghiitaliani.it/topic/64336-naucoria-salicis-pd-orton-1960/). Further basidiomata of this fungus were observed in the same site on the 19th of April 2023.

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

***Arthonia epiphyscia* Nyl. (Arthoniaceae)**

+ **TAA**: Dolomiti, Monte Castellazzo N of Passo di Rolle (Trento) (UTM WGS84: 32T 715182.5131793), on slope exposed to the S, on boulders of marly limestone, on the thallus of *Physcia dubia* (Hoffm.) Lettau, c. 2100 m, 23 October 1976, *J. Hafellner* (no. 84354 GZU). – Species new to Trentino-Alto Adige.

The lichenicolous *A. epiphyscia* is easily recognized by its pure black, convex ascomata, often arranged in isolated small dense groups on the host thallus. The species is known

from all continents – for a sketch of the overall distribution see Brackel (2014) – and is also widely distributed in Italy (Brackel 2016; Nimis 2016; Nimis and Martellos 2023), but apparently rare compared to the commonness of its hosts, i.e., various ordinary *Physcia* species. In the north of the country, it was so far only known from Venezia-Giulia (Nimis and Martellos 2023). The collection reported here is the first in Italy above the treeline. Earlier records on *Phaeophyscia* refer to *A. phaeophysciae* Grube & Matzer (see there).

J. Hafellner

***Arthonia phaeophysciae* Grube & Matzer (Arthoniaceae)**

+ **TAA**: Val Venosta, ca. 1 km NE above of Schlanders, by the trail to Vezzan (Bolzano) (UTM WGS84: 32T 636831.5165507), on slope exposed to the S, on soil layer over siliceous outcrops, on the thallus of *Phaeophyscia cernohorskyi* (Nádv.) Essl., ca. 800 m, 5 September 1992, *J. Hafellner* (no. 30406 GZU). – Species new to Trentino-Alto Adige.

The lichenicolous *A. phaeophysciae* is distinguished from the otherwise similar *A. epiphyscia* Nyl. by its ascomata breaking through the upper cortex of the host. In early stages of development, the ascomata remain partly covered by remnants of the cortex and the epinecral layer, a diagnostic feature easily observed under the dissecting microscope. This species behaves as parasite on the thallus of various *Phaeophyscia* species, causing finally a bleaching of the infected areas. This species is widely distributed in Europe but rare in Asia and the Americas. For an outline of the overall distribution see Brackel (2014). In Italy it is widely distributed (Brackel 2016; Nimis 2016; Nimis and Martellos 2023) but so far only rarely recorded. For instance, it is possibly a repeatedly overlooked inhabitant on the ordinary *Phaeophyscia orbicularis* (Neck.) Moberg. In the north of the country, it was so far only known from Friuli-Venezia Giulia (Brackel 2013) and Emilia-Romagna (Nimis and Martellos 2023).

J. Hafellner

***Cortinarius vernus* H.Lindstr. & Melot (Cortinariaceae)**

+ **CAL**: Botanical Garden, University of Calabria, Rende (Cosenza) (UTM WGS84: 33S 605764.4357037), on the ground under the crown of *Quercus ilex* L. trees, 220 m, 26 April 2023, *L. Bernardo*, *G. Sicoli*, *N.G. Passalacqua* (CLU F328). – Species new to Calabria.

A group of dark cespitose basidiomata, lacking a peculiar smell and taste, immediately attributable to *Cortinarius* subg. *Telamonia* (Fr.) Loudon, was found in late April 2023 on the ground among the litter of young planted *Quercus ilex* L. trees. The fungus was identified as *Cortinarius vernus* since spores were strongly verrucose, but broadly ellipsoid (7.5–9.0 × 4.5–5.5 µm in size), thus longer than those belonging to the closely related species *C. erythrinus* (Fr.) Fr., which is still a spring species, but also mainly recorded in coniferous forests (Moser 1986; Brandrud 1992). So far, *C. vernus* has been reported in northern and central Italy, as a synonym of *C. erythrinus*, or as a putative variety of *C. castaneus* (Bull.) Fr. (Onofri et al. 2013).

L. Bernardo, G. Sicoli, N.G. Passalacqua

***Inocybe assimilata* Britzelm. (Inocybaceae)**

+ **CAL**: Botanical Garden, University of Calabria, Rende (Cosenza) (UTM WGS84: 33S 605877. 4357175), on the ground in the proximity of a *Quercus pubescens* Willd., 210 m, 24 May 2023, *G. Sicoli*, *A.B. De Giuseppe*, *N.G. Passalacqua* (CLU F329). – Species new to Calabria.

A group of solitary, but gregarious inocyboid basidiomata belonging to *I. assimilata* were observed on the ground just outside the crown of a *Quercus pubescens* Willd. subsp. *pubescens* at the edge of a path. In Italy *I. assimilata* has been reported so far in most northern regions, but also in Toscana and Campania (Onofri et al. 2013).

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

***Inocybe bresadolae* Massee (Inocybaceae)**

+ **CAL**: Botanical Garden, University of Calabria, Rende (Cosenza) (UTM WGS84: 33S 605926. 4357228), on the ground at the margin of the crown of *Quercus* sp. pl. (*Q. pubescens* Willd. and *Q. ilex* L.), 210 m, 26 October 2022, *G. Sicoli*, *A.B. De Giuseppe*, *N.G. Passalacqua* (CLU F327). – Species new to Calabria.

A group of cespitose, inocyboid basidiomata were observed on the ground at the edge of a deciduous tree-species stand. In Italy *I. bresadolae* has been reported so far in almost all northern administrative regions, but also in Toscana and Sicilia (Onofri et al. 2013).

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

***Leucoagaricus purpureolilacinus* Huijsman (Agaricaceae)**

+ **CAL**: Botanical Garden, University of Calabria, Rende (Cosenza) (UTM WGS84: 33S 605822.4357361), on the ground at the edge of a riparian wood among the litter of natural *Populus* ×*canescens* trees (prevailing species), and planted trees of *Taxodium distichum* (L.) Rich., 200 m, 12 October 2022, *G. Sicoli*, *A.B. De Giuseppe*, *N.G. Passalacqua* (CLU F326). – Species new to Calabria.

Three gregarious, slender and fragile, lepiotaceous basidiomata were found emerging among the living foliage of herbaceous plants (*Hedera helix* L. and *Galium verum* L. prevailing) and the litter of *Populus* and *Taxodium* as overhead trees. *L. purpureolilacinus* (= *L. purpureorimosus* Bon & Boiffard) (Courtecuisse and Duhem 1995), has been reported only in a few Italian regions, so far, such as Emilia-Romagna, Lombardia, and Sardegna (Onofri et al. 2013).

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

***Neohygrocybe ovina* (Bull.) Herink (Hygrophoraceae)**

+ **CAL**: Botanical Garden, University of Calabria, Rende (Cosenza) (UTM WGS84: 33S 605822.4357361), on the ground in the grass, close to planted young broadleaved

trees (*Acer monspessulanum* L., *Crataegus monogyna* Jacq. and *Olea europaea* L.), 210 m, 26 May 2023, *A.B. De Giuseppe*, *N.G. Passalacqua*, *G. Sicoli* (CLU F330). – Species new to Calabria.

A couple of fasciculate basidiomata belonging to *N. ovina* were observed on the ground in the grass, in the middle between a Montpelier maple, a common hawthorn and an olive tree. In Italy *N. ovina* has been reported so far only in some northern and central administrative regions (Onofri et al. 2013).

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

***Puccinia phragmitis* (Schumach.) Tul. (Pucciniaceae)**

+ **CAL**: Bosco di Mavigliano, Montalto Uffugo (Cosenza), (UTM WGS84: 33S 604678.4360969), on leaves of *Rumex crispus* L., 191 m, 18 May 2020, *D. Puntillo* (CLU 442) – Species new to Calabria.

In Calabria *P. phragmites* has been recorded on the leaves of *Rumex crispus* L. (I and II stage) and on leaves of *Arundo donax* L. (III, IV, V stage). The second stage produces bright and brilliant red spots on the leaves. In Italy it is known from Friuli-Venezia Giulia (Tomasi 2018), Piemonte, Lombardia, Veneto, Emilia-Romagna, Toscana, Puglia, Lazio, Campania, and Sicilia (Trotter 1910; Venturella 1991).

D. Puntillo

Lichens

***Bacidina adastra* (Sparrius & Aptroot) M.Hauck & V.Wirth (Ramalinaceae)**

+ **LOM**: Bosco La Goccia, area of the former gasometers between Via M. Pacuvio and Via S. Siccoli, Milano (Milano), on trunks of *Robinia pseudoacacia* L. and *Populus nigra* L. in a broadleaved wood (UTM WGS84: 32T 511977.5039310 and 511804.5039340), 130 m, 11 March 2023, *G. Gheza* (BOLO); sports field of Tromello (Pavia), on trunks in a row of *Tilia* sp. (UTM WGS84: 32T 489945.5006842), 98 m, 21 March 2023, *G. Gheza* (Herb. Gheza). – Species new to Lombardia.

Bacidina adastra, described recently from the Netherlands (Sparrius and Aptroot 2003), had been reported in Italy only twice from Emilia-Romagna so far (Nascimbene et al. 2021). The first site reported here is a broadleaved woodland dominated by *Celtis australis* L., *Populus nigra* L. and *Robinia pseudoacacia* L. growing, in the last 25 years, on a former industrial site near the city center of Milano (Galasso et al. 2022). The second one is located on the outskirts of an agricultural village, confirming the attitude of the species to develop in anthropized habitats under eutrophicated conditions (Sparrius and Aptroot 2003).

G. Gheza, G. Rapaccini, G. Galasso

***Chaenotheca gracilenta* (Ach.) Mattsson & Middelb. (Coniocybaceae)**

+ **UMB**: Grotte di Abeto, Fiano d'Abeto, Preci (Perugia) (UTM WGS84 33T 342733.4743163), on *Juniperus* bark and roots at the entrance to the prehistoric caves n. 1 and n. 2, ca. 980 m, 30 April 2023, leg. *R. Galli*, det. *S. Ravera* (PAL). – Species new to Umbria.

Chaenotheca gracilenta is a very to extremely rare pinhead lichen (Nimis and Martellos 2023) in Italy, usually found in niches protected from rain, such as the prehistoric caves where it was collected, on rotting wood and decaying bark of trees and stumps mostly in old-growth forests, in boreal and continental climates. It is listed in the Red List of Italian epiphytic lichens as "vulnerable" (Nascimbene et al. 2013).

R. Galli, S. Ravera

***Flavoplaca communis* (Vondrák, Říha, Arup & Søchting) Arup, Søchting & Frödén (Teloschistaceae)**

+ **LIG**: Framura (La Spezia) (UTM 32T 544971.4893366), on S-facing coastal rocks, 0 m, 29 April 2012, leg *J. Malíček*, det. *J. Vondrák* (PRA). – Species new to Liguria.

Flavoplaca communis is a maritime crustose species of siliceous seashore cliffs, closely related to *F. marina* (Wedd.) Arup, Frödén & Søchting. In Italy, it was reported so far only from Toscana and Sardegna (Vondrák et al 2009; Nimis and Martellos 2023), but it is likely more widespread in the Tyrrenian side of the Peninsula.

S. Ravera, J. Malíček

***Gyalecta ophiospora* (Lettau) Baloch & Lücking (Gyalectaceae)**

+ **ITA** (**EMR**): trail between Rifugio Firenze and Monte Cimone, Sestola (Modena), on trunk of *Fagus sylvatica* L. in a beech forest (UTM WGS84: 32T 637500.4896589), 1577 m, 21 October 2022, leg. *F. Bottegoni*, det. *J. Nascimbene*, *G. Gheza* (BOLO). – Species new to Italy (Emilia- Romagna).

Gyalecta ophiospora is characterised by the hyaline, acicular, multiseptate spores that are strongly curved and arranged spirally within the asci (Nimis and Martellos 2023). It is a widespread species in montane broadleaved forests of temperate Europe and Asia (Nimis and Martellos 2023). It was already reported from the Alps outside Italy (Nimis et al. 2018).

J. Nascimbene, G. Gheza

***Heterodermia speciosa* (Wulfen) Trevis. (Physciaceae)**

+ **LAZ**: Val Leonina, Monte Terminillo (Rieti) (UTM WGS84 33T: 335775.4705926), on *Fagus sylvatica* L., 1520 m, 17 July 1999, leg. *G. Massari*, *S. Ravera*, det. *S. Ravera* (PAL). − Species confirmed for Lazio.

The only previous record of *H. speciosa* for this region were from Villa Pamphili in Rome (Tamburlini 1884; Jatta 1889) but, according to Nimis (1993), it might refer to *Heterodermia obsurata* (Nyl.) Trevis. This sample was collected on bark and over bryophytes in a moist beech stand (Natura 2000 Habitat 9210 "Apeninne beech forests with *Taxus* and *Ilex*"), which is coherent with it having its optimum in humid, mostly montane woodlands (Nimis and Martellos 2023). *Heterodermia speciosa* is listed in the Red List of Italian epiphytic lichens as "near-threatened" (Nascimbene et al. 2013).

S. Ravera

***Rinodina immersa* (Körb.) J.Steiner (Physciaceae)**

+ **LOM**: Monte Misma (Bergamo) (UTM WGS84: 32T 563635 5064808), on calcareous outcrop, 1000 m, 9 May 2023, leg. *D. Isocrono*, *S. Ongaro*, *A.M. Gibellini*, det. *D. Isocrono*, *S. Ongaro* (ORO). – Species confirmed for Lombardia.

Rinodina immersa is a calcicolous endolithic lichen characterized by apothecia immersed in deep depressions in rocks. Although the spores are *bischoffii*-type, the immersed apothecia and lack of oil droplets in the hymenium clearly separate this species from *R. bischoffii* (Hepp) A.Massal. The only previous record from Lombardia date back to 1860 and refers to a single collection in Valtellina (Anzi 1860, sub *Rinodina bischoffii* Hepp. Massal var. *immersa* Korb.).

D. Isocrono, S. Ongaro

***Scytinium fragile* (Taylor) Otálora, P.M.Jørg. & Wedin (Collemataceae)**

+ **TOS**: La Castellaccia, near Convento del Petreto, Scansano (Grosseto) (UTM WGS84: 32T 691852.4729807), on calcareous outcrops partially shaded in a mixed oak forest with *Lobaria pulmonaria* (L.) Hoffm, on overhanging rock, 511 m, 24 April 2023, leg. *A. Guttová*, *L. Paoli*, det. *A. Guttová*, *L. Paoli*, *Z. Fačkovcová* (SAV). – Species new to Toscana.

Scytinium fragile is a small-lobate (to subcrustose) lichen, with cyanobacterial photobiont, dark green-brown to brown-black thallus of small, convex and sparsely branched lobes forming rosettes (diameter 2–3 cm). Apothecia are rare (Degelius 1954), but present in collected specimens. It seems to prefer steeply inclined rock surfaces and infiltration tracks in calcareous rocks, especially in areas with a humid-warm climate. So far reported from Liguria, Piemonte, Puglia and Sicilia (Nimis 1993; Nimis and Martellos 2023), it has been probably overlooked and perhaps it is more widespread in Tyrrhenian Italy (Nimis and Martellos 2023).

A. Guttová, L. Paoli, Z. Fačkovcová

***Scytinium turgidum* (Ach.) Otálora, P.M.Jørg. & Wedin (Collemataceae)**

+ **TOS**: La Castellaccia, near Convento del Petreto, Scansano (Grosseto) (UTM WGS84: 32T 691852.4729807), on calcareous outcrops partially shaded in a mixed

oak forest with *Lobaria pulmonaria* (L.) Hoffm, on overhanging rock, 511 m, 24 April 2023, leg. *A. Guttová*, *L. Paoli*, det. *A. Guttová*, *L. Paoli*, *Z. Fačkovcová* (SAV). – Species confirmed for Toscana.

Scytinium turgidum is a small lobate lichen, with cyanobacterial photobiont and blackish, brownish, subcylindrical lobes. The surface is wrinkled to plicate and granularly isidiate (Cannon et al. 2020). It prefers calcareous rocks, on surfaces with some water infiltration after rain, such as in the investigated locality, which also hosts a small population of the rare *Solenopsora marina* (Ravera et al. 2018). The publication of a previous record of *S. turgidum* from Toscana dates back to 1871 (Baglietto 1871; Nimis 1993).

A. Guttová, L. Paoli, Z. Fačkovcová

***Squamarina nivalis* Frey &Poelt (Stereocaulaceae)**

+ **PIE**: Alpi Cozie, Ridge NW above Crissolo N above Pian di Melzè (Cuneo) (UTM WS84: 32T 350805.4951796), S-exposed slopes of calcareous schist, 1880 m, July 2001, leg. *P.L. Nimis*, *M. Tretiach*, det. *P.L. Nimis* (TSB 35320). – Species new to Piemonte.

A species growing on wind-exposed outcrops of calcareous schists near or above treeline, sometimes on calciferous soil, reaching the nival belt in the Alps, where it is probably more widespread but certainly not common. The species is an altitudinal vicariant of the very similar *S. lentigera* (Weber) Poelt which has a mainly Mediterranean distribution in Europe.

J. Nascimbene, P.L. Nimis

***Squamarina subcetrarioides* (Zahlbr.) Y.Y.Zhang (Squamarinaceae)**

+ **ITA** (**FVG**): Carnic Alps, M. Coglians (Udine) (UTM WGS84: 33T 336964.5163706), on calcareous rocks, 2200 m, 1983, leg. *M. Palma*, det. *P.L. Nimis* (TSB 3798). – Species new to Italy (Friuli-Venezia Giulia).
+ **VEN** Dolomiti Bellunesi National Park, Cimonega, Col dei Bechi (Belluno) (UTM WGS84: 32T 727065.5115734), on calcareous rocks, 1975, 12 August 2020, *J. Nascimbene* (BOLO - JN6855). – Species new to Veneto.
+ **TAA** Paneveggio-Pale di S. Martino, Pale di San Martino Natural Park, Passo Canali (Trento) (UTM WGS84: 32T 723657.5126498), on calcareous rocks, 2480 m, 11 August 2021, *J. Nascimbene* (BOLO – JN7697). – Species new to Trentino-Alto Adige.
+ **PIE** Alpi Cozie Ridge NW above Crissolo N above Pian di Melzè (Cuneo) (UTM WGS84: 32T 350804.4951795), S-exposed slopes of calcareous schist, 1880 m, 2001, *P.L. Nimis*, *M. Tretiach* (TSB 35323). – Species new to Piemonte.
+ **MAR** Sibillini Mnts., M. Bove near Visso (Macerata) (UTM WGS84: 33T 351814.4753199), on calcareous rocks, 1850 m, 1996, *P.L. Nimis*, *M. Tretiach* (TSB 23783). – Species new to Marche.
+ **ABR** Maiella National Park, near Martellese (Chieti) (UTM WGS84: 33T 430023.4662845), on calcareous rocks, 2065 m, 25 July 2017, *J. Nascimbene* (BOLO – JN5242). – Species new to Abruzzo.

Squamarina gypsacea (Sm.) Poelt, the type species of the genus, was considered as a polymorphic calcicolous lichen with two distributional optima, the typical variety in the Mediterranean belt, *S. gypsacea* var. *subcetrarioides* (Zahlbr.) Pišút, in the alpine belt of the Alps and the Carpathians. The two varieties were not distinguished by most Italian authors (see Nimis 1993; 2016, Nimis et al. 2018). The study by Zhang et al. (2023) showed that *S. gypsacea* var. *subcetrarioides* differs from the typical variety not only in terms of morphology and altitudinal distribution, but also in terms of molecular data and should, therefore, be treated as a distinct species.

J. Nascimbene, P.L. Nimis

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References

Aleffi M, Tacchi R, Poponessi S (2020) New checklist of the bryophytes of Italy. Cryptogamie, Bryologie 41: 147–195. https://doi.org/10.5252/cryptogamie-bryologie2020v41a13

Anzi M (1860) Catalogus lichenum quos in Provincia Sondriensi et circa Novum-Comum collegit et in ordinem systematicum digessit presbyter Martinus Anzi. Tipografia C. Franchi, Como, 126 pp.

Auderset Joye D, Boissezon A (2018) New insights into the ecology and phenology of two Characeae: *N. opaca* (Bruzelius) C. Agardh and *N. gracilis* (Sm.) C. Agardh. Botany Letters 165: 91–102. https://doi.org/10.1080/23818107.2017.1365259

Azzella MM (2012) Flora, vegetazione e indicatori macrofitici dei laghi vulcanici d'Italia. PhD Thesis, Sapienza University, Roma.

Azzella MM (2014) Italian Volcanic lakes: a diversity hotspot and refuge for European charophytes. Journal of Limnology 73: 502–510. https://doi.org/10.4081/jlimnol.2014.950

Baglietto F (1871) Prospetto Lichenologico della Toscana. Nuovo Giornale Botanico Italiano 3: 211–298.

Bazzichelli G, Abdelahad N (2009) Alghe d'acqua dolce d'Italia. Flora analitica delle Caroficee. Università degli Studi di Roma La Sapienza – Ministero dell'Ambiente e della Tutela del Territorio e del Mare, Roma. 73 pp.

Bolpagni R, Bettoni E, Bonomi F, Bresciani M, Caraffini K, Costaraoss S, Giacomazzi F, Monauni C, Montanari P, M Mosconi C, Oggioni A, Pellegrini G, Zampieri C (2013) Charophytes

of the lake Garda (Northern Italy): a preliminary assessment of diversity and distribution. Journal of Limnology 72: 388–393. https://doi.org/10.4081/jlimnol.2013.e31

Brackel W von (2013) Miscellaneous records of lichenicolous fungi from the Italian Alps. Herzogia 26: 141–157. https://doi.org/10.13158/heia.26.1.2013.141

Brackel W von (2014) Kommentierter Katalog der flechtenbewohnenden Pilze Bayerns. Bibliotheca Lichenologica 109: 1–476.

Brackel W von (2016) Preliminary checklist of the lichenicolous fungi of Italy. Notiziario della Società Lichenologica Italiana 29: 95–145.

Brandrud TE (1992) *Telamonia* (Fr.) Loudon. In: Hansen L and Knudsen H (Eds) Nordic Macromycetes, Vol. 2. Nordsvamp, Copenhagen, Denmark.

Callaghan DA, Bell NE, Forrest LL (2019) Taxonomic notes on *Weissia* subgenus *Astomum*, including *Weissia wilsonii* D.A.Callaghan, a new species from Europe. Journal of Bryology 41: 135−148. https://doi.org/10.1080/03736687.2018.1551590

Cannon P, Otálora MAG, Košuthová A, Wedin M, Aptroot A, Coppins B, Simkin J (2020) Peltigerales: Collemataceae, including the genera *Blennothallia*, *Callome*, *Collema*, *Enchylium*, *Epiphloea*, *Lathagrium*, *Leptogium*, *Pseudoleptogium*, *Rostania* and *Scytinium*. Revisions of British and Irish Lichens 2: 1–38.

Consiglio G, Marchetti M (2022) Contributo alla conoscenza del Genere *Alnicola*. Rivista di Micologia 65: 5–95.

Dalla Torre KW, Sarnthein L (1904) Flora der gefürsteten Grafschaft Tirol, des Landes Vorarlberg und des fürstenthumes Liechtenstein. V. Die Moose (Bryophyta) von Tirol, Vorarlberg und Liechtenstein. Wagner, Innsbruck. 671 pp.

Degelius G (1954) The lichen genus *Collema* in Europe. Morphology, taxonomy, ecology. Symbolae Botanicae Upsalienses 13: 1–499.

FloraFaunaSüdtirol (2023) Das Portal für Tier- und Pflanzenarten in Südtirol. Naturmuseum Südtirol, Bozen. https://www.florafauna.it [accessed 17 August 2023]

Galasso G, Banfi E, Gentili R (2022) Dalla Goccia a Piazza d'Armi: piante spontanee e qualità della vita nella metropoli milanese. Notiziario della Società Botanica Italiana 6: 107–142.

Gallardo T, Gómez Garreta A, Ribera MA, Alvarez M, Conde F (1985) A preliminary checklist of Iberian benthic marine algae. Real Jardín Botánico. Madrid, 83 pp.

Gallardo T, Gómez Garreta A, Ribera MA, Cormaci M, Furnari G, Giaccone G, Boudouresque C-F (1993) Check-list of Mediterranean Seaweeds, II. Chlorophyceae Wille s.l. Botanica Marina 36: 399–421. https://doi.org/10.1515/botm.1993.36.5.399

Gallardo T, Bárbara I, Afonso-Carrillo J, Bermejo R, Altamirano M, Gómez Garreta A, Barceló Martí MC, Rull Lluch J, Ballesteros E, De la Rosa J (2016) Nueva lista crítica de las algas bentónicas marinas de España. A new checklist of benthic marine algae of Spain. Algas. Boletín Informativo de la Sociedad Española de Ficología 51: 7–52.

Jatta A (1889 [1890]) Monographia Lichenum Italiae Meridionalis. Tip. Vecchi, Trani, 261 pp.

Kairesalo T, St. Jónsson G, Gunnarsson K, Lindegaard C, Jónasson PM (1992) Metabolism and community dynamics within *Nitella opaca* (Charophyceae) beds in Thingvallavatn. Oikos 64: 241–256. https://doi.org/10.2307/3545054

Krajewski L (2017) *Drepanocladus turgescens* (Bryophyta, Amblystegiaceae) rediscovered in Poland. Cryptogamie, Bryologie 38: 265–273. https://doi.org/10.7872/cryb/v38.iss3.2017.265

Larkin DJ, Monfils AK, Boissezon A, Sleith RS, Skawinski PM, Welling CH, Cahill BC, Karol KG (2018) Biology, ecology, and management of starry stonewort (*Nitellopsis obtusa*; Characeae): A Red-listed Eurasian green alga invasive in North America. Aquatic Botany 148: 15–24. https://doi.org/10.1016/j.aquabot.2018.04.003

Moser M (1986) Guida alla determinazione dei funghi, Vol. 1 (Polyporales, Boletales, Agaricales, Russulales). Arti Grafiche Saturnia s.a.s., Trento.

Mouronval JB, Baudouin S, Borel N, Soulié-Märsche I, Klesczewski M, Grillas P (2015) Guide des Characées de France méditerranéenne. Office National de la Chasse et Faune Sauvage, Paris.

Nascimbene J, Gheza G, Hafellner J, Mayrhofer H, Muggia L, Obermayer W, Thor G, Nimis PL (2021) Refining the picture: new records to the lichen biota of Italy. MycoKeys 82: 97–137. https://doi.org/10.3897/mycokeys.82.69027

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

Nimis PL (1993) The lichens of Italy: an annotated catalogue. Monografie XII. Museo Regionale di Scienze Naturali di Torino, Torino, 897 pp.

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

Nimis PL, Martellos S (2023) ITALIC - The Information System on Italian Lichens. Version 7.0. University of Trieste, Department of Biology. www.italic.units.it [accessed 13.8.2023]

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. https://doi.org/10.3897/mycokeys.31.23568

Onofri S, Bernicchia A, Filipello Marchisio V, Padovan F, Perini C, Ripa C, Savino E, Venturella G, Vizzini A, Zotti M, Zucconi L (2013) Checklist of the macrobasidiomycetes of Italy. http://dryades.units.it/macrobasidiomiceti/index.php [accessed 2.10.2023]

Pérez-Ruzafa IM (1990) Fenología de las algas del Mar Menor (Murcia, SE de España). Botanica Complutensis 16: 21–36.

Pérez-Ruzafa I, Honrubia M (1984) Aportación al conocimiento de la flora algal bentónica de la costa murciana. III. Anales de Biología. Secretariado de Publicaciones. Universidad de Murcia 2 (Sección Especial, 2): 135–146.

Pérez-Ruzafa A, Hegazi MMI, Pérez-Ruzafa IM, Marcos C (2008) Differences in spatial and seasonal patterns of macrophyte assemblages between a coastal lagoon and the open sea. Marine Environmental Research 65: 291–314. https://doi.org/10.1016/j.marenvres.2007.11.008

Privitera M, Puglisi M (1994) *Octodiceras fontanum* (Musci): a new record from Sicily. Flora Mediterranea 4: 171–174.

Ravera S, Cogoni A, Vizzini A, Bonini I, Cheli F, Fačkovcová Z, Gheza G, Guttová A, Mair P, Mayrhofer H, Miserere L, Pandeli G, Paoli L, Prosser F, Puntillo D, Puntillo M, Selvaggi A, Spitale D, Tratter W (2018) Notulae to the Italian flora of algae, bryophytes, fungi and lichens: 6. Italian Botanist 6: 97–109. https://doi.org/10.3897/italianbotanist.6.30873

Ribera Siguán MA, Gómez Garreta A (1985) Catálogo de la flora bentónica marina de las Islas Baleares: II (Phaeophyceae, Chlorophyceae). Collectanea Botanica 16: 25–41.

Rodríguez-Prieto C, Ballesteros A, Boisset F, Alfonso-Carrillo J (2010) Guía de las macroalgas y fanerógamas del Mediterraáneo occidental. Ediciones Omega, Barcelona.

Ros RM, Mazimpaka V, Abou-Salama U, Aleffi M, Blockeel T L, 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

Sparrius LB, Aptroot A (2003) *Bacidia adastra*, a new sorediate lichen species from Western Europe. The Lichenologist 35 (4): 275–278.

Tamburlini F (1884) Prima contribuzione alla lichenografia romana. Annuario del Regio Istituto Botanico di Roma 1: 122–153.

Tomasi E (2018) I Fito-Zoocecidi della Riserva Naturale Orientata del bacino del Prescudin (Friuli-Venezia Giulia, Italia NE). Atti del Museo Civico di Storia Naturale di Trieste 59: 168, 195.

Trajanovska S, Blaženčić J, Trajanovski S, Budzakoska-Gjoreska B (2012) Distribution, morphological variability, ecology and the present state of *Nitella* from Lake Ohrid and its surroundings. Archives of Biological Science 64: 549–556. https://doi.org/10.2298/ABS1202549T

Trotter A (1908) Laghi di Monticchio - Introduzione, considerazioni generali, sguardo botanico, cenni sulla morfologia fisica e sulla biologia. Annali di Botanica (Roma) 11: 1–30.

Trotter A (1910) Flora Italica cryptogama. Pars I: Fungi. Fasc. 7. Tipografia Cappelli, Rocca San Casciano: 319.

Valet G (1968) Contribution à l'étude des Dasycladales 1. Morphogenèse. Nova Hedwigia 16: 21–82.

Venturella G (1991) A check-list of Sicilian fungi. Bocconea 2: 102.

Vondrák J, Riha P, Arup U, Søchting U (2009) The taxonomy of the *Caloplaca citrina* group (Teloschistaceae) in the Black Sea region; with contributions to the cryptic species concept in lichenology. Lichenologist 41: 571–604. https://doi.org/10.1017/S0024282909008317

Zhang Y, Wang L, Wang X, Printzen C, Timdal E, Wang L (2023) *Squamarina subcetrarioides* comb. & stat. nov. (Stereocaulaceae), a separate species from the type species of *Squamarina*. Lichenologist 55:133–137. https://doi.org/10.1017/S0024282923000166

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RESEARCH ARTICLE

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Global and Regional IUCN Red List Assessments: 16

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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 *Aubrieta columnae* subsp. *sicula*, *Calligonum zakirovii* and *Santolina decumbens* subsp. *tisoniana* at global level.

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

Aubrieta columnae Guss. subsp. *sicula* (Strobl) M.A.Koch, D.A. German & R.Karl

Global assessment
Taxonomy and nomenclature
Order: Brassicales *Family*: Brassicaceae

Aubrieta deltoidea (L.) DC. subsp. *sicula* (Strobl) Phitos, Candollea 25: 76 (1970) = *Aubrieta deltoidea* (L.) DC. var. *sicula* Strobl, Verh. Zool.-Bot. Ges. Wien 53: 458 (1903).

Common name: Aubrezia sicula (It), Sicilian Aubrieta (En).

Geographic distribution range: *Aubrieta columnae* subsp. *sicula* (Fig. 1) is endemic to the limestone cliffs of Sicily (Italy). This subspecies is mainly distributed in the Madonie massif (north-west Sicily), and only one population in the Peloritani Mounts (north-east Sicily). Both areas hosting several narrow endemic plants (Brullo et al. 1995; Sciandrello et al. 2015). In particular, this subspecies occurs in the Madonie massif in the following localities: Pizzo Carbonara (1979 m a.s.l.), Cozzo Piombino (1620 m a.s.l.), Mufara Mount (1865 m a.s.l.), Quacella Mount (1869 m a.s.l.), Rocca di Mele (1620 m a.s.l.), Piano della Noce, and Piano della Principessa (Domina et al. 2016 onwards; Cambria 2020). The only site in the Peloritani Mountains, named Rocca Salvatesta (Novara di Sicilia municipality), was first reported by Nicotra (1880) (Fig. 2).

Figure 1. *Aubrieta columnae* Guss. subsp. *sicula* (Strobl) M.A.Koch, D.A.German & R.Karl (Rocca Salvatesta, Sicily). Photograph by Gianmarco Tavilla.

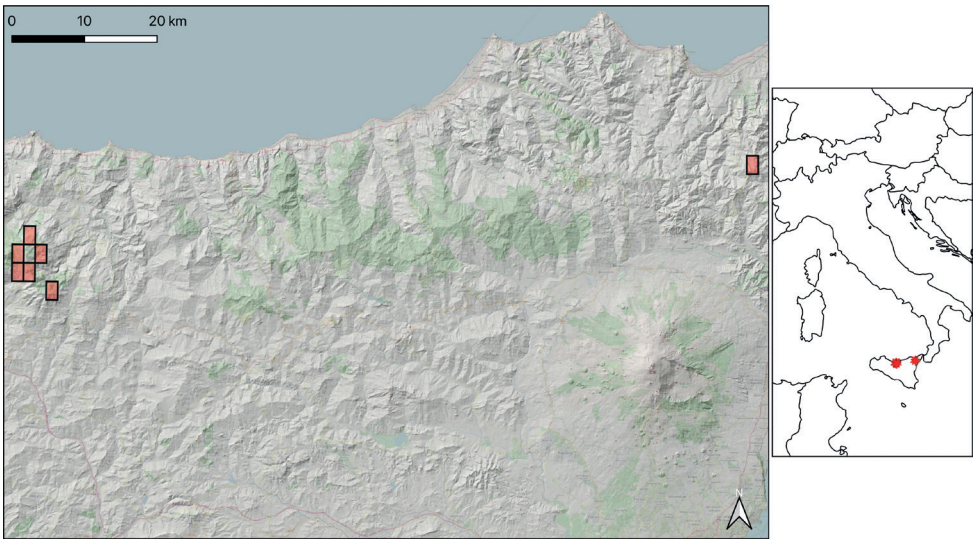

Figure 2. Geographic range and distribution map of *Aubrieta columnae* Guss. subsp. *sicula* (Strobl) M.A.Koch, D.A.German & R.Karl.

Distribution: *Countries of occurrence*: Italy (Sicily).

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

Chromosome number: 2*n* = 16 (Romano et al. 1987).

Flowering and fruiting time: flowering from May to June, fruiting from July to August.

Reproduction: No detailed information is available.

Habitat and ecology: *Aubrieta columnae* subsp. *sicula* is a perennial plant belonging to orophilous carbonate communities referable to *Saxifragion australis* Biondi & Ballelli ex Brullo 1984 alliance [*Asplenietea trichomanis* (Br.-Bl. in Meier & Br.-Bl. 1934) Oberd. 1977 class]. This vegetation grows on limestone rocks with a maximum altitude of 1,900 m a.s.l. This subspecies is characteristic of this alliance together with *Cynanchica gussonei* (Boiss.) P.Caputo & Del Guacchio, *Draba turgida* É.Huet & A.Huet ex Ces., Pass. & Gibelli, *Helichrysum nebrodense* Heldr., *Hieracium symphytifolium* Froel., *Saxifraga callosa* subsp. *australis* (Moric.) Pignatti ex Tavilla & Del Guacchio, *Silene saxifraga* L. subsp. *rupicola* (É.Huet ex Nyman) C.Brullo & Brullo (Cambria 2020; Tavilla and Del Guacchio 2023).

Population information: The Madonie massif hosts the highest number of individuals, found in seven sites. Moreover, in almost all sites in which the species occurs, it is limited to single isolated stands. The Peloritani population is represented by over 100 mature individuals. This taxon occurs in rock crevices and occupies outcrops with limited growth surfaces. These rocky outcrops do not allow an accurate count of the individuals; in particular, this stand is located on a steep slope that makes the plants difficult to monitor, especially in the Madonie area.

Threats:

2.3 Livestock farming and ranching (nomadic grazing): grazing by goats poses a significant threat as they consume wild plants on outcrops at lower elevations, reaching even the most remote areas.

6.3 Work and other activities: the construction of the FlyEye astronomical observatory on Mt. Mufara will cause a significant disturbance to this population and nearby areas, such as Mt. Quacella and P. Carbonara (ESA 2018). Additionally, it is expected to attract more tourists to the area.

11.1 Habitat shifting and alteration: climate change alters environmental niches, causing species to shift their habitat range. Moreover, a shift in the flowering period was observed, probably due to changes in temperature and rainfall trends in Sicily (Cannarozzo et al. 2008; Viola et al. 2014) that may increase or decrease individual fertility.

CRITERIA APPLIED

Criterion B: **AOO:** 28 km^2 calculated with GeoCAT (Geospatial Conservation Assessment Tool) software (Bachman et al. 2011).

a) Severely fragmented.
b) Continuing decline observed and projected in: (iii) area extent and quality of habitat, and (iv) number of subpopulations or location.

Red List category and Criteria (Global Assessment)

EN	**Endangered**	**B2ab(iii,iv)**

Rationale for the assessment: Thanks to detailed fieldwork in Sicily, literature surveys, and confirmation of occurrences, the assessment of *Aubrieta columnae* subsp. *sicula* must be reevaluated. Due to the grazing that affected the species habitats and the ongoing climate change, a reduction in population size can be expected. In the investigations carried out, it was observed that most individuals flowered in May, while, until recent years, flowering peaks were observed in late June. This observation suggests a future threat to individual fertility, particularly in high Mediterranean mountain zones that are most vulnerable to climate change (Kazakis 2021). The future construction of the astronomical observatory on the top of Mt. Mufara is a concrete threat to the Madonie population. The construction of the observatory will attract more people to the area, leading to potential risks for this population. Furthermore, it should be highlighted that Mt. Mufara represents a connection point between the Mt. Quacella and Pizzo Carbonara sites. Hence, according to criterion B, *Aubrieta columnae* subsp. *sicula* can be assessed as Endangered (EN) based on its AOO of 28 km^2.

Previous assessment: This subspecies has been previously classified as vulnerable (VU) at a global level according to criterion D2 (Orsenigo et al. 2018; Rossi et al. 2020).

Conservation actions: Currently, *Aubrieta columnae* subsp. *sicula* grows only within Natura 2000 areas. In the Madonie massif, it is found in the SPA "Parco delle Madonie" (code ITA02050), and two SACs, viz. "Monte Quacella, Monte dei Cervi,

Pizzo Carbonara, Monte Ferro, Pizzo Otiero" (code ITA020016) and "Monte S. Salvatore, Monte Catarineci, Vallone Mandarini, Ambienti Umidi" (code ITA020004). All these sites are also located within the boundaries of the Madonie Regional Natural Park. In the Peloritani mountains, the species grows exclusively in the SAC "Rocca di Novara" (code ITA030006). Although it thrives in these nature reserves, *Aubrieta columnae* subsp. *sicula* is not protected by international, national, or regional laws.

Conservation actions needed: Further research is necessary to understand the reproductive biology, phenology, and population trends. Conducting research activities and establishing a monitoring program is recommended. Populations that are vulnerable to climate change should be regularly monitored through dedicated management actions. Additionally, in-situ and ex-situ conservation measures are suggested for potential plant translocation programmes to increase the number of individuals in the population.

Gianmarco Tavilla, Manuela Porrovecchio, Salvatore Cambria

Calligonum zakirovii (Khalk.) Czerep.

Global assessment
Taxonomy and nomenclature
Order: Polygonales *Family*: Polygonaceae

Calligonum zakirovii (Khalk.) Czerep., Vasc. Pl. Russia & Adj. States: 407 (1995).

Common name: Kandym zakirov (En).

Geographic distribution range: *Calligonum zakirovii* (Fig. 3) is a narrow endemic and locally rare shrub growing in the remnant lowlands of Kyzylkum desert in Uzbekistan (Khasanov et al. 2019). It occurs on the territory of Bukhara and Navoi regions (Fig. 4). This species was described by Khalkuziev (1966) as *Calliphysa zakirovii* from southwestern Kyzylkum on the southern part of Kuldzhuktau mountains, near the village of Churuk. Later, when dealing with the vascular plants of Russia and neighboring countries, Cherepanov (1995) renamed it as *Calligonum zakirovii*. In recent years, the subpopulations of Ayakguzhumdy and Chontabay, located in Navoi region, have been reported (Tojibaev et al. 2020). To date, only one population of this species is known, divided into three subpopulations (Fig. 4).

Distribution: *Countries of occurrence*: Uzbekistan.

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

Flowering and fruiting time: flowering from April to May and fruiting from May to June.

Reproduction: Literature sources do not provide enough information about reproduction.

Habitat and Ecology: *Calligonum zakirovii* is a shrub 70–150 cm high, with slightly curved branches, white flowers and spherical fruits (Khasanov et al. 2019). It occurs in fixed gypsum sands of the foothills at an altitude of 304–363 m a.s.l.

Figure 3. *Calligonum zakirovii* (Khalk.) Czerep. from Kyzylkum desert (Bukhara region Uzbekistan). Photograph by Khabibullo F. Shomurodov.

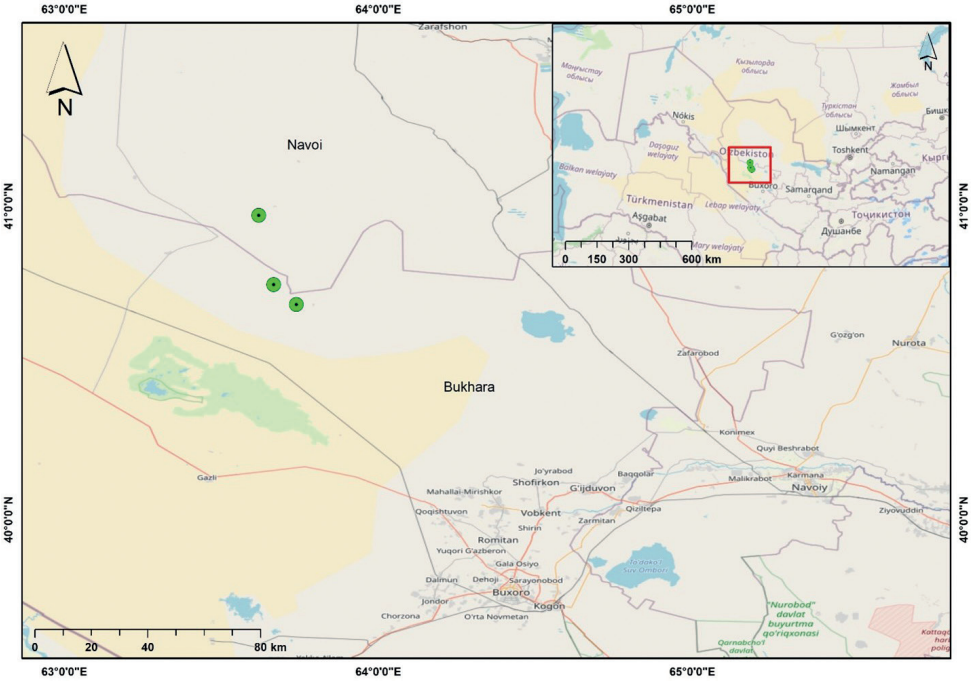

Figure 4. Geographic range and distribution map of *Calligonum zakirovii* in Kyzylkum desert (Uzbekistan).

According to Saribaeva (2009), the average annual temperature in the arid regions of the southern Kyzylkum, where it grows, is 17 °C, and the amount of precipitation is < 80 mm (Djangeldi weather station, 2007). It is recorded that all subpopulations, including the main one (Churuk), occur in phytocoenoses dominated by *Artemisia diffusa* Krasch. ex Poljakov and *Salsola arbuscula* Pall.

Population information: In 2019–2020 we observed the existence of two subpopulations of this species showing a total number of around 500 individuals (Tojibaev et al. 2020). Another small subpopulation was identified during field research in 2021–2023. Currently, there are 394 individuals in the Churuk subpopulation, and 103 and 11 in the Ayakguzhumdy and Chontabay subpopulations, for a total of 508 plants. Reproductive individuals are the majority (90.3%), senescent plants 5.8%, while juveniles represented only 3.9% of the total. The lack of historical data on the demographic structure of this population does not allow us to draw unambiguous conclusions about its dynamics, but the indicators of the demographic structure in all subpopulations revealed that the global population is in a regressive state.

Threats:

2.3 Livestock farming & ranching (*2.3.1 Nomadic grazing* and *2.3.2 Small-holder grazing, ranching or farming*): the Kyzylkum desert is used as a pasture for fattening small and large cattle in all seasons of the year (Shomurodov, Khasanov 2014) and continuous livestock grazing is one of the most destructive effects on the population (Shomurodov, Khabibullaev 2022). The use of the territory as an active pasture is responsible, in particular, for a sharp decline in young individuals of *C. zakirovii*.

4.1 Transportation & Service corridors (Roads & railroads): all subpopulations are crossed by roads that are actively used. A bush base is used to rescue cars that have become bogged down in the mud in winter. Roadside individuals are the most heavily damaged by this practice.

5.2 Gathering terrestrial plants (5.2.2 Unintentional effects [species is not the target]): branches of *C. zakirovii* are harvested and used as firewood by locals (Tojibaev et al. 2020).

11 Climate change & severe weather (Storms & flooding): due to climate change, frequent frosts observed during flowering and at the beginning of fruiting negatively affect rejuvenation of the population.

CRITERIA APPLIED:

Criterion B: **EOO:** 72 km^2 calculated with a GeoCAT (Geospatial Conservation Assessment Tool) software (Bachman et al. 2011).

AOO: 12 km^2 calculated with GeoCAT software and based on user defined cell width (2 km) (Bachman et al. 2011).

a) No more than three locations based on the main threat (*2.3 Livestock farming & ranching*).

b) Continuous decline observed in extent of occurrence: (i), area of occupancy (ii), extent and quality of habitat (iii), number of locations or subpopulations (iv), and number of mature individuals (v).

Red List category and Criteria (Global Assessment)

EN	**Endangered**	**B1ab(i,ii,iii,iv,v)+B2ab(i,ii,iii,iv,v)**

Rationale for the assessment: *Calligonum zakirovii* is endemic to the Kyzylkum desert where this plant has a very narrow range, consisting of a single population divided in three subpopulations. The northern subpopulation, located near Chontabay, is especially at risk of extinction being composed by only 11 individuals. The analysis of the demographic structure of subpopulations shows that the elimination of seedlings occurs for various reasons (livestock grazing, frosts, water erosion); the low proportion of juvenile plants suggested that the population has regressed in its recovery, while the high percentage of senescent individuals is an indication of a continuous decline in mature plants. Summarizing, *C. zakirovii*, considering the restricted EOO and AOO, the number of locations (three based on the main threat) and the continuous decline in extent of occurrence, area of occupancy, quality of habitat, number of subpopulations, and number of mature individuals, must be considered as Endangered (EN) at a global level.

Previous assessment: The taxon was not evaluated at the global level (IUCN 2023).

Conservation actions: As a rare and endemic species, since 2019, *C. zakirovii* has been included in the national Red Book of the Republic of Uzbekistan with category 1 (on the brink of extinction; Khasanov et al. 2019). The area where its population is distributed is not included in any reserve or protected area.

Conservation actions needed: Territories where *C. zakirovii* populations grow spontaneously should be included in protected areas; in fact, when protecting this species, first of all, necessary focus on subpopulations that are more prone to extirpation. In-situ and ex-situ conservation studies of this species are required. To protect juvenile plants from being trampled by livestock, translocation should be planned and carried out. Through joint projects and/or articles, it is necessary to make the international community aware of the actual situation of rare species in Uzbekistan (Orsenigo et al. 2022; Fenu et al. 2022) and thereby search for ways to solve the problem.

Khabibullo F. Shomurodov, Bekhruz Sh. Khabibullaev, Giuseppe Fenu

Santolina decumbens Mill. subsp. *tisoniana* Giacò & Peruzzi

Global assessment

Taxonomy and nomenclature

Order: Asterales *Family*: Asteraceae, Tribe: Anthemideae

Santolina decumbens Mill. subsp. *tisoniana* Giacò & Peruzzi J. Syst. Bot. 61: 13 of 16 (12 Dec 2022) [epublished]

Common name: This subspecies has no common name. The common names of *S. decumbens* are creeping hoary lavender-cotton (En), and santoline couchée (Fr).

Geographic distribution range: *Santolina decumbens* subsp. *tisoniana* (Fig. 5) was recently described by Giacò et al. (2023), and is endemic to a restricted area at Bouches-du-Rhône (southern France), approximately between Berre-L'Ėtang and Lançon-Provence (Fig. 6).

Distribution: *Countries of occurrence*: France.

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

Flowering and fruiting time: flowering from May to June and fruiting in July.

Reproduction: The pollination strategy is entomophily, and the most probable dispersal strategy is barochory (i.e., the seeds are dispersed just through gravity). There is no data concerning the germination rate of this subspecies.

Habitat and ecology: *Santolina decumbens* subsp. *tisoniana* is an evergreen aromatic shrub occurring in garrigues from 5 to 160 m a.s.l., on poor calcareous soils. It is associated with other Mediterranean thermophilous plants, such as *Cistus albidus* L., *Rhaponticum coniferum* (L.) Greuter, *Staehelina dubia* L., and *Thymus vulgaris* L.

Population information: The distribution of *S. decumbens* subsp. *tisoniana* covers less than 25 km^2. In this small area, the single extant population is severely fragmented in nine small sites that are located at least 1 km apart; five fall within a strongly anthropized area, whereas four fall in the ZPS ("Zone de Protection Spéciale" of the network Natura 2000) "Garrigues de Lançon et Chaînes alentour". However, according to our field observations, this taxon is rarer in the latter zone. In the ZPS, a natural recolonization, resulting in reconnection of the isolated sites, is improbable due to the scarce dispersal capability of the diaspores. In the anthropized area, a natural recolonization is probably impossible due to the high percentage of land used for human activities.

Figure 5. *Santolina decumbens* Mill. subsp. *tisoniana* Giacò & Peruzzi. Photograph by Lorenzo Peruzzi.

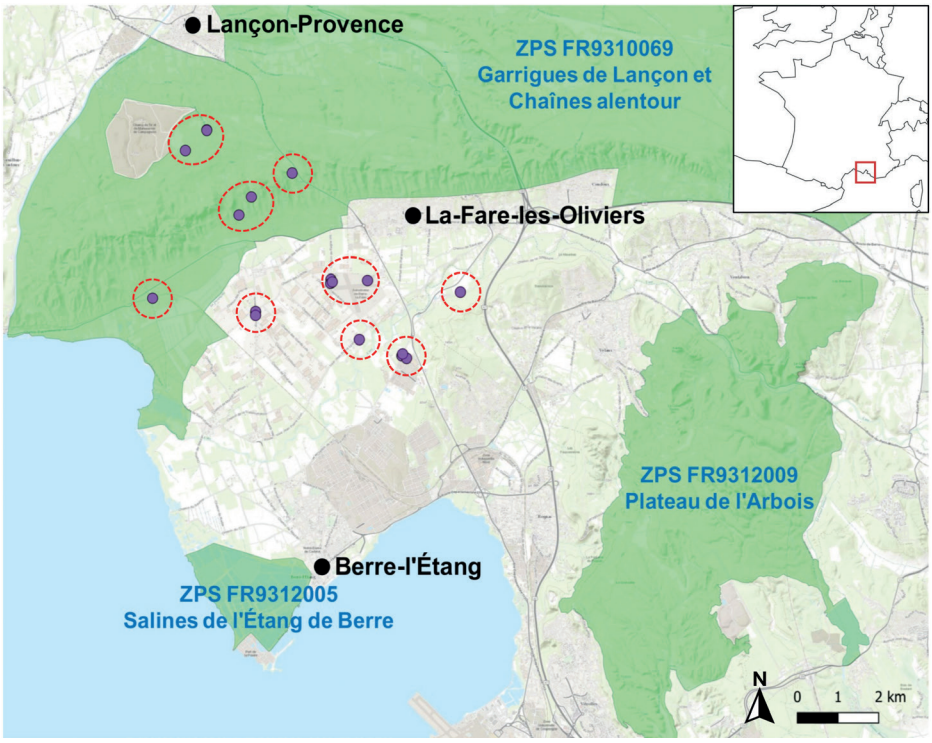

Figure 6. Distribution map of *Santolina decumbens* Mill. subsp. *tisoniana* Giacò & Peruzzi. The nine isolated sites are circled in red.

Threats:

1.1 Housing & Urban Areas and *1.2 Commercial & Industrial Areas*: most of the population grows in a strongly anthropized area potentially affected by the expansion of both suburbs and industrial activities. Since the taxon was just recently described (Giacò et al. 2023), there is no previous demographic information, but it can be hypothesized that this subspecies was more abundant in its small range before the urbanization and the expansion of human activities.

7.1.1 Increase in Fire Frequency/Intensity: the south-eastern portion of France is strongly affected by wildfires, especially during the summer period (San-Miguel-Ayanz et al. 2022). A wildfire in the ZPS "Garrigues de Lançon et Chaînes alentour", a typical Mediterranean scrubland, can be a huge threat for that portion of the population growing in semi-natural environments.

11.2 Habitat Shifting & Alteration and *11.3 Droughts*: *Santolina decumbens* subsp. *tisoniana* grows in Mediterranean environments with long periods of summer drought. Climate change could exacerbate these conditions, leading to a highly inhospitable environment.

CRITERIA APPLIED:

Criterion B: **EOO:** 40 km^2 calculated with GeoCAT (Geospatial Conservation Assessment Tool) software (Bachman et al. 2011).

AOO: 40 km^{2}calculated with GeoCAT software (Bachman et al. 2011).

a) Severely fragmented.
b) Continuing decline projected in: (iii) area extent and quality of habitat.

Red List category and Criteria (Global Assessment)

CR	**Critically Endangered**	**B1ab(iii)**

Rationale for the assessment: Giacò et al. (2023) pointed out the need for an extinction risk assessment. Indeed, *S. decumbens* subsp. *tisoniana* is endemic to a very restricted area at Bouches-du-Rhône. Here, it can be found in the protected area (ZPS) "Garrigues de Lançon et Chaînes alentour", but it is more common in the southernmost anthropized area potentially affected by further expansion of urbanization and industrial activities. During fieldworks in 2020 and 2023, a strong fragmentation was observed both in the ZPS and in the anthropized area. By applying the criterion B, considering the EOO of 40 km^2, the low quality of the habitat and the strong fragmentation, this taxon has to be considered as critically endangered at a global level.

Previous assessment: This subspecies was not previously evaluated (IUCN 2023).

Conservation actions: A portion of the single extant population falls in the ZPS "Garrigues de Lançon et Chaînes alentour". During summer 2023, seeds were collected and stored in the seed bank of the PLANTSEED Lab, Department of Biology, University of Pisa (Italy). In addition, plants will be cultivated in the Botanic Garden of Pisa.

Conservation actions needed: Periodical monitoring would be helpful to understand demographic trends.

Antonio Giacò, Lorenzo Peruzzi

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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]

Brullo S, Minissale P, Spampinato G (1995) Considerazioni fitogeografiche sulla flora della Sicilia. Ecologia Mediterranea 21: 99–117. https://doi.org/10.3406/ecmed.1995.1759

Cambria S (2020) Vegetation prodrome of Sicily. PhD Thesis in Geological, Biological and Environmental Sciences, University of Catania.

Cannarozzo M, Noto L, V, Viola F (2006) Spatial distribution of rainfall trends in Sicily (1921–2000). Physics and Chemistry of the Earth, Parts a/b/c, 31(18): 1201–1211. https://doi.org/10.1016/j.pce.2006.03.022

Czerepanov SK (1995) Vascular Plats of Russia and Adjacent Sates (the former USSR). Cambridge university press, Cambridge, 407 pp.

Domina G, Peruzzi L, Bedini G [Eds] (2016) onwards. Wikiplantbase #Sicilia. http://bot.biologia.unipi.it/wpb/sicilia [Accessed 2023]

ESA (2018) One step closer to the Flyeye network. [Available at:] https://www.esa.int/ESA_Multimedia/Images/2018/11/One_step_closer_to_the_Flyeye_network [Accessed: 2023]

Fenu G, Al-Rammahi HM, Cambria S, Cristaudo AE, Khabibullaev BS, Mohammad MK, Shomurodov KF, Tavilla G, Orsenigo S (2022) Global and Regional IUCN Red List Assessments: 14. Italian Botanist 14: 81–94. https://doi.org/10.3897/italianbotanist.14.97176

Giacò A, Varaldo L, Casazza G, De Luca D, Caputo P, Sarigu M, Bacchetta G, Sáez L, Peruzzi L (2023) An integrative taxonomic study of *Santolina* (Asteraceae) from southern France and north-eastern Spain reveals new endemic taxa. Journal of Systematic and Evolution 61(5): 827–842. https://doi.org/10.1111/jse.12925

IUCN (2023) The IUCN Red List of Threatened Species. Version 2022-2. https://www.iucnredlist.org [Accessed on 5 September 2023]

Kazakis G, Ghosn D, Remoundou I, Nyktas P, Talias MA, Vogiatzakis IN (2021) Altitudinal vascular plant richness and climate change in the alpine zone of the Lefka Ori, Crete. Diversity 13(1): 1–22. https://doi.org/10.3390/d13010022

Khalkuziev P (1990) On the Relationship of some Plant Families of Desert Regions, 85 pp.

Khasanov FO, Kuchkarov BT, Tozhibaev KSh, Pratov UP, Belolipov IV, Shomurodov HF, Beshko NYu, Mukhtoraliev SG (2019) The Red Data Book of The Republic of Uzbekistan. Chinor ENK, Tashkent.

Nicotra L (1880) Notizie intorno alla vegetazione del Salvatesta. Nuovo Giornale Botanico Italiano 12: 366–370.

Orsenigo S, Cambria S, Khabibullaev BSh, Shomurodov FKh, Tavilla G, Troia A, Fenu G (2022) Global and Regional IUCN Red List Assessments: 13. Italian Botanist 13: 85–94. https://doi.org/10.3897/italianbotanist.13.86714

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 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

Romano S, Mazzola P, Raimondo FM (1987) Numeri cromosomici per la flora italiana: 1106–1117. Informatore Botanico Italiano 19(2): 173–180.

Rossi G, Orsenigo S, Gargano D, Montagnani C, Peruzzi L, Fenu G, Abeli T, Alessandrini A, Astuti G, Bacchetta G, Bartolucci F, Bernardo L, Bovio M, Brullo S, Carta A, Castello M, Cogoni D, Conti F, Domina G, Foggi B, Gennai M, Gigante D, Iberite M, Lasen C, Magrini S, Nicolella G, Pinna MS, Poggio L, Prosser F, Santangelo A, Selvaggi A, Stinca A, Tartaglini N, Troìa A, Villani MC, Wagensommer RP, Wilhalm T, Blasi C (2020) Lista Rossa della Flora Italiana. 2 Endemiti e altre specie minacciate. Ministero dell'Ambiente e della Tutela del Territorio e del Mare.

San-Miguel-Ayanz J, Durrant T, Boca R, Maianti P, Libertá G, Artés-Vivancos T, Oom D, Branco A, de Rigo D, Ferrari D, Pfeiffer H, Grecchi R, Onida M, Löffler P (2022) Forest Fires in Europe, Middle East and North Africa 2021. Publications Office of the European Union, Luxembourg. https://doi.org/10.2760/34094

Saribaeva ShU (2009) Description of bioecological characteristics and senopopulations of *Astragalus centralis* YE. Sheld. in South-Western Kyzylkum conditions. PhD dissertation, Toshkent, 22–24.

Sciandrello S, Guarino R, Minissale P, Spampinato G (2015) The endemic vascular flora of Peloritani Mountains (NE Sicily): Plant functional traits and phytogeographical relationships in the most isolated and fragmentary micro-plate of the Alpine orogeny, Plant Biosystems 149(5): 838–854. https://doi.org/10.1080/11263504.2014.908978

Shomurodov HF, Khasanov FO (2014) Fodder plants of the Kyzyl Kum Desert. Arid Ecosystems 4: 208–213. https://doi.org/10.1134/S2079096114030093

Shomurodov KhF, Khabibullaev BSh (2022) Investigation of changes in the species composition within the plant community containing relict shrub *Moluccella bucharica* for half a century Malayan Nature Journal 74(1): 19–29.

Tavilla G, Del Guacchio E (2023) An updated taxonomic treatment for *Saxifraga callosa* sensu amplo (Saxifragaceae). Phytotaxa 622(2): 165–171. https://doi.org/10.11646/phytotaxa.622.2.6

Tojibaev KSh, Beshko NY, Shomurodov KhF, Abduraimov OS, Adilov BA, Rakhimova T, Rakhimova NK, Polvonov FI, Saribaeva ShU, Khabibullaev BSh, Khaitov RSh, Sharipova VK, Esanov KhK (2020) Cadastre of flora of Uzbekistan: Bukhara region. O'qituvchi, Tashkent, 24–29.

Viola F, Liuzzo L, Noto LV, Lo Conti F, La Loggia G (2014) Spatial distribution of temperature trends in Sicily. International Journal of Climatology 34(1): 1–17. https://doi.org/10.1002/joc.3657

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RESEARCH ARTICLE

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Chromosome numbers for the Italian flora: 13

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Abstract

In this contribution, new chromosome data obtained on material collected in Italy are presented. It includes the first count for *Dianthus carthusianorum* subsp. *tenorei*, *Helosciadium nodiflorum*, *Hieracium hypochoeroides* subsp. *cilentanum*, *H. lesimanum*, *H. scopolioides*, *H. terraccianoi*. In addition, first Italian counts for *Crupina vulgaris*, *Damasonium alisma*, and *Illecebrum verticillatum* are reported.

Keywords

Caryophyllaceae, cytotaxonomy, endopolyploidy, *Hieracium*, Sardegna, seasonal water bodies

How to contribute

Texts concerning new chromosome data should be submitted electronically to Antonio Giacò (antonio.giacò@biologia.unipi.it), including indications on voucher specimens and methods used.

Chromosome counts

***Damasonium alisma* Mill. (Alismataceae)**

Chromosome number. $2n = 28$ (Fig. 1).

Voucher specimen. Italy. Sardegna. Funtana Satoa (Montresta, Oristano), stagno temporaneo mediterraneo, 479 m a.s.l. (WGS84: 40.359688N, 8.490948E), 8 April 2023, *G. Rivieccio, M.C. Caria, S. Bagella* (seeds collected in the field and stored in the Sardinian Germplasm Bank of the University of Cagliari, under acc. BG-SAR 91/23).

Method. Squash preparations were made on root tips obtained from seedlings collected in the field. The material was treated with 0.3% colchicine solution for three hours, and then fixed in a modified Carnoy solution (5:2) for 30 minutes. After washing in water, tissues were hydrolyzed in 1 N HCl for 8 min at 60 °C, put in the Schiff reactive for 30 min, and squashed and stained in 50% acetic acid (Bagella et al. 2011).

Observations. According to Rich and Nicholls-Vuille (2001) this species is tetraploid with $2n = 4x = 28$ chromosomes, and considered as a northern counterpart of the diploid *D. bourgaei* Coss. with $2n = 2x = 14$. *Damasonium alisma* is distributed throughout England, France, Italy, Portugal, Russia, and Ukraine (Rich and Nicholls-Vuille 2001; Talavera and Talavera 2010). In Italy its presence is confirmed for Toscana, Lazio, Campania, Puglia, and Sicilia (Portal to the Flora of Italy 2023). Nevertheless, it was reported in recent years, for the habitat 3120 characterized by oligotrophic water and amphibious vegetation, in several localities of Sardegna (Bagella et al. 2009; Bagella and Caria 2013; Bagella et al. 2018). Pignatti (2017a) also considered the species present in this region.

Figure 1. *Damasonium alisma* Mill. from Funtana Satoa (Montresta, Oristano), $2n = 28$. Scale bar: 10 µm.

Our chromosome count aligns with that of the tetraploid *D. alisma*, confirming the occurrence of this species in Sardegna. As regards other Italian populations, a further count for *D. alisma* is reported for Sicilia (Bartolo et al. 1981 under the name *D. stellatum* Thuill.; Bedini and Peruzzi 2021 onwards), but it shows a diploid chromosome number. Indeed, in Sicilia *D. bourgaei* is also reported (Portal to the Flora of Italy 2023), pointing to a possible misidentification. In order to clarify the distribution of these two taxa in Italy, a more in-depth study involving both morphological and karyological aspects is needed.

G. Rivieccio, M. Urbani, M.C. Caria, S. Bagella

***Helosciadium crassipes* W.D.J.Koch ex Rchb. (Apiaceae)**

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

Voucher specimen. Italy. Sardegna. Perdiana (Mogoro, Oristano), stagno mediterraneo temporaneo, 479 m a.s.l. (WGS84: 40.359796N, 8.490924E), 26 March 2020, *G. Rivieccio, M.C. Caria, S. Bagella* (SS-2000/6723).

Method. Squash preparations were made on root tips obtained from seedlings collected in the field. The material was treated with 0.3% colchicine solution for three hours, and then fixed in a modified Carnoy solution (5:2) for 30 minutes. After washing in water, tissues were hydrolyzed in 1 N HCl for 8 min at 60 °C, put in the Schiff reactive for 30 min, and squashed and stained in 50% acetic acid (Bagella et al. 2011).

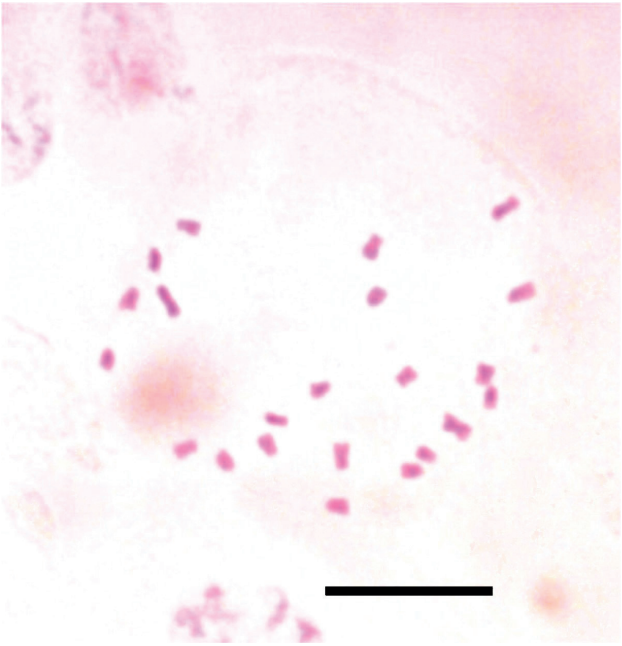

Figure 2. *Helosciadium crassipes* W.D.J.Koch ex Rchb. from Perdiana (Mogoro, Oristano), 2*n* = 22. Scale bar: 10 μm.

Observations. This species is distributed in southern Italy, Corsica and parts of North Africa (Ronse et al. 2010). In Italy, its presence is confirmed for Lazio, Sardegna and Sicilia (Portal to the Flora of Italy 2023). It is found in shallow seasonal ponds that typically appear in winter or late spring. These habitats support amphibian vegetation and are associated with the *Preslion cervinae* alliance related to the Habitat Directive's habitat 3120 (Bagella et al. 2010; Rivieccio et al. 2020). The chromosome number for this species was unknown so far according to Stinca and Ricciardi (2018) and Arrigoni (2006). The chromosome number here reported is consistent with those reported for the closely related *H. inundatum* species group (Ronse et al. 2010), as well as for most of the other related *Helosciadium* W.D.J.Koch and *Apium* L. species (Constance et al. 1976).

G. Rivieccio, G. Becca, M.C. Caria, S. Bagella

***Hieracium terraccianoi* Di Grist., Gottschl. & Raimondo (Asteraceae)**

Chromosome number. $2n = 36$ (Fig. 3).

Voucher specimen. Italy. Calabria. Scala di Gaudolino (Morano Calabro, Cosenza) (WGS84: 39.900306N, 16.169194E), carbonate rocky slopes, 1,350 m a.s.l., 23 July 2022, *E. Di Gristina & E. Bajona* (SAF n°100107).

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 for 7–8 minutes, the tips were stained in leuco-basic fuchsine for 3 hours.

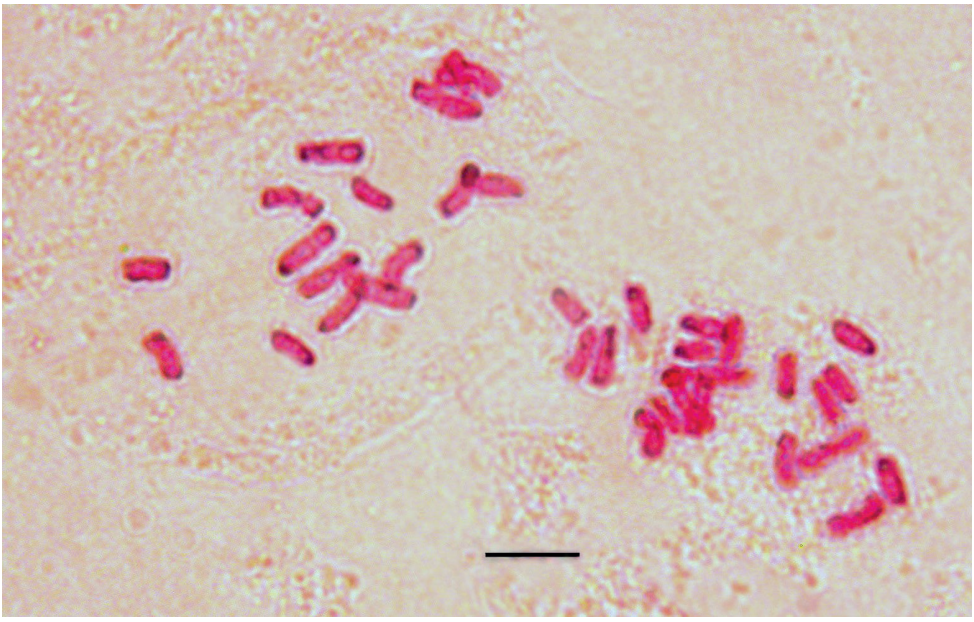

Figure 3. *Hieracium terraccianoi* Di Grist., Gottschl. & Raimondo from Scala di Gaudolino (Morano Calabro, Cosenza), $2n = 36$. Scale bar: 10 µm.

Observations. *Hieracium terraccianoi* is a pseudorosulate hemicryptophytic hawkweed endemic to the Pollino National Park (Calabrian side of the Pollino Massif) (Di Gristina et al. 2014a), and it belongs to a complex of similar morphotypes which have been grouped together in *Hieracium* sect. *Grovesiana* Gottschl. (Gottschlich et al. 2013). The chromosome number $2n = 4x = 36$ (Fig. 1), found here for the first time on material from the type locality of this species, agrees with counts available ($2n = 27$, $2n = 36$) for other taxa belonging to the *H.* sect. *Grovesiana* (Brullo et al. 2005; Di Gristina et al. 2005; Di Gristina et al. 2014b; Di Gristina et al. 2021).

E. Bajona, G. Barone, E. Di Gristina

***Hieracium hypochoeroides* S.Gibson subsp. *cilentanum* Di Grist., Gottschl. & Raimondo (Asteraceae)**

Chromosome number. $2n = 27$ (Fig. 4).

Voucher specimen. Italy. Campania. Monte Cervati (Sanza, Salerno) (WGS84: 40.290278N, 15.478333E), carbonate rocks, 1,860 m a.s.l., 24 July 2022, *E. Di Gristina & E. Bajona* (SAF n°100106).

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

Figure 4. *Hieracium hypochoeroides* subsp. *cilentanum* Di Grist., Gottschl. & Raimondo from Mt. Cervati (Sanza, Salerno), $2n = 27$. Scale bar: 10 µm.

Carnoy fixative solution for 1 hour. After hydrolysis in HCl 1N at 60 °C for 7–8 minutes, the tips were stained in leuco-basic fuchsine for 3 hours.

Observations. *Hieracium hypochoeroides* subsp. *cilentanum* is a chasmophytic hawkweed endemic to Mount Cervati (Campania, S Italy) (Di Gristina et al. 2016). The *H. hypochoeroides* aggregate includes many apomictic taxa which have probably evolved during the post-glacial period (Di Gristina et al. 2015a). Many of the taxa described so far are narrow endemics, likely relict in southern Europe (Di Gristina et al. 2015b). The chromosome number $2n = 3x = 27$ (Fig. 2), reported here for the first time on material from the type locality of this subspecies, agrees with counts ($2n = 27$, $2n = 36$) available for the *H. hypochoeroides* aggregate (Sell and West 1976; Di Gristina et al. 2021).

E. Bajona, G. Barone, E. Di Gristina

***Hieracium lesimanum* Gottschl. & S.Orsenigo (Asteraceae)**

Chromosome number. $2n = 27$ (Fig. 5).

Voucher specimen. Italy. Emilia-Romagna. Mount Lesima (Zerba, Piacenza) WGS84: 44.68717N, 9.25339E), meadows along the road to the summit, 1500–1650 m, 3 August 2021, *R. Oldani, S. Orsenigo* (PAV).

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 for 7–8 minutes, the tips were stained in leuco-basic fuchsine for 3 hours.

Figure 5. *Hieracium lesimanum* Gottschl. & S.Orsenigo from Mt. Lesima (Zerba, Piacenza), $2n = 27$. Scale bar: 10 μm.

Observations. *Hieracium lesimanum* is a perennial montane species described in 2021 for Mount Lesima, in the Ligurian Apennines. It is known only from the type locality, where it was found only in a restricted area on the northern slope at elevations between 1,550 and 1,650 m a.s.l. (Gottschlich and Orsenigo 2021). The chromosome number $2n = 3x = 27$, reported here for the first time, is consistent with observations made in other taxa belonging to *H.* sect. *Prenanthoidea* Koch such as the *H. prenanthoides* Vill. aggregate in Europe (Chrtek et al. 1996; Zdvorak et al. 2020).

F. Fainelli, S. Orsenigo

***Hieracium scopolioides* Gottschl. & S.Orsenigo (Asteraceae)**

Chromosome number. $2n = 27$ (Fig. 6).

Voucher specimen. Italy. Emilia-Romagna. Mount Lesima (Zerba, Piacenza) (WGS84: 44.68717N, 9.25339E), meadows along the road to the summit, 1500–1650 m, 3 August 2021, *R. Oldani, S. Orsenigo* (PAV).

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 for 7–8 minutes, the tips were stained in leuco-basic fuchsine for 3 hours.

Observations. *Hieracium scopolioides* is a perennial species endemic to the northern Apennines (Gottschlich and Orsenigo 2021). It is currently known only for Mount Lesima, in the Ligurian Apennines, where its range overlaps those of *H. lesimanum* Gottschl. & S.Orsenigo and *H. scopolii* Gottschl. & S.Orsenigo. The chromosome number $2n = 3x = 27$, reported here for the first time on material from the type locality, is consistent with the ploidy level reported for *H. umbrosum* subsp. *oleicolor* (Zahn)

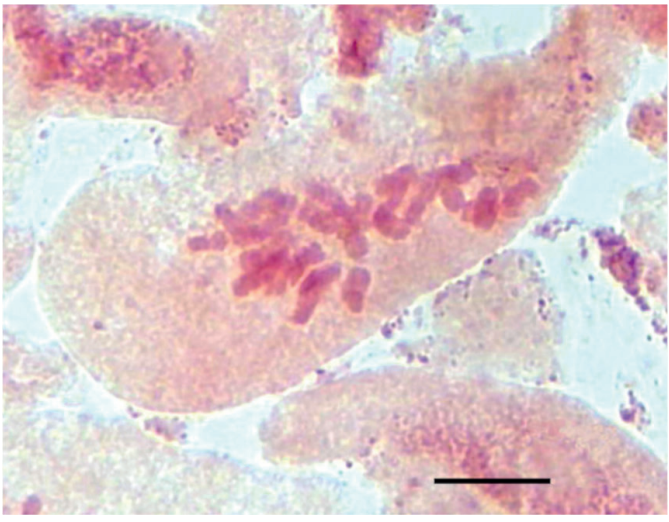

Figure 6. *Hieracium scopolioides* Gottschl. & S.Orsenigo from Mt. Lesima (Zerba, Piacenza), $2n = 27$. Scale bar: 10 µm.

Greuter (Schuhwerk 2010). The latter taxon is the only member of *H.* sect. *Umbrosa* Stace & P.D.Sell. for which a chromosome count is available.

F. Fainelli, S. Orsenigo

***Dianthus carthusianorum* L. subsp. *tenorei* (Lacaita) Pignatti (Caryophyllaceae)**

Chromosome number. $2n = 30$ (Fig. 7a).

Voucher specimen. Italy. Basilicata. Monte Pollino (Terranova di Pollino, Potenza) (WGS84: 39.906303N, 16.190823E), vallette lungo il crinale sud-orientale, 2000 m, 11 August 2023, *L. Peruzzi* (seeds collected and deposited at the germplasm bank of the Department of Biology, University of Pisa; IPEN: IT-0-PI-2023-0498; a herbarium specimen collected from the same area in 1994 is conserved at CLU2042).

Method. Squash preparations were made on root tips obtained from germinating seeds. Root tips were pre-treated with 0.4% colchicine for 3 h and then fixed in Carnoy solution for 1 h. After hydrolysis in 1 N HCl at 60 °C for 8.5 minutes, the tips were stained with leuco-basic fuchsine.

Observations. *Dianthus carthusianorum* subsp. *tenorei* is a subspecies endemic to Italy (Peruzzi et al. 2015), distributed in southern-central Apennines, from Marche to Calabria (Pignatti 2017b, Bartolucci et al. 2018). Here we report the first chromosome count for this subspecies, further confirming the numbers obtained for other subspecies in Italy and central-eastern Europe (Fedorov 1969; Holub et al. 1972; Löve 1975; Löve and Löve 1982; Kovanda 1984; Baltisberger and Widmer 2009). Although most of the cells observed contained $2n = 30$ chromosomes, we also found, within the same root tip, some cells showing $2n = 60$ chromosomes (Fig. 1b). Indeed, endopolyploidy is

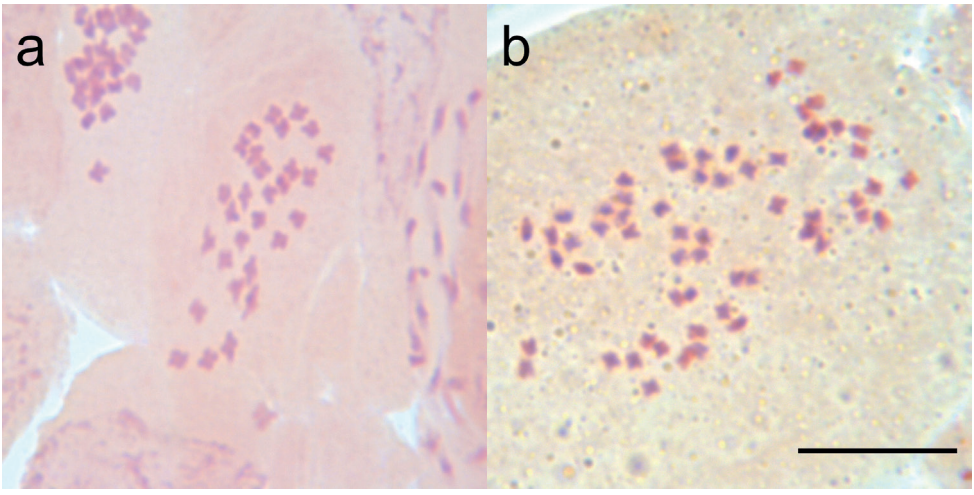

Figure 7. *Dianthus carthusianorum* L. subsp. *tenorei* (Lacaita) Pignatti from Monte Pollino (Basilicata): (**a**) diploid cell, $2n = 30$, (**b**) endotetraploid cell, $2n = 60$. Scale bar: 10 µm.

a common phenomenon in many *Dianthus* species (Agulló-Antón et al. 2013; Terlević et al. 2022; Franzoni et al. 2023).

J. Franzoni, M. Paliy, L. Peruzzi

***Illecebrum verticillatum* L. (Caryophyllaceae)**

Chromosome number. 2*n* = 10 (Fig. 8).

Voucher specimen. Italy. Toscana. Montalbano, Prato Rosello (Carmignano, Prato) (WGS84: 43.77028N, 11.03722E), 9 July 2023, *L. Peruzzi* (seeds collected and deposited at the germplasm bank of the Department of Biology, University of Pisa; IPEN: IT-0-PI-2023-0497; a herbarium specimen collected from the same area in 2008 is conserved at PI062694).

Method. Squash preparations were made on root tips obtained from germinating seeds. Root tips were pre-treated with 0.4% colchicine for 3 h and then fixed in Carnoy solution for 1 h. After hydrolysis in 1N HCl at 60 °C for 8.5 minutes, the tips were stained with leuco-basic fuchsine.

Observations. *Illecebrum verticillatum* is a sub-Atlantic species, growing in temporary ponds throughout Europe and North Africa (Marhold 2011). In Italy, this species occurs in Piemonte, Sardegna and Toscana, whereas its presence has not been recently

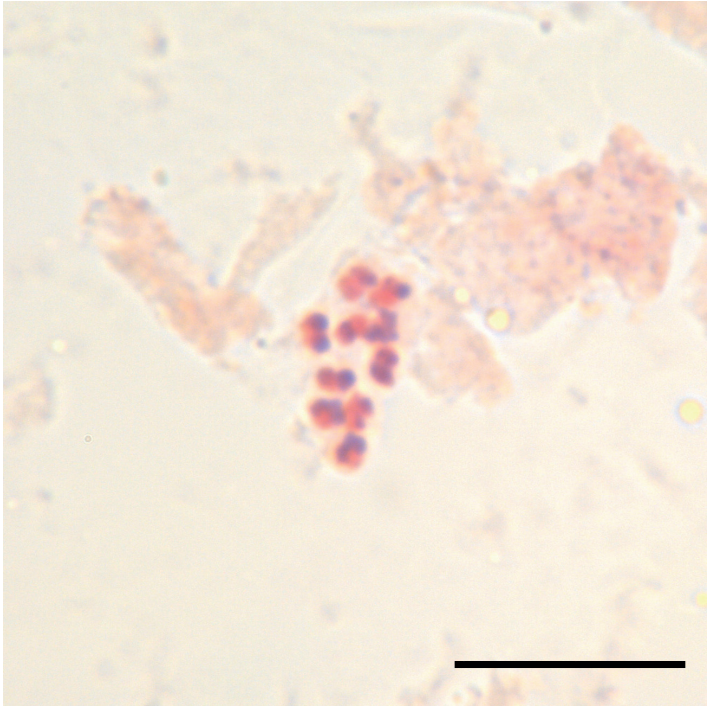

Figure 8. *Illecebrum verticillatum* L. from Prato Rosello (Toscana), 2*n* = 10. Scale bar: 10 µm.

confirmed in Lazio, Lombardia and Marche, while it is doubtfully occurring in Abruzzo (Bartolucci et al. 2018). Specifically, in Toscana this species is quite rare, and the few recently confirmed localities occur in a single area of Montalbano, in the municipality of Carmignano (Prato) (Gestri and Peruzzi 2013). The material collected from this area shows $2n = 10$ chromosomes. Although the same chromosome number was already known for elsewhere in Europe (Fedorov 1969; Löve 1976; Dvořák and Dadáková 1984; Dalgaard 1985), this count is the first for Italian populations of this species.

J. Franzoni, M. Paliy, L. Peruzzi

***Crupina vulgaris* Cass. (Asteraceae)**

Chromosome number. $2n = 30$ (Fig. 9).

Voucher specimen. Italy. Piemonte. A sud di Acqui Terme (Acqui Terme, Alessandria) (WGS84: 44.651056N, 8.4702228E), 8 July 2023, *A. Giacò & A. Mo* (seeds collected and deposited at the germplasm bank of the Department of Biology, University of Pisa; IPEN: IT-0-PI-2023-0496; a herbarium specimen is conserved at PI064811).

Method. Squash preparations were made on root tips obtained from germinating seeds. Root tips were pre-treated with 0.4% colchicine for 3 h and then fixed in Carnoy solution for 1 h. After hydrolysis in 1 N HCl at 60 °C for 8.5 minutes, the tips were stained with leuco-basic fuchsine.

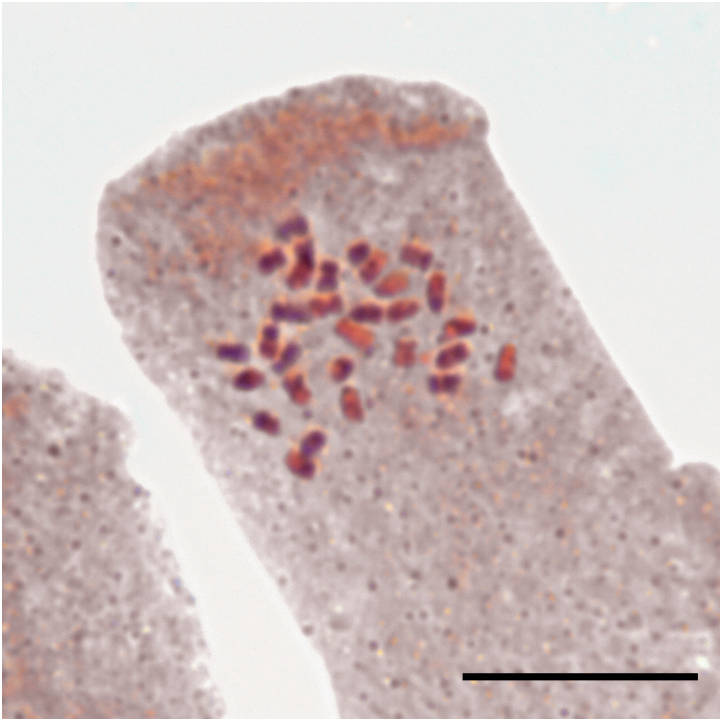

Figure 9. *Crupina vulgaris* Cass. from Acqui Terme (Piemonte), $2n = 30$. Scale bar: 10 µm.

Observations. *Crupina vulgaris* is widespread in southern Europe, reaching also northern Africa and eastern Europe (do Amaral Franco 1976, Greuter 2006 onwards). In Italy, the distribution range of this species overlaps with *C. crupinastrum* (Moris) Vis. (2*n* = 28), a more Mediterranean taxon, and with *C. intermedia* (Mutel) Walp. (2*n* = 58), an allopolyploid species of hybrid origin (Domina and Iamonico 2019). Here we report the first chromosome count for an Italian population of *C. vulgaris*. Our result agrees with counts made for other European populations (Fedorov 1969; Löve 1979, 1980; Luque and Díaz Lifante 1991; Petrova and Vladimirov 2020).

J. Franzoni, M. Paliy, A. Giacò

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References

Agulló-Antón MÁ, Olmos E, Pérez-Pérez JM, Acosta M (2013) Evaluation of ploidy level and endoreduplication in carnation (*Dianthus* spp.). Plant Science 201–202: 1–11. https://doi.org/10.1016/j.plantsci.2012.11.006

Amaral Franco J do (1976) *Crupina* (Pers.) Cass. In: Tutin TG, Heywood VH, Burges NA, Valentine DH, Walters SM, Webb DA (Eds) Flora Europaea (Vol. 4). Cambridge University Press, Cambridge, 301 pp.

Arrigoni PV (2006) Flora dell'Isola di Sardegna 1. Delfino, 280 pp.

Bagella S, Caria MC, Filigheddu RS, Farris E (2009) Phytosociological analysis in Sardinian Mediterranean temporary wet habitats. Fitosociologia 46(1): 11–26.

Bagella S, Caria MC (2013) Sensitivity of ephemeral wetland swards with *Isoetes histrix* Bory to environmental variables: Implications for the conservation of Mediterranean temporary ponds. Aquatic Conservation: Marine and Freshwater Ecosystems 23(2): 277–290. https://doi.org/10.1002/aqc.2290

Bagella S, Caria MC, Beccarisi L, Zuccarello V (2018) Ecological responses of selected vascular plants to water chemistry parameters in habitat types 3120, 3130 and 3170* (Habitat Directive 92/43/EEC). Plant Biosystems 152(6): 1338–1345. https://doi.org/10.1080/11263504.2018.1461697

Baltisberger M, Widmer A (2009) Karyological data of some angiosperms from Romania. Willdenowia 39: 353–363. https://doi.org/10.3372/wi.39.39213

Bartolo G, Brullo S, Pavone P (1981) Números cromosomáticos de plantas occidentales, 138–156. Anales del Jardin Botánico de Madrid 38(1): 289–299.

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: 179–303. https://doi.org/10.1080/11263504.2017.1419996

Bedini G, Peruzzi L (2021 [onwards]) Chrobase.it. Chromosome numbers for the Italian flora v. 2.0. http://bot.biologia.unipi.it/chrobase/ [accessed 27 October 2023]

Brullo S, Campo G, Romano S (2005) Indagini citotassonomiche sul genere *Hieracium* L. (Asteraceae) in Sicilia. Informatore Botanico Italiano 36(2): 481–485.

Chrtek JJ (1996) Chromosome numbers in selected species of *Hieracium* (Compositae) in the Sudeten Mts. and the Western and Ukrainian Eastern Carpathians. Fragmenta Floristica et Geobotanica 41(2): 321–332.

Constance L, Chuang TI, Bell CR (1976) Chromosome numbers in Umbelliferae. V. American Journal of Botany 63(5): 608–625. https://doi.org/10.1002/j.1537-2197.1976.tb11849.x

Dalgaard V (1985) Chromosome studies in flowering plants from Madeira. Willdenowia 15: 137–156.

Di Gristina E, Geraci A, Raimondo FM (2005) Osservazioni citotassonomiche su popolazioni siciliane afferenti a *Hieracium pallidum* (Asteraceae). Informatore Botanico Italiano 37(1): 26–27.

Di Gristina E, Gottschlich G, Raimondo FM (2014a) *Hieracium terraccianoi* (Asteraceae), a new species endemic to the Pollino National Park (Southern Italy). Phytotaxa 188(1): 55–60. https://doi.org/10.11646/phytotaxa.188.1.8

Di Gristina E, Domina G, Geraci A (2014b) Report 1837. In: Kamari G, Blanché C, Siljak-Yakovlev S (Eds) Mediterranean Chromosome Number Reports – 24. Flora Mediterranea 24: 283–284.

Di Gristina E, Gottschlich G, Raimondo FM (2015a) *Hieracium hypochoeroides* subsp. *peracutisquamum* (Asteraceae), a new taxon from Basilicata, southern Italy. Annales Botanici Fennici 52: 376–380. https://doi.org/10.5735/085.052.0519

Di Gristina E, Gottschlich G, Raimondo FM (2015b) Taxonomic remarks on *Hieracium sartorianum* var. *lucanicum* (Asteraceae), a little known taxon of Cilento (Campania, southern Italy). Nordic Journal of Botany 33: 465–468. https://doi.org/10.1111/njb.00755

Di Gristina E, Gottschlich G, Raimondo FM (2016) *Hieracium hypochoeroides* subsp. *cilentanum* (Asteraceae), a new taxon from S Italy. Phytotaxa 246(3): 192–197. https://doi.org/10.11646/phytotaxa.246.3.3

Di Gristina E, Domina G, Geraci A (2021) Karyological data of three *Hieracium* (*Asteraceae*) from Sicily and South Italy. Flora Mediterranea 31: 336–340. https://doi.org/10.7320/FlMedit31.336

Domina G, Iamonico D (2019) *Crupina* (Pers.) DC. In: Pignatti S (Ed.) Flora d'Italia (Vol. 3). Edagricole-New Business Media, Milano, 969–970.

Dvořák F, Dadáková B (1984) Chromosome counts and chromosome morphology of some selected species. Folia Geobotanica et Phytotaxonomica 19: 41–70. https://doi.org/10.1007/BF02853329

Fedorov AA [Ed.] (1969) Chromosomnye cisla cvetkovych rastenij. Academy of Sciences of the USSR, V. L. Komarov Botanical Institute, Leningrad.

Franzoni J, Astuti G, Bacchetta G, Barone G, Bartolucci F, Bernardo L, Carta A, Conti F, Domina G, Frajman B, Giusso del Galdo GP, Iamonico D, Iberite M, Minuto L, Sarigu M, Terlević A, Turini A, Varaldo L, Volgger D, Peruzzi L (2023) A cytosystematic study of the *Dianthus virgineus* complex (Caryophyllaceae) in the Central Mediterranean. Journal of Systematics and Evolution. https://doi.org/10.1111/jse.13025

Gestri G, Peruzzi L (2013) I Fiori di Leonardo: la Flora Vascolare del Montalbano in Toscana. Aracne, Roma.

Gottschlich G, Orsenigo S (2021) New taxa of *Hieracium* (Asteraceae) from Mount Lesima and adjacent regions (Northern Apennine, Italy). Phytotaxa 505(1): 39–55. https://doi.org/10.11646/phytotaxa.505.1.2

Gottschlich G, Raimondo FM, Di Gristina E (2013) *Hieracium pallidum* subsp. *aetnense* (Asteraceae), a new subspecies from Sicily (Italy), with notes on the taxonomy of *H. pallidum* Biv. Plant Biosystems 147(3): 826–831. https://doi.org/10.1080/11263504.2013.829882

Greuter W (2006 [onwards]) Compositae (pro parte majore). In: Greuter W, Raab-Straube E von (Eds) Compositae. Euro+Med Plantbase. https://europlusmed.org/cdm_dataportal/taxon/34ed56e3-38fd-44f8-92ac-a810eb9f4ea3 [accessed 15 November 2023]

Holub J, Měsíček J, Javůrková V (1972) Annotated chromosome counts of czechoslovak plants (31–60) (Materials for "Flóra ČSSR"–3). Folia Geobotanica et Phytotaxonomica 7: 167–202. https://doi.org/10.1007/BF02852032

Kovanda M (1984) Chromosome numbers in selected Angiosperms (2). Preslia 56: 289–301.

Löve Á (1975) IOPB Chromosome Number Reports XLIX. Taxon 24: 501–516. https://doi.org/10.1002/j.1996-8175.1975.tb00341.x

Löve Á (1976) IOPB Chromosome Number Reports LIII. Taxon 25: 483–500. https://doi.org/10.1002/j.1996-8175.1976.tb00446.x

Löve Á (1979) IOPB Chromosome Number Reports LXV. Taxon 28: 627–637. https://doi.org/10.1002/j.1996-8175.1979.tb00575.x

Löve Á (1980) Chromosome Number Reports LXVIII. Taxon 29: 533–547. https://doi.org/10.1002/j.1996-8175.1980.tb00677.x

Löve Á, Löve D (1982) IOPB chromosome number reports LXXVI. Taxon 31: 583–587. https://doi.org/10.1002/j.1996-8175.1982.tb03560.x

Luque T, Díaz Lifante Z (1991) Chromosome numbers of plants collected during Iter Mediterraneum I in the SE of Spain. Bocconea 1: 303–364.

Marhold K (2011) Caryophyllaceae. In: Greuter W, Raab-Straube E von (Eds) Compositae. Euro+Med Plantbase. http://ww2.bgbm.org/EuroPlusMed/PTaxonDetail.asp?NameCache=Dianthus&PTRefFk=7200000 [accessed 8 March 2022]

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, Carta L, Conti F, Croce A, Iamonico D, Iberite M, Iiriti G, Longo D, Marsili S, Medagli P, Pistarino A, Salmeri C, Santangelo A, Scassellati E, Selvi F, Soldano A, Stinca A, Villani M, 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

Petrova A, Vladimirov V (2020) Chromosome atlas of the Bulgarian vascular plants. Phytologia Balcanica 26: 217–427.

Pignatti S (2017a) *Damasonium* Mill. In: Pignatti S (Ed.) Flora d'Italia (Vol. 1). Edagricole-New Business Media, Milano, 127 pp.

Pignatti S (2017b) *Dianthus carthusianorum* L. In: Pignatti S (Ed.) Flora d'Italia (Vol. 2). Edagricole-New Business Media, Milano, 210–211.

Portal to the Flora of Italy (2023) Portal to the Flora of Italy. http://dryades.units.it/floritaly/ [accessed on 27 October 2023]

Rich TCG, Nicholls-Vuille FL (2001) Taxonomy and distribution of European *Damasonium* (Alismataceae). Edinburgh Journal of Botany 58(1): 45–55. https://doi.org/10.1017/S0960428601000464

Rivieccio G, Bagella S, Bazan G, Bonini F, Caria MC, Casavecchia S, Castello M, Dagnino D, De Francesco MC, Farris E, Fanfarillo F, Fiaschi T, Forte L, Gianguzzi L, Landucci F, Maneli F, Mantino F, Mariotti M, Pirone G, Poldini L, Poponessi S, Praleskouskaya S, Stanisci A, Tomaselli V, Tozzi FP, Turcato C, Venanzoni R, Gigante D (2020) New national and regional Annex I Habitat records: from# 16 to# 20. Plant Sociology 57: 133–144. https://doi.org/10.3897/pls2020572/05

Ronse AC, Popper ZA, Preston JC, Watson MF (2010) Taxonomic revision of European *Apium* L. s.l.: *Helosciadium* W.D.J. Koch restored. Plant Systematics and Evolution 287: 1–17. https://doi.org/10.1007/s00606-010-0284-3

Schuhwerk F (2010) Chromosomenzahlen von *Hieracium* (Compositae, Cichorieae)–Teil 5. Berichte der Bayerischen Botanischen Gesellschaft 80: 141–160.

Sell PD, West C (1976) *Hieracium* L. In: Tutin TG, Heywood VH, Burges NA, Moore DM, Valentine DH, Walters SM, Webb DA (Eds) Flora Europaea (Vol. 4). Cambridge University Press, Cambridge, 358–410.

Stinca A, Ricciardi M (2018) *Helosciadium* W.D.J.Koch. In: Pignatti S (Ed.) Flora d'Italia (Vol. 3). Edagricole-New Business Media, Milano, 589–591.

Talavera S, Talavera MM (2010) *Damasonium* Mill. In: Talavera S, Gallego MJ, Romero ZC, Herrero A (Eds) Flora Iberica 17, Real Jardín Botánico, CSIC, Madrid, 18–22.

Terlević A, Bogdanović S, Frajman B, Rešetnik I (2022) Genome size variation in *Dianthus sylvestris* Wulfen sensu lato (Caryophyllaceae). Plants 11: e1481. https://doi.org/10.3390/plants11111481

Zdvořák P, Mráz P, Rich T (2020) Flow cytometry measurements of ploidy level in British *Hieracium* section *Foliosa* and section *Prenanthoidea* (Asteraceae). British & Irish Botany 2(2): 154–157. https://doi.org/10.33928/bib.2020.02.154

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RESEARCH ARTICLE

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Can floral volatile organic compounds contribute to the taxonomy of the *Rhamnus* sect. *Alaternus*?

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Abstract

The chemistry of plants represents a taxonomic and phylogenetic value. Researchers have recently used volatile organic compounds (VOCs) for taxonomic studies. The present work analysed and determined, for the first time, the usefulness of floral volatile compounds in the taxonomy of two species of *Rhamnus* sect. *Alaternus*, as well as the hybrid between these taxa. The two species show significant quantitative and qualitative differences. The terpenes linalool, ocimene, caryophyllene, and green volatiles are exclusive to *Rh. alaternus*, while farnesene (terpene), methyl salicylate and methyl benzoate (benzoids) are obtained from *Rh. ludovici-salvatoris*. Both volatilomes were attractive to Hymenoptera pollinators; therefore, these pollinators could serve as the main hybridisation vector. In addition, *Rh. alaternus* shows greater chemical and genetic heterogeneity than *Rh. ludovici-salvatoris*. Hybrids between the two species, *Rh.×bermejoi*, are closer in chemical similarity to *Rh. alaternus* than *Rh. ludovici-salvatoris.*

Keywords

Balearic Islands, hybrids, *Rhamnus*, taxonomy, VOCs

Introduction

Plant chemistry has repeatedly been used in systematics (Hegnauer 1986a; Tundis et al. 2014 It has long been known that chemical traits and characteristics, notably the secondary metabolites (such as alkaloids, terpenoids, and flavonoids) contained in vegetative parts of the plants, help to establish relationships between plant taxa (Cronquist

1977; Singh R 2016). Moreover, they have wide applications in plant systematics (see Seigler 1981; Roma-Marzio et al. 2017); however, their use presents some limitations (Hegnauer 1986b; Hadacek 2002). It is also known that the variability of volatile secondary metabolites in the vegetative parts of plants can be high (Ahmad et al. 2014). For this reason, several authors consider the construction of phylogenies on this basis too labile (Whitehead and Peakall 2009). The chemistry of floral biogenic volatile organic compounds (BVOCs) has been well studied as it relates to communication (with pollinators) and defence (mainly herbivore-related) (Bouwmeester et al. 2019). The analysis of BVOCs also enables the evaluation of their important role in the adaptation, environmental adequacy, and medicinal interest of plants (Goswami et al. 2016).Their stability and repeatability can also allow accurate identification of natural or cultivated closely-related species and varieties (Nogueira et al. 2001; Kong et al. 2012; Yang et al. 2014; Carta et al. 2015; Jaeger et al. 2016; Peruzzi et al. 2019). Recently, BVOCs have also been studied from the standpoint of taxonomy (e.g., Levin et al. 2003; Raguso et al. 2006; Meekijjaroenroj et al. 2007; Feulner et al. 2011; Tóth et al. 2016; Stocki et al. 2020), showing their utility as discriminating characteristics. BVOCs have also been used to recognise hybrids, in which new compounds, absent in the parents, can appear (Orians 2000; Cheng et al. 2011), together with others that are not taxonomically relevant (Georgescu et al. 2015). Additionally, some VOC-related phylogenetic patterns have been recognised in some taxa, such as *Ophrys* (Gögler et al. 2009).

Rhamnus is a wide-ranging genus of the Temperate and (sub)Tropical regions of the Northern Hemisphere that comprises more than 100 species (Hauenschild et al. 2016). In the Mediterranean region it is represented by 37 species, where *Rh. cathartica* L. and *Rh. alaternus* L. are the most widespread (Henning and Raab-Straube 2016). Molecular studies performed on *Rhamnus*, excluding *Oreoherzogia* W.Vent (Hauenschild et al. 2016), recognise the existence of at least two sections: sect. *Rhamnus* and sect. *Alaternus* (Mill.) DC. The latter includes different species of Mediterranean and Macaronesian distribution (such as *Rh. alaternus* L. and related taxa, *Rh. lojaconoi* Raimondo, *R. ludovici-salvatoris* Chodat for Mediterranean, as well *Rh. glandulosa* Ait. and *Rh. integrifolia* DC. for Macaronesia. Generally, hybrids are uncommon or rare; however, *Rh. cathartica* (Gil-ad and Reznicek 1997; Kurylo et al. 2007) and, occasionally, *Rh. alaternus* (Llorens 1979; Fraga and Bermejo 2008) have shown a notable capacity to hybridise.

Rhamnus alaternus is an evergreen tree native to the Mediterranean region and is often cultivated as an ornamental garden shrub in Mediterranean-climate regions. For this purpose, this tree was introduced to many areas of the Australasian-Pacific region, where it became an invasive tree along coastlines (Muyt 2001; GISD 2018). This wide distribution and the different types of plant communities in which it thrives agree with its remarkable morphological variability (López-González 2006; Rivas-Martínez and Pizarro 2011, 2013). On the other hand, although *Rh. alaternus* is a defined species, its differentiation from other species of the *Rh.* sect. *Alaternus*, especially the hybrids, is problematic (Ferriol et al. 2009). This differentiation occurs with *Rh. ludovici-salvatoris* (Fig. 1), from which it differs basically in its larger size and the arrangement of the leaf teeth (approximately perpendicular to the margin in *Rh. ludovici-salvatoris* and obliquely oriented upwards in

Rh. alaternus). This difficulty has taxonomic and nomenclatural consequences, especially in plants that develop in unfavorable conditions. This difficulty occurs with the definition and identification of some specimens, such as *Rh. jacobi-salvadorii* O.Bolòs & Vigo or *Rh. alaternus* var. *ferruginea* Pourr. ex Texidor, making it difficult to establish a more precise distribution range. This is the case, for example, in the confusing or erroneous indications of *Rh. ludovici-salvatoris* in the eastern Iberian Peninsula or the actual distribution of the hybrid of this species with *Rh. alaternus* (i.e., *Rh.* ×*bermejoi* Fraga & Rosselló).

The Balearic Islands are the largest archipelago of continental islands in Spain. These islands display a complex palaeogeography, although they have been isolated relatively recently. The eastern islands (Gymnesian) and western islands (Pithyusian) have been separate groups from the early Pliocene. Nevertheless, the Gymnesian Islands (Majorca and Minorca) have only been completely isolated from each other since the Würm glaciation, approx. 15,000 ya (Cardona and Contandriopoulos 1979). In these islands, only two species from *Rh*. sect. *Alaternus* grow: the Mediterranean *Rh. alaternus* and the Gymnesian endemic *Rh. ludovici-salvatoris*. However, both species are related, and some hybrid plants have been identified in one locality of Minorca (Tirant) (Llorens 1979; Fraga and Rosselló 2008). Despite this, phenological and ecological barriers establish good isolation of the populations (Ferriol et al. 2009).

The chemical profile of the floral scent of the taxa of *Rhamnus* sect. *Alaternus* present in Majorca, Minorca, Ibiza, and eastern Iberian Peninsula was analysed in order to address the following three goals: 1) to recognise the volatile compounds of the two species, 2) to establish analogies and chemical differences between the hybrid plants and the parental species, and 3) to determine their value in taxonomy and their usefulness as discriminating characteristics in these species and their hybrids, as well as to establish their possible application to the taxonomy of other *Rhamnus* species.

Materials and methods

Plant material

The two species under study and their hybrids were collected from the Balearic Islands and the eastern Iberian Peninsula (Fig. 2, Suppl. material 1). Samples of natural hybrid plants reported as *Rh.* ×*bermejoi* (Llorens 1979; Fraga and Rosselló 2008) were collected in the locality of Tirant (N of Minorca), where they coexist with the parental species. Hybrid plants obtained by manual artificial hybridisation, cultivated and vegetatively propagated were also sampled. A total of 35 plants (14 female and 21 male) were screened for floral VOCs. The wild plants were collected from 13 sites, and the cultivated hybrids were collected from two sites.

Floral scent trapping

The volatiles emitted by flowers were obtained by the headspace solid phase extraction (HS-SPME) sampling technique, adapted from Friberg et al. (2013) and Tomas et al.

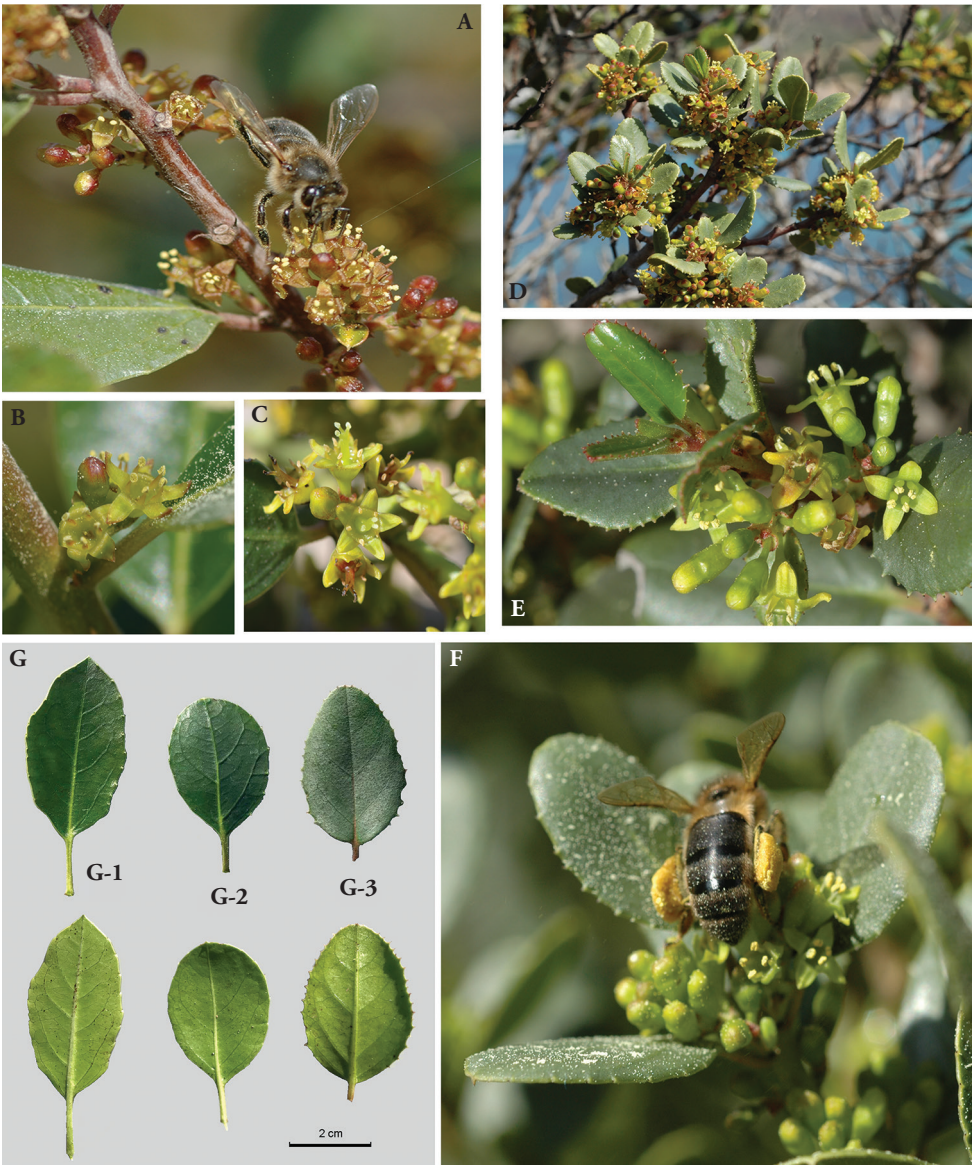

Figure 1. Inflorescences, flowers and major pollinator (*Apis mellifera*) of *Rhamnus* **A–C** *Rh. alaternus* **D, E** *Rh. ludovici-salvatoris* **F** *Rh.* ×*bermejoi* **G** leaves of the three species.

(2022). Volatile compounds were extracted in a manual SPME holder together with 10 mL vials and PDMS-DVD fibres (Supelco Inc., Bellefonte, USA). First, ten flowers of each plant were placed in a vial. Next, these vials were placed at 25 °C for 20 min; then, the SPME fibre was exposed in the upper space (headspace) of the sealed vial for 30 min at 25 °C to adsorb the analytes. Three collections and their respective controls (empty vials) were prepared simultaneously. In addition, to distinguish between

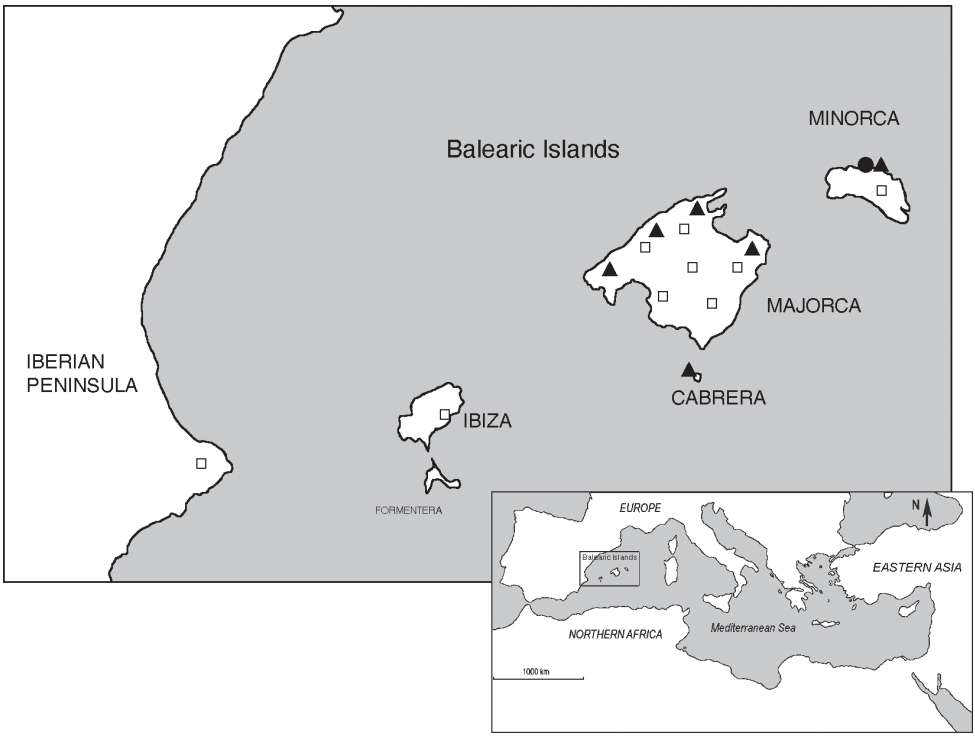

Figure 2. Location of the *Rhamnus* populations included in the study. (See Suppl. material 1 for population abbreviations). *Rh. alaternus* open squares; *Rh. ludovici-salvatoris* filled triangles; Hybrids filled circle.

BVOCs from flowers and those from flower pedicels, volatiles emitted by ten pedicels in both parental species were analysed.

Evaluation of scent composition

Analyses were conducted no longer than 24 hours after collection. HS-SPME-GC-MS analyses were performed on an Agilent 6980 GC - MDS 5975 inert XL (Agilent Technologies, USA), using a Supelcowax 10 gas capillary column (60 m × 0.25 mm × 0.25 mm; Supelco, Bellefonte, Pennsylvania, USA). The PDMS-DVB fibre of the SPME was aged for 3 min in the inlet of the GC. Helium was used as a carrier gas at a flow of 1.3 mL min^{-1}. The splitless sample injection mode was used. The injector temperature was 220 °C. The initial oven temperature was programmed as follows: 45 °C for 2 min, increasing to 250 °C at a rate of 5 °C min^{-1}, which was continued for 5 min. These settings were sufficient for the quantitative desorption of all analytes studied. Mass spectra (MS) were obtained in electron ionisation (EI) mode at 70 eV, while the ionisation source was 180 °C. The MS scan range was set between 45–300 amu. The chromatograms and spectra of the samples were processed using the GC-EM software Turbomass version 5.1 (Perkin-Elmer, Inc.).

The main isolated volatile compounds were annotated by comparing the mass spectra with mass spectral libraries (Wiley 7th edition and NIST08) and by comparing the calculated retention indices with those provided by NIST08, Adams (2007) and El-Sayed (2012). The annotation of the main compounds was verified using an in-house-developed mass spectra/RI library. The main compounds were verified by comparison with synthetic standards. All compounds that were not identified immediately as floral/plant volatiles were verified in the literature to determine if they were accepted as floral BVOCs or at least as potential volatiles.

Statistical analysis of data

Differences in BVOCs composition were analysed using the statistical software R version 4.1.2 (R Project for Statistical Computing). Since the total amount of volatiles released strongly fluctuated between individuals, we used the relative amounts taken as the peak area of each compound in relation to the total peak area. Those compounds considered as likely artefacts were excluded from the analysis. The volatiles from three plants were analysed for each population, averaged, and then treated as a single data set.

Data were transformed using the *decostand* function in the *vegan* library (Oksanen et al. 2019). To assess similarities between individual samples, a permutational multivariate analysis of variance (PERMANOVA) was performed with the *adonis2* function on the *vegan* library using the Bray-Curtis dissimilarity indices (Oksanen et al. 2019). Finally, as a post hoc test to detect differences in volatile composition between each of the species, a pairwise contrast for multilevel comparison (*pairwise.adonis* function, Martínez-Arbizu 2020) was used.

Significant *p*-values in a PERMANOVA indicate a significant difference between groups in the centroid or spread of objects in a multivariate space, so non-metric multidimensional scaling (NMDS, metaMDS function with Bray-Curtis distance, performing a Wisconsin double standardisation and also an sqrt transformation) was used. (Clarke et al. 2014).

To test whether there is a separation between groups in relation to the sex of the flowers, an analysis of similarities (*anosim* function, *vegan* package) was performed. To identify the percentage contributions of each volatile compound to the average dissimilarity amongst the three Rhamnus species, the similarity percentage analysis (SIMPER, the simper function in vegan) was used (Clarke 1993).

Results

Floral scent chemistry

No relevant traces of BVOCs were detected in floral pedicel samples. In the flowers, the entire GC–MS dataset allowed the detection of 41 compounds, of which 22 had greater presence and abundance (with percentages higher than 0.1%; Suppl. material

2). Chromatographic profiles of *R. alaternus* showed high heterogeneity. Thus, some plants exhibited the presence of certain components in high proportions (up to 89.9%), e.g., ionones (dihydro-β-ionone and α-ionone), 3-hexen-1-ol, acetate (*Z*), benzaldehyde 4-dimethoxy, caryophyllene, and linalools (cis-linaloxide, (*E*)-linalool oxide (furanoid), linalool, hotrienol). However, some of these components were absent in other plants. By contrast, despite including a larger number of samples, *R. ludovici-salvatoris* showed a remarkable uniformity. Thus, the major compounds, such as methyl salicylate, methyl benzoate, or α-farnesene, were found in 85–100% of the samples. Similarly, the largest number of minority compounds, such as ethyl benzoate, 1-butanol, and 3-methyl-benzoate, were present in more than 75% of the samples.

Floral scent species relations

The chromatographic profiles of *Rh. alaternus* and *Rh. ludovici-salvatoris* showed significant qualitative and quantitative differences between the species (Suppl. material 2 and Fig. 3). Thus, the following components were exclusive to *Rh. alaternus*: acetic acid hexyl ester, certain terpenoids and ocimene including *cis*- and *trans*-β-ocimene (6.73%); linalools including linalool, cis-linaloxide, trans-linalool oxide furanoid, linalyl formate, and hotrienol (9.10%); caryophyllenes including β- and α-caryophyllene (15.71%), and ionones including α-ionone and dihydro-β-ionone (48.28%). On the other hand, in *Rh. ludovici-salvatoris*, unique compounds were found, namely benzoic acid derivatives (methyl salicylate, methyl benzoate, 1-butanol, 3-methyl benzoate) and farnesenes (farnesene and α-farnesene). Among the quantitatively differential products, 3-hexen-1-ol acetate (Z) emerged because in *Rh. alaternus*, it was present in high amounts (25.92 ± 7.55%), while in *Rh. ludovici-salvatoris* it was only found in low quantities (0.65 ± 0.37%) and in less than half of the samples.

The results of the SIMPER analysis (Table 1 and Fig. 4) clearly highlight the differences in the aroma profile of the two species. They show that the two species have a distinct floral aroma profile and that four compounds (methyl salicylate, 3-hexen-1-ol acetate, ionone complex, and b-caryophyllene) account for 75% of these differences. On the other hand, no differences were found between the BVOC profiles in relation to sex (ANOSIM statistic R = -0.03533, p = 0.8222). According to the chemical composition of the hybrid samples and their uniformity, it is noteworthy that they exhibited a great affinity with *Rh. alaternus* (Table 1, Figs 3, 4, Suppl. material 2).

Discussion

Volatile compounds of the green parts of the plants have been used repeatedly as taxonomic characteristics (see Hegnauer 1986a, Nwafor et al. 2018). By contrast, the analysis of volatile biogenic compounds of flower aromas (floral BVOCs) has been scarcely studied. Despite this, most recently, the qualitative and quantitative variations of these compounds have shown their value as discriminating characteristics in related species or in ecotypes,

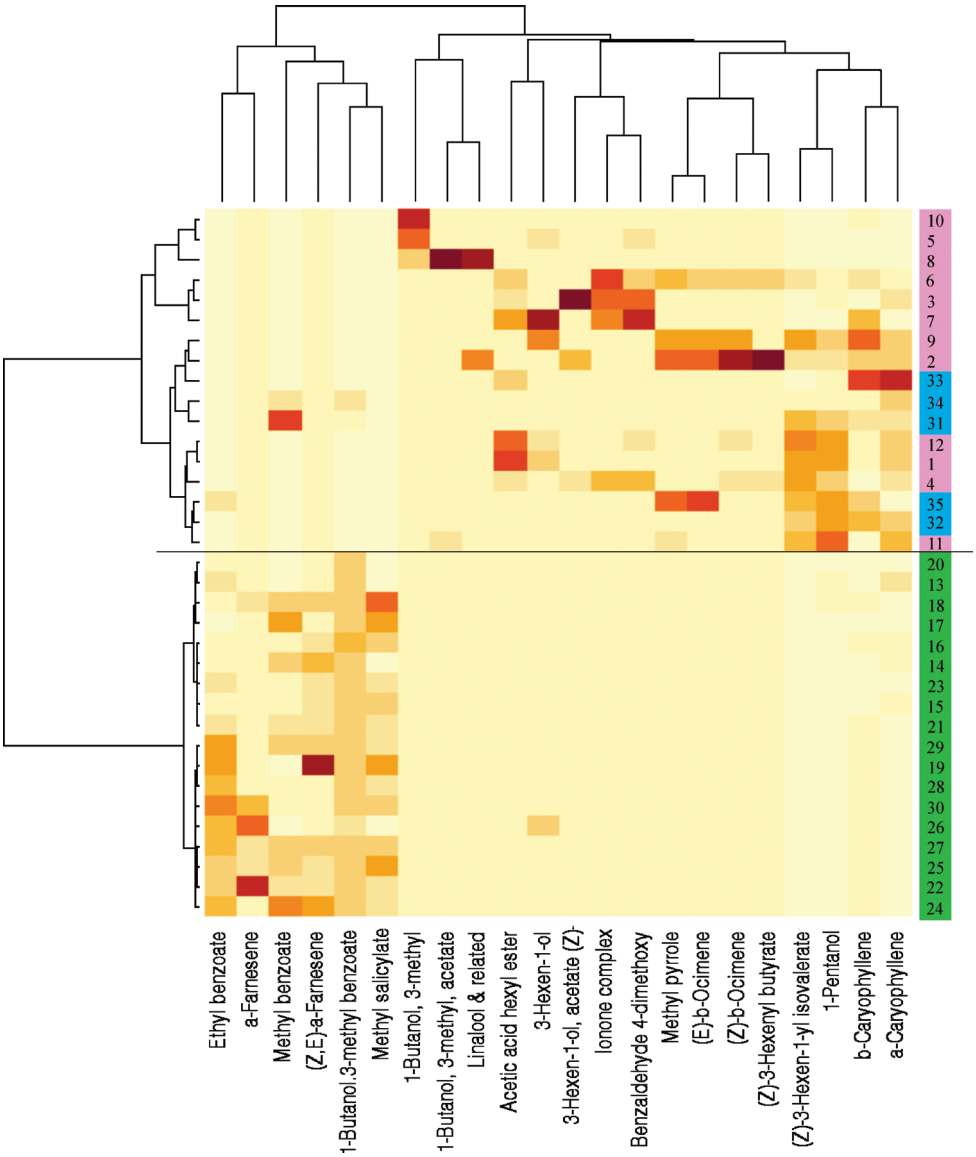

Figure 3. VOCs similarity histogram of *Rhamnus alaternus* (violet), *Rh.* ×*bermejoi* (blue) and *Rh. ludovici-salvatoris* (green). Colour intensity is related to the level of presence of a component in each sample.

such as in the genus *Clusia* (Nogueira et al. 2001), *Nicotiana* (Raguso et al. 2006), *Lilium* (Kong et al. 2012) or *Artemisia* (Jaeger et al. 2016). The results obtained in *Rh. alaternus* and *Rh. ludovici-salvatoris* and their hybrids were consistent with these observations.

The main differences between *Rh. alaternus* and *Rh. ludovici-salvatoris* were found in the types of terpenoids and benzoids emitted, as well as in their emission rates (Suppl. material 2). Thus, among the terpenoids, *R. alaternus* exhibited the emission

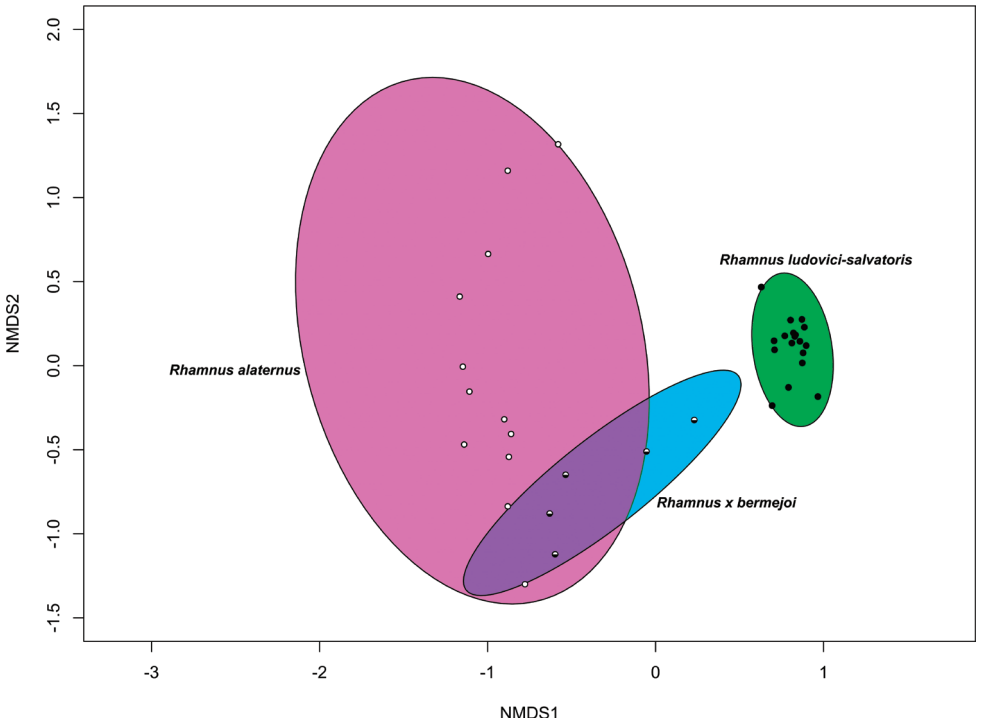

Figure 4. Non-metric multidimensional scaling ordination (NMDS) of floral scent profiles for *Rhamnus alaternus* (violet and empty circles), *Rhamnus ×bermejoi* (blue and half black circles) and *Rhamnus ludovici-salvatoris* (green and black points).

Table 1. Results of SIMPER analysis indicate the cumulative contributions of most influential compounds. AvA: Average in *Rhamnus alaternus*; AvB: Average in *Rhamnus ludovici-salvatoris*; Cumsum: cumulative contribution (in%).

	AvA	AvB	Cumsum
Methyl salicylate	0.00	82.32	44.4
3-Hexen-1-ol, acetate (Z)-	24.88	0.64	57.6
Ionone complex	16.09	0.00	66.4
b-Caryophyllene	15.18	0.00	74.6
Methyl benzoate	0.00	9.25	79.6
Linalool and related	9.11	0.00	84.4
Benzaldehyde 4-dimethoxy	5.23	0.00	87.1
(Z)-b-Ocimene	4.69	0.00	89.7
1-Butanol, 3 methyl, acetate	4.26	0.54	92.0

of monoterpenes ((Z)- and (E)-β-ocimene and linalool and related compounds) and ionones; all these products are absent in *Rh. ludovici-salvatoris*. There were also different types of sesquiterpenes, farnesenes being characteristic of *Rh. ludovici-salvatoris* and caryophyllenes being characteristic of *Rh. alaternus*. On the other hand, the uniformity and

richness of benzoids in *Rh. ludovici-salvatoris* (specifically, methyl salicylate and methyl benzoate) were very prevalent. This finding contrasts with its absence in *Rh. alaternus*, because in this species, only the rare presence of benzaldehyde 4-dimethoxy has been recognised. Methyl salicylate (83.3%) and methyl benzoate (9.2%) constitude the primary components of the floral aroma in *Rh. ludovici-salvatoris*. These compounds are also present in hybrids but notably absent in *Rh. alaternus*. Both esters are biosynthesised by the action of carboxyl methyltransferases and have been associated with pollinator attraction (Negre et al. 2003), but they also play an important role as aerial signals involved in inter- and intra-plant communication to activate disease (Shulaev et al. 1997) and, as also seems plausible in this case, signalling an abiotic stress situation for this species (Munné-Bosch and Peñuelas 2003; Karl et al. 2008; Liu et al. 2018; Gondor et al. 2022).

The high intra-population heterogeneity of chemical compounds of *Rh. alaternus* was evidenced by the fact that not all differential compounds were found in all the plants; however, some of them were always present. This observation stands in contrast with *Rh. ludovici-salvatoris*, which has a high chemical similarity with all plants, as evidenced by the presence of its main differential compounds, methyl salicylate and methyl benzoate. These chemical diversity profiles followed a pattern similar to that of genetic diversity (Ferriol et al. 2009; Hauenschild et al. 2016), which recognizes much higher levels of genetic variation in the populations of *Rh. alaternus* than in those of endemic *Rh. ludovici-salvatoris*.

The qualitative and quantitative patterns of VOC expression in hybrids are heterogeneous (López-Caamal 2014). In some species, hybridization could lead to the production of new secondary metabolites that are not present in parental species, due to the obstruction of biosynthetic pathways (Vereecken et al. 2010; Kong et al. 2012). In other hybrid species, highly variable proportions of several compounds are present. In some, the emission rates of some of these may be interpreted as transgressive with the parents; however, they are not always consistently intermediate. In others, only the emission of specific compounds was intermediate (Bischohff et al. 2014). In general, whenever hybridization occurs, a large qualitative variation in secondary metabolites is expected. In the studied hybrids, compounds shared with parental strains were produced at different levels, but no new products were recognized (Suppl. material 2). In the amounts of shared compounds, there was a clear tendency to be more like *Rh. alaternus* (Fig. 4).

Both personal observations and those of Canale et al. (2016) showed that the main pollinators of the two *Rhamnus* species were Hymenoptera (mainly *Apis mellifera* Linnaseus, 1758). This finding was consistent with the fact that the two groups of BVOCs that are dominant in the flowers of the two species of *Rhamnus* attract honey bees: terpenoids for *Rh. alaternus* (Dobson 2006; Twidle et al. 2015) and benzoids for *Rh. ludovici-salvatoris* (Negre et al. 2003; Mallinger et al. 2011; Dötterl et al. 2014). Thus, this could be the pollination vector that mediates the hybridization process.

When the diversity of BVOCs is greater in hybrids than in the parentals, their heterogeneity and progression are encouraged, since this could help in attracting more pollinator species (Ayasse et al. 2011), breaking the reproductive isolation of hybrids. However, this increase does not occur in the studied hybrids; therefore, their VOC content, as in their parent *R. ludovici-salvatoris*, was not a factor that favours pollination and reproduction.

Under these conditions, compared to *Rh. alaternus*, lower photosynthetic efficiency of *Rh. ludovici-salvatoris* and its hybrids in the current climatic Mediterranean circumstances (Yll et al. 1997; Gulias et al. 2002) would be, together with the inability of regrowth, the main cause that would explain both the progressive decrease in the populations of this species as well as the rarity of hybrids and the relictual character of the current population of *Rh. ludovici-salvatoris* and its hybrids in Minorca (Fraga and Bermejo 2008).

Conclusions

The analysis of the floral volatile compounds in the studied taxa reveals both qualitative and quantitative differences in the chemical profile of *R. alaternus* and *Rh. ludovici-salvatoris*. Among them, the discriminatory nature of various compounds stands out, such as methyl salicylate and methyl benzoate (present in *Rh. ludovici-salvatoris* and absent in *Rh. alaternus*), linalool and related compounds, ionones, β-caryophyllene, 4-dimethoxy benzaldehyde, and (Z)-β-ocimene (present in *Rh. alaternus* and absent in *Rh. ludovici-salvatoris*). In contrast, the chemical profile does not allow differentiation between *Rh. alaternus* and the hybrid *Rh.* ×*bermejoi*. According to these results, it is suggested that floral volatile compounds could be an effective discriminatory trait among species in *Rh.* sect. *Alaternus*. This finding should be confirmed through the study of plants from other populations of *Rh. alaternus*, as well as samples from *Rh. lojaconoi* and the Macaronesian endemic species *Rh. glandulosa* and *Rh. integrifolia*.

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References

Adams RP (2007) Identification of Essential oil Components by Gas Chromatography/ MassSpectroscopy. Carol Stream, IL. Allured Publishing Corporation.

Ahmad R, Baharum SN, Bunawan H, Lee M, Mohd Noor N, Rohani ER, Ilias N, Zin NM (2014) Volatile profiling of aromatic traditional medicinal plant, *Polygonum* minus in different tissues and Its biological activities. Molecules 19: 19220–19242. https://doi.org/10.3390/molecules191119220

Aysse M, Stökl J, Francke W (2011) Chemical ecology and pollinator-driven speciation in sexuallly deceptive orchids. Phytochemistry 72: 1667–1677. https://doi.org/10.1016/j.phytochem.2011.03.023

Bischoff M, Jürgens A, Campbell DR (2014) Floral scent in natural hybrids of *Ipomopsis* (Polemoniaceae) and their parental species. Annals of Botany 113: 533–544. https://doi.org/10.1093/aob/mct279

Bouwmeester H, Schuurink RC, Bleeker PM, Schiestl F.(2019) The role of volatiles in plant communication. Plant Journal 100(5): 892–907. https://doi.org/10.1111/tpj.14496

Canale A, Benvenuti S, Raspi A, Benelli G (2016) Insect pollinators of the late winter flowering *Rhamnus alaternus* L., a candidate for honeybee-friendly scrubland spots in intensively managed agricultural areas. Plant Biosystems 150: 611–615. https://doi.org/10.1080/11263504.2014.993742

Cardona MA, Contandriopoulos J (1979) Endemism and evolution in the islands of the western Mediterranean. In: Bramwell D (Ed.) Plant and islands. Academic Press, London, UK, 133–169.

Carta A, Flamini G, Cioni PL, Pistelli L, Peruzzi L (2015) Flower bouquet variation in four species of *Crocus* ser. *Verni*. Journal of Chemical Ecology 41: 105–110. https://doi.org/10.1007/s10886-014-0541-y

Cheng D, Vrieling K, Klinkhamer PG (2011) The effect of hybridization on secondary metabolites and herbivore resistance: implications for the evolution of chemical diversity in plants. Phytochemistry Reviews 10: 107–117. https://doi.org/10.1007/s11101-010-9194-9

Clarke KR (1993) Non-parametric multivariate analyses of changes in community structure. Australian Journal of Ecology 18: 117–143. https://doi.org/10.1111/j.1442-9993.1993.tb00438.x

Clarke KR, Gorley RN, Somerfield PJ, Warwick RM (2014) Change in marine communities: an approach to statistical analysis and interpretation, 3nd edn. PRIMER-E Ltd, Plymouth, 1–262.

Cronquist A (1977) On the taxonomic significance of secondary metabolites in Angiosperms. In: Kubitzki K (Ed.) Flowering Plants. Plant Systematics and Evolution / Entwicklungsgeschichte und Systematik der Pflanzen, vol 1. Springer, Vienna. Flowering Plants, 179–189. https://doi.org/10.1007/978-3-7091-7076-2_12

Dobson HEM (2006) Relationship between floral fragrance composition and type of pollinators. In: Duradeva N, Pichersky E (Eds) Biology of floral scent. CRC Taylor & Francis, 147–198. https://doi.org/10.1201/9781420004007-8

Dötterl S, Glück U, Jürgens A, Woodring J, Aas G (2014) Floral reward, advertisement and attractiveness to honey bees in dioecious Salix caprea. PLoS ONE 9(3): e93421. https://doi.org/10.1371/journal.pone.0093421

El-Sayed AM (2023) The Pherobase: Data base of Insect Pheromones and Semiochemicals. http://www.pherobase.com

Ferriol M, Llorens L, Gil L, Boira H (2009) Influence of phenological barriers and habitat differentiation on the population genetic structure of the Balearic endemic *Rhamnus ludovici-salvatoris* Chodat and *Rh. alaternus* L. Plant Systematics and Evolution 277: 105–116. https://doi.org/10.1007/s00606-008-0110-3

Feulner M, Schuhwerk F, Dötterl S (2011) Taxonomical value of inflorescence scent in *Hieracium* s. str. Biochemical Systematics and Ecology 39: 732–743. https://doi.org/10.1016/j.bse.2011.06.012

Fraga P, Bermejo A (2008) Notes i contribucions al coneixement de la flora de Menorca (IX): característiques i estat de conservació de la població menorquina de *Rhamnus ludovici-salvatoris* Chodat. Bolletí de la Societat d'Història Natural de les Balears 51: 17–32.

Fraga P, Rosselló JA (2008) *Rhamnus* ×*bermejoi*, a new wild hybrid between *Rh. alaternus* and *Rh. ludovici-salvatoris*. Flora Mont 40: 47–79.

Friberg M, Schwind C, Raguso R, Thompson JN (2013) Extreme divergence in floral scent among woodland star species (*Lithophragma* spp.) pollinated by floral parasites. Annals of Botany 111: 539–550. https://doi.org/10.1093/aob/mct007

Georgescu L, Stefanakis MK, Kokkini S, Katerinopoulos HE, Pirintsos SA (2015) Chemical and genetic characterization of *Phlomis* species and wild hybrids in Crete. Phytochemistry 122: 91–102. https://doi.org/10.1016/j.phytochem.2015.11.007

Gil-ad NL, Reznicek AA (1997) Evidence for hybridation of two Old Word *Rhamnus* species -*R. cathartica* and *R. utilis* (Rhamnaceae)- in the New World. Rhodora 99: 1–22.

GISD [Global Invasive Species Database] (2018) Species profile: *Rhamnus alaternus*. http://www.iucngisd.org/gisd/species.php?sc=893 [Downloaded on 10-09-2018]

Gögler J, Stökl J, Sramkova A, Twele R, Francke W, Cozzolino S, Cortis P, Scrugli A, Ayasse M (2009) Menage a trios: two endemic species of deceptive orchids and one pollinator species. Evolution 63: 2222–2234. https://doi.org/10.1111/j.1558-5646.2009.00712.x

Gondor OK, Pál M, Janda T, Szalai G (2022) The role of methyl salicylate in plant growth under stress conditions. Journal of Plant Physiology 277: 153809. https://doi.org/10.1016/j.jplph.2022.153809

Goswami P, Chauhan A, Verma RS, Padalia RC (2016) Chemical constituents of floral volatiles of *Plumeria rubra* L. from India. Medicinal and Aromatic Plants Research Journals S3: 005. https://doi.org/10.4172/2167-0412.S3-005

Gulias J, Flexas J, Abadia A, Medrano H (2002) Photosynthetic responses to water deficit in six mediterranean sclerophyll species: possible factors explaining the deckining distribution of *Rhamnus ludovici-salvatoris*, an endemic Balearic species. Tree Physiology 22: 687–697. https://doi.org/10.1093/treephys/22.10.687

Hadacek F (2002) Secondary metabolites as plant traits: current assessment and future perspectives. Critical Reviews in Plant Sciences 21: 273–322. https://doi.org/10.1080/0735-260291044269

Hauenschild F, Favre A, Gerardo A, Salazar GA, Muellner-Riehl AN (2016) Analysis of the cosmopolitan buckthorn genera *Frangula* and *Rhamnus* s.l. supports the description of a new genus, Ventia. Taxon 65: 65–78. https://doi.org/10.12705/651.5

Hegnauer R (1986a) Phytochemistry and plant taxonomy-an essay on the chemotaxonomy of higher plants. Phytochemistry 25: 1519–1535. https://doi.org/10.1016/S0031-9422(00)81204-2

Hegnauer R (1986b) Comparative phytochemistry and plant taxonomy. Gior Botany Italia 120: 15–26. https://doi.org/10.1080/11263508609428018

Henning T, Raab-Straube E von (2016): Rhamnaceae. In: Euro+Med Plantbase - the information resource for Euro-Mediterranean plant diversity. http://ww2.bgbm.org/EuroPlusMed/ [Accessed 2023]

Jaeger DM, Runyon JB, Richardson BA (2016) Signals of speciation: volatile organic compounds resolve closely related sagebrush taxa, suggesting their importance in evolution. New Phytologist 211: 1393–1401. https://doi.org/10.1111/nph.13982

Karl T, Guenther A, Turnipseed A, Patton EG, Jardine K (2008) Chemical sensing of plant stress at the ecosystem scale. Biogeosciences 5: 1287–1294. https://doi.org/10.5194/bg-5-1287-2008

Kong Y, Sun M, Pan H, Zhang Q (2012) Composition and emission rhythm of floral scent volatiles from eight lily cut flowers. Journal of the American Society for Horticultural Science 137: 376–382. https://doi.org/10.21273/JASHS.137.6.376

Kurylo JS, Knight KS, Stewart JR, Endress AG (2007) *Rhamnus cathartica*: native and naturalized distribution and habitat preferences. The Journal of the Torrey Botanical Society 143: 420–430. https://doi.org/10.3159/1095-5674(2007)134[420:RCNAND]2.0.CO;2

Levin RA, McDade L, Raguso RA (2003) The systematic utility of floral and vegetative fragrance in two genera of Nyctaginaceae. Systematic Biology 52: 334–351. https://doi.org/10.1080/10635150390196975

Liu B, Kaurilind E, Jiang Y, Niinemets Ü (2018) Methyl salicylate differently affects benzenoid and terpenoid volatile emissions in *Betula pendula*. Tree Physiology 38(10): 1513–1525. https://doi.org/10.1093/treephys/tpy050

Llorens L (1979) Nueva contribución al conocimiento de la flora balear. Mediterranea 3: 101–122. https://doi.org/10.14198/MDTRRA1979.3.04

López-Caamal A, Tovar-Sánchez E (2014) Genetic, morphological, and chemical patterns of plant hybridization. Revista Chilena de Historia Natural 87: 16. https://doi.org/10.1186/s40693-014-0016-0

López-González G (2006) Los árboles y arbustos de la Península ibérica e Islas Baleares. Mundi-Prensa, Barcelona, 533–536.

Mallinger RE, Hogg DB, Gratton C (2011) Methyl salicylate attracts natural enemies and reduces populations of soybean aphids (Hemiptera: Aphididae) in Soybean Agroecosystems. Journal of Economic Entomology 104: 115–124. https://doi.org/10.1603/EC10253

Martinez-Arbizu P (2020) pairwiseAdonis: Pairwise multilevel comparison using adonis. R package version 0.4. https://github.com/pmartinezarbizu/pairwiseAdonis

Meekijjaroenroj A, Bessière JM, Anstett MC (2007) Chemistry of floral scents in four *Licuala* species (Arecaceae). Flavour and Fragrance Journal 22: 300–310. https://doi.org/10.1002/ffj.1797

Munné-Bosch S, Peñuelas J (2003) Photo-and antioxidative protection, and a role for salicylic acid during drought and recovery in field-grown *Phillyrea angustifolia* plants. Planta 217: 758–766. https://doi.org/10.1007/s00425-003-1037-0

Muyt A (2001) Bush Invaders of South-east Australia. RG and FJ Richardson Meredith, Victoria, Australia, 213–214.

Negre F, Kish CM, Boatright J, Underwood B, Shibuya K, Wagner C, Clark DG, Dudareva N (2003) Regulation of methylbenzoate emission after pollination in snapdragon and *Petunia* flowers. The Plant Cell 15: 2992–3006. https://doi.org/10.1105/tpc.016766

Nogueira PCL, Bittrich V, Shepherd GJ, Lopes AV, Marsaioli AJ (2001) The ecological and taxonomic importance of flower volatiles of *Clusia* species (Guttiferae). Phytochemistry 56: 443–452. https://doi.org/10.1016/S0031-9422(00)00213-2

Nwafor FI, Orabueze IC (2018) Role of phytochemistry in plant classification: Phytochemotaxonomy. In: Egbuna C, Ifemeje JC, Udedi SC, Kumar S (Eds) Phytochemistry: Fundamentals, Modern Techniques, and Applications vol 1, Apple Academic Press, 198–224.

Oksanen AJ, Blanchet FG, Friendly M, Kindt R, Legendre P, Mcglinn D, Minchin PR, Hara RBO, Simpson GL, Solymos P, Stevens MHH, Szoecs (2019) E. vegan:

community ecology package. R package version 2.5-6. https://CRAN.R-project.org/package=vegan

Orians CM (2000) The effects of hybridization in plants on secondary chemistry: implications for the ecology and evolution of plant-herbivore interactions. American Journal of Botany 87: 1749–1756. https://doi.org/10.2307/2656824

Peruzzi L, Roma-Marzio F, Dolci D, Flamini G, Braca A, De Leo M (2019) Phytochemical data parallel morpho-colorimetric variation in *Polygala flavescens* DC. Plant Biosystems 153(6): 817–834. https://doi.org/10.1080/11263504.2018.1549615

Raguso RA, Schlumpberger BO, Kaczorowski RL, Holtsford TP (2006) Phylogenetic fragrance patterns in *Nicotiana* sections Alatae and Suaveolentes. Phytochemistry 67: 1931–1942. https://doi.org/10.1016/j.phytochem.2006.05.038

Rivas-Martínez S, Pizarro JM (2011) Taxonomical system advance to *Rhamnus* L. & *Frangula* Mill. (Rhamnaceae) of Iberian Peninsula and Balearic Islands. International Journal of Geobotanical Research 1: 55–78. https://doi.org/10.5616/ijgr110004

Rivas-Martínez S, Pizarro JM (2013) *Rhamnus* L. In: Muñoz Garmendia F, Navarro C, Quintanar A, Buira A (Eds) Flora Iberica 9, Real Jardín Botánico, CSIC, Madrid, 36–44.

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

Seigler DS (1981) Secondary metabolites and plant systematics. In: Conn EE (Ed.) The biochemistry of plants. Secondary plant products vol 7, Academic Press, 139–171. https://doi.org/10.1016/B978-0-12-675407-0.50012-9

Shulaev V, Silverman P, Raskin I (1997) Airborne signalling by methyl salicylate in plant pathogen resistance. Nature 385: 718–721 https://doi.org/10.1038/385718a0

Singh R (2016) Chemotaxonomy: A Tool for Plant Classification. Journal of Medicinal Plants Studies 4(2): 90–93.

Stocki M, Banaszczak P, Stocka N, Borowik T, Zapora E, Isidorov V (2020) Taxonomic implications of volatile secondary metabolites emitted from birch (*Betula* L.) buds. Biochemical Systematics and Ecology 92: 104132. https://doi.org/10.1016/j.bse.2020.104132

Tomas J, Cardona C, Ferriol P, Llorens L, Gil L (2022) Floral traits and reproductive biology of two Mediterranean species of *Clematis*, asynchronous and sympatric, are key food sources for pollinator survival. South African Journal of Botany 151: 85–94. https://doi.org/10.1016/j.sajb.2022.09.027

Tóth P, Undas AK, Verstappen F, Bouwmeester H (2016) Floral Volatiles in Parasitic Plants of the Orobanchaceae. Ecological and Taxonomic Implications. Frontiers in Plant Science 7: 312. https://doi.org/10.3389/fpls.2016.00312

Tundis R, Peruzzi L, Menichini F (2014) Phytochemical and biological studies of *Stachys* species in relation to chemotaxonomy: a review. Phytochemistry 102: 7–39. https://doi.org/10.1016/j.phytochem.2014.01.023

Twidle AM, Mas F, Harper AR, Horner RM, Weish TJ, Suckling DM (2015) Kiwifruit flower odor perception and recognition by honey bees, *Apis mellifera*. Journal of Agricultural and Food Chemistry 63: 5597–5602. https://doi.org/10.1021/acs.jafc.5b01165

Vereecken NJ, Cozzolino S, Schiestl FP (2010) Hybrid floral scent novelty drives pollinator shift in sexually deceptive orchids. BMC Evolutionary Biology 10: 103. https://doi.org/10.1186/1471-2148-10-103

Whitehead MR, Peakall R (2009) Integrating floral scent, pollination ecology and population genetics. Functional Ecology 23: 863–874. https://doi.org/10.1111/j.1365-2435.2009.01620.x

Yang L, Ren J, Wang Y (2014) Chemical investigation of volatiles emitted from flowers of three varieties of Damask rose cultivated in Beijing. Horticulture Environment and Biotechnology 55: 524–530. https://doi.org/10.1007/s13580-014-0176-5

Yll E, Pérez-Obiol R, Pantaleon-Cano J, Roure JM (1997) Palynological evidence for climatic change and human activity during the Holocene on Minorca (Balearic Islands). Quaternary Research 48: 339–347. https://doi.org/10.1006/qres.1997.1925

Supplementary material 1

Geographical location and sexuality of *Rhamnus* sampled plants

Authors: Leonardo Llorens, Pere Ferriol, Joan Tomàs, María Trinidad García, Lorenzo Gil

Data type: xlsx

Link: https://doi.org/10.3897/italianbotanist.16.116255.suppl1

Supplementary material 2

Floral scent chemistry

Authors: Leonardo Llorens, Pere Ferriol, Joan Tomàs, María Trinidad García, Lorenzo Gil

Data type: docx

Explanation note: Floral scent chemistry of *Rhamnus alaternus* (blue), *R. ludovici-salvatoris* (yellow) and hybrids (green). For each species, compounds with presence in >10% of samples.

Link: https://doi.org/10.3897/italianbotanist.16.116255.suppl2