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FLORA
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Article

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F. Conti, F. Falcinelli, L. Bracchetti, E. De Santis, A. Guiggi, A. Manzi, D. Palermo, P. Muñoz Rodríguez, J. R. I. Wood & F. Bartolucci

New additions to the vascular flora of central and southern Italy

Abstract

Conti, F., Falcinelli, F., Bracchetti, L., De Santis, E., Guiggi A., Manzi, A., Palermo, D., Muñoz-Rodríguez, P., Wood, J.R.I. & Bartolucci, F.: New additions to the vascular flora of central and southern Italy. — Fl. Medit. 35: 5-14. 2025. — ISSN: 1120-4052 printed, 2240-4538 online.

New or revised plant records of 27 taxa (species and subspecies) are reported for central and southern Italy, of which 13 are natives and 14 aliens. Two native taxa are new for the Apennines, one is new for central Italy, nine are new or confirmed for Abruzzo and one is new for Marche. We excluded one previously accepted species from Umbria, one from Abruzzo, one from Molise, and one from Campania. Among the aliens, two species are new for Italy, six for Umbria, four for Abruzzo, two (one confirmed) for Lazio and one for Molise. Furthermore, we propose to change alien status from casual to naturalized for three taxa. Some discoveries are very interesting from a phytogeographical and/or conservation point of view. Additionally, several new locations for very rare species are reported.

Key words: Native taxa, alien taxa, Apennines, biodiversity, floristics.

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Introduction

The establishment of the Floristic Research Center of the Apennines has had a positive impact on our knowledge of the Italian flora due to its work in coordinating the checklist of the Italian flora (Conti & al. 2005; Bartolucci & al. 2018, 2024; Galasso & al. 2018, 2024) and in developing the Portal to the Flora of Italy (Martellos & al. 2020 available at https://dryades.units.it/floritaly/). Furthermore, the establishment and development of the Herbarium Apenninicum (APP) stimulated the growth in floristic knowledge especially of the Abruzzo region and central Italy (Conti & al. 2024). This paper contributes to the knowledge of the flora of central Italy reporting unpublished records for several taxa, including some discoveries of phytogeographical interest, such as disjunct populations of species with a northern distribution or new localities of rare taxa.

Materials and Methods

The area investigated is located in central southern Italy and comprises the territories of Umbria, Lazio, Abruzzo, Molise and Campania administrative regions. Floristic data were collected during field work carried out in 2023 and 2024, while some specimens collected in the past have been revised. Herbarium specimens collected are deposited in APP and the herbaria AQUI and VER were also consulted (codes follow Thiers 2025).

Nomenclature follows the checklists of the Italian native (Bartolucci & al. 2024) and alien (Galasso & al. 2024) vascular flora and subsequent updates summarized in the Portal to the Flora of Italy (2024). Taxa are categorized as native and alien and alphabetically listed.

For each taxon, the following information is provided: current accepted name; family; reason(s) for its inclusion in the list; current invasive status (for aliens only); herbarium material revised with details about the collection locality (in Italian, according to the information reported on the herbarium label), UTM coordinates (datum WGS84) when available, altitude, habitat, collection date, collector(s), herbarium code, additional notes.

DNA for the *Ipomoea* sample was extracted using the Qiagen DNEasy extraction kit. Amplification of the *rpl32-trnL* non-coding chloroplast region was performed using the primers VR27-F (5'-GTAATACAATAAGGCGGATA) and VR27-R (5'-ATTACATGACAAGATAGTCTTG) (Muñoz-Rodríguez & al. 2022; Supplementary Material) in a reaction volume of 15 µl containing 7.3 µl H_2O, 3 µl buffer, 0.7 µl $MgCl_2$, 0.3 µl of each primer (10× concentration), 0.5 µl dNTPs, 1 µl BSA, 0.4 µl Taq polymerase, and 1.5 µl sample DNA. The PCR conditions were as follows: an initial denaturation step of 5 minutes at 80°C, followed by 30 cycles of 1 minute at 95°C, 1 minute at 50°C, and 4 minutes at 65°C, with a final extension of 4 minutes at 65°C. The PCR product was purified using the GeneJET PCR purification kit and sequenced using Sanger sequencing. The resulting sequence has been deposited in GenBank under accession number PQ863735.

Results

Native taxa

Colchicum bivonae Guss. (*Colchicaceae*)
Species not confirmed for the flora of Abruzzo.

Species recorded in Abruzzo from a specimen collected by Tenore on Abruzzo mountains and housed at G (D'Amato 1957). The species was not reported for the region by Bartolucci & al. (2024) and recent evidence of its presence in Abruzzo region is lacking.

Dichodon viscidum (M.Bieb.) Holub (*Caryophyllaceae*)
Species confirmed for the flora of Abruzzo.
San Panfilo d'Ocre (L'Aquila), loc. Prati del Lago (WGS84: 33T 373774E, 4683340N), prati mesofili, 761 m, 06.04.2024, *F. Bartolucci* (APP No. 73008).

This species was recorded for Abruzzo in the Sulmona territory (Gravina 1812) and the Natural Reserve "Sorgenti del Pescara (Pirone & al. 1997), but we have not re-found the

species and there are no herbarium specimens kept at AQUI, where the collections cited by Pirone & al (1997) should be preserved.

Eryngium alpinum L. (*Apiaceae*)
Species new for the flora of the Apennines (Abruzzo).
Isola del Gran Sasso (Teramo), Vallone Fossaceca, praterie, 1795 m, 03.09.2024, *F. Bartolucci & F. Conti* (observed but not collected).

Eryngium alpinum is an endangered alpine species, distributed in France, Italy, Austria, Switzerland and the Balkan Peninsula (Wörz 2011, POWO 2024). It is included in Annex II and IV of Habitats Directive (92/43/EEC), and is assessed by the IUCN as NT (Gygax & al. 2011). The discovery of this species in the Central Apennines is of considerable phytogeographical and conservation interest. Unfortunately, we found only one individual, of which we collected a small basal leaf for molecular analysis, but no herbarium specimen was collected for conservation reasons, and we prefer not to indicate the exact coordinates of the locality. Next year we will attempt to better assess the population size and possibly collect some plant material or information to characterise this population morphologically, as it is extremely isolated from main range of the species.

Galeopsis bifida Boenn. (*Lamiaceae*)
Species new for the flora of central Italy (Abruzzo).
Ovindoli (L'Aquila), Piana di Ovindoli presso il rifugio degli Alpini in loc. Le Conche (WGS84: 33T 377912E 4667388N), prati, 1354 m, 28.08.2024, *F. Bartolucci* (APP No. 72961).

This species is distributed in northern Italy as far south as Emilia-Romagna (Bartolucci & al. 2024). The population found in Abruzzo, due to its separation from the main Italian range, has considerable phytogeographical and conservation importance.

Loncomelos pyrenaicum subsp. ***sphaerocarpum*** (A.Kern.) Holub (*Asparagaceae*)
Subspecies new for the flora of Abruzzo.
Isola del Gran Sasso d'Italia (Teramo), boschi sopra Casale San Nicola (WGS84: 33T 385016E, 4704380N), 05.06.2016, *F. Conti & A. Mainetti* (APP No. 68515).

The locality where this species was found in Abruzzo represents the southern limit in the range of this subspecies in Italy (Bartolucci & al. 2024).

Lotus creticus L. (*Fabaceae*)
Species new for the flora of Marche.
Porto d'Ascoli (Ascoli Piceno), Riserva Naturale Regionale Sentina (WGS84: 33T 411293E, 4749905N), spiaggia, 1 m, 17.10.2024, *F. Conti & L. Bracchetti* (APP No. 72858).

The population found in Marche region marks the northern limit of the distribution of this species along the Adriatic coast in Italy (Bartolucci & al. 2024).

Lycopsis arvensis L. (*Boraginaceae*)
Species to be excluded from the flora of Umbria and not confirmed for the flora of Abruzzo.

The previous records for Umbria (Pian Grande di Castelluccio) (Falcinelli & al. 2015) and the recent ones for Abruzzo (Piano Laroma, Colle Truscino) (Conti & al. 2002, 2022) should be referred to *L. orientalis* L. (see below). The presence of *L. arvensis* in Abruzzo needs to be confirmed as it is based only on ancient data (Di Giuseppe 1909; Zodda 1954). The record cited by Tammaro (1983) for Gran Sasso without locality is probably based on these previous records.

Origanum vulgare subsp. ***viridulum*** (Martrin-Donos) Nyman (*Lamiaceae*)
Subspecies confirmed for the flora of Abruzzo.
Pettorano sul Gizio (L'Aquila), M. Genzana a Valle Frevana (WGS84: 33T 412821E, 4645921N), 600-700 m, 02.08.1997, *F. Conti* (APP No. 35794).

This subspecies was recorded in Abruzzo only for the Gran Sasso Massif at Ruzzo (Zodda 1967), where, however, we observed and collected only *O. vulgare* L. subsp. *vulgare*.

Rumex thyrsiflorus Fingerh. (*Polygonaceae*)
Species new for the flora of Abruzzo.
Ovindoli (L'Aquila), Laghetto d'Arano, ambienti umidi, 1260 m, 09.07.1997, *F. Conti* (APP No. 28596).

This species is considered native to Eurasia, including Italy (POWO 2024), although in Galasso & al. (2024) it was treated as alien to Italy, and recorded from Trentino-Alto Adige, Emilia-Romagna and Toscana. Given its wide Eurasian range this new record from naturally occurring meadows leads us to believe that it should be considered native, as many other Eurasian plants reach the Abruzzo region.

Salvia pratensis L. (*Lamiaceae*)
Species to be excluded from the flora of Molise.

Reported by mistake for Molise by Conti & al. (2018). Revision of the specimen allowed us to re-identify it as *S. haematodes* L.

Seseli annuum L. subsp. ***annuum*** (*Apiaceae*)
Species new for the flora of the Apennines (Abruzzo).
Terranera (L'Aquila), nei pressi dell'abitato lungo la SP38 (WGS84: 33T 378639.73E, 4677209.71N), pascoli aridi pietrosi, 1292 m, 23.09.2024, *F. Bartolucci* (APP No. 72771).

A species with a European range (POWO 2024), present in Italy only in northern regions (Bartolucci & al. 2024). This discovery is of considerable phytogeographical and conservation importance, since it represents a significant disjunction from the main range of the species.

Seseli peucedanoides (M.Bieb.) Koso-Pol. (*Apiaceae*)
Species to be excluded from the flora of Abruzzo.

It has been recorded for Abruzzo at Velino (Petriccione 1993), Serra Rocca Chiarano (Di Pietro & al. 2004) and for the territory of Lucoli (De Santis & Soldati 2019, 2021) but these records are not supported by herbarium specimens. The images of this taxon showed by De Santis & Soldati (2019, 2021) should be referred to *Carum carvifolium* (DC.) Arcang. We argue that the record from Serra Rocca Chiarano should also be attributed to

C. carvifolium, since it was recorded in a high-altitude scree, a type of habitat that it is not favourable for *S. peucedanoides* but is preferred by *C. carvifolium*.

Veronica fruticans Jacq. (*Plantaginaceae*)
Species to be excluded from the flora of Campania.
Veronica fruticans is distributed in Greenland and Europe (POWO 2024). In Italy it is a rare species known only from the Alps and mistakenly recorded from the central Apennines (Bartolucci & al. 2024). The species has been reported in Campania only for Matese (Bianchini 1897), but in VER, where Bianchini's herbarium is preserved, there are no specimens referable to *V. fruticans* (S. Andreatta, pers. comm.). Considering the distribution of the species in Italy and the erroneous records for the central Apennines, we believe that *V. fruticans* has been listed in Campania as a result of confusion with other species.

Alien taxa

Abies pinsapo Boiss. subsp. ***pinsapo*** (*Pinaceae*)
Casual alien species new for the flora of Italy (Abruzzo).
L'Aquila (L'Aquila), loc. Monte Luco di Roio (WGS84: 33T 366288.15E, 4688791.08N), pineta, ca. 980 m, 26/09/2024, *F. Bartolucci* (APP Nos. 72755, 72760).

Many sterile individuals of different ages , have been observed occurring spontaneously in a restricted part of a reforestation area dominated by *Pinus sylvestris* L. and *P. nigra* J.F.Arnold subsp. *nigra*.

Aesculus hippocastanum L. (*Sapindaceae*)
Status change from casual to naturalized alien for the flora of Italy (Abruzzo).
Goriano Sicoli (L'Aquila), base di Monte Ventola, lungo un fosso a margine della SP 9 presso il cimitero di Goriano Sicoli (WGS84 33T: 398157E, 4660070N), fosso, 660 m, 29.04.2024, *F. Bartolucci, F. Conti* (APP No. 72943).

We observed many individuals of different ages growing spontaneously along a ditch in a mixed broadleaf forest.

Cotoneaster thymifolius Lindl. (*C. thymifolius* Hort. ex Baker, nom. illeg.) (*Rosaceae*)
Casual alien species new for the flora of Italy (Abruzzo).
L'Aquila (L'Aquila), loc. Monte Luco di Roio (WGS84: 33T 366288.15E, 4688791.08N), pineta, ca. 980 m, 26.09.2024, *F. Bartolucci* (APP No. 72759).

This species was identified following Fryer and Hylmö (2009 sub *C. thymifolius* Baker) and Stace (2010 sub *C. thymifolius* Wall. ex Lindl.). It is regarded as a synonym of *C. integrifolius* (Roxb.) G.Klotz by Dickoré & Kasperek (2010) and POWO (2024), whereas Kurtto & al. (2013, sub *C. thymifolius* Baker) regard it as a distinct taxon. According to Fryer & Hylmö (2009) *C. thymifolius* is native to India and Nepal. It has narrowly oblong or oblong-ovate to linear-lanceolate leaves, 1.5–5.0(–7.0) mm width (see also Lu & Brach 2003, sub *C. microphyllus* var. *thymifolius* (Baker) Koehne). The name *C. thymifolius* Lindl. (in Paxton's Fl. Gard. 2: 132. 1851) has priority over the illegitimate later homonym *C. thymifolius* Hort. ex Baker (Refug. Bot. [Saunders] i. t. 50. 1869). We

detected two individuals grown naturally in a reforestation area dominated by *Pinus sylvestris* L. and *P. nigra* J.F.Arnold subsp. *nigra*.

Eschscholzia californica Cham. subsp. ***californica*** (*Papaveraceae*)
Casual alien species new for the flora of Umbria.
Assisi (Perugia), Tordandrea, via Guido Sorignani (WGS84: 33T 300798E, 4767410N), margine stradale, 195 m, 24.05.2023, *F. Falcinelli* (APP No. 69680).

We observed a few individuals close to a garden where they are cultivated.

Gazania* ×*splendens Hend. & Andr.Hend. (*Asteraceae*)
Casual alien hybrid new for the flora of Umbria.
Assisi (Perugia), via della Cooperazione (WGS84: 33T 306790E, 4770709N), parcheggio asfaltato, 455 m, 22.05.2023, *F. Falcinelli* (APP No. 69679).

We observed a few individuals close to a garden where they are cultivated.

Ipheion uniflorum (Lindl.) Raf. (*Amaryllidaceae*)
Casual alien species new for the flora of Umbria.
Foligno (Perugia), Strada Statale n. 77 Della Val di Chienti nei pressi del km 11 e nelle vicinanze del centro abitato di Scòpoli (WGS84: 33T 320873E, 4760512N), margine stradale, 515 m, 02.04.2023, *F. Falcinelli* (APP No. 69682).

We observed a few individuals close to a garden where they are cultivated.

Ipomoea triloba L. (*Convolvulaceae*)
Casual alien species new for the flora of Lazio.
Anagni (Frosinone), loc. Famelica, margine di campo, 309 m, 29.10.2023, *E. De Santis* (APP No. 72044).

We observed this species only in a small area (4 m^2) of roadside where organic fertilizer had accumulated. The morphological characteristics suggest that the sample belongs to the Batatas clade (Wood & al. 2020) and phylogenetic analysis using the *rpl32-trnL* non-coding chloroplast region indicated it to be *Ipomoea triloba*, a species of American origin now widespread in various Mediterranean countries, including Spain (Silvestre 2012), Turkey (Yazlik & al. 2018) and Italy. In Italy, *I. triloba* was previously recorded only in Lombardia as a casual alien (Villa & al. 2017, Galasso & al. 2024). This record suggests that the distribution of this species across the Mediterrranean basin is expanding.

Larix decidua Mill. (*Pinaceae*)
Status change from casual to naturalized alien for the flora of Abruzzo.
Castel del Monte (L'Aquila), Campo Imperatore (WGS84: 33T 397919.18E 4693043.13N), pascoli tra la strada e il rimboschimento, 1470 m, 11.09.2024, *F. Conti & F. Bartolucci* (observed but not collected).

In Campo Imperatore we have noticed a great population expansion starting from the areas affected by reforestation into surrounding meadows.

Lycopsis orientalis L. (*Boraginaceae*)
Naturalised alien species new for the floras of Umbria, Abruzzo and Molise.

Palombaro (Chieti), Piano Laroma (WGS84: 33T 438647E, 4665340N), incolti, 460 m, 09.04.1999, *F. Conti & A. Manzi* (APP No. 13151); Gioia dei Marsi (L'Aquila), Colle Truscino (WGS84: 33T 390419E, 4647919N), 06.06.2017, *F. Bartolucci, F. Conti & L. Di Martino* (APP No. 59723); Cerchio (L'Aquila), Campo dell'Olmo (WGS84: 33T 383795E, 4656069N), 688 m, 21.07.2021, *F. Conti & B. Santucci* (APP No. 68377); Norcia (Perugia), Pian Grande di Castelluccio (WGS84: 33T 354427E, 4742520N), sito erboso, 1306 m, 01.07.2014, *F. Conti* (APP No. 55055); Campomarino (Campobasso), loc. Ramitelli (WGS84: 33T, 509995E, 4641702N), incolto sabbioso, 2 m, 20.10.2023, *D. Palermo* (APP No. 69678).

The records for Umbria at Pian Grande di Castelluccio (Falcinelli & al. 2015 sub *L. arvensis* L.) and the recent ones for Abruzzo (Piano Laroma, Colle Truscino) (Conti & al. 2002, 2022 sub *L. arvensis* L.) should be referred to this species.

Opuntia phaeacantha Engelm. (*Cactaceae*)
Casual alien species new for the flora of Umbria.
Baschi (Terni), tra Morre e Casa Cerqueto lungo S.P. 34 Montecchio per Todi (UTM WGS84: 33T 281915E 4731351N), margine stradale, suolo calcareo, 530 m, 20.10.2024, *F. Falcinelli* (APP No. 73305).

We observed a few individuals close to a garden where they are cultivated.

Opuntia robusta H.L.Wendl. ex Pfeiff. (*Cactaceae*)
Casual alien species new for the flora of Umbria.
Montecchio (Terni), Monti Amerini, Monte Boccialone versante sud-ovest (UTM WGS84: 33T 279218E 4727501N), margine stradale, suolo calcareo, 630 m, 30.10.2024, *F. Falcinelli* (APP No. 73306).

A few naturalised individuals over 3–4 m^2.

Picea abies (L.) H.Karst. (*Pinaceae*)
Status change from casual to naturalized alien for the flora of Abruzzo.
Castel del Monte (L'Aquila), Campo Imperatore (WGS84: 33T 397580.79E 4693206.60N), pascoli tra la strada e il rimboschimento, 1470 m, 11.09.2024, *F. Conti & F. Bartolucci* (observed but not collected).

At Campo Imperatore we have noticed a great expansion of the population with young individuals spreading from areas affected by reforestation into the surrounding meadows.

Solanum elaeagnifolium Cav. (*Solanaceae*)
Casual alien species new for the flora of Abruzzo.
Fossacesia (Chieti), loc. Piana di Fossacesia, 10 m, 19.11.2023, *A. Manzi* (observed but not collected).

Abundant as a weed in tomato fields. No specimen was seen but photographic documentation exists.

Tulipa raddii Reboul (*Liliaceae*)
Casual alien species confirmed for the flora of Lazio.
Anagni (Frosinone), nei pressi del cimitero (WGS84: 33T 347267E, 4623121N), 429 m, 31.03.2023, *E. De Santis* (APP No. 69725).

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Karel Sutorý

New lectotypification of *Cynoglossum columnae* Ten. (*Boraginaceae*, *Cynoglossae*)

Abstract

Sutorý, K.: New lectotypification of *Cynoglossum columnae* Ten. (Boraginaceae, Cynoglossae). — Fl. Medit. 35: 15-18. 2025. — ISSN: 1120-4052 printed, 2240-4538 online.

A new lectotype and epitype are selected for *Cynoglossum columnae* Ten. The lectotype previously chosen by Selvi & Cecchi (2009) is regarded as unacceptable. The name *C. columnae* published three years later by Antonino Bivona-Bernardi is a later heterotypic synonym.

Key words: *Boraginaceae*, *Cynoglosseae*, heterotypic synonym, Italy.

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Cynoglossum columnae Ten. in Fl. Napol. 1 (Prodr.): XIV. 1811.

Lectotype: [illustr.] "Cynoglossa altera media fructu" in Colonna, Ekphrasis: 178, 1616 (designated here, Fig. 1).

Epitype (designated here) *Cynoglossum columnae* 3. Cent. inedit. Sicily, A. Bivona 1810. LINN-HS 256-13

Synonym: *Cynoglossum columnae* Biv., Stirp. Rar. Sicilia 2: [7], 1814.

Lectotype (designated by Cecchi & Selvi in Nat. Hist. Sci. 2: 97. 2015): [Italy, Sicily] s.d., *[Bivona]* ("Cynoglossum columnae nobis. Man. 2 [Bivona's handwriting] / Habui a Cl. Bivona [Parlatore's handwriting]", FI 2584!)

The name *Cynoglossum columnae* Ten. was described in the prodromus portion of the first volume of Tenore's Flora Napolitana (1811). The species described three years later under the same name by Antonino Bivona-Bernardi (1814) undoubtedly refers to the same taxon. A lectotype of Tenore's name was designated by Selvi and Cecchi (2009: 622), who selected the specimen "in pascuis montanis, Tenore" deposited in Florence (FI). However, this type designation for Tenore´s name was later questioned in the ineffectively published "Supplementary materials" (http://pwt.pensoft.net//getfile.php?filename=oo_42064.html) by Hilger & al. (2015). They considered it "hardly appropriate as it was probably collected long after 1811, having been sent to Florence in 1844, and moreover consists of two plants in different stages of development, which likely represent two distinct gatherings".



Fig. 1. *Cynoglossum columnae* Ten. Lectotype, Colonna, Ekphrasis: Tab. 178, 1616.

A lectotype for Bivona-Bernardi's name was also selected by Selvi and Cecchi (Cecchi & Selvi 2015: 97). The chosen specimen was collected on Sicily by Bivona-Bernardi, without a specified date, and was labelled "*Cynoglossum columnae* nobis. Man. 2". F. Parlatore included a note stating "Habui a Cl. Bivona". It is deposited in FI and is clearly an effective lectotypification of *C. columnae* Biv. However, this is not a specimen that is part of the original mate-

rial of *C. columnae* Ten. and so Cecchi & Selvi (2015) were correct in treating the names as heterotypic synonyms and Hilger & al. (2015) were incorrect in considering them to be isonyms. According Turland & al. (2019, Art. 6 Note 2) "when the same name, based on the same type, has been published independently at different times, perhaps by different authors, then only the earliest of these "isonyms" has nomenclatural status" and the selection of the lectotype for the later published name would not be necessary. Because *C. columnae* Ten. cannot be based on the same specimen as *C. columnae* Biv., the names must they be considered as heterotypic synonyms. However the lectotype selected for Tenore´s name by Selvi and Cecchi (2009) must be replaced.

The protologues of both names cite a plant described by Fabio Colonna in his Ekphrasis (Colonna 1616) and the unpublished name "*Cynoglossum cristatum* var." (Lamarck 1786: 238). Bivona-Bernardi assigned the authorship of this name on the label (Fig. 2) to Willdenow (1797: 764). Since Tenore´s description does not provide any specific locality or specimen, the illustration cited in protologue (Colonna 1615) should be selected as lectotype. As an epitype (a specimen … selected to serve as an interpretative type when … the lectotype, … cannot be identified for the purpose of the precise application of the name … Art 9.9. Turland & al. 2019), Bivona-Bernardi's specimen with the reference to Colonna, collected before the first use of the binomial "*columnae*" is selected. This specimen is deposited in the LINN herbarium. Importantly, the note "Cent. 3" on the selected specimen indicates that it was intended to be distributed in Bivona-Bernardi's third exsiccate series (centurie). The content of two previous series was published by Bivona-Bernardi (1806). The selected specimen was collected four years after the publication of Bivona-Bernardi´s first two series and was intended for the third, which was never published. It is not excluded that some specimen from this "third series" could also been in Teneore´s possession.

In the protologue of Bivona-Bernardi's synonym (Bivona-Bernardi 1814) two collection sites are mentioned : "in Monte Cuccio Panormum prope" and in the Smith's collection as "In Appenninis [sic !] Montibus". We may assume that no other localities of this species were known and available in the years of Tenore's (1811) and Bivona-Bernardi's publications (1814), as they would certainly have mentioned them. Both specimens are present in the Smith Herbarium (LINN-SM). The specimen from Sicily was selected as a lectotype due to its better

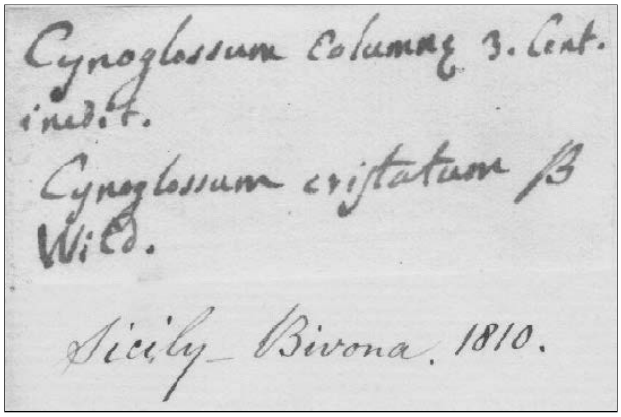


Fig. 2. Label of the epitype specimen *Cynoglossum columnae* Ten. LINN-HS 256-13.

developed fruits, which are characteristic of this species, and because the accompanying text corresponds well with the protologue. The text is written by Bivona-Bernardi, while the locality (Sicily) and date of collection or delivery (l810) are written in English, likely by Smith. The second specimen from the Apennines, mentioned in protologue, is also deposited in the Smith Herbarium (LINN-HS 256.14.). It was collected on 29 April 1787 on "Hills behind the inn at Valcimara [Valcimarra ?], foot of the Appenines [sic!]" with reference to "*C. columnae* Bivon. Cent. 3". The Bivona´s name was added to the locality later in pencil (locality itself is in ink) and with question mark. The question mark would not be present if the specimen had been seen by Tenore or Bivona-Bernardi. https://linnean-online.org/30038/#?s=0&cv=0&z=0.1809%2C1.1495%2C0.4663%2C0.5762. The specimen from the Apennines is just beginning to flower and is not optimal for selection.

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Article

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G. Calvia, A. Ruggero, M. Fois, E. Farris, A. Lallai, F. Mascia, L. Podda, G. Campus, M. Porceddu & G. Bacchetta

Contribution to a new vascular flora of Sardinia (Italy): II (31-60)

Abstract

Calvia, G., Ruggero, A., Fois, M., Farris, E., Lallai, A., Mascia, F., Podda, L., Campus, G., Porceddu, M. & Bacchetta, G.: Contribution to a new vascular flora of Sardinia (Italy): II (31-60). — Fl. Medit. 35: 19-50. 2025. — ISSN: 1120-4052 printed, 2240-4538 online.

Following the first contribution for a new, updated, and revised vascular flora of Sardinia, this work adds new data on the distribution of 30 taxa growing in the island. The treated taxa are both native and alien, and are characterised by their rarity, phytogeographical significance, endemicity, conservation issues, or novelty to Sardinia and Italy. These updates result from floristic research mostly conducted in South Sardinia but include several discoveries from the rest of the island. The first report of *Commelina erecta*, *Ficus watkinsiana*, *Morus kagayamae*, *Opuntia elatior* (casual alien species) in Sardinia is documented here. Additionally, *Casuarina glauca* and *Robinia* ×*ambigua*, are reported for the first time in Italy (casual alien). Moreover, the confirmation of *Ajuga chamaepitys* subsp. *chamaepitys* is here provided. Furthermore, new distributional data for 23 taxa, some of which known for their rarity, are gathered. Notably, *Elatine hexandra* and *Cosentinia vellea* subsp. *bivalens*, previously reported only once in recent years, along with *Elatine alsinastrum* and *Halopeplis amplexicaulis*, which were indicated only for a few sites. For others, an expansion or an improvement of their distribution range on the island is documented, as for rare endemics including *Artemisia campestris* subsp. *variabilis*, *Bellium crassifolium*, *Borago morisiana*, *Dianthus cyathophorus* subsp. *cyathophorus*, *Filago tyrrhenica*, *Helicodiceros muscivorus*, *Limonium racemosum*, *Phleum sardoum*, and *Torilis nemoralis*. New findings are also reported for *Asplenium sagittatum*, *Ludwigia palustris*, *Malva lusitanica*, *Mandragora autumnalis*, *Persicaria decipiens*, *Piptatherum caerulescens*, *Rorippa sylvestris* subsp. *sylvestris*, and *Veronica anagalloides* (rare or scattered native). In addition, new information on the distribution of *Artemisia verlotiorum* and *Lycium ferocissimum* (invasive alien species) is here reported. Finally, new data about some of the taxa recorded in the first contribution are added or modified.

Key words: Alien taxa, Endemic taxa, Mediterranean vascular flora, Native taxa, Rare Plants..

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Introduction

This second contribution represents a continuation of the previous work dedicated to new regional vascular plant records for the island of Sardinia (Ruggero & al. 2024).

Despite the general good knowledge on the distribution of vascular plants, previously synthesised by the work of Arrigoni (2006-2015), there are still many parts of Sardinia that in the past were not investigated. Consequently, new findings are continuously made, which enlarge the ranges of these taxa at a regional level. Often, these records are located far from the earlier studied areas of a given species, and in the meantime, distinctly broaden knowledge about its range. During field explorations across the island of Sardinia, from late 1990s to March 2025, as well as during taxonomic revisions of herbarium material of different groups of vascular plants, we also found some taxa that are new to the flora of Sardinia and, sometimes, Italy.

In this second report, we provide new records of 30 vascular plant taxa from Sardinia. These records are significant in terms of knowledge on the distribution range of these vascular plants, their endemicity and the potential/current invasiveness of some alien taxa. Particularly, six of the taxa here presented are regarded as casual alien new to the studied area, whereas other two were previously considered naturalised alien taxa, whose status has been changed to invasive. The other 22 taxa are native elements for the island, nine of which are endemic to Sardinia and, sometimes, to other islands and regions of the Tyrrhenian area, while the others can be considered rare or threatened at a regional level and have phytogeographic relevance. Furthermore, we add new reports, occurred during this last year, regarding some of the taxa treated in the previous contribution (Ruggero & al. 2024). These recent discoveries testify the importance of intensifying field surveys (Marignani & al. 2014) to have dynamic floras (Fois & al. 2022) for a better and precise comprehension of the regional floristic richness and the dynamics related to spread and invasion of alien taxa.

Material and methods

This work is based on extensive plant collections made by the authors in Sardinia and neighbouring islands and islets between 1997 and March 2025, together with a bibliographic and herbarium revision. Complementary to the field research, which has engaged the authors for years and still does, was the study of herbarium samples and extensive bibliographic material. In addition, reports from websites such as Wikiplantbase, iNaturalist or floristic pages on Facebook were considered. Plants were identified using Italian and European floras (Tutin & al. 1964-80, 1993; Pignatti 1982; Castroviejo & al. 1986-2015; Arrigoni 2006-2015; Jeanmonod & Gamisans 2013; Tison & De Foucault 2014; Pignatti & al. 2017-2019).

The status of each alien species was determined and ordered based on the criteria proposed by Richardson & al. (2000), elaborated by Pyšek & al. (2004) and reviewed according to Richardson & al. (2011). Archaeophyte and neophyte taxa were differentiated depending on their introduction before or after 1492/1500, respectively.

The list of taxa follows Pignatti & al. (2017-2019), while the nomenclature is derived from Bartolucci & al. (2024) and Galasso & al. (2024). Herbarium specimens are preserved in personal herbaria of some authors (e.g. Herbarium Ruggero, Herb. Calvia, Herb. Mascia, Herb. Farris) and in the CAG and SS herbaria. Acronyms follow Thiers (2025).

The taxa are presented in two lists, native and alien, following alphabetical order for each one. Information on ex situ conservation actions carried out for native taxa at the Sardinian Germplasm Bank (BG-SAR; Porceddu & al. 2017) is also reported.

All the cited municipalities are accompanied by their referential province code in brackets. Following the establishment of the Metropolitan City of Sassari, which occurred as a result of the Regional Law of April 12, 2021, and became officially active on April 1, 2025, the Province of Olbia-Tempio has been reconstituted under the new name of Province of Gallura (North-East Sardinia). Therefore, new province abbreviations are as follows: Cagliari is CA, Nuoro is NU, Oristano is OR, Olbia-Tempio is OT, Sassari is SS and South Sardinia is SU.

Native taxa

Ajuga chamaepitys (L.) Schreb. subsp. ***chamaepitys*** (*Lamiaceae*)

Distribution update and subspecies confirmation

New findings: Laconi (OR), Funtanamela, 700–710 m, 14/6/2018, *G. Bacchetta*, *C. Dessì* (CAG); Gadoni (NU) Foresta Corongia, area di Bauzzoni, 740–780 m s.l.m., 27/5/2023; 4/5/2024, *G. Campus* (Herb. Campus).

Observations: the presence of *Ajuga chamaepitys sensu lato* in the Italian territory is extended throughout all regions (Bartolucci & al. 2024). *A. chamaepitys* subsp. *chamaepitys* appears as the commonest subspecies throughout the distribution range of the taxon in Italy, while *A. chamaepitys* subsp. *chia* (Schreb.) Arcang. is reported as common in Sicily and nearby islands (Pignatti & al. 2017-2019) but is also present in Abruzzo, Apulia, Basilicata, Calabria, and was no longer found in Campania (Bartolucci & al. 2024). *A. chamaepitys* subsp. *suffrutescens* (Willk.) Greuter et Burdet is indicated for Sicily (Bartolucci & al. 2024).

Ajuga chamaepitys was first reported in Sardinia by Moris (1837-1859) from Mount Corrasi (Oliena, NU). Subsequently, it was only recorded a few other times, from Alghero (SS, an herbarium sample collected by Valsecchi in 1971 and preserved in SS), and Orgosolo (NU, an herbarium sample collected by Deiana in 2019 and preserved at the Supramonte Museum). A further report came from Torrente Quirra (Villaputzu, SU) by Mossa & al. (2003). Later, Arrigoni (2013) cited Lanusei (NU) mountains. All these records were done without subspecific attribution.

Here we report the presence of *A. chamaepitys* in three new stations in the territory of Gadoni (NU), falling in an approximately 1.5 km^2 area. A few plants were also found near Taccu ‘e Ticci (Seulo, NU) and Funtanamela (Laconi, OR). All the plants observed can be attributed to *A. chamaepitys* subsp. *chamaepitys* due to the width of the leaf laciniae (1–2 mm), the corolla measuring between 8 and 12 mm and the nucules with reticulated venation, of 3 × 1–1.2 mm (updated distribution in Fig. 1).

Rarity and threats: the new populations from Gadoni are quite poor in individuals, counting around 20 individuals at one station along the edges of a dirt road, and a more substantial presence (50 individuals) in other two stations was observed. Despite being quite rare on the island, this taxon is likely not facing specific threats.

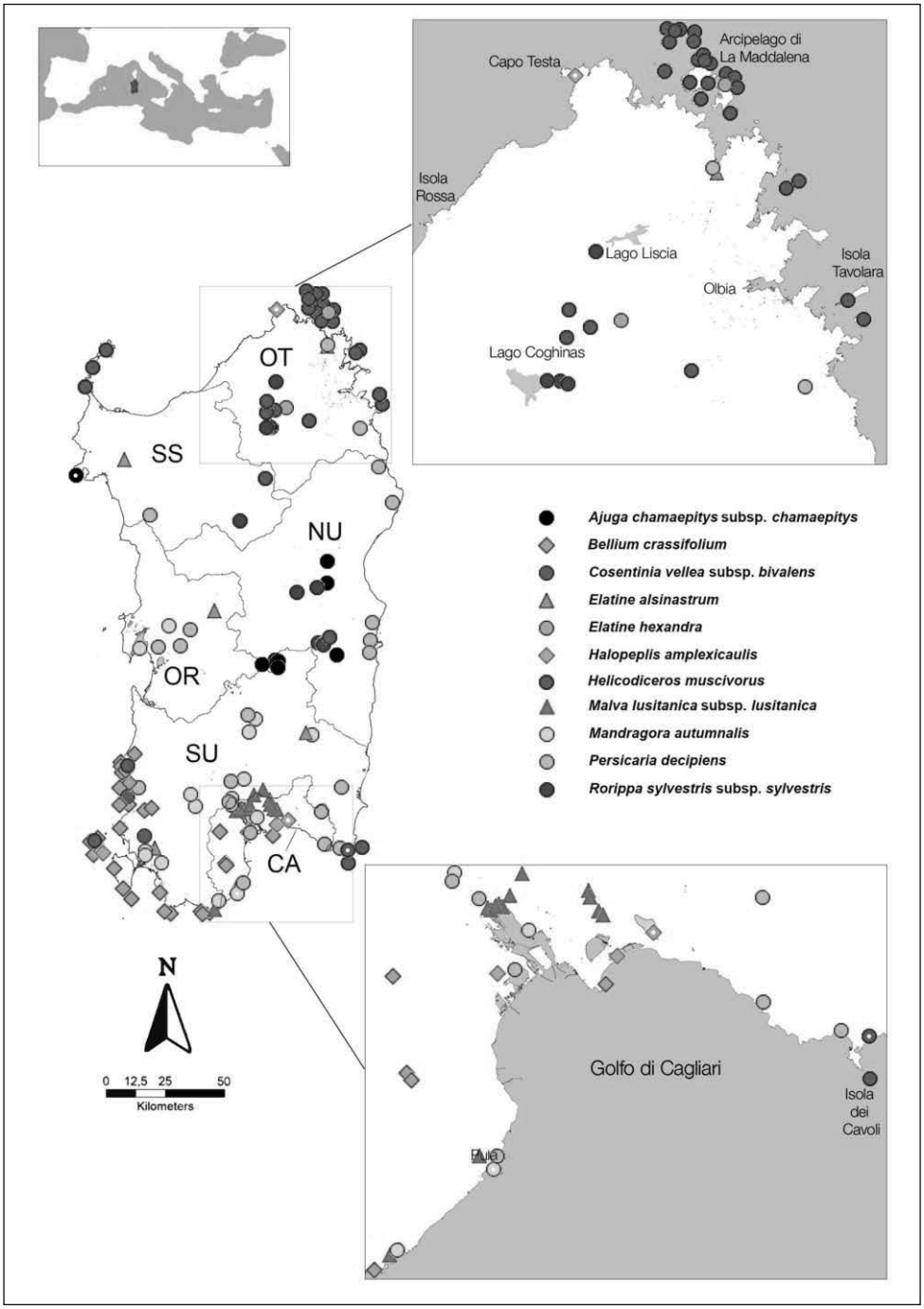


Fig. 1. Distribution map of half of the native taxa cited in this article. Pointed symbols refer to not confirmed data.

Artemisia campestris subsp. ***variabilis*** (Ten.) Greuter (*Asteraceae*)
Distribution update
New findings: Cagliari (CA) Campo di Santa Gilla, 9/2004, *B. De Martis*, *B. Mulas* (CAG); loc. Porto Canale, 0 m s.l.m., 14/2/2008, *G. Bacchetta* (CAG); Elmas (CA) loc. Is Buronàrgius, 0 m s.l.m., 02-05-2008; Uta (CA) loc. San Tommaso/Sa Tuerra, 2 m s.l.m., 28/2/2010 *F. Mascia* (Herb. Mascia); Cagliari, loc. Donna Laura, 5 m s.l.m., 20/3/2013, *F. Mascia* (Herb. Mascia); Carbonia (SU) Miniera di sterili di Serbariu, 75 m s.l.m., 5/5/2018, *G. Calvia* (Herb. Calvia); San Giovanni Suergiu/Sant'Antioco (SU) lungo la ciclabile tra Is Cordeddas e Is Loddus in diversi punti, negli incolti, 0–2 m s.l.m. 03/3/2025, *G. Calvia* (Herb. Calvia).
Observations: this taxon is considered endemic to the Tyrrhenian area, including southern Italy, Sardinia and Sicily (Pignatti & al. 2027-2019). The first report of this taxon in Sardinia was by De Marco & Mossa (1973), who documented it in their study about the flora of San Pietro Island (SU). Actually, a first collection seems to be related to an herbarium sample from Palau (OT) preserved in PI (PI-GUAD 019171; legit: M. Guadagno) and recently reported by the site Wikiplantbase. Further confirmation came from Milia & Mossa (1976), who identified it on the isthmus of Sant'Antioco (SU) and nearby areas. Despite these records, Pignatti (1982) did not include Sardinia within the distribution range of the taxon. Later, Filigheddu & Urbani (1994) clarified its distribution after discovering it in the Sassarese sector (Ossi, SS). They also reported new occurrences from the South-western part of Sardinia, namely from the surroundings of San Giovanni Suergiu (SU). More recently, we have identified it in the outskirts of Carbonia and in another area of San Giovanni Suergiu (SU), notably in fallow fields, along roadsides and on hills of mining waste materials, and around Santa Gilla Lagoon in fallow land and on scarps (Fig. 2).
Rarity and threats: the species has a restricted distribution in Sardinia, but it is locally frequent. Despite being an endemic taxon, Filigheddu & Urbani (1994), followed by Arrigoni (2015a), raised doubts about its native status in Sardinia. Although the taxon is effectively almost exclusive to secondary and disturbed environments, it can be otherwise assumed that the habitats of this taxon are particularly exposed to human pressures. Seed lots of four populations from the SAC ITB040023 "Stagno di Cagliari, Saline di Macchiareddu, Laguna di Santa Gilla" are preserved under long-term conservation at -25°C at the BG-SAR.

Asplenium sagittatum (DC.) Bange (*Aspleniaceae*)
Distribution update
New findings: Cagliari (CA) Cisterna del Tempio di Astarte, Capo Sant'Elia, 135 m s.l.m., 7/5/2000, *G. Bacchetta* (CAG); Alghero (SS) Monte Doglia, 380 m s.l.m., 15/4/2001, *G. Bacchetta*, *E. Farris* (CAG).
Observation: this circum-Mediterranean taxon is scattered along the coasts of almost all Mediterranean countries and in the islands (Pichi Sermolli 1979). It was first reported in Sardinia, sub *Scolopendrium hemionitis* Sw., *ad rupes S. Tenera, Cagliari* (cliffs of Santa Tenera, Cagliari) (Moris 1827). Later, Barbey (1884) cited Santa Teresa Gallura (a sample collected by Reverchon in 1881), Monte Santa Giusta, Nurra (a sample collected by Forsyth Major in 1884), and in a cave in Monte Argentaro, in 1883, a speci-

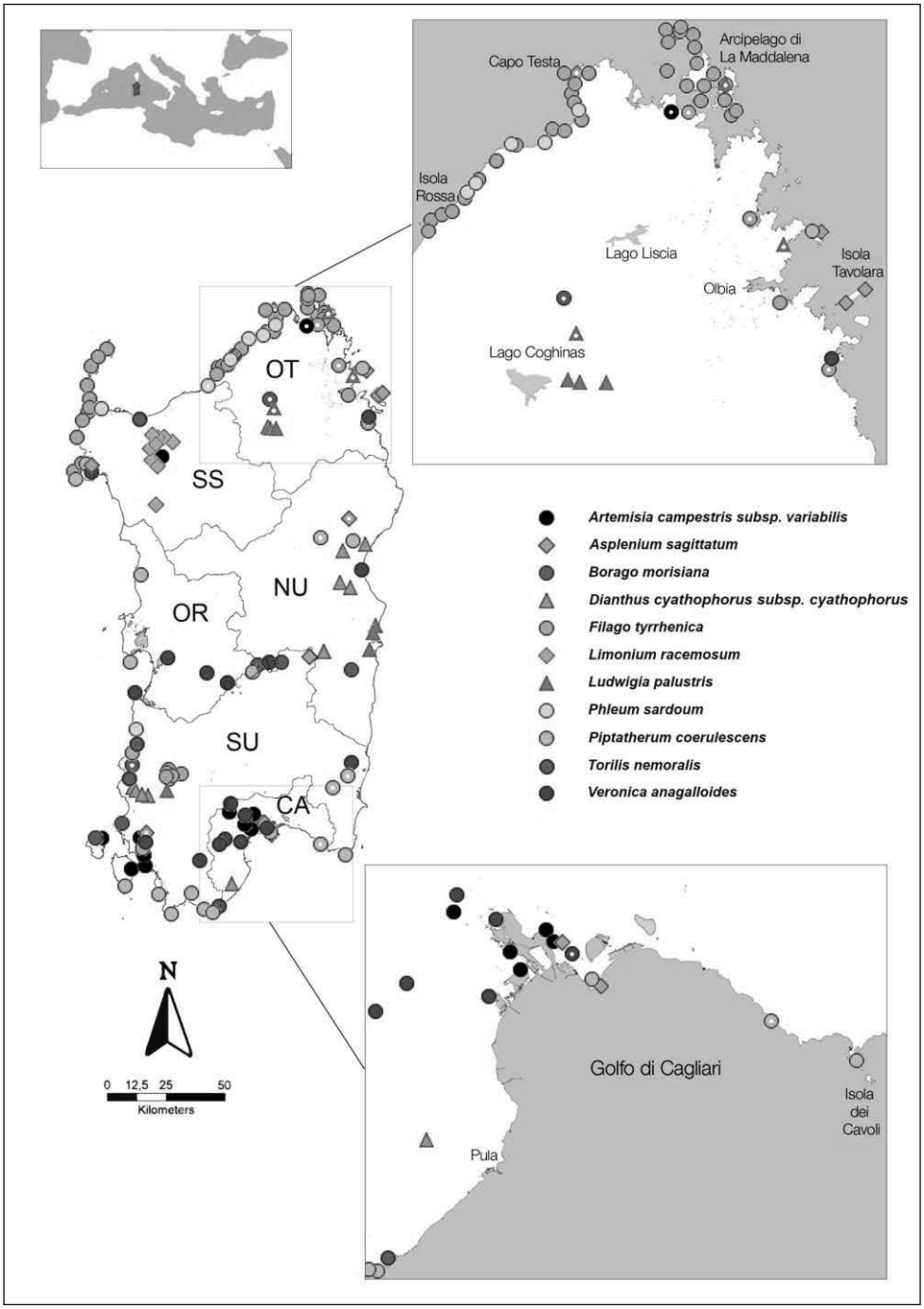


Fig. 2. Distribution map of half of the taxa species cited in this article. Pointed symbols refer to not confirmed data.

men collected by M. Major (this last site is hard to be geographically placed). Finally, he recorded it at *Grottes de Su Stiddiu, S. Avendrace, Cagliari* (samples collected by Moris and his contributors). Then, he referred that Gennari had described a var. *tenoreanum* from this last site. During the 20th century, the taxon was recorded as abundant in wet and shadowy calcareous cliffs of the northern slopes of Tavolara Island (Desole 1960). Subsequently, the species was recorded at Grotta del Diavolo (Seui, NU) and Sa Domu 'e S'Orcu (Carbonia, SU; Berta & Chiappini 1978). Then, it was also reported as very rare in the cave Conca 'e Crapa, on Monte Albo (Lula, NU; Camarda 1984), Lastly Arrigoni (2006) added Capo Figari (Golfo Aranci, OT).

An erroneous report exists from the island of Caprera: Nicotra (1896), citing a finding by Binna, recorded the doubtful occurrence of *Scolopendrium breve* Bert. The presence of this taxon on Caprera was already questioned by Vaccari (1896), then definitely excluded by Bocchieri (1996).

Few years ago, we found two new populations in the Roman cistern beside the Temple of Astarte on Capo Sant'Elia (Cagliari) and in a cave on the side of the road leading to the summit of Monte Doglia (Alghero, SS; Fig. 2).

Rarity and threats: the species in Sardinia is very rare, often giving rise to extremely small populations in limestone rocky environments and locally it has not been confirmed in recent years, as in the cave Conca 'e Crapa, where it was unsuccessfully searched for in 2022. For this reason, in situ and ex situ protection measures should be taken and the species should be assessed at a regional level using IUCN criteria (IUCN 2012).

Bellium crassifolium Moris (*Asteraceae*)

Distribution update

New findings: Buggerru (SU) San Nicolò. Calcari paleozoici; esposizione E 100°, inclinazione 100°, 150 m s.l.m., 11/6/1998, *S. Brullo*, *G. Bacchetta* (CAG); Fluminimaggiore (SU) Gutturu Pala. Calcari, esposizione NNW 350°, inclinazione 80°, bioclima meso-medit. inf./subumido sup., 6/6/2002, *G. Bacchetta*, *M. Casti*, *C. Pontecorvo* (CAG); Siliqua (CA) Sa Spindula di Monte Arcosu, 292 m s.l.m., 7/9/2021, *G. Bacchetta*; Sant'Antioco (SU) Isola della Vacca, tra le rocce a margine della gradinata semi-naturale, 28/9/2022, *F. Mascia*.

Observations: this taxon is endemic of south-western Sardinia, where it was first described by Moris (1827) at Capo Sant'Elia (Cagliari), and San Pietro Island (Cala Vinagra). Subsequently, it was found in other coastal sites, in the municipalities of Arbus, Buggerru, Carloforte, Domus de Maria, Fluminimaggiore, Iglesias (Masua), Sant'Anna Arresi, Teulada (SU; Arrigoni 1969, 1979, 2015a; Bacchetta 2006; Pontecorvo 2007). It is also present on coastal rocky areas of Gonnesa and Portoscuso (from Goroneddu to Capo Altano), and of Sant'Antioco Island (Mangiabarche, Calasetta; Capo Sperone, Sant'Antioco, SU). In smaller islands, it is also present at Tuarredda Island (Teulada) and Pan di Zucchero (Bocchieri 2001). The species thrives on rocky environments and appears to be indifferent to geological substrates, being rather frequent in volcanic, metamorphic and calcareous coastal areas. Nonetheless, it is also known from inner sites, although rarer, as in the hills of Sarroch, in the contiguous localities Is Cioffus and Bidda Mores, on metamorphic vertical cliffs (Bacchetta 2006) and at Sa Spindula waterfall in Monte Arcosu (Siliqua) on granitoids, while in meta-calcareous cliffs it grows

near Monte San Giovanni and Bindua (Iglesias), and in the area of Gutturu Pala, Arenas (Fluminimaggiore) (Arrigoni 1979; Pontecorvo 2007).

Here, we slightly enlarge the distribution of the species in the main island (Fig. 1), and we add a population on the coastal cliffs of the Vacca Island, where it was not previously reported by Bocchieri (1992).

Rarity and threats: despite being typical of coastal areas, the species grows in sites that do not face particular threats, apart from trampling and climbing, which are limited to small areas. Seed lots of six different populations are stored at BG-SAR. The oldest accession, which comprises 1283 seeds, was collected in 2007.

Borago morisiana Bigazzi & Ricceri (*Boraginaceae*)

Distribution update

New finding: Ulassai (NU) Sa Canna, 749 m s.l.m., 3/9/2023, *F. Mascia* (Herb. Mascia).

Observations: this species is a narrow endemic, which is limited to central and south-western Sardinia, where it appears to be very rare. It was described by Bigazzi & Ricceri (1992) for a single site, a rivulet close to the coast, on San Pietro Island. The authors reported other findings, especially by Moris, under *Borago laxiflora* var. *parviflora* Moris (Moris 1837-1859), which were related to an unconfirmed herbarium collection from Fluminimaggiore (Bacchetta & Pontecorvo 2005). Moreover, a few other Moris´ herbarium samples exist, some of which are mixed with *B. pygmaea*, from Tempio Pausania (OT), Ogliastra, and generic mountain areas of Sardinia (Bigazzi & Ricceri 1992). Up to now, there has been no confirmation about Tempio Pausania. In more recent times, the species has been found and reported in other localities, particularly near Laconi (OR; Bigazzi & al. 2005; Selvi & al. 2006), and along a rivulet in the locality Goroneddu (Portoscuso, SU; Mascia and Orrù 2023).

Here, we add a few new growing localities (Fig. 2), of which one confirms the old findings by Moris from Ogliastra, specifically from Ulassai (NU), while the second was in the locality Bauzzoni (Gadoni, NU; from this last no sample was collected given its rarity).

Rarity and threats: the species has been considered endangered (EN) in recent years (Orsenigo & al. 2018). Among the threats it has to face, droughts, natural evolution of the surrounding vegetation and diffusion of invasive alien plants have been recognised as the major potential causes of loss. Despite the addition of these latest findings, the species remains at great risk of extinction due to a general poor number of plants for each growing station. Ex situ actions were provided through the collection, in 2004, of 48 seeds from San Pietro Island and 26 from Laconi. These seeds are safely preserved at -25°C at BG-SAR.

Cosentinia vellea subsp. ***bivalens*** (Reichst.) Rivas Mart. (*Pteridaceae*)

Distribution update

Findings: Iglesias (SU) Falesia di Masua. Calcari paleozoici, esp. ESE 120°, inclin. 90°, biocl. termomedit. sup./secco sup., 20/4/2002, *G. Bacchetta*, *M. Casti*, *C. Pontecorvo* (CAG); Iglesias (SU) Falesia di Masua. Calcari paleozoici, 140 m s.l.m., esp. ESE; inclin. 90°, biocl. termomedit. sup./secco sup., 14/7/2006, *C. Pontecorvo*, *M. Casti* (CAG).

Observations: for a long time, this taxon was thought to be absent in Italy, with only *C. vellea* subsp. *vellea* reported, as noted by Marchetti (2004). However, the taxon has been

cited for the first time in Sardinia and Sicily by Brullo & al. (2007), who reported unpublished data from Bacchetta. While *C. vellea* subsp. *vellea* is quite widespread on metamorphic and granitic substrates, mostly in the southern half of Sardinia, the only known report up to now known for *C. vellea* subsp. *bivalens* was from Masua (Iglesias, SU), on calcareous outcrops. We also observed, although not collecting them, some plants that could be referred to this taxon on meta-calcareous outcrops near Carbonia (SU; Fig. 1).

Rarity and threats: the taxon is extremely rare on the island and is locally threatened by human activities such as climbing on the calcareous cliffs of Masua. These issues, the taxon warrants protection through both in situ and ex situ efforts. Additionally, it should be assessed at a regional level using IUCN criteria (IUCN 2012).

Dianthus cyathophorus Moris subsp. ***cyathophorus*** (*Caryophyllaceae*)

Distribution update

New findings: Domusnovas (SU) Presso la Grotta di San Giovanni, 510 m s.l.m., substrato metamorfiti paleozoiche, 4/6/2006, *G. Bacchetta*, *C. Pontecorvo* (CAG); Iglesias (SU) San Benedetto, Monte Perda, 570 m s.l.m., 14/4/2024, *G. Bacchetta*, *T. Carai*, *E. Pontecorvo* (CAG); Iglesias (SU) Perdu Carta, 768 m s.l.m., 14/4/2024, *G. Bacchetta*, *T. Carai*, *E. Pontecorvo*.

Observations: this taxon is endemic to central eastern and south-western Sardinia, where is typical of calcareous outcrops of Supramontes and Sulcis-Iglesiente (Bacchetta & al. 2010). It was first described by Moris (1837-1859) from specimens collected by Lisa on the Dorgali mountains. Then it was collected in other parts of Supramontes, in the municipalities of Oliena, Orgosolo and Urzulei. Other findings were related to Marganai (Iglesias, SU), and to the locality of Sa Pala is Arangius (Pula, SU; Bacchetta 2006). More recently, it was reported for Ogliastra calcareous outcrops (Cuena-Lombraña et al. 2023). This last report is due to a sample collected by Bacchetta in 2013 at Perd'e Liana (Gairo, NU) and preserved at the herbarium CAG.

Here, we report the discovery of new growing localities at San Giovanni (Domusnovas, SU), Monte Perda (San Benedetto, Iglesias, SU) and Perdu Carta (Iglesias; Fig. 2).

Rarity and threats: though not very rare, this taxon is threatened by constant and massive overgrazing in several of its growing stations, both by wild animals and feral livestock. Only plants growing on vertical calcareous cliffs are often left without any damage. In situ conservation measures are needed, while ex situ action was ensured through the conservation at BG-SAR of two different seed lots collected from Marganai and San Benedetto respectively. The species should be considered for a regional IUCN assessment (IUCN 2012).

Elatine alsinastrum L. (*Elatinaceae*)

Distribution update

New finding: Carbonia (SU) laghetto di Sirimagus, acque poco profonde lungo le sponde, 272 m s.l.m., 1/5/2021, *G. Calvia, A. Tatti, F. Tatti* (Herb. Calvia).

Observations: this Eurasian species has a limited distribution in Italy, where it is known from the Abruzzi, Apulia, Latium, Lombardy, Piedmont, Sardinia, and Tuscany. It is considered extinct in Sicily and its presence is doubtful in Emilia-Romagna and Umbria (Bartolucci &

al. 2024). On the island of Sardinia, the species was first reported by Barbey (1884) "*Teste Rev*[erchon] *cat. mss*.". Later, Pignatti (1982) confirmed its presence in Sardinia, though without specifying a place. Subsequently, Arrigoni (1983) excluded it from the Sardinian flora. More recently, Iiriti (2006) found it on the shores of Flumendosa River (Ballao, SU), while Desfayes (2008) observed it along Rio San Giovanni (Arzachena, OT). Some specimens, preserved in the herbarium SS, were reported on the website Wikiplantbase Sardegna for Sos Fungarones (Olmedo, SS) and Paule Longa (Ghilarza, OR).

Here, we report the discovery of a new population of this species on a small, isolated lake in the south-western Sardinia (Fig.1), where it grows in still waters, approximately 30 cm to 1 m deep, alongside other hydrophytes such as *Myriophyllum alterniflorum* DC. and *Ranunculus baudotii* Godr.

Rarity and threats: the species is very rare on the island of Sardinia. Specifically, the new population is small and is isolated within a closed water system, of supposedly Nuragic origin (1500-700 BCE), which currently serves as a water reserve for shepherds and is grazed by livestock. Both in situ and ex situ conservation measures are needed, and the species should be considered for a regional IUCN assessment (IUCN 2012).

Elatine hexandra (Lapierre) DC. (*Elatinaceae*)

Second record to Sardinia and distribution update

New finding: Isola di Caprera (SS) Fosso Stefano, rive umide bacino artificiale, 11/6/2024, *A. Ruggero*, *A. Di Giacomo* (CAG).

Observation: this species has a European-Atlantic distribution (Popiela & al. 2011; POWO 2024). In Italy, it is reported as a cryptogenic taxon growing in Lombardy, Piedmont, Emilia Romagna and Sardinia, while in Corsica it is considered native (Delage & Hugot 2020). Its presence is doubtful in Veneto and was erroneously reported in Liguria and Friuli Venezia Giulia (Bartolucci & al. 2024). In Sardinia, the taxon has been only reported from one site, Vena Limbara (Calangianus, OT), on the eastern border of Mount Limbara, in the northern part of the island (Bartolucci & al. 2022).

In this contribution, we report the occurrence of this species on the La Maddalena Archipelago (OT), near the shores of the artificial basin of Fosso Stefano, on the island of Caprera (Fig. 1).

Rarity and threats: the species is quite widespread within its range and does not need special protection measures globally. However, in Sardinia, the species is currently known from only two sites, both in semi-artificial contexts (some lakes originated from abandoned granite quarries and an artificial water basin). These two Sardinian populations should be monitored and potentially protected through in situ and ex-situ conservation efforts. In the case of Caprera, within the "Project for the conservation of plant diversity in the La Maddalena Archipelago National Park", in 2024 a germplasm collection has been gathered and preserved at the BG-SAR.

Filago tyrrhenica Chrtek & Holub (*Asteraceae*)

Distribution revision

Findings: Isola di Caprera (SS) davanti Is. Porco. Scogliera, 25/4/1997, *A. Ruggero*, *A. Di Giacomo* (Herb. Ruggero); Aglientu-Vignola (SS) M. Russu. Suolo sabbioso compatto e nudo, 26/4/1998, *A. Ruggero* (Herb. Ruggero); Trinità d'Agultu (SS) La Marinedda.

Sabbie nude e compatte tra gariga ad *Helichrysum*, 25/4/2004, *A. Ruggero* (Herb. Ruggero); Trinità d'Agultu (SS) Cala Sarraina. Sabbie compatte a margine sentieri, tra le garighe costiere, 15/4/2018, *A. Ruggero*, *A. Di Giacomo* (Herb. Ruggero); Alghero (SS) Cala Barca. Sfatticcio sabbioso, tra le garighe al limite del sentiero, 25/3/2024, *E. Farris*, *A. Maccioni* (Herb. Farris); Villacidro (SU) Punta Santu Miali, 1062 m s.l.m., 18/5/2024, *G. Bacchetta* (CAG).

Observations: this species is endemic to Sardinia and Corsica. Historically, its distribution was believed to be limited to northern Sardinia and southern Corsica (Martinoli 1958; Corrias 1977). However, in Corsica, the species is widespread along the coasts of the southern half, from Punta d'Omigna in the West, to North of Portovecchio in the East. More recently, it has been found in a single population on the northern side of the island, North of the Ostriconi dune system (Gehu & al. 1989; Delage & Hugot 2020).

In Sardinia, the species range is primarily northern, with two main populations. One stretching along the north-western coast of Nurra, from Cala Viola to Stintino (SS), including the island of Asinara (Corrias, 1977). In this north-western range, the southern limit reported by Corrias (1977) should be corrected, because a small population occupying a few square meters in the locality Cala della Barca (Capo Caccia Peninsula, Alghero, SS), was recently discovered. The second main population is located along the Gallura coasts, from the northern Badesi shores up to Capo Falcone (Santa Teresa Gallura, OT) (Corrias 1977; Ruggero 2022), including La Maddalena Archipelago, where it is quite common, and the type specimen was described (Moris 1837-1859). The taxon appears less commonly along the north-eastern coasts of Gallura, where Vaccari (1894) recorded it from a beach near Palau (OT). Then, the species was found at Le Saline Pond (Olbia, OT) by Corrias (1977), here confirmed, along with additional reports by Arrigoni (2015a) from Cugnana (Olbia) and Capo Coda Cavallo (San Teodoro, OT).

However, the taxon is also present in a few sites along the south-western coast. Corrias (1977) cited an herbarium sample preserved in FI from San Giovanni Suergiu (SU), not confirmed in recent studies, while another population was found on the island of Sant'Antioco by Gehu & al. (1989).

Interestingly, the species has been reported in unusual environments, pastures and garrigues of Monte Linas, between 800 and 1200 m a.s.l. (Genna Miratta, Beigherrus, Argiolas de Serpi, Perda de Sa Mesa, Punta Cabixettas) by Angiolino & Chiappini (1983), a finding later confirmed by Bacchetta & Pontecorvo (2005). We confirm the presence of this endemic species in almost all the previously known Sardinian locations, included the mountain population in the south-western area, where we add a new station found on the locality Santu Miali (Villacidro, SU), which is a separated part of Monte Linas. Moreover, we report new findings along the south-western coast, specifically in the municipality of Arbus (SU), between Scivu and Capo Pecora, on stabilised dunes (Fig. 2).

Rarity and threats: The species typically thrives on bare soils, in open environments with scattered vegetation, primarily in coastal areas, which may be naturally or artificially disturbed through trampling or other factors. While the taxon often occupies a limited area within individual populations, it is widespread across a large range and has been classified as "Least Concern" (LC) on the IUCN Red List (Rossi & al. 2020). However,

given its prevalently coastal localization, some populations are at potential risk of destruction due to infrastructure development related to tourism (new roads, paths, hotels, villas). Excessive trampling is a major disturbance factor, although a complete absence of trampling can sometimes lead to habitat transformation as more evolute vegetation types take over. The spread of the species may also be hindered by the presence of alien invasive taxa, such as *Acacia saligna* and *Carpobrotus* sp. pl. The ex situ conservation is ensured at BG-SAR through the preservation of three different seed lots collected in 2023 and 2024 from La Maddalena Archipelago, and one accession obtained in 2009 from San Pietro Island.

Halopeplis amplexicaulis (Vahl) Ces., Pass. & Gibelli (*Amaranthaceae*)

Distribution update

New findings: Carloforte (SU) Saline, dietro il Cimitero, fanghi umidi lungo le sponde, 0 m s.l.m., 7/6/2019, *M. Fois*, *A. Cuena*; Assèmini (CA) loc. Saline Contivecchi, superfici temporaneamente emerse ai margini delle vasche evaporanti, 6 m s.l.m., 19/8/2021, *F. Mascia* (Herb. Mascia).

Observations: this Eurasian species has a limited distribution in Italy, where it is known from Apulia (Salina Grande di Taranto), Sicily (Trapani and Isola grande dello Stagnone), and Sardinia, while the last record for Basilicata dated back to 1886 (Silletti 2012). In Sardinia, it was first reported by Barbey (1884) on samples collected by Reverchon at Santa Teresa Gallura (OT), a population no longer present today, and by Casu (1905) for the "Saline della Spiaggia di Cagliari". Later, it was reported in the Simbirizzi Pond (Onnis 1964), from which it disappeared following its transformation into a freshwater reservoir. Later, it was certainly known in a single population in the Molentargius Pond (De Martis & Mulas 2008). However, in 2019 it was reported from San Pietro Island (SU) (https://italiaiswet.it/general/report.php?code=ITG27PIE0005&lang=en; Fois & al. 2022; Cogoni & al. 2021). That report was given along the banks of the former Saline di Stato, a few hundred metres from the town centre of Carloforte. The area of this population is further expanded here, bringing back a second location along the banks of the Saline, behind the cemetery. In both cases, these are small stands of less than 50 individuals; for this reason, no samples were taken for deposit in herbaria (a picture is available on the above-mentioned website). Similarly, the finding in the Saline Contivecchi expands its range in the Gulf of Cagliari from Molentargius to Santa Gilla Lagoon (Fig. 1).

Rarity and threats: the population of Molentargius Pond is within the Molentargius-Saline Regional Nature Park. Both extant populations are located within Special Areas of Conservation (SACs ITB040027 "Isola di San Pietro", ITB040022 "Stagno di Molentargius e territori limitrofi" and ITB040023 "Stagno di Cagliari, Saline di Macchiareddu Laguna di Santa Gilla"). The species lives in specific conditions of hyperumid-alophytic muds that limit the potentially suitable conditions to few and fragmented sites. It may suffer over-trampling of waterflows, particularly by flamingos (which can be, in turn, also dispersers) and, especially in Carloforte, human-related disturbances such as land reclamation and waste disposal. In situ conservation efforts are necessary while, regarding the ex situ preservation, seven seed lots from the SAC ITB040022 are stored at the BG-SAR under long-term conservation. The species should be considered for a regional assessment under IUCN criteria (IUCN 2012).

Helicodiceros muscivorus (L.f.) Engl. (*Araceae*)

Distribution update

Findings: Pattada (SS) Sponda nord del lago di Lerno, sopra la diga. Tra le rocce (rarissimo) 600-650 m s.l.m., 20/5/2019, *G. Calvia*; Arbus (SU) Capo Pecora, anfratti tra le rocce, 6/3/2022, *G. Calvia* (georeferenced picture); Tempio Pausania (SS) Monte Limbara, Lu Fossu di Lu Pisciaroni, rocce, pietraie e scarpate, 850-900 m s.l.m., 10/9/2023, *G. Calvia* (Herb. Calvia).

Observations: *Helicodiceros muscivorus* is a western Tyrrhenian endemic species found in restricted areas of Sardinia, Corsica and the Balearic Islands (Fridlender 2000). For a long time, it was considered a coastal species, primarily associated with small islands: Stintino peninsula, La Maddalena Archipelago, Asinara, Tavolara and Molara, Cavoli and Serpentara Islands, San Pietro Island, despite a report by Veri & Bruno (1974) from Mount Limbara (Diana Corrias 1982, Arrigoni 2015b). A sample collected in 1998 near Villasimius is preserved at the herbarium CAG (Iiriti 2006). Later, it was discovered in various hilly to mountainous areas of central Corsica (Fridlender 2000), as well as inland areas of northern Sardinian, specifically on the highland between Monti and Alà dei Sardi (OT) and in two sites on Mount Limbara, in the municipality of Berchidda (Cañadas & al. 2013; Calvia & Ruggero 2020). More recently, a small population was discovered in the countryside of Villagrande Strisaili (NU; Scudu 2022). With the discoveries here reported, we have extended the species range to Monte Lerno (Pattada, SS), also confirming the initial report from Limbara by Veri & Bruno (1974) (Calvia & Ruggero 2023). In addition, we identified a new site in the coastal area of Arbus (Capo Pecora, a few plants found in March 2022) in south-western Sardinia (Fig.1).

Rarity and threats: except for some coastal sites, the species often has low population numbers and a poor reproductive rate. Generally, it grows in rocky areas that can be subject to grazing, consumption of the bulbs by wild boar, and human activities such as tourist development. In May 2024, in the Island of La Maddalena, locality Lo Strangolato, within the boundaries of the La Maddalena National Park, illegal eradication has been observed possibly due to the unpleasant odour released during flowering, or for tourist-related reasons. Locally, in situ conservation actions are necessary, while ex situ actions were ensured through seed collection and conservation of 11 different seed lots at BG-SAR. The three oldest accessions were stored in 2007, while germplasm of the newest seed lot was collected and preserved in 2024.

Limonium racemosum (Lojac.) Diana (*Plumbaginaceae*)

Distribution update

New finding: Monteleone Roccadoria (SS) pareti calcaree mioceniche all'interno della cava presso il paese, 400-420 m, 15/9/2022, *E. Farris* (Herb. Farris).

Observations: this narrow endemic species is known for the Miocene limestones surrounding Sassari and the nearby villages of Tissi and Ossi (SS), in north-western Sardinia. From this restricted area it was described (Lojacono-Pojero 1906), and even later, after detailed floristic research in the vast area occupied by Miocene limestones in northern Sardinia, no significant extensions to the species' range were added (Diana Corrias 1978; Bagella & Urbani 2006). This finding expands southwards the species' distribu-

tion (Fig. 2) and also suggests that other Miocene limestone areas in northern Sardinia could be suitable habitats for this chasmophyte.

Rarity and threats: despite Orsenigo & al. (2018) classified it as least concern (LC), it should be noted that urban expansion around Sassari is slowly eroding its range. Therefore, this new finding, increasing the known areas from one to two, greatly expands the species' extent of occurrence. However, in situ and ex situ conservation actions, and a new global assessment according to IUCN criteria (IUCN 2012) are strongly recommended.

Ludwigia palustris (L.) Elliott (*Plantaginaceae*)

Distribution update

New finding: Domusnovas (SU) Bacino di Siuru, 320 m s.l.m., 27/9/2019, *M. Fois*, *A. Cuena* (Report MedIsWet).

Observations: this species has a temperate subcosmopolitan distribution. In Italy, it has been reported in Calabria, Campania, Emilia-Romagna, Friuli-Venezia Giulia, Latium, Liguria, Lombardy, Piedmont, Sardinia, Tuscany and Veneto. It was erroneously recorded in Trentino-Alto Adige and there are no recent records from Umbria (Bartolucci & al. 2024).

Regarding Sardinia, the species was first recorded on the island of Caprera, under the binomial *Isnardia palustris* L., "along the stream near the cistern in Cala Garibaldi" (Vaccari 1894). The same author noted another record by Fiori from "Terranova (Olbia) in Golfo Aranci". A third location was later identified on Mount Limbara (Veri & Bruno 1974), with the species being found on a "forest road leading to Vallicciola". Unfortunately, the species is currently considered locally extinct in this area (Ruggero & Calvia 2014; Calvia & Ruggero 2020, 2023). Likewise, the species presence near Golfo Aranci is unconfirmed, likely due to the strong urbanization, and it has not been rediscovered at Cala Garibaldi on the island of Caprera in recent surveys. Arrigoni (2010a) described the species as "rare and in need of further searches".

However, in the last two decades, we have discovered the species at several sites along the Rio Mannu of Berchidda and Rio Badu Pedrosu (OT), confirming its presence on the Island (Ruggero & Calvia 2014; Calvia & al. 2021). More recently, three different localities were reported for Ogliastra (Rio Pramaera, Rio Girasole and Rio Foddeddu; Lotzorai, Girasole, Tortolì, NU) by Scudu (2022). Additionally, a recent find has extended its distribution to the south-western part of the island, on a small lake (https://italiaiswet.it/general/report.php?code=ITG27SAR2050&lang=en) of artificial origin near Domusnovas (SU), where it grows along the shores among the hygrophilous vegetation (Fig. 2). In this case, the population consists of less than 10 individuals; for this reason, no samples were taken for deposit in herbaria (a picture is available on the above-mentioned website).

Rarity and threats: the species is quite rare, as evidenced by its inclusion in the Red Book of Italian Plants (Conti & al. 1992). It was also listed among the "Species and habitats selected for the identification of Important Areas for Plants in Italy" (Blasi & al. 2010). In Sardinia, the distribution of the species is confined to a few wetlands, with a relatively small area of occupancy. The species faces threats from the increased frequency of extreme floods, droughts, and invasive alien species like *Procambarus clarckii* Girard,

1852, and *Myocastor coypus* Molina, 1782. Locally, it is grazed and trampled by livestock. Both in situ and ex situ conservation actions are necessary, and the species should be considered for a regional assessment under IUCN criteria (IUCN 2012).

Malva lusitanica (L.) Valdes subsp. ***lusitanica*** (*Malvaceae*)

Distribution update

Findings: Monserrato (CA) Riu Saliu, 24 m s.l.m., 11/5/2024, *G. Bacchetta*; Sestu (CA) Santa Rosa, 33 m s.l.m., 11/5/2024, *G. Bacchetta*.

Observations: this taxon has a West-Mediterranean distribution, which includes Iberian Peninsula and Sardinia (Escobar & al. 2010). In this latter island, its known distribution range was limited to the lowest Campidano and Sulcis area, including Assemini, Elmas, Monserrato, Selargius, Sestu (CA), Chia (Domus de Maria), Pula, and Serdiana (SU), for a total 13 localities (Santo & al. (2015). In these areas, the taxon grows especially in sub-salty sites near small rivulets and wet places, sometimes adapted to fallow land, ruderal sites and more rarely along small roadsides (Santo & al. 2015).

Here, we add new sites along Rio Saliu, in the stretch between the University Polyclinic (Monserrato) and the locality of Santa Rosa (Sestu; Fig. 1).

Rarity and threats: in Sardinia, the taxon is very rare and faces constant threats related to mechanical earth works for agricultural and bonification activities. Moreover, overgrazing, wildfires, pollution and, locally, tourist activities can represent other damages for the species conservation (Santo & al. 2015) For this reason, since 2008 ex situ actions have been taken through conservation of several seed lots at the BG-SAR. Nonetheless, in situ actions and a constant monitoring should be applied to preserve the species persistence on the island of Sardinia.

Mandragora autumnalis Bertol. (*Solanaceae*)

Distribution update

New findings: San Giovanni Suergiu (SU) tra Is Loccis e Medau Tracasi in loc. Craminalana. Campi incolti e margini stradali, 20 m s.l.m., 8/10/2017, *G. Calvia* (Herb. Calvia); Cabras (OR) Nasu de Canna, 2 m s.l.m., 2/11/2018, *F. Mascia*; Vallermosa (SU) loc. Is Porcilis, 114 m s.l.m., 12/10/2022, *F. Mascia*; Siliqua (SU) loc. Serra Pubusa-Zimigàrgiu, 53 m s.l.m., 24/10/2023, *F. Mascia* (Herb. Mascia); Ballao (SU) bordo strada SP23, 104 m s.l.m., 13/10/2024, *L. Podda*.

Observations: *M. autumnalis* is a South-Mediterranean species that is rare in Italy, where it is only found in the southern peninsular regions and in the islands, specifically Apulia, Basilicata, Calabria, Sardinia and Sicily. It has not been recently found in Campania, Latium, and Marche (Bartolucci & al. 2024).

In Sardinia, the species was first recorded in Decimomannu (CA), Guasila and Ussana (SU; Moris 1827), and its presence has since been confirmed based on a few herbarium specimens and reports. Therefore, it has always been considered rare on the island (Corrias & Diana 1983), with known populations limited to South Sardinia, including Campidano, Elmas (CA), Mandas, Chia (Domus de Maria, SU), and Oristanese (Atzei 2003; Bacchetta 2006; Pontecorvo & al. 2009; Arrigoni 2013). This latter author hypothesised that the species could be extinct in the island, as he did not find it during his research. However, the species still persists in some areas, particularly in the south-

western part of Sardinia, including new findings from several sites in the countryside of Ballao, Masainas, San Giovanni Suergiu, Siliqua, Vallermosa (SU) and Cabras (OR). A few plants were also observed near Nora lagoon (Pula, CA) until 2022, then disappeared. Several other reports periodically appear in social networks such as Facebook, shared by people from Siliqua (SU), Tramatza (OR), Uta (CA; Fig. 1), showing the potential usefulness of citizen science for the improvements of plants distribution knowledge (Marcenò & al. 2021).

Rarity and threats: in Sardinia, this species has populations with an area of occupancy often limited to just a few square meters. One of the primary threats to the species is its toxicity. Uninformed individuals sometimes mistake it for *Beta vulgaris* L., a naturalised plant commonly collected from fallows and roadsides, leading to cases of intoxication occasionally reported by local news. This has prompted a subsequent "witch hunt", resulting in the extirpation of local populations. Another threat comes from habitat transformation due to roadworks, construction and agricultural activities. An accession of 206 seeds, collected in 2006 from Santa Caterina (Elmas), is preserved at BG-SAR, along with three additional seed lots obtained from 25 individuals of this locality translocated at the Botanical Garden of Cagliari (Hortus Botanicus Karalitanus, HBK) in 2006 (Pontercorvo & al. 2009). Nonetheless, other in situ and ex situ conservation efforts are necessary, and the species should be considered for a regional assessment under IUCN criteria (IUCN 2012).

Persicaria decipiens (R. Br.) K. L. Wilson (*Polygonaceae*)

Distribution update

New findings: Assemini (CA) Riu Cixerri, comunità igro-nitrofile a fenologia tardo-estiva dei fanghi temporaneamente emersi, 2 m s.l.m., 18/8/2020, *F. Mascia* (Herb. Mascia); San Teodoro (SS) Rio Schifoni, letto asciutto del torrente, 113 m s.l.m., 16/9/2024, *G. Calvia* (Herb. Calvia).

Observations: this subcosmopolitan species is known across almost all peninsular Italian regions and in Piedmont, Sardinia and Sicily, but it is uncertain in Marche and Umbria (Bartolucci & al. 2024). In Sardinia, the species is quite rare. Its first mention was by Moris (1837-1859), under *Polygonum salicifolium* (non Delil.) Brousson. The author did a general report "*in fossis humidis et ad rivulorum stagnorumque margines*" (in humid ditches and along the edges of small streams and ponds). A second report was an herbarium specimen collected in 1858 near Assemini by Gennari, preserved in CAG. This locality was not confirmed by Bacchetta (2006). Another record was provided by Casu (1911), who reported it at Santa Gilla Lagoon (CA). After a long time, Iiriti (2006) added Rio Picocca (San Vito, SU) and Rio Monte Cresia (Sinnai, SU), while Pontecorvo (2007) mentioned the mouth of Riu Mannu of Fluminimaggiore (SU) , and Orrù (2007) recorded it along Riu Mannu of Siamanna (OR). Soon after, Desfayes (2008) clarified the species' distribution with more detail, reporting it in several locations: Cannigione at Madonna del Lago (Arzachena, SS), Rio Berchida (Siniscola, NU), Rio Pramaera (Lotzorai, NU), Girasole (NU), Lido di Orrì (Tortolì, NU), between Nurachi and Oristano, Tirso River near Villanova Truschedu (OR), Tuili (SU), and near Villasor (SU). Later, Arrigoni (2010a) reported it along Rio Mannu of Decimomannu (CA). More recently, the taxon was reported in the southern part of the island, along Rio Pula

(Pula, CA) by Lazzeri & al. (2015) and Riu Foxi (Villasimius, CA) by Carlo Solla (on Facebook). Two herbarium samples from Posada (NU) and Monte Minerva (Villanova Monteleone, SS) further define the range of the species in Sardinia (Fig. 1).

We have confirmed the presence of the species at Santa Gilla Lagoon and in the lower part of Rio Cixerri. Additionally, a new discovery in north-eastern Sardinia, in the municipality of San Teodoro (OT), adds more information about the known range of the species on the island.

Rarity and threats: to our knowledge, the species is scattered to a few localities, where it is often quite rare within populations. The primary threats include the increased frequency of extreme flooding events and, conversely, long periods of drought. In situ and ex situ conservation measures are necessary. A unique seed lot collected near Geremeas (Quartu Sant'Elena, CA) in 2013 is stored at BG-SAR.

Phleum sardoum (Hack.) Hack. (*Poaceae*)

Distribution update

Findings: Sassari (SS) Duna a nord dello Stagno di Pilo verso il confine comunale con Stintino. Pratelli terofitici su sabbie, 10/4/2006, *E. Farris* (Herb. Farris); Santa Teresa Gallura (SS) porzione N Rena Majore. Bassura umida in duna consolidata, 21/5/2006, *A. Ruggero*, *A. Di Giacomo* (Herb. Ruggero); Trinità d'Agultu (SS) Lu Cinoni. Duna fossile, su sabbie quasi cementate e prive di vegetazione, 5/5/2021, *A. Ruggero* (Herb. Ruggero).

Observations: *Phleum sardoum* is an exclusive endemic species of Sardinia. This species was described for the first time from the coastal areas of Rena Majore (Aglientu, OT), on the base of samples collected by Reverchon in May 1881 (Hackel, in Barbey 1884). Later, Corrias and Diana collected it in the dunes of Marina di Arbus (SU) (Camarda 1980). In these localities the species still persists. More recently, several other populations have been discovered along the Trinità d'Agultu (OT) coastline (including Lu Cinoni, near Costa Paradiso, and Cala Sarraina) as well as other localities in Aglientu (Lu Litarroni and Portobello) (Santo & al. 2013; Ruggero 2022). Arrigoni (2015b) also mentioned its presence in the countryside of Fluminimaggiore (SU). In this contribution, we report a new station from the gulf of Asinara, North to the Pilo Pond, that was firstly discovered in 2006 and later observed again in 2016 by Farris and Bacchetta. However, we were unable to confirm the population near Badesi (OT) as reported by Camarda (1995), despite extensive surveys in suitable areas (Ruggero 2022; Fig. 2).

Rarity and threats: the species thrives on compact and bare sands of dune systems and on partly consolidated sands of fossil dunes. It was listed as Critically Endangered (CR) by the IUCN Red List (Rossi & al. 2013), mainly due to its restricted range, then limited to only two growing stations, and the decline of these populations caused by significant anthropogenic pressures related to tourism. The species' preferred habitats face intense trampling, new path and road development, and invasion by alien species such as *Acacia saligna* and *Carpobrotus* sp. pl. The recent discovery of new populations in north-western Sardinia slightly improves its status, because its known locations grow from two to three, although the Rena Majore population remains in precarious condition. The previously identified threats (tourist pressure on dune systems and alien inva-

sive species) continue to persist. Ex situ actions, specifically collection and conservation of eight seed lots at BG-SAR, were undertaken for nearly all known populations.

Piptatherum coerulescens (Desf.) P.Beauv. (*Poaceae*)
Distribution update
Findings: Alghero (SS) Grotta Verde, 33 m s.l.m., 10/6/2001, *G. Bacchetta*; Sant'Anna Arresi (SU) Punta Menga, 19 m s.l.m., *F. Mascia*; Tresnuraghes (OR) Torre Foghe, su basalti costieri, 8/5/2024, *E. Farris* (Herb. Farris).
Observations: this species was firstly reported in Sardinia by Moris (1827), then confirmed by Valsecchi (1964, Capo Caccia and Calich Pond in the municipality of Alghero, SS), Pignatti (1982), Ballero & Bocchieri (1987, Capo Teulada, SU), Bacchetta (2006, Capo Spartivento, Monte Calcinaio, Tuerredda, SU) and Arrigoni (2015b). This latter author detailed its presence on the island, specifically reporting it for Alghero, Capo Figari (Golfo Aranci, OT), Mt. Ortobene (Nuoro), Oddoene (Dorgali, NU), Laconi (OR), Capo Carbonara (Villasimius, SU), Capo Sant'Elia (Cagliari), Capo Teulada (Teulada, SU), Sant'Antioco Island (SU), and Capo San Marco (Cabras, OR). The species seems to be quite frequent in the Sarrabus sector, where it was reported on different localities from the municipalities of Burcei, San Vito, Villasimius (SU), and Maracalagonis (CA; Camarda & Ballero 1981; Ortu & Marchioni Ortu 1989; Iiriti 2006). The new finding from Tresnuraghes (OR) is the first report for the area of Montiferru-Planargia and completes the species' distribution in the western Sardinian coast since it is intermediate between the two already known in Nurra (to the North) and Sinis (to the South); that from Sant'Anna Arresi completes the species' distribution in south-western Sardinia (Fig. 2).
Rarity and threats: the species is confined to a few rocky sites, mainly located in coastal environments, with few exceptions (e.g. Mt. Ortobene). The species grows on different geological substrata, including granitic (Capo Carbonara), calcareous (Capo Figari), and effusive volcanic rocks (our finding). Despite having a large extent of occurrence, its area of occupancy is small, and the species should be evaluated for a regional assessment according to IUCN criteria (IUCN 2012).

Rorippa sylvestris (L.) Besser subsp. ***sylvestris*** (*Brassicaceae*)
Distribution update
New findings: Berchidda (OT) Riu Mannu di Berchidda in loc. Silvani. Pietraie, bordi del fiume e di pozze, tamericeti, fanghi, 163-165 m, 20/6/2009, *G. Calvia* (Herb. Calvia); Fonni/Lodine (NU) Rio Govosoleo, pietraie e fanghi lungo le sponde, 23/7/2023, *G. Calvia* (Herb. Calvia); Orgosolo (NU), Pratobello, lungo un rigagnolo in secca tra la SS389 e la SP2 al bivio di Fonni, 874 m s.l.m., 7/10/2024, *G. Calvia* (Herb. Calvia).
Observations: this species was first reported in Sardinia by Valsecchi (1969), who collected herbarium samples from Rio Sa Teula in Foresta Burgos (Burgos, SS), now preserved in the SS herbarium. Later, Corrias & Diana (1983) mentioned it as a rare species in Sardinia. Ruggero (2001) further confirmed its presence on the island, having found it along Rio Carana (Luras, OT), where it still thrives today. Another confirmation came from Desfayes (2008), who recorded the species in Pratobello (Orgosolo, NU) along Rio Olai, and reaffirmed its presence at Rio Carana. Around the same period, we also

found the species along the Riu Mannu of Berchidda and near the shores of Lake Coghinas (OT). In 2018, the species was reported on the Acta plantarum forum (topic 104457) after being discovered in a stream near Villagrande Strisaili (NU). More precisely, the species is found along Rio Siccaderba and on the shores of Bau Muggeris lake (Scudu 2022). More recently, we identified it along Rio Govosoleo (Fonni-Lodine, NU) and were able to confirm the population of Orgosolo (Fig. 1).

Rarity and threats: the species is confined to a few watercourses' stretches, resulting in a relatively small area of occupancy. Its main threats include the increased frequency of extreme flooding events and, conversely, droughts. In situ and ex situ conservation measures are necessary, and the species should be evaluated for a regional assessment according to IUCN criteria (IUCN 2012).

Torilis nemoralis (Brullo) Brullo & Giusso (*Apiaceae*)

Distribution update

New finding: Porto Torres (SS) Pineta La Farrizza, 30 m s.l.m., 10/4/2023, *M. Fois*.

Observations: *T. nemoralis* was first described by Brullo in Brullo & Marcenò (1985) and therefore considered an independent species due to its distinguishable morphological characters, ecology and distribution (Brullo & Giusso del Galdo 2003). This species differs mainly from *T. nodosa* by its erect habitus, the lax inflorescence and the homocarpic achenes. In addition, while *T. nodosa* is a ruderal and nitrophilous species, widespread in many territories of Eurasia, *T. nemoralis* is confined to psammophilous coastal scrubs. After being described, it was considered endemic to Sicily until it was reported in south-western Sardinia, specifically, Chia (Pula, CA; Bacchetta 2006; Angiolini & al. 2013) and Rio Sciopadroxiu (Arbus, SU; Pontecorvo 2007). On the other hand, Arrigoni (2006-2015) considered it a synonym of *T. nodosa*. Here, we record the presence of this species in the dune system of Portixeddu (Buggerru, SU), where it was found but not collected for its rarity, in natural *Pinus pinea* formations. Moreover, we found a new population in the north-western part of Sardinia, widening its regional distribution, and suggesting its presence in other parts of the island (Fig.2).

Rarity and threats: based on current knowledge, it can be considered rare in Sardinia and possibly threatened by common pressures linked to the expansion of tourism and general coastal degradation and erosion. Nonetheless, the real distribution of this species needs further investigation.

Veronica anagalloides Guss. (*Plantaginaceae*)

Distribution update

New finding: Carbonia (SU) Mitza Saixi, pozze del ruscello, 200-240 m s.l.m., 12/4/2015, *G. Calvia* (Herb. Calvia).

Observations: this European-Mediterranean species is found in several Italian regions, except for Liguria, Piedmont, Umbria, and Val d'Aosta, where it is absent. In Marche, it is only known from historical reports, and in Trentino-Alto Adige it is currently considered extinct (Bartolucci & al. 2024). In Sardinia, the species was first reported "*in aquosis, ad rivulos et ad stagna*" (in wetlands, near streams and ponds) by Moris (1837-1859). A more precise report was provided by Barbey (1884), who mentioned its presence in Cagliari, Santa Barbara, based on a sample collected by Gennari, Ascherson and

Reinhardt. Then, Falqui (1905) recorded its presence near Capoterra (CA). Later, Landi (1934) recorded it at Calich Pond (Alghero, SS). Glück (1936) also reported the species near Oristano (OR) and Decimomannu (CA). Additional records came from Capo Frasca (Arbus, SU) (Bocchieri & Mulas 1992), from Sulcis-Iglesiente (Camarda & al. 1993, 1995) and from Flumendosa River (San Vito, SU, Iiriti 2006). Based on the available literature, this species appears rare in Sardinia, mostly concentrated in the southern half, particularly in the Sulcis area, as summarised by Bacchetta (2006). Arrigoni (2013) extended its known distribution on a few locations in the central and north-eastern parts, such as Cala Luna (Dorgali/Urzulei, NU) and San Teodoro (OT), while also recording it in other central-southern areas like Sarcidano (here confirmed at Laconi, OR), Marmilla (here confirmed at Genoni, SU and Usellus, OR), and Santa Gilla Lagoon (CA).

In our research, we were only able to partly confirm its presence at several of the mentioned sites, where the species seems to be in local decline. However, we found it in new sites, particularly in the south-western part of the island, such as in the surroundings of Carbonia (SU), along a streamlet, and near a spring on meta-limestone outcrops (Fig. 2).

Rarity and threats: the species is likely more widespread than currently recognised. Some populations appear to be robust, but threats such as prolonged droughts, heatwaves and human activities (e.g. canalization and wetlands reclamation) raise concerns about the local survival of the species. Ex situ conservation efforts are needed to address these concerns.

Alien taxa

Artemisia verlotiorum Lamotte (*Asteraceae*)

Status change from Naturalised to Invasive

Findings: Tempio Pausania (SS) M. di Deu, Limbara. Bordo ferrovia, 7/9/1997, *A. Ruggero* (Herb. Ruggero); Lodine (NU) prati e incolti ai piedi del paese (invasiva), 17/8/2023, *G. Calvia* (Herb. Calvia).

Observations: the original distribution of this species is South-East Asia, but it has since spread to most of Europe, Australia, Africa, the Middle East and South America (POWO 2024). In Italy, the species is recorded in all regions. It is considered a naturalised alien in Apulia, Basilicata, Calabria, Campania, Liguria, Sardinia, Val d'Aosta and the Republic of S. Marino, and an invasive alien in the other regions (Galasso & al. 2024).

In Sardinia, the species was first recorded by Nicotra (1897) and later by Pampanini (1933-1934) at Baddimanna (Sassari), at "Sant'Avendrace", and in the "Nursery of the Public Gardens on Viale Regina Elena" (Cagliari). These reports were then confirmed by Cobau (1940) and Chiappini (1963), who added Tempio Pausania (OT), Bolotana, and Desulo (NU). Further confirmations arrived by Viegi (1993), Bagella & Urbani (2006), and Arrigoni (2015a). A subsequent report arrived from San Gregorio (Sinnai, CA, Iiriti, 2006). Finally, Calvia & Ruggero (2020, 2023) included the species in the flora of Mount Limbara, based on numerous findings from the lower areas up to 1215 m a.s.l., which is currently the highest known altitude for the species in Sardinia. Lastly, Scudu (2022) recorded its abundance in all the lower parts of the Ogliastra former province.

Here, we confirm the presence of the species in the town and surroundings of Tempio

Pausania and Mount Limbara, where it often occupies small areas, mostly wet places, fallows, rural road and railroad margins. Furthermore, we report its presence in various localities in the municipalities of Arzachena, Berchidda, Calangianus, Monti, Oschiri (OT), Chiaramonti, Martis, Tula (SS). Moreover, we observed the species in different sites in central Sardinia, including the municipalities of Aritzo, Fonni, Gavoi, Lodine, Orani, Osini, Talana, and Tonara (NU), where it grows along roadsides, in fallows, in abandoned pastures and wet places. Furthermore, we add new reports from Monte Arci (Pau, OR), San Gavino Monreale and Sardara (SU; Fig. 3).

Invasiveness: in Sardinia, the species is likely more diffuse than here reported. It was previously considered a naturalised alien, as it appears in most of the studied locations. However, in some areas (e.g. Tempio Pausania, Lodine and Aritzo) it is exhibiting clear invasive behaviour, occupying massively even areas of tens of square meters within grasslands and fallows.

Casuarina glauca Sieber ex Spreng. (*Casuarinaceae*)

New casual taxon for the flora of Italy (Sardinia)

Finding: Quartu Sant'Elena (CA) località Foxi (39.223942°N - 9.247649°E) lungo il marciapiede della via Leonardo da Vinci (SP17), 10/7/2024, *A. Lallai* (CAG).

Observations: this taxon originates in eastern Australia but has been introduced to various countries across all continents, including Bahamas, Canary Islands, Dominican Republic, Florida, Haiti, Hawaii, India, Madeira, Mauritius, Morocco, New Zealand North, Norfolk Islands, Pakistan, Réunion, Tunisia, and Venezuela (POWO 2024).

In Sardinia, this species has been cultivated in the Cagliari area since the 19th century, though it has only recently shown signs of potential naturalization. A few saplings have been observed in the surroundings of Cagliari, specifically in the town of Quartu Sant'Elena, along roadsides not far from the planted specimens (Fig. 3). This is the first record of this species as a casual alien in Italy. Considering its invasiveness under certain conditions, most notably in the Hawaiian Archipelago and in Florida (Potgieter & al. 2013), it is essential to eradicate these plants and monitor the species closely to mitigate future invasion risks.

Commelina erecta L. (*Commelinaceae*)

New casual taxon for the flora of Sardinia

Findings: Quartu Sant'Elena (CA) (39.246708°N - 9.181778°E) via Dante lungo lo scolo del marciapiede, 7/6/2024, *G. Campus*; Quartu Sant'Elena (CA) via Marconi bordo strada (39.254233°N - 9.204418°E) 10/8/2024, *G. Campus* (Herb. Campus); Selargius (CA), via Cavour bordo strada (39.252812°N - 9.166421°E) *A. Lallai*; Cagliari (CA) Valle di Palabanda (39.222997°N - 09.112057°E) Orto Botanico di Cagliari, prati e aiuole, 39 m s.l.m., 30/5/2024, *L. Podda*, *G. Bacchetta*, *A. Lallai* (CAG).

Observations: the native range of this species includes the Americas, central and southern Africa, and the Arabian Peninsula (POWO 2024). In Italy, it is recorded as a casual alien species in Calabria and Sicily (Galasso & al. 2024). This perennial herb has fleshy and stout roots, and under ideal wet conditions, such as those in the Botanical Garden of Cagliari - HBK, can spread rapidly, warranting careful monitoring to prevent it from escaping cultivation. The individuals observed in Selargius and Quartu Sant'Elena are

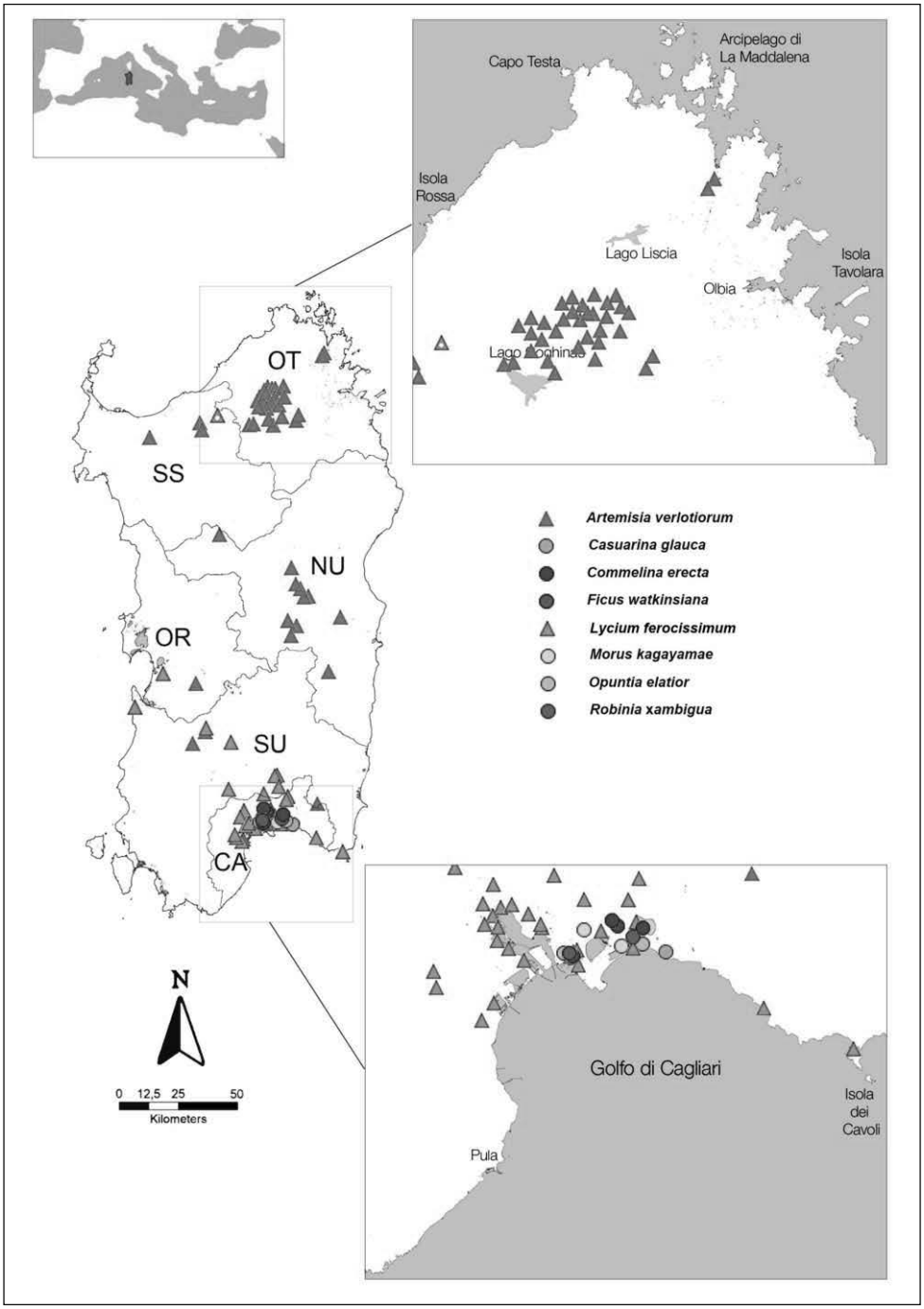


Fig. 3. Distribution map of the exotic taxa cited in this article. Pointed symbols refer to not confirmed data.

likely the result of escape from nearby gardens, where they were originally planted as ornamentals (Fig. 3).

Ficus watkinsiana F.M.Bailey (*Moraceae*)

New casual taxon for the flora of Sardinia

Findings: Cagliari (CA) Viale Sant'Ignazio. Spontaneizzata a distanza dagli individui coltivati, 38 m s.l.m., 15/10/2020, *G. Bacchetta*, *G. Lallai*, *G. Calvia* (CAG).

Observations: this eastern Australian taxon (POWO 2024) does not display a strong tendency for naturalization and is considered naturalised in Italy only in Sicily (Galasso & al. 2024).

The species was introduced in Sardinia from the 19th century for ornamental purposes and has since been used in urban landscaping in the city of Cagliari (Vannelli 1986). Recently, we observed that some plants of this species have begun growing on walls and along roads within approximately 200 m of cultivated specimens in Cagliari (Fig. 3). The fruits are consumed by pigeons (*Columba livia*, Gmelin, 1789) and monk parakeets (*Myiopsitta monachus*, Boddaert, 1783), which then disperse the seeds. The pollinator of the plant remains unknown.

Lycium ferocissimum Miers (*Solanaceae*)

Status change from Naturalised to Invasive

Findings: Elmas (CA) ex campo sportivo, 5 m s.l.m., 1/6/2018, *M. Fois*, *R. Cugusi*; Cagliari (CA) loc. S. Simone, -2 m s.l.m., 24/11/2023, *L. Podda*, *M. Fois*, *G. Bacchetta*; Villasimius (SU) presso la pineta, 3 m s.l.m., 10/2/2024, *R. Stocchino*; Cagliari (CA) Orto Botanico, Valle di Palabanda, invasiva nelle aree incolte e tra le aiuole, 52 m s.l.m., 17/6/2024, *G. Bacchetta*, *L. Podda*, *A. Lallai* (CAG); Selargius (CA) bordo strada pressi statale 554, 16 m s.l.m., 30/8/2024, *L. Podda*; Monserrato (CA) via Riu Mortu, bordo strada, 0 m s.l.m., 14/10/2024, *L. Podda*; Cagliari (CA) Anfiteatro romano, diffusa tra la vegetazione naturale, 64 m s.l.m., 26/11/2024, *L. Podda*, *A. Lallai*, *B. Gori* (CAG).

Observations: This taxon is a spiny shrub native to South Africa (POWO 2024) and reported in Italy only on Sardinia (Galasso & al. 2024). It is primarily used as a border plant (Lazzeri & al. 2013). Initially classified under the binomial *L. barbarum* (Mulas & al. 2008), it was correctly attributed and reported as invasive by Lazzeri & al. (2013). These authors specified that it thrived in many places around Santa Gilla Lagoon but was also present in several other sites within the Metropolitan City of Cagliari, and near Furtei (SU). Soon after, Zucconi & al. (2013) recorded a further locality in the Monumental Cemetery of Bonaria (Cagliari). Later, the status of this species was re-evaluated as naturalised by Galasso & al. (2018). After a few years, the populations of Santa Gilla were re-declared as invasive by Mascia & al. (2023). Nonetheless, this information was not received by Galasso & al. (2024). The species is primarily diffused in South Sardinia, where it has fast spread especially all around Santa Gilla Lagoon, as well as in other sites of Assemini, Cagliari, Capoterra, Elmas, Maracalagonis, Monserrato, Quartu Sant'Elena at Molentargius Pond (CA); Dolianova, Sardara, Serdiana, Serramanna, Soleminis and Villasimius (SU), but also in the western coast, South of Oristano and at Torre dei Corsari (Arbus, SU). A single report from North Sardinia exists, from Perfugas (SS), which needs confirmation (Fig. 3).

Invasiveness: the taxon has undergone a significant expansion in all previously recorded areas, likely facilitated by birds that consume its berries (Lazzeri & al. 2013), accelerating dispersal and posing a threat to various habitats, especially wetlands in South Sardinia, where propagule pressure is higher. Additionally, its ability to germinate under high saline concentrations and temperatures (Mayoral & al. 2020) makes it a serious invasive species for Sardinian coastal environments and throughout the Mediterranean, as it tolerates both saline and drought stress.

Morus kagayamae Koidz. (*Moraceae*)

New casual taxon for the flora of Sardinia

Findings: Quartu Sant'Elena (CA) lungo i margini del giardino della scuola dell'infanzia di via Allegri, 13/9/2023, *G. Bacchetta*, *A. Lallai*; Cagliari (CA), Parco Terramaini, ai margini delle aree coltivate all'interno del parco urbano, 15/5/2024, *A. Lallai*.

Observation: the species is native to South-East Asia and has a broad distribution range (POWO 2024). It has been recorded as an alien species in various countries across Europe, Americas and Oceania (POWO, 2024) where it was introduced for ornamental purposes. In Italy, it is reported as a casual alien species in Emilia-Romagna, Friuli-Venezia Giulia, Liguria, Lombardy, and Marche (Galasso & al. 2024).

In Sardinia, the species is rarely cultivated for ornamental purposes. Recently, we observed several young trees and saplings growing spontaneously along roadsides and in fallow areas near parks and gardens where it had been planted, with its fruits dispersing into nearby areas (Fig. 3).

Opuntia elatior Mill. (*Cactaceae*)

New casual taxon for the flora of Sardinia

Findings: Cagliari (CA) valle di Palabanda (39.222639°N - 9.110630°E) Orto Botanico, sfuggita dalla coltivazione nelle aree incolte, 51 m s.l.m., 15/7/2023, *A. Lallai*, *L. Podda*; Quartu Sant'Elena (CA) tra la vegetazione spontanea disturbata e vecchi coltivi abbandonati in aree suburbane residenziali, 9/7/2024, *A. Lallai*.

Observations: this taxon originates from central-southern America, notably in Colombia, Costa Rica, Leeward Islands, Netherlands Antilles, Panamá, Trinidad-Tobago, Venezuela, Venezuelan Antilles (POWO 2024). Due to human activity, it has been introduced to several countries on all the other continents, particularly in India and Australia (POWO 2024). In Italy, it is considered invasive in Tuscany, naturalised in Apulia, Latium, Liguria, and Sicily, while it is classified as a casual alien in Marche (Galasso & al. 2024).

In Sardinia, it was recently identified in fallow land near Quartu Sant'Elena, where it currently exhibits a slow tendency toward naturalization (Fig. 3).

Invasiveness: the species is potentially invasive, as evidenced in Tuscany (Lazzeri & al. 2018). Therefore, containment and monitoring are recommended to prevent a potential colonization of adjacent habitats.

Robinia* ×*ambigua Poir. (*Fabaceae*)

New casual taxon for the flora of Sardinia and Italy

Findings: Quartu Sant'Elena (CA) nei campi incolti adiacenti al Viale Guglielmo Marconi, 28/4/2023, *A. Lallai* (CAG).

Observations: this nothospecies, originated from the hybridization of *Robinia pseudoacacia* L. × *R. viscosa* Michx. ex Vent., occurs in the wild in North Carolina (POWO 2024). In Europe, the taxon was introduced for ornamental purposes and has now been documented as subspontaneous in parts of Eastern Europe (POWO 2024; Zieliński & al. 2015). Currently, *R.* ×*ambigua* is marketed as an ornamental species and used as a street tree. In Sardinia, this taxon is found in the town Quartu Sant'Elena, where a few specimens planted along a roadside have begun colonizing a nearby field with their suckers, which have currently developed into low shrubs (Fig. 3).

Addenda to the first contribution (1-30)

Allium sardoum Moris (*Amaryllidaceae*)

In the previous contribution we did not cite reports by Iiriti (2006) from Sarrabus (South-East Sardinia), specifically from Grommai (Maracalagonis, CA), Bruncu de Su Soli (Quartu Sant'Elena, CA) and Baccu Sa Ceraxa (Sinnai, CA). Moreover, to the previously reported localities, we add here its diffusion on the area between Posada (NU) and Siniscola (NU), both on inner and in coastal grasslands. We also report the presence of a small population in the locality Corongiu (Sinnai).

Allium savii Parl. (*Amaryllidaceae*)

A new locality, the only coastal site currently known in Sardinia, has been found at the Casaraccio Pond (Stintino, SS).

Butomus umbellatus L. (*Butomaceae*)

On the previous contribution we neglected to mention Desfayes (2008), who collected this species along Temo River (Bosa, OR), confirming the first report of Moris (1827). He also recorded it from Riu Mannu of Ozieri (SS), near the mouth of the watercourse on the Coghinas lake shores.

Cladium mariscus (L.) Pohl (*Cyperaceae*)

We found two new inner populations: one along Rio Pitrisconi (San Teodoro, OT) and one in the countryside of Benetutti (SS).

Jacobaea maritima (L.) Pelser & Meijen subsp. ***maritima*** (*Asteraceae*)

We report here its abundant presence on the promontory of Capo Testa (Santa Teresa Gallura, OT). We also add coastal areas near Cala Sarraina and a few plants around Monti di Lu Pinu, at 245 m a.s.l. (Trinità d'Agultu, OT) and in the hills of San Pantaleo (Olbia, OT) up to 400 m a.s.l.

Leersia oryzoides (L.) Sw. (*Poaceae*)

In July 2023 we found several non-flowering plants of this species along the shores of Rio Govosoleo (Fonni/Lodine, NU). Though suspecting a right recognition of the species through leaf features, we did not confirm it with certainty. Only in October 2024 were we able to come back to that site and confirm its presence there by collecting fruiting plants. This is the first record of the species out of the Coghinas river Basin.

Eragrostis curvula (Schrad.) Nees (*Poaceae*)

We confirm its presence along SS 131 D.C.N., where it was recorded in 2013, and we report a few plants along a neighbouring road, SS 129, still in the countryside of Oniferi (NU).

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Article

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Notes and chorological updates regarding the native and introduced vascular flora of Gran Canaria (Canary Islands, Spain)

Abstract

Déniz Suárez, E. A. & Verloove F.: Notes and chorological updates regarding the native and introduced vascular flora of Gran Canaria (Canary Islands, Spain). — Fl. Medit. 35: 51-64. 2025. — ISSN: 1120-4052 printed, 2240-4538 online.

This paper covers 21 taxa of native or introduced vascular plants that were recently recorded in the island of Gran Canaria. Five taxa are new records for the Canary Islands: *Aegilops triuncialis*, *Aristolochia baetica*, *Dysphania pumilio*, *Holcus mollis* and *Ranunculus paludosus*. Five are new to Gran Canaria: *Anacyclus clavatus*, *Erodium touchyanum*, *Helianthemum ledifolium*, *Parentucellia latifolia* and *Scleranthus annuus* subsp. *polycarpos*. Furthermore, new chorological data are presented for eleven rare or little-known species: *Cynanchum acutum*, *Diplotaxis tenuifolia*, *Euphorbia serrata*, *Ephedra fragilis*, *Helianthemum salicifolium*, *Krubera peregrina*, *Lupinus albus*, *Ornithopus pinnatus*, *Rhamnus crenulata*, *Serapias parviflora* and *Veronica cymbalaria*.

Key words: floristic research, alien flora, chorological data, Mediterranean Area.

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Introduction

During numerous excursions spread throughout the island of Gran Canaria, several species have been discovered that are either new to the flora of the Canary Islands or to the flora of the island of Gran Canaria. This article has a threefold purpose. Firstly, to present these newly discovered species; secondly, to update the distribution of some other poorly known taxa; and finally, to confirm the presence of certain species that were once reported, often a long time ago, for Gran Canaria, but without concrete data that confirmed their real presence on the island. Our data are important for updating the floristic catalogues and even, in some cases, to gain a better understanding of the local distribution of some very rare species. Furthermore, it is essential that the BIOTA database (Biodiversity Database of the Canary Islands) is as up-to-date and accurate as possible, as it is an important source of information for both private users and public authorities that consult it to check the distribution of species, their legal status or their residence status (indigenous or introduced).

This database is considered a reliable source for decision making, even if the references are old or outdated. For this reason, we consider it essential to update this database with our newly acquired information.

Materials and methods

The data presented here are supported by herbarium material collected by the first author and deposited in the BR herbarium (Meise Botanic Garden, Belgium), as well as by field observations and photographs for taxa that were not collected. For hard-to-reach sites, a binocular was used and photographs were taken to help us with the identification. The botanical nomenclature follows that of the Canary Islands Biodiversity Database (BIOTA, www.biodiversidadcanarias.es, various consultations in 2024). In the case of species not included in this database, the Plants of the World Online (POWO) database was followed (https://powo.science.kew.org/, various consultations in 2024). For the geographical location of each species we used maps of the Military Cartography of Spain, series L, scale 1:50,000, published by the Army Cartographic Service. The data were then converted to WGS84 coordinates.

Results

This article presents data on 21 taxa belonging to 20 genera and 18 families. Five taxa are new to the Canary Islands: *Aegilops triuncialis* L., *Aristolochia baetica* L., *Dysphania pumilio* (R. Br.) Mosyakin & Clemants, *Holcus mollis* L. and *Ranunculus paludosus* Poir. Five are new to Gran Canaria: *Anacyclus clavatus* (Desf.) Pers., *Erodium touchyanum* Delile ex Godron, *Helianthemum ledifolium* (L.) Mill., *Parentucellia latifolia* (L.) Caruel and *Scleranthus annuus* subsp. *polycarpos* (L.) Bonnier & Layens. The presence of the native species *Serapias parviflora* Parl. is confirmed on Gran Canaria. In addition, new chorological data are provided that confirm the presence on the island of species with only historical references: *Euphorbia serrata* L., *Helianthemum salicifolium* (L.) Mill., *Krubera peregrina* (L.) Hoffm. and *Lupinus albus* L. For the recently newly reported species *Ornithopus pinnatus* (Mill.) Druce, concrete localities are presented for the first time. Furthermore, new chorological data are reported for *Cynanchum acutum* L., *Diplotaxis tenuiflora* (L.) DC. and *Veronica cymbalaria* Bodard. Finally, new localities of rare or interesting native species, such as *Ephedra fragilis* Desf. and *Rhamnus crenulata* Aiton, are given.

Taxa new to the Canary Islands

Aegilops triuncialis L. (*Poaceae*)

This species has a circum-Mediterranean and Iranian-Turanian distribution (Negrillo 2011). In Gran Canaria, a small population has been found in a mountain grassland, dominated by the species *Avena barbata* Pott ex Link, at about 1300 m. a.s.l., in an area with a humid and cold climate in winter and dry and warm in summer. The population is located at the edge of a path, which could indicate an accidental introduction, since only two small groups could be found.

Exsiccatum: Islas Canarias, Gran Canaria, La Siberia (Cueva Grande), WGS84: 27º 59' 50.90" N, 15º 34' 05.20" W, 1300 m. a.s.l., 12-06-2020, *Eliseo A. Déniz Suárez* (BR).

Aristolochia baetica L. (*Aristolochiaceae*) (Fig. 1a)

A native species in the south of the Iberian Peninsula and northwest Africa (Morales Torres 2011), of which a small naturalized population has been observed near the Sintes or Umbría Dam at an altitude of 610 m. More exotic species have been found recently at this site (Verloove & al. 2018), such as *Cistus ladanifer* L., *Phlomis purpurea* L., *Iris albicans* Lange and *Crassula ovata* (Mill.) Druce. Likewise, naturalized endemic species can be observed there, resulting from a repopulation carried out on the slopes of the dam, including striking specimens of *Dracaena draco* (L.) L. subsp. *draco*, *Juniperus turbinata* subsp. *canariensis* (Guyot & Mathou) Rivas Mart., Wildpret & P. Pérez and *Marcetella moquiniana* (Webb & Berthel.) Svent. Remnants of potential thermosclerophilic forests are also observed in the area, from the *Pistacio lentisci-Oleetum cerasiformis* (del Arco Aguilar & Rodríguez Delgado 2018), with species such as *Pistacia lentiscus* L., *Olea cerasiformis* Rivas-Mart. & del Arco, *Periploca laevigata* Aiton, *Hypericum canariense* L., *Convolvulus floridus* L.f., *Aeonium percarneum* (R.P. Murray) Pit. & Proust, and *A. arboreum* (L.) Webb & Berthel. subsp. *arboreum*, among others.

Exsiccata: Islas Canarias, Gran Canaria, Entornos de la Presa de Sintes (Umbría), WGS84 28º 03' 18.28" N, 15º 29' 30.72"W, 610 m. a.s.l., 14-04-2023, *Eliseo A. Déniz Suárez* (BR); *ibid.*, 17-11-2023, *Eliseo A. Déniz Suárez* (BR).

Dysphania pumilio (R. Br.) Mosyakin & Clemants (*Amaranthaceae*) (Fig. 1b)

This species is native to Australia, New Zealand and New Caledonia (Uotila 1990). A small population has been found on the edge of the road from Laguna de Valleseco to Pico de Osorio. It is associated with other species such as *Chenopodium album* L., *Amaranthus hybridus* L. subsp. *hybridus*, *Rumex obtusifolius* L., *Portulaca oleracea* L., *Echinochloa crus-galli* (L.) P. Beauv. and *Polygonum aviculare* L., among others.

Exsiccata: Islas Canarias, Gran Canaria, Entornos de la Laguna de Valleseco, WGS84 28º 04' 01.43 N, 15º 33' 44.26 W, 825 m. a.s.l., 9-7-2023, *Eliseo A. Déniz Suárez* (BR); *ibid.*, 14-08-2023, *Eliseo A. Déniz Suárez* (BR).

Holcus mollis L. (*Poaceae*)

This is a species with European distribution, which extends to Western Asia and also reaches Northwest Africa (Algeria and Tunisia) (Sequeira 2020). A small population of this grass has been observed in the bed of a ravine, near an old spring, which is dry most of the year and from which water only flows in winter, in the Hoya de la Cruz area in Galaz (Vega de San Mateo). Among the accompanying species were *Rumex conglomeratus* Murray and *Juncus effusus* L.

The species is here taken in a broad sense; it differs slightly from the plants found in Western Europe, notably in the nodes and sheaths that are glabrous whereas they normally are hairy.

Exsiccatum: Islas Canarias, Gran Canaria, Hoya de la Cruz (Galaz), Vega de San Mateo, WGS84 28º 00' 52.84" N, 15º 34' 48.07" W, 1380 m. a.s.l., 13-06-2023, *Eliseo A. Déniz Suárez* (BR).

Ranunculus paludosus Poir. (*Ranunculaceae*) (Fig. 1c)

Herbaceous plant of Mediterranean and Western European origin, including most of the Iberian Peninsula and the Balearic Islands (Cook & al. 1986), of which a small population has been found in the area known as Era del Barranco, more precisely in the protected area called "Paisaje Protegido de las Cumbres", which is also a Site of Community Importance. This population has been known since 2018, always with the same number of individuals, at most 20 specimens. These are found in the middle of a thicket formed by *Teline microphylla* (DC.) P.E. Gibbs & Dingwall and *Adenocarpus foliosus* (Aiton) DC. The plants are found next to a forest path, which could indicate an accidental introduction. The area is rich in species, in particular a population of *Onopordum carduelium* Bolle, an endangered species, seriously affected by land use changes.

Ranunculus paludosus is a variable species. It is a pubescent perennial with fusiform tubers and a usually stout, fibrous stock; cauline leaves are rudimentary and petals are orangish yellow.

Exsiccatum: Islas Canarias, Gran Canaria, Era del Barranco (Vega de San Mateo), WGS84 27º 57' 52.63" N, 15º 33' 34.73" W, 1840 m. a.s.l., 18-05-2024, *Eliseo A. Déniz Suárez* (BR).

Taxa new to Gran Canaria

Anacyclus clavatus (Desf.) Pers. (*Asteraceae*)

Previously reported from La Palma (Otto & Verloove 2016), Tenerife (Santos Guerra & al. 2013), Fuerteventura (Weller 2011) and Lanzarote (Hohenester & Welss, 1993; Hansen & Sunding 1993), this species has been observed, with a very small number of specimens, on the edge of a street in the village of Valsequillo, where it behaves as a ruderal species. In this locality, it appears with other herbaceous plants, notably *Convolvulus althaeoides* L. subsp. *althaeoides*, *Malva parviflora* L. and *Polycarpon tetrapyllum* (L.) L. subsp. *diphyllum* (Cav.) O. Bolòs & Font Quer, among others. It should be noted that most specimens were removed during a cleanup of the area, after which less than 10 individuals survived. Therefore, the survival of this species is uncertain unless it is found in other locations.

Exsiccata: Islas Canarias, Gran Canaria, Valsequillo, (al lado del campo de fútbol), WGS84 27º 59' 40.39" N, 15º 29' 45.67" W, 550 m. a.s.l., 13-03-2024, *Eliseo A. Déniz Suárez* (BR); *ibid.*, 24-05-2024, *Eliseo A. Déniz Suárez* (BR).

Erodium touchyanum Delile ex Godron (*Geraniaceae*)

Therophyte native to the Sahara-Syndian region, from Morocco to Iraq (Guittonneau 1972) and reported in the Canary Islands from Lanzarote (Reyes Betancort & al. 2000) and Fuerteventura (Scholz & al. 2004). In Gran Canaria, a small population was observed at the beginning of the 'camino real' on the north face of the Tauro Mountain. The fact that all the individuals were found along the path suggests that it is an accidental introduction, as the area is frequented by tourists. The plants grow in Canary pine forest, belonging to the association *Pinetum canariensis* subass. *typicum* (del Arco Aguilar & Rodríguez Delgado 2018), characterized, in general, by low humidity, abundant sunshine and scarce rainfall in the autumn and winter months. This pine forest, is, however, very rich in both

shrubs and herbaceous plants, as is shown by the occurrence of *Vicia filicaulis* Webb & Berthel., as well as *Sonchus acaulis* Dum. Cours., *Ferula linkii* Webb or *Silene tamaranae* Bramwell, among others.

Exsiccatum: Islas Canarias, Gran Canaria, Camino real a la Montaña de Tauro. Carretera Presa de las Niñas al Barranquillo Andrés, WGS84 27º 54' 14.02" N, 15º 41' 15.01" W, 930 m. a.s.l., 26-01-2024, *Eliseo A. Déniz Suárez* (BR).

Helianthemum ledifolium (L.) Mill. (*Cistaceae*)

This species is native to the Mediterranean region, Macaronesia and western Asia (López González 1993). In the Canary Islands, it was cited for Lanzarote and Fuerteventura (Webb & Berthelot 1842). During fieldwork in the 'tabaibales' in the east of the island, which are very rich in herbaceous plants, several populations of this species were found at altitudes ranging from 120 m (Montaña los Vélez) to 200 m (Montaña Malfú). The specimens observed are very small in size, sometimes barely exceeding 1 cm in height, and the largest less than 5 cm tall. The associated flora is very interesting: *Euphorbia balsamifera* Aiton subsp. *balsamifera*, *Plantago ovata* Forssk., *Euphorbia regis-jubae* Webb & Berthel. and *Bupleurum semicompositum* L., among others, corresponding to the *Euphorbietum balsamiferae* association (del Arco Aguilar & Rodríguez Delgado 2018).

Localities: Islas Canarias, Gran Canaria, Lomo Gordo (Telde), WGS84 27º 58' 04.76" N, 15º 24' 59.82" W, 190 m. a.s.l., 20-02-2021, *Eliseo A. Déniz Suárez* s.c.; *ibid*., Montaña Malfú, WGS84 27º 55' 42.78" N, 15º 25' 10.94" W, 200 m. a.s.l., 13-03-2021, *Eliseo A. Déniz Suárez* s.c; *ibid*., Montaña Los Vélez, WGS84 27º 54' 24.28" N, 15º 24' 39.03" W, 120 m. a.s.l., 14-02-2023, *Eliseo A. Déniz Suárez* s.c.

Parentucellia latifolia (L.) Caruel (*Orobanchaceae*) (Fig. 1d)

This annual herbaceous plant has a Mediterranean, Macaronesian and Iranian-Turanian distribution (Mota Poveda & Pérez García 2011). In the Canary Islands it was cited for Tenerife by Hansen (1979). In Gran Canaria it was, very rarely, found in a few places in the high midlands of the island, specifically in the Aríñez-Valleseco area (in Galaz), and in grasslands near the Cueva Grande area, corresponding to the *Echio plantaginei-Galactition tomentosae* alliance (del Arco Aguilar & Rodríguez Delgado 2018). In addition, small populations have also been found in Los Llanos de Constantino and in the Malpaís del Montañón Negro. All locations have high rainfall and winter cold in common, so in years with low rainfall this species is difficult to find.

Exsiccata: Islas Canarias, Gran Canaria, Galaz (Cruce de Ariñez-Valleseco), WGS84 28º 01' 02.43" N, 15º 34' 54.76 W, 1400 m. a.s.l., 01-04-2024, *Eliseo A. Déniz Suárez* (BR); *ibid*., Cruce de Cueva Grande, WGS84 27º 59' 59.92" N, 15º 34' 13.48" W, 1250 m. a.s.l., 08-04-2024, *Eliseo A. Déniz Suárez* (BR).

Scleranthus annuus L. *subsp.* ***polycarpos*** (L.) Bonnier & Layens (*Caryophyllaceae*) (Fig. 2a)

Herb native to Europe, North Africa and Asia Minor, including much of the Iberian Peninsula (Rössler 1990), as *Scleranthus polycarpos* L. Hansen & Sunding (1993) mentioned *Scleranthus annuus* L. subsp. *annuus* for Tenerife and Gran Canaria. However, for Tenerife two subspecies are cited: subsp. *polycarpos* and subsp. *annuus*, while for Gran



Fig. 1. a) *Aristolochia baetica*, Presa de Sintes, November 2023, Eliseo Déniz Suárez; b) *Dysphania pumilio*, Laguna de Valleseco, July 2023, Eliseo Déniz Suárez; c) *Ranunculus paludosus*, Era del Barranco, May 2024, Eliseo Déniz Suárez; d) *Parentucellia latifolia*, Galaz, May 2018, Eliseo Déniz Suárez.

Canaria only the latter is mentioned (Acebes Ginovés & al. 2010; BIOTA 2024). The herbarium specimens that were recently collected turned out to be of the subspecies *polycarpos*, which, according to Díaz de la Guardia (2011), is distinguished by having smaller fruits (achenes) (1.5–2.8(–3) mm) and erect or slightly curved sepals. In contrast, the subspecies *annuus* has larger fruits (3–4(–4.5) mm) and patent sepals, rarely erect (p. 494). The population was found in Era del Barranco, a locality in the mountainous area of Gran Canaria that is very rich in species belonging to the association *Micromerio benthamii-Telinetum microphyllae* (del Arco Aguilar & Rodríguez Delgado 2018). Part of the population is located along a forest path, while other specimens are accompanied by other interesting species, among which one of the largest populations on the island of the rare *Ranunculus parviflorus* L., together with other interesting species, such as *Ranunculus cortusifolius* Willd., *Centranthus calcitrapae* L., or the only population known to date of another species mentioned in this article, *Ranunculus paludosus* Poir. Land use changes in the protected area of Las Cumbres represent a real threat to these and many other species. These changes have significantly reduced a population of the endangered *Onopordum carduelium* Bolle.

Exsiccatum: Islas Canarias, Gran Canaria, Era del Barranco (Vega de San Mateo), WGS84 27º 57’ 52.22” N, 15º 33’ 36.44” W, 1840 m. a.s.l., 08-05-2024, *Eliseo A. Déniz Suárez* (BR).

Miscellaneous records of interest

Cynanchum acutum L. (*Apocynaceae*) – new locality for Gran Canaria.

This species of circum-Mediterranean and Iranian-Turanian origin (Blanca 2011), has been reported from Lanzarote (Kunkel 1973), Fuerteventura (Kunkel 1985) and Tenerife (Santos Guerra & al. 2013) in the Canary Islands. Salas Pascual (2013) was the first to mention it for Gran Canaria. Both this author and Kunkel (1973, 1985) believe that the vector of introduction to the islands is the import of palm trees for gardening. A small population of less than 20 individuals was observed at the edge of a gravel parking lot in the town of Cruce de Arinaga. This is almost certainly a recent introduction, the seeds probably having arrived with materials deposited in the area. The small size of the individuals may support this hypothesis. It is a ruderal area subject to trampling and dog walking, where other species such as *Malva parviflora* L. or *Atriplex semilunaris* Aellen can be found.

Exsiccatum: Islas Canarias, Gran Canaria, Cruce de Arinaga, WGS84 27º 52’ 30.77” N, 15º 25’ 36.77” W, 60 m. a.s.l., 30-05-2024, *Eliseo A. Déniz Suárez* (BR).

Diplotaxis tenuifolia (L.) DC. (*Brassicaceae*) – new localities for Gran Canaria.

This species was previously reported on Gran Canaria, in “Arguineguín near Patalavaca, barranco, dry riverbed, one plant” (Verloove 2013: 80). Recently, we found a large individual along the road from Maspalomas to Palmitos Park. This ephemeral species is known from few locations, although it is becoming more frequent. A small population of between 5 and 10 specimens was found amidst *Euphorbia balsamifera* Aiton subsp. *balsamifera* thickets on the Montaña de Agüimes.

Exsiccatum: Islas Canarias, Gran Canaria, Carretera a Palmitos Park, (al lado del club Hípico “El Álamo”), WGS84 27º 46’ 56.82” N, 15º 36’ 54.06” W, 90 m. a.s.l., 20-04-2024, *Eliseo A. Déniz Suárez* (BR).

Euphorbia serrata L. (*Euphorbiaceae*) – confirmation for Gran Canaria.

In the area known as Llanos de Constantino, at about 1640 m. a.s.l., amidst the pastures of *Avena barbata* Pott ex Link and the shrub communities of *Adenocarpus foliosus* (Aiton) DC., a small population consisting of four specimens of *Euphorbia serrata* was found. The species is seriously threatened because it grows in the narrow strip along the road that is periodically cleared to prevent fires. In addition, it is also subject to grazing by a flock of sheep. This species was cited for "San Bartolomé de Tirajana (Gran Canaria), route de Fataga, terrains vagues découverts aux abords d'une pineraire claire, altitude environ 800 m, 29 mars 1975, rec. J. Vivant. Espèce non encore signalée à la Gran Canaria" (Duvigneaud & Vivant 1977: 42). The area was revisited – even though the exact location was unknown – but the actual presence of the species could not be confirmed.

It is important to point out that our herbarium specimen shows leaf margins that are less serrate than usual.

Exsiccatum: Islas Canarias, Gran Canaria, Llanos de Constantino, WGS84 28º 00' 57.87" N, 15º 36' 02.91" W, 1640 m. a.s.l., 03-06-2023, *Eliseo A. Déniz Suárez* (BR).

Ephedra fragilis Desf. (*Ephedraceae*) – new locality for Gran Canaria.

According to Marrero (2021) this "taxon is very rare in Gran Canaria, with sporadic populations (individuals) mainly in the north and west of the island from Barranco de Guiniguada and Azuaje to Tirma and Güigüí" (p. 82). A group of at least four adult specimens and another four juvenile ones was observed on the right slope of Barranco de Guiniguada, at the height of Angostura (Santa Brígida). These specimens grow in front of a house, on a vertical slope, mixed with remains of thermosclerophyllous vegetation from the *Pistacio lentisci-Oleetum cerasiformis* association (del Arco Aguilar & Rodríguez Delgado 2018). As accompanying species we highlight *Olea cerasiformis* Rivas-Mart. & del Arco, *Rumex lunaria* L. and *Bosea yervamora* L. Other interesting species present on the same slope are *Syderoxilon canariense* T. Leyens, Lobin & A. Santos and *Crambe pritzelii* Bolle. The population can hardly expand as it is limited by agricultural lands.

Locality: Islas Canarias, Gran Canaria, Ladera derecha del barranco de Guiniguada (Santa Brígida), Escarpes verticales, WGS84 28º 02' 55.22" N, 15º 28' 56.67" W, 380 m. a.s.l., 21-09-2022, *Eliseo A. Déniz Suárez* s.c.

Helianthemum salicifolium (L.) Mill. (*Cistaceae*) – confirmation for Gran Canaria. (Fig. 2b)

This species has been mentioned for Gran Canaria for a long time, although without concrete locations that confirm its real presence. It was first reported by Despréaux, cited by Webb (1840). However, later authors (e.g. Lems 1960) have often doubted the real presence of the species. According to Kunkel (1975) the references to this species had to be revised, while for Marrero & Mesa Coello (2003) "it could be confused with certain more or less young forms of *Helianthemum canariense*" (p.150); according to Marrero & al. (1995) it is a species of rather doubtful presence. Hansen & Sunding (1993) included the species in their checklist and it is still mentioned in the most recent lists and databases (Acebes Ginovés & al. 2010; BIOTA 2024), still without any locations that unequivocally confirm its presence. This species actually occurs in the very species-rich grasslands of the tabaibal in the east of the island, corresponding to the *Euphorbietum balsamiferae* association (del Arco Aguilar & Rodríguez Delgado 2018), dominated by the shrub *Euphorbia*

balsamifera Aiton subsp. *balsamifera*. The specimens observed, exposed to extremely dry weather conditions, with sporadic rainfall during autumn and winter, hardly reach a height of 15 cm. The species is accompanied by *Artemisia reptans* C. Sm., *Helianthemum canariense* (Jacq.) Pers. and the rare *Trigonella stellata* Forssk., among others.

Exsiccatum and localities: Islas Canarias, Gran Canaria, Montaña Malfú, WGS84 27º 55' 43.32" N, 15º 25' 13.95" W, 350 m. a.s.l., 11-03-2021, *Eliseo A. Déniz Suárez* s.c.; *ibid*., Montaña de Agüimes, WGS84 27º 53' 50.88" N, 15º 26' 15.55" W, 350 m. a.s.l., 04-01-2023, *Eliseo A. Déniz Suárez* (BR); *ibid*., Montaña los Vélez, WGS84 27º 54' 24.33" N, 15º 24' 37.82" W, 120 m. a.s.l., 14-02-2023, *Eliseo A. Déniz Suárez* s.c.

Krubera peregrina (L.) Hoffm. (*Apiaceae*) – confirmation for Gran Canaria. (Fig. 2c)

This species was already recorded in quite old documents, starting with Webb & Berthelot (1842). Specific localities were mentioned in the literature by Pitard & Proust (1908), who listed the species for San Lorenzo (Bourg.) and San Cristóbal, as well as Lid (1967), who reported the species for Jinámar. A visit to these localities, which are imprecise in the case of the first two, did not confirm its current presence there. After this last reference, the species was no longer reported for the island. Hansen & Sunding (1993) did include it in their checklist and it is still mentioned in recent lists and databases (Acebes Ginovés & al. 2010; BIOTA 2024). Nevertheless, the presence of the species has been recently confirmed on the island: a small population was found at the edge of a mud pool on the campus of the Tafira University. As accompanying species, we found *Cenchrus ciliaris* L., *Phagnalon saxatile* (L.) Cass. and *Beta macrocarpa* Guss., among others.

Locality: Islas Canarias, Gran Canaria, Campus Universitario de Tafira, WGS8428º 04' 31.18" N, 15º 27' 08.60" W, 280 m. a.s.l., 11-04-2018, *Eliseo A. Déniz Suárez* s.c.

Lupinus albus L. (*Fabaceae*) – confirmation for Gran Canaria.

In the 1960s, this species was cited as an escape from cultivation in Las Lagunetas (Kunkel 1967), without giving an exact location. During several visits to the region in 2023, the presence of this species, either spontaneously or in cultivation, could not be confirmed. The taxon is still listed for Gran Canaria, as a safe non-invasive introduced species for the Las Lagunetas area (BIOTA 2023). We confirm its presence on the island, in another nearby location. Since at least 2018, a naturalized population has been found, possibly since the cessation of cultivation, of more than 50 specimens, in the Lechuza district in the Vega de San Mateo.

Exsiccatum: Islas Canarias, Gran Canaria, La Lechuza, WGS84 28º 00' 07.87" N, 15º 33' 02.35" W, 1040 m. a.s.l., 26-04-2024, *Eliseo A. Déniz Suárez* (BR).

Ornithopus pinnatus (Mill.) Druce (*Fabaceae*) – confirmation for Gran Canaria.

Quintana Vega (2015) first mentioned this species for Gran Canaria in his thesis for the municipality of Valleseco as: "a plant of roadsides, abandoned farms, borders of uncultivated land" (p. 292), without mentioning any locations. We confirm its presence on the island, where a large population has been found along the road that goes from Laguna de Valleseco to Pico de Osorio, as well as some specimens near Chorros de Firgas. The species seems to be very expansive.



Fig. 2. a) S*cleranthus annuus* subsp. *polycarpos*, Era del Barranco, May 2024, Eliseo Déniz Suárez; b) *Helianthemum salicifolium*, Montaña de Agüimes, January 2023, Eliseo Déniz Suárez; c) *Krubera peregrina*, Tafira, April 2018, Eliseo Déniz Suárez; 2) *Serapias parviflora*, near Presa de Sintes, April 2018, Eliseo Déniz Suárez.

Exsiccatum: Islas Canarias, Gran Canaria, Entre la Laguna de Valleseco y el Pico de Osorio, WGS84 28º 04' 21.70" N, 15º 33' 28.68" W, 830 m. a.s.l., 06-05-2024, *Eliseo A. Déniz Suárez* (BR).

Rhamnus crenulata Aiton (*Rhamnaceae*) – new locality for Gran Canaria.

This rare native species was cited by Suárez (1994) from the right slope of Montaña de Guía, Siete Puertas and La Calzada. Marrero (2021) confirmed its presence in the Jardín Canario and also mentioned it from Cabezo in Bandama. On the right slope of the ravine of Guiniguada, at the end of the vertical wall, very close to the confluence with the Colegio ravine, two specimens of this species have been observed, partially covered by a specimen of *Pistacia lentiscus* L. These individuals are of great interest due to their scarcity on the island. According to Suárez (1994: 391), "in Gran Canaria it is found in very localized situations. Sporadically present on steep edges of the potential zone of the thermophilic forest in places with elements typical of the green mountain".

Locality: Islas Canarias, Gran Canaria, Ladera derecha del barranco Guiniguada, (Santa Brígida), WGS84 28º 03' 01.50" N, 15º 28' 52.04" W, 375 m. a.s.l., 21-09-2022, *Eliseo A. Déniz Suárez* s.c.

Serapias parviflora Parl. (*Orchidaceae*) – confirmation for Gran Canaria. (Fig. 2d)

In a recent study of the Orchidaceae family on Gran Canaria, Marrero & al. (2019) could not confirm the presence of this species on the island. It had previously been reported by Bornmüller (1904) for Tafira at 400 m; later, Sventenius (1947) cited it for Santa Brígida at 650 m and Suárez (1994) for San Isidro de Teror. Bramwell & Bramwell (1990) also mentioned it for Tafira and Teror. In the vicinity of the Umbría or Sintes dam, near communities with *Erica canariensis* Rivas-Mart., M. Osorio & Wildpret and *Pistacia lentiscus* L., a few specimens of this very rare plant have been found. *Serapias parviflora* grows in cracks on the upper edge of the local road and in the shade of reforested palm groves. The droughts of recent years have had a very negative effect on this species, leading to a drastic decrease in numbers; possibly less than 20 individuals are left. If no new populations are found and the weather conditions remain the same, it is not unlikely that this species will become extinct in Gran Canaria. The fence around the water reservoir unfortunately does not allow to search for new populations or individuals. It is worth noting that in the same location some individuals of another rare orchid, *Ophrys bombyliflora* Link, are growing along the side of the road.

Locality: Islas Canarias, Gran Canaria, Entorno de la presa de la Umbría, WGS84 28º 03' 02.95" N, 15º 29' 59.96" W, 625 m. a.s.l., 16-04-2016, *Eliseo A. Déniz Suárez* s.c.

Veronica cymbalaria Bodard (*Plantaginaceae*) – new locality for Gran Canaria.

Santos & Fernández (1981) cited a find from Ayagaures in the south of the island, at 400 m, based on a report by Sventenius (1947). More recently, Sauerbier & al. (2023) mentioned this species for Risco Prieto and Aríñez (Vega de San Mateo). In Galaz (Vega de San Mateo) we have found this species in very small numbers on damp, northeast facing walls, accompanied by other herbaceous plants such as *Avena barbata* Pott ex Link, *Lathyrus clymenum* L. and *Aichryson punctatum* (C. Sm. ex Link) Webb & Berthel., among others.

Exsiccatum: Islas Canarias, Gran Canaria, Galaz (Vega de San Mateo), WGS84 28º 00' 48.69" N, 15º 34' 55.70" W, 1410 m. a.s.l., 18-04-2024, *Eliseo A. Déniz Suárez* (BR).

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Article

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M. Tsachouridis, K. Theodoropoulos & E. Eleftheriadou

Contribution to the flora of Mt Symvolo in the Kavala regional unit (NE Greece)

Abstract

Tsachouridis, M., Theodoropoulos, K. & Eleftheriadou, E.: Contribution to the flora of Mt Symvolo in the Kavala regional unit (NE Greece). — Fl. Medit. 35: 65-74. 2025. — ISSN: 1120-4052 printed, 2240-4538 online.

Mt Symvolo is in the Kavala Regional Unit in North-Eastern Greece. This contribution to the flora of the study area consists of 777 taxa, which belong to 386 genera and 92 families. The most species-rich families are: *Asteraceae*, *Fabaceae*, *Poaceae*, *Brassicaceae*, *Lamiaceae*, *Caryophyllaceae* and *Rosaceae*, whereas 28 families contribute with only one taxon. The most species-rich genera are: *Trifolium*, *Vicia* and *Euphorbia*, and 230 genera have only one taxon. Most of them are therophytes (329 taxa), followed by hemicryptophytes (254 taxa), phanerophytes (82 taxa), geophytes (81 taxa), chamaephytes (30 taxa) and aquatics (1 taxon). The high percentage of therophytes reflects the mediterranean character of the flora. Most of the taxa (356 taxa) are Mediterranean (175 taxa Mediterranean, 81 taxa Mediterranean-European, 62 taxa Mediterranean-SW Asian, etc.), followed by the Widespread unit with 327 taxa (156 taxa European-SW Asian, 47 taxa Paleotemperate, etc.) and the Balkan unit with 65 taxa (31 taxa Balkan-Anatolian, 24 taxa Balkan, etc.).

Key words: chorology, life-forms, Mediterranean, Widespread, therophyte.

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Introduction

The area of Greece is of great interest from a floristic and phytosociological perspective. A total of 7,992 taxa makes up the country's flora, of which a very large percentage are native or endemic species according to the fifth edition of the Flora of Greece Web site (http://portal.cybertaxonomy.org/flora-greece, 03/10/2024), while the endemism rate amounts to 22%. These indicators are particularly high given the small area of this European and Mediterranean country (Strid & Tan 1997, 2002; Tan & Iatrou 2001; Thompson 2005; Georghiou & Delipetrou 2010).

The above have contributed to an increased interest in the flora and vegetation in Greece, while remarkable progress has been made in their study in recent years. However,

there are many areas that have not been explored and studied to a satisfactory degree, while many data regarding the distribution of species in the Greek area and the co-ecological relationships between them remain unknown (Dimopoulos & al. 2012).

The area of Mount Symvolo in the Regional Unit of Kavala, in Eastern Macedonia, is among those areas that have not been adequately studied.

The aim of this study is to contribute to the knowledge of the flora of Mount Symvolo. For this reason, after recording the data and extracting the results, a comparison was made with other regions of Greece.

Material and methods

Study area – Mount Symvolo is located in the Kavala Regional Unit of the Region of Eastern Macedonia and Thrace, comprising a total area of 307 km^2. Its starting point is Paralia Ofryniou near the mouth of Strymonas River in the West and Nea Peramos and Nea Iraklitsa in the East, while from the North the Pieria Basin (a valley drained by the Marmaras River) and the Egnatia Motorway separate it from Mt Pangaeo which runs parallel to it and in the South, it is washed by the Aegean Sea (Fig. 1). The latitude of the research area is defined between 40.885539° and 40.717941° N of latitude, while its longitude is defined between 23.882872° and 24.340909° E. It is a low mountain with its higher peak being Agriada or Tsali (694 m). It has a relatively poor road network in its interior, nevertheless its proximity to the sea and its position on the road axis between Thessaloniki and Kavala, make access to the area relatively easy.

Geologically, the area is part of the Rhodopi massif (Mountrakis 1985). The substrate consists mainly of igneous and metamorphic rocks of the Mesozoic Age and especially of the Triassic Period, while there is a lack of sedimentary rocks. The lack of sedimentary rocks results in relatively unclear stratigraphy in this zone. Particularly important is the presence of acidic igneous rocks, plutonites and volcanic rocks.

The climate can be characterized as Csa Mediterranean climate with relatively hot dry summers and moderate winters (Flokas 1997). The bioclimate can be characterized as having a strong mid-mediterranean character, with higher altitudes belonging in the humid bioclimatic layer with cold winter and lower altitudes in the semi-arid bioclimatic layer with cold winter (Mavrommatis 1980).

The area is of great importance to the local population. Apart from the fact that there are many villages and settlements in the area, there is also presence of cultivated land, mainly olive groves and vineyards. The effects of grazing are also evident on it.

According to a management study for the Public Forest Complex of Mount Symvolo, the forests and woodlands of the research area form about 53.6% of the total area and are comprised of evergreen broadleaves at a rate of 36.89%, partially forested areas of evergreen broadleaves comprise 12.77%, mixed forest of *Quercus* species and other broadleaves comprise 3.94%. About 38.39% are agricultural lands, 2.82% reforestations with *Pinus pinaster* Aiton, 1.58% settlements, 1.43% grasslands and 0.59% barren lands (Tsitsonis & Kontos 2019).

Data collection and analysis – The research was based on field collections, carried out during the years 2017-2021, as well as on herbarium specimens (TAUF). All specimens are

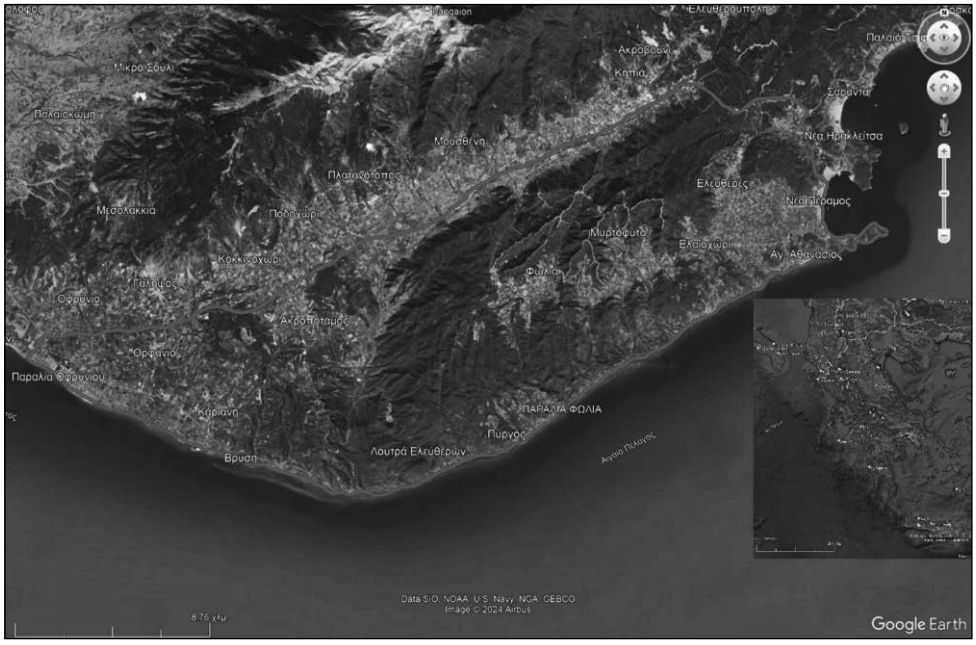


Fig. 1. Map of the study area.

deposited in the herbarium of the Aristotle University of Thessaloniki, Greece (TAUF). For the identification, Strid & Tan (1991, 1997, 2002), Tutin & al. (1968–1980, 1993), Strid (1986) and Pignatti (1982) were used. The nomenclature is in accordance with Dimopoulos & al. (2013, 2016) as well as the 6th Version of "The Flora of Greece web". Families, genera, species and subspecies are assorted in alphabetical order within the major groups of vascular plants such as *Pteridophyta*, *Gymnospermae*, *Angiospermae* (*Dicotyledones* and *Monocotyledones*). Life-form categories are presented in accordance with Raunkiaer's classification system as was modified by Dimopoulos & al. (2013) as well as the 6th Version of "The Flora of Greece web". Chorological categories of taxa are in accordance with Dimopoulos & al. (2013) and derive from the 6th Version of "The Flora of Greece web".

Results & Discussion

Floristic analysis – As a result of this research, 777 specific and subspecific taxa (760 species and for 194 is given the rank at subspecific level) belonging to 386 genera and 92 families have been identified in the study area (Table 1). The most taxa-rich family is *Asteraceae*, which accounts for 93 taxa (11.97% of all taxa), followed by: *Fabaceae* (82 taxa), *Poaceae* (77 taxa), *Brassicaceae* (52 taxa), *Lamiaceae* and *Caryophyllaceae* (with 38 taxa each), *Rosaceae* (24 taxa), *Apiaceae*, *Orchidaceae* and *Boraginaceae* (with 20 taxa each), whereas

Table 1. Numbers of plant families and genera in the four main taxonomic groups of the vascular flora studied.

	Families	**Genera**	**Species[1]**	**Subspecies**	**Taxa[2]**
Pteridophytes	3	3	7	2	7
Gymnosperms	3	3	4	2	4
Angiosperms - Dicotyledons	70	301	607	142	620
Angiosperms - Monocototyledons	16	79	142	48	146
Total	**92**	**386**	**760**	**194**	**777**

1. are comprised of (a) species that have no subspecies and (b) species that have one or more subspecies.
2. taxa are defined as comprising a) subspecies and b) species that have no subspecies.

26 families are represented by only one taxon. The ten most taxa-rich families together include 464 taxa comprising 59.72% of the total flora of the area. The first five families appear in a slightly different order among the six most species-rich families for the entire Greek flora (Dimopoulos & al. 2013). A similar or even the same order in the richest families was also observed in other regions (Dimopoulos 1993; Karetsos 2002; Chochliouros 2005; Dimitrellos 2005; Vlachos 2006; Chasapis 2017). The first six families have the same order as those found by Mermygas (2021) on Mount Saitas. The most taxa-rich genera are *Trifolium* (17 taxa), *Vicia* (13 taxa), *Euphorbia* (11 taxa), *Medicago* (11 taxa), *Silene* (10 taxa), *Anthemis* (9 taxa) and *Allium*, *Alyssum*, *Bromus* (with 8 taxa each) and *Carex* (7 taxa), which account for 13.13% of the total species of the study area, whereas 230 genera contribute with only one taxon. Of those ten genera, all but *Medicago*, *Alyssum* and *Bromus*, belong to the 20 most taxa-rich genera of the total flora of Greece as presented by Dimopoulos & al. (2013).

Life-form spectrum – The life-form spectrum shows that therophytes prevail (42.34%) followed by hemicryptophytes (32.69%), phanerophytes (10.55%), geophytes (10.42%), chamaephytes (3.86%) and aquatics (0.13%) (Table 2). The prevalence of therophytes reflects the Mediterranean character of the flora, while the high percentage of hemicryptophytes reflects a strong temperate influence (Emberger 1967). An increase in the percentage of therophytes in

Table 2. Life-form spectrum of the vascular flora of the study area.

Life-form	**Taxa**	
	Number	**Percentage (%)**
Therophytes (T)	329	42.34
Hemicryptophytes (H)	254	32.69
Phanerophytes (P)	82	10.55
Geophytes (G)	81	10.42
Chamaephytes (C)	30	3.86
Aquatics (A)	1	0.13
Total	**777**	**100.00**

the life-form spectrum, due to human activities, has been found by many researchers worldwide such as: Barbero & al. (1990), Dogan & al. (2004), Malik & al. (2007), Manhas & al. (2009), Schmidt (2012). Various researchers have found similar results with therophyte prevalence and high percentages of hemicryptophytes (Konstantinidis 1997; Mermygkas 2021; Zikos 2023,). Those mountains have a significantly higher altitude but are located in Southern Greece.

Chorology - The analysis of the chorological spectrum (Table 3) shows that the most prevalent chorological group of plants are the Mediterranean taxa (356 taxa – 45.81%), followed by the Widespread (327 taxa – 42.08%) and the Balkan taxa (65 taxa – 8.37%). Although the percentage of Greek endemics (0.64%) is considered very low, this can be reasonably explained, according to Dimopoulos & al. (2013), because the research area is at a great distance from the most important centers of endemism located in Southern and insular Greece (Médail & Quézel 1997; Georghiou & Delipetrou 2010). Finally, the high rate of 3.1% which is recorded for the Alien taxa (Table 3) can be explained by the intense human activities in the area (settlements, roads, crops, grazing). As far as the Mediterranean taxa and their prevalence are concerned, the greatest similarities of Mount Symvolo (45.81%) have been observed with the mountains of Saitas (Mermygkas 2021) in which Mediterranean taxa comprise 47.3% of its flora, and Kyllini (Dimopoulos 1993) with a percentage of 47.01%. Both mountains have a much higher altitude (1814 m and 2376 m respectively) than Symvolo (694 m), but they are much further south, both located in the Northern Peloponnese.

Endemism **-** In the research area, 5 endemic taxa have been identified, which constitute 0.64% of the total area's flora. The percentage is small compared to mountains such as

Table 3. Chorological spectrum of the vascular flora of the study area. The chorological categories are classified into 5 wide chorological groups.

Chorological group/category	Taxa	
	Number	%
1. Widespread taxa	**327**	**42.08**
European-SW Asian (EA)	156	20.07
Paleotemperate (Pt)	47	6.04
Cosmopolitan (Co)	40	5.15
Euro-Siberian (ES)	34	4.38
European (Eu)	22	2.83
Circumtemperate (Ct)	14	1.80
Subtropical-Tropical (ST)	7	0.90
Cosmopolitan / European-SW Asian (Co EA)	5	0.64
Cosmopolitan / Euro-Siberian (Co ES)	1	0.13
Cosmopolitan / Paleotemperate (Co Pt)	1	0.13
2. Mediterranean taxa	**356**	**45.81**
Mediterranean (Me)	175	22.65
Mediterranean-European (ME)	81	10.42

Table 3. continued.

Mediterranean-SW Asian (MS)	62	7.98
East Mediterranean (EM)	30	3.86
Mediterranean-Atlantic (MA)	8	1.03
3. Balkan taxa	**65**	**8.37**
Balkan-Anatolian (BA)	31	3.99
Balkan (Bk)	24	3.08
Balkan-Italian (BI)	6	0.77
Balkan-Central European (BC)	4	0.51
4. Endemic taxa		
Greek endemic (●)	**5**	**0.64**
5. Alien taxa	**24**	**3.1**
[North American] (N-Am.)	11	1.41
[South American] (S-Am.)	3	0.39
[Neotropical] (neotrop.)	3	0.39
[South African] (S-Afr.)	2	0.26
[West Asian] (W-As.)	1	0.13
[Arabian] (Arab.)	1	0.13
[Central Asian] [East Asian] (C-As.) (E-As.)	1	0.13
[West Mediterranean] [Central Mediterranean] (W-Med.) (C-Med.)	1	0.13
[South West Asian] [Central Asian] (SW-As.) (C-As.)	1	0.13
Total	**777**	**100.00**

Panachaiko (Kokkoris 2014), Saitas (Mermygkas 2021), Erymanthos (Maroulis 2003) and Kyllini (Dimopoulos 1993) with percentages 9.53%, 8.25%, 8.27% and 12.34% respectively. All the above-mentioned mountains have a much higher altitude and a wide presence of the mountain-Mediterranean vegetation floor. In addition to the altitude and the presence of more layers of vegetation in the above mountains, an important factor for the presence of endemic taxa is the presence of specific habitats, since some of them are particularly rich in endemic taxa (Georghiou & Delipetrou 2010; Mermygkas 2021). Endemic taxa are strong phytogeographical indicators due to their limited distribution, in contrast to taxa that show a large geographical distribution (Iatrou 1986; Carlström 1986; Konstantinidis 1997).

Range-restricted taxa - Range-restricted taxa are considered to be those whose most distant populations are separated by a linear distance equal to or less than 500 km. This concept was first used for the Greek flora, under the term "range restricted" (Dimopoulos & al. 2013) and examines the distribution of taxa with purely geographical criteria, regardless of national borders or administrative division limits. 15 range-restricted taxa have been recorded in the flora of Mount Symvolo (including the 5 Greek endemics) (Table 4).

Table 4. Range-restricted taxa.

Taxon	Range-Restricted	Greek endemic
Alyssoides utriculata subsp. *bulgarica* (Sagorski) Hartvig	+	
Anthemis werneri Stoj. & Acht.	+	+
Asperula aristata subsp. *nestia* (Rech. f.) Ehrend. & Krendl	+	
Berteroa orbiculata DC.	+	
Campanula scutellata Griseb.	+	
Cerastium decalvans subsp. *orbelicum* (Velen.) Stoj. & Stef.	+	
Digitalis lanata subsp. *leucophaea* (Sm.) Werner	+	
Erysimum calycinum Griseb.	+	
Festuca rubra subsp. *thessalica* Markgr.-Dann.	+	+
Galium aegeum (Stoj. & Kitan.) Ančev	+	
Ophrys sphegodes subsp. *epirotica* (Renz) Gölz & H.R. Reinhard	+	
Scabiosa balcanica Velen.	+	
Taraxacum extimum Kirschner & al.	+	+
Verbascum cylincrocarpum Griseb.	+	+
Veronica chamaedrys subsp. *chamaedryoides* (Bory & Chaub.) M.A. Fisch.	+	+

Conclusion

Mount Symvolo comprises a small and low area, heavily affected by human activities. The vascular flora identified inside the investigated area consists of 777 taxa, which belong to 386 genera and 92 families. The most taxa-rich family of the vascular flora is *Asteraceae*, which consists of 93 taxa (11.97% of all taxa). The most taxa-rich genus is *Trifolium* with 17 taxa. Therophytes and hemicryptophytes are the most abundant plant life forms with 42.34% and 32.69% respectively, while the most abundant chorological group consists of the Mediterranean plants with 356 taxa belonging to this group.

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Article

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P. Fraga, M. Capó, J. Rita, J. Borràs & J. Cursach

New data for the alien vascular flora of Menorca (Balearic Islands, Spain)

Abstract

Fraga, P., Capó, M., Rita, J., Borràs J. & Joana Cursach, J.: New data for the alien vascular flora of Menorca (Balearic Islands, Spain). — Fl. Medit. 35: 75-84. 2025. — ISSN: 1120-4052 printed, 2240-4538 online.

Plant species introductions are a major threat to biodiversity worldwide, being especially harmful in island ecosystems. These introductions have increased significantly over the past decades, and understanding their ability to spread along the invaded areas is one of the key issues for optimising management actions. This study provides new findings on alien plants in Menorca, an island declared a Biosphere Reserve in 1993 located in the western Mediterranean Basin. In particular, we provide chorological data for 16 taxa: four of them are a novelty for the flora of the Balearic Islands (*Crassula tetragona* subsp. *robusta, Gazania linearis*, *Portulaca grandiflora* and *Turnera ulmifolia*), and nine are new for Menorca. Furthermore, we provide new chorological data from four other taxa previously cited in other studies. Overall, we include 13 new taxa for the alien flora of Menorca, reaching a total of 326 taxa that represent approximately 23% of the entire flora of the island.

Key words: chorology, alien flora, Menorca, western Mediterranean Basin.

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Introduction

The introduction of alien species is a major environmental issue in the context of global change (Simberloff & al. 2013), the consequences of which are particularly detrimental in insular ecosystems (Wood & al. 2017). Knowledge of non-native flora, especially invasive or potentially invasive species, is essential to properly manage biodiversity and natural areas (Fraga-Arguimbau 2023). Therefore, having updated information on the distribution and invaded habitats of alien species helps ensure more appropriate management, preventive or direct control (Foxcroft & al. 2017).

Data on plant introductions to Mediterranean islands have increased over the past decade, highlighting a significant increase in alien flora in recent years (e.g., Moragues & Rita 2005; Camarda & al. 2016; Cerrato & al. 2023; Galasso & al. 2024). In the particular

case of the Balearic Islands (western Mediterranean basin), changes in land-use from rural activities to urbanization and tourism have exacerbated habitat degradation and promoted the introduction of alien floral (Mayoral & al. 2018; Cerrato & al. 2023).

The most recent updates of the alien floral checklist of Menorca, the second largest island in the Balearic archipelago, compiled 313 alien taxa (Fraga-Arguimbau 2023). In this study, we present novelties for the alien flora of Menorca in terms of taxonomy, floristics and ecology.

Materials and Methods

Menorca is an island of 702 km^2 located on the northeast side of the Balearic archipelago (39°58′00″N 4°05′00″E) that was declared a Biosphere Reserve by UNESCO in 1993 (Vidal 1994). A field exploration was developed between 5th and 12th October 2023 throughout the island. To ensure homogeneous exploration, the surface was divided into 12 UTM grids of 10 × 10 km, excluding those with a land area less than 5%. In each of the study grids, inventories of alien flora were carried out in eight different habitats and, after bibliographic research, we filtered those taxa which previous knowledge was absent or scarce. The consideration of an alien species followed the criteria of Moragues & Rita (2005), Cerrato & al. (2023) and Fraga-Arguimbau (2023).

For each of the taxa considered in this study, we provide the following information: taxon name, locality, agricultural, ornamental or forestry uses (if applicable), municipality, geographic location, altitude, date, environment or habitat and geological materials. Also, this information is followed by a discussion on aspects such as taxonomy, morphology, chorology, habitat and state of conservation.

For both nomenclature and chorology, we followed POWO (2024). Only in the particular case of the genus *Canna*, we followed the criteria of Ciciarelli & Rolleri (2008). The names of the authors were abbreviated according to the criteria established by Brummitt & Powell (1992), and for those authors who did not appear in this publication, the criteria established by POWO (2024) were followed. Taxa that are new to the flora of the Balearic Islands are preceded by two asterisks (**) and those that are new to the flora of Menorca by one (*).

The geographical location is also indicated in each record. We recorded the GPS position using a Gamin 66i handheld GPS. The georeferencing system that has been used is the local UTM coordinates (spindle 31 and zones S or T, depending on whether they are above or below parallel 40 respectively), with datum ETRS89, and a precision of 100 m. Height, due to the error that mobile devices with GPS often provide, has been subsequently verified using the information provided to IDE Menorca (https://ide.cime.es/visoride/).

To categorize if taxa are considered naturalized (autonomous populations that can penetrate natural environments) or is only casual (grows only in anthropogenic environments, no proliferation of new individuals is observed or there is no evidence of the persistence of populations) we followed the criteria of Richardson & al. (2000).

For those taxa that are floristic novelties in the Balearic Islands, material is deposited in the General Herbarium of Menorca (HGM), hold at the Institut Menorquí d'Estudis.

Results and Discussion

As a result of field explorations, new chorological data and taxonomic observations are provided for the alien flora of Menorca referring to 16 taxa. Four taxa are new records for the alien flora of the Balearic Islands: *Crassula tetragona* subsp. *robusta* (Toelken) Toelken, *Gazania linearis* (Thunb.) Druce, *Portulaca grandiflora* Hook and *Turnera ulmifolia* L. Eight taxa are new to the alien flora of Menorca (but not for other islands from the Balearic archipelago): *Acacia saligna* (Labill.) H.L.Wendl., *Campsis radicans* (L.) Bureau, *Cardiospermum grandiflorum* Sw., *Datura wrightii* Regel, *Lagunaria patersonia* (Andrews) G. Don, *Salix alba* L., *Sorghum bicolor* (L.) Moench and *Sporobolus indicus* (L.) R.Br. Information for the other four taxa (*Baccharis halimifolia* L., *Canna coccinea* Mill., *Cortaderia selloana* (Schult. & Schult.f.) Asch. & Graebn.) and *Parkinsonia aculeata* L. corresponds to new localities that expand their hitherto known distribution areas, which confirm their naturalization process and, sometimes, also their invasive behaviour.

*List of taxa newly recorded in the alien flora of Menorca**

Acacia saligna (Labill.) H.L.Wendl.
Torre Solí Nou, Alaior, 39°54’43.64”N 4°4’15.03”E, 25 m, 08/10/2023, ruderal vegetation at the margins of a forest trail, calcareous materials. Naturalized.
Cultivated as an ornamental in Menorca, this is the first record of its naturalization. It is considered an invasive species in many parts of the world, mainly in Mediterranean areas (Thompson & al. 2015). Unlike other nearby regions and islands, in Menorca it has not been used as a forest species, which could explain its low naturalization rate.

Baccharis halimifolia L.
Cala Lladró, Port Maó, Maó, 39°53’12.59”N 4°17’56.69”E, 2 m, 07/10/2023, bushy vegetation in a small seasonal stream, close to the sea, siliceous soils. Naturalized.
This species is considered one of the worst invasive plants in Spain (GEIB 2006). Widespread along the Atlantic coasts of Europe (Fried & al. 2016). In Menorca, it was first recorded in a marshy area in the southern part of the island (Podda & al. 2010). This small population was immediately eradicated. Thus, this new location is the second record for the island. As in the previous, its eradication is recommended, especially considering its ability to colonize and modify coastal vegetation (Fried & al. 2016).

Campsis radicans (L.) Boreau
Urbanització Son Parc, Son Saura del Nord, Es Mercadal, 40°1’29.23”N 4°9’41.67”E, 6 m, 8/10/2023, at the margins and climbing on drystone walls of a highly anthropized seasonal stream, alluvial materials, mainly calcareous. Naturalized (Fig. 1).
A climbing species widely cultivated as ornamental. In Menorca, it is known in cultivation at least since the XIX century (Rodríguez 1874). As a naturalized alien species, it is known in some countries around the Mediterranean (POWO 2024). In Menorca, the hybrid *C.* × *tagliabuana* has recently been reported to be naturalized (Serapio & al. 2023).



Fig. 1. Flowers (A) and leaves (B) of *Campsis radicans* (L.) Bureau.

Canna coccinea Mill.

Torrent de ses Pletes, Ferreries, 39°59'12.50"N 4°1'7.18"E, 69 m, 05/10/2023, herbaceous, nitrophilous vegetation in a seasonal stream, siliceous soils. Naturalized.

This represents the second record of this Neotropical species in Menorca. As in the previous (Fraga-Arguimbau & al. 2022), this population clearly escaped from cultivated plants, now colonizing a seasonal stream. The other two species of the genus are naturalized in Menorca: *C. flaccida* Salisb. (Fraga & al. 2004), and *C. glauca* L. (Fraga & al. 2015). The mention of *C. indica* L. in Podda & al. (2010) should be interpreted as a generic name, as this binomial has often been applied to any plant of the genus cultivated as an ornamental.

****Cardiospermum grandiflorum*** Sw.

Es Canal Salat, Ciutadella de Menorca, 39°59'52.41"N 3°50'35.29"E, 6 m, 06/10/2023, herbaceous nitrophilous vegetation in a seasonal stream, climbing through the drystone walls that delimit the channel, calcareous soils. Naturalized.

This is the first record in Menorca for this herbaceous climber, but the species was previously known from Mallorca (Sáez & al. 2016). It was also listed for the Balearic Islands by Moragues & Rita (2005), but without indicating any specific island. It is indigenous to the central and eastern United States (POWO 2024), but it is considered a serious invasive

species in South Africa (Gildenhuys & al. 2013) and Australia (Carroll & al. 2005), where it is related to riparian habitats. We recommend the eradication of this population to prevent further expansion of this invasive species, since the location represents the suitable habitat for the species to develop and thrive.

Cortaderia selloana (Schult. & Schult.f.) Asch. & Graebn.
Sínia des Moret, Maó, 39°53'46.9"N 4°15'14.7"E, 36 m, 09/10/2023, scrub vegetation on rocky calcareous soil, in an urban plot; cala Figuera, Port Maó, Maó, 39°53'06.9"N 4°16'28.4"E, 10 m, 07/10/2023, rocky calcareous slopes with scrub vegetation; Urbanització de cala Llonga, Port Maó, Maó, 39°53'12.6"N 4°17'56.7"E, 43 m, 09/10/2023, scrub vegetation on siliceous stony ground, in an urban plot; Urbanització de cala Llonga, Port Maó, Maó, 39°53'34.8"N 4°17'57.0"E, 17 m, 09/10/2023, scrub vegetation on siliceous rocky ground; Torre Solí Nou, Alaior, 39°54'41.2"N 4°04'12.3"E, 22 m, 08/10/2023, ruderal vegetation at the margins of a forest trail, calcareous materials; Urbanització de Son Saura des Mercadal, Es Mercadal, 40°01'00.5"N 4°09'47.1"E, 15 m, 08/10/2023, bushy vegetation, siliceous soils. Naturalized.
This species is native to South America, but widespread in many regions of the world, and is considered one of the worst invasive alien plant species (Liendo & al. 2023). Its presence in Menorca as naturalized has been known since 2003, but it was then considered a rare species (Fraga-Arguimbau & al. 2004). In recent years, its populations have increased significantly, and these new records represent proof of this expansion process.
Two of the populations, Sínia des Murta and cala Figuera, are notable for their distinctive behaviour and ecology. In these locations, the plants grow on dry rocky soil and the population is very dense, with smaller plants with narrower inflorescences compared to typical plants. Consequently, they could be another species of the genus (Houliston & Goeke 2017), a hybrid (Connor 1983) or an ecological adaptation of the species, as has been suggested in other Mediterranean regions (Lambrinos 2001).

****Crassula tetragona*** subsp. ***robusta*** (Toelken) Toelken
Camí de s'Hort de ses Taronges, Ciutadella de Menorca, 39°58'38.5"N 3°51'09.8"E, 14 m, 06/10/2023, om top of drystone walls, growing with other ornamental succulents (*Aloe*, *Cotyledon*, *Sedum*, etc.), calcareous materials. Casual alien.
This is a widely and traditionally succulent species that is used in domestic gardens throughout the island. It reproduces easily through leaves and, mainly, stem segments, but until now has not been spotted as escaped. This is the first record for the Balearic Islands, although it is known to be naturalized in nearby areas of Catalonia and Valencia (Aymerich & Sáez 2019; Fabado-Alós & al. 2022).

****Datura wrightii*** Regel
Sa cala Blanca, Ciutadella de Menorca, 39°58'04.3"N 3°50'11.5"E, 2 m, 06/10/2023, sand dunes with herbaceous psammophilous and ruderal vegetation. Naturalized.
Datura innoxia Mill. and *D. wrightii* are two closely related species that have often been confused. The main character of their discrimination is the indumentum of the corolla (Gallego 2012). Examination of the individuals at this locality showed that they have an adpressed indumentum on the stems, but the outer parts of the corolla are glabrous (Fig. 2).

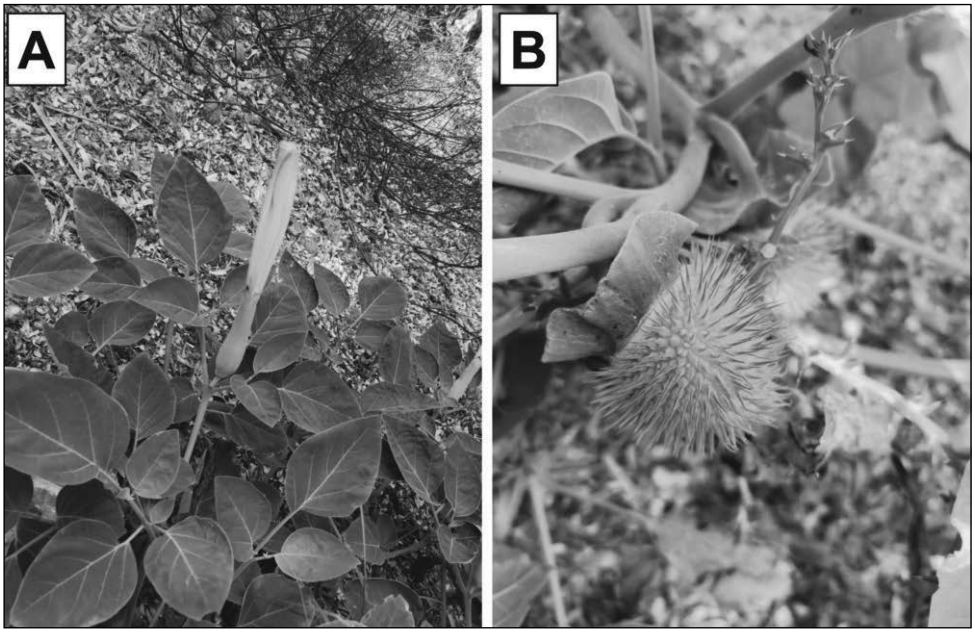


Fig. 2. Flowering plant (A) and fruit (B) of *Datura wrightii* Regel.

Datura innoxia has already been recorded for Menorca (Fraga-Arguimbau & al. 2004). Recently, *D. wrightii* has been classified as invasive in Romania (Niculescu 2022). It is widely naturalized around the Mediterranean (POWO 2024). In the Balearic archipelago, *D. wrightii* has previously been reported only in Mallorca (Sáez & al. 2015).

****Gazania linearis*** (Thunb.) Druce

Es Grau, Maó, 39°57'01.2"N 4°16'06.1"E, 1 m, 11/10/2023, coastal rocky ground, with herbaceous vegetation, siliceous materials. Naturalized.

The taxonomy of the genus *Gazania* Gaertn. is not fully solved (Howis & al. 2009; Magee & al. 2011). The so-called K-R Clade is particularly complex with poorly defined species (Howis & al. 2009). Within this group, there are some commonly cultivated species as ornamentals: *G. krebsiana* Less., *G. linearis*, *G. rigens* (L.) Gaertn. Some authors refer to naturalized plants as *G. rigens s.l.* (Verloove & al. 2019), but the existence of an updated key for the genus with precise discriminatory characters (Magee & al. 2011) makes its identification more feasible. Until now, *G. rigens* was known in Menorca as naturalized (Fraga-Arguimbau & al. 2004), but during the fieldwork of this study, the examination of some populations showed up characters compatible with those of *G. linearis* such as rosulate leaves and non-ciliate petioles.

Lagunaria patersonia (Andrews) G. Don

Cala Galdana, Ferreries, 39°56'15.3"N 3°57'40.2"E, 2 m, 06/10/2023, ruderal nitrophilous vegetation of shady places growing on mixed calcareous materials of soil and stones. Naturalized.

This is the first record for Menorca. In the Balearic Islands it has recently been recorded from Mallorca (Cerrato & al. 2023b). This species is native to the Pacific Islands and eastern Australia. It seems to be in expansion, naturalized in Kenya, South Africa, California and New Zealand, and has recently been reported as an alien in Tunisia (El Mokni & Iamonico 2020).

Parkinsonia aculeata L.

S'Hort de ses Taronges, Ciutadella de Menorca, 39°58'36.6"N 3°51'12.7"E, 11 m, 6/10/2023, nitrophilous vegetation in a small ravine, mainly brambles and some other alien plants such as *Ailanthus altissima* (Mill.) Swingle and *Anredera cordifolia* (Ten.) Steenis. Naturalized.

This species is cultivated as a traditional ornamental on the island, at least since the XIX century (Rodríguez 1901). Since it has been classified as an invasive species at the national level and thus banned as a commercial plant, its cultivation has decreased. The species was recorded for the entire Balearic Islands (Moragues 2005), but we provide a new record for this alien species in Menorca.

****Portulaca grandiflora*** Hook.

Urbanització de cala Blanca, Ciutadella de Menorca, 39°58'30.8"N 3°49'54.8"E, 11 m, 06/10/2023, rocky calcareous ground with halophytes and small ruderals. Naturalized.

This is one of the most popular summer flowering annuals, cultivated in the island, at least, since the second half of the nineteenth century (Rodríguez-Femenías 1874), but until now never recorded as naturalized. This is the first record of this species as an alien to the Balearic Islands. In the western Mediterranean region, it is widely naturalized in Italy (Galasso & al. 2024).

Salix alba L.

Cala en Porter, Alaior, 39°52'23.1"N 4°07'51.6"E, 2 m, 09/10/2023, young plants growing in marginal vegetation of wetlands, mainly brambles and nitrophilous herbaceous plants. Naturalized.

In the same area, there are several mature individuals of *Salix alba*. They are the remnants of a previous riparian forest, partially destroyed to make the existent parking area. It is considered a cultivated species on the island, as in other islands of the archipelago (Bonafè 1978; Torres 1981). This is the first record of naturalized plants in Menorca, but it has been already cited in Mallorca and Eivissa (Barceló i Combis 1867).

Sorghum bicolor (L.) Moench

Prat de Son Bou, Alaior, 39°54'19.0"N 4°04'03.4"E, 3 m, 08/10/2023, nitrophilous vegetation of wet and deep soils, at the margins of a wetland. Naturalized.

This species has been cultivated on the island as a forage plant since the nineteenth century (Rodríguez 1904). This is the first record in Menorca as naturalized, but in the Balearic Islands it has already been recorded in Eivissa and Mallorca (Gil 2004; Sáez & al. 2016).

Sporobolus indicus (L.) R.Br.

Camí de cala Mitjana, Ferreries, 39°56'17.6"N 3°58'16.3"E, 43 m, 05/10/2023, nitrophilous herbaceous vegetation, seasonally wet, at the margins of an old artificial pond, previously used as a trough for cattle, calcareous soils. Naturalized.

This is the first record for Menorca, but it was previously recorded in Mallorca (Medina & Aedo 2021). Also, this species is widely spread in nearby Iberian territories (Gómez & al. 2006; Muñoz-Rodríguez 2021) and in most Mediterranean countries (POWO 2024). This population was found far from urban areas and surroundings, which could be explained by its ability to spread over long distances, mainly through ornithocory (Vélez-Gavilán 2022). *Sporobolus indicus* belongs to a taxonomic complex that poses difficulties in identifying the species (Shrestha & al. 2003; Simon & Jacobs 1999). We identified as *S. indicus s.s.* these plants for their narrow and compact spikes, with all branches short and adpressed to the axis.

*****Turnera ulmifolia*** L.

Platja de Punta Prima, Sant Lluis. 39°48'49.1"N 4°16'47.0"E, 1 m, 22/11/2024, sand dunes with herbaceous vegetation. Casual alien.

This is the first record of this species for the Balearic Islands and the Iberian Peninsula. The closest region where it is known to be naturalized is the Canary archipelago (Verloove & Reyes-Betancourt 2011; Verloove 2013). It is native to Central America and the Caribe, and naturalized in tropical and warm regions of America, India and Insulindia (POWO 2024). It is classified as an invasive species in India (Reddy 2008). *Turmera ulmifolia* is widely used as a medicinal plant in Central and South America (Szewczyk & Zidorn 2014). This popularity is also increasing in Spain, where it is now being cultivated on a domestic scale.

Conclusions

The results of this fieldwork highlight how efficient specific explorations can be in the knowledge of non-native flora. Until now, most citations of alien flora of Menorca have been the result of random locations or have been framed in other more generic floristic explorations. In this case, during eight days of exploration, we were able to find 13 novelties for the alien flora of Menorca, which have to be added to the 313 alien taxa previously reported (Fraga-Argiumbau 2023). Considering that the native flora of Menorca comprises 1090 taxa (Sáez & al. 2013), the alien flora represents approximately 23% of the flora of the island. All this information will be useful for the preventive management of alien invasive plants and to optimize the actions needed to eradicate them.

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Article

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Impact of climate change on Holm Oak mortality and dieback in the High Atlas, Morocco's Mediterranean climate

Abstract

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Forests are facing unprecedented mortality and dieback globally. While Holm oak decline is well-studied in the northern Mediterranean, its drivers in North Africa remain poorly understood, challenging conservation efforts. In Morocco's High Atlas, Holm oak forests span altitudes of 1200–2200 meters on limestone substrates in subhumid and semi-arid bioclimates. The Standardized Precipitation Evapotranspiration Index (SPEI) reveals severe droughts, and PCA analyses show strong links between reduced precipitation, rising temperatures, and Holm oak decline. Areas with low rainfall and high temperatures suffer the most, especially during hot seasons. Mixed Holm oak shrubs exhibit the highest decline rate (40.31%), followed by pure Holm oak shrubs (25.88%) and forests (19.92%). Mixed forests are more vulnerable. Larger trees with greater height and diameter at breast height (DBH) show higher resistance, while factors like elevation, soil type, and canopy cover have minimal impact. Southern slopes are particularly affected due to increased solar radiation. Holm oak decline begins with dieback, leading to mortality. This decline underlines significant ecological and socio-economic consequences, including habitat loss and severe impacts on local community. These findings emphasize the need for targeted conservation strategies to mitigate the effects of climate change on these forests.

Key words: *Quercus ilex*, Forest, Decline, Tree resilience, Drought, SPEI.

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Introduction

Forest ecosystems serve as important long-term sinks for carbon and essential nutrients source (García-Angulo & al. 2020). In addition, forests serve as highly diverse habitats and ecological systems that cover nearly a third of the world's land surface area (Fischbein & Corley 2022). Furthermore, forest ecosystems are crucial to the survival and development of human societies (Zhang & al. 2022). Generally, forests are a cornerstone of our planet's health, offering immense economic, ecological, and cultural values (Kassie & al. 2024).

However, these ecosystems are under unprecedented pressure, for instance, climatic change, invasive species, natural disasters, land use change, and pest/diseases that can severally impact the ability of forest to sustain ecosystem services (Randhir & Erol 2013). Indeed, forests are experiencing growing risks of drought-induced mortality in a warming world (Batllori & al. 2020). Trees mortality is an emergent worldwide environment phenomenon (Allen Breshears 2007). In addition, biotic agents and abiotic stress factors interact in time and space to produce tree decline (Jung & al. 2000; Oliva & al. 2013; Sena & al. 2018; Gea-Izquierdo & al. 2021) The decline of forests in developed countries, including Morocco, has become a global concern (Mueller-Dombois 1988). Moroccan forests are also subject to degradative pressures, which vary in intensity depending on the region (Dallahi & al. 2023), for instance, Atlas cedar dieback and decline (Linares & al. 2011; Camarero & al. 2021) as well as cork oak decline (Dorado & al. 2022), palm tree (Rafiqi & al. 2022; Khayi & al. 2023), Aleppo pine (Vieira & al. 2022) and the holm oak. Indeed, *Quercus* forests are suffering serious decline worldwide, closely linked to the consequences of climate change (Rodríguez-Romero & al. 2022).

In general, woodland mortality in the Mediterranean Basin, is strongly influenced by severe water deficit(Peñuelas & al. 2001; Linares & Tíscar 2010; Linares & al. 2013). The study of natural forest dynamics in Mediterranean ecosystems is challenging due to the frequency and severity of disturbances (fires, firewood cutting, coal mining, grazing, etc.) (Panaïotis & al. 1997). In addition, Holm oak forests are a dominant type of vegetation in transition zone between temperate forests, and tropical forests, where large human populations, massive tourism, and intense industrial activity are significant (Terradas 1999). Indeed, the regions of occurrence of holm oak areas are highly affected by human activities, such as fire, grazing pressure, shifting agriculture, and overcutting for fuel and other purposes (Caliskan 2014). This tree is also subjected to water stress, reduced foliar nutrient concentrations, and damage to foliage by insects (Landsberg & Wylie 1983). It is distributed mainly in the thermo-, meso- and supra-Mediterranean altitudinal vegetation level and in semiarid to humid Mediterranean climates (Rivas Martínez & Gandullo 1987). In Morocco, holm oak grows between 600 and 2700 m, covering 1.4 million ha, over 30% of the natural forest area (Braun-Blanquet & Maire 1921; Khatouri 1992; Terradas 1999). The forest domain of Holm oak woodlands in Morocco covers approximately 1,430,000 hectares, extending from the Rif region in the north to the Anti-Atlas in the south (Benaibid 1985). *Quercus ilex* L. is native to the central-western Mediterranean basin, where it represents the dominating species, in North Africa from Tunisia to Morocco, on several large islands, e.g., Crete, Sicily, and Corsica, and southern (continental) Europe, along a continuum from Turkey to Portugal (Michaud & al. 1995). It is very important due to its significant ecological and economical values (Liñán & al. 2011). Holm oak reproduces through mast seeding and shoot production (Le Roncé & al. 2023). Increase in holm oak decline has been observed in the last decade (Alderotti & Verdiani 2023).

Holm oak growth was strongly controlled by climatic changes in recent decades (Natalini & al. 2016). Climatic stress has been proposed as the primary cause of diebacks and declines around the world (Jurskis 2005). In the Mediterranean region, it is predicted that temperatures will rise (Molina & al. 2020), climate change may affect Holm oak fecundity by changing weather patterns, physiological processes, and resource allocation (Le Roncé & al. 2021), indeed extreme climatic events, such as heatwaves, frost, drought and flooding,

usually reduces plant production and induces mortality (Niu & al. 2014). The mechanisms underlying such mortality, however, are debated, owing to complex interactions between the drivers and the processes. Understanding drought-related mortality is fundamental for ecosystem management and climate-feedback predictions (Anderegg & al. 2013).

The use of vegetation indices is a common approach for analyzing seasonal vegetation variations in satellite imagery (Meneses-Tovar 2011). The Normalized Difference Vegetation Index (NDVI) is the most frequently used indicator to monitor tree mortality, representing 28% of the studies (Eliades & al. 2024). These techniques enable accurate assessments, thereby reducing costs and saving time (Gharnit & al. 2025). The main hotspots of mortality studies are North America (39%) and Europe (26%) (Eliades & al. 2024).

In a recent study by Gharnit & al. (2024), the vegetation cover in the Central High Atlas was evaluated. The findings indicate severe degradation of *Juniperus thurifera* L., *Pinus halepensis* Mill. forests, *Quercus ilex* and *Juniperus phoenicea* L. forests (Gharnit & al. 2025). In addition, Youssef & al. (2024) have demonstrated that the percentage of vegetation density, oak groves, Matorrals, red juniper, and thuja, displays a declining trend, as medium cover vegetation decreased by 29.5%, while dense vegetation decreased considerably by 70.9% (Youssef & al. 2024; Outourakhte & al. 2025).

The mortality and decline of Holm oak has been extensively studied in the northern Mediterranean (Europe), providing valuable insights into the factors driving this decline. However, our understanding of this phenomenon in the southern part (North Africa) remains limited, leaving a significant knowledge gap in our understanding of the region's ecological dynamics and key factors that drive this degradation. This highlights the critical need for research to address the factors driving Holm oak decline in this region. Consequently, the study aims to determine the primary factors contributing to the recent decline in Morocco's Holm oak forests and to assess how Holm oak forest decline is evolving in relation to the important ecological factors.



Fig. 1. The aspect of the lower limit of *Quercus ilex* mixed with *Juniperus phoenicea*, *J. oxycedrus*, and *Pistacia lentiscus* is particularly vulnerable to decline and mortality. While Holm oak shrubs are significantly impacted, other species in this community, such as *Juniperus* and *Pistacia*, show greater resistance.

Materials and Methods

Study area

Central High Atlas is located in central Morocco, the altitudes range from 500 to 3700 meters, with an average elevation of 1588 meters. The climate is Mediterranean with four distinct seasons: winter, spring, summer, and autumn (Ouchbani & Romane 1995), generally, the climate is characterized by hot and dry summers in contrast to cold and rainy winters. Precipitation varies between 400 and 730 millimeters, the bioclimate is semi-arid and subhumid (Gharnit & al. 2023) , the temperatures mean is about 18 °C and significant snow contribution occurs during the winter, temperatures fall below 0 °C in winter and may reach more 46°C in summer (Bell & al. 2022). The substrate types are generally carbonates (limestones, dolomite, or limestones associated with dolomite) and clays associated with sandstone (Gharnit al. 2025). The figure 1 represent the geographic location of the study area.

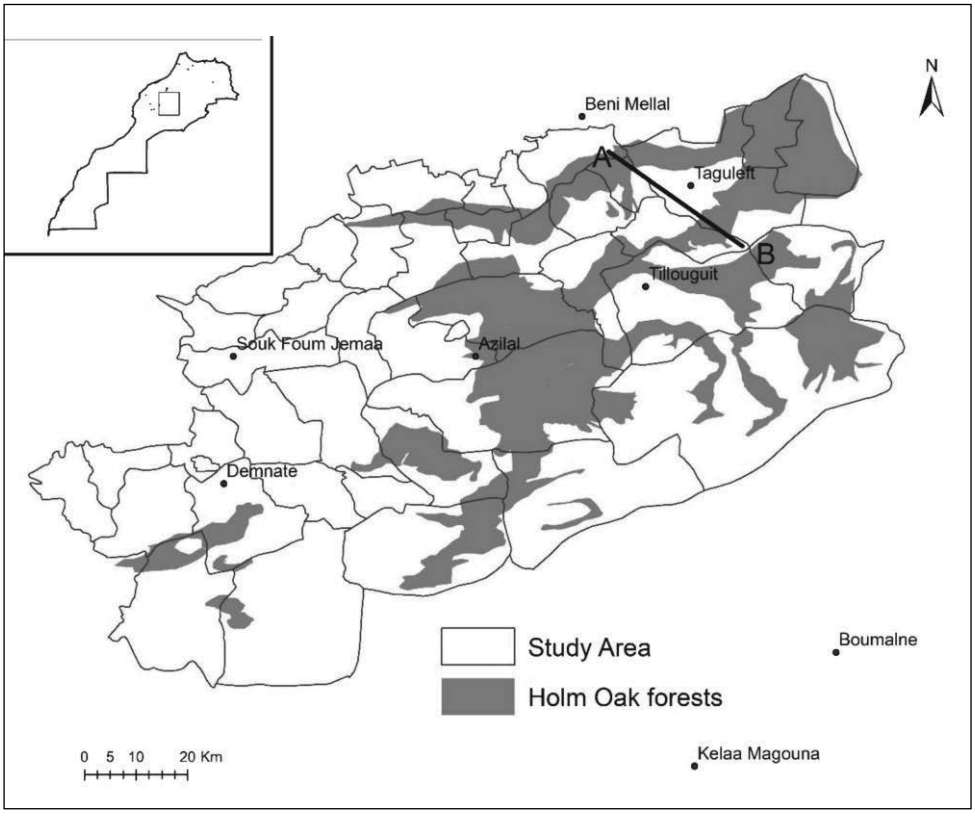


Fig. 2. Study area location

Vegetation patterns and decline sampling

The vegetation sampling was conducted using 80 rectangular plots measuring 10 × 20 meters, separated by 100 meters. Within each plot, data collected included the number of individuals, dieback trees, mortality, DBH (Diameter at Breast Height), plant height, and cover. To measure DBH, we used a measure tape. Tree height was measured using a clinometer and the following formula:

$$H = (\mathrm{Tan}(a) \times D) + h$$

H is the height of the tree, tan(a) is the tangent of the angle (a) between the observer's eye and the top of the tree, D is the distance between the observer and the tree, and h is the height of the observer's eye level.

In this study, dieback refers to a plant where at least one branch is dead, while mortality is considered when the entire plant is dead. Decline is considered as the combination of mortality and dieback rates. Additionally, both mortality and dieback rates are calculated as the proportion of affected plants within each plot.

To identify the specific periods of the year when decline occurs, four sites were selected. Collectively, these sites contained 855 Holm oak trees. Dieback and mortality were assessed throughout the year, including winter, spring, summer, and autumn.

In addition, elevation, slope and aspect values were determined for each plot.

Climate data

The climate data is downloaded from Nasa Data Access Viewer (https://power.larc.nasa.gov/data-access-viewer/). This data included precipitation (P), minimum temperature (Tmin), maximum temperature (Tmax). These climatic factors were then used to calculate the Standardized Precipitation Evapotranspiration Index (SPEI) and Potential Evapotranspiration (PET). The bioclimate are determined based on Emberger method created to classify Mediterranean climate:

$$Q2 = 2000P/M^2\text{-}m^2$$

Where P represents the average of annual precipitation, M represents the temperature of the hottest month of the year, and m represents the temperature of the coldest month.

To determine the temperature at each plot, punctual data was downloaded from Nasa Data Access Viewer. 31 stations are used, subsequently, Kriging interpolation was employed to generate maps of climate parameters.

PET and SPEI

The evapotranspiration is the loss of water by evaporation of the soil surface and transpiration from plants in a given area during particular period (Novák 2011). The PET is also called reference evapotranspiration (Allen & al. 1998). PET is crucial for computing crop and vegetation evapotranspiration, and for characterizing the local climate (Paredes & Pereira 2019) :

$$\mathrm{PET\ (mm/day)} = 0.0135\ (\mathrm{Tmean} + 17.78)\ \mathrm{Rs}$$

where: Tmean = average temperature (°C), Rs = incident solar radiation (mm/day), Rs = R0KT (tmax − tmin)0.5, R0 = extraterrestrial solar radiation (MJules/m2/day), KT = empirical coefficient (0.162 for interior and 0.19 for coastal areas), tmax = maximum temperature (°C), and tmin = minimum temperature (°C).

SPEI presents the overall climatic water balance as the difference between precipitation and potential evapotranspiration at different time scales (Zhang & al. 2018). Positive values of SPEI indicate conditions that are wetter than average, whilst negative values indicate conditions that are drier than average. The calculation of this index uses the accumulated differences between precipitation and potential evapotranspiration (Montes-Vega & al. 2023):

$$SPEI = (P\text{-}PET)/\sigma;$$

P is precipitation, PET is potential Evapotranspiration and σ = standard deviation of P-PET. R software is used to compute SPEI and PET.

Remote sensing

Several remotely sensed vegetation indices are used in vegetation monitoring and assessment. Indeed, NDVI (Normalized Difference Vegetation Index) is now the most popular index used for vegetation assessment (Huang al. 2021). It is related with the vegetation cover decline, and employed as an indicator to reflect the response of the vegetation dynamics (Zheng & al. 2018). NDVI is an indicator of vegetation health, as the decrease in greenness is reflected by NDVI decrease (Meneses-Tovar 2011). Hence NDVI is implemented to detect the amount of change in vegetation and the most affected zones by mortality and dieback in the study area. Google Earth Engine is implemented to compute NDVI maps.

Statistical analysis

The statistical analysis to investigate the impact of different environmental factors on Holm oak decline was conducted in R software (https://posit.co/download/rstudio-desktop/). Principal Component Analysis (PCA) was used to study the influence of quantitative variables such as precipitations, temperatures (Tmin and Tmax), elevations, cover, slopes, density (number of trees per plot or number of individuals per m2), and NDVI. Multiple correspondence analysis (MCA) was employed to test the relationship between qualitative variables (soil types, aspect) and the levels of dieback and mortality. Dieback and mortality were categorized into three levels: Low (values below the first quartile, Q1), Moderate (values between the first and third quartiles, Q2 and Q3), and High (values above the third quartile, Q3).

Results

The Central High Atlas of Morocco presents a biodiverse, generally Mediterranean vegetation cover. This region is formed by depressions with low altitudes, where the substrates are clay and sandstone, and the climate is semi-arid with fresh or locally temperate variants. The main vegetation cover at this level includes *Tetraclinis articulata* (Vahl) Mast., associated with *Juniperus phoenicea* L., *Ceratonia siliqua* L., *Pistacia lentiscus* L., and *Olea europea* var. *sylvestris* (L.) (Mill.) Lehr. As the elevation rises, *Juniperus phoenicea* dominates, along with *Pistacia lentiscus*. Holm oak in the High Atlas forms distinct tree communities at different altitudes. Its lower limit (linked to upper limit of *Juniperus phoenicea*) is characterized by mixed Holm oak forests with a diverse Mediterranean tree community, including *Juniperus phoenicea, Pistacia lentiscus*, and *Phyllirea angustifolia*.

The second level consists of pure Holm oak shrubs, while higher and medium altitudes feature well-developed pure Holm oak forests, the bioclimate is subhumid at this level, with *Juniperus thurifera* often found at the upper limit as the climate shifted to semi-arid with its cold variant. As revealed by Figure 3 (according to axis AB in figure 2), the Holm oak occurrence coincides with limestone (and locally dolomite or dolomite associated with limestone) substrates. Generally, Holm oak occupies particularly mesomediterranean (Meso), supramediterranean (Supra), and locally mountain Mediterranean (M Med) zones. Additionally, some dispersed thermophilic individuals can be found in the thermomediterranean (Thermo) zone, while the oromediterranean (Oro) lacks generally the woody plants and hosts the xerophytes. Two bioclimates are located in the study area: semi-arid and subhumid. The semi-arid bioclimate has two variants: semi-arid hot at low altitudes and cold semi-arid at high altitudes.

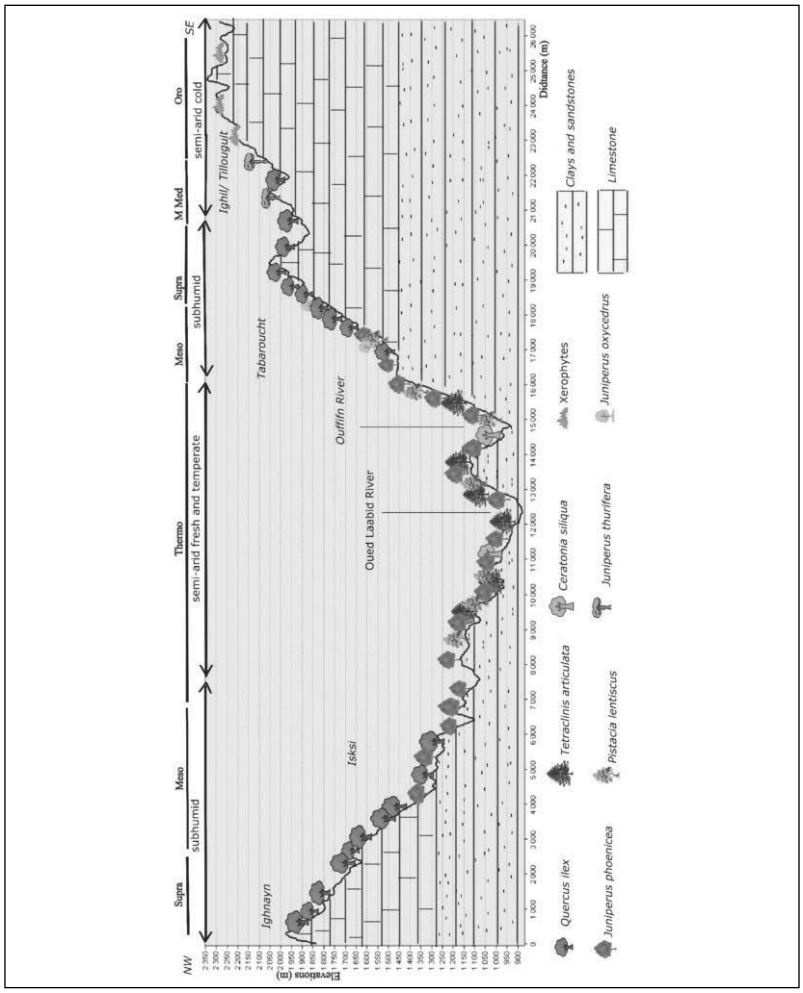


Fig. 3. Ecological overview of the study area. The decline rate varies significantly among different holm oak forest structures. Mixed shrubs, where Holm oak is the most vulnerable, experience the highest decline, with significant dieback and mortality. The decline rate within these structures reaches 40.31%. In contrast, pure Holm oak shrubs have a decline rate of 25.88%, and large trees in Holm oak forests exhibit a decline rate of 19.92% (Fig. 4).

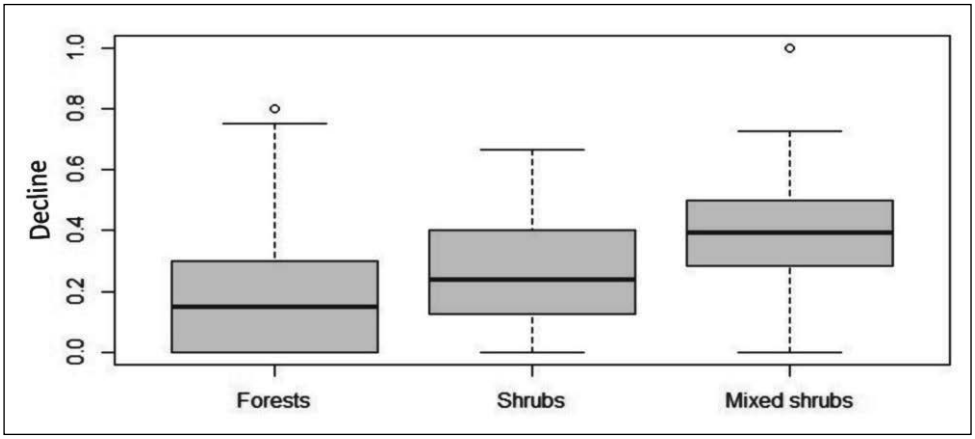


Fig. 4. The decline of Holm oak varies according to forest type.

Based on tree size, healthy plants are taller and larger than declining trees. Healthy oak trees have a larger diameter at breast height (mean = 30 cm) than declining oak trees (mean = 28 cm). Additionally, healthy plants have a mean height of 8.2 meters, while declining plants have a mean height of (Fig. 5).

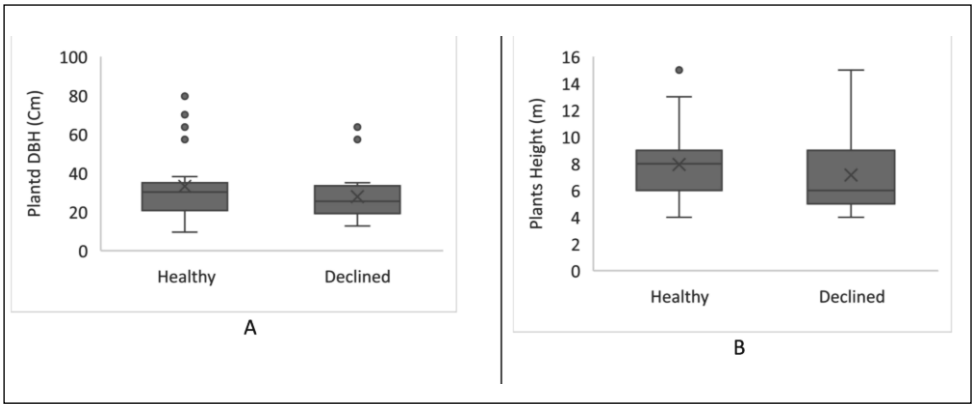


Fig. 5. Plant decline according to plant size: A) DBH and B) Height.

Figures 6a, 6b, and 6c depict the spatial variations of climate variables (Precipitation, Tmax, and Tmin) within the study area. Figure 6 d illustrates the bioclimatic classification of the regions, categorizing them as semi-arid and subhumid.

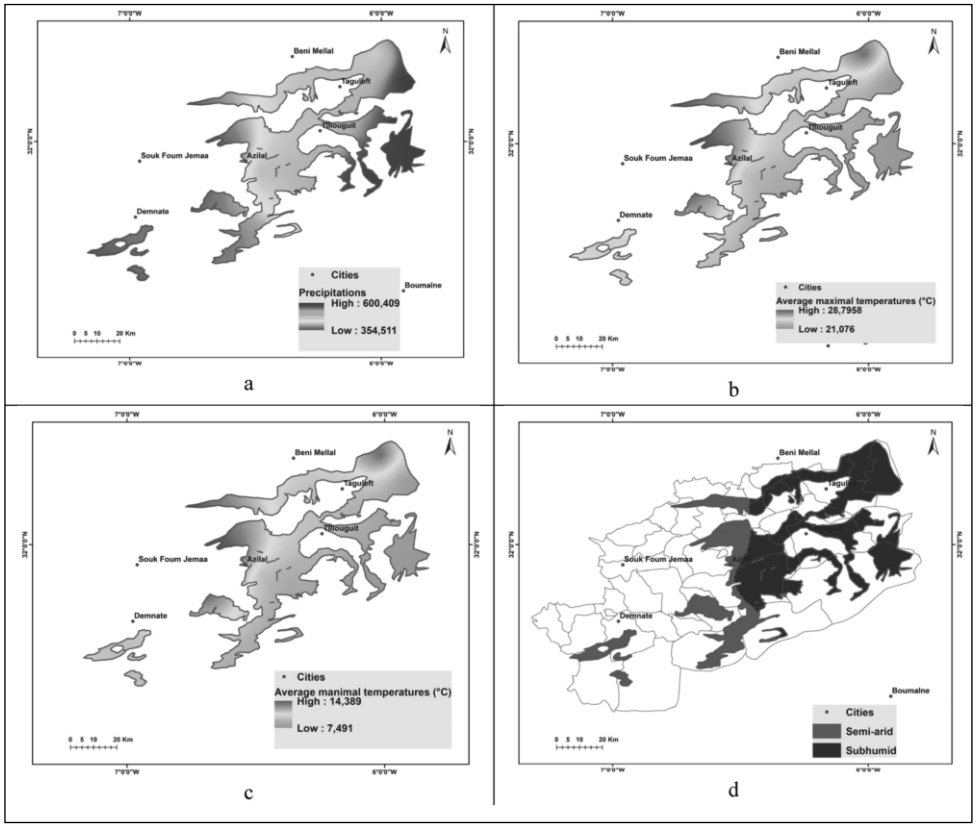


Fig. 6. Climatic parameters for 2024: a) precipitations, b) average of maximum temperatures, c) average of minimum temperatures and d) the Holm oak forests bioclimates.

The figure 7 represents the climate factors evolution between 1982 and 2024, and demonstrates a continuous increase in temperatures and decrease in precipitation accompanied with irregularities.

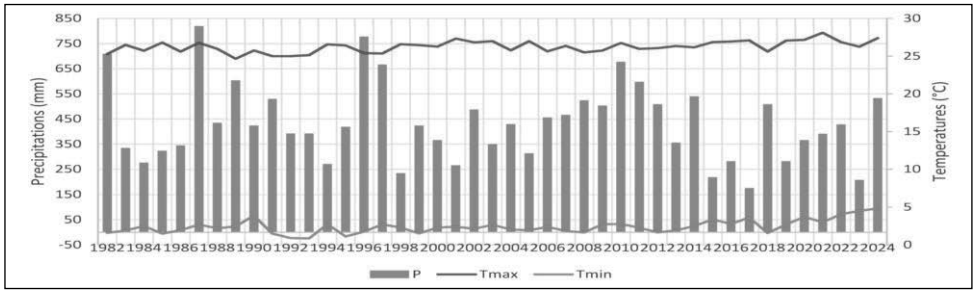


Fig. 7. The temperatures and precipitations variation between 1982 and 2024.

The PET trend over the last 42 years shows a significant increase in recent years (p-value = 0.004) (Fig. 8).
According to the SPEI, the region experienced five drought periods (Table 1)

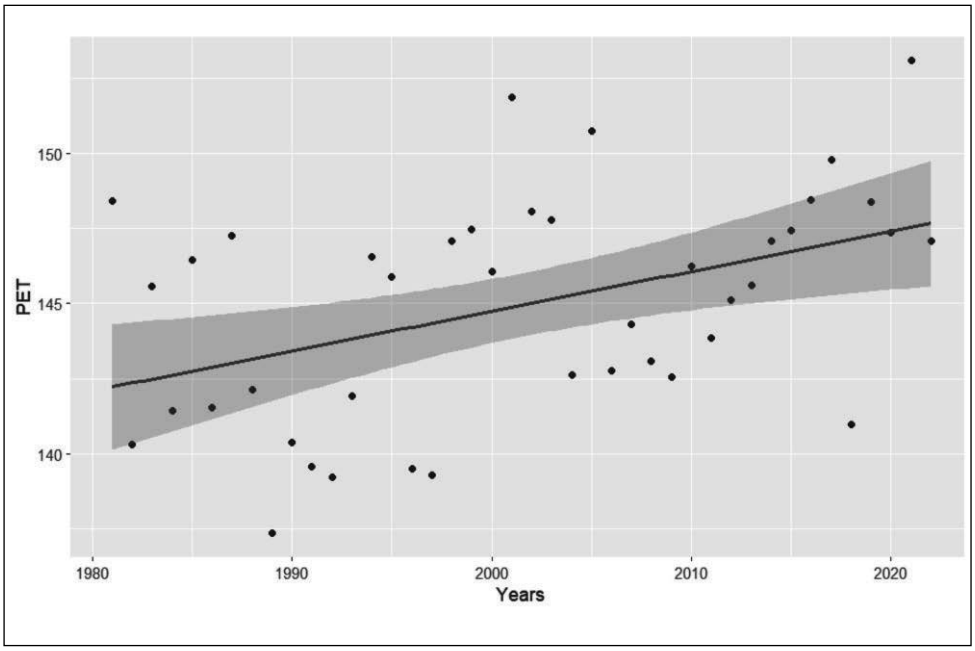


Fig. 8. The PET trend in the study area from 1980 to 2023.

Table 1.The drought episodes in the study area according to SPEI.

Drought Period	SPEI max value	Interpretation (drought severity)
1984-1988	< -1.4	Moderately dry
1994-1996	< -1.3	Moderately dry
2000-2004	< -1.4	Moderately dry
2006-2007	< -1.2	Moderately dry
2014-2022	>-2	Extremely dry

Over the past 42 years, the region has experienced recurrent drought periods. However, the severity of the drought in recent years is unprecedented, indicating extremely dry conditions (Fig. 9).

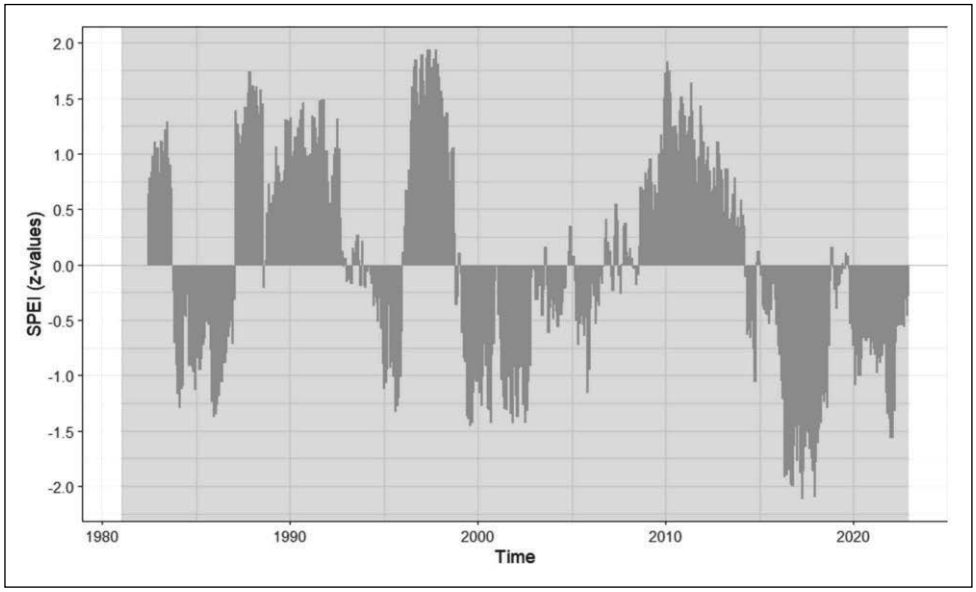


Fig. 9. The SPEI (Drought Index) variation in the study area between 1982 and 2023.

Dim 1 and Dim 2 explain 41.32% and 15.4% of the variance, respectively. Mortality and decline are closely clustered in the same quadrants, indicating that mortality is prevalent in areas with significant dieback. Strong drivers of forest dieback and mortality include minimal and maximal temperatures (Tmax and Tmin), which are positively correlated with forest decline. Furthermore, precipitation exhibits a negative correlation with dieback and mortality, with both increasing as precipitation decreases. Slope, cover, density, and elevation have a lesser influence on mortality and decline. NDVI and plant decline (mortality and dieback) are located on opposite sides, confirming that higher vegetation health (indicated by high NDVI values) corresponds to lower levels of decline (Fig. 10).

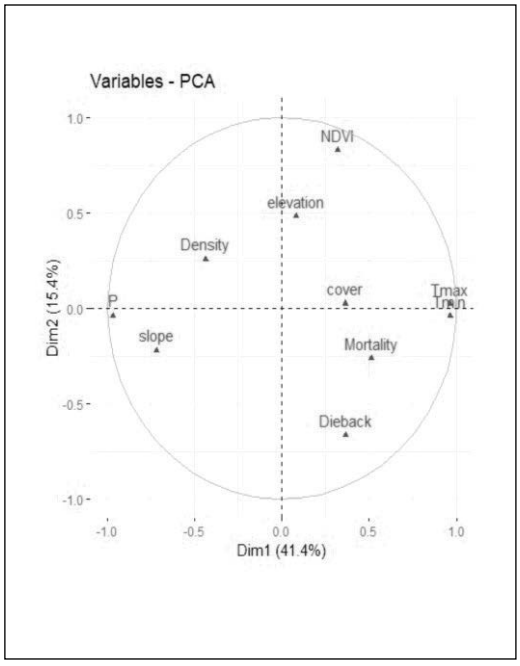


Fig. 10. Principal Component Analysis plot of variables affecting Holm oak decline.

The mortality and dieback of Holm oak occur primarily during the summer and autumn months, when temperatures reach extreme levels and heatwaves are frequent (Figs. 11 a & b).

The mortality of plants is rarely sudden. Most dead plants show signs of dieback and decline over time. In fact, 81.08 % of the newly reported dead trees had a history of dieback during previous years, while the remaining dead trees declined completely at once (Fig. 11 c).

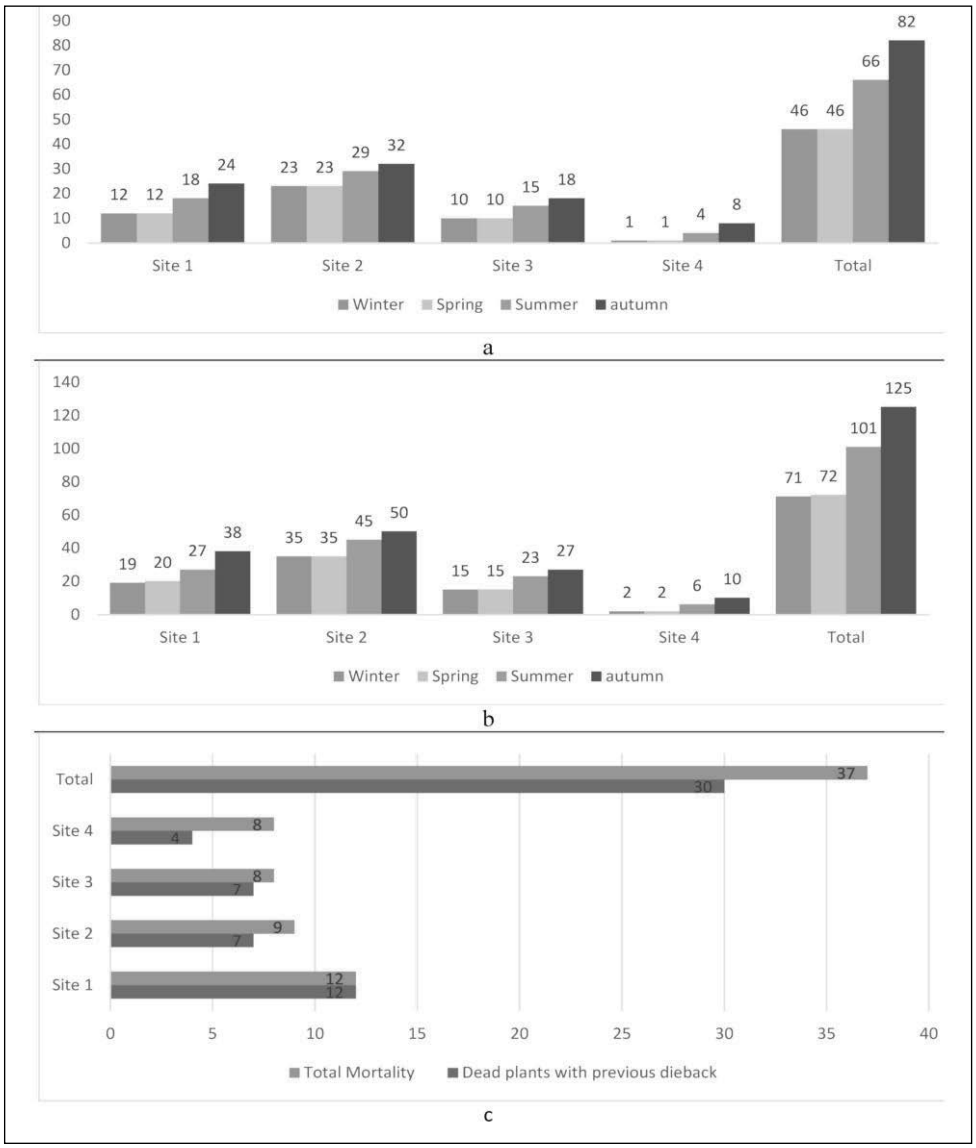


Fig. 11. The holm oak decline in the study area, a) The mortality fluctuation during 2024. b) The dieback fluctuation during 2024, c) Plant mortality and its relation to dieback in 2024.

Regarding the MCA test (Fig. 12), mortality is relatively related to aspect. Indeed, terrain observations revealed that mortality is high in sunny aspects (south). However, soil types have less effect on decline. The main soil types in the area are limestones: earthy limestone, rocky limestone, organic limestone soils, and basaltic areas.

The northern parts of the holm oak forests are highly degraded (Fig. 13). The NDVI change confirms the 3769 Ha of holm oak forests are degraded during three years (2022, 2023 and 2024). Table 2 depicts the vegetation cover changes in different climate variants. In addition, the holm oak decline affects all the climate variants as reflected in Table 2.

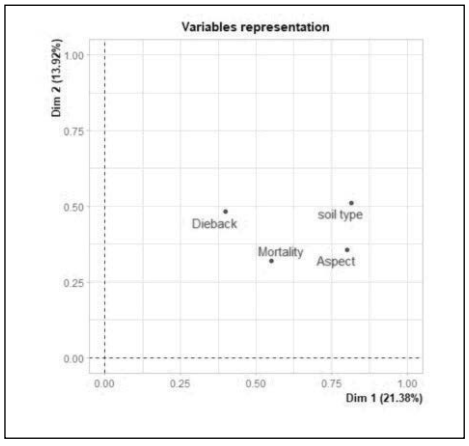


Fig. 12. MCA (Multiple Correspondence Analysis) plot.

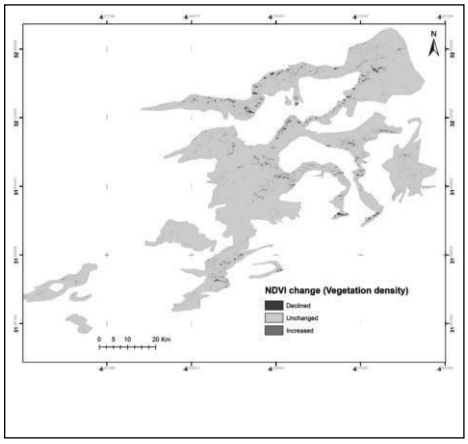


Fig. 13. Map of the vegetation cover change between 2022 and 2024.

Table 2. Change in vegetation cover in Semi-arid and Subhimid bioclimatic zone during 2022-2024.

Period	Bioclimate	Rate	Decline (ha)	Unchanged (ha)	Uncreased (ha)
2022-2024	Semi-arid	30,79 %	745	89931	96
	Subhumid	69.21 %	2885	201358	140
	Total	100	3630	300399	236

Discussion

The Holm oak occupies subhumid and semi-arid bioclimates in the Central High Atlas. Generally, these forests occupy limestone substrates between 1200 and 2200 m. The Central High Atlas exhibits a diverse range of vegetation levels with distinct plant communities, the mesomediterranean zone is the main level of finest Holm oak groves, while supramediterranean, also featuring significant Holm oak stands, and mountain Mediterranean presents Holm oak mixed with *Juniperus thurifera*. Some dispersed thermophile Holm oaks are also located at the upper limits of the thermomediterranean. Similar findings are reported by Benabid (1982) and Gharnit & al. (2024), indicating that Holm oak forms large groves at the mesomediterranean level in the High Atlas between 1100 and 1500 m, and at the supramediterranean level between 1500 and 2000 m (Benabid 1982; Gharnit & al. 2024).

The study revealed that *Quercus ilex* mortality and dieback is a major forest decline driver in High Atlas of Morocco. This fact has been corroborated by numerous studies conducted in Mediterranean countries and climate (Alderotti & Verdiani 2023). Furthermore, the decline due to dieback and mortality is unprecedented and threaten the future of this fortune, as this phenomenon is appeared in High Atlas during last few years. the decline rate inside these structures achieves 40.31% in mixed shrubs. As for the pure holm oak shrubs, the decline rate is 25.88 %, while the large trees holm oak forests have a decline rate of 19.92%. Generally, the forests are widely degraded in the High Atlas due to human activities combined with climate change (Youssef & al. 2024).

There is a fundamental relationship among biodiversity, production, resilience and stability in forests (Thompson & al. 2009). In our study area, the decline within the shrubs is highly important comparing to forests. While, diversity at different levels (genetic, specific and ecosystemic) facilitates forest ecosystems adaptation to dramatic climate changes (DeHayes & al. 2000). However, the biodiverse shrubs present considerable decline and mortality compared with pure holm oak shrubs. This effect is explained by a potential strong competition between species where the cover is biodiverse, as the accumulated competition-caused stem volume loss, combined with age effect and site condition (Pretzsch & al. 2023). In addition, mortality may increase because trees under competition stress are more vulnerable to climate change as their growth is already compromised (Magalhães & al. 2021). The holm oak shrubs in High Atlas are mixed with a biodiverse cover at low altitudes, consisting of *Juniperus phoenicia, Pistacia atlantica, Phillyrea* sp. These regions, characterized by low elevations and mixed shrubland, are semi-arid. In contrast, Holm oak, whose moisture requirement is higher than other Mediterranean evergreen oaks (Yilmaz & al. 2024), is generally well-adapted to subhumid and humid Mediterranean climates (Gharnit & al. 2024). This difference in a response to climate may favor and support the other mentioned species (Figure 1) over Holm oak in these areas, yet this constatation needs further investigation.

Potential Evapotranspiration (PET), a measure of plant water loss, has increased significantly in recent years. Furthermore, the High Atlas region, and Morocco territory, has experienced a series of drought episodes (notably: 1984-1988, 1994-1996, 2000-2004, 2006-2007, and 2014-2022). While the earlier drought periods were moderate in severity and often followed by significant precipitation events that could potentially regulate the

water balance and allow plant recovery, the recent drought episodes, as indicated by SPEI values, has been the longest and most severe. This unprecedented drought has resulted in widespread decline and mortality, highlighting the crucial role of accumulated scarce precipitation, as revealed by negative strong correlation between precipitations and decline (Figure 13). Additionally, a strong correlation has been established between Holm oak decline and temperature. The decline primarily occurs during the summer and autumn (hot seasons) when temperatures and heatwaves are prevalent. Several studies have shown similar findings in the Mediterranean region, particularly the western and central Mediterranean basin, which is facing increasing decline and dieback episodes due to the severity and frequency of heatwaves and drought events (Liyaqat & al. 2024). In the southwestern Iberian Peninsula, Mediterranean holm oak open woodlands currently undergo large-scale population-level tree die-off due to temperature and aridity increase during recent decades (Natalini & al. 2016). Indeed, warmer climate with longer droughts had a key-role determining the mortality process (Natalini & al. 2016), and strong evidence indicate that drought events (regardless of the accumulation period) increased the risk of all-cause mortality and for specific causes (Salvador al. 2024). Holm oak dieback episodes are generally associated with extreme events such as wildfires, heat waves and droughts (Alderotti & Verdiani 2023). The Mediterranean species are adapted to summer droughts but may not be able to cope with future increases in drought intensity, duration, and/or frequency (Barbeta & Peñuelas 2016). In addition, an increase in winter drought spells might have contributed significantly to the decline of this species (Alderotti & Verdiani 2023). By definition, a Mediterranean climate is characterized by rainy and cold winters, while the summers are dry and hot (Daget 1977; Gharnit & al. 2023; Youssef & al. 2024). However, winters have also become drier.

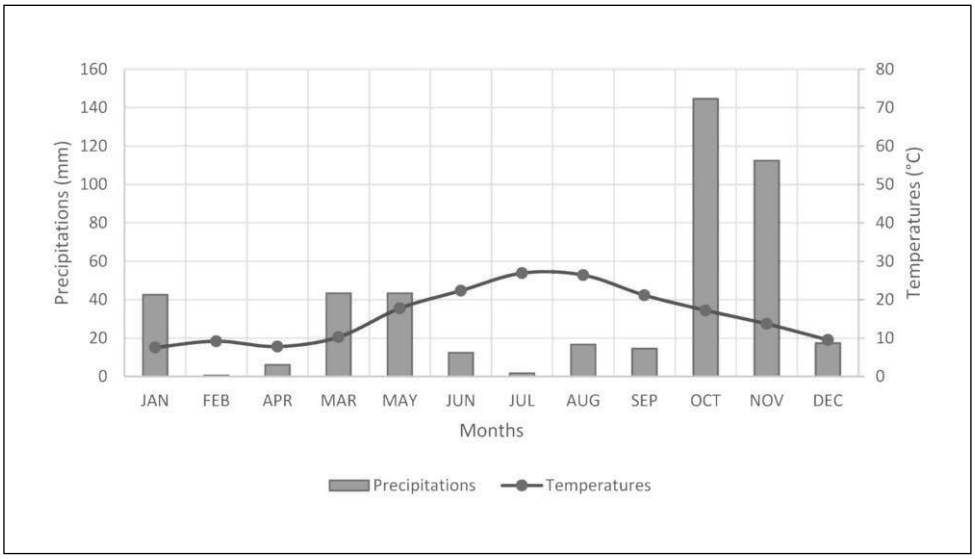


Fig. 14. Climatic diagram of the area during 2024.

Why some individuals in the same location and under similar conditions exhibit varying levels of sensitivity to climate change? Climate extremes can cause differential survivorship among species due to their different sensitivity (Niu & al. 2014), this is due; intuitively, to individual variations. Furthermore, the plant mortality is not sudden; indeed, the plants death generally is a progressive process, as the majority of new reported dead plant has a dieback history (Figure 11 c). This funding are in consistent with Gea-Izquierdo et al., indicating that the plants dieback and decline is not sudden and marks a drought legacies (Gea-Izquierdo & al. 2021). A relative difference in DBH and height were observed between healthy and declined plants. Notably, larger trees (with higher DBH and height) exhibited greater resistance to mortality. Larger plants, as products of efficient water management, biomass production, and other vital biological and physiological processes, are better equipped to mitigate stress effects. A review study assessed more than 125 studies, proved that taller trees present a range of structural and functional adjustments, including more efficient water use and transport and greater water uptake and storage capacity, that mitigate the path-length-associated drop in water potential (Fernández-de-Uña & al. 2023). Other factors that may favor large plants are, strong root systems, as the roots are capable of reach important depth. In addition mortality is often skewed towards young trees but recent evidence suggests that large, old trees are also vulnerable (Da Costa & al. 2010; Lindenmayer & Laurance 2017; Choat & al. 2018). In fact, large trees may exhibit large mortality rate, especially when community-wide mortality was high or when bark beetles (parasites) were present (Bennett & al. 2015). In addition, the root distribution and rooting depth are the main belowground plant functional traits used to indicate drought resistance in arid and semiarid regions (Lihui & al. 2021). Obviously the rises in temperatures and precipitation reductions lead to reduced soil moisture as well as VPD, knowing that VPD is a combined function of air temperature and relative humidity (Medina & al. 2019), and the transpiration rate of the plant is driven by changes in VPD (Kholová & al. 2012; Belko & al. 2013). Stomatal conductance declines under high VPD and transpiration increases in most species , leading to photosynthesis and growth reduction, and higher risks of carbon starvation and hydraulic failure (Grossiord & al. 2020). In addition, the stomatal closure strongly reduces holm oak carbon uptake (Peguero-Pina & al. 2008), hence, the depletion of plant water and carbon pools are accelerated (McDowell & al. 2022).

The main soil types in the area are limestones: earthy limestone, rocky limestone, organic limestone soils, and basaltic areas. Generally, the holm oak forests show decline under all the soil variants. However, holm oak decline and mortality under climate change can be resulted in soil stoichiometric imbalances triggered by net losses of essential oligonutrients (García-Angulo & al. 2020). In addition, the impact of climate on forest decline may be influenced by topographic features. Previous studies provide substantial evidence that local modifications of the climate by topography and canopy cover can create microclimates at the forest floor, which can partially mitigate regional macroclimate variability (Rita & al. 2021). Besides climate change and disturbance that influence tree growth, topography is a factor determining the vulnerability of forest declines (Allen & Breshears 1998; Wang & al. 2021). However, our study reveals a slight effect of elevation on dieback and mortality. Additionally, plant responses to climate effects vary based on aspect. Southern slopes exhibit higher levels of forest decline, likely due to increased solar radiation exposure, as showed by the relatedness of mortality and aspect in Fig. 12. Indeed,

south-facing slopes are characterized by drier and hotter microclimates and, thus, harsher environments for trees (Wang & al. 2021), and the highest rates of evapotranspiration occur on south-facing slopes, followed by ridges, valleys, and north-facing slopes (Dyer 2009).

The carbon and water pools and fluxes are interdependent and underlay plant defenses against biotic agents (McDowell & al. 2022), hence, attacks by insects or pathogens are frequent with drought associated mortality (Anderegg & al. 2015; Kichas & al. 2020). Dead holm oak infected by *Phytophthora cinnamomi* Rands expressed drought legacies (Gea-Izquierdo & al. 2021). *P. cinnamomi* (root rot) is one of the main causes of oak mortality in Mediterranean open woodlands (Ruiz-Gómez & Miguel-Rojas 2021; Tkaczyk & Sikora 2024). However, other factors, such as age, prior parasite infestations, and individual tree health, may significantly influence the variability in mortality rates observed in response to climate change. These factors were beyond the scope of the present study but warrant further investigation. A deeper understanding of these additional variables is crucial for a more comprehensive understanding of Atlas Holm oak decline.

The High Atlas Holm oaks forests are subject to various stressors, including overgrazing; Gharnit & al. (2025) assessed the Geoparc M'goun rangelands (located in the Central High Atlas) and reported that 27.73% of the assessed species are threatened according to IUCN (International Union for Conservation of Nature) criteria, while a significant portion (74.45%) lack adequate evaluation. Endemism is high, with 21% of species endemic to Morocco, and nearly half of these (49.5%) restricted solely to the country. Additionally, 17.43% of species are considered rare(Gharnit & al. 2025). In recent years, the exploitation of these plants for wood and charcoal production has intensified, further exacerbating the pressure on these ecosystems (Moujane & al. 2023).

Mortality and decline rates can reach 40% in some areas. To mitigate economic losses and prevent further degradation, it is recommended to harvest dead trees for wood production. Additionally, removing dead trees can protect healthy trees and limit potential pest outbreaks, as the vulnerable trees are predisposed to parasites attacks. Mortality and dieback rates are particularly pronounced in shrublands. These findings underscore the importance of targeted forest restoration initiatives in the High Atlas, prioritizing areas where Holm oak is favored. Implementing such strategies can help preserve these valuable ecosystems and mitigate the impacts of climate change and other mentioned stressors.

Climate change is profoundly affecting the dynamics of vegetation cover, not only in terms of density and quality, as confirmed by de decline in NDVI change during last three years, but also in terms of the nature and floristic composition of these forests. For instance, as mixed forests become increasingly degraded, they are transitioning from Holm oak-dominated forests towards *Juniperus phoenicea* forests or other species that coexist with Holm oak. This shift is further influenced by the differential responses of various species to climate fluctuations, as illustrated in Figure 1.

The province of Azilal, where the study area is located, is home to extensive rangelands. The province is a home to approximately 2,770,000 sheep flocks, 378,000 cattle herds, and 967,000 goat herds roam (Gharnit & al. 2025). In addition, the local population relies on the forests for firewood and as a source of forage for their livestock (Moujane & al. 2023; Youssef & al. 2024). As a result, the dieback and mortality of High Atlas forests have significant socio-economic consequences, including potential increases in poverty and out-migration from rural areas.

These High Atlas forests are home to a diverse array of fauna, including 24 wild mammal species and over 100 bird species. Many of these species are listed as critically endangered, endangered, or vulnerable on the IUCN Red List, such as the Barbary sheep, Barbary macaque, Cuvier's gazelle, Eurasian otter, red fox, African wolf, Barbary ground squirrel, wild cat, and common genet (Alami 2022). Therefore, the degradation of these forests will significantly alter their habitat and breeding sites. The combined effects of climate change on forests and shrubs can lead to significant changes in ecosystem structure and function (Kodero & al. 2024).

Conclusion

The High Atlas is a biodiversity hotspot in Morocco, dominated by Mediterranean Holm oak forests. These forests provide invaluable ecosystem services to the local population, including timber, habitat for aromatic and medicinal plants, and grazing land for large herds of livestock. However, in recent years, these forests have come under significant pressure from human activities and climate change, leading to unprecedented levels of dieback and mortality. This degradation has detrimental impacts on the ecological and economic services provided by these forests. As a result, urgent mitigation and conservation measures are imperative. Our findings emphasize the need for more accurate assessments of the processes underlying Holm oak dieback and mortality, particularly understanding the physiological responses that contribute to decline.

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Article

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Nature's Contributions to People (NCP): case of aromatic and medicinal plants in Morocco

Abstract

Jamaleddine, M., Taleb, M. S. & Rhazi, L.: Nature's Contributions to People (NCP): case of aromatic and medicinal plants in Morocco. — Fl. Medit. 35: 109-118. 2025. — ISSN: 1120-4052 printed, 2240-4538 online.

Nature's contributions to people (NCP) refers to all contributions, beneficial or harmful, that people, individually or collectively, derive from nature at various scales. NCP offers a pluralistic framework for understanding how the status and trends of nature - including biodiversity and ecological processes - are linked to changes in people's quality of life, while at the same time acknowledging a plurality of perspectives and world views on human-nature relations. NCP serves as an umbrella embodying different concepts, such as ecosystem goods and services, nature's gifts, and many others, and facilitates respectful collaboration between knowledge systems and world views.
Morocco's aromatic and medicinal plants (AMP) are classified as a type of NCP by IPBES (Intergovernmental Platform on Biodiversity and Ecosystem Services). These high-value products contribute to the country's socio-economic development. In addition to this material contribution, the Moroccan pharmacopoeia is a nonmaterial contribution strongly linked to the use of AMPs. Morocco has a long-standing tradition and considerable expertise in phytotherapy.

Key words: phytotherapy, ecosystem services, phyto-resources, North Africa.

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Introduction

Multiple frameworks have been deployed in efforts to reconceptualize the nature–people relationship and improve sustainability outcomes. For example, the ecosystem service framework which describes the benefits people obtain from ecosystems has been developed to change how communities view and value natural resources (Costanza & al. 2017). But there is scant evidence that the ecosystem services framework has improved biodiversity conservation outcomes (Dempsey 2016). Recently, Diaz and colleagues (2018) proposed a shift from ecosystem services to nature's contributions to people (NCP), incorpo-

rating broader and more inclusive perspectives of nature–people relationships. The NCP framework encompasses "all the positive contributions, losses or detriments, that people obtain from nature" to understand the beneficial and harmful effects of nature (Díaz & al. 2018). The NCP framework emerged from the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), which was established by the United Nations (Díaz & al. 2018). The framework has roots in the social sciences, biocultural diversity, and Indigenous or local perspectives (Díaz & al. 2018).

The use of aromatic and medicinal plants and their derivatives for food and therapeutic purposes is very common worldwide since ancient times. Currently, almost 80% of the world's population, mainly in developing countries, depend on herbal medicines to answer their basic primary health needs for the management of numerous diseases (WHO 2004, 2018). Traditional medicine in Morocco is an integral part of Moroccan culture, a culture that is directly stems from it and serves as its concrete manifestation in areas such as care, hygiene, prevention, nutrition, and, more broadly, the fight against diseases. It is this transhistorical cultural dimension, this continuity, that gives traditional medicine practiced in Morocco extraordinary adaptability and a very practical sense of the tasks of our time (Bellakhdar 2020). Faced with threats of anthropogenic and climatic nature to the survival of plant resources, it was important to acquire as much information as possible about plant species for which Moroccans had traditional know-how and knowledge, to protect floristic diversity and preserve traditional knowledge.

The objective of this work is to study one of the aspects of nature's contribution to people by focusing on the different uses of AMP in Morocco.

Materials and Methods

Consultation of bibliographic data (Jamaleddine 2021) allowed us to establish an exhaustive list of all the aromatic and medicinal plants of Morocco. The uses of these AMPs, their therapeutic properties, and the parts used have been extracted from ethnobotanical studies conducted at the national level (Jamaleddine 2021) and from the book of Bellakhdar (2020) on the traditional Moroccan pharmacopeia. The various indications collected are classified according to the type of use (medicinal, food, or technical).

Data concerning aromatic and medicinal plants used in traditional phytotherapy in Morocco were organized using computer-aided systems engineering (CASE) Windev version 17 to create a database called "MaPlanteMedicinal" using the HyperFilSQL database search engine. Windev, published by the French company PC SOFT, is a software engineering workshop designed to rapidly develop data-oriented applications. As an advanced RAD tool, Windev uses MERISE or UML analysis to build operational applications and can generate code for Java, standard, or .NET platforms. It supports both the procedural and object-oriented programming paradigms (https://etcsoft.fr/blog/definition-logiciel-sur-mesure/).

This database has the advantage of being dynamic and up-to-date as knowledge of plant uses evolves. The use of this database allowed us to study the different characteristics of AMP in Morocco (uses of AMP, therapeutic properties, parts used), calculate the percentages, and analyze the results after their graphical representations. Regarding the taxonomy

and nomenclature of the inventoried AMPs, the two catalogues of the vascular flora of Morocco (Fennane & Ibn Tattou 2005, 2008) as well as the three volumes of the practical flora of Morocco (Fennane & al. 1999, 2007, 2014) are the main references.

Results and discussion

The total number of inventoried taxa used in traditional Moroccan phytotherapy is 750, belonging to 102 families and 375 genera. The most represented families are *Lamiaceae* with 82 taxa (10.93%), *Asteraceae* with 80 taxa (10.66%), *Fabaceae* (6.26%), *Apiaceae* (5.06%), *Brassicaceae* and *Poaceae* (3, 73%).

1. Uses of aromatic and medicinal plants

1.1. Medicinal uses

There are 2748 indications for medicinal use listed, 93.9% of which are for human medicine, 5.1% for cosmetology and hair care, and 1% for veterinary medicine. (Fig.1a). The list of AMPs used in cosmetology - hair care and veterinary medicine is presented in the Electronic Supplementary File (ESF, Table S1).

Analysis of the therapeutic indications used in cosmetology and hair care shows that cosmetic hair care predominates with more than half of the indications (54%), while cosmetic facial care accounts for about a quarter (22%). Cosmetic skin care comes third with 11% of the therapeutic indications (Fig. 1b).

Concerning indications intended for veterinary medicine, one-third of these indications (30%) mention use in the case of scabies for pasture and farmed animals, and 16.6% are used against colic (mainly in dromedaries). In third place are skin diseases (13.3%), and in fourth place with 6.6% are treatments for diseases of the pulmonary system (dromedaries, horses, and mules) and the application of emollient cataplasms (cows) (Fig. 1c).

The therapeutic indications used in human medicine by the local Moroccan populations, come first with more than 25% of the indications for use against diseases of the digestive system and its annexes (Fig. 1d).

The percentage of indications treating dermatological infections is 15%, while neurological infections are 11.4%. Other pathologies treated have less than 10%; bronchopulmonary, urinary, and osteoarticular pathologies each (6%), pathologies of the ENT sphere and gyneco-obsteric each (5.6%), metabolic pathologies (4.5%), pathologies of the buccodental sphere and cardiovascular and blood 3.8% and 3.6% successively (Fig. 1d).

1.2. Food use

On the whole 324 aromatic and medicinal plants inventoried have food uses in addition to their medicinal use. They represent 43% of all AMPs inventoried. 67% of these plants are used in human food, 12.6% in animal feed, while the rest (20.4%) are used in both human and animal food (Fig. 1f)

In terms of animal feed, these plants in their fresh or dry state provide either pasture for animals (sheep, cattle, goats, horses, camels, wild boars, gazelles, etc.) or fodder for live-

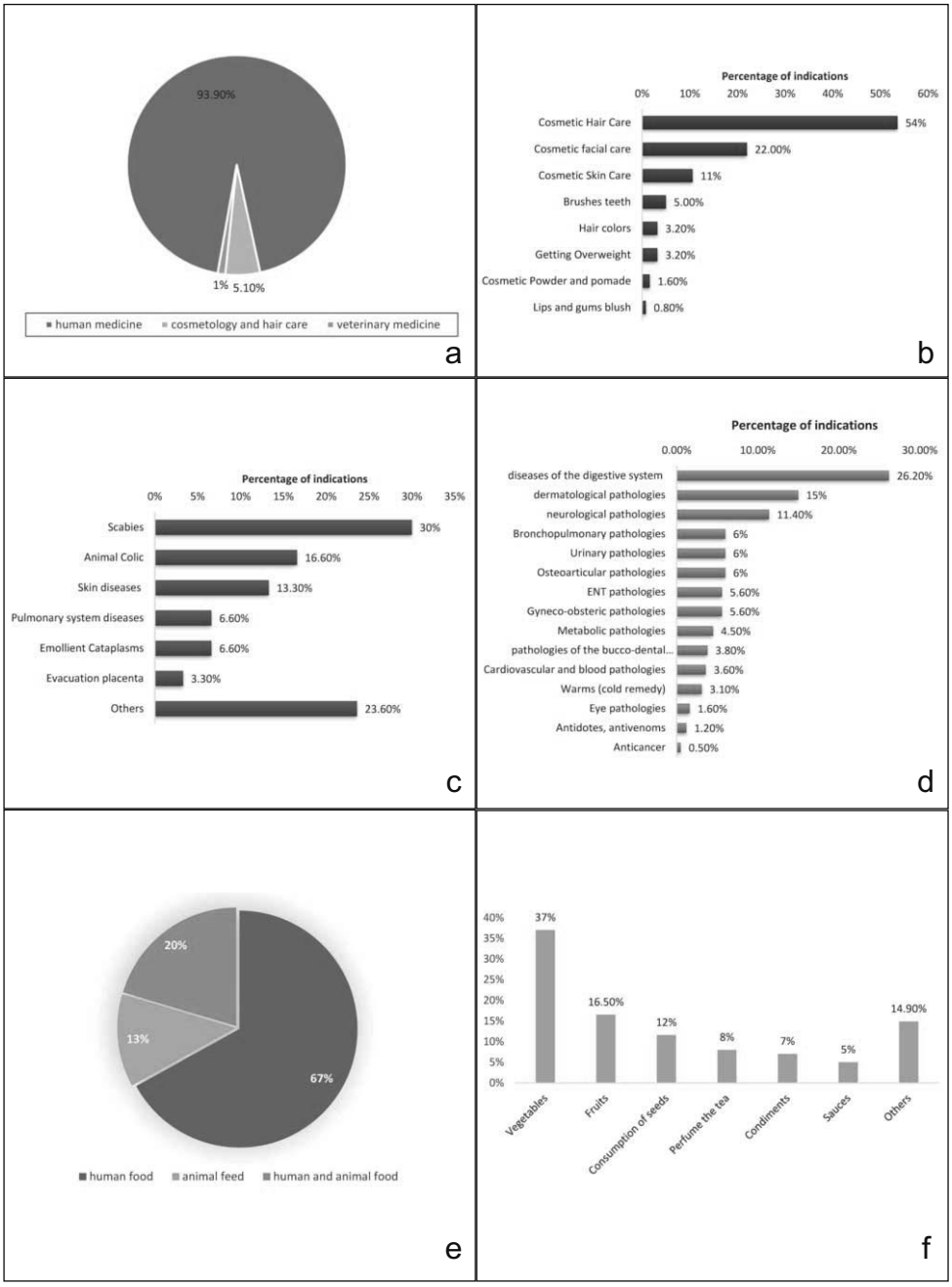


Fig. 1. a) Types of uses of Aromatic and Medicinal Plants (AMPs); b) Distribution of therapeutic indications used in cosmetology and hair care; c) Distribution of therapeutic indications used in veterinary medicine; d) Distribution of indications used in human medicine; e) Food use of Aromatic and Medicinal Plants; f) Types of uses of Aromatic and Medicinal Plants (AMPs) in human food.

stock (horses, cattle, mules, etc.). Common millet (*Panicum milaceum* L.) seeds are used for bird and poultry feed.

On the other hand, an analysis of the various types of use of these aromatic and medicinal plants in human food showed that more than half of these plants are consumed as vegetables 37% (leaves, stems, rhizomes, young plants, etc.), as fruit (16.5%). The consumption of seeds in various forms (basic food cereals, flavoring bread, flour, etc.) accounts for a significant proportion (12%). They can be used to perfume tea (8%), as a condiment (7%), to make sauces (5%), and more other uses (Fig. 1f).

1.3. Other uses (technical uses)

Other uses of AMPs mentioned in the bibliography (Jamaleddine 2021) are grouped under technical uses. The main areas concerned by these indications are saponiferous plants, handicrafts, tanneries, manufacture of household and other objects, charcoal, fuels, natural pesticides, etc. (Table 1).

Table 1. List of technical uses of Aromatic and Medicinal Plants (AMPs) in Morocco.

Indication area	Examples
Saponiferous plants	-
Handicrafts	Baskets, mats, basketry, marquetry, cabinetmaking
Tanneries	Skins, waterskins, leathers, fishing nets
Domestic objects and others	Wooden poles, net floats, handles
Charcoal	-
Fuels	-
Natural pesticides	Insecticide (mosquito, mites…), raticide, against worms
Dyeing	Wool, leather, fabrics, skins, waterskins, hands and feet
Woodworking	-
Perfumery	Deodorant, eau de toilette, perfume linen
String Manufacturing	-
Poison	-
Inks	Delebile or indelible
Traditional glue	-
Cellulose industry	-
Gunpowder	-
Mattress making	Mattress padding
Toothpicks	-
Cochineal farming	-
Polish utensils	-

Table 2. The principal therapeutic properties in order of decreasing frequency.

Therapeutic properties	Linked pathology
Diuretic	Urinary
Antidiabetic	Digestive
Antiseptic	Dermatological
Stomachic	Digestive
Laxative	Digestive
Anti-inflammatory	Several pathologies
Antidiarrheal	Digestive
Tonic	Neurological
Aphrodisiac	Neurological
Stimulating	Neurological
Astringent	Dermatological
Healing	Dermatological
Purgative	Digestive
Sedative	Neurological
Emmenagogue	Gyneco-obstetric
Vermifuge	Digestive
Depurative	Several pathologies
Abortive	Gyneco-obstetric
Expectorant	Broncho-pulmonary

2. Therapeutic properties

Many AMPs (130) have one or more uses in traditional Moroccan medicine but lack therapeutic properties. This means that additional work must be done within research laboratories to fill this gap, especially since seven species of them are endemic to Morocco: *Nepeta atlantica* Ball; *Calendula maroccana* (Ball) B. D. Jacks.; *Lavandula maroccana* Murb.; *Abies maroccana* Trab.; *Centaurium pulchellum* subsp. *grandiflorum* (Batt.) Maire; *Clinopodium atlanticum* (Ball) N. Galland; *Micromeria peltieri* (Maire) R. Morales.

On the other hand, although more than 50 plants are included in the list of AMPs used in traditional Moroccan medicine, they have no medicinal use in ethnobotanical studies carried out at the national level to date. Using our database to analyze the various characteristics of these AMPs, we found that 25% of them fall into the endangered categories according to Fennane (2021): seven endangered species EN (*Nymphaea alba* L.; *Ligustrum vulgare* L.; *Phlomis purpurea* L.; *Astragalus monspessulanus* L.; *Persicaria bistorta* (L.) Samp.; *Nepeta hispanica* Boiss. & Reut.; *Carum jahandiezii* Litard. & Maire) and five others vulnerable VU (*Digitalis purpurea* L.; *D. obscura* L. *Quercus lusitanica* Lam.; *Argyrocytisus battandieri* (Maire) Raynaud; *Salix elaeagnos* Scop.). Local populations have used them less over time, which may be why there is less data on their medicinal use. For the rest, ethnobotanical field studies are likely to fill in the remaining gaps (Fig. 2a).

The analysis of the distribution of human medicine's therapeutic indications (Fig. 1d) shows that the latter is strongly correlated with the frequency of therapeutic properties (Table 2).

3. Used parts of aromatic and medicinal plants

All parts of aromatic and medicinal plants are used in traditional Moroccan medicine. A total of 37 parts have been listed in medicinal uses (ESF1, Table S2). This number reflects the richness of traditional Moroccan herbal medicine.

Analysis of these results shows that the whole plant and the leaf are the most cited plant parts with 21.6 % and 20.6 % respectively. Seed and root ranked third and fourth with 10.5% and 10.4% respectively, followed by fruit (8.7%), flower (7.2%), stem (5%), bark (3.2%), and latex (2%). All remaining used parts are represented by a cumulative rate of 10.8% (Fig. 2b).

The high percentage of use of the whole plant indicates, in most cases, the uprooting of the entire plant. This anarchic method of gathering seriously compromises the sustainability of aromatic and medicinal species and causes the degradation of ecosystems and natural resources (Alaoui & al., 2018). Similarly, the high frequency of use of leaves may be explained by the ease and speed of harvesting (Bitsindou 1986), but also by the fact that they are the site of photosynthesis and sometimes storage of secondary metabolites responsible for the plant's biological properties (Bigendako-Polygenis & Lejoly 1990). The use of leaves is safe for plant regeneration and will ensure the conservation of plant richness. There is a clear relationship between the used part of the plant exploited and the effects of that exploitation on its existence and long-term sustainability (Cunningham 1996). The exploitation of certain plant parts, such as the example of pyrethrum (*Anacyclus pyrethrum* (L.) Lag.) could harm the survival and sustainability of the species.

A collaborative, integrated approach is key to preserving Morocco's plant biodiversity (Labrighli & al. 2025).

4. Nature's Contributions to People (NCP)

The IPBES identifies 18 types of NCP and classifies them according to the nature of their contribution to the quality of life.

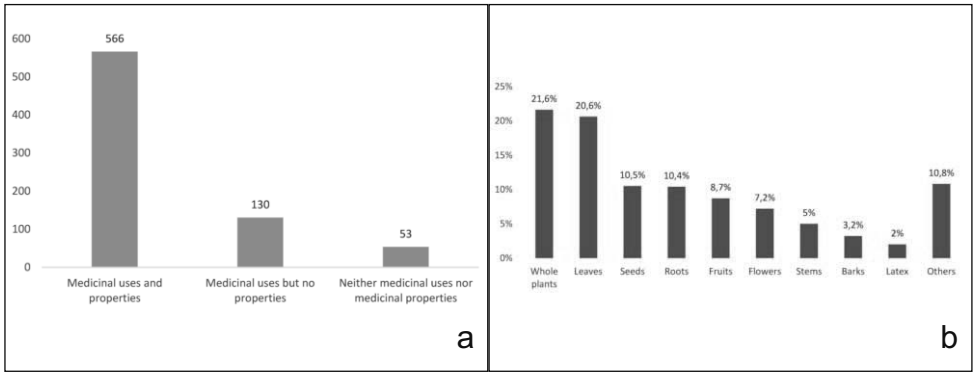


Fig. 2. a) Proportion of Aromatic and Medicinal Plants (AMPs) according to their therapeutic properties and medicinal uses; 2b) Distribution of plant part used in AMPs in Morocco.

Classified among the elements of the 14th NCP proposed by IPBES, aromatic and medicinal plants constitute products with very high added value which contribute to the valorization of Moroccan plant biodiversity and the socio-economic development of the country. Indeed, the total number of AMPs used in traditional Moroccan medicine is 750, belonging to 102 families and 375 genera. The most represented families are: *Lamiaceae*, *Asteraceae*, *Fabaceae*, and *Apiaceae*. The number of endemics in Morocco is 48 taxa (representing more than 6 % of the total). Thus, the analysis of data concerning the status of these plants shows that 75 % are spontaneous (Jamaleddine & al. 2019). The collection of AMP constitutes a means of diversifying agricultural production and remains an income-generating activity for local rural populations. Morocco is ranked 12th among the world's AMP exporters as a result. In detail, around 60% of these exports are from the food sector (carob, spices, etc.), while 35% are from perfumery and cosmetics, and 5% are from the exploitation of their medicinal properties. Over the last decade, Moroccan exports of AMP have grown significantly. Over the last decade, Moroccan exports of AMP products have grown significantly. AMPs exports increased from 12,386 tons in 2014 to 46,000 tons in 2019, which represents an average annual growth rate of 30%. The European Union market is the main destination, absorbing around 60% of exports. From 2014 to 2019, exports of essential oils, extracts, and perfumes rose from 350 to 687 tons, representing an average annual growth rate of 14.5% (https://agadirinvest.com/etudes-data/).

In addition to these material contributions from nature, Moroccan pharmacopeia as a non-material contribution is strongly linked to the use of AMPs. Morocco has an ancient tradition and significant know-how in traditional phytotherapy, and not far, the number of indications of medicinal use listed in this present work which is of the order of 2748 indications reflects the extent of this tradition. Another important factor that makes this knowledge unique is its deep roots in the natural environment of the country that supplies it with most of its resources, its innovative character concerning written knowledge (Greek, Arabic, essentially) is manifested in particular by the presence in the Moroccan drogue of certain products that are specific to it and that are provided by the environment, characterized by a high rate of endemicity of the taxa (Bellakhder 2020).

Conclusion

Morocco's traditional medicine is undoubtedly a cultural treasure rooted in history. Centuries of interaction between humans and nature have led to a wealth of knowledge and expertise in treating illnesses. For a long time, this was the only way to be cured. The use of AMPs, the mainstay of traditional medicine, has created a strong link between local populations and nature. In Morocco today, collecting aromatic and medicinal plants is a means of diversifying agricultural production and remains an income-generating activity for rural populations. In addition to these material contributions, the Moroccan pharmacopoeia provides non-material contributions.

Using our newly created database, we studied the uses of AMPs in traditional medicine and counted all the therapeutic indications. There are 2748 indications for medicinal use, 93.9% of which are for human medicine, 5.1% for cosmetology and hair care, and 1% for veterinary medicine. The most common therapeutic indications used in human medicine

by the local Moroccan populations are those employed to treat affections of the digestive system and its annexes, accounting for more than 25% of all cases. In traditional Moroccan medicine, all parts of aromatic and medicinal plants are used. Depending on the therapeutic indication, the entire plant or a small part, such as buds, leaf ribs, or stigmas, may be used. A total of 37 parts are listed for medicinal use. This number reflects the richness of traditional Moroccan phytotherapy.

On the other hand, the latest economic data confirms the growth of the AMP sector. For instance, the volume of AMP exports and essential oils and their derivatives increased from 12,386 and 350 tons in 2014 to 46,000 and 687 tons, respectively, in 2019.

Undoubtedly, all this gives Morocco's AMP sector an important role in NCP.

The collection of AMPs constitutes a means of diversifying agricultural production and remains an income-generating activity for local rural populations, in addition to these material contributions of nature, Moroccan pharmacopeia as a non-material contribution is strongly linked to the use of AMPs. Morocco has an ancient tradition and significant know-how in traditional phytotherapy. This undoubtedly gives the AMP sector in Morocco an important role in the NCP.

However, it should be noted that AMP resources are being abused and exploited excessively and haphazardly, which poses a real threat to biodiversity and ecosystem services. These services are an integral part of nature's contribution to people.

Conserving and enhancing traditional knowledge related to AMPs, as well as building capacity in terms of awareness, education, training, and taxonomy, contributes greatly to the conservation and sustainable use of AMPs. This ensures the socioeconomic development of local populations and, consequently, human well-being.

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Article

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Dar Ben-Natan & Bar Shemesh

Isoetes durieui (*Isoetaceae*) – a new species to the Flora Palaestina Region

Abstract

Ben-Natan, D. & Shemesh, B.: *Isoetes durieui* (*Isoetaceae*) – a new species to the Flora Palaestina Region. — Fl. Medit. 35: 119-125. 2025. — ISSN: 1120-4052 printed, 2240-4538 online.

Isoetes durieui, a Mediterranean lycophyte, is reported for the first time from the southern Levant, significantly extending its known range. Newly discovered populations inhabit rare, non-calcareous sandy clay soils – often near vernal ponds. These sites, largely unprotected, are threatened by habitat loss. The findings highlight both the underexplored status of Isoetes in the region and the importance of conserving its unique habitats.

Key words: Chorology, relict population, siliceous soil ecology, Lycophyte.

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Introduction

Isoetes L. is a large genus in the class *Lycopodiopsida* Bartl., comprising roughly 200 species, distributed across all continents except Antarctica. *Isoetes* species richness centres are South America, SW USA and Australia, with a secondary centre in the northern Mediterranean (Troìa & al. 2016). In the Middle East, there are only few *Isoetes* species. In the entire Eastern Mediterranean, *Isoetes* is a relatively unstudied genus, with only seven currently known species, two of which described fairly recently (Prada & Rolleri 2005; Bolin & al. 2011).

In the Eastern Mediterranean, the abundance of *Isoetes* populations and species diminishes southwards from seven species in Turkey (Bolin & al 2008; Troìa & Greuter 2015a; Zare & al. 2016), to three in northern Lebanon (Mouterde 1966; Musselman & Al-Zein 2010; Bolin & al. 2011), and none recorded yet from Flora Palaestina region (Zohary 1966, 1972; Feinbrun-Dothan 1978, 1986; Feinbrun-Dothan & Danin 1998; Fragman-Sapir & al. 1999).

Most *Isoetes* species are aquatic and few, including *Isoetes durieui* Bory, are terrestrial. *I. durieui* has a wide Mediterranean distribution, including north Tunisia and Algeria (from which it was originally described), the southern Iberian Peninsula to Italy, some of the

Aegean Islands, and the northern Levant from western Turkey to northern Lebanon (Davis 1965; Bolin & al. 2008; Musselman & Al-Zein 2010; Troìa & Greuter 2015a, 2015b). Despite the general difficulty in distinguishing *Isoetes* sp. pl. due to lack of vegetative parts, *I. durieui* is easily characterized by the terrestrial habit, short phyllopodia of up to 3 mm, and most importantly - the clearly reticulate-alveolate megasphore coat (Davis 1965; Bolin et al. 2008; Musselman & Al-Zein 2010).

Materials and methods

In 2023, two populations of *Isoetes durieui* were discovered and identified by the authors during field survey for Deshe OLI (Open Landscape Institute) (Shemesh & al. 2023); one in the area of Hadera (Sharon Plain), and the other in Mt Kata, at the lower flanks of Mt Hermon. Both populations are very localized, although consisting of many individuals (Figs. 1-2). The habitat of both populations is sandy clay loam, with relatively similar water regime conditions and soil type. Since then, three further localities were discovered in similar habitats in the Sharon Plain, by Dar Ben-Natan, Bar Shemesh and Dvora Low-Ramati. New herbarium specimens were deposited at herbarium of The Hebrew University of Jerusalem (HUJ).

Prior to these discoveries, *I. durieui* was never collected or recorded in the Eastern Mediterranean south of Akkar in Northern Lebanon (Musselman & Al-Zein 2010), although its generally Mediterranean distribution makes its occurrence in the Coastal Plain of Israel unsurprising. It might be more common in Syria and Lebanon than is currently known, and should be looked for in sandstone areas, and along the coast.

Chorology and ecology

Geography and habitat: All Israeli populations occur on several variations of clay-rich red sandy clay loam, locally named Hamra (=Reddish, in Arabic). When shaded by shrubs and tall herbaceous vegetation, the more clay-rich variations of Hamra soil retains moisture during winter and spring, and dries in summer (Eig 1939). Similar conditions exist in the more mature soil variation locally named Nazaz – a soil comprised of sandy loam in A horizon, and a sandy clay or clay loam B horizon, often waterlogged (Dan 1984; Singer 2007); in which the porous, sandy A horizon locks the moisture in the underlying clay B horizon. In Sharon Plain, *I. durieui* is currently known only from the now-rare habitats of these two soil variations. On Mt Kata it is known from a single patch, growing on a steep slope, on yellowish-brown sandy clay loam, which is kept moist during winter and spring due to various small local aquifers.

These habitats are widely known locally as a sanctuary for several “calciphobic” plants. These do not occur at all in more calcareous soils in the region, but are sometimes abundant on sandy and basalt derived soils in the Coastal Plains, N Golan Heights and Mt Kata. Many have become locally endangered following the large-scale urbanization and agricultural cultivation of the Coastal Plains, which has drastically diminished their natural habitats. (Pollak 1984a, 1984b; Shmida & Pollak 2007; Shmida & al. 2011).

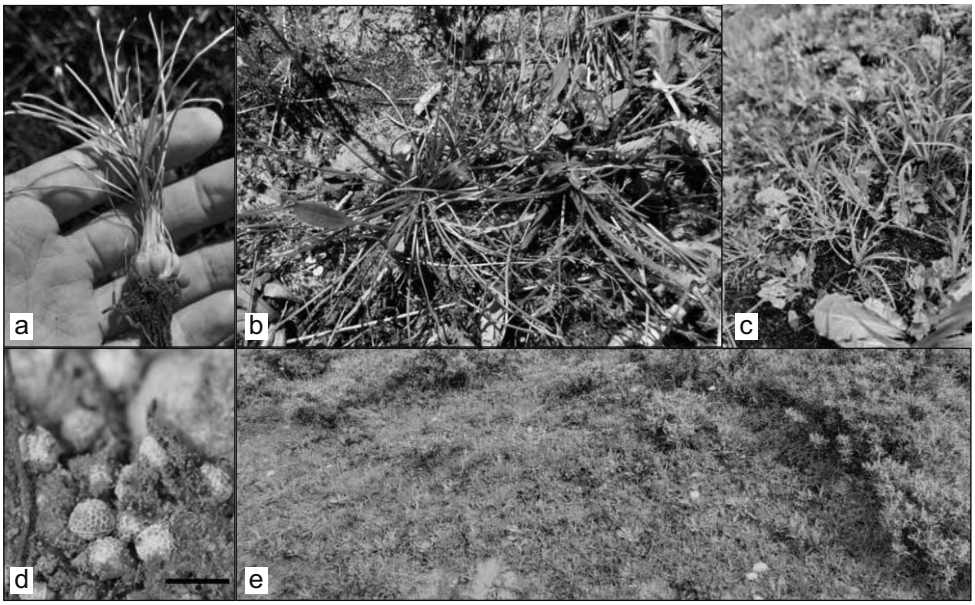


Fig. 1. *Isoetes durieui*: a) A whole plant, Hadera area, 4.4.2023, Dar Ben-Natan; b) Plants growing in Bryophyte soil crusts on sandy clay loam, Hadera area, 4.4.2023 Dar Ben-Natan; c) Plants growing in Bryophyte soil crusts in damp soil, Mt Kata, 28.3.2025 Dar Ben-Natan; d) Megasphores, Mt Kata, 28.3.2025, Shlomi Aharon (Scale bar 1 mm); e) habitat in Mt Kata – a batha of *Sarcopoterium spinosum* in Yellowish-brown sandy clay loam, 28.3.2025, Dar Ben-Natan.

Similarly, *Isoetes durieui* is described from the Iberian Peninsula as preferring a siliceous and acidic substrates, often near vernal ponds (Molina 2005; López-Tirado & al. 2015; López-Tirado 2022). In Italy, Sardinia and Sicily it occurs on siliceous soils, often waterlogged (Troìa & Greuter 2015b). From the Aegean Archipelago it is mentioned as occurring in ophiolitic schists (Troìa & Greuter 2015a); from Turkey, Syria and Lebanon as occurring on sandy soils and on basalt derived soils respectively, often near vernal ponds (Davis 1965; Bolin & al. 2011) – all of which are consistent with its non-calcareous, sand derived, and often vernal pond-adjacent habitats in Israel. Several species which were mentioned by Molina (2005) as associated with *I. durieui*, in Israel are also specialized to this particular habitat. They are locally rare and co-occur with *I. durieui* on sandy soils in the Coastal Plain and in Mt Kata. Among these are *Juncus capitatus* Weigel, *Tolpis umbellata* Bertol., *Ornithopus pinnatus* (Mill.) Druce, *Tuberaria guttata* (L.) Fourr., and *Centaurium maritimum* (L.) Fritsch.

Climate: Specific information on annual mean temperatures and precipitation is not recorded for most of the species' global range. However, by comparing meteorological maps (Aemet 2025) to distribution maps in relevant sources (Lopez-Tirado & al. 2015, 2022; Molina 2005), we can assess that mean temperatures in areas where *Isoetes durieui* is recorded in S Spain is 5-10 °C in January, and 22-25 °C in July, and annual precipitation is between 600 and 1000 mm in Huelva Province, 400-700 mm in Cordova Province, and



Fig. 2. A map showing *Isoetes durieui*'s distribution in Israel.

600-800 mm in Girona Province. In the area of Alger (Algeria), where the type for *I. durieui* was collected, annual mean temperature is 18.23 °C and average annual precipitation is 625 mm (World Bank Groupe 2025). Considering this, the Sharon Plain Populations experience warm and dry conditions, relative to most other known populations of this species – occurring at 20-40 m elevation in mean temperatures of 8–17 °C in January and 21–30 °C in July, and average annual precipitation of 550 mm. Meanwhile, Mt Kata population occurs at 1050 m elevation under cooler and wetter conditions: in mean temperatures of 3–9 °C in January and 17–25 °C in July, and annual precipitation of 950 mm (Israel Meteorological Service 2025).

Threats and conservation

Isoetes durieui is very rare in Israel, currently recorded from only six sites, all of which restricted in area, and mostly unprotected. Only the smallest of the known populations, consisting of few individuals, is included in a nature reserve. It should be considered as locally threatened according to the Israeli model of assessment, with a Red Number of 8 (Rarity: 3, Habitat vulnerability: 5, Endemism: 0, Attractivity: 0) (Shmida & Pollak 2007; Shmida & al. 2011, Lebel-Vine & al [in prep.]). The largest population both in terms of area and number of individuals, is in Hadera Forest. The plants grow there on moist Nazaz at the margins of a large vernal pond, exceptionally rich in locally rare and endangered species of Nazaz soils, and of wet habitats (Low-Ramati & al. 2022), in a forest of *Eucalyptus camaldulensis* Dehnh., planted and regulated by KKL-JNF, and are threatened by forest maintenance, urban development, and changes to the local drainage system.

Closing remarks

This discovery sets a new southern and southeastern border to *Isoetes durieui*'s area of distribution; from the previous southernmost known population in Akkar, in the northernmost part of Lebanon, to the Sharon Plain in central Israel. It is a partial result of considerable renewed interest and study of the local flora in the region recently, adjoined by more than 50 other species of vascular plants newly discovered to the local flora in the last two decades (Ben-Natan & al. 2024). It is worthwhile noting that in terms of soil and water regime characteristics, *I. durieui* occurs in similar habitats across much of its global distribution, and even in marginal populations such as those recently found in Israel. This should be taken into consideration worldwide in attempts to conserve this species *in-situ*.

Specimens examined

ISRAEL, Sharon Plain, Hadera, Giv'at Zeita, 6.4.2023, *Dar Ben-Natan and Bar Shemesh* (HUJ135046!); ISRAEL, Mt Katta, west of Nimrod, 18.5.2023, *Dar Ben-Natan* (HUJ1000046!); ISRAEL, Sharon Plain, Binyamina Meadow, 24.3.2024, *Bar Shemesh* (HUJ1003768!); ISRAEL, Sharon Plain, Illanot Forest – eastern side, sandy clay loam soil, moist with patches of Bryophytes, in the shade of *Cistus* and *Calicotome* shrubs, 20-30 individuals, 24.4.2024, *Dar Ben-Natan* (HUJ1003761!); ISRAEL, Hadera Forest, 26.2.2025, *Dvora Low-Ramati & Bar Shemesh*

(HUJ1008821!); ISRAEL, Lower Mt Hermon, Mt Kata, light brown sandy loam, moist from seeping from small, local aquifers, in an open batha of *Sarcopoterium spinosum* (L.) Spach, 28.3.2025, *Dar Ben-Natan* (HUJ1009193!).

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Article

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Ridha El Mokni

Studies on the genus *Euphorbia* (*Euphorbiaceae*) in North Africa: First records of the invasive weed *Euphorbia hypericifolia* (*E.* subsect. *Hypericifoliae* Boiss.) in Tunisia

Abstract

El Mokni, R.: Studies on the genus *Euphorbia* (*Euphorbiaceae*) in North Africa: First records of the invasive weed *Euphorbia hypericifolia* (*E.* subsect. *Hypericifoliae* Boiss.) in Tunisia. — Fl. Medit. 35: 127-133. 2025. — ISSN: 1120-4052 printed, 2240-4538 online.

Euphorbia hypericifolia L. (*Euphorbiaceae*) a neophyte native to tropical and sub-tropical Americas with scattered occurrences as alien in many countries within the Mediterranean area is here reported for the first time from several localities in Tunisia. An abbreviated morphological description with original photographs, ecological features with a first map distribution and taxonomic notes, considering comparisons with commonly misidentified related species, are presented.

Key words: *Anisophyllum*, Chorology, floristic records, *Euphorbia* Subgen. *Chamaesyce*; xenophytes.

Article history: Received 29 August 2025; received in revised form 10 Ocotober 2025; accepted 24 October 2025; published 16 November 2025.

Introduction

Spurges with mainly small procumbent to erect annual habit bearing stipules and asymmetrical leaf base were formerly included in the genus *Chamaesyce*, reclassified later (Yang & al. 2012) under the genus *Euphorbia* L. subg. *Chamaesyce* Raf. sect. *Anisophyllum* Roeper subsect. *Hypericifoliae* Boiss. Being drought-tolerant plant and naturally adapted to survive even in arid regions with minimal water availability, several species of this group are naturalizing and even more recently becoming invasive throughout many countries of the word (see e.g., Kao & Chaw 1987; Somlyay 2009; Bátori & al. 2012; Verloove 2015; Taylor & Terry 2015; Geltman & Medvedeva 2017; Atha & al. 2018; Sîrbu & Şuşnia Tone 2018; Abaas Aliwy 2022) and within the Mediterranean (see e.g., Roux 1992; Kervyn & Lambinon 2000; Sutorý & Verloove 2015; Sciandrello & al. 2016; Spadaro & Raimondo 2017; Mifsud 2018; Mugnai & al. 2021; Khamar & al. 2021, 2024; Mahklouf 2023), amongst them we find notably, the graceful spurge (*Euphorbia hypericifolia* L.). It is native to the New World

(including the southern United States, the Caribbean, and South America) but has become a common and widespread weed of the warm temperate, tropical, and subtropical countries (Chen & Wu 2004, *sub Chamaesyce hypericifolia* (L.) Millsp.; Atha & al. 2018; POWO 2025a[+]). Far away its native range, *E. hypericifolia* has been recorded as a weedy or invasive plant in many areas of the Old World, including the Mediterranean Basin, Western Europe (Belgium), tropical Africa, the Mascarene Islands, and certain parts of Asia (including China, India, Iraq, Oman, Pakistan, Taiwan) (Coode & al. 1982; Li & al. 2008; CABI 2025[+]). The species is considered to be a pantropical weed in disturbed areas, on irrigated grounds near cultivation, sandy soils, hillsides, and sea shores, at altitudes up to 1700 m (Pahlevani 2017). Moreover, the graceful spurge was listed among the top 20 invasive plants on Guam island, where despite that its occurrence do not causing serious damage to wild ecosystems, is certainly not a very welcomed species (Reddy 2011). In North Africa, the species is known only from Morocco and Libya with very recent records (Dobignard & Chatelain 2013; Mahklouf 2023; Khamar & al. 2024; POWO 2025a[+]).

In continuity to further updating the list of the Tunisian vascular flora and it surrounding countries within North Africa mainly Euphorbiaceous taxa (see e.g. El Mokni 2023; El Mokni & al. 2024; El Mokni 2025), specimens of annual erect little-branched (sub-shrub-by like) spurge from several distant populations, within coastal regions of Tunisia, of an unknown/unfamiliar species of *Euphorbia* subgen. *Chamaesyce* sect. *Anisophyllum* subsect. *Hypericifoliae* were collected since 2021. On the basis of literature and herbaria studies it was referred to *E. hypericifolia*, an alien species not previously reported from Tunisia. It is here its third record to North Africa.

Material and Methods

Plant material collected in the field was conserved in the personal Herbarium of the author (Herb. R. El Mokni) deposited at the Faculty of Pharmacy of Monastir (Monastir University). The morphology of the species is described on the basis of material collected in Tunisia, in agreement with relevant descriptions (Mifsud 2018; Mugnai & al. 2021; Makhlouf 2023; Khamar & al. 2024). Data about the habitats and the population size of *E. hypericifolia* are based on personal observations in the field. Nomenclature of the species found together with *E. hypericifolia* follows POWO (2025b[+]).

Taxonomic Treatment

Euphorbia hypericifolia L., Sp. Pl. 1: 454. 1753.
Lectotype (designated by Fosberg & Mazzeo 1965: 191): Herb. Linn. No 630.4 (LINN) (image available at http://linnean-online.org/4598/).
≡ *Anisophyllum hypericifolium* (L.) Haw. In Syn. Pl. Succ.: 161 (1812)
≡ *Chamaesyce hypericifolia* (L.) Millsp. In Publ. Field Columb. Mus., Bot. Ser. 2: 302 (1909)

Morphological description – *Euphorbia hypericifolia* is an annual (pluri-annual in some Mediterranean countries), herbaceous, erect plant, with taproot. *Stems* little-branched erect to

ascending, 15–50(–60) cm high, glabrous; generally much-branched from upper parts, branches deflexed at apex. *Leaves* opposite (Fig 1.A); stipules connate, deltate, sometimes laciniate-fringed at tip, 1.5–2.2 mm, glabrous (Fig 1.C); petiole 1–3 mm, glabrous (Fig 1.A); blade obliquely oblong, 10–35 × 7–15 mm, base asymmetric, oblique, margins serrate or serrulate, especially toward apex, apex broadly acute, surfaces glabrous; palmately veined at base, pinnate distally. *Cyathia* in dense, axillary and terminal (Fig 1.A), capitate glomerules with reduced, bract-like leaves subtending cyathia; peduncle 0.5- 1.8 mm. *Involucre* obconic, 0.9–1.1 × 0.4–0.9 mm, glabrous; glands 4, yellow-green to brown, subcircular, 0.2 × 0.2 mm; appendages white to pink, shape highly variable, usually round to elliptic, 0.3–0.4 × 0.5–0.7 mm, margin entire. *Staminate flowers* 2–20. *Pistillate flowers*: ovary glabrous; styles 0.4 mm, 2-fid ½ length. *Capsules* 3-lobed, globoid (Fig 1.E), 1.3–1.4 × 1.1–1.5 mm, glabrous; columella 1.0–1.1 mm, 3-seeded. *Seeds* ovoid, light brown, with very thin coat, ovoid-triangular, slightly 4-angled in cross section, 0.9–1.1 × 0.5 mm, with shallow irregular depressions alternating with low, smooth ridges, without caruncle.

Phenology in Tunisia – Flowering and fruiting in Tunisia (within NE & TC) were observed from June to December (within Kroumiria).

Iconography – Chen & Wu (2004: 103, Fig. 1, *sub Chamaesyce hypericifolia* (L.) Millsp.)

Habitat and ecology in Tunisia – *Euphorbia hypericifolia* can be found wild in Tunisia especially near and around nurseries, in pots planted with ornamentals and less frequently along ruderal places and railway stations within the centraleastern and northwestern parts of Tunisia. The plant occupies habitats featuring very superficial and poor soils in association with several synanthropic plants namely, *Amaranthus deflexus* L., *Digitaria sanguinalis* (L.) Scop., *Eclipta prostrata* (L.) L., *Erigeron canadensis* L., *Euphorbia serpens* Kunth, *Lythrum thymifolia* L., *Oxalis corniculata* L., *Portulaca oleracea* L. (var. *oleracea*), *Setaria adhaerens* (Forssk.) Chiov., *Solanum nigrum* L., *Tagetes erecta* L.

Distribution and alien status in Tunisia – (Fig. 1B). *Euphorbia hypericifolia* is found within northeastern Tunisia [NE]: Bizerta (Nadhour); within Kroumiria in the northwestern part [K]: Jendouba (Tabarka); in central Tunisia [TC]: Monastir (Monastir-city, Ksar Hellal, Touza). It can be considered as naturalized.

Pathways of introduction and eventual invasion – The introduction of *E. hypericifolia* in Tunisia is definitely unintentional, mainly importing potted plants for horticulture purposes. In fact, most of the areas affected in Tunisia are coastal localities (Bizerta, Monastir and Tabarka) not far away from numerous nurseries. Once introduced, the species usually spreads rapidly along the watercourses due to its high number of produced seeds and its growth rate, reproductive capacity and adaptation potential, which enables it to become easily naturalized in newly occupied areas. According to personal observations, the seeds are minute and very light and can easily disperse by water and by wind. The species was found often with the other two known introduced/naturalised spurges (*E. serpens* Kunth and *E. maculata* L.) and perhaps all are in full process of expansion in the surroundings areas thus monitoring of their dispersion range is needed in the near future.

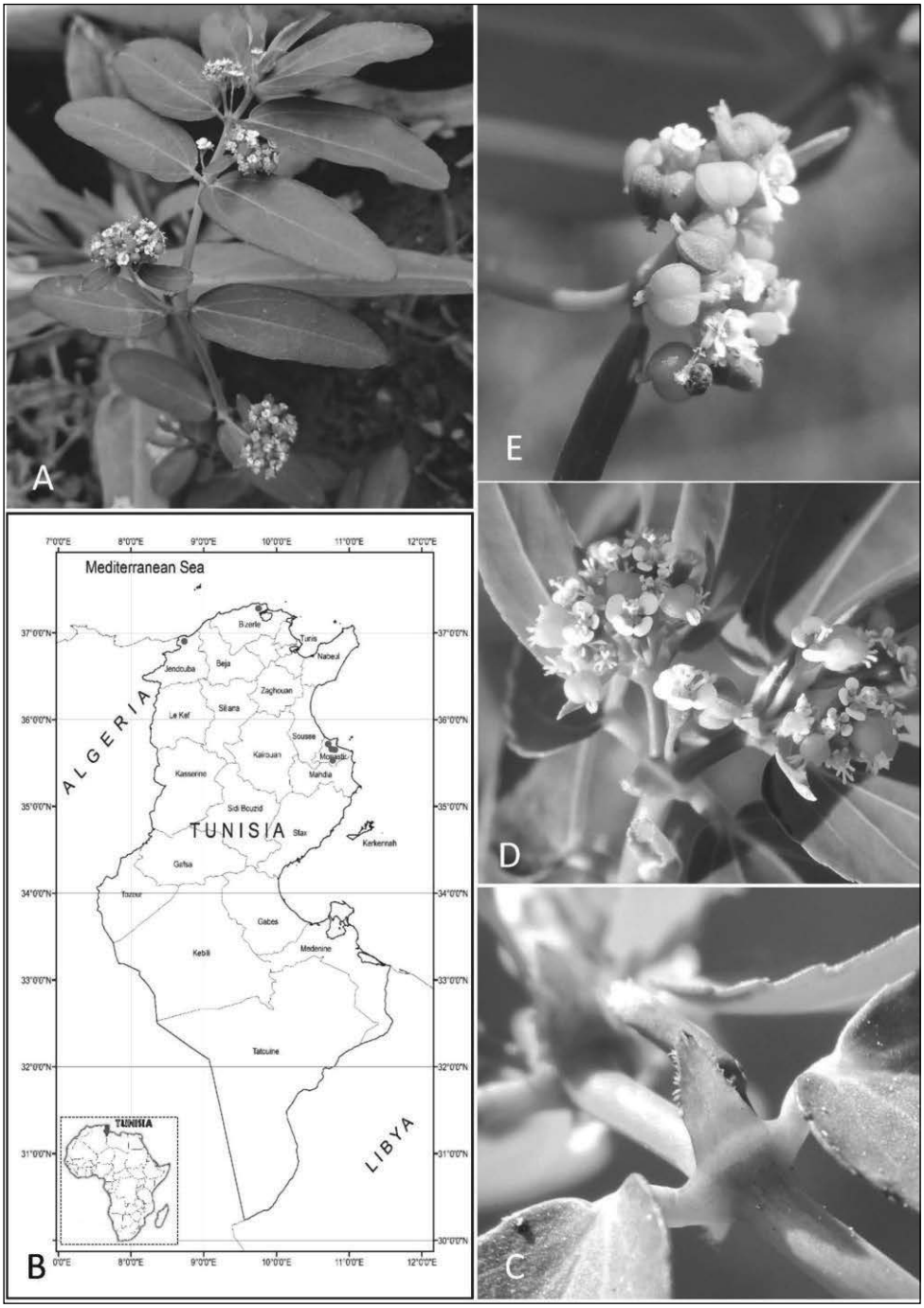


Fig. 1. *Euphorbia hypericifolia* in Tunisia. A. Habit, B. Map distribution in Tunisia, C. Stipule shape, D. Inflorescence and cyathia, E. Capsules. (Photographs by R. El Mokni).

Taxonomic annotations – *Euphorbia hypericifolia* can be confused with other species previously included in the '*E. hypericifolia* aggregate'. In fact, *E. hypericifolia* shows affinities with *E. hyssopifolia* (a taxon reported present as introduced within some countries of the African continent, Benin, Burkina, Burundi, Cameroon, Chad, Gabon, Ghana, Greece, Guinea, Guinea-Bissau, Liberia, Mali, Nigeria, Togo), especially for similar habit and leaf morphology (Mugnai & al. 2018, 2021). In *E. hypericifolia* cyathia are subtended by reduced, bract-like leaves and grouped in capitate glomerules (see Fig. 1A), while *E. hyssopifolia* is characterized by solitary cyathia or in small cymose clusters at distal nodes or on congested, axillary branches (Steinmann & al. 2016). *E. hypericifolia* also differentiates from *E. hyssopifolia* for its complete glabrescence, larger purplish red coloration fresh stipules and smaller seeds (Chen & Wu 2004). Moreover, the species has been also confused with *E. nutans* Lag. (a taxon reported introduced in African continent only from Morocco). In its general habit and size, *E. nutans* shows a clear resemblance to both *E. hypericifolia* and *E. hyssopifolia*. However, *E. nutans* differs by having stem hairs arranged in lines. Compared to *E. nutans*, *E. hypericifolia* is completely glabrous (see Figs. 1A, C-E) (*vs*. hairy at least on the internodes, and hairs could also be present on leaves, especially towards the base) with conspicuous, outspreading and as much as 2 mm long stipules joined into a clearly visible membranous sheath (see Fig. 1C) (*vs*. inconspicuous), fruits (see Fig. 1E) are not longer than 1.4 mm (*vs*. 1.5–2.0 mm long), and seeds are ca. 0.8 mm long with often poorly defined transverse ribs (*vs*. seeds are 1.0–1.3 mm long with usually prominent transverse ribs) (see more in Pahlevani & Riina 2011). *Euphorbia hypericifolia* shows also affinities with *E. indica* Lam., another member of the aggregate group (reported in the Africa continent as a weed in Angola, Botswana, Ethiopia, Malawi, Mozambique, Sudan-South Sudan, Zambia and Zimbabwe). The two species are very closely related, but easily distinguished by the larger, sparsely pilose, rarely almost glabrous, often purplish tinged capsule of *E. indica* and its stipules which remain separated (see more in Pahlevani & Riina 2011).

Specimina visa: **TUNISIA**: Bizerta, Bizerta-city, El-Bhira, 03/06/2021, *R. El Mokni s.n.* (Herb. R. El Mokni); Monastir, Ksar Hellal, 11/09/2023, *R. El Mokni s.n.* (Herb. R. El Mokni), *ibidem*, 30/06/2025, *R. El Mokni s.n.* (Herb. R. El Mokni), *ibidem*, 18/08/2025 *R. El Mokni s.n.* (Herb. R. El Mokni), Monastir-city, 29/06/2025, *R. El Mokni s.n.* (Herb. R. El Mokni), *ibidem*, 29/07/2025, *R. El Mokni s.n.* (Herb. R. El Mokni), Touza, 18/08/2025 *R. El Mokni s.n.* (Herb. R. El Mokni); Jendouba, Tabarka, 12/12/2024, *R. El Mokni s.n.* (Herb. R. El Mokni).

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Article

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Mediterranean element in the flora of Armenia

Abstract

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The aim of this study was to analyze the representation of Mediterranean species in the broad sense (s.l.) in the flora of Armenia. Despite the significant distance from the Mediterranean basin, species of Ancient Mediterranean origin make up about half of the total flora in Armenia. The article analyzes the growth of Mediterranean species in various altitude zones, ecosystems and floristic regions of Armenia. It shows their greatest association with arid ecosystems, lower and middle mountain belts and floristic regions of Armenia, related to the Armeno-Iranian floristic province.

Key words: Floristic analysis, phyto-geographical elements, Mediterranean element, Caucasus.

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Introduction

Armenia is a country located in the South Caucasus with an area less than 30.000 sq. km^2.. The country's flora is surprisingly rich. This small territory hosts about 3,800 species of vascular plants, which comprises more than half of the entire Caucasus flora (Fayvush 2023). The flora includes a very large number of endemic species - local endemics, endemics of the Caucasus or Southern Transcaucasia, and the Armenian Highlands (Gabrielian & Fayvush 1989; Fayvush 2007; Solomon & al. 2013; Fayvush & Aleksanyan 2020).

Based on the position that allo- and autochthonous trends in the evolution of the Armenian flora were approximately equivalent (Fayvush 1990), it should be recognized that approximately half of the species migrated to the territory of Armenia from other regions, while the second half evolved on the territory of the republic. This does not recognize administrative boundaries, the autochthonous trend should be extended to the Armenian Highlands as a whole and partially to the Caucasus.

Although it is believed that the modern flora of Eurasia is a derivative of the Cretaceous period flora (Krishtofovich 1936), the history of the formation of Armenia's flora can safely begin from the times when both the Greater Caucasus and the Lesser Caucasus were islands and underwater elevations in the ancient Tethys Ocean (that is, from the late

Miocene, approximately 5.5 million years ago). It is well known that at the end of the Cretaceous and the beginning of the Paleogene periods in Central Asia on the eastern shore of Tethys, there already existed a very diverse floristic complex. The reduction of the Tethys was going from east, and this complex moved to the west including its original elements (Kamelin 1988). During this period that the main ecosystems were established in the territory of the Armenian Highlands, which became crucial for the entire Ancient Mediterranean region - shiblyak, arid open forests, semi-deserts, tragacanths, etc. These complexes had a similar coenotic structure, but the floristic composition differed significantly throughout the vast Ancient Mediterranean, and included both local species and migrant species. In this work, we present the results of an analysis of the flora of Armenia, aimed at examine the distribution and association with ecological conditions and ecosystems of plant species belonging to Mediterranean s.l. geographical element. Meaning by Mediterranean s.l. geographical element we mean species that are widespread both throughout the entire territory of the Ancient Mediterranean or in its individual parts.

Material and methods

Study Area

Armenia is a republic in the South Caucasus, neighbouring Georgia, Azerbaijan, Türkiye, and Iran. The total area of Armenia is 29,740 km². It is considerably distant from sea basins—approximately 145 km from the Black Sea and 175 km from the Caspian Sea. It is situated between 38°50’ and 41°18’N latitude and between 43°27’ and 46°37’E longitude (Fig. 1). The distance from north to southeast along the main axis is approximately 400 km. Armenia is a predominantly mountainous country, with an average altitude of 1850 m above sea level, the lowest point being 375 m and the highest 4095 m above sea level (Fayvush 2023).

A wide range of climatic zones are distinguished within Armenia (Fig. 2). This territory shows a pronounced vertical succession of six basic climate types – from dry subtropical up to severe alpine. The average annual temperature ranges from -8°C in high-altitude mountainous regions (2500 m a.s.l. and higher) to 12–14°C in low-traced valleys. In the lowlands the average air temperature in July and August reaches 24–26°C, but in the alpine belt the temperature does not exceed 10°C. January is the coldest month with an average temperature of -6.7°C. The absolute minimum temperature is -42°C. The overall climate is best characterized as dry continental, in some areas with an annual rhythm more or less similar to the Mediterranean climate regime. The average annual precipitation in Armenia is 592 mm. The most arid regions are the Ararat valley and the Meghri region with annual precipitations of 200–250 mm. The highest annual precipitation, 800–1000 mm, is observed in high altitude mountain regions. Major part of the precipitation falls in the spring. Long-lasting snow cover exists in the mountains above 1300 m, where the annual snowfall could attain 2 m. In the northern part of Armenia, humidity comes from the Black Sea in the west, in the southern part from the Caspian Sea in the east, while the central part lies in the rain shadow of mountain ridges and is the driest area (Bagdasaryan 1958; Republic of Armenia 2015). In general terms, the climate is best characterized as dry continental with an annual rhythm more or less similar to the Mediterranean type, especially in lowlands (Fig. 2).

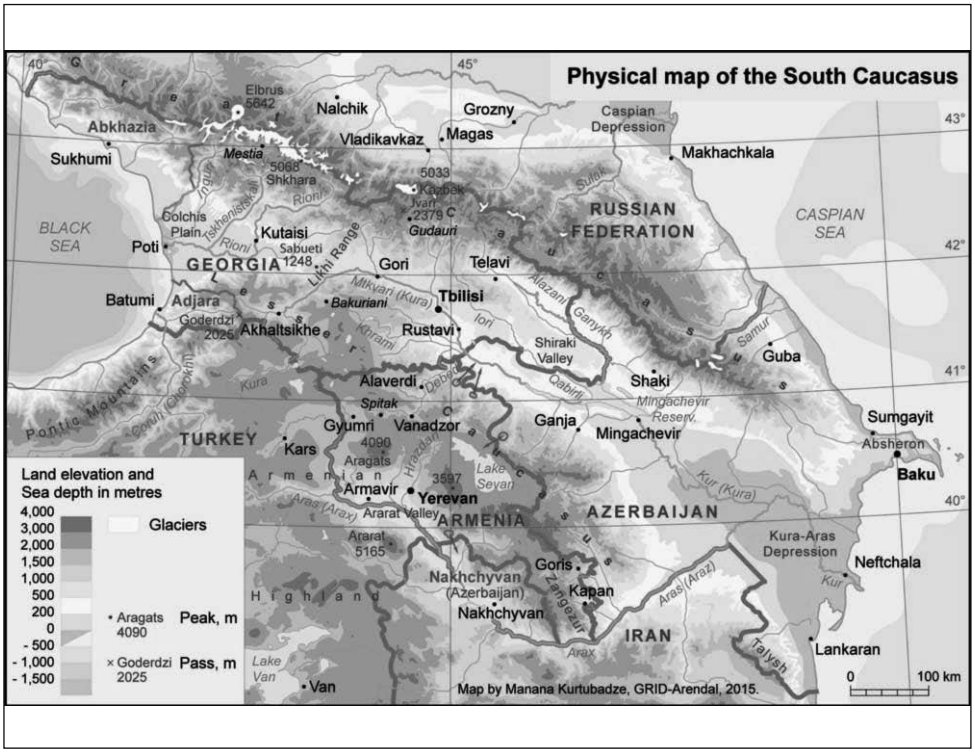


Fig. 1. Location of Armenia in the Caucasian Ecoregion.

The diversity of landscapes and orography is a significant determinant of Armenia's diverse vegetation. The lower mountain belt (375–1300 m) is covered by semi-desert formations, gypsophilous or halophilous vegetation. There are salt marsh areas as well as the South Caucasian sand desert. The middle and upper mountain belts (1300–2200 m) are characterised by various kinds of steppe and forest vegetation, meadow-steppes, shrub steppes and thorny cushion (tragacanth) vegetation. The altitudinal span of the forest belt varies from 500 to 2000 m depending on the region and may approach 2400 m when open park-like tree stands are included. The subalpine and alpine belts (2200–4095 m) are covered by meadows and carpets (Magakyan 1941; Takhtadjan 1941; Fayvush 2006; Fayvush & Aleksanyan 2016; Fayvush 2023).

Armenia lies at the intersection of two biodiversity hotspots (Caucasian and Irano-Anatolian; Mittermeier & al. 2011) and two phytogeographical subkingdoms: Boreal (Euro-Siberian) and Ancient Mediterranean (Takhtadjan 1986).

On the basis of numerous literature and herbarium data, as well as long-term observations in nature, we adjusted the floristic zoning of Armenia by Takhtajan (1954). In this

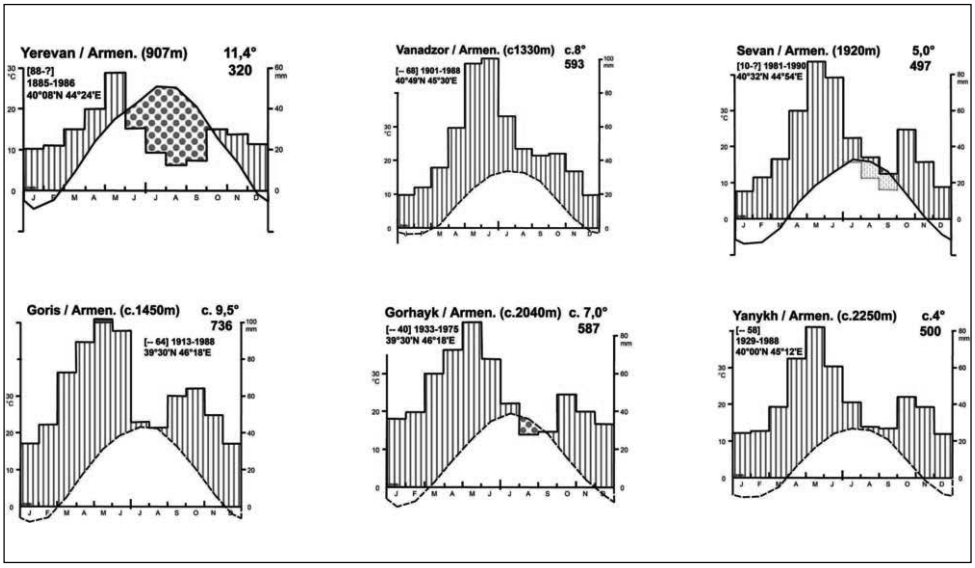


Fig. 2. Climatic diagrammes of some meteostations of Armenia (Fayvush 2023).

work, we use this updated scheme to indicate the distribution of plant species throughout the republic (Tamanyan & Fayvush 2009) (Fig. 3).

It should be noted that according to our previous studies, the Shirak, Aparan, Yerevan, Darelegis, and Meghri floristic regions belong to the arid Armeno-Iranian floristic province (Ancient Mediterranean subkingdom), while the rest belong to the more mesophilic Caucasian province (Boreal subkingdom; Tamanyan & Fayvush 2009; Fayvush & al. 2023).

Methods

The flora of Armenia includes approximately 3800 species of vascular plants (Republica of Armenia 2014), of which about 50% are distributed mainly in the Ancient Mediterranean region (Saghatelyan 2006; Fayvush & al. 2023). Investigating species of the flora of Armenia for the determination of geographical elements, we used the scheme of N. Portenier (2000), adapted by us for the conditions of the South Caucasus (Fayvush & Adamyan 2015).

The analysis included 463 distinct species of vascular plants distributed in the Ancient Mediterranean region, for which we had accurate data on their distribution and confinement to altitudinal zones and specific ecosystems. This represents approximately 25% of all species whose main range lies in the Ancient Mediterranean region. In addition, we included in the analysis another 99 species with a somewhat wider range – Euro-Ancient Mediterranean and Euro-Mediterranean.

Based on the objectives of this study, we did not include in the analysis species with a very wide range – polychoric and Holarctic, as well as species whose main range lies in the Greater Caucasus, as this area belongs to the Boreal subkingdom of Takhtajan (1986).

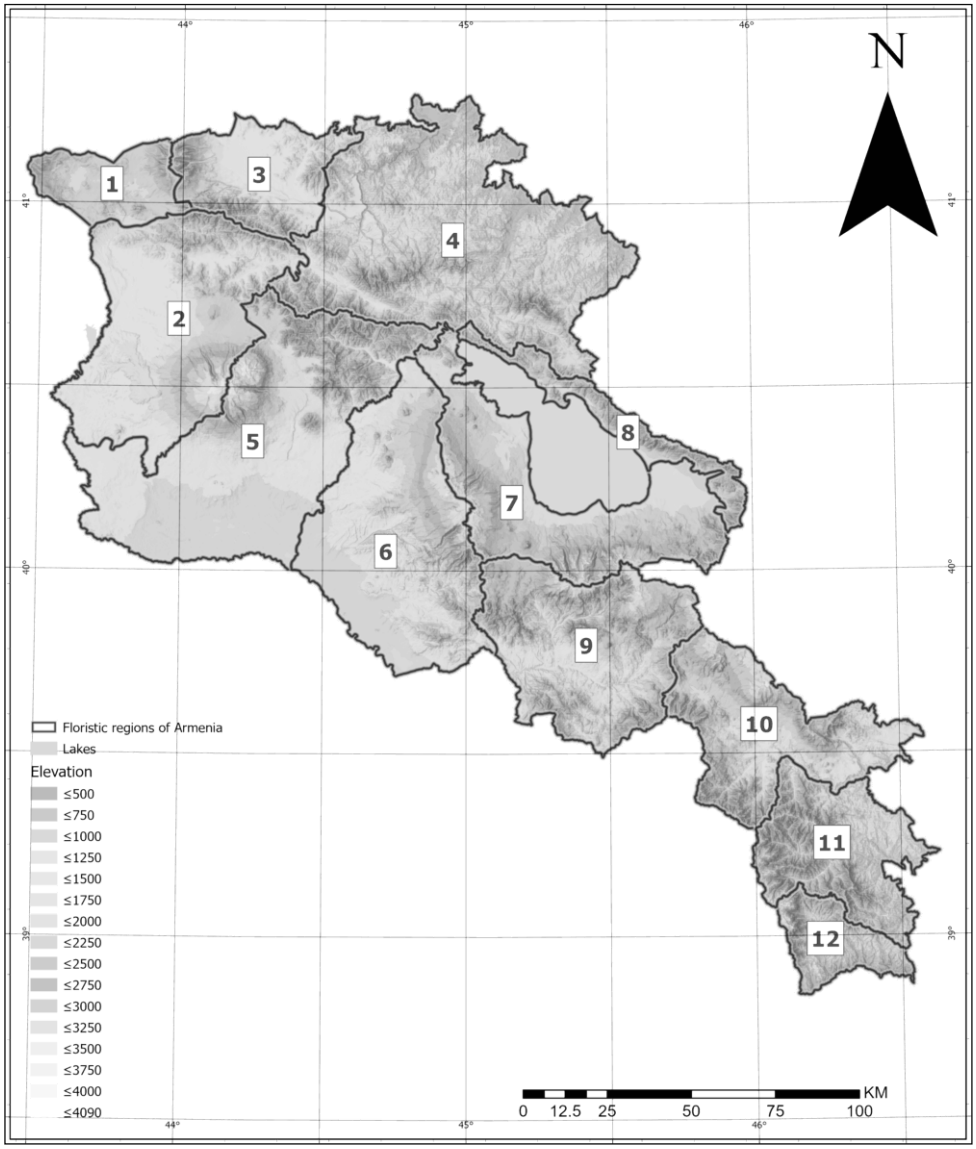


Fig. 3. Floristic regions of Armenia (Tamanyan & Fayvush 2009): 1) Upper Akhuryan; 2) Shirak; 3) Lori; 4) Idjevan; 5) Aparan; 6) Yerevan; 7) Sevan; 8) Areguni; 9) Darelegis; 10) North Zangezur; 11) South Zangezur; 12) Meghri.

To determine the altitudinal confinement of the studied species, literary data were used (primarily "Flora of Armenia" 1954–2009), data from the herbarium of the Institute of Botany after the name A. Takhtajan of the National Academy of Sciences of the Republic of Armenia (ERE) and the results of our own observations in nature for more than 40 years.

To assess the distribution of plant species in different habitats, we used the EUNIS habitat classification system (Fayvush & Aleksanyan 2016), the new version of this classification can be found on the website https://www.eea.europa.eu/data-and-maps/data/eunis-habitat-classification-1.

Results and discussion

The analysis of 562 species of Armenia's flora (Electronic Supplementary File 1, Table S1), which in their distribution are directly related to the Ancient Mediterranean subkingdom (Takhtajan 1986), showed that among the studied taxa, the largest part consists of species growing exclusively on the Armenian Highlands (Armenian geographical element) (Table 1).

Due to the fact that Armenia is predominantly a mountainous country with well-expressed altitudinal zonation of vegetation, in our analysis of the studied species, we primarily examined their distribution in altitudinal zones (Table 2). It should be noted that many species grow in more than one altitudinal zone. Because of this, the sum of species across zones is greater than the number of studied species.

As we can see, the middle mountain belt is the richest in species of the ancient Mediterranean flora. This is most likely due to the fact that this belt hosts the greatest diversity of ecosystems – it is here that steppe and forest ecosystems, woodlands, and tragacanth habitats reach their greatest variety. Intrazonal habitats (such as wetlands and petrophilous habitats) are also well represented. Fewer species are found in the lower mountain belt, where deserts and semi-deserts are more prominent. The fewest species are recorded in the alpine belt, likely due to the smaller areas covered by alpine vegetation and the predominance of Caucasian and boreal plant species in this region (Fayvush & Ghukasyan 2023).

Table 1. Geographical elements (according to Fayvush & Adamyan 2015) of investigated species and subspecies.

Geographical element	**Number of taxa**
Ancient Mediterranean (taxa distributed in the whole area of Ancient Mediterranea)	55
East Ancient Mediterranean (taxa distributed only in the East part of Ancient Mediterranea – from Turkey to East border)	68
Mediterranean (taxa distributed in Mediterranean basin with small irraditions or disjunctions)	14
East Mediterranean	10
Armeno-Iranian	91
Armeno-Atropatenian	46
Iranian	12
Atropatenian	18
Armenian	149
Total Ancient Mediterranean	463
Euro-Ancient Mediterranean	79
Euro-Mediterranean	20

Table 2. Confinement of Ancient Mediterranean taxa to altitudinal zones of Armenia.

Geographical elements	**Altitudinal zones** (number of taxa)				
	Lower (375 – 1300 m a.s.l.)	Medium (1300 – 1800 m a.s.l)	Upper (1800 – 2200 m a.s.l.)	Subalpine (2200-2700 m a.s.l.)	Alpine (2700 – 4095 m a.s.l.)
Ancient Mediterranean	49	44	26	11	4
East Ancient Mediterranean	57	54	26	6	3
Mediterranean	9	12	5	4	3
East Mediterranean	5	8	7	5	2
Armeno-Iranian	52	76	46	30	14
Armeno-Atropatenian	24	40	27	16	6
Iranian	9	8	6	1	0
Atropatenian	8	10	7	6	5
Armenian	46	96	71	41	23
Total (Ancient Mediterranean s.l.)	**259**	**348**	**221**	**120**	**60**
Euro-Ancient Mediterranean	62	73	40	21	8
Euro-Mediterranean	13	16	10	7	3
Total	***75***	***89***	***50***	***28***	***11***

Table 3 illustrates the representation of ancient Mediterranean species in the major ecosystems of Armenia. The first noticeable trend is that most of the studied species are found in grassland ecosystems, with the highest number concentrated in mountain steppes (E1.2). A similar, if not larger, number of species occurs in Armenia's semi-deserts (categories E1.3 and E1.4). A significant number of species have also been recorded in mountain hay meadows (E2.3). Among forest vegetation, oak forests (G1.A1) stand out, as they are found in northern, central, and southern Armenia, in contrast to beech forests (G1.6H), which are only present in northern Armenia. Among shrub ecosystems, the richest in ancient Mediterranean species are the arid woodlands (F5.3 – Pseudomaquis). In petrophilous ecosystems, ancient Mediterranean species are better represented in scree habitats than on rocks, particularly on calcareous and ultrabasic screes of warm exposures (H2.6). Very few species are associated with aquatic and wetland ecosystems (categories C and D). However, it is worth noting that salt marshes (D6.2) host typical Mediterranean species such as *Microcnemum coralloides* (Loscos et J. Pardo) Buen*, Frankenia hirsuta* L., *Merendera sobolifera* Fisch. et C. A. Mey., *Sphaerophysa salsula* (Pall.) DC., and *Iris spuria* subsp. *musulmanica* (Fomin) Takht.

Species with a very broad Euro-Ancient Mediterranean range type are best represented in both mountain steppes (E1.2) and calcareous and ultra-basic screes of warm exposures (E2.3), meaning that most of them prefer calcareous substrates. The same can be said for Euro-Mediterranean species. A relatively small number of Euro-Ancient Mediterranean and Euro-Mediterranean species are found in Armenia's forests (slightly more in oak forests), and surprisingly, none have been recorded in Grecian juniper (*Juniperus excelsa* M. Bieb.) woods (G3.93). Interestingly, very few ancient Mediterranean species are found in agricultural lands (Category I), with Euro-Ancient Mediterranean species preferring bare tilled, fallow, or recently abandoned arable land (I1.5).

Table 3. Distribution of Ancient Mediterranean Plant Taxa Across Main Ecosystems.

Habitats	**Geographical elements**											
	Ancient Mediterranean s.str.	East Ancient Mediterranean	Mediterranean	East Mediterranean	Armeno-Iranian	Armeno-Atropatenian	Iranian	Atropatenian	Armenian	**Total**	Euro-Ancient Mediterranean	Euro-Mediterranean
C3.2		1							4	**5**		
D4.1	5	6	1	1	10	1	1		7	**32**	13	4
D6.2	3	2				1			1	**7**		
E1.2	26	36	9	6	53	31	6	4	65	**236**	29	8
E1.3	23	34	1	1	27	16	8	7	20	**137**	20	2
E1.4	23	34	1	1	27	16	8	7	14	**131**	20	2
E1.6	1									**1**		
E1.C									1	**1**		
E2.3	11	11	3	5	23	14	3	1	33	**104**	29	7
E4.3	1	1	1		7	3			16	**29**	3	3
E4.4	1	1	1		6	2			19	**30**	3	3
E5.4	4	6	1	1	4	3		1	9	**29**	8	1
E5.5					1	1			2	**4**		
F2.3	5	5	1	3	5	1	2		10	**32**	7	2
F3.1									1	**1**		
F3.2									4	**4**		
F5.1	2	2			1	3			3	**11**		
F5.3	10	8	1		12	3	2	1	20	**57**	14	
F7.4									3	**3**		
G1.6H	4	2	1	1	3	1	1		7	**20**	6	3
G1.A1	5	4	2	3	7	5	1	3	17	**47**	12	5
G3.93	2	2			1	3			4	**12**		
H2.3	1	1		1	3	3		3	11	**23**	2	1
H2.4	1	1			3	1			6	**12**	1	1
H2.5	4	4	2		6	3			5	**24**	1	1
H2.6	4	8			15	4	3	1	8	**43**	2	2
H3.1	1	3		1	4	3		2	11	**25**	1	1
H3.2	2	4			2	3		2	9	**22**	1	2
H5.3	3	2			4		1		3	**13**		1
I1.22											5	
I1.3	4	4	2		1					**11**	5	
I1.5	3	5							1	**9**	12	1
I2.2	1									**1**		

C3.2 - Water-fringing reedbeds and tall helophytes other than canes

D4.1 - Rich fens, including eutrophic tall-herb fens and calcareous flushes and soaks

D6.2 - Inland saline or brackish species-poor helophyte beds normally without free-standing water

E1.2 - Perennial calcareous grassland and basic steppes

E1.3 - Mediterranean xeric grassland

E1.4 - Mediterranean tall-grass and wormwood – *Artemisia* - steppes
E1.6 - Subnitrophilous annual grassland
E1.C - Dry mediterranean lands with unpalatable non-vernal herbaceous vegetation
E2.3 - Mountain hay meadows
E4.3 - Acid alpine and subalpine grassland
E4.4 - Calcareous alpine and sub-alpine grassland
E5.4 - Moist or wet tall-herb and fern fringes and meadows
E5.5 - Subalpine moist or wet tall-herb and fern stands
F2.3 - Subalpine deciduous scrub
F3.1 - Temperate thickets and scrub
F3.2 - Submediterranean deciduous thickets and brushes
F5.1 - Arborescent matorral
F5.3 - Pseudomaquis
F7.4 - Hedgehog-heaths
G1.6H - Caucasian beech forests
G1.A1 - Oak - ash - hornbeam woodland on eutrophic and mesotrophic soils
G3.93 - Grecian juniper - *Juniperus excelsa* - woods
H2.3 - Temperate-montane acid siliceous screes
H2.4 - Temperate-montane calcareous and ultra-basic screes
H2.5 - Acid siliceous screes of warm exposures
H2.6 - Calcareous and ultra-basic screes of warm exposures
H3.1 - Acid siliceous inland cliffs
H3.2 - Basic and ultra-basic inland cliffs
H5.3 - Sparsely- or unvegetated habitats on mineral substrates not resulting from recent ice activity
I1.22 - Small-scale market gardens and horticulture, including allotments
I1.3 - Arable land with unmixed crops grown by low-intensity agricultural methods
I1.5 - Bare tilled, fallow or recently abandoned arable land
I2.2 - Small-scale ornamental and domestic garden areas

It should also be noted that at least three species (*Silybum marianum* (L.) Gaertn., *Clematis vitalba* L., *Cirsium incanum* (S. G. Gmel.) Fisch ex M. Bieb.) of Mediterranean, Euro-Mediterranean or Ancient Mediterranean origin appeared on the territory of Armenia in the 20th century. They are currently considered invasive alien species in Armenia and are confined mainly to disturbed habitats.

Table 4 shows the occurrence of Ancient Mediterranean species across various floristic regions of Armenia. As we can see, the largest number of these species is found in the Darelegis, Yerevan, and Meghri floristic regions. This is not surprising, as the flora of the Darelegis region is directly linked to the ancient Tethys Ocean – according to geologists, this area was already an island during the Paleogene (Derkur & Sonnenschein 1990). It later served as a refugium where many Tertiary relic species survived. The Yerevan and Meghri floristic regions are areas with the most pronounced arid climate, to which Ancient Mediterranean species are particularly well adapted.

Table 4. Distribution of Ancient Mediterranean Plant Species Taxa Across the Floristic Regions of Armenia (Tamanyan & Fayvush 2009).

Geographical elements	**Floristic regions of Armenia**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Ancient Mediterranean s.str.	13	31	23	34	32	45	27	21	43	35	38	46
East Ancient Mediterranean	13	27	18	23	32	64	26	24	50	29	27	47
Mediterranean	4	5	4	7	6	7	6	4	6	5	8	9
East Mediterranean	4	3	4	5	7	1	6	6	6	6	5	6
Armeno-Iranian	29	43	23	30	56	71	49	41	75	64	53	59
Armeno-Atropatenian	15	18	12	14	24	31	19	20	31	12	19	21
Iranian	0	4	1	2	6	9	4	3	9	6	4	8
Atropatenian	0	0	0	1	2	5	2	2	6	3	7	12
Armenian	26	50	29	41	55	67	50	38	78	41	39	35
Total (Ancient Mediterranean s.l.)	104	181	114	157	220	300	189	159	304	201	200	243
Euro-Ancient Mediterranean	39	43	47	64	55	58	46	46	59	62	67	59
Euro-Mediterranean	8	9	14	16	13	9	13	11	9	16	15	9

1 – Upper Akhuryan, 2 – Shirak, 3 – Lori, 4 – Idjevan, 5 – Aparan, 6 – Yerevan, 7 – Sevan, 8 – Areguni, 9 – Darelegis, 10 – North Zangezur, 11 – South Zangezur, 12 – Meghri

Conclusion

The flora of Armenia represents a complex and multifaceted structure, in which species of Ancient Mediterranean and Holarctic distribution are present in approximately equal proportions. Additionally, it includes species whose origins are directly linked to the territory of the republic, the Ancient Mediterranean, and the Caucasus. It has been shown that most species of Ancient Mediterranean origin in Armenia grow in the middle and lower mountain belts, where the climate, in terms of seasonal patterns, is most similar to that of the Mediterranean. These species are best represented in steppes, semi-deserts, and, in general, in ecosystems developing on calcareous substrates. According to the floristic division of the Earth by A. Takhtajan (1986), the boundary between the Caucasian and Armeno-Iranian provinces passes through the territory of Armenia, thus separating the Boreal and Ancient Mediterranean subkingdoms. Naturally, this boundary is not a geometric line but rather a broad corridor, within which species with predominantly “northern” and “southern” distributions are represented in varying proportions. The conducted analysis confirms our earlier assumption that the Yerevan, Darelegis, Meghri, and Shirak floristic regions should be attributed to the Armeno-Iranian province of the Ancient Mediterranean subkingdom, while all other regions belong to the Caucasian province of the Boreal subkingdom. At the same time, two floristic regions—Sevan and Areguni—occupy an intermediate position, where Caucasian and Armeno-Iranian species are represented in nearly equal proportions.

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Article

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Galinsoga parviflora (*Asteraceae*): A new alien species recorded in Morocco

Abstract

Benkhnigue, O. Boudik, S., Chriqui, A., Léger, J.-F., Chambouleyron, M., Verloove, F., Chaachouay, N. & Zidane, L.: *Galinsoga parviflora* (*Asteraceae*): A new alien species recorded in Morocco. — Fl. Medit. 35: 147-152. 2025. — ISSN: 1120-4052 printed, 2240-4538 online.

Native to America, *Galinsoga parviflora* Cav. was recently discovered in Morocco for the first time, marking a further extension of its range. The species was identified as a naturalized species in the North Atlantic Morocco floristical division during botanical prospections carried out between 2022 and 2025. The morphological characters, geographical coordinates, habitat, and ecology of this species are described in this work.

Key words: First record, Alien flora, Invasive, North Atlantic Morocco.

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Introduction

In recent years, several alien species have been introduced and discovered in Morocco, including *Ageratum houstonianum* Mill., *Cardiospermum halicacabum* L., *Eichhornia crassipes* (Mart.) Solms, *Euphorbia hyssopifolia* L., *Ipomoea indica* (Burm.) Merr., *Ipomoea triloba* L., *Lemna minuta* Raf., *Mirabilis jalapa* L., *Physalis ixocarpa* Nees, *Setaria palmifolia* (J.Koenig) Stapf, *Tithonia diversifolia* (Hemsl.) A. Gray (Léger & al. 2025), *Lilium candidum* L. (Chriqui & al. 2024), *Chorispora tenella* (Pall.) DC. (Homrani Bakali & al. 2024), *Cotula australis* Hook.f. (Chambouleyron 2023; Jbilou & al. 2023), *Amaranthus spinosus* L. and *Cardamine occulta* Hornem. (Sukhorukov & al. 2023), *Chenopodium glaucum* L. (Chambouleyron & al. 2022). *Galinsoga parviflora* Cav. can, from now be added to this list. The genus *Galinsoga* Ruiz & Pav. belongs to the Asteraceae family, with twelve species recognised worldwide and a native distribution in tropical and subtropical America (POWO 2025). The natural distribution range of this diverse and taxonomically complex genus extends from Mexico to Chile, covering part of South and Central America (Canne 1977; Boulos 2002). It spread quickly across Europe and was

reported by the early 19th century in several countries (Vinogradova & al. 2009). In North Africa, *Galinsoga* is represented by two species: *G. quadriradiata* Ruiz & Pav. and *G. parviflora* Cav. (Dobignard, Chatelain & al. 2011; APD 2025). In Morocco, according to Fennane (2021) and Dobignard (2025), this genus is represented only by *G. quadriradiata.* During our botanical surveys in the Rabat-Salé-Kénitra region (Man-3, Fig. 1) between January 2022 and March 2025, we discovered eight populations of *G. parviflora*. This species is very similar to *G. quadriradiata*; the possibility that both *Galinsoga* will hybridize (Gopinathan & Babu 1982) makes their determination difficult. So, we propose a comparison between these two species below (Fig. 2).

Materials and Methods

As part of updating the Moroccan vascular flora, several botanical surveys were carried out between 2022 and 2025 in the Moroccan Atlantic North-3 (Man-3) floristical division (as defined by Ibn Tattou & Fennane 2008). The geographical coordinates were measured with a GPS receiver (generally with a decametric inaccuracy). They are expressed in degrees-minutes-seconds (WGS84). The determination relied on relevant pertinent literature (e.g. Tutin & al. 1976). The nomenclature adopted follows the International Plant Name Index (IPNI 2025). Chorology is derived from databases such as POWO (2025), Euro+Med PlantBase (2025), and APD (2025). The exsiccata of these plants have been deposited at the Rabat National Herbarium (RAB114822) and the Emirates Center for Wildlife Propagation Herbarium (ECWP).

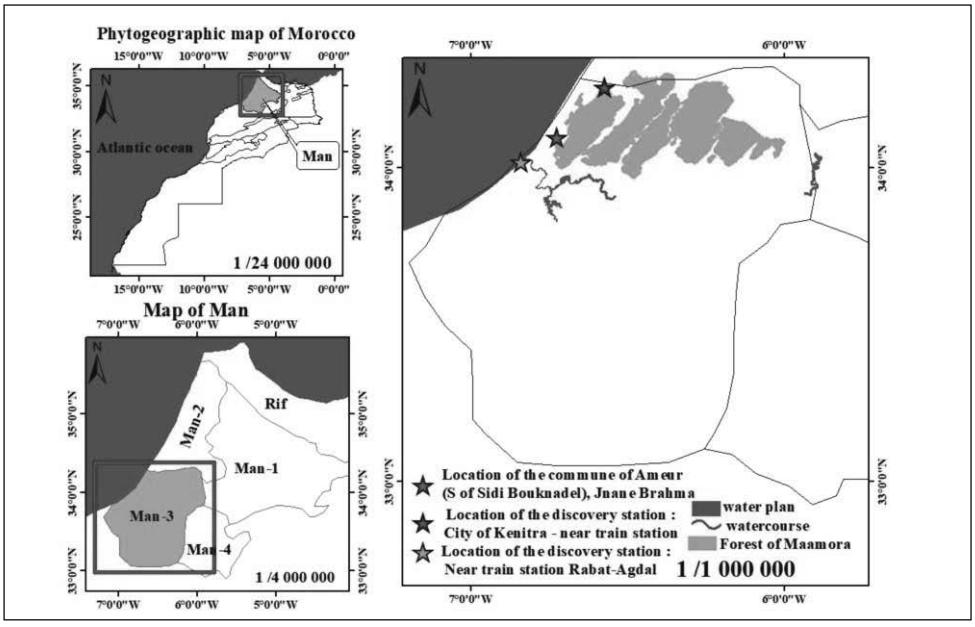


Fig. 1. Known locations of *Galinsoga parviflora* in Morocco.

Results and Discussion

Galinsoga parviflora Cav., Icon. Descr. 3: 41, t. 281 (1795). ≡ *Adventina parviflora* (Cav.) Raf. in New Fl. 1: 67 (1836) ≡ *Wiborgia parviflora* (Cav.) Kunth in F.W.H. von Humboldt, A.J.A. Bonpland & C.S. Kunth, Nov. Gen. Sp., ed. fol., 4: 201 (1818).

Morphology: Below, we provide Figure 2 illustrating the main diagnostic morphological characteristics of *Galinsoga parviflora and G. quadriradiata*.

G. parviflora differs from *G. quadriratiata* by the following characters: The Lower part of the *stem* is almost glabrous to pubescent (vs. densely hairy in *G. quadriratiata)*, *leaves* very sparsely hairy (vs. densely hairy); *peduncle*: sparsely hairy, with appressed hairs and some reddish glandular hairs (vs. densely hairy with simple, spreading hairs and reddish glandular hairs); *Bracts* in three rows (vs. in two rows); *Receptacle scales*: deeply trifid, the central lobe being generally ob-lanceolate (vs. usually entire, or weakly bifid or trifid); *Achenes* of the ray flowers are 1.5–2 mm long (vs. 1.3–1.8 mm long).



Fig. 2. Distinctive Morphological characters of *G. parviflora* (**A, C, F, G, I and K a**) and *G. quadriradiata* (**B, D, E, H, J and K b**): **A** & **B.** Leafy stems with inflorescences; **C** & **D**. Flower peduncles topped by flower heads; **E** & **F.** Floral receptacles with internal scales; **G & H.** Internal scales**; I & J.** Central achenes **& K.** Peripheral achenes (Photos by O. Benkhnigue, 2025).

Flowering and Fructification: *Galinsoga parviflora* is a ruderal plant found in agricultural and urban ecosystems. It grows rapidly and reproduces abundantly in disturbed environments. In Morocco, it flowers and fruits from January to late spring, then dries quickly.

Distribution and Ecology: *Galinsoga parviflora* mainly colonizes disturbed habitats and agricultural areas in Central and South America, as well as in Europe Rojas-Sandoval & Acevedo-Rodríguez 2015). (It extends from Arizona to Texas, as well as in tropical America (POWO 2025). It has been introduced and widely naturalized throughout the world. It is sometimes considered invasive and problematic (e.g. Riemens & Weide 2008). These introductions were generally involuntary via shipments of seeds, fodder or soil. In North Africa, it was known until now in all countries, except Morocco (Boulos 2002; Dobignard & al. 2011; Brahim & al. 2024; APD 2025).

In Morocco, *Galinsoga parviflora* was found in eight locations in the North Atlantic region of Morocco (Man-3). The region exhibits a subhumid Mediterranean climate. O. Benkhnigue documented a total of seven occurrence sites within the urban commune, four of which are situated in the city of Kénitra (La-Hay district, 34°14’56.3”N 6°34’51.6”W, 07.02.2023-2025; Av. Mohamed Diouri, 34°15’12.7”N 6°34’52.3”W, 10.02.2022- 2025; two sites in the la ville haute district (near Oued Sebou, 34°15’53”N 6°35’19”W, 22.02.2024 and Hammam El Fatouaki Street, 34°15’48”N 6°35’16”W, 22.02.2025) and three sites in the city of Rabat (two roadside sites and near the Arribat Center, 34°00’08.2”N 6°50’44.2”W, 12.02.2025, and in the Ministry of Education car park, 34°00’41”N 6°50’19”W, 10.01.2022-2025). J.-F. Léger did another observation in the rural commune (Ameur S of Sidi Bouknadel), Jnane Brahma 34°06’14”N 6°43’58”W, 13.02.2022, on the edge of a humus-rich field (det. M. Chambouleyron, then F. Verloove, herb. Emirates Center for Wildlife Propagation at Missour (ECWP s.n.) (Fig. 1).

Regarding the habitat and ecology of *Galinsoga parviflora*, both in Rabat and Kénitra, we found this species in urban or rural locations with highly disturbed habitats and environments (e.g., roadsides, sidewalks, ornamental plant pots, old damp walls, wet ditches, gardens, greenhouses, nurseries, and abandoned gardens). Since January 2022, over 100 individuals of *G. parviflora* have been consistently observed in Man-3 on moderately humid sandy-clay soils, or at the edge of cultivated fields on humus-rich, hygrocline soils. This ecology is similar to that of other species cited in Spain (Blanca López & al. 2011).

Conclusion

Naturalized long ago around the Mediterranean and on the African continent, the introduction of *Galinsoga parviflora* into North Africa is recent (or remained unnoticed). After Egypt, Algeria, it is now observed in Morocco. It is one of two non-native *Galinsoga* species in Morocco and is often confused with *G. quadriradiata* due to morphological similarities. Recently, in Morocco, Fennane (2021) and Dobignard (2025) mentioned *G. quadriradiata* as a weed in the Middle Atlas region. Benkhnigue & al. (2024) mentioned the recording of this species in a new floristical division (Man-3) and, more precisely, in the city of Kénitra. This is consistent with the fact that these two species have similar ecological needs, as previously reported by Warwick & Sweet (1983). The species was likely

introduced recently to Morocco through seeds present in horticultural substrates used for urban ornamental plantings. Now naturalized, it exhibits invasive potential in open environments such as vegetable crops.

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Article

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Trees and shrubs of the Vashlovani Protected Areas (East Georgia, South Caucasus)

Abstract

Lachashvili, N., Mikeladze, G., Meghvinetukhutsesi, N. & Khetsuriani, L.: Trees and shrubs of the Vashlovani Protected Areas (East Georgia, South Caucasus). — Fl. Medit. 35: 153-166. 2025. — ISSN: 1120-4052 printed, 2240-4538 online.

The dendroflora of the Vashlovani Protected Areas situated in the East Georgia is studied. Its floristic composition and systematic structure are established. The floristic composition of trees and shrubs includes 99 species and subspecies belonging to 61 genera and 34 families. The leading families by content number of species are: *Rosaceae* with 23 species (23.2%), *Fabaceae* 7 (7.1%), *Salicaceae* 6 (6.1%), *Cupressaceae* 5 (5.1%), *Rhamnaceae* 5 (5.1%), *Amaranthaceae* 4 (4.0%), *Oleaceae* 4 (4%), *Anacardiaceae* 3 (3%), *Ulmaceae* 3 (3%). Based on the analysis of the systematic structure and the composition of the chorotypes, florogenetic connections are identified, the main directions of which are Mediterranean, South-West Asia, Europe, Euxine and Hyrcan. A complete list of trees and shrubs attached to the article. Key synonyms and chorotypes for each species are given.

Key words: Dendroflora, systematic structure, chorotype, boreal, Ancient Mediterranean, florogenetic connections.

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Introduction

Woody plants (trees and shrubs) are an important component of most ecosystems on Earth. They are distributed from sea level to the subalpine and alpine belts in the completely different physical-geographic conditions.

In addition to being the main constituent plants of various types of forests and shrubberies distributed from the lowlands to the alpine belt, trees and shrubs are also found in the desert and wetland habitats, and their separate individuals also invading into grassland ecosystems.

Trees and shrubs are an important component and characteristic feature of the regional floras. The physical-geographic conditions of the region, anthropogenic impact, ecological state and stability, as well as the dynamics of the vegetation cover, succession processes

and, often, the past of the vegetation cover are clearly reflect on the composition and structure of the dendroflora.

Trees and shrubs have a wide variety of uses, which is why they have been under strong anthropogenic pressure since time immemorial. In this regard, both massive deforestation and exploitation of forests, as well as large-scale fires, are particularly noteworthy. In addition, global climate change on Earth is most reflected on the trees and shrubs. As a result, the area of trees and shrubs is decreasing and their taxonomic diversity is threatened.

Based on the above, the study of dendroflora in the various directions is one of the current issues of modern biodiversity and ecological research. In the regional studies, it is first necessary to determine the composition and systematic structure of dendroflora, which is the basis of any research.

Particularly noteworthy in terms of diversity are the areas located at the intersection of different physical-geographic regions and floristic centers. To one such transitional and floristically interesting territories belongs the Vashlovani Protected Areas in the South Caucasus, namely, in Eastern Georgia (Map 1), where areas of various floristic centers (Southwest Asia, Turanian area, Mediterranean, Euxine, Hyrcanian, Europe, etc.) intersect; at the same time, the complex nature of physical-geographical conditions is clearly expressed. The mentioned circumstances determine the biodiversity of the Vashlovani Protected Areas. In the past, this area was under strong anthropogenic pressure (deforestation, grazing, artificial fires, etc.), which left its negative mark on the vegetation cover of the area.

All of the above-mentioned circumstances led to our scientific interest in the dendroflora of the Vashlovani Protected Areas and its selection as the object of research.

The aim of our research was to determine the composition and systematic structure of the dendroflora of the Vashlovani Protected Areas; based on the analysis of the systematic structure and composition of chorotypes to identify florogenetic connections; to determine the habitat of each species and assess their current state. The present article include the complete composition of trees and shrubs of the study area and discusses aspects of the systematic structure and florogenetic connections.

Materials and Methods

The research is based on both our researches of the latest years (2015-2024) and our publications of previous years (Lachashvili & al. 2004, 2007; Lachashvili & al. 2004; Lachashvili & Khachidze 2010; Lachashvili & al. 2020, etc.).

The separation of chorotypes is based on the methodology and principles used in our previous publications (Lachashvili & al. 2020; Lachashvili & al. 2021; Lachashvili & al. 2023, etc.). The concepts of Brovich (1989), Meusel and Jager (1989), Ivanishvili (1978), Portenier (2000a, 2000b) and Gagnidze (2004) are taken into account. The borders of the boreal and Ancient Mediterranean regions is based to Takhtajan's floristic division of the Earth (Takhtajan 1978). Caucasus endemics are discussed within the borders of the Caucasus ecoregion (Solomon & al. 2013).

The terrain and hydrological network characteristics of the study area are given according to Maruashvili (1964) and Lachashvili & al. (2004, 2007). Climatic data are reconciled

with data of Dzotsenidze (1964), Loladze (1967, 1970), Gobejishvili (2012) and Bolashvili & al. (2018). Soils and related terms follows Urushadze (1999, 2016).

Description of study area

Physical-geographical conditions. – Vashlovani Protected Areas are located in the south-eastern and eastern parts of the Iori Plateau (East Georgia) (Fig. 1). It consists of several objects with different statuses. These are: 1. Vashlovani Nature Reserve (9962 ha), 2. Vashlovani National Park (25021 ha), 3. Alazani Floodplain Forests Natural Monument (201 ha), 4. Artsivis Kheoba Nature Monument (98 ha), 5. Takhti-Tepha Natural Monument (10 ha) (Fig. 2). The total area of the study areas is (35292 ha). Vashlovani Nature Reserve and Vashlovani National Park are adjacent to each other and form a single natural system; and Artsivis Kheoba and Takhti-Tepha Natural Monuments are quite far from them and represent independent fragments. Alazani Floodplain Forests Natural Monument is to some extent a continuation of Alazani River floodplains entering the territory of the Vashlovani National Park.

Hypsometrical amplitude of the Vashlovani Protected Areas is about from 90 to 800 m a.s.l.

The area is characterized by a difficult terrain. In the Vashlovani Nature Reserve and Vashlovani National Park, the complex alternation of peneplainized plains and asymmetric low ridges is expressed. Most of low ridges are lessons with dry gorges and ravines and

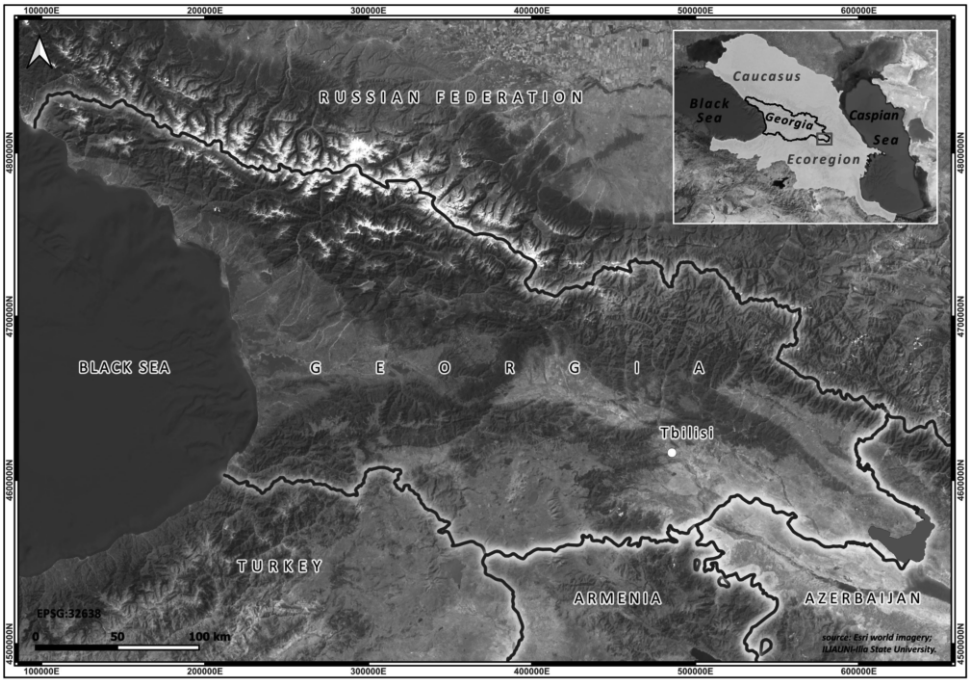


Fig. 1. Location of the Vashlovani Protected Areas in the Caucasus Ecoregion and Georgia (the study area is marked in red).

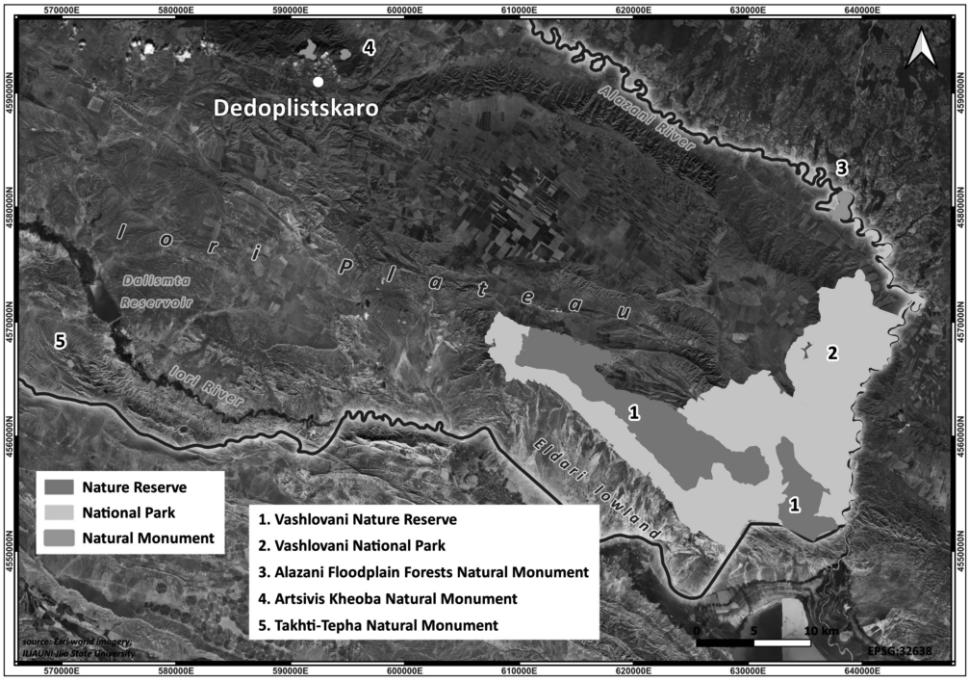


Fig. 2. Map of the Vashlovani Protected Areas.

are characterized by gullies terrain. Canyon-like gorges are not uncommon. Badland low ridges occupy a prominent place in the terrain of the study area. In the various parts of the area, hilly relief is also well expressed.

A narrow bed and narrow floodplains mostly characterize the Alazani River valley in the study area. Not infrequently, the slopes and low ridges are almost directly adjacent to the river.

Artsivis Kheoba Nature Monument characterized by rocky limestone massifs. Itself the Artsivis Kheoba ("Eagle Gorge") presents a narrow rocky canyon.

Despite the non-large area of the territory, the zonal change of climate from south to north is expressed, which is consistent with hypsometric amplitude. Four types of the climate are distinguished in the research area.

Hypsometrically the lowest extreme southern part belongs to moderately warm steppe climate zone with hot summer and precipitation with two minimum per year (BSxa). The average annual temperature is within 13°–14°C, while the average annual atmospheric precipitation is from 350–400 mm, evaporability is up to 1000 mm, humidity ratio 0.4–0.5.

Small part of the territory is located in the transitional climate zone from a moderate warm steppe to a moderate humid with hot summer and two minimums of precipitation per year (BS-Cxa). The average annual temperature is approximately 11–12°C, while the average annual atmospheric precipitation is within 400–450 mm, evaporability approximately 900–1000 mm; the humidity ratio is within 0.6.

Moderate humid climate with moderately cold winter and prolonged warm summer and precipitation with two minimum per year (Cxb) is expressed in the hypsometrically highest part. The average annual temperature is within 10.5–11°C, while the average annual atmospheric precipitation is 600–700 mm, evaporability 800–900 mm, humidity ratio 0.6–1.

A small part of the Alazani River valley entering the study area belongs to the moderate humid climate zone with moderately cold winter and hot summer and precipitation with two minimum per year (Cxa). The average annual temperature is within 14°C, while the average annual atmospheric precipitation is 400 mm, evaporability 800–900 mm, humidity ratio 0.4–0.5.

The hydrological network is poor. The main is transit river Alazani which borders the research area from the east. However, its influence extends only to the riverbed and narrow floodplains. The small river Lekistskali (Salty Water) also belongs to the permanent water stream. It is a salty and small debit river and its influence includes only the bed.

Instead, there are many periodically watered dry ravines in which water will pass as debris/mudflow during rains. There are also several springs that are largely saline. There are no lakes in the study area.

A diverse soil cover is expressed in this small area. According to literature data (Urushadze 1999, 2016; Gobejishvili 2012; Bolashvili & al. 2018), at least five soil types are developed in the study area. Such diversity and regularities of distribution of soil cover are related to climate and hypsometric variability and relief, as well as geomorphological processes.

Light grey-cinnamonic and grey-cinnamonic soils cover the largest area. The first of them mainly is developed on the plains and gently sloping slopes and is salinized to varying degrees. Sometimes white spots of the salts are on the soil surface. Highly salinized moist soils developed on the small places with depressed terrain are rare. Grey-cinnamonic soils mainly are skeleton (stony) and are common on the slopes and hills of different inclination. Compared to the light grey-cinnamonic soils, their salinization is mostly low or insignificant. Hypsometrically relatively high areas are characterized by cinnamonic light and cinnamonic calcareous soils. Alluvial calcareous soils are developed on the terraces of Alazni River.

One of the main ones in the Vashlovani Nature Reserve and Vashlovani National Park is clayey, loamy and clay-sandy badlands. They are mostly salinized - “plates” of salt (especially gypsum containing) sprinkled on the surface are not uncommon. Cemented conglomerate slopes and low ridges are also common. As already noted, the Artsivis Kheoba Nature Monument, located in the vicinity of the Dedoplistskaro stands out for its rocky limestone massifs. In the study area exposed rocky bedrock slopes are rare.

Flora and vegetation. – Vashlovani Protected Areas are distinguished by their floristic richness. Approximately 800–1000 species and subspeciesof vascular plants are distributed in this small area. Xerophilous and hemi-xerophilous plants form the main core of the floristic composition. Compared to them, the number of mesophilic and hydrophilic species is small.

As well as the floristic composition, the vegetation cover is characterized by a rich typological composition. The main types of vegetation are: arid open woodlands (xerophytic wodlands), steppe, hemixerophilous shrubberies, plain deserts, foothill deserts and phryganoid vegetation. Of the xerophilous vegetation, plant communities of tragacanthic shrubberies are rare. In comparison with xerophilous and hemi-xerophilous vegetation,

deciduous forests of the foothills and xeromesophilous shrubberies cover smaller areas.

Floodplain forests and mesophilic shrubberies are developed on the river terraces. Plant communities of the wetland ecotopes, which are mainly associated with riverbanks and terraces, are rare.

Florocomplexes of limestone and exposed rocky sandstones should be mentioned separately.

Results

Systematic structure. – The dendroflora of the Vashlovani Protected Areas includes 99 species and subspecies, which constitutes approximately 28.5% of the local dendroflora of Georgia. They belong to 61 genera and 34 families. The spectrum of the leading families by species content is presented in the form of a table (Table 1).

Most of the families are represented by two or one species (13 families with 2 species each, and 12 families with one species each).

Leading families by content number of genera are: *Rosaceae* – 10 genera (14.9%), *Fabaceae* 5 (7.5%), *Amaranthaceae*, *Anacardiaceae*, *Oleaceae* and *Rhamnaceae* 3 genera for each (4.5%-4.5%). 6 families are represented by 2 genera each, and 22 families by only one genus each. The number of the species is distributed disproportionally in the genera. Most of the genera are represented by one (37 genera) or two (16 genera) species. Only seven genera contain 3-5 species (*Juniperus* and *Pyrus* 5 species each, *Cotoneaster* and *Prunus* 4 each, *Crataegus*, *Populus*, *Rhamnus* and *Salix* 3 each).

Composition of chorotypes (Geographical Range Types). – 99 recorded species of trees and shrubs were distributed in 26 chorotypes, which are united in four main groups: Ancient Mediterranean, boreal, "conjunctive" and "widespread". In addition to main

Table 1. Number of species and subspecies by the leading families in the dendroflora of the Vashlovani Protected Areas.

Family	Number of species & subspecies	%
Rosaceae	23	23.2
Fabaceae	7	7.1
Salicaceeae	6	6.1
Cupressaceae	5	5.1
Rhamnaceae	5	5.1
Chenopodiaceae	4	4.0
Oleaceae	4	4.0
Anacardiaceae	3	3.0
Ulmaceae	3	3.0
Total	60	60.6

Remark: only the genus *Fraxinus*, within the family *Oleaceae*, contains two subspecies.

groups, non-local (alien) species are separated. Quantitative and percentage proportions of chorotypes are given in the tabular form (Table 2).

Endemics. – 8 out of 99 species and subspecies are endemics of the Caucasus. These are: *Acer ibericum* M. Bieb., *Alnus glutinosa* subsp. *barbata* (C.A. Mey.) Yalt., *Astracantha caucasica* (Pall.) Podlech, *Berberis iberica* DC., *Cotoneaster meyeri* Pojark.,

Table 2. Proportion of chorotypes in the dendroflora flora of the Vashlovani Protected Areas.

Chorotype	Number of species	%	Number of species	%
Ancient Mediterranean species				
Mediterranean	6	6.1	32	32.3
Mediterranean–South-West Asian	9	9.1		
Mediterranean– South-West Asian–Turanian	1	1		
South-West Asian	5	5		
South-West Asian–Turanian	3	3.0		
South-West Asian–Turanian–Central Asian	7	7.1		
Caspian	1	1		
Boreal species				
Caucasian	10	10.1	19	19.2
European–Caucasian	6	6.1		
European	1	1		
Euro–Siberian	2	2.0		
“Conjunctive” species				
Caucasian–South-West Asian	10	10.1	39	39.4
Caucasian–South-West Asian–Middle Asian	1	1		
Caucasian–Middle Asian	1	1		
Submediterranean	3	3		
Mediterranean–Eurasian steppe	1	1		
Euxino–Hyrcanean	8	8.1		
Caucasian–Hyrcanean	1	1		
European–Mediterranean	8	8.1		
European–Mediterranean–South-West Asian	4	4.1		
European–Mediterranean–South-West Asian–Central Asian–East Asian	1	1		
Euro–Siberian–Central Asian	1	1		
Widespread species				
Palearctic	6	6.1	7	7.1
Holarctic	1	1		
Non local species				
North American	1	1	2	2
Central Asian (Central and North China)	1	1		
All	99	100	99	100

Remark – “Middle Asian” means mountainous Middle Asia (Pamir-Alay, Tian Shan, etc.).

Crataegus caucasica K. Koch, *Pyrus georgica* Kuth., *Pyrus sachokiana* Kuth. Of these, only *Alnus glutinosa* subsp. *barbata* (C.A. Mey.) Yalt. is a Euxino–Hyrcanean plant and the rest belong to the Caucasian chorotype.

Discussion

Systematic structure and habitats. – In the systematic structure, dominance of family *Rosaceae* is expressed. It is one of the characteristic families of the Nemoral, Sub-mediterranean and Boreal floras. It is also noteworthy that the location of *Rosaceae* in regional floristic spectra decreases from humid to arid regions. At the same time, it is one of the characteristic and leading families of forests and shrubberies. Accordingly, its share decreases from forested to non-forested regions (Turrill 1929; Tolmachev 1986; Lachashvili & al. 2007; Chasapis & al. 2020; Lachashvili & al. 2020; Vladimirov & al. 2020; Lachashvili, & al. 2021, etc.).

Considering the climatic conditions and vegetation cover of the Vashlovani Protected Areas, the dominance of *Rosaceae* in the systematic spectrum of its dendroflora is completely natural.

However, if we compare it with the dendroflora spectrum of the Tbilisi area (Lachashvili, & al. 2021), its share is reduced (32.6% and 23.4%, respectively). This, in our opinion, is related, on the one hand, to the location and physical-geographical parameters of the territories and, on the other hand, to their vegetation cover. Namely:

- Compared to the Tbilisi area, the climate in the Vashlovani Protected Areas is more arid;
- Soil conditions should also be taken into account - various modifications of grey-cinnamonic soils are predominant in the Vashlovani Protected Areas (including relatively dry and saline soils to varying degrees), while cinnamonic soils are of limited distribution; In addition, brown forest soils are not spread at all;
- In the vegetation cover of the Vashlovani Protected Areas, the role of deciduous forests of the foothills and lower mountain belts has sharply decreased, while the role of xerophilous and semi-xerophilous vegetation has increased;
- Compared to the Tbilisi area, the Vashlovani Protected Areas are more closely connected to the arid and semi-arid regions of the South Caucasus and their ecosystems, which leads to a weakening of the influence of the boreal world.

On the contrary, the presence of *Amaranthaceae* (*Chenopodiaceae*) in the top ten is noteworthy, which is one of the characteristic and leading families of the Irano-Turanian (and in general, Sahara-Gobi) deserts (Lavrenko 1962; Bykov 1978; Quesel 1979; Agakhanyants 1986; Wickens 1984; Abd El-Ghani 2000; Lachashvili & al. 2007; Baayo 2008; Lachashvili & Khachidze 2010; Salama & al. 2014; Dhief & al. 2022; Rekis 2023, etc.). Its presence in the top ten is related to the distribution of desert vegetation in the study area.

The presence of *Cupressaceae* and *Anacardiaceae* in the top ten also is directly related to the above.

The remaining leading families (except *Fabaceae*) mainly include woody plants and are characteristic of the dendroflora of different regions. Accordingly, their leading positions in the floristic spectrum are regular.

From the bioecological point of view, the composition of trees and shrubs of the

Vashlovani Protected Areas is very diverse, which is due, on the one hand, to the physical-geographical conditions and, on the other hand, to the diversity of the vegetation cover. Both xerophilic and mesophilic aspects are reflected in the composition of the dendroflora of the Vashlovani Protected Areas. In this regard, the composition of the leading families in terms of species content is particularly important.

In the study area the species of family *Rosaceae* are distributed in the different environments. They can be conditionally divided into three main groups: 1. trees and shrubs characteristic of arid woodlands and hemixerophilic shrubberies [*Prunus incana* (Pall.) Batsch, *Prunus microcarpa* C.A. Mey., *Pyrus salicifolia* Pall., *Cotoneaster morulus* Pojark.]; 2. species growing in the floodplains and other mesophilic environments [*Rubus anatolicus* Focke, *Crataegus pentagyna* Waldst. & Kit. ex Willd., *Sorbus torminalis* (L.) Crantz]; 3. shrubs and trees growing in the foothill deciduous forests and their edges [*Pyrus communis* subsp. *caucasica* (Fed.) Browicz, *Prunus cerasifera* Ehrh., *Mespilus germanica* L., *Cydonia oblonga* Mill., *Crataegus caucasica* K. Koch]. However, it should be noted that such differentiation is conditional, because some species are common in the various environments. It is obvious that the rich floristic composition of the *Rosaceae* family in the study area was also reflected in the bioecological diversity of species.

The species of the *Fabaceae* family distributed in the study area are characteristic of the vegetation cover of xerophilous and semi-xerophilous ecosystems (tragacanthic and hemixerophilous shrubberies, phryganoid vegetation, arid woodlands, rocky and stony ecotopes). Their composition is enriched by the invasive shrub *Amorpha fruticosa* L., which is widespread in floodplain forests and shrubberies developed on river terraces.

The high position of the family *Salicaceae* in the spectrum is associated with the presence of floodplain ecosystems (floodplain forests) in the study area. Whereas the high position of *Cupressaceae* is due to the characteristic and dominant trees and shrubs of arid (xerophytic) woodlands (*Juniperus* spp.).

Two species of the *Rhamnaceae* family – *Paliurus spina-christi* Mill. and *Rhamnus erythroxyloides* Hoffmanns. subsp. *erythroxyloides* – are widespread in the study area. They are one of the characteristic plants of arid woodlands, xerophilous and semi-xerophilous shrubberies. The other three species are rare in the study area. Of these, *Frangula alnus* Mill. is a very rare plant in the Vashlovani Protected Areas and its single individuals are distributed only in the floodplain forests. While *Rhamnus cathartica* L. and *R. spathulifolia* Fisch. & C.A. Mey. grows in various shrubberies.

The high position of the family *Amaranthaceae* in the floristic spectrum is related to the presence of desert vegetation in the study area. The Vashlovani Protected Areas are one of the extreme ends of the distribution range of the shrubs included in this family [*Halostachys caspica* (M. Bieb.) C.A. Mey., *Kalidium caspicum* (L.) Ung.-Sternb., *Suaeda dendroides* (C.A. Mey.) Moq., *S. microphylla* Pall.]. These species are very rare in the study area.

We also note that in the study area and its adjacent territories, *Amaranthaceae* is widely represented by semi-shrubs and annuals and is among the leading families in the general floristic spectra (Lachashvili 1989; Lachashvili & al. 2004, 2007).

The species of the *Oleaceae* family distributed in the study area are predominantly components of deciduous forests of the foothills and lower mountain belts [*Fraxinus excelsior* L. subsp. *excelsior*, *F. excelsior* subsp. *coriariifolia* (Scheele) A. E. Murray, *Ligustrum vul-*

gare L.] and their range in the study area is limited. The exception is *Chrysojasminum fruticans* (L.) Banfi, which is one of the characteristic plants of arid woodlands and various types of shrubberies and is widely distributed in the Vashlovani Protected Areas.

All three species in the family *Anacardiaceae* are components of arid woodlands and hemixerophilous shrubberies. Of these, *Pistacia atlantica* Desf. is the main dominant of arid woodlands.

Composition of chorotypes (Geographical Range Types). – The composition of the chorotypes reflects both Ancient Mediterranean and boreal roots.

The number of Ancient Mediterranean species is almost 1.7 times higher than the number of boreal species. The largest part of the study area belongs to semi-arid climate regions with appropriate soil types and vegetation (arid woodlands, deserts, hemixerophilous shrubberies, etc.), which determines deeper florogenetic connections with Ancient Mediterranean.

Connections with the boreal world are mostly related to the presence of foothill deciduous forests and floodplain forests in the study area, which occupy small areas.

In the composition of the Ancient Mediterranean species both Mediterranean and South-West Asian connections are expressed. Compared to them, links with Turan are small.

Within the Ancient Mediterranean, such directional links are completely regular. These connections, together with the location and physical-geographical conditions of the study area, are determined by the dominance of arid woodlands, hemixerophilous shrubberies and desert vegetation in the vegetation cover.

Both the scarcity of boreal chorotypes (4 in total) and the small number of boreal species are evident. The main ones are the Caucasian and European-Caucasian chorotypes.

In the chorological spectrum, Caucasian species share 1-2 places with Caucasian–South-West Asian, 10 species for each (10.1% for each). In addition, seven of the Caucasian species are endemics of the Caucasus, while the distribution range of the rest species slightly exceeds the Caucasus ecoregion. Such a level of endemism for the dendroflora of the territory located at the intersection of various floristic centers should not be considered a low indicator.

As in our previous publications (Lachashvili & al. 2020, 2021, 2023), we emphasize here that the Caucasian chorotype is attributed by various researchers (Gagnidze & Davitadze 2000; Shetekauri & Gagnidze 2000; Gagnidze 2004) to the Ancient Mediterranean world, namely the Submediterranean. In such a case, the number of boreal species in the dendroflora of the Vashlovani Protected Areas will be insignificant, and the proportion of "transitional" species will also decrease; against this background, the proportion of Ancient Mediterranean species will significantly increase. It is also worth noting that the majority of Caucasian species distributed in the study area are hemixerophilous plants and in their bio-ecology are closer to Ancient Mediterranean plants than to boreal ones. The same applies to Caucasian–South-West Asian species – most of them are also more similar in their bio-ecology to Ancient Mediterranean plants.

If we do not take into account the Caucasian chorotype, then the boreal connections will be reflected mainly in the diversity of the so-called "conjunctive" chorotypes.

In the chorological spectrum, the diversity of "conjunctive" chorotypes and the abundance of "transitional" species are first of all noteworthy. In our opinion, this is completely regular, since the study area is located at the crossing of the boreal and Ancient Mediterranean worlds.

Of the "conjunctive" chorotypes, the Caucasian–South-West Asian chorotype is the most numerous (10 species). These species, together with the Caucasian–South-West Asian–Middle Asian and Caucasian–Middle Asian species form a kind of floristic circle between the Caucasus and South-West Asia. At the same time, these chorotypes emphasize and strengthen the florogenetic connections of the Southwest Asian direction.

The connections of the European direction are also mainly reflected in the "conjunctive" chorotypes (European–Mediterranean, European–Mediterranean–South-West Asian). Accordingly, together with the European–Caucasian chorotype the European–Mediterranean–Caucasian–Southwest Asian florogenetic circle is formed.

One of the notable "conjunctive" chorotypes is the Euxine–Hyrcanian chorotype (8.2%). Given the intermediate location of the study area between the Euxine and Hyrcanian floristic centers, no small number of these species is completely natural.

The comparative analysis of the leading families' composition and chorotypes is interesting. The rich floristic composition of the *Rosaceae* family determines a wide range of chorotypes, which has been revealed in florogenetic links of various directions. The various directions of florogenetic connections (Europe, Mediterranean, Euxine, Hyrcan, Southwest Asia, etc.) are most reflected in the wide range of so-called "transitional" species (15 species). The Caucasian species (5 species) also deserve attention, of which four are endemics of the Caucasus.

Within the composition of the family *Fabaceae*, both Mediterranean (East Mediterranean) and Southwest Asian connections are clearly expressed. Boreal links are only associated with the Caucasian-Southwest Asian [*Astracantha microcephala* (Pall.) Podlech, *Caragana grandiflora* (M. Bieb.) DC.] and Caucasian [*Astracantha caucasica* (Pall.) Podlech] species.

As noted, the representatives of the *Cupressaceae* family (*Juniperus* spp.), common in the Vashlovani Protected Areas, are components of the xerophytic forests and their composition clearly shows Ancient Mediterranean florogenetic links. *Pistacia atlantica* Desf. and *Rhus corriaria* L. (*Anacardiaceae*) belong to the Mediterranean–South-West Asian species. In contrast, *Cotinus coggygria* Scop. is a South Palearctic species, although it is closely related to the Ancient Mediterranean. The shrubs of the family *Amaranthaceae*, distributed in the study area, are typical components of the Irano-Turanian deserts and their participation emphasizes the influence of the Ancient Mediterranean.

The location of the study area at the intersection of the boreal and Ancient Mediterranean worlds is well reflected in the species of the family *Salicaceae*. Both boreal [*Populus canescens* (Aiton) Sm., *Salix caprea* L.] and Ancient Mediterranean (*Populus euphratica* Oliver, *Salix wilhelmsiana* M. Bieb.), as well as Palearctic plants (*Populus nigra* L., *Salix alba* L.) are represented.

The majority of species in the family *Oleaceae* are so-called "conjunctive" species. Accordingly, both boreal (Europe, Caucasus, Euxine) and Ancient Mediterranean (Mediterranean, Southwest Asia, Hyrcan) connections are expressed. *Ulmaceae* family trees (*Celtis caucasica* Willd., *C. glabrata* Steven ex Planch., *Ulmus minor* Mill.) are also belong to the "binding" species.

By chorotypes, the composition of species within family *Rhamnaceae* is "variegated", showing both boreal and Ancient Mediterranean connections.

The presented data show that in the majority of the leading families dominated so-called "conjunctive" species. Both Ancient Mediterranean and boreal connections in the most of

these families are reflected. The exceptions are the families *Cupressaceae*, *Chenopodiaceae* and *Anacardiaceae*, in whose compositions the Ancient Mediterranean connections are clearly expressed.

General Conclusion

The diversity of the physical-geographic conditions and vegetation cover determines the diversity of the dendroflora of the Vashlovani Protected Areas. The diversity is reflected in both species and bioecological diversity, which is consistent with the physical-geographic conditions of the study area.

The transitional location of the territory at the intersection of the boreal and Ancient Mediterranean floristic centers was reflected in the directions of the florgenetic connections of the dendroflora.

The number of Ancient Mediterranean species significantly exceeds the number of boreal ones, which is consistent with the climatic and soil conditions, as well as the vegetation cover of the study area.

The so-called "conjunctive" chorotypes dominate, the composition of which is represented by a wide spectrum. Ancient Mediterranean connections are expressed both in the Mediterranean and South-West Asian directions; links with the Turanian area are very weak. Boreal connections mainly cover Europe and the Euxine, and links towards Siberia are insignificant.

Analysis of the data reveals that, despite the multifaceted phylogenetic connections, the connections with the Ancient Mediterranean are sharper.

On the one hand, the florogenetic connections of various directions and, on the other hand, the high share of Caucasian species emphasize the originality of the dendroflora of the Vashlovani Protected Areas.

Floristic composition indicating key synonyms and chorotypes for each species are given in the Electronic Supplementary file 1 (ESF 1).

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Article

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Ecology and conservation status of Algerian fir (*Abies numidica*) in Babor-Tababort National Park (Northeast Algeria)

Abstract

Adjrad, S., Tababouchet, M., Zemouri, M., Bouchibane, M. & Bougaham, A. F.: Ecology and conservation status of Algerian fir (*Abies numidica*) in Babor-Tababort National Park (Northeast Algeria). — Fl. Medit. 35: 167-182. 2025. — ISSN: 1120-4052 printed, 2240-4538 online.

The Algerian fir (*Abies numidica*), a species strictly endemic to Algeria and protected under national legislation, has a highly localized distribution area, confined to the Babor-Tababort National Park in the northeast of the country. Our study allowed us to map the species' distribution range, estimate the mature trees of its populations, their altitudinal distribution, and reassess its conservation status according to IUCN criteria. The study was conducted between June 2020, and April 2025. For the counting of mature trees, a systematic sampling was carried out in the Babor forest, while a direct count was conducted in the Tababort forest. The Babor location has a relatively homogeneous and continuous distribution. The Tababort location, characterized by a fragmented distribution. The total population size is estimated to be around 8,561 mature trees, distributed across an area of occupancy of 40 km². The species preferentially occupies the north and northeast slopes, which are cooler and more humid, located between 1500 and 2000 meters in altitude, with a high abundance between 1717 and 1788 meters. It coexists with several forest tree species, including *Cedrus atlantica*, *Quercus canariensis*, *Populus tremula*, and *Acer obtusatum*. A reassessment based on IUCN criteria suggests that the species has to be classified as Vulnerable (VU). Its conservation status is justified by its very restricted distribution and small population size. These results confirm the urgent need to implement targeted conservation strategies based on updated data, in order to ensure the perennity of this relict species, which is particularly vulnerable to both historical and current human pressures, as well as the effects of climate change.

Key words: endemism, habitat, IUCN reassessment, threats, conservation, North Africa.

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Introduction

Biodiversity hotspots are regions characterized by high species richness and high levels of endemism, yet they are subject to significant threats from human activities (Hoffmann

& al. 2016). These areas are crucial for conservation, as they host a large proportion of the world's biodiversity (Reid 1998; Bedair & al. 2022). There are 36 hotspots worldwide, covering approximately 3.3 million km², or about 2.3% of the Earth's terrestrial surface (Hoffmann & al. 2016; Ge & al. 2022). They harbor at least 1,500 endemic vascular plant species and have lost more than 70% of their original habitat (Hoffmann & al. 2016).

The Mediterranean biogeographic region is considered the second most important biodiversity hotspot globally (Bedair & al. 2022). It spans more than 30 countries and includes a wide variety of terrestrial habitats, from forests and maquis to coastal wetlands and transitional desert environments. It hosts more than 25,000 flowering plant species, approximately 63.5% of which are endemic (Zahran 2010). At the junction of Europe, Asia, and Africa, the region is influenced by contrasting biogeographical zones, ranging from temperate to arid and tropical climates. Combined with great heterogeneity of soils and topography, this explains its exceptional richness (Thompson 2020). The high endemism is linked to strong specialization of plant species to localized ecological conditions, particularly in restricted habitats such as isolated mountain ranges, islands, or rocky soils. Geographic isolation, topographic and climatic diversity, and the complex geological history of the region have contributed to the persistence of numerous rare species with narrow distribution ranges (Zahran 2010; Thompson 2020; Vargas 2020; Médail 2022).

Algeria, a southern Mediterranean country, is distinguished by exceptional floristic richness, particularly in its northern mountainous areas. Ecological variation, topographic isolation, and climatic diversity within these ecosystems (Bougaham & Moulai 2014) have contributed both to speciation and to the preservation of relict species. Babors Kabylie is a major refuge for floristic diversity (Quézel & Santa 1962-1963; Gharzouli 2007; Bouchibane & al. 2024), hosting unique plant groups and many species with restricted distributions, some of them strictly endemic (Véla & Benhouhou 2007). Among these species is the Algerian fir (*Abies numidica* de Lannoy ex Carrière), strictly endemic to this region.

The genus *Abies* is considered one of the most complex within the *Pinaceae* family (Parducci & al. 2001). With the exception of *Abies tazaotana* Cozar and *A. pardei* Gaussen, which remain poorly known, Quézel (1998) identifies six species around the Mediterranean basin, divided into two groups. The first, with sharp needles, includes *A. pinsapo* Boiss., *A. maroccana* Trab., and *A. cephalonica* Loudon. The second, with emarginate or blunt needles, comprises *A. numidica*, *A. nebrodensis* (Lojac) Mattei, and *A. cilicica* (Ant. & Kotschy) Car. The Algerian fir is one of the last living indicators of relict North African fir forests (López-Tirado 2023). It forms relict localities in high-altitude limestone habitats, under conditions requiring high atmospheric humidity (De Smet & Bouazza 1984; Kolai 1992). Its distribution is restricted to the northern slopes of Jebel Babor and Tababort, within the Babor-Tababort National Park (JORADP 2019), where it is vulnerable to environmental disturbances intensified by human activities (Tlili-Ait Kaki & al. 2013).

Due to its restricted geographical range, the species was first classified as Vulnerable (VU) by Walter & Gillett (1998), then reclassified as Critically Endangered (CR) by Yahi & al. (2011). It is also listed among the protected plants in Algeria (JORADP 2012). Although studied for its phytochemical properties (Tlili-Ait Kaki & al. 2013; Adjaoud & al. 2024), data on its current spatial distribution and demographic structure remain limited, despite its ecological and heritage value (Quézel & Santa 1962-1963; Hachi-Illoul 2016). Most ecological studies have focused on the Babor forest, whereas Tababort has only been

described in a few early publications, notably by Barbey (1934). Previous conservation assessments (Walter & Gillett 1998; Yahi & al. 2011) were based mainly on historical data. However, growing threats such as forest wildfires, overgrazing, habitat fragmentation, and climate change now increase the risk of genetic erosion by limiting exchanges between localities (De Smet & Bouazza 1984; Barbero & al. 1990; Madoui 2020).

In this context, a precise assessment of the species' conservation status and population size is crucial to guide management and conservation. This study aims to fill the knowledge gap regarding the distribution and ecology of *Abies numidica* within the Babor-Tababort National Park, through: (1) the development of a detailed spatial distribution map across the Babor and Tababort forests; (2) the estimation of its population size; (3) the assessment of the effect of altitude and slope aspect on its distribution; and (4) the reassessment of its conservation status according to IUCN criteria, with identification of priority areas for its preservation.

Material and Methods

Study area. **-** The Babor-Tababort National Park is located in the Babors Kabylie, in northeastern Algeria. Established as a protected area in 2019 (JORADP 2019), it covers an area of 23,656 hectares, across the three wilayas of Sétif, Béjaïa and Jijel (Fig. 1). It is characterized by four forests, which are considered the central zone of the Babor-Tababort National Park, namely Jebel Tenedet, Jebel Zan Oughilas, Jebel Tababort and Jebel Babor (JORADP 2019). Our study was carried out on these last two jebels, which reach an altitude of 1969 m a. s. l. and 2004 m a. s. l. and cover areas of 346 hectares and 1268 hectares respectively (Ledant & al. 1985). These summits dominate a mountainous landscape with diverse ecological and Palearctic bioclimatic conditions shaped by complex geomorphology, high altitudinal gradients, and a climate ranging from subhumid to per-humid (Quézel & Santa 1962-1963; Ledant & al. 1985; Gharzouli 2007). The Tababort and Babor forests host remarkable biodiversity, including endemic and relict species of major biogeographical interest, such as *Abies numidica*, *Erodium battandieranum* Rouy and *Vicia ochroleuca* subsp. *baborensis* (Batt. & Trab.) Greuter & Burdet for the flora (Bouchibane & al. 2024), and the Algerian Nuthatch (*Sitta ledanti* Vielliard) for the fauna (Zemouri & Bougaham 2022). These forests are mainly composed of Algerian fir, Atlas cedar (*Cedrus atlantica* (Manetti ex Endl.) Carrière), Algerian oak (*Quercus canariensis* Willd.), and African oak (*Q. afares* Pomel). Beyond these dominant trees, the area contains rare and endemic plant species of Babors Kabylie, such as Eurasian Aspen (*Populus tremula* L.), *Epimedium perralderianum* Coss., and *Saxifraga numidica* Maire (Quézel & Santa 1962-1963).

Field sampling and distribution mapping. – The identification of Algerian fir locations was based on existing literature sources (Battandier 1888-1890; Quézel & Santa 1962-1963), as well as unpublished personal field observations across the entire distribution range of the species. Surveys were conducted in both the Babor and Tababort forests. In Babor, sampling was carried out between June and July 2020, with 240 points surveyed using systematic sampling along line transects spaced at 100-meter altitudinal intervals (sensu Hacioğullari & al. 2019) (Fig. 2). This method covered the entire forest, extending over seven kilometers. Sampling points were placed every 200–300 meters, with adjust-

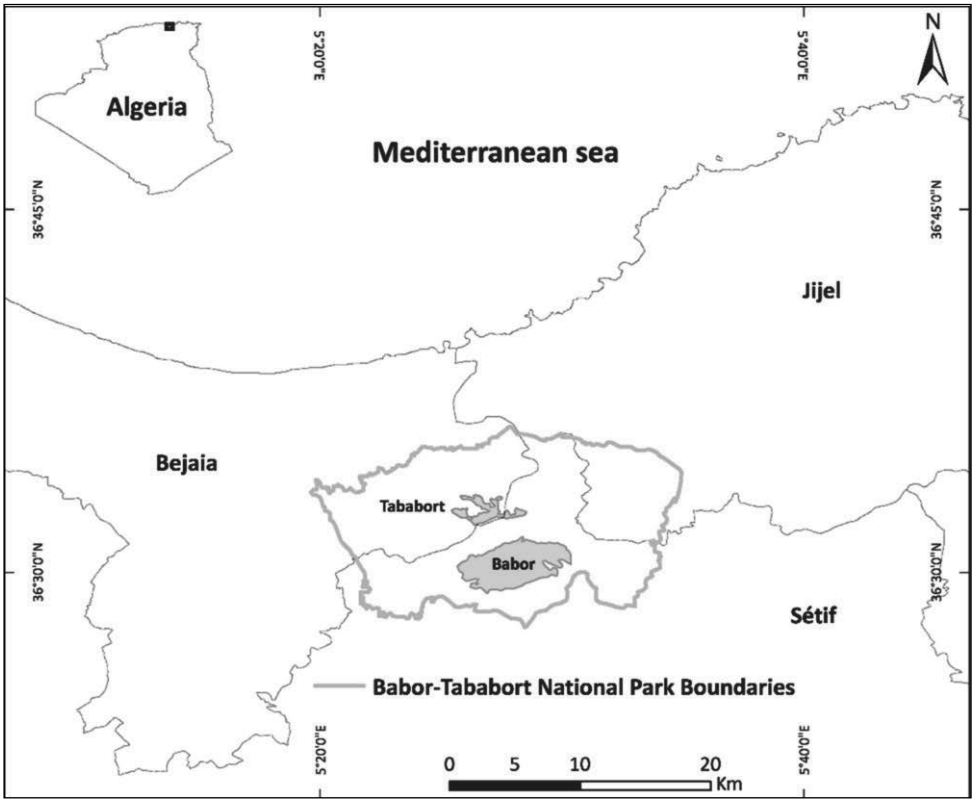


Fig. 1. The study area and field sites within the Babor-Tababort National Park, northeastern Algeria.

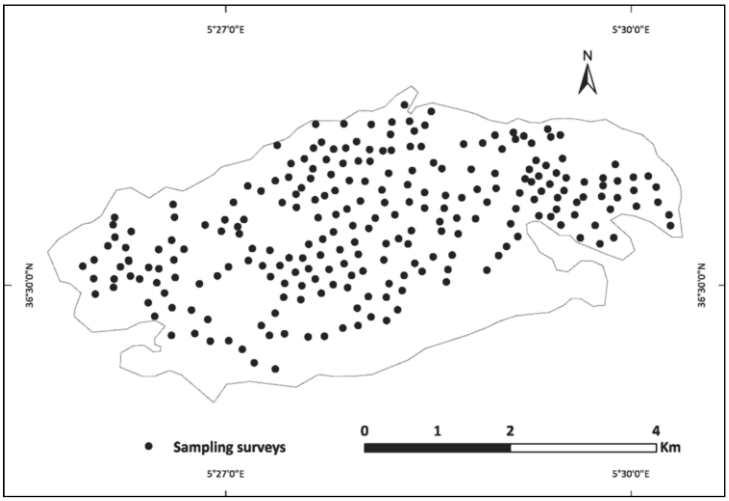


Fig. 2. Sampling points of the Algerian fir in the Babor Forest.

ments only when field access was limited. In Tababort, mature trees were counted by direct observation between March and April 2025. At each site, slope aspect, associated tree species, and GPS coordinates were recorded using a Garmin Map 76CSx.

Using ArcGIS (ArcMap v10.7.1, ESRI 2019), we produced (1) a distribution map of Algerian fir locations and cantons within Babor-Tababort National Park, and (2) a spatial georeferencing of all field-collected data.

Abies numidica ***population size.*** – Two complementary field methods were applied to estimate the total population size of Algerian fir in Babor-Tababort National Park. In Babor, 45 sampling plots of 10,000 m² (100 × 100 m) were established (Pisanu 2009), each centered on a verified occurrence point. The mean number of mature trees per plot was extrapolated to the species' distribution area to estimate the total population size. In Tababort, given the small effective population size and fragmentation, all mature trees were counted directly in the field (Bullock 1996). Mature trees were distinguished from immature ones based on cone production and/or the presence of a central rachis from the previous season. Data from both approaches were combined to estimate the total population size of the species.

Altitudinal distribution range. **–** To assess the altitudinal distribution of the species across both forests, 51 plots (100 × 100 m) were established, 45 in Babor and six in Tababort. These plots were positioned along altitudinal bands where Algerian fir occurs, providing representative data on local abundance and distribution patterns. Altitudinal classes were determined following Sturges' rule (Sturges 1926):

number of classes = 1 + (3.3 × log n), where n = 51. The resulting number of classes was rounded to the nearest whole number. Class intervals were then calculated as (Highest altitude – Lowest altitude) / Number of classes.

Reassessment of the IUCN conservation status. **–** To reassess the conservation status of Algerian fir, we georeferenced all known forest plots (Quézel & Santa 1962-1963), quantified the Area of Occupancy (AOO) and Extent of Occurrence (EOO), and estimated the number of mature trees. The reassessment was based on 51 occurrence records, 45 from Babor and 6 from Tababort (Fig. 3). We first focused on criteria D, as no reliable historical demographic data were available for criterion A and C, and no extinction probability models for criterion E. Criterion A requires quantitative data on abundance or density spanning at least 10 years or three generations (IUCN 2024), which in this case represents several decades and possibly the maximum capped at 100 years. Criterion E was not applicable, as no quantitative extinction, risk analysis was available. This reassessment was conducted in accordance with the IUCN Red List (2024) categories and criteria, version 16. GPS coordinates from field surveys were used to calculate both Extent of Occurrence (EOO) and AOO using the GeoCAT tool (Bachman & al. 2011, https://geocat.iucnredlist.org/editor). The AOO was estimated with the standard 2 × 2 km grid, as recommended by IUCN (2024). The EOO was calculated as the minimum convex polygon enclosing all confirmed occurrences, excluding unsuitable or unoccupied areas (IUCN 2024; Fig. 3). These values informed the reassessment under criterion B.

Results

Distribution and cartographic representation of **Abies numidica** ***population.*** **-** The Algerian fir population is composed of two separate locations (Babor and Tababort). These

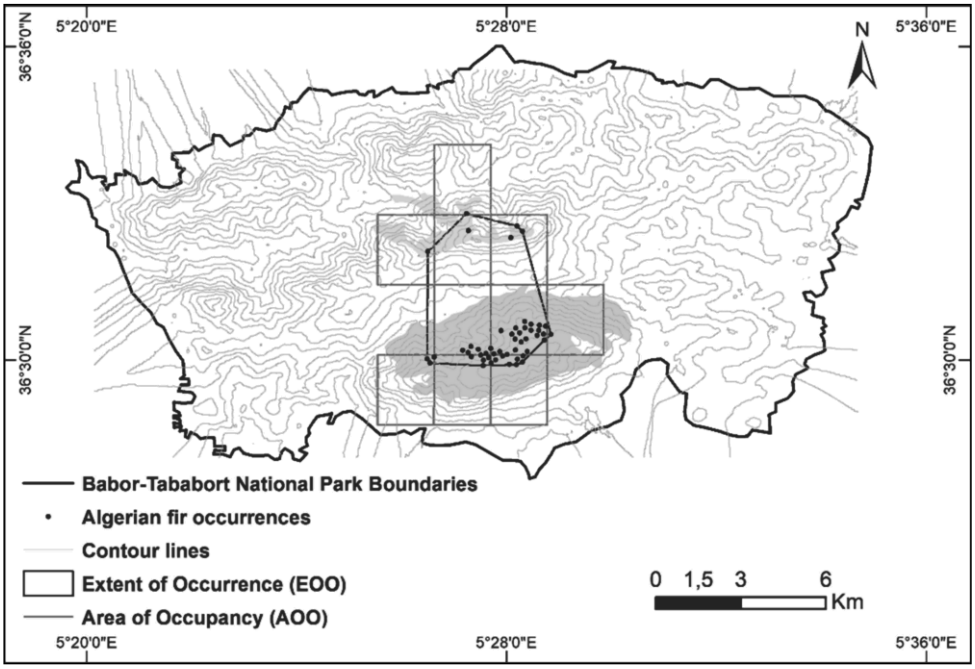


Fig. 3. Calculation of the area of occupancy (AOO) and extent of occurrence (EOO) of the Algerian fir and its potential distribution area according to the UICN tool 'GeoCAT'. (modified by ArcGis).

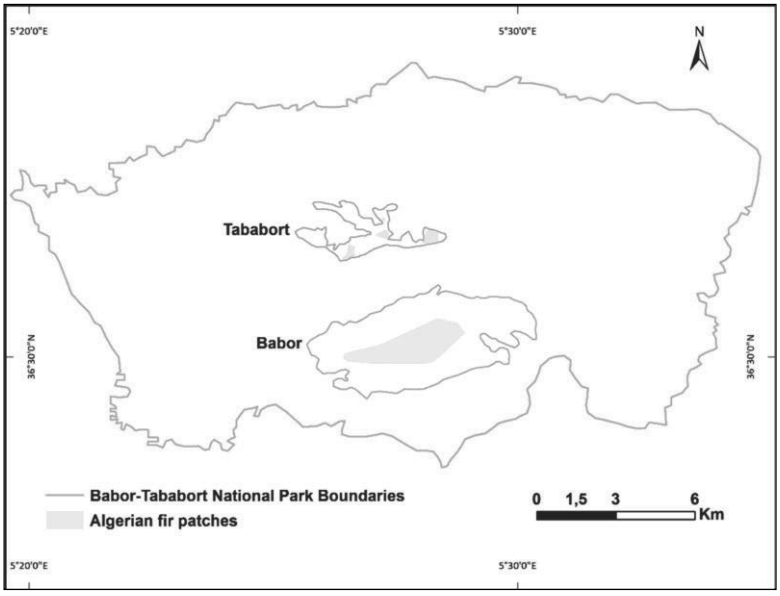


Fig. 4. Distribution of the Algerian fir in the Babor-Tababort National Park.

locations are isolated by a non-forested area, with a distance of approximately 4 kilometers (Fig. 4). In the Tababort location, the species is distributed across four isolated forest patches, covering a more limited area and showing an habitat fragmentation. In Babor, its distribution area extends over a length of 4.5 km and a maximum width of 1.5 km, forming a relatively continuous and homogeneous forest stand.

Overall, the species tends to establish preferentially on the north-facing slopes of the Babor-Tababort National Park. It is found in the moist-facing slopes, particularly the northern (49.01%) and northeastern (29.41%) slope (Fig. 5). In some sites, it forms relatively continuous and extensive pure fir stands. Nevertheless, the species is also present on northwest, west, and east oriented slopes, although less abundantly.

***Population size of* Abies numidica. -** The number of mature trees per sampling plot varies between the Babor and Tababort forests (Table 1). Overall, 1,241 mature trees were recorded, with 1,122 in the Babor and 119 in the Tababort. The mean number of mature trees per sampling plot is 24.93 ± 11.63 in Babor, compared to 19.83 ± 11.47 in Tababort. The total area occupied by the species is estimated at 40 km^2, with approximately 24 km^2 located in the Babor and 16 km^2 in the Tababort. The total population size of the species is estimated at 8,561 mature trees, distributed between 8,302 mature trees in Babor and 259 in Tababort.

***Altitudinal distribution of* Abies numidica. -** The altitudinal distribution of *Abies numidica* varies according to the different altitude classes (Table 2). The class [1717–1788 m] contains the highest proportion of mature trees, with a relative abundance of 26.51% (329 mature trees). It is followed by the classes [1859–1930 m] and [1930–2003 m], which represent 23.85% (296 mature trees) and 18.53% (230 mature trees), respectively. The class [1646–1717 m] also shows a notable presence, accounting for 17.08% of the entire population (212 mature trees). Although the species is also observed at lower elevation, particularly between 1575 and 1646 m a. s. l., where it is significantly less abundant.

Habitat and associated tree species. - The Algerian fir is associated with several other forest tree species. In both forests, it coexists notably with the Atlas cedar, the Algerian oak, the Eurasian Aspen, and Italian Maple (*Acer obtusatum* Walds. & Kit. ex Willd.).

***IUCN redlist status of* Abies numidica. -** The reassessment of the conservation status of *Abies numidica* in the Babor-Tababort National Park, according to the IUCN Red List criteria, indicates that only criterion D can be reliably applied with the available data. Criterion A remains uncertain: historical data from 1934 don't suggest a potential decline of mature individuals that could allow us to use subcriteria A1 or A2, but the lack of precise information on the rate and continuity of this decline prevents a robust assessment. Criterion C might be applicable in situations involving historical decline, but it is not our case. In contrast, criterion D, via subcriteria D2, is directly applicable: the species is known from only two locations (≤ 5), supporting a classification as Vulnerable (VU). Thus, based on the available data, criterion D provides the only solid justification for the current conservation assessment of the species.

Discussion

The Algerian fir in the Babor forest shows a continuous and homogeneous spatial distribution, covering a vast area (Fig. 6a). These observations confirm those of several

Table 1. Number of mature Algerian fir trees in Babor-Tababort National Park. (*) direct estimation in the field.

	Babor	**Tababort**	**Total**
Number of sampling plot	45	6	**51**
Number of mature trees	1122	119	**1241**
Mean ± standard deviation (Extreme values)	24.93 ± 11.63 (6 - 58)	19.83 ± 11.47 (7 - 36)	**24.33 ± 11.62 (6 - 58)**
Occupied area (km²)	24	16	**40**
Total number of mature trees	8302	259*	**8561**

Table 2. Altitudinal range of Algerian fir in Babor-Tababort National Park.

Classes (m)	**Individual number**	**Relative abundance (%)**
[1504-1575[	141	11.36
[1575-1646[	20	1.61
[1646-1717[	212	17.08
[1717-1788[	329	26.51
[1788-1859[	13	1.05
[1859-1930[	296	23.85
[1930-2003]	230	18.53

Table 3. Estimation of extent of occurrence (km²), and area of occupancy (km²) for Algerian fir in Babor-Tababort National Park.

	Babor	**Tababort**	**Total**
Extent of occurrence (EOO)	2.914	1.720	**15.20**
Area of occupancy (AOO)	24	16	**40**
Number of locations	2		

authors who consider this forest an ecological refuge, representing the main conservation bastion for this endemic species (Beauverie & Barbey 1934; Quézel 1956; De Smet & Bouazza 1984; Kolai 1992). The species benefits from favorable ecological conditions for its survival, including relatively deep and well-drained soils, limited exposure to desiccating winds, and a relatively stable hydrological regime (Kolai 1992). According to Quézel (1985), as with all Mediterranean fir species, *Abies numidica* is strictly associated with calcareous-dolomitic bedrock, particularly on karstified landscapes. These factors contribute to a well-structured forest composition and continuous natural regeneration processes, as indicated by the presence of individuals across multiple age cohorts (De Smet & Bouazza 1984). Furthermore, the low anthropogenic pressure, due to the site's difficult accessibility, limits human-induced disturbances and contributes to the preservation of this endemic species in its natural habitat (Aussenac 2002; Tlili-Ait Kaki & al. 2013).

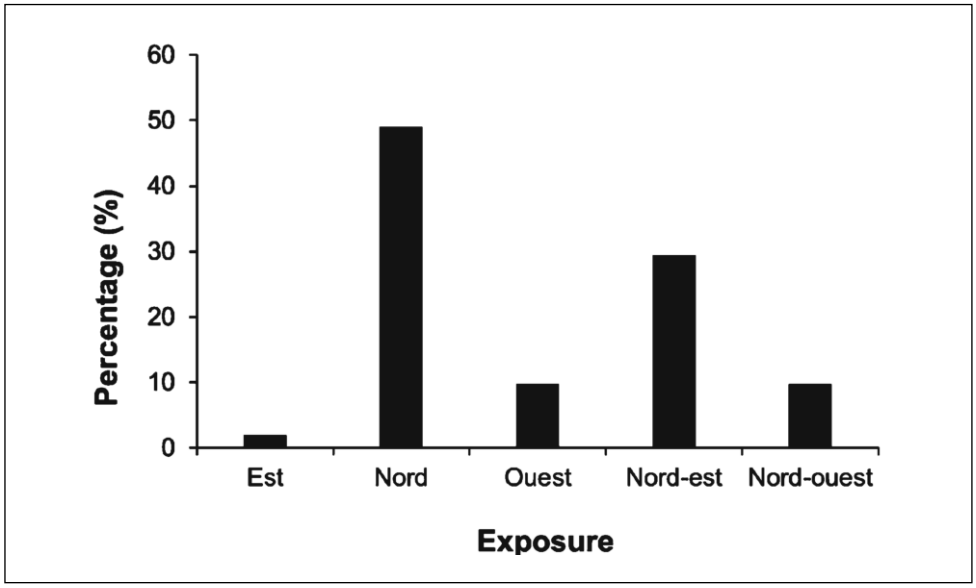


Fig. 5. Percentage of Algerian fir trees according to their slope aspect in the Babor-Tababort National Park.

In contrast, in the Tababort forest the species presents a fragmented distribution, occurring as small, isolated forest patches (Fig. 6b). This situation reflects a continuous process of habitat degradation (Médail & Quézel 1999; Fischer & Lindenmayer 2007). For centuries, different human societies present in North Africa have played a major role in the decline of forest ecosystems (Madoui 2020). This process, caused by war conflicts, agricultural activities, overgrazing, repeated fires, and logging, continued until the 16th century and persisted, in various forms, until the 19th century. By that period, approximately half of the native forests had already been lost (Quézel 1976). The decline of forested areas is estimated at an annual rate of 1 to 2%, highlighting the severity of the situation and the threats facing some forest species, such as the Algerian fir (Barbero & al. 1990). Endemic species with limited geographic ranges are especially susceptible to habitat deterioration, often caused by anthropogenic activities, which also compromise their capacity for natural regeneration (Saidi & al. 2016).

As with the circum-Mediterranean fir species, slope aspect appears to be an important ecological determinant influencing the spatial distribution of the Algerian fir in the Babor-Tababort National Park (Aussenac 2002). This species shows a strong affinity for north-facing slopes, which offer more moist and cooler bioclimatic conditions, favoring both its regeneration and vigorous development (Quézel & Médail 2003; Gharzouli 2007; Caudullo & Tinner 2016). In contrast, its rarer presence on south-facing slopes may be explained by less favorable climatic conditions, compounded by topographic constraints and the effects of historical deforestation (Kolai 1992; Tlili-Ait Kaki & al. 2013). Indeed, this species is absent from the southern slope of Babor, where the more arid climatic conditions and desiccating temperatures are not conducive to its growth (Kolai 1992; Madoui 2020).



Fig. 6. Photos showing the Babor forest (a) and the Tababort forest (b).

The variation noted between the two Algerian fir locations is reflected in the mean mature tree density per sampling plot, which is higher in Babor than in Tababort. Our results do not confirm the estimates by Barbey (1934), who assessed the Algerian fir in Babor as ranging between 2,000 and 3,000 individuals, with densities sometimes exceeding 30 trees per hectare in areas where the species predominates. The high variability observed in our study reflects marked heterogeneity among the sampling plots. This trend aligns with the observations of De Smet and Bouazza (1984), who highlighted strong variability in the proportions of the species (between 15% and 40%) depending on the forest types in Babor, linked to altitude, slope aspect, and the intensity of local disturbances. According to Barbey (1934), only a few stunted individuals, deformed by snow and wind stress, survived in Tababort, although the area was likely once more continuously covered by fir stands. We note that we do not have any other comparison data regarding the popu-

lation size of the species in the Babor-Tababort National Park. Furthermore, Barbey (1934) does not clarify whether his estimate includes only mature trees or also immature ones in the total count.

The high abundance of *Abies numidica* trees between 1717 and 2003 meters of altitude suggests that this altitudinal range constitutes the optimal development zone for the species, due to microclimatic conditions particularly favorable to its growth. Indeed, in their natural ranges, with the exception of *A. bornmuelleriana* Mattf., which can be found at very low altitudes, different fir species generally develop above 400 meters, with some even reaching 2400 meters (Aussenac 2002). This trend is also observed in the Moroccan fir, Abies marocana, which is localized between 1600 and 2000 meters (Barbero & Quézel 1975). High-altitude areas receive abundant rainfall in autumn and spring but may be subject to severe summer droughts (López-Tirado & al. 2022). Overall, the species develops in a region characterized by a low annual temperature range, compared to other forest formations (Aussenac 2002). In contrast, lower altitudes, notably between 1575 and 1646 meters, show lower abundances, suggesting a greater sensitivity of the species to high temperatures and interspecific competition. These results do not align with the observations of De Smet and Bouazza (1984), who reported a complete absence of the Algerian fir below 1750 meters on the northern slope. According to De Smet and Bouazza (1984), the species in the Babor forest is showing a dynamic expansion, characterized by its progression through the colonization of Atlas cedar stands at lower elevations.

The Algerian fir associates with *Cedrus atlantica*, *Quercus canariensis*, *Populus tremula*, and *Acer obtusatum*, forming plant communities typical of moist montane forests (Kolai 1990; Gharzouli & Djellouli 2005). These associated species share the same ecological niche and are found in habitats characterized by cooler and wetter conditions. Their presence highlights the importance of habitat structural diversity for the conservation of Abies numidica. Because of its shade-tolerant trait, this species can persist in the understory for several decades until a canopy gap enables it to ascend to the dominant forest stratum (De Smet & Bouazza 1984). An appropriate plant canopy optimizes growth conditions for juvenile firs, facilitating their natural regeneration by decreasing water loss, increasing soil moisture, mitigating the effects of late frosts, and stimulating more efficient photosynthetic activity, leading to better growth than observed in exposed sites (Aussenac 2002).

The species can be reassessed as Vulnerable (VU) based on the application of criteria D (subcriterion D2), following the IUCN (2024) categories and criteria. Previous assessments have successively classified the species as ″Vulnerable″ (VU) (Walter & Gillett 1998) and later as ″Critically Endangered″ (CR) (Yahi & al. 2011). However, these assessments were primarily based on literature reviews (Maire 1952, Quézel & Santa 1962-1963, Technoexportstroy 1970) and applied criterion B of the IUCN classification. Similarly, the Saharan cypress (*Cupressus dupreziana* A. Camus), classified as ″Endangered″ (EN) (Abdoun 2013), has a Moroccan subpopulation estimated at 6,650 mature trees, compared to only 233 mature trees recorded in the Algerian Sahara. This situation reflects a broader pattern of vulnerability of Mediterranean montane forests, particularly in the southern Mediterranean region (Barbero & al. 1990). Several endemic and geographically isolated fir species, such as *Abies marocana*, *A. pinsapo*, and *A. nebrodensis*, currently face a high risk of extinction (Médail & Quézel 2003). The species' conservation status results from the combined impact of several factors, including forest wildfires, fuel wood harvesting

and seasonal grazing by livestock (Yahi & al. 2011; Madoui 2020). Moreover, natural regeneration through seedling emergence appears to be limited by dense understory vegetation and snow accumulation during winter (De Smet & Bouazza 1984). Although the limited accessibility to these forests, especially during winter, provides some degree of protection, threats to this endemic species are regarded as persistent. This situation further highlights the urgency of implementing coordinated conservation measures in response to the growing impacts of climate change.

Threats and conservation recommendations. **-** The evaluation of ecological data and the determination of the conservation status of *Abies numidica* in the Babor and Tababort forests highlight the application of differentiated conservation strategies, each adapted to the particularities and current situation of each location, within an integrated management framework at the scale of the Babor-Tababort National Park.

The Babor forest is the strategic core habitat for the preservation of the Algerian fir; it is therefore essential to maintain this dynamic by reinforcing in situ conservation measures. Classified as an integral zone of the Babor-Tababort National Park (JORADP 2019), this forest should be placed under controlled access and monitoring by conservation officers to prevent deforestation, wildfires and overgrazing (Yahi & al. 2011; Madoui 2020). It is particularly important to preserve the optimal habitat of this species, located in the summit zone between 1717 and 2003 m a. s. l., which represents the most favorable environment for its development and natural regeneration (De Smet & Bouazza 1984). This area should be placed under strict protection to prevent any form of ecological disturbance, particularly through the establishment of exclusion zones, the control of human impact, and the maintenance of natural forest dynamics. Furthermore, regular ecological monitoring is necessary to track the evolution of the species in Tababort forest (age classes, mortality rate, natural regeneration) (De Smet & Bouazza 1984) and to detect early signs of decline or water stress related to climate change. The species at Tababort shows a low density of mature trees and fragmentation, which impedes natural regeneration and heightens its susceptibility to disturbances such as recurrent wildfires, overgrazing, and habitat loss. It is therefore essential to prioritize forest ecosystems rehabilitation efforts, including the establishment of habitat corridors to link forest patches and the initiation of afforestation programs. These measures must be supported by strict fire prevention measures, rigorous regulation of grazing pressure, and close surveillance of natural regeneration in restored sites, particularly through the deployment of exclusion zones. It is imperative to recognize the vulnerable situation of the species in the Babor-Tababort National Park, which is exposed to a high risk of extinction in the medium term. Targeted conservation actions must be undertaken to enhance its protection. These include the establishment of a seed bank and ex situ collections housed in specialized arboreta or experimental stations, in order to preserve the species' genetic diversity and support potential restoration programs (De Smet & Bouazza 1984; Hachi-Illoul 2016). Encouraging detailed investigations into the species' resilience to climatic fluctuations and its capacity to withstand hydric stress, with a view to predicting climate-driven changes and informing adaptive management, is recommended. Additionally, the installation of a meteorological station is recommended to enable real-time adaptation of management strategies in response to fluctuating environmental variables. The association of this endemic conifer with other species such as *Cedrus atlantica*, *Quercus canariensis*, *Populus tremula* and *Acer obtusatum* highlights the importance of preserving the structural complexity and floristic composition

of these mountain forests (Bouchibane & al. 2024). Maintaining a vegetation cover improves the forest microclimate, facilitates natural regeneration of Algerian fir and reinforces the forest's stability in the face of climatic variations. Finally, engaging local human populations in conservation initiatives is crucial. Environmental education initiatives, the development of sustainable ecotourism, and the adoption of participatory management approaches can all contribute to strengthening local community support for the conservation objectives targeting this endemic and relict species in Algeria.

Conclusion

The Algerian fir is well developed in the Babor forest, which is characterized by its homogeneous spatial distribution. In contrast, the species distribution at Tababort is fragmented and subject to historical and current disturbances, compromising its natural regeneration. The species shows a marked ecological affinity for altitudes between 1717 and 2003 m a. s. l., where microclimatic conditions are optimal. Its spatial distribution is also influenced by slope aspect, with a preference for cooler and more humid exposures. The species coexists with other forest species, and its survival depends on the maintenance of a structured forest cover. The conservation status of the species has been updated to Vulnerable (VU), reflecting its limited distribution restricted to only two known locations. This situation highlights the urgent need to implement coordinated conservation measures, combining in situ and ex situ strategies, to ensure the long-term viability of this relict species of North African mountain forests. It is particularly important to conduct in-depth research on the dieback observed in the field for *Abies numidica*, in order to determine its causes and ecological impacts within the context of ongoing climate change.

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Article

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M. Meço, L. Kashta & A. Mullaj

First records for the Flora of Albania of *Euphrasia picta* (*Orobanchaceae*), *Maianthemum bifolium* (*Asparagaceae*), and *Satureja thymbra* (*Lamiaceae*)

Abstract

Meço, M., Kashta, L. & Mullaj, A.: First records for the Flora of Albania of *Euphrasia picta* (*Orobanchaceae*), *Maianthemum bifolium* (*Asparagaceae*), and *Satureja thymbra* (*Lamiaceae*). — Fl. Medit. 35: 183-189. 2025. — ISSN: 1120-4052 printed, 2240-4538 online.

Recent floristic investigations conducted between 2017 and 2024 in northern and central Albania have led to the discovery of three vascular plant species new to the national flora: *Euphrasia picta* (*Orobanchaceae*), *Maianthemum bifolium* (*Asparagaceae*), and *Satureja thymbra* (*Lamiaceae*). These records expand the known distribution range of each taxon within the Balkans and include the first report of the genus *Maianthemum* in Albania. The discoveries clarify both northern and southern range limits of the species in the region and highlight the significance of continued botanical exploration in an underexplored part of the Balkan Peninsula. The findings provide important baseline data for future biogeographical and conservation assessments of the Albanian vascular flora.

Key words: Vascular flora, new records, plant distribution, Balkan Peninsula, conservation.

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Introduction

Albania hosts an exceptionally rich and diverse flora shaped by its complex topography, climatic gradients, and its strategic position in the central Balkans (Paparisto & al. 1988). Despite a long tradition of botanical exploration, many areas remain insufficiently studied, and new floristic records continue to emerge (Pils 2024), reflecting the country's role as a biogeographical crossroads between Central Europe and the Mediterranean basin. Documenting such findings is essential for refining national checklists, improving knowledge of species distributions, and supporting conservation planning.

The family *Asparagaceae* is currently represented in Albania by 13 genera and approximately 50 species. Until now, the genus *Maianthemum* had not been recorded in the country. *Lamiaceae* includes 32 genera; the genus *Satureja* is represented by three species (S. *cuneifolia* Ten., *S. hortensis* L. and *S. montana* L.), though historical records suggest up to

nine taxa, several of which have since been synonymized or corrected through recent revisions (Saliaj & al. 2022). *Orobanchaceae* is represented by 12 genera and nearly 90 species, although earlier literature lists considerably fewer taxa. Within this family, the genus *Euphrasia* is currently known in Albania with seven confirmed species (Barina & al. 2017).

The present study reports three additional vascular plant taxa: *Euphrasia picta* Wimm. (*Orobanchaceae*), *Maianthemum bifolium* (L.) F.W. Schmidt (*Asparagaceae*), and *Satureja thymbra* L. (*Lamiaceae*), recorded during recent field investigations in northern and central Albania. These data contribute to the ongoing effort to complete the national flora and to better understand the phytogeographical relationships and diversity patterns of the Balkan Peninsula.

Materials and Methods

The new records presented in this study are the result of continuous floristic investigations conducted between 2017 and 2024 in northern and central Albania. All localities were georeferenced using a Garmin Dakota 10 GPS device. At each site, ecological parameters, including substrate type, slope exposure, associated plant species, and population size, were recorded. Observations on potential and current threats to the populations were also noted.

Taxonomic identification was based on morphological examination of collected specimens and comparison with relevant literature, including Flora Europaea (Tutin & al. 1964-1980). Nomenclature and distribution data were verified using major international databases such as Euro+Med PlantBase and the Kew World Checklist. Voucher specimens are preserved in the private herbarium of M. Meço (Department of Biology, Faculty of Natural Sciences, University of Tirana) and will be deposited in the National Herbarium of Albania (TIR). Species distribution maps were generated using georeferenced coordinates to document collection sites and visualize the known ranges of the taxa in the Balkans.

Results and Discussion

Euphrasia picta Wimm. (*Orobanchaceae*)

Euphrasia picta is a hemiparasitic annual species distributed mainly in temperate Europe. According to Euro+Med PlantBase, the species has been recorded in the Balkan Peninsula, specifically in Romania and Bulgaria, while KEW data indicate its presence even in the northwestern Balkans without specifying a country.

In Albania, *E. picta* was recorded for the first time during a floristic survey in September 2024. The species was found on wet limestone substrates near the spring of "Kroi i Shtrazës" in the Theth Valley, at the edge of a mixed *Pinus heldreichii–Fagus sylvatica* forest (Figs. 1 & 4), within the Albanian Alps National Park (42°25′39.88″N, 19°45′42.37″E; 1150 m a.s.l.).

Other *Euphrasia* specimens collected from this locality and adjacent areas have been assigned to the *E. rostkoviana* Hayne group (Barina & al. 2017). According to Flora

Europaea (Tutin & al. 1964-1980), members of this group are characterized by capsules not exceeding twice their width in length. In the examined material, the capsule is emarginate, measuring 5.5 × 2 mm, and is approximately equal in length to the calyx. Cauline leaves attain up to 13 mm in length and possess 1–5 pairs of marginal teeth. The lower floral leaves are 3–10(–12) mm in length and are suborbicular to deltate or oblong-ovate, with a cuneate to rounded base. The combination of these diagnostic characters corresponds more closely to *E. picta* than to typical representatives of the *E. rostkoviana* group.

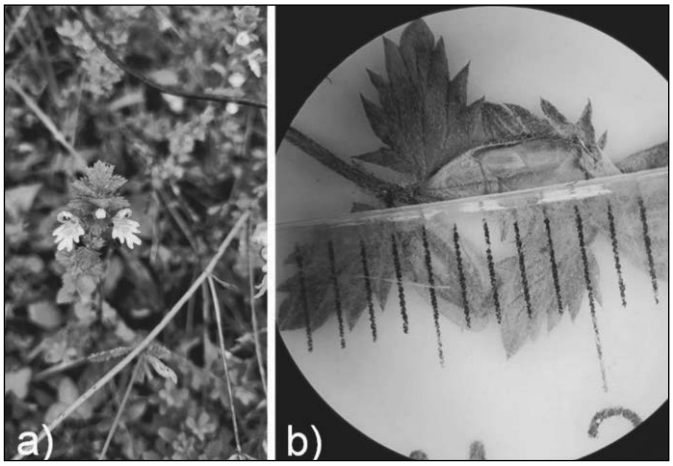


Fig. 1. (a) *Euphrasia picta* in its natural habitat; (b) herbarium specimen with capsules and scale in mm; (c) collection site on a map of Albania (Photos by M. Meço).

***Maianthemum bifolium* (L.) F.W. Schmidt (*Asparagaceae*)**

Maianthemum bifolium is a rhizomatous geophyte distributed across temperate Eurasia, typically inhabiting temperate forest ecosystems. In the Balkans, the species has been recorded from northwestern Croatia (Mitić & al. 2007) and Serbia, where it is regionally classified as Endangered (Ostojić & al. 2020).

The first Albanian record was made in June 2017, with further observations in July 2023. The species was found in the herb layer of a spruce–beech forest on stabilized gravel substrates (Figs. 2 & 4), along the Valbona River, Tropojë (42°26′41.78″N, 19°53′9.05″E; 42°25′29.94″N, 19°52′19.67″E; 950 m a.s.l.). This represents the first occurrence of the genus *Maianthemum* in Albania and the southernmost known distribution of the species in the Balkans.



Fig. 2. (a,b) *Maianthemum bifolium* in its natural habitat (Photos: a by L.Kashta; b by M. Meço)

***Satureja thymbra* L. (*Lamiaceae*)**

Satureja thymbra is a Mediterranean chamaephyte distributed from Sardinia (Italy) to the eastern Mediterranean. In the Balkans, the species is known from Greece (POWO 2025).

In Albania, *S. thymbra* was recorded in autumn 2022 on southwestern slopes near Thumanë (Figs. 3 & 4), north-central Albania (41°32'50.2"N, 19°43'03.1"E; 150 m a.s.l.). The population occurs in degraded shrubland between an asphalted road and coppice oak forest, on dry clay soil over limestone. This record represents the northernmost distribution limit of the species in the Balkans and increases the number of *Satureja* species known from Albania to four.

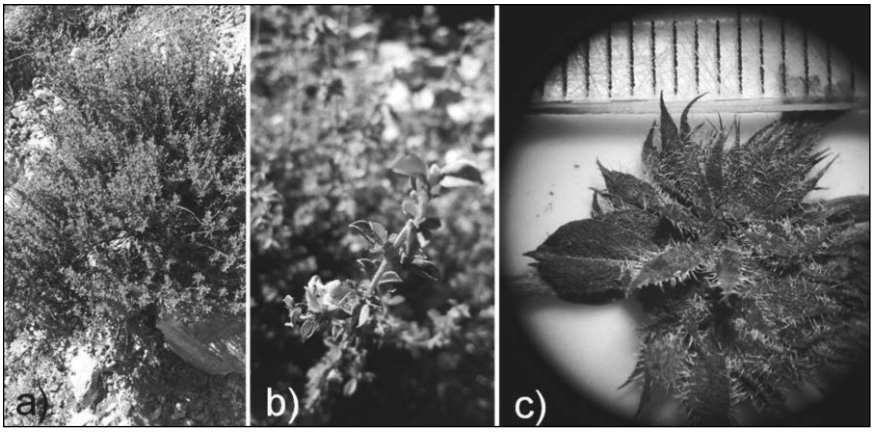


Fig. 3. (a, b) *Satureja thymbra* in its natural habitat; (c) verticillaster detail photographed under a binocular microscope, scale in mm (Photos by M. Meço).

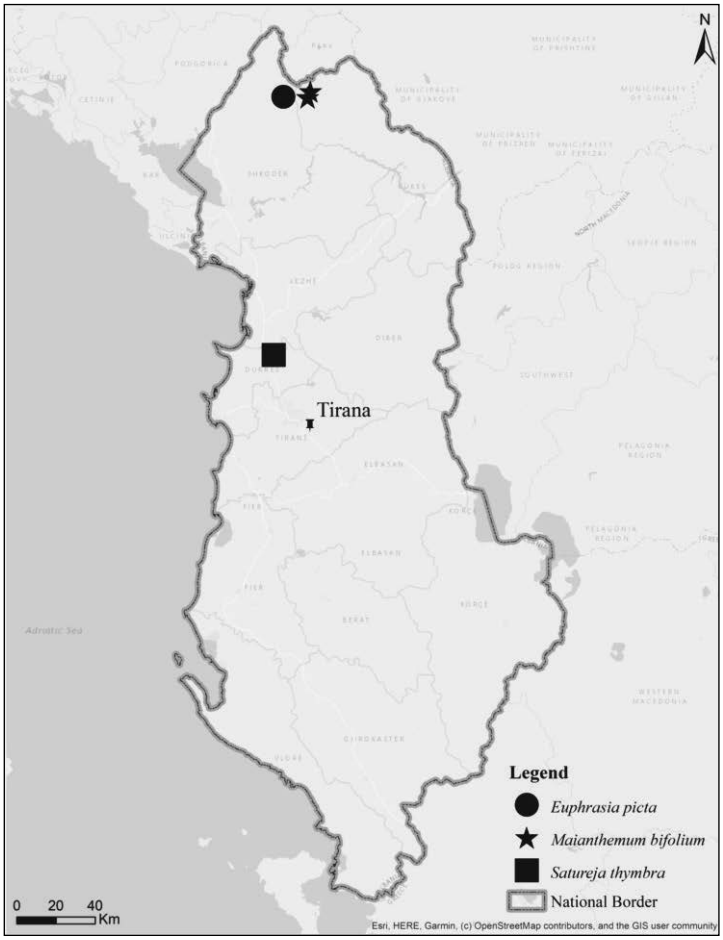


Fig. 4. Distribution map of the three plant species newly recorded for Albania.

Three of these newly recorded species for the Flora of Albania exhibit a highly restricted distribution range. Although further research is required to better delineate their geographic extent, the implementation of conservation measures at the national level should be considered a priority.

Among these taxa, *Maianthemum bifolium* is of particular concern due to its narrow distribution, both within Albania and across the Balkan region. This species should be formally proposed for inclusion in the Albanian Red List. It is currently classified as Endangered (EN) at the regional level (Ostojić & al. 2020) and is also listed as Vulnerable (VU) in the Vascular Plant Red List for England (2014), highlighting its broader conservation significance.

Maianthemum bifolium is a characteristic component of Norway spruce (*Picea abies* (L.) H.Karst.) forests (Purina & al. 2016), and in Albania, it occurs within mixed spruce–

beech stands in Valbona Valley. Its limited distribution, coupled with increasing anthropogenic pressures, particularly tourism-related construction, and the impacts of climate change, poses a serious threat to the persistence of its local populations.

Given its conservation status at both regional and international levels, as well as the specific threats to its Albanian populations, *M. bifolium* warrants inclusion in the updated Albanian Red List as an Endangered (EN) species.

Conclusion

The discovery of *Maianthemum bifolium, Satureja thymbra,* and *Euphrasia picta* represents a significant contribution to the knowledge of Albania's vascular flora and its biogeographical context within the Balkans. These records extend the known distribution ranges of all three taxa, document the first occurrence of the genus *Maianthemum* in Albania, and highlight previously unrecognized northern and southern distribution limits in the region.

The findings underscore the floristic underexploration of Albania, particularly in ecologically diverse and topographically complex areas. They also emphasize the importance of continued field surveys, herbarium research, and taxonomic revisions in refining the national flora and supporting conservation planning.

Among the recorded taxa, *M. bifolium* stands out for its very limited distribution and regional threat status, warranting its inclusion in the updated Albanian Red List as an Endangered (EN) species. Targeted monitoring, habitat protection, and population studies are recommended to ensure the long-term conservation of this species and to better assess the status of *S. thymbra* and *E. picta* in Albania.

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Article

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On two Cavanillesian names from *Malvaceae*

Abstract

Ferrer-Gallego, P. P., Roselló, R., Vázquez, J. R. & Peris, J. B.: On two Cavanillesian names from *Malvaceae*. — Fl. Medit. 35: 191-207. 2025. — ISSN: 1120-4052 printed, 2240-4538 online.

The nomenclatural types of the Cavanillesian names *Malope multiflora* and *Malva cretica* (*Malvaceae*) are discussed. When the Linnaean name *Lavatera cretica* is transferred to the genus *Malva*, the priority name becomes *Malva multiflora*, based on *Malope multiflora*. For this name, a neotype is designated from a specimen preserved at SEV and collected in Carmona (Sevilla, Spain), a city mentioned in the protologue by Cavanilles. The correspondence between Cándido Trigueros and Cavanilles has been essential in understanding the origin and description of this name. This typification definitively establishes Cavanilles' name within the genus *Malva* according to Linnaeus' concept of *Lavatera cretica*. On the other hand, the type of the name *Malva cretica* had previously been indicated, in 2017, as the "holotype" from a specimen collected by Antoine-Tristan Danty d'Isnard and cultivated in the Jardin du Roi in Paris, preserved at P (P00662859). However, beause that type indication did not include the phrase "designated here", nor a similar expression, it is not an effective type designation according to the International Code of Nomenclature for algae, fungi, and plants. We formally confirm this attempted typification and designate the specimen at P as the lectotype of the name *Malva cretica*.

Key words: Cándido Trigueros, Cavanilles, nomenclature, original material, syntype, typification.

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Introduction

Molecular studies on *Malvoideae* (= *Malvaceae* sensu stricto) (Ray 1995; Fuertes & al. 2003; Tate & Simpson 2003; Escobar & al. 2009 among others) have demonstrated that some genera, as traditionally defined, are not monophyletic, this requiring a recircumscription. *Malva* L. and *Lavatera* L. are among these genera. Consequently, species of *Malva* and *Lavatera* are distributed across two different clades: the "Lavateroid clade" and "Malvoid clade" (Ray 1995).

According to Fernandes (1968), the distinction between *Malva* and *Lavatera*, based on the epicalyx segments fused at the base in former genus, is highly unsatisfactory. Ray (1995) emphasized the significance of the fruit morphology, more reliable than epicalyx

connation, for a more accurate taxonomy that aligns with molecular data (see e.g., Tate & al. 2005). As a result of these findings, *Lavatera* taxa were transferred from the "Malvoid clade" to *Malva*, under different names and combinations (Ray 1998; Molero & Montserrat 2005, 2006; Banfi & al. 2005; Iamonico 2010, 2014; Valdés 2011; Conti & Bartolucci 2012).

The name of a well-known species, *Lavatera cretica* L., becomes notably complex when transferred from the genus *Lavatera* to *Malva*. Being widely distributed across the Mediterranean, it has been referred to by various names throughout history (see below), especially in 18th and 19th centuries. Thus, several binomials come into play during this transfer from *Lavatera* to *Malva*, complicating the search for the correct priority name. Linnaeus's combination in the genus *Malva* would create a later homonym with Cavanilles's name *Malva cretica*. The search for the oldest heterotypic synonym is not straightforward, especially when many of these names have not been analyzed from a nomenclatural perspective and their respective types have not been designated. In such cases, typification becomes a crucial act in order to establish a solid nomenclature. A relevant candidate for naming the Linnaean species (*Lavatera cretica*) within the genus *Malva* is Cavanilles's name *Malope multiflora*, a name that had been forgotten and scarly used in subsequent works since its publication. In this context, Webb (1968: 249) mentioned: "*M. multiflora* Cav., *Monad. Class. Diss. Dec.* 85 (1786), from S. Spain, has never been seen since its original discovery, and may belong to some other genus. It was said to have 3–4 small, white flowers in each leaf-axil". This name was not included in the revision of the Malvaceae family for the Iberian flora (see Nogueira & Paiva 2005).

On the other hand, a comprehensive review of the nomenclatural types of the names of the taxa included and accepted within *Malva cretica* Cav. was presented by Iamonico & Del Guacchio (2017). For Cavanilles's name *Malva cretica*, its nomenclatural type is indicated. However, the indication of the type as "holotype" is incorrect according to the rules of the International Code of Nomenclature for algae, fungi, and plants (*ICN*, *Madrid Code* of 2025).

This paper revisits the types and original material of the Cavanillesian names *Malva cretica* and *Malope multiflora*, designating the corresponding types accordance with the articles of the International Code of Nomenclature. This act is essential, particularly for the latter name, in order to confirm the correct nomenclature for a well-known plant.

Materials and methods

The Historical Archive of the Royal Botanical Garden of Madrid (Spain) has been consulted to study the correspondence between Cándido Trigueros and Cavanilles (see San Pío Aladrén & Collar del Castillo 1995, Aguilar & Valdés 1998). This documentation has been crucial in understanding the origins of the description of *Malope multiflora*.

A preliminary screening of the material was possible thanks to digital type images provided at JSTOR Global Plants web (http://plants.jstor.org) and other online sources. The herbaria acronyms follow Thiers (2025 [continuously updated]).

In typifying names of taxa, we strictly followed the International Code of Nomenclature for algae, fungi, and plants, *ICN* onwards (Turland & al. 2025). The identity of the designated types has been verified with the current use of their respective names.

The homotypic synonyms are indicated with the symbol ≡, the heterotypic synonyms are indicated with the symbol =. Currently accepted names are set in bold italics typeface.

Results and discussion

Lavatera cretica L.

When considering the name *Lavatera cretica* (Linnaeus 1753) within the genus *Malva*, a homonymy arises with the name *Malva cretica* (Cavanilles 1786). This issue led Webb and Berthelot to propose the name *Malva pseudolavatera* (Webb & Berthelot 1836) as a new name based on Linnaeus's replaced synonym (see Molero & Montserrat 2005).

A few years later, Visiani (1851) proposed another substitute name for Linnaeus's binomial, *Malva hederifolia ('hederaefolia')*, just as Ray (1998) did more recently with his proposed binomial *Malva linnaei*, also as a substitute name for Linnaeus's name. However, in both cases, the names are superfluous and illegitimate, as a new name with the same purpose had already been proposed by Webb & Berthelot (1836).

However, there are several earlier species names that could be considered potential heterotypic synonyms, which could take priority over the new name proposal by Webb & Berthelot (1836). Before proposing new names, it is essential to consider the existence of older available synonyms in adhere to the principle of priority. For instance, Fernandes (1993) proposes Cavanilles' name *Malope multiflora* as a synonym of *Lavatera cretica* (see Banfi & al. 2005; Juan & Crespo 2011).

Malope multiflora is undoubtedly a forgotten name, but its combination within the genus *Malva* and its typification would help resolve a longstanding issue in the nomenclature of this species. It is the oldest name on which certain authors believe the Linnaean concept of *Lavatera cretica* should be based.

However, if this is not the case, before accepting the substitute name proposed by Webb & Berthelot (1836) as the priority name for this species, it would have been necessary to examine the types of other candidate heterotypic synonyms under Linnaeus name, such as: *Lavatera empedoclis* Ucria ex Roemer, *L. sicula* Tineo, *L. neapolitana* Ten., and *Anthema tenoreana* C.Presl.

Since its publication by Cavanilles, *Malope multiflora* has been rarely used, with few exceptions such as Candolle (1824: 430) and more recently Banfi & al. (2005). As no original material has been located, only a brief description by the author in comparison with other species described in his work exists, and no iconography was created by Cavanilles, the name was considered somewhat ambiguous. In this context, a suitable alternative could have been not to use the name published by Cavanilles.

However, this approach would further destabilize the nomenclature of the group, as it would require an in-depth study of the original materials of candidate names that could be used to designate Linnaeus' species under the genus *Malva*.

On the other hand, preserving *Malva pseudolavatera* over other potentially priority names for assigning the specific epithet within the genus *Malva* for Linnaeus' species does not appear to be the best suited option. This is because there is an opportunity, through typification, to use a name to designate this widely known species, without resurrecting other

names that also are rarely known or used. The typification of Cavanilles's name *Malope multiflora* could reaffirm the acceptance of this name as proposed by Banfi & al. (2005) and Juan & Crespo (2011), among other authors, and accepted by POWO (2025).

The protologue of *Malope multiflora* includes a brief diagnosis in polynomial form "M. [*Malope*] Foliis subrotundis crenatis villosis: floribus 3–4 axillaribus" [trans.: M. [*Malope*] Leaves suborbicular, crenate, villous; flowers 3–4 per leaf axil] followed by the reference "*Trigueros, Sp. Floræ Carm. mss*.", and a brief description of the plant "Caulis vix semipedalis, parum ramosus. / Folia subrotunda, crenata, villosa. / Flores axillares parvi, tres aut quatuor in singulis axillis. / Calyces villosi. / Corolla alba. / Fructus (habita proportione) maior quam in ceteris." [trans.: Stem scarcely half a foot tall, slightly branched. / Leaves subrounded, crenate, villous. / Small axillary flowers, three or four in each axil. / Calyces villous. / Corolla white. / Fruit (in proportion) larger than in the others]. The protologue also includes the provenance "*Habitat in Bæticæ pratis prope Hispalim et Carmonam*" [trans.: It grows in the meadows of Baetica near Seville and Carmona], the symbol "Ʊ" (indicating that it is an annual plant), and a very relevant comment "Observata a D. de Trigueros. Quum specimen videam, delineabo, ac primo quoque tempore cum, aliis plantis incidendum dabo" [trans.: Observed by Mr. de Trigueros. When I see the specimen, I will illustrate it, and at the first opportunity, I will provide it along with other plants].

As will be explained later, Cavanilles merely translated into Latin the exact description of this species provided by Trigueros, without adding any additional details. Furthermore, the polynomial or synonym included in the diagnosis, "M. Foliis subrotundis crenatis villosis: floribus 3–4 axillaribus", was not mentioned in the correspondence Trigueros sent to Cavanilles (as will be shown below). This strongly suggests that the "Specimen Floræ Carmonensis" was, in fact, an independent work (a manuscript "mss." [manuscriptum]), of which Cavanilles merely had a copy. The text of Trigueros' *Specimen Floræ Carmonensis* is believed to have begun in 1779, and by 1785 (the year of his correspondence with Cavanilles), it was already finished. Unfortunately, this manuscript seems to have been lost, as, apart from Trigueros and possibly Cavanilles, no one else is known to have seen it (see Aguilar & Valdés 1998). This manuscript was cited by Cavanilles (1786) in several names in his *Secunda Dissertatio Botanica* (e.g., *Malva nicaeensis*, *Malope trifida*, *Triguera ambrosiaca*). Although related to the Trigueros's *Flora Carmonensis*, the *Specimen Florae Carmonensis* should be considered an independent work. The testimonies of Trigueros and Cavanilles are the only evidence of the existence of this work, which is not mentioned elsewhere in botanical literature. Based on how Cavanilles uses it in his synonymies, it appears the work employed a polynomial nomenclature, perhaps following José Quer's *Flora Española* (Quer 1762-1764).

Cavanilles clearly indicates in the protologue that he has not seen the material, but that as soon as he can study it, he will include it in his work along with other species ("Quum specimen videam, delineabo, ac primo quoque tempore cum, aliis plantis incidendum dabo"). For this reason, this species is not included among the illustrations in Cavanilles' work.

After an exhaustive search in the herbaria where Cavanilles' and Trigueros' material or its duplicates are preserved (see Muñoz Garmendia 2004), we have been unable to locate any specimens of this species. Garilleti (1993) reported that no specimen corresponding to *Malope multiflora* could be found at MA or LINN. Although material from the herbarium

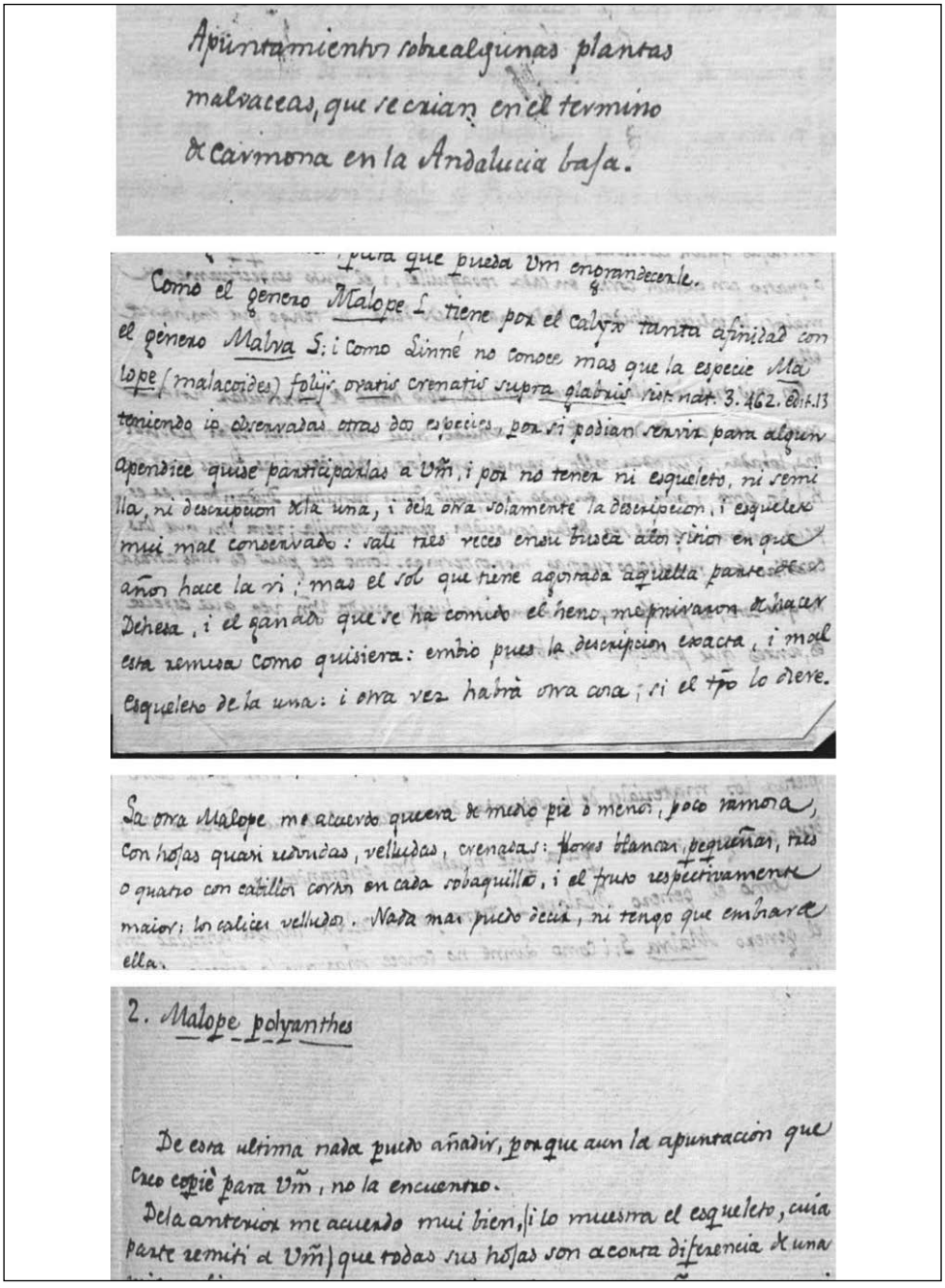
of the University of Sevilla (SEV) has been catalogued by Salgueiro González (1998), we have not found any relevant material related to this species related to Cavanilles and Trigueros in this collection either.

The description of *Malope multiflora* indicates that it has suborbicular, crenate leaves with 3–4 flowers per leaf axil (Cavanilles 1786). Many species of *Lavatera* or *Malva* exhibit the combination of these features described by Cavanilles. However, the characteristics of the genus *Malope*, with its four recognized species (e.g., *M. anatolocha* Hub.-Mor., *M. malacoides* L., *M. rhodoleuca* Maire, and *M. trifida* Cav.), are highly distinctive. It is highly likely that Cavanilles did not have any specimen of this species; his description was taken verbatim from a letter sent to him by Trigueros on 27 June 1785 (see Aguilar & Valdés 1998; correspondence that we have been able to study thanks to Esther García Guillén -The Historical Archive of the Royal Botanical Garden of Madrid-) (see below). Therefore, this name will remain of uncertain status in the absence of any type material. However, its typification with material belonging to the Linnaean concept of *Lavatera cretica* would resolve a major nomenclatural issue, as it would definitively fix the name without the need for further in-depth research on the subsequent heterotypic synonyms proposed.

A similar situation involving the absence of original material from Cavanilles also applies to the name *Triguera inodora* Cav., which was also published in the same 1786 work and based on a communication from Trigueros (see Knapp 2007).

Cándido Melchor María Trigueros Díaz de Lara y Luján (Orgaz, Toledo, September 4, 1736 – Madrid, May 20, 1798) was a Spanish writer, Hebraist, translator, and Enlightened playwright. He was a member of the Economic Society of Seville, the Royal Academy of History, and a correspondent of the Botanical Garden. In Carmona, he studied a wide range of subjects, including poetry, epigraphy, numismatics, botany, archaeology, philology, law, history, mathematics, physics, and chemistry, as evidenced by his rich and diverse library, which contained books written in Latin, Greek, Hebrew, English, French, and Italian, languages he taught himself (Aguilar & Valdés 1998).

After studying the correspondence between Trigueros and Cavanilles (see San Pío Aladrén & Collar del Castillo 1995; Aguilar & Valdés 1998), and with the help of Esther García Guillén (Historical Archive, Royal Botanical Garden of Madrid - CSIC, Madrid), we have been able to access the original description Trigueros sent to Cavanilles in the letters dated June 27 and October 3, 1785 (Fig. 1). In these letters, Trigueros wrote: "*Apuntamientos sobre algunas plantas malvaceae, que se crian en el termino de Carmona en la Andalucia baja* […] *Como el género Malope L. tiene por el calyx tanta afinidad con el género Malva L; i como Linné no conoce mas que la especie Malope (malacoides) foliis ovatis crenatis supra glabris sist. nat. 3. 462. edit. 13 teniendo io observadas otras dos especies, por si podían servir para algún apéndice quise participarlas a Vm, i por no tener ni esqueletos, ni semilla, ni descripción de la una, i de la otra solamente la descripción, i esqueleto mui mal conservado; Sali tres veces en su busca alos sitios en que años hace la vi; mas el sol que tiene agotada aquella parte de Dehesa, i el ganado que se ha comido el heno, me privaron de hacer esta remesa como quisiera; embio pues la descripción exacta, i mal esqueleto de la una; i otra vez habrá otra cosa, si el tipo [tiempo?] lo diere.* […] *La otra Malope me acuerdo quera de medio pie o menos, poco ramosa, con hojas quasi redondas, velludas, crenadas, flores blancas, pequeñas, tres o quatro con cabillos cortos*



Apúntamientos sobre algunas plantas malvaceas, que se crian en el termino de Carmona en la Andalucia baja.

para que pueda Vm enmendarle.

Como el genero Malope L. tiene por el calyx tanta afinidad con el genero Malva L: i como Linné no conoce mas que la especie Malope (malacoides) foliis ovatis crenatis supra glabris Syst nat. 3. 462. Edit. 13 teniendo io observadas otras dos especies, por si podian servir para algun apendice quise participarlas a Vm, i por no tener ni esqueleto, ni semilla, ni descripcion de la una, i de la otra solamente la descripcion, i esqueleto mui mal conservado: vali tres veces en su busca algunos años hace la vi; mas el sol que tiene agostada aquella parte de la Dehesa, i el ganado que se ha comido el heno, me privaron de hacer esta remesa como quisiera: embio pues la descripcion exacta, i mal esqueleto de la una: i otra vez habrá otra cosa; si el tpo lo diere.

La otra Malope me acuerdo que era de medio pie ó menos, poco ramosa, con hojas quasi redondas, vellidas, crenadas: flores blancas, pequeñas, tres o quatro con cabillos cortos en cada sobaquillo, i el fruto respectivamente mayor: los calices vellidos. Nada mas puedo decir, ni tengo que embiar de ella.

2. Malope polyanthes

De esta ultima nada puedo añadir, porque aun la apuntacion que creo copié para Vm, no la encuentro.

De la anterior me acuerdo mui bien, si lo muestra el esqueleto, cuia parte remití a Vm; que todas sus hojas son a corta diferencia de una

Fig. 1. Letters from Cándido Trigueros to Cavanilles: the three excerpts above: June 27, 1785 (in "Apuntamientos 1", see Aguilar & Valdés (1998: 111-113); the excerpt below: October 3, 1785 (in "Apuntamientos 5", see Aguilar & Valdés (1998: 119-124). Image courtesy of the Historical Archive of the Royal Botanical Garden of Madrid, reproduced with permission.

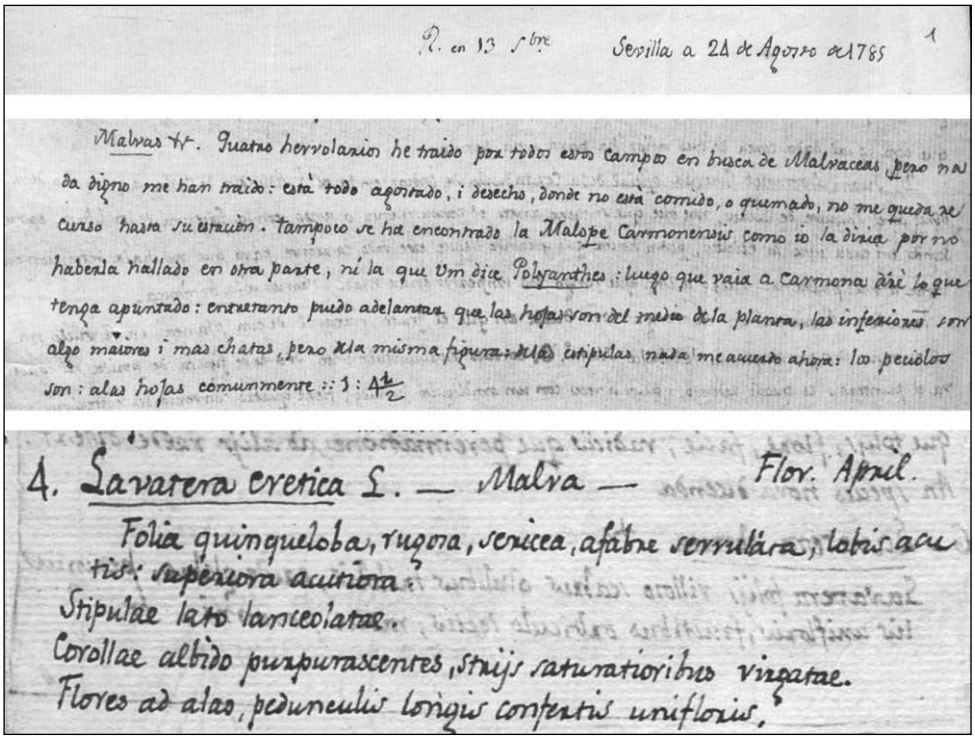
en cada sobaquillo, i el fruto respectivamente maior; los calices velludos, Nada mas puedo decir, ni tengo que embiar de ella. […]" (letter from Cándido Trigueros to Cavanilles in "Apuntamientos 1" (June 27, 1785), see Aguilar & Valdés (1998: 111-113); and "*2. Malope polyanthes / De esta ultima nada puedo añadir, porque aun la apuntación que creo copiè para Vm, no la encuentro*" (letter from Cándido Trigueros to Cavanilles in "Apuntamientos 5" (October 3, 1785), see Aguilar & Valdés (1998: 119-124) (see Fig. 1) [trans.: "Notes on some Malvaceae plants found in the Carmona area in Lower Andalusia […] Since the genus *Malope* L. shares so many similarities with the genus *Malva* L. in terms of the calyx, and since Linnaeus only recognizes the species *Malope* (*malacoides*) with ovate, crenate leaves, glabrous on top, as described in *Systema Naturae* 3. 462, edit. 13; having observed two other species, I thought they might be useful for an appendix and wanted to share them with you. However, as I do not have herbarium samples, seeds, or a description of one of them, and only a description and a poorly preserved herbarium sample of the other, I went out three times to search for them in the places where I had seen them years ago. But the sun, which has dried out that part of the Dehesa, and the livestock that has eaten the grass, prevented me from making the collection as I had hoped. I am sending the exact description and an herbarium sample of one of them; perhaps at another time, if the weather allows, I will be able to send more. […] The other *Malope* I remember was about half a foot tall or less, not very branched, with nearly round, hairy, crenate leaves, small white flowers, three or four with short pedicels in each axil, and a relatively larger fruit; the calyces were hairy. I cannot say anything more, nor do I have anything else to send about it. […] (letter from Cándido Trigueros to Cavanilles in "Apuntamientos 1" (June 27, 1785), see Aguilar & Valdés (1998: 111-113) // 2. *Malope polyanthes* / I cannot add anything about this last one, as I cannot even find the note that I believe I copied for you" (letter from Cándido Trigueros to Cavanilles in "Apuntamientos 5" (October 3, 1785), see Aguilar & Valdés (1998: 119-124)].

We translate this part of the letter sent by Trigueros to Cavanilles, in which he mentions his inability to collect material for what could have been a new species of *Malope*, that he tentatively names "*Malope polyanthes*". Cavanilles likely relied on this brief description for the species (see Cavanilles 1786: 85), altering the name to *Malope multiflora*. This letter makes it clear that Trigueros was never able to send material of this plant to Cavanilles, something that remained pending between them. However, Cavanilles, trusting Trigueros' description, still included the species in his work as a new species.

In a later letter sent from Trigueros to Cavanilles, dated August 24, 1785, he will again express his regret for the lack of material of this plant: "*Malvas*. Cuatro herbolarios he traido por todos estos campos en busca de *Malváceas*, pero nada digno me han traido: está todo agostado y deshecho, donde no está comido o quemado; no me queda recurso hasta su estación. Tampoco se ha encontrado la *Malope carmonensis*, como yo la diría por no haberla hallado en otra parte, ni la que Ud. dice *Polyanthes*: luego que vaya a Carmona diré lo que tenga apuntado; entretanto puedo adelantar que las hojas son del medio de la planta, las inferiores son algo mayores y más chatas, pero de la misma figura; de las estípulas, nada me acuerdo ahora; los pecíolos don a las hojas comúnmente: $1{:}4^{1/2}$" [trans.: *Malvas*. I have sent four herbalists across all these fields in search of *Malvaceae*, but they have brought nothing of value: everything is parched and destroyed, where it is not eaten or burned. I have no resources left until its season. Neither has the *Malope carmonensis*

been found, as I would call it for not having encountered it elsewhere, nor the one you refer to as *Polyanthes*. Once I go to Carmona, I will share what I have noted; in the meantime, I can report that the leaves are from the middle of the plant; the lower leaves are somewhat larger and more flattened, but of the same shape. As for the stipules, I cannot recall them at the moment. The petioles are usually attached to the leaves: 1:4[1/2]] (see Fig. 2). The name "*Malope carmonensis*" corresponds to *M. trifida* Cav., which at that time was only known from Carmona. The name "*Malope polyanthes*" is most likely the species described by Cavanilles as *Malope multiflora*.

However, what species was Trigueros really talking about? According to Trigueros' correspondence with Cavanilles (letter dated October 3, 1785, "Apuntamientos 5" (see Aguilar & Valdés, 1998: 122), see Fig. 2), Trigueros was well acquainted with the Linnaean species *Lavatera cretica*, providing the following details about it: "4. *Lavatera cretica* L. – Malva. – Flor. April. / Folia quinqueloba, rugosa, sericea, afabre [affabre] serrulata, lobis acutis: superiora acutiora. Stipulae lato lanceolatae. Corollae albido purpurascentes, striis saturatioribus virgatae. Flores ad alas, pedunculis longis confertis unifloris"


P. en 13 Sbre Sevilla a 24 de Agosto de 1785 1

Malvas &c. Quatro herborizaciones he traido por todos estos campos en busca de Malvaceas, pero nada digno me han traido: esta todo agostado, i desecho, donde no esta comido, o quemado, no me queda recurso hasta su estacion. tampoco se ha encontrado la Malope Carmonensis como io la dixia por no haberla hallado en otra parte, ni la que Vm dice Polyanthes: luego que vaia a Carmona dare lo que tenga apuntado: entretanto puedo adelantar que las hojas son del medio de la planta, las inferiores son algo mayores i mas chatas, pero de la misma figura: de las estipulas nada me acuerdo ahora: los peciolos son: alas hojas comunmente :: 1 : 4 1/2

4. Lavatera cretica L. — Malva — Flor. April.
Folia quinqueloba, rugosa, sericea, afabre serrulata, lobis acutis: superiora acutiora.
Stipulae lato lanceolatae.
Corollae albido purpurascentes, striis saturatioribus virgatae.
Flores ad alas, pedunculis longis confertis unifloris.

Fig. 2. Letters from Cándido Trigueros to Cavanilles: the two excerpts above: August 24, 1785 (see Aguilar & Valdés (1998: 241); the excerpt below: October 3, 1785 (in "Apuntamientos 5", see Aguilar & Valdés (1998: 122). Image courtesy of the Historical Archive of the Royal Botanical Garden of Madrid, reproduced with permission.

[trans.: Leaves with five lobes, rough, silky, finely serrated, with sharp lobes: the upper ones are sharper. Stipules wide, lanceolate. White-purple corollas, with more intense stripes in a rod-like pattern. Flowers arranged in [wings?], with long, dense, and uniflorous pedicels] (see Fig. 2). Trigueros owned a copy of Linnaeus' *Species Plantarum* (Editio tertia, 1764) in his library, a work with which he was very well acquainted (Aguilar & Valdés 1998: 127). In western Andalusia, *Lavatera cretica*, alongside *L. trimestris* L., is one of the most common species. Moreover, Cavanilles was also thoroughly familiar with this Linnaean species, having included and illustrated it in his own work (Cavanilles 1786: 89, Tab. XXXII, f. 1).

Thus, it seems that the use of this "phantom" name by Cavanilles, *Malope multiflora*, to definitively fix the concept of Linnaeus' name *Lavatera cretica* within the genus *Malva*, may have been merely an act of convenience for the stability of the nomenclature of this group. What species did Trigueros have in mind? Did Cavanilles really come to know this species? Or was he simply influenced by the information provided by his friend Trigueros? These questions are difficult to answer.

In conclusion, and to continue with the act of fixing the name, as an exhaustive search for original material of *Malope multiflora* failed to locate any original material, a neotype is selected according to Art. 9.8 of the Madrid Code (Turland & al. 2025). We have located a well-preserved herbarium sheet at SEV (No. 41292), collected in Carmona (Seville, Spain) in 1979. The sheet contains a complete specimen, matches the description in the protologue, and shows diagnostic features of this species (e.g., plant stellate-pubescent to slightly hispid, up to 20 cm; stems herbaceous; suborbicular-cordate leaves, with 5–7 short lobes; flowers in clusters of 2–8; pedicels unequal, shorter than the subtending petiole; epicalyx-segments shorter than sepals, ca. 6 mm, free nearly to the base, ovate; sepals only slightly acrescent, 8 mm, triangular-ovate, acuminate; petals 10–20 mm, lilac), and clearly represents the current application of the name. This material is selected as the neotype of *Malva multiflora* (Fig. 3).

This typification definitively establishes Cavanilles' name within the genus *Malva* according to Linnaeus' concept of *Lavatera cretica*.. It simplifies and stabilizes the nomenclature of this group of plants.

Malva multiflora (Cav.) Soldano, Banfi & Galasso in Atti Soc. Ital. Sci. Nat. Mus. Civico Storia Nat. Milano 146(2): 230. 2005

≡ *Malope multiflora* Cav., Diss. 2, Secunda Diss. Bot.: 85. 1786 [basionym]

Neotype (designated here): Spain, Sevilla, Carmona, Ermita de Santa María de Gracia, 24 April 1979, *P. Candau, I. Fernández et T. Luque 1498/79* (SEV No. 41292 [photo!]) (Fig. 3).

≡ *Lavatera cretica* L., Sp. Pl.: 691. 1753 ≡ *Anthema cretica* (L.) Medik., Malvenfam.: 42. 1787 ≡ *Althaea cretica* (L.) Alef. in Oesterr. Bot. Z. 12: 260. 1862, nom. illeg., non Weinm., Syll. Ratisb. 2: 171. 1828 ≡ *Malva cretica* (L.) Pau, Not. Bot. Fl. Españ. 3: 29. 1889, nom. illeg., non Cav., Diss. 5, Quinta Diss. Bot.: 280. 1788 ≡ *Malva pseudolavatera* Webb & Berthel., Hist. Nat. Iles Canaries 3(2) [Phytogr. Canar. 1]: 29-30. 1836 [syn. subst.] ≡ *Malva hederaefolia* Visiani, Flora dalmatica 3(2): 205. 1851 [syn. subst. pro *Lavatera cretica* L. (1753)], nom. superfl. ≡ *Malva linnaei* M.F. Ray in Novon 8: 292. 1998 [syn. subst. pro *Lavatera cretica* L. (1753)], nom. superfl.



Fig. 3. Neotype of *Malope multiflora* Cav., SEV (No. 41292). Image courtesy of the herbarium SEV, reproduced with permission.

Lectotype (designated by Fernandes 1968: 429): Herb. Linn. No. 287.11 (S-LINN). For an image of the lectotype: http://linnaeus.nrm.se/botany/fbo/l/lavat/lavacre.html.en

Note: Regarding the lectotype of the Linnaean name *Lavatera cretica*, Fernandes (1968: 429) mentioned: "No herbario de Lineu (S) existe um exemplar dessa espécie, proveniente do Hortus Upsaliensis, e com a indicação, no verso do papel de montagem, de ter sido visto por aquel botánico. É este, pois, o *lectotypus* de *L. cretica* L. / Em LINN, o espécime 871-10, etiquetado também como *L. cretica*, é um typus da espécie" [In the Linnaean herbarium (S), there is a specimen of this species, originating from the *Hortus Upsaliensis*, with a note on the back of the mounting paper indicating that it was seen by that botanist. This is, therefore, the lectotype of *L. cretica* L. In LINN, specimen 871.10, also labeled as *L. cretica*, is a type of the species]. The term "typus" attributed to the specimen LINN 871.10, should be understood as "original material" (image of the sheet available at https://linnean.access.preservica.com/uncategorized/IO_d56527b1-e7de-4e0c-ae51-acdc7697b940/).

Malva cretica Cav.

Malva cretica comprises two recognized subspecies: *M. cretica* subsp. *cretica*, which is distributed across the central and eastern Mediterranean Basin, from Corsica and Sardinia to Cyprus and Turkey, including Tunisia and Malta; some populations in Spain may be introduced (see Valdés 2011; Del Guacchio & al. 2020); and *M. cretica* subsp. *althaeoides* (Cav.) Béguinot (based on *Malva althaeoides* Cav. Icon. 2: 30. 1793), and distributed in Spain, northwestern Africa, and Corsica (see Jeanmonod 2002; Nogueira & Paiva 2005; Valdés 2011; Del Guacchio & al. 2020).

The lectotype of *M. althaeoides* was designated by Iamonico & Del Guacchio (2017: 285) from a specimen collected by Cavanilles in Valencia province, Spain ("Enguerae tractu vulgo Lloruz") in May 1791 (MA barcode MA179849; image of the lectotype available at https://imagenes.rjb.csic.es/herbarioV/visorVCat.php?img=MA-01-00179849).

On the other hand, Iamonico & Del Guacchio (2017) also indicated a "holotype" for the name *Malva cretica*, from a specimen kept at the Herbarium of the Muséum national d'Historie Naturelle in Paris, at P: "*Malva cretica* Cavanilles (1786: 67) ≡ *Dinacrusa cretica* (Cav.) Krebs (1994: 309). Type:—FRANCE. Jardin du Roi [Paris], *s.d.*, *Isnardi s.n.* (holotype P-00662859 [Digital image!])" (see Fig. 4).

However, in our opinion, the original material for *M. cretica* comprises more than one element. Moreover, the "holotype" indicated by these authors, as they failed to include the phrase "designated here" (or a similar one) cannot be treated as an effective "typification", nor can it be corrected to "lectotype" (see *ICN* Art. 7.11 and 9.10 Note 9; see Turland & al. 2025). Consequently, the result is that, even though a "holotype" was cited, in fact, no type was formally designated.

Cavanilles (1786: 67) included the name *Malva cretica* in the protologue under number 108, followed by a brief diagnosis, the synonym "Alcea cretica hirsuta" cited from Tournefort (1703: 2), a detailed description of the plant, its geographical provenance "*Habitat in Creta*", and two relevant comments:

"V. S. apud de Jussieu in herbario D. Isnardi. Unicum exemplar" [trans.: V. S. [vidi siccum] I saw it in its dried state at the house of Jussieu, in the herbarium of Mr.

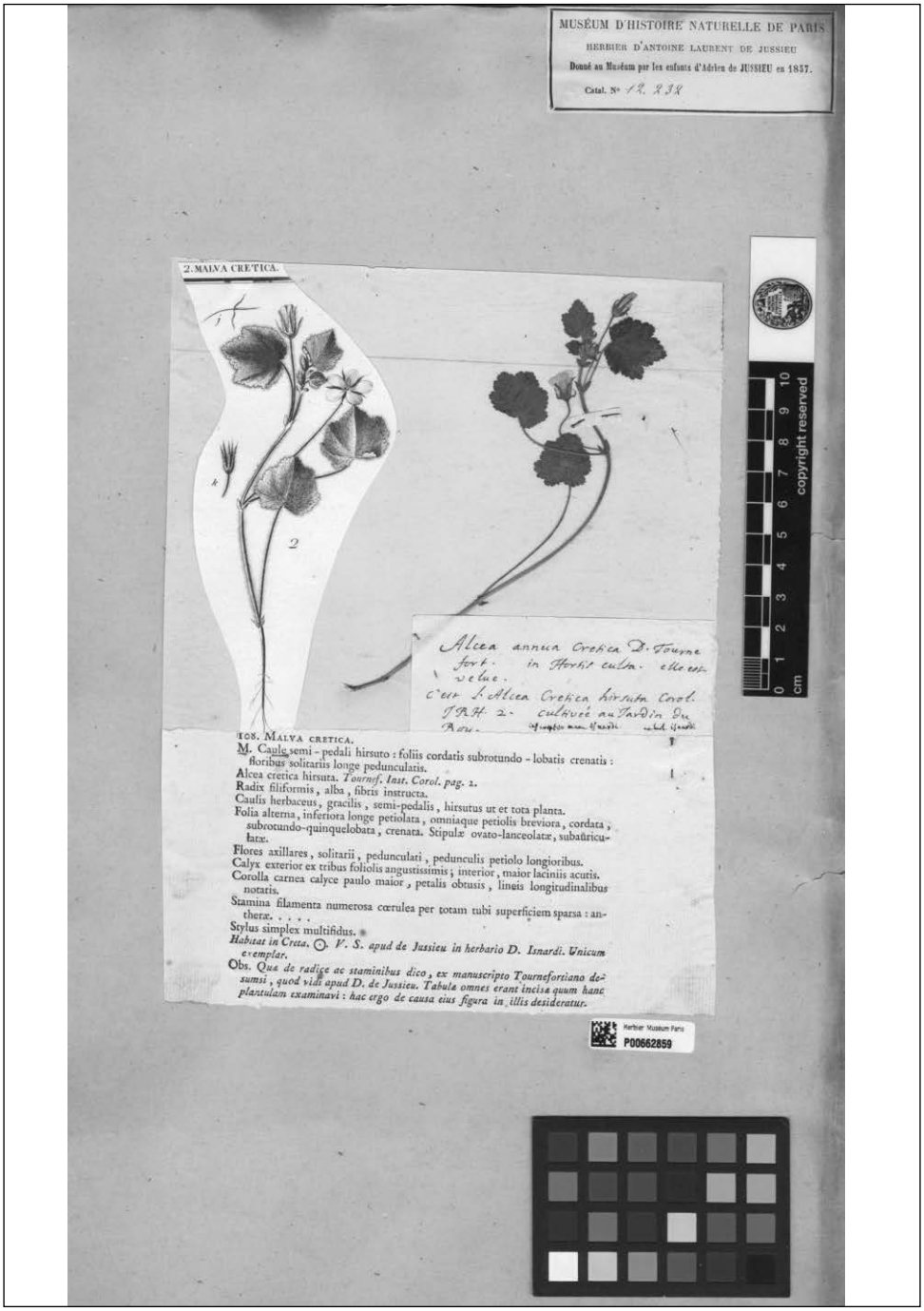


Fig. 4. Lectotype of *Malva cretica* Cav., P (2-D code P00662859). Image courtesy of the herbarium P, reproduced with permission.

Isnardi", or more generally, "in the herbarium of Mr. Isnardi, under the supervision of Jussieu". "A single specimen"].

"Obs. Quæ de radice ac staminibus dico, ex manuscripto Tournefortiano desumsi, quod vidi apud D. de Jussieu. Tabulæ omnes erant incisæ quum hanc plantulam examinavi: hac ergo de causa eius figura in illis desideratur" ["Remarks: What I say about the root and stamens I took from a manuscript by Tournefort, which I examined at Mr. de Jussieu's. All the plates were engraved when I studied this plant; therefore, for this reason, its figure is lacking from them"].

Iamonico & Del Guacchio (2017) mentioned that: "since Cavanilles (1786) reported "*Unicum exemplar*", and there is no suggestion that the Tournefortian manuscript was more than text, this specimen [i.e., P00662859] is the holotype of the name *Malva cretica* (see Art 9.1, and the discussion by McNeill 2014)". They further added: "according to the author, the book was already in press when he examined the holotype, therefore its illustration is lacking. Effectively, Cavanilles published the illustration some years later (Cavanilles 1788: Tab. CXXXVIII fig. 2). Notably, it is the faithful portrait of P-00662859 (the holotype), including a precise detail: the root was drawn on the basis of the Tournefort's manuscript, because it lacks in the Isnard's specimen".

The illustration of *Malva cretica* published by Cavanilles in 1788 closely matches the specimen P00662859, with the addition of roots, highlighting the specimen's key role in typification. As the only specimen cited in the protologue, it qualifies as original material and, by *ICN* rules, must be accepted as the lectotype. Cavanilles examined this specimen, cultivated in the Jardin du Roi and part of Antoine-Tristan Danty d'Isnard's herbarium, in the presence of Jussieu. While details of roots and stamens were drawn from the Tournefort manuscript, the rest of the morphological description derives from the Isnard specimen. The illustration was likely created while studying the specimen but could not be included in *Secunda Dissertatio Botanica* because all plates had already been engraved before its publication. Therefore, both the Isnard specimen (Fig. 4) and the original drawing (Fig. 5) constitute Cavanilles' original material. However, the specimen P00662859 plays a key role in typification and, being the single specimen cited in the protologue (i.e., the only syntype), it must be accepted as the lectotype (see *ICN* Art. 9.12), since, according to this article, an illustration (cited or not) can be designated as a lectotype only when no syntype (cited specimen) exists.

Thanks to the invaluable assistance of Esther García Guillén, we have become aware of the existence of Cavanilles' original drawing, which is preserved in the Historical Archive of the Royal Botanical Garden of Madrid (Fig. 5). Figures 5 and 6 show both the front and back of the sheet containing Cavanilles' drawing, along with the original drawings of *Malva scabra* and *Malva polystachya*. On the reverse side of the sheet, Cavanilles wrote by hand: "Hotel del Ynfantado rue St Florentin place de Louis XV. / 15. Juin 1787. / Cavanilles" (Fig. 6). This date on the reverse may correspond to the time when the other two drawings, *M. scabra* and *M. polystachya*, were made. In creating these two drawings, it is reasonable to assume that Cavanilles was aware that he would later insert the cutout of the *M. cretica* drawing between them. On the other hand, after reviewing the letters from Jussieu to Cavanilles and several other documents related to *Monadelphia*, we have found no references to the *M. cretica* drawing.

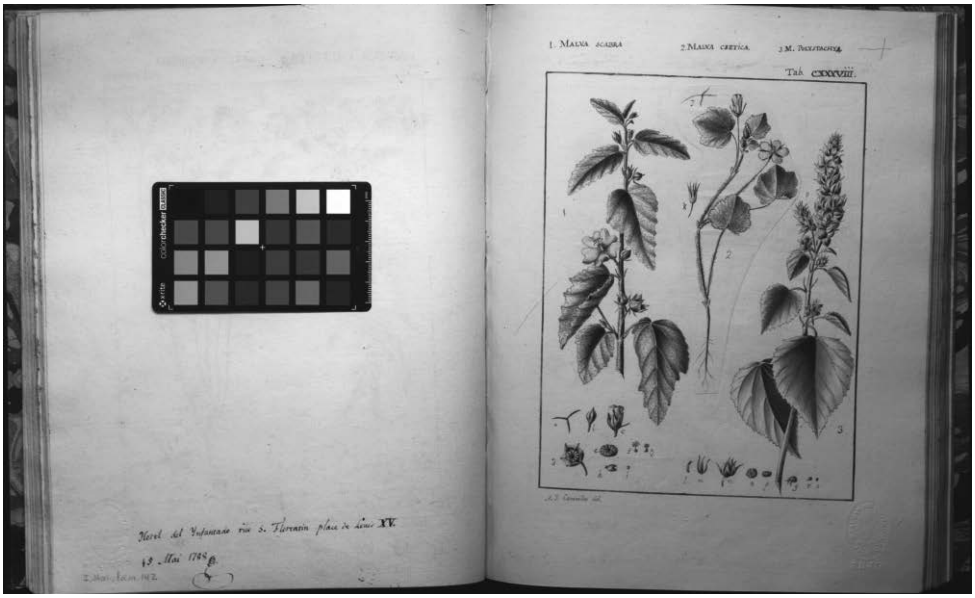


Fig. 5. Front of the sheet with the drawing of *Malva cretica* Cav. by Cavanilles, and publishedin Cavanilles (1788: Tab. CXXXVIII, fig. 2). Call number: AJB, Div. 1, Mon, 2, 143r. Image courtesy of the Historical Archive of the Royal Botanical Garden of Madrid, reproduced with permission.

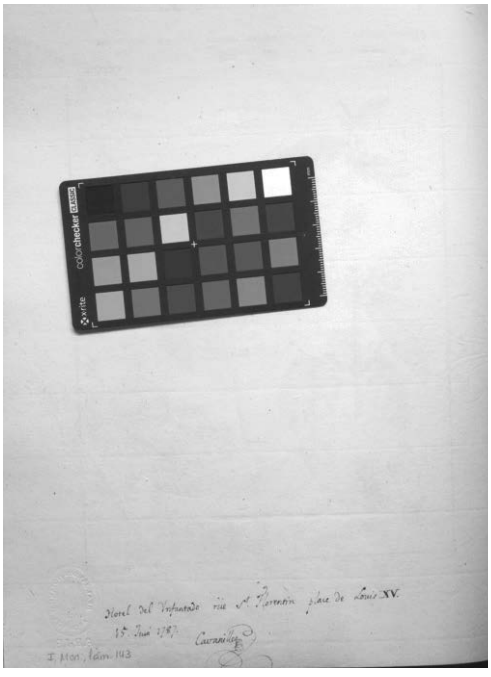


Fig. 6. Reverse side of the sheet with the drawing of *Malva cretica* Cav. by Cavanilles, including Cavanilles' handwritten annotation: "Hotel del Ynfantado rue St Florentin place de Louis XV. / 15. Juin 1787. / Cavanilles". Call number: AJB, Div. 1, Mon, 2, 143v. Image courtesy of the Historical Archive of the Royal Botanical Garden of Madrid, reproduced with permission.

In conclusion, although Iamonico & Del Guacchio (2017) treated specimen P00662859 as the sole material, under *ICN* Art. 9.1 and Art. 9.4, original material can include both specimens and illustrations associated with the taxon at the time of description. Consequently, the previous "type" designation cannot be corrected from "holotype" to "lectotype" because it was not formally indicated. Following *ICN* rules, we formally designate the Isnard specimen at P (P00662859) as the lectotype of *Malva cretica*.

Malva cretica Cav., Diss. 2: 67. 1786

Lectotype (designated here): [France], Jardin du Roi [Paris], *s.d.*, *A.-T. D. d'Isnard s.n.*, P (2-D code P00662859 [photo!]). (Fig. 4).

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We thank Dr. Esther García Guillén (Archivo Histórico, Real Jardín Botánico – CSIC, Madrid) for her invaluable assistance in studying the correspondence between Trigueros and Cavanilles, as well as the original drawings by Cavanilles. We also thank Dr. Francisco Javier Salgueiro González (SEV) for his help in examining the herbarium sheets preserved at SEV, and Dr. Werner Greuter for reviewing the manuscript and providing valuable contributions that have greatly improved the work.

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Article

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Ridha El Mokni

Furcraea hexapetala and *F. selloana* (*Asparagaceae*, *Agavoideae*), new genus and species records for Tunisian alien succulents

Abstract

El Mokni, R.: *Furcraea hexapetala* and *F. selloana* (*Asparagaceae*, *Agavoideae*), new genus and species records for Tunisian alien succulents. — Fl. Medit. 35: 209-215. 2025. — ISSN: 1120-4052 printed, 2240-4538 online.

The present work documents the occurrence in the wild of two casual alien succulent plant species, *Furcraea hexapetala* (Jacq.) Urb. and *F. selloana* K.Koch, from the central and northern regions of Tunisia. These species, native to the American continents, have been recorded for the first time to occur as casual individuals in some localities within urban habitats. Being closely related to some species of *Furcraea* subgen. *Furcraea*, typical distinguished macromorphological features are provided to validate these new records together with photos.

Key words: Flowering Monocots, Succulents, Tunisia, casual aliens, North Africa.

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Introduction

The genus *Furcraea* Vent., is a member of the *Agavoideae* subfamily (*Asparagaceae*, *Asparagales*), characterized mainly by its spiral succulent to semi-succulent leaves, arranged in rosettes and its terminal paniculate inflorescence of large dimensions that present events of vegetative proliferation (false viviparity), producing numerous bulbils that once falling to the ground, can easily form new roots. Thus, constitute an important part for the propagation of the species (García-Mendoza 2000, 2001; Thiede 2020). Approximately the genus includes 20–25 species that are recognized in two subgenera: *F.* subgen. *Furcraea* Baker and *F.* subgen. *Roezlia* Baker (Baker 1888; Verhoek 1998; Garcia-Mendoza 1999). These species have a neotropical distributive range within the Americas, from central Mexico to Paraguay, as well as in the West Indies with its southernmost range reaching as far south as the Andes mountains, usually restricted to dry habitats and nutrient-poor substrates, between sea level and 3000 m altitude (García-Mendoza 2000, 2001; Thiede 2020). Due to several uses attributed to leaves and/or flowers in industrial or ethnobotanical scales, many species (mainly of the subgen. *Furcraea*) have been introduced

and cultivated as ornamentals worldwide in (sub-)tropical and Mediterranean climates (Thiede 2020). Within the European Mediterranean (including Canary Islands, Portugal, Spain), several species can be found with different status of naturalisation namely, *Furcraea foetida* (L.) Haw., *F. hexapetala* (Jacq.) Urb., and *F. selloana* K. Koch (see e.g., Domingues de Almeida & Freitas 2006; Sánchez Gullón 2013; Verloove & al. 2019; Verloove & Smith 2024).

In the North African mainland, no official/confirmed reports of the occurrence of any species of *Furcraea* in the wild except those of Maire (1959). This latter mentioned the presence of two species [*F. foetida* (L.) Haw. and *F. stricta* Jacobi, sub *F. elegans* Tod.] that were introduced and cultivated within coastal gardens of North Africa for fibre purposes, with any precised localities. More recently, *F. hexapetala* has been documented from Morocco in the Tangier region (Homrani Bakali & al. 2025 in press).

The present contribution is continuity to the updating of the diversity of *Agavoideae* in North Africa (see e.g. El Mokni & Verloove 2021; Homrani Bakali & al. 2026). It deals with the first documented records of the genus *Furcraea* with two of its species (of the subgen. *Furcraea*) from Tunisia, *F. selloana* (first report to N-Africa from Tunisia) and *F. hexapetala* (second report to N-Africa and first report to Tunisia) as casual alien succulents of the North African mainland.

Materials and Methods

Botanical surveys were carried out in various urban habitats within central and northern Tunisia (North Africa), mostly between 2010 and 2024, revealed new national and even North African records of several interesting specimens of *Furcraea*. Digital photographs and GPS coordinates were taken in the field. The identification of the specimens was done mainly according to García-Mendoza (2001), Verloove & al. (2019), Thiede (2020). The nomenclature follows Valdés (2012). Voucher specimens are deposited in the personal herbarium of the author housed at the faculty of Pharmacy of Monastir (Monastir University).

Results

Furcraea hexapetala (Jacq.) Urb., Symb. Antill. 4: 152 (1903) ≡ *Agave hexapetala* Jacq., Enum. Syst. Pl.: 18 (1760)

Furcraea hexapetala (Fig. 1) is subshrub native to SE Mexico, Caribbean to Ecuador, very spread in the west part of the Cuba Island (Alvarez de Zayas 1996). This species seems among the most widely cultivated as ornamental but has rarely been reported as an escape so far. It was known as a naturalised alien species only from Canary Islands (Verloove & al. 2019) till recently discovered as a well-established alien in Morocco (Homrani Bakali & al. 2026).

Macromorphologically, *F. hexapetala* is a robust, acaulescent to subacaulescent plant, characterised mainly by a woody trunk up to 50cm, long rigid semisucculent leaves 100–

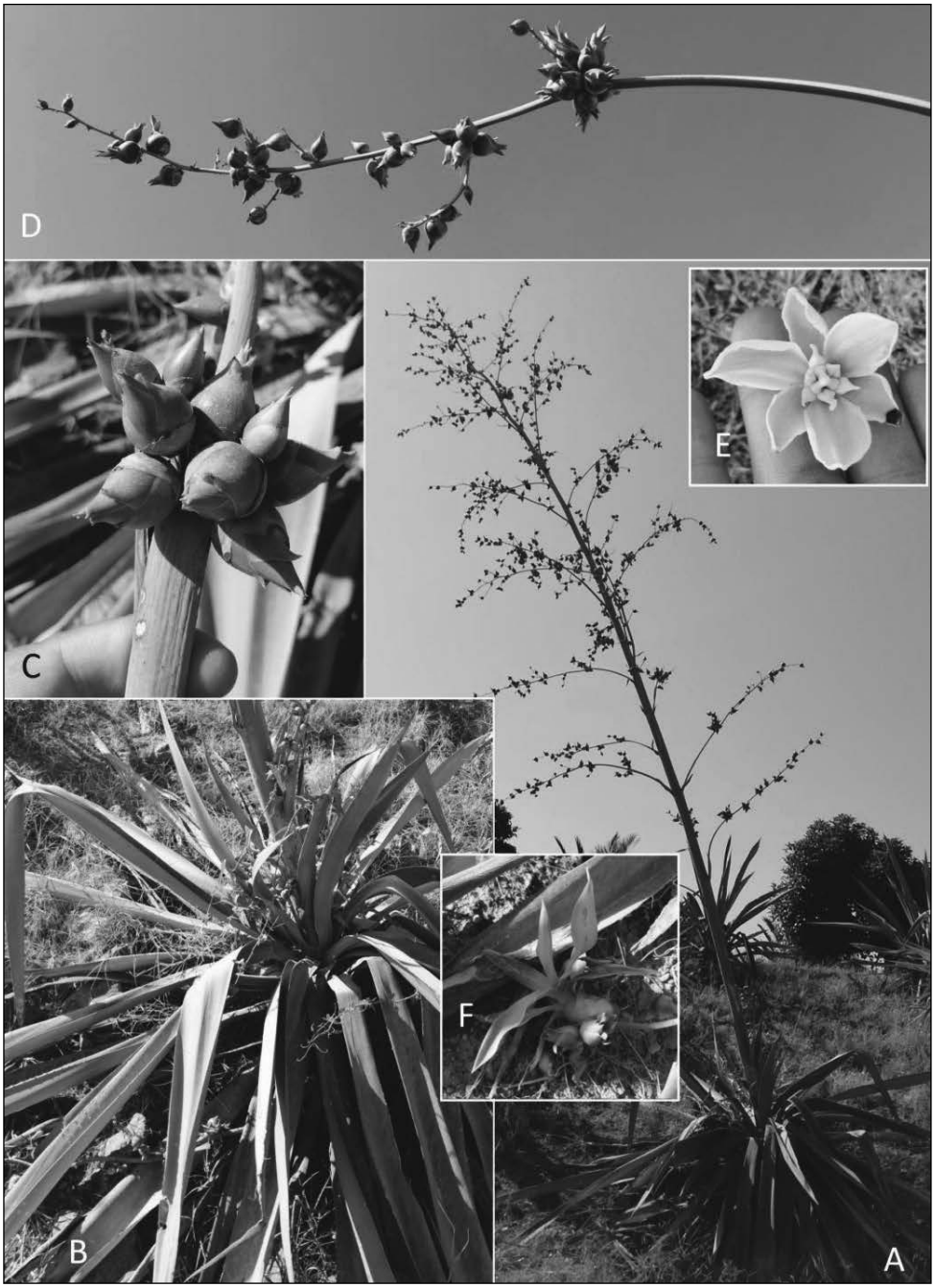


Fig. 1. *Furcraea hexapetala* in Tunisia. A. Habit and habitat during bulbils producing period, B. Leaves, C. Bulbils, D. Lateral ramification of the inflorescence, E. Opened flower in Front view, F. Advanced bulbil (seedling stage), Photographs by R. El Mokni.

160(–200) × (5.5–)8.0–12.0(–20.0)cm with spiny margins, and a rhomboidal outline terminal panicle up to 8m long (García-Mendoza 2001; Verhoek 2002; Homrani Bakali & al. 2025). The species could be confused with some closely related species of the subgen. *Furcraea* mainly *F. cabuya* Trel., *F. guatemalensis* Trel., and *F. selloana* K.Koch (see more in Verloove & al. 2019: 492) from which it can be easily distinguished by its more massive habit, persistent marginal spines, and vegetative propagation via bulbils (Thiede 2020).

Occurrence in Tunisia with Status of naturalisation – The species was found in two localities:

In central regions (CT, Monastir), during flowering period on 27/11/2021 and 01/02/2022 (two mature individuals with three juvenile individuals that have one meter tall in an area of 100m square), growing in an urban habitat together with *Arundo donax* L., *Parkinsonia aculeata* L., *Saccharum spontaneum* subsp. *aegyptiacum* (Willd.) Hack, *Vachellia karroo*.

In northern region (NE, Tunis), during bulbs producing period on 06/08/2024 (thee mature individuals of different height with a lot of juvenile individuals from rooting bulbs in an area of 1 hectare), growing in a disturbed habitat within roadsides together with *Agave americana* L., *Ficus microcarpa* L.f., *Phoenix canariensis* H.Wildpret, *Washingtonia filifera* var. *robusta* (H.Wendl.) Parish, *Yucca* sp.

According to the definitions of Pyšek & al. (2002), *Furcraea hexapetala* should be treated as a casual alien.

Furcraea selloana K.Koch, Wochenschr. Vereines Beförd. Gartenbaues Königl. Preuss. Staaten 3: 22 (1860) = *F. lindenii* Jacobi in Gard. Chron. 1869: 587 (1869)

Furcraea selloana (Fig. 2) is a subshrub or a shrub with a native range restricted from Colombia to Ecuador. The plant seems widely cultivated as an ornamental or for fibre purposes in dry warm-temperate and subtropical areas of the world widely. It has been reported as an escape so far from several localities in Florida, in Australia and India, within the European countries (Including Canary Islands Spain, Portugal), and South Africa (see e.g. Castroviejo 2013; Sánchez Gullón 2013; Smith & Figueiredo 2016; Verloove & al. 2019; Verloove & Smith 2024). In North African mainland, the species was reported as cultivated only from Lybia (Raab-Straube 2022+).

Macromorphologically, *F. selloana* is a robust, acaulescent to subacaulescent plant, characterised mainly by a rosette leaves up to 4m in diameter, linear-lanceolate to oblanceolate, erect semisucculent, coriaceous, concave leaves (70–)100–170 × (7–)10–15cm with a specifically yellow leaf-margined form, and a lax oblong outline terminal panicle up to 10m long (García-Mendoza 2001; Homrani Bakali & al. 2026). The species could be confused with some closely related species of the subgen. *Furcraea* mainly *F. cabuya* and *F. hexapetala* (see more in Verloove & al. 2019: 494) from which it can be easily separated by its lanceolate leaves that are distinctly narrowed above base, 23–35(–50) teeth per leaf margin, an oblong, lax inflorescence, and oblong bracts with denticles at their apex only (Thiede 2020).

Occurrence in Tunisia with Status of naturalisation – The species was found only in the northern region (NE, Tunis), during flowering period on 20/12/2022 and 11/02/2022

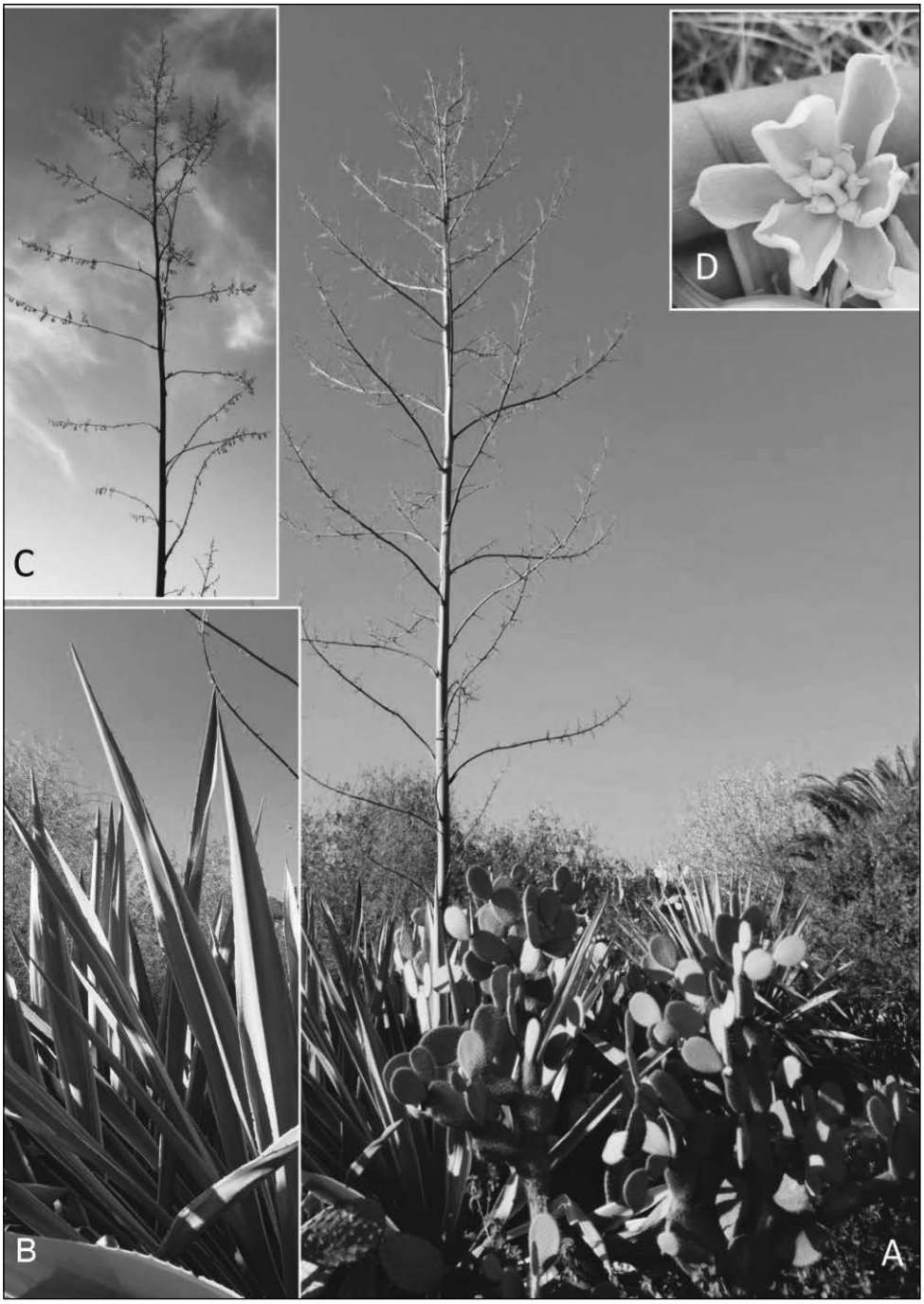


Fig. 2. *Furcraea selloana* in Tunisia. A–habit and habitat, B. Leaves, C. Inflorescence in large and high panicle, D. Opened flower in Front view, Photographs by R. El Mokni.

(five mature individuals with different wide rosette leaves in an area of 200m square), growing in an urban habitat together with mainly, *Campsis radicans* (L.) Bureau, *Lantana camara* L. subsp. *aculeata* (L.) R.W.Sanders, *Opuntia* spp., *Vachellia karroo* (Hayne) Banfi & Galasso. According to the definitions of Pyšek & al. (2002), *Furcraea hexapetala* should be treated as a casual alien.

Note – It was reported (Verloove & al. 2019) that records of *Furcraea selloana* made in the wild within Canary Islands were different mainly in leaves color. In Gran Canaria and Tenerife, specimens with a variegated form with creamy-yellow stripes along the leaf margin were relate to *F. s.* var. *marginata* Trel. (syn. *F. lindenii* Jacobi) whereas only in Puerto de la Cruz (La Paz) in Tenerife specimens with green leaves have been observed. Individuals with creamy-yellow stripes leaved is much more common in cultivation than the wild green forms.

Over the last decade, few amendments and additions to the generic diversity of the *Agavoideae* subfamily (*Asparagaceae*/*Agavaceae* s.l., Flowering Monocots) in North Africa have been made (see e.g., El Mokni 2018; El Mokni & Verloove 2022). The genus *Furcraea*, reported here for the second time, represents one such addition.

Discussion

In North African mainland, as elsewhere in the World, the ability of introduced *Furcraea* species to escape and to increasingly invade urban habitats is associated with their ability to produce numerous bulbils (ca. several thousand per plant) on a massive inflorescence. After flowering, these viviparous plantlets eventually drop, rooting easily on contact with the soil to form dense monotypic thickets that competes and can disturb/exclude native vegetation (ISSG Database 2009; Verloove & al. 2019).

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Article

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New records and notes on the vascular flora of Porto Santo (Madeira Archipelago, Portugal)

Abstract

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New records for the vascular flora of Porto Santo Island (Madeira Archipelago, Portugal) are presented. A total of 13 taxa is reported for the first time, including one possible native species (*Trifolium obscurum*), one "possible introduced" species (*Trifolium repens*) and 11 naturalized species. In addition, 12 taxa are confirmed, comprising six native species, including the Madeira endemic *Sonchus ustulatus* subsp. *imbricatus*, and six naturalized species. The native *Beta macrocarpa*, overlooked since 1904, is now documented as widespread on Porto Santo and adjacent islets. The rare *Ophioglossum lusitanicum* is also confirmed, contradicting previous suggestions of extinction. Clarification is provided regarding *Helichrysum melaleucum* subsp. *roseum*, which occurs in both Madeira and Porto Santo, and not exclusively in the latter. Finally, an updated account of the vascular flora of Porto Santo is also presented.

Key words: floristics, biogeography, vascular flora.

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Introduction

The Madeira volcanic archipelago is located in the Northeast Atlantic, about 795 km southwest of mainland Portugal, and comprises the islands of Madeira (734 km², 1861 m), the three uninhabited Desertas Islands (14.8 km², 479 m) and Porto Santo (42 km², 517 m) with its six surrounding islets.

Porto Santo, with a maximum length of 11 km and 5 km width, lies about 60 km northeast of Madeira and is the oldest island of the archipelago (c. 14 Ma vs. <7 Ma for Madeira; Ramalho & al. 2015). Its lower relief and smoother orography result from long-term erosion processes. The southern coast is characterized by a 9 km sandy calcareous beach, contrasting with the steep cliffs of the remaining coastline. The island has a semi-arid climate, with annual rainfall usually 380-400 mm and a mean annual temperature of about 18 ºC (Carvalho & Brandão 1991).

Jardim & Menezes de Sequeira (2008) reported 463 species and subspecies of vascular plants for Porto Santo, based on published data. Since then, several additions have been published. New species endemic to Porto Santo have been described, e.g., *Pericallis menezesii* R.Jardim, K.E.Jones, Carine & M.Seq. (Jones & al. 2014). Some species have had their native status revised, and former Macaronesian endemisms are now considered endemic to the Madeira archipelago, e.g., *Andryala glandulosa* Lam. (Ferreira & al. 2014). New records for Porto Santo Island and its surrounding islets – some native but mainly introduced species, including some clearly invasive – have also been reported, e.g., *Ipomoea pes-caprae* (L.) R. Br. (Jardim & Menezes de Sequeira 2014). By 2014, the vascular flora of Porto Santo comprised 507 taxa, including nine endemics restricted to Porto Santo, 33 endemics to the Madeira archipelago, 26 Macaronesian endemics, 265 native species, 35 "possible natives," 13 "possible introduced," and 126 introduced taxa (Jardim & Menezes de Sequeira 2014). Further additions have been published subsequently (Jardim & Menezes de Sequeira 2015, 2021).

The present study reports additional new records for Porto Santo Island and its islets, and confirms previously reported taxa, providing an updated account of the vascular flora.

Material and Methods

This study is based on specimens collected in Porto Santo Island and its surrounding islets, during field excursions from 2011 to 2025 deposited in the UMAD – R.T. Lowe Herbarium, and the revision of specimens kept at the MADJ, MADS, and MA herbaria.

Taxonomic treatment follows Jardim & Menezes de Sequeira (2008) and Flora iberica (Castroviejo 1986-2021). The native status criteria follow Jardim & Menezes de Sequeira (2008), namely on possible native status "taxa that are considered to be native by recent authors, but previous authors considered that they were probably introduced" and possible introduced as "taxa considered to have been introduced by most of the authors, but even so some doubts remain as to its colonisation status".

Results

A total of 13 vascular plant taxa is newly recorded for Porto Santo Island, including one possible native species, one "possible introduced" species and 11 naturalized species. In addition, 12 previously reported taxa are confirmed for the island, comprising 6 native species, including 1 endemic to the Madeira archipelago, and 6 naturalized taxa.

1. New records for the flora of Porto Santo Island

PTERIDOPHYTA

Pteridaceae

Pteris vittata L.

Native to Mediterranean region and naturalized in Madeira and Deserta Grande (Jardim & Menezes de Sequeira 2021), this species is now recorded as naturalized in wall crevices in Vila Baleira, Porto Santo.

PORTUGAL, MADEIRA: Porto Santo: Vila Baleira, Rua Brig. Couceiro, nas fendas do muro da antiga Subestação de Electricidade, ca. 21m, 14-VII-2025, *R. Jardim RJ7095* (UMAD 25036).

SPERMATOPHYTA
MAGNOLIOPSIDA
Aizoaceae
Aptenia ×vascosilvae Gideon F.Sm., E.Laguna, Verloove & P.P.Ferrer

Nothospecies recently reported as naturalized in Madeira Island (Verloove & Gonçalves Silva 2022), is here recorded for first time as naturalized in Porto Santo Island. This robust hybrid has been extensively cultivated in recent years in gardens and roadsides in Porto Santo, and it spreads mainly by rooting of discarded cuttings, to nearby areas, e.g., Vila Baleira, Campo de Baixo, Campo de Cima, Pico de Ana Ferreira, Pé do Pico. This hybrid is distinguished from long-naturalized and cultivated *Aptenia cordifolia* (L.f.) Schwantes (Vieira 2002) by bright strawberry-red staminodes (not pinkish-purple) and leaves with usually cuneate (not cordate) bases (Smith & al. 2020). Vieira (2002) refers to cultivars of *A. cordifolia* being cultivated but not naturalized that could correspond to this newly described taxon.

PORTUGAL, MADEIRA: Porto Santo: Pé do Pico, Est. Francisco Bernardo Martins, na berma, ca. 85m, 14-VII-2025, *R. Jardim RJ7093* (UMAD 25034); Campo de Cima, Est. Benvinda Ascenção Oliveira, na berma, ca. 87m, 14-VII-2025, *R. Jardim RJ7100* (UMAD 25040); Pico de Ana Ferreira, proximidades do Campo de Golfe, ca. 58m, 14-VII-2025, *R. Jardim RJ7102* (UMAD 25041).

Carpobrotus acinaciformis (L.) L. Bolus

Species native to South Africa (Gonçalves 1990), found naturalized in several localities in Porto Santo, e.g., Lombas, Campo de Baixo, Campo de Cima. It has flowers with purple petaloid staminodes and was probably misidentified as rosed-flowered individuals of *C. edulis* (L.) N.E.Br. (Tebbs 1994). Although Porto Santo specimens have flowers less than 10 cm in diameter, their base narrowing abruptly into the pedicel and the sabre-shaped leaves, with the transverse section from the mid-length forms an isosceles triangle, are diagnostics features of this species. The yellow-flowered *C. edulis* is the most problematic invasive species on the island, occurring widely from sea level to the highest peaks. *C. acinaciformis* is also found in Madeira Island.

PORTUGAL, MADEIRA: Porto Santo: Lombas, Rua da Tamargueira, na berma. ca. 51m, 13-VII-2025, *R. Jardim RJ7080* (UMAD 25027); Campo de Cima, Est. Jorge Brum do Canto, na berma, ca. 98m, 14-VII-2025, *R. Jardim RJ7096* (UMAD 25037).

Asclepiadaceae
Gomphocarpus physocarpus EMey.

Subshrub native to Southeast Asia (Arista & Ortiz 2012) and previously reported as naturalized in Madeira Island (Vieira 2002), is here recorded as naturalized in Porto Santo Island. This species has globose non-apiculate follicles, in contrast with the apiculate follicles of *Gomphocarpus fruticosus* (L.) W.T.Aiton fully naturalized both in Madeira and Porto Santo. *G. physocarpus* was found along a small rocky ephemeral streambed, within *Cenchro ciliaris-Hyparrhenietum sinaicae* Wildpret & al. community (Costa & al. 2004).

PORTUGAL, MADEIRA: Porto Santo: Serra de Fora, no leito de uma linha de água, próximo à estrada ER233, ca. 95 m, 24-V-2014, *R. Jardim RJ5685* (UMAD s.n.); 28-VII-2014, *R. Jardim RJ5756* (UMAD s.n.).

Bignoniaceae

Podranea ricasoliana (Tanfani) Sprague

Species native to South Africa, long cultivated in Madeira and Porto Santo and reported as naturalized in Madeira by Vieira (2002). This scrambling shrub is now also naturalized in Porto Santo at Campo de Baixo, where it has been present for at least 20 years showing a clear expansion.

PORTUGAL, MADEIRA: Porto Santo: Campo de Baixo, baldio entre a Est. José Vasconcelos e o ribeiro Cochino, ca. 28 m, 14-VII-2025, *R. Jardim RJ7106* (UMAD 25044).

Casuarinaceae

Casuarina glauca Sieber ex Spreng.

Native to East Australia, this species was recently recorded as naturalized in Madeira (Verloove & Gonçalves Silva 2022) and is here reported for the first time as naturalized in Porto Santo, at Pico do Castelo. It reproduces by root suckers and seeds, and its population there has been expanding for at least the last 20 years. In Porto Santo, other species of the genus (*C. obesa* Miq., *C. cunninghamiana* Miq., *C. equisetifolia* L. and *C. stricta* Aiton) are cultivated in gardens, along paths, at lower altitudes, and on peaks (e.g. Pico Castelo), as well as in former trial plots established between 1990 and 1994 for afforestation purposes (Søndergaard 1997). Some individuals occur sporadically as escapes from cultivation, but none are naturalized.

PORTUGAL, MADEIRA: Porto Santo: Pico Castelo, vertente S, zona do parque de merendas, ca. 251 m, 14-VII-2025, *R. Jardim RJ7083* (UMAD 25029).

Crassulaceae

Kalanchoe ×houghtonii D.B.Ward

The nothospecies was "newly" reported as naturalized in Madeira Island by Verloove & Gonçalves Silva (2022), although it was previously referred as cultivated and escaped there by Guillot Ortiz & al. (2014), is here recorded for the first time as naturalized in Porto Santo Island. This hybrid was most likely overlooked in previous surveys and misidentified as *Kalanchoe daigremontiana* Raym.-Hamet & H. Perrier, a species reported as naturalized in Porto Santo by Vieira (2002). In Porto Santo, the nothospecies occurs both cultivated in gardens and naturalized in several localities, including Vila Baleira, Pé do Pico, Portela, Campo de Baixo, Campo de Cima and Pico do Castelo. This hybrid exhibits morphological variation, and several cultivars have been described (Guillot Ortiz & al. 2014).

PORTUGAL, MADEIRA: Porto Santo: Pé do Pico, Estrada Francisco Bernardo Martins, na berma, ca. 66 m, 13-VII-2025, *R. Jardim RJ7079* (UMAD 25047); Pico Castelo, vertente S, junto a um muro, na zona do parque de merendas, ca. 256 m, 14-VII-2025, *R. Jardim RJ7082* (UMAD 25048).

Fabaceae

Acacia cyclops A.Cunn. ex G.Don

Species native to West Australia (Paiva 1999), now fully naturalized in Porto Santo, at

Pico Castelo and Campo de Baixo. It was previously reported by Vieira (2002) as an escape from cultivation in gardens and parks in Madeira and Porto Santo.

PORTUGAL, MADEIRA: Porto Santo: Pico Castelo, vertente S, zona do parque de merendas, ca. 252 m, 14-VII-2025, *R. Jardim RJ7084* (UMAD 25030).

Trifolium obscurum Savi

Species native to Iberian Peninsula, Italy, Turkey, Northwest Africa and Canary Islands (Muñoz Rodríguez & al. 2000). Recorded in wet grasslands along streams in the North of Porto Santo. It has likely been previously overlooked and misidentified as *T. squarrosum* L., with which it co-occurs. Given its known distribution range, the species is considered as possible native to Porto Santo, corresponding to the first record for the Madeira archipelago.

PORTUGAL, MADEIRA: Porto Santo: Ribeiro Machado, s/d, *Costa* (MADM s.n.); Pico Juliana, vertente N, próximo à linha de água, ca. 252 m, 4-III-2014, *R. Jardim RJ4884* (UMAD s.n.).

Trifolium repens L.

Species native to Madeira (Jardim & Menezes de Sequeira 2008) is here recorded for first time in Porto Santo, where it occurs in lawns. Its presence in Porto Santo should be considered as possible introduced.

PORTUGAL, MADEIRA: Porto Santo: Salões, no relvado do Parque Florestal dos Salões, ca. 37 m, 12-II-2013, *R. Jardim RJ3576* (UMAD s.n.); 14-IV-2013, *R. Jardim RJ4132* (UMAD s.n.).

Pittosporaceae

Pittosporum undulatum Vent.

Tree species native to Southeast Australia, naturalized in Madeira Island (Press 1994d) is also found naturalized in Porto Santo Island, mainly at Pico Castelo. Previously reported before for Porto Santo only as cultivated (Costa 1948; Pickering 1962; Vieira 2002), several individuals were found originated from seeds, growing in rock crevices on the slopes of Pico Castelo and Pico Juliana.

PORTUGAL, MADEIRA: Porto Santo: Pico Juliana, vertente N, 7-III-2011, *R. Jardim RJ1067* (UMAD s.n.); Pico Castelo, vertente NW, nas fendas do maciço rochoso, ca. 251 m, 14-VII-2025, *R. Jardim RJ7089* (UMAD 25032).

LILIOPSIDA

Commelinaceae

Commelina benghalensis L.

Species native to tropical Asia and Africa, naturalized in Madeira (Cannon 1994), and now also recorded as naturalized in Porto Santo, growing in a water channel.

PORTUGAL, MADEIRA: Porto Santo: Pé do Pico, Rua da Levada, no leito e margem da levada, ca. 80 m, 14-VII-2025, *R. Jardim RJ7094* (UMAD 25035).

Poaceae

Setaria pumila (Poir.) Roem. & Schult.

Native to tropical and warm temperate regions of the Old World, naturalized in Madeira Island (Cope 1994), found on roadsides at Campo de Cima.

PORTUGAL, MADEIRA: Porto Santo: Campo de Cima, berma do passeio da estrada Dr. Francisco Rodrigues Jardim, ca. 70m, 01-V-2014, *R. Jardim RJ5411* (UMAD 13244).

2. Remarks on some previously reported taxa

PTERIDOPHYTA

Ophioglossaceae

Ophioglossum lusitanicum L.

This species although first reported for Porto Santo by Costa (1946), based on a very abundant collection made at Rocha de Nossa Senhora in January 1941 (MADS 1611, MADM 2019-2022), was later stated by Gibby & Paul (1994) as a rare native species, occurring in only two localities on Madeira Island but as requiring confirmation for Porto Santo, they state "but these records have not been confirmed". After the original record, the species was only recollected in Porto Santo in 2015 by R. Jardim, at the same locality cited by Costa, 74 years later (Fig. 1). The species is very rare, appearing locally abundant only in rainy winters and absent in dry years. This rediscovery was first reported in an oral presentation at the FloraMac 2018 Symposium in Funchal (Jardim & al. 2018). Fontinha & al. (2020) proposed considering this taxon extinct in Porto Santo, a view not supported by the evidence, as the species was collected again in 2022 at the same locality by M. Sequeira and C. Bairos.

PORTUGAL, MADEIRA: Porto Santo: Rocha da Nossa Senhora, I-1941, *J.G. Costa* (MADS 1611, MADM 2019-2022); Rocha de Nossa Senhora, vertente NW, ca. 210 m, 21-II- 2015, *R. Jardim RJ5835* (UMAD s.n.); Rocha de Nossa Senhora, vertente NE, ca. 205 m, 22-II- 2015, *R. Jardim RJ5837* (UMAD s.n.); Vereda na Rocha de N. Sra., na crista, a meio da vereda, comunidades de *Erica platycodon*, em mosaico com comunidades de herbáceas sobre solos húmicos, exp. NNE, 9-IV-2022, *M. Sequeira & C. Bairos MS11111* (UMAD 24030).



Fig. 1. *Ophioglossum lusitanicum*, Serra de Nossa Senhora, February 2015, a) fertile plant, Miguel photo by Menezes de Sequeira; b) habitat, photo by Roberto Jardim.

SPERMATOPHYTA
PINOPSIDA
Cupressaceae

Hesperocyparis macrocarpa (Hartw.) Bartel (= ***Cupressus macrocarpa*** Hartw.)

Tree species native to southern California and naturalized in Madeira (Vieira 2002). Long cultivated in Porto Santo, mainly for afforestation since early 20th century, it covers large areas in peaks such as Pico Castelo, Pico do Facho, Pico Juliana and Pico Branco. Previously, it was not considered naturalized in Porto Santo in Madeiran floras (Menezes 1914; Press & Short 1994) or checklists (Hansen & Sunding 1993; Jardim & Menezes de Sequeira 2008), although Jardim & al. (1998) reported it for Pico Branco. Its naturalization in Porto Santo is confirmed, with observations over several years, including seedlings on rocky slopes, indicating an ongoing expansion.

PORTUGAL, MADEIRA: Porto Santo: Pico Castelo, vertente NE, na vereda para o topo, ca.352 m, 3-V-2014, *R. Jardim RJ5458* (UMAD s.n); Pico do Facho, em comunidade arbórea de *Pinus halepensis* e *Cupressus macrocarpa*, junto ao caminho pedonal de acesso ao Pico do Facho, zona pouco húmida, decl. 10º, exp. S, 346 m, 15-III-2018, *E. Nóbrega, J.P. Ferreira, L. Cabral, M. Sequeira, P. Nascimento & R. Jardim LC119* (UMAD 7179); Pico do Facho numa zona de encosta. Junto do percurso que liga o Pico do Facho, local húmido e fresco, solo relativamente rico em matéria orgânica, decl. 45, exp. SO, 297 m, 15-III-2018, *E. Nóbrega, J.P. Ferreira, L. Cabral, M. Sequeira, P. Nascimento & R. Jardim PN176* (UMAD 8399).

Pinaceae

Pinus radiata D.Don

Tree species native to South California (Franco 1986), reported as naturalized in Madeira Island (Vieira 2002) and as planted in the summits of the higher peaks of Porto Santo (Press 1994c) is now confirmed as naturalized in Porto Santo Island. It occurs on the summits of several peaks, including Pico Branco, Pico Juliana, Pico do Facho e Pico Castelo. Our observations reinforce the first report given by Jardim & al. (1998) for Pico Branco. *Pinus radiata* grows on rocky slopes of Pico Branco, where several seedlings were observed, confirming an effective naturalization.

PORTUGAL, MADEIRA: Porto Santo: Pico Juliana, vertente NNW, na vereda para o topo, ca. 365 m, 6-III-2014, *R. Jardim RJ4908* (UMAD s.n.).

MAGNOLIOPSIDA
Asteraceae

Sonchus asper (L.) Hill subsp. ***asper***

This subspecies was not reported for Porto Santo by Lowe (1868), Menezes (1914), Pickering (1962), Hansen & Sunding (1993), Jardim & Menezes de Sequeira (2008) or Carvalho & al. (2013). Press (1994a) cited the species for all islands except Selvagem Pequena but did not include Porto Santo in the distribution of the subspecies [*S. asper* subsp. *asper* and *S. asper* subsp. *glaucescens* (Jord.) Ball]. Jardim & al. (1998), cited *S. asper* subsp. *asper* from Porto Santo (Pico Branco), while Fontinha & Jardim (1999) reported from islets Ilhéu de Cima and Ilhéu de Ferro, and Costa & al. (2004) also recorded it in vegetation relevés. *Sonchus asper* subsp. *asper* is here confirmed for Porto Santo, being

more frequent on peaks (e.g. Pico Branco, Pico do Castelo, Pico do Facho) and also occurring on the surrounding islets (Ilhéu de Cima, Ilhéu da Cal and Ilhéu de Ferro). Recently Mejías (2017) although referring to occurrence of morphotypes does not recognize any subspecies within *Sonchus asper*.

PORTUGAL, MADEIRA: Porto Santo: Pico Branco, 16-IV-1996, *F. Fernandes* & *R. Jardim* (MADJ 8493); Ilhéu de Cima, 18-III-1998, *Fontinha* (MADJ 8796); Pico Castelo, 06-IV-2009, *R. Jardim* (MADJ 10823); Ilhéu da Cal, 16-V-2013, *F. Fernandes, L. Costa & C. Nóbrega* (MADJ 13006); Ilhéu da Cal, topo N, junto à falésia E, 16-V-2014, *R. Jardim, C. Gois-Marques & M. Sequeira RJ5557* (UMAD s.n.); Pico do Facho, numa zona de encosta, junto do percurso que liga ao Pico do Facho, local com boa exposição solar, solo relativamente rico em matéria orgânica e algo rochoso, decl. 55, exp. O, 267 m, 15-III-2018, *E. Nóbrega, J.P. Ferreira, L. Cabral, M. Sequeira, P. Nascimento & R. Jardim PN184* (UMAD 8407); Pico do Facho, em comunidade herbácea junto ao percurso pedonal de acesso ao Pico do Facho, zona relativamente húmida, decl. 40º, exp. N, 346 m, 15-III-2018, *E. Nóbrega, J.P. Ferreira, L. Cabral, M. Sequeira, P. Nascimento & R. Jardim LC112* (UMAD 7186).

Sonchus ustulatus subsp. ***imbricatus*** (Lowe) R.Jardim & M.Seq.

This taxon, so far considered as endemic to the Desertas and Madeira Island (Jardim & Menezes de Sequeira 2011a), is here reported from llhéu de Ferro (Fig. 2) and Ilhéu de Fora. The population of *Sonchus ustulatus* occurring on Ilhéu de Fora, was previously cited by Fontinha & Jardim (1999) as *S. ustulatus* subsp. *maderensis* Aldridge. However, in a later publication Jardim & Menezes de Sequeira (2011a) recognize three distinct taxa formerly included in *Sonchus ustulatus* s.l.: *Sonchus parathalassius* J.G.Costa ex R.Jardim & M. Seq., endemic to Porto Santo; *Sonchus latifolius* (Lowe) R.Jardim & M.Seq., endemic to the northern coast of Madeira; and *S. ustulatus* subsp. *imbricatus*, endemic to the Desertas and Madeira Island. Carvalho & al. (2013) also reported *S. ustulatus* from Ilhéu de Ferro and Ilhéu de Fora, but their records lack a precise subspecific identification. *S. ustulatus* subsp. *imbricatus* was found on the islets of Ilhéu de Ferro (on the northern coastal cliffs) and Ilhéu de Fora, its distribution includes therefore Madeira Island (East), Desertas Islands and the islets of Porto Santo.

PORTUGAL, MADEIRA: Porto Santo: Ilhéu de Fora, 31-V-2012, *F. Fernandes* (MADJ 12876, 12878-12880); Ilhéu de Ferro, 02-VI-2012, *F. Fernandes* (MADJ 12883,12892, 13137); Ilhéu de Ferro, 20-XI-2012, *F. Fernandes* (MADJ 12886-12889, 12890-12893); Ilhéu de Fora, 14-IV-2013, *F. Fernandes* (MADJ 13067, 13097); Ilhéu de Ferro, vertente N, na falésia. 23-V-2014, *R. Jardim RJ5640* (UMAD 13275).

Chenopodiaceae

Beta macrocarpa Guss.

Species native to South Europe, East Mediterranean, North Africa and Macaronesia (Gutiérrez Bustillo 1990), first recorded for Porto Santo Island by Bornmüller (1904). It was omitted from subsequent Madeiran floras (Menezes, 1914; Press & Short, 1994) and checklists (Hansen & Sunding 1993; Jardim & Menezes de Sequeira 2008; Carvalho & al. 2013), although Leys & al. (2014) sampled two populations in Porto Santo Island (Serra de Dentro e Adega das Levadas) for molecular studies. Common in Porto Santo Island, occurring mainly



Fig. 2. *Sonchus ustulatus* subsp. *imbricatus*, Ilhéu de Ferro, May 2014, Roberto Jardim.

on clay and sandy soils, from lowland areas up to the highest peaks of the main island. It is also present on the surrounding islets (Ilhéu de Ferro, Ilhéu da Cal and Ilhéu de Cima). *B. macrocarpa* should be considered native to Porto Santo and probably misidentified as *B. maritima* L.

PORTUGAL, MADEIRA: Porto Santo: Ilhéu de Ferro, topo N, 23-V-2014, *R. Jardim RJ5632* (UMAD 13270); Costa norte a W da vereda para o Pico Branco, numa ribeira, exp. NE, 68 m, 7-IV-2021, *M. Sequeira, M. Gouveia & C. Góis Marques MS10303* (UMAD 22179).

Fabaceae

Astragalus hamosus L.

Species native to the Mediterranean, Irano-Turanian regions and Macaronesia (Podlech 1999) was first recorded for Porto Santo Island by Costa (1946) and cited by Hansen & Sunding (1993). However, Cannon & Turland (1994a) considered that these references were almost certainly misidentifications of *Astragalus solandri* Lowe. The presence of *A. hamosus* in Porto Santo is hereby confirmed. It occurs on the main island, from near sea-level up to higher altitudes, in pastures and within *Cenchro ciliaris-Hyparrhenietum sinaicae* Wildpret & al. communities (Costa & al. 2004), being also present on the nearby islet Ilhéu de Cima. Its abundance fluctuates with interannual rainfall variation, being more frequent and numerous in wetter years, as already noted by Costa (1946). On Porto Santo, only yellow-flowered individuals have been observed, sometimes growing with *A. solandri*.

Costa (1946) also reported *Astragalus cymbaecarpos* Brot. from Porto Santo, later referring to it as *Astragalus cymbaecarpos* var. *brevipes* Lange (Costa 1948). The study of Costa's voucher specimen (MADM 2276), showed that it corresponds to *A. hamosus*, characterized by a very short peduncle and almost sessile flowers. Additional specimens col-

lected on Porto Santo share the same morphology and could be referred to *A. hamosus* var. *brevipes* Lange (Lange 1865). Nevertheless, this taxon, along with other infraspecific entities of *A. hamosus*, is no longer accepted (Podlech 1999; Podlech & Zarre 2013). The short-pedunculate plants from Porto Santo are therefore regarded as part of the morphological variability of *A. hamosus* (peduncles 0.5-10 cm).

PORTUGAL, MADEIRA: Porto Santo: Pé do Pico, IV-1940, *Costa* (MADS 380, 381); Lombas, IV-1940, *Costa* (MADM 2276); Campo de Baixo, nas proximidades do campo de golfe, 14-IV-2011, *R. Jardim RJ1166* (UMAD 12501); Sítio do Lombo, ca.62, 16-IV-2011, *R. Jardim RJ1235* (UMAD 12451 duplicate at MA); Portela, vertente SE, na berma de um caminho, ca. 149m, 16-IV-2011, *R. Jardim RJ3768* (UMAD 12464 duplicate at MA); Ilhéu de Cima, na vereda para o topo, 25-III-2013, *R. Jardim & M. Sequeira RJ3828* (UMAD 12464); Cabeço do Centro de Hipismo, vertente N, ca. 76m, 29-III-2013, *R. Jardim RJ3960* (UMAD 12499 duplicate at MA).

Ulex europaeus L. subsp. ***europaeus***

Native to Western Europe (Cubas 1999) and naturalized in Madeira, Porto Santo, and Deserta Grande (Jardim & Menezes de Sequeira 2021), this species was first reported from Porto Santo by Costa (1948) at Pico Castelo, and later by Pickering (1962). However, it was not recorded for Porto Santo by Hansen & Sunding (1993) or Cannon & Turland (1994b), although subsequently referred by Vieira (2002). This subspecies is still present on Porto Santo at Pico Castelo, in two localities not showing a clear invasive status, unlike in Madeira, where is a troublesome invasive.

PORTUGAL, MADEIRA: Porto Santo: Pico Castelo, 5-VIII-2013, *R. Jardim RJ4631* (UMAD s.n.).

Myoporaceae

Myoporum laetum G.Forst.

Native to New Zealand (Paiva 2001), this species is here confirmed as naturalized on Porto Santo. In earlier Madeiran literature, it was referred to as *Myoporum acuminatum* R.Br. or *M. tenuifolium* G.Forst. but following Paiva (2001) the plants from Porto Santo are assigned to *M. laetum*. It was already cited by Hansen & Sunding (1993) as *M. tenuifolium*, for both Porto Santo and Madeira. It was also referred as cultivated in Porto Santo by Menezes (1914) and Short (1994) and later reported as escaped by Vieira (2002). Jardim & al. (1998) recorded it from Pico Branco, and Fontinha & Jardim (1999) cited it from Ilhéu de Cima. Currently, the species is cultivated in gardens and used as hedges on Porto Santo, but naturalized individuals are also found near cultivated areas (e.g. Ribeiro Cochino, Fonte da Areia), confirming its naturalization.

PORTUGAL, MADEIRA: Porto Santo: Cabeço da Ponta, 18-VIII-1999, *R. Vieira* (MADJ 9121); Ribeira do Tanque, 14-IX-2000, *R. Vieira* (MADJ 9457); Ribeiro Salgado, próximo da Quinta do Ribeiro Salgado, ca. 10 m, 31-VII-2012, *R. Jardim RJ3118* (UMAD s.n.).

Nyctaginaceae

Mirabilis jalapa L.

Native to tropical America and naturalized in Madeira (Vieira 2002), this species was reported from Porto Santo by Pickering (1962), under the name *Mirabilis divaricata* Lowe.

However, it was not listed for the island by Hansen & Sunding (1993) or Press (1994b). Vieira (2002) noted that he had observed the species in May 1958 in Porto Santo, where it remained rare. Its presence as a naturalized species in Porto Santo is here confirmed, occurring along roadsides near houses and in other areas, such as Vila Baleira, Campo de Cima, and Ponta.

PORTUGAL, MADEIRA: Porto Santo: Vila, 28-V-1958, *R. Santos* (MADJ 6220); Camacha, na levada, ca. 135 m, 5-I-2012, *R. Jardim RJ1884* (UMAD s.n.); Campo de Cima, Rua Vila de Velas, na berma, ca. 92 m, 14-VII-2025, *R. Jardim RJ7097* (UMAD 25038).

LILIOPSIDA

Agavaceae

Agave americana L.

Species native to Mexico, naturalized in Madeira Island since the late 19th century, was first reported as naturalized in Porto Santo by Vieira (1974). However, it was not mentioned for this island by Hansen & Sunding (1993) or Turland (1994). Vieira (2002) again reported the species from several localities, e.g., Fonte da Areia, Morenos, Serra de Fora. It is currently naturalized in Porto Santo and Ilhéu de Cima (Fontinha & Jardim 1999; Carvalho & al. 2013), occurring mainly along roadsides and slopes, and reproducing primarily by bulbils. Besides the typical form of *A. americana*, the variegated cultivar 'Marginata' also occurs on the island, as already reported by Vieira (2002).

PORTUGAL, MADEIRA: Porto Santo: Cabeço do Dragoal, vertente W, caminho para os Morenos, na berma, ca. 135 m, 13-IV-2011, *R. Jardim RJ1144* (UMAD s.n.).

Poaceae

Gastridium ventricosum (Gouan) Schinz & Thell.

This species, native to circum-Mediterranean and Atlantic regions (Romero García 2021), was reported by Menezes (1914) [as *Gastridium lendiferum* (L.) Gaudin] as a common native plant in Porto Santo. According to Cope (1994), previous records of this taxon from Porto Santo probably correspond to the naturalized *G. phleoides* (Nees & Meyen) C.E.Hubb. The occurrence of *G. ventricosum* in Porto Santo is nevertheless here confirmed, with populations recorded on peaks (e.g. Pico do Facho), although less frequent than *G. phleoides*.

PORTUGAL, MADEIRA: Porto Santo: Pico do Facho, vertente N, clareira junto ao caminho florestal, 19-V-2011, *R. Jardim RJ1510* (UMAD 12453); Pico Castelo, vertente N, ca. 318 m, 26-V-2012, *R. Jardim RJ2899* (UMAD s.n.); Cabeço do Guilherme, na vereda, ca. 140 m, *R. Jardim RJ5424* (UMAD s.n.).

Discussion

A total of thirteen taxa of vascular plants are reported for the first time from Porto Santo Island, including one possible native (*Trifolium obscurum*), one "possible introduced" (*Trifolium repens*) and eleven naturalized species. Additionally, twelve previously recorded taxa are confirmed, comprising six native species, including one endemic to the Madeira archipelago (*Sonchus ustulatus* subsp. *imbricatus*), and six

naturalized taxa. These findings indicate ongoing introductions and naturalization of exotic plants on the island.

Several alien species introduced in afforestation programs (Søndergaard 1997) are now escaping from cultivation and may become fully naturalized in the near future, e.g. *Retama monosperma* (L.) Boiss., found on a slope at Cascais (Zimbralinho), and *Ziziphus mauritiana* Lam. A clear example of rapid naturalization and ongoing invasion is *Dodonaea viscosa* (L.) Jacq. (Jardim & Menezes de Sequeira 2014), which is becoming a troublesome invasive species. Other ornamentals have also been found escaping from cultivation and may naturalize in the future, e.g., *Eschscholzia californica* Cham., *Coleus barbatus* (Andrews) Benth. ex G.Don var. *grandis* (L.H.Cramer) A.J.Paton, *Callisia fragrans* (Lindl.) Woodson, *Euphorbia aphylla* Brouss., *Agave attenuata* Salm-Dyck, *Hylocereus undatus* (Haw.) Britton & Rose (= *Selenicereus undatus* (Haw.) D.R.Hunt), *Impatiens walleriana* Hook.f. and *Narcissus jonquilla* L.

Rare and endemic taxa remain restricted to specific habitats, highlight the importance of small islets and microhabitats for conservation. *Sonchus ustulatus* subsp. *imbricatus* is confined to Ilhéu de Ferro and Ilhéu de Fora. Notably, *Ophioglossum lusitanicum* persists on Porto Santo and should not be considered extinct, contrary to suggestions by Fontinha & al. (2020).

Some previous taxonomic interpretations require correction. Fontinha & al. (2020) erroneously treated *Helichrysum melaleucum* subsp. *roseum* (Lowe) R.Jardim & M.Seq. as endemic to Porto Santo. In fact, this subspecies also occurs in Madeira, as noted by Lowe (1868) and Menezes (1914), and more recently also by Jardim & Menezes de Sequeira (2011b), that proposed the above new combination, never referring this taxon as exclusive to Porto Santo Island.

Beta macrocarpa, a native species overlooked since 1904, is in fact widely distributed on Porto Santo and its surrounding islets.

With the new records reported here, together with previous additions by Jardim & Menezes de Sequeira (2015, 2021), the vascular flora of Porto Santo now comprises 548 species and subspecies, including 10 endemics restricted to Porto Santo, 33 endemics of the Madeira archipelago, 27 Macaronesian endemics, 270 native species, 36 "possible natives," 15 "possible introduced," and 157 introduced taxa [following the criteria proposed by Jardim & Menezes de Sequeira (2008) for the native status].

The increase in naturalized taxa on Porto Santo, largely linked to horticulture and afforestation, underscores the need for continuous monitoring of alien species, as early detection and management are crucial to prevent further spread and ecological impacts of potential new invasive species. More importantly, stricter biosecurity measures should be implemented, particularly for passengers and cargo transported from Madeira Island to Porto Santo, together with improved outreach and information for both residents and visitors.

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Article

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Typification of the name *Rosa viscosa* Jan ex Guss. (*Rosaceae*), an endemic species from southern Italy

Abstract

Iamonico, D. & Lattanzi, E.: Typification of the name *Rosa viscosa* Jan ex Guss. (*Rosaceae*), an endemic species from southern Italy. — Fl. Medit. 35: 233-238. 2025. — ISSN: 1120-4052 printed, 2240-4538 online.

The name *Rosa viscosa* (*Rosaceae*), published by G. Gussone in 1818 in Catalogus Plantarum Phaenogamarum is here lectotypified on a specimens preserved at the Herbarium NAP. *Rosa viscosa* is an endemic species to southern Italy where is currently recorded with certainty only in the Calabria region. However, Gussone described *R. viscosa* from the Madonie mountains (locus classicus), a calcareous massif occurring in Sicily. The lectotype here designated, therefore, confirms the occurrence in Sicily as historical record. A clarification about the occurrence of the species in Central Italy is provided.

Key words: Calabria, Gussone, historical occurrence, Madonie mountains, *Rosa*, Sicily.

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Introduction

The genus *Rosa* L. [*Rosoideae* (Juss.) Arn., *Rosaceae* Juss.] comprises 200–285 species mainly distributed throughout the temperate and sub-tropical regions of northern hemisphere (half of the roses occurs in Asia, whereas approximately a quarter of the species grows in Europe and North America); one species is recorded in tropical Africa (Gu & Robertson 2003; Fougère-Danezan & al. 2015; POWO 2025).

Roses have been cultivated for more than 2000 years (see Guoliang 2003) and are now day economically important being used as ornamental shrubs and cut flowers and for pharmaceutical research (see e.g., Jager & al. 2007; Guimaraes & al. 2010).

Rosa is a genus critical from the taxonomical point of view due to the high phenotypic variability, as well as the high amount of hybridization (Fougère-Danezan & al. 2015). This morphological variability led to the

description of hundreds of names (IPNI 2025+; Tropicos 2025+) and, consequently, nomenclatural disorders and misapplication of names occur.

The Italian flora includes 41 native taxa of the genus *Rosa* (Bartolucci & al. 2024) of which one (*R. viscosa* Jan ex Guss.) is endemic to southern Italy (Peruzzi & al. 2015); further 13 species are alien (Galasso & al. 2024).

As part of ongoing studies on endemics of Italy (see e.g. Iamonico & al. 2011, 2022; Sciuto & al. 2023), and the genus *Rosa* (see e.g. Lattanzi 2012; Lattanzi & al. 2003, 2006, Pavesi & al. 2007), we noted that *R. viscosa* is currently recorded only for one region, i.e. Calabria, whereas it was firstly described by Gussone (1818: 8) from the Madonie mountains, a calcareous massif occurring in Sicily. Moreover, Gussone's name does not appear still typified (see also Peruzzi & al. 2015). All things considered, we here present a nomenclatural note regarding the typification of *Rosa viscosa* and update its distribution.

Materials and methods

The work is based on the analysis of the relevant literature (protologues included) and the examination of the specimens preserved in the Herbaria NAP, where Gussone's herbarium and types are mainly preserved (see Stafleu & Cowan 1976: 1025 and HUH-Index of Botanists 2013) and in the personal collection of Lattanzi which was recently included in the Herbarium RO (codes according to Thiers 2025+).

The articles cited throughout the text are those of the *Madrid Code*, hereafter reported as "ICN" (Turland & al. 2025).

Typification

Gussone (1818: 8) validly published the name *Rosa viscosa* providing a short diagnosis, the habitat ("In apricis montosis"), and the type locality ("Madonie", which are mountains occurring in north of Sicily); a morphological comparison with *R. rubiginosa* L. was also given. Gussone (1818: 8) reported after the binomial "Jan. Cat. p. 8, ex ejus specimine" so referring to a Jan's specimen; this citation is a sintype according to the Art. 9.6 of ICN.

According to Stafleu & Cowan (1976: 1025), Gussone's collection is mainly preserved at NAP and secondly at FI, whereas further material is preserved in other European (not Italian) herbaria. At NAP we traced only one useful specimen for the typification purpose (Fig. 1). It bears the following two labels: "*(2a) Rosa viscosa. Jan cat. p. 8* | *Majo, Junio ħ* | *In apricis montosis*", and "*Rosa viscosa* | Herb. Jan. *Gen. 448* spec. *45* | *Sicilia* | *B.*". Although the date of collection is lacking the specimen is clearly part of Jan's herbarium and was seen by G. Gussone. We consider this specimen as part of the original material used by Gussone to describe *Rosa viscosa*. The plant on the sheet (a terminal part of a branch with leaves, calyx, and

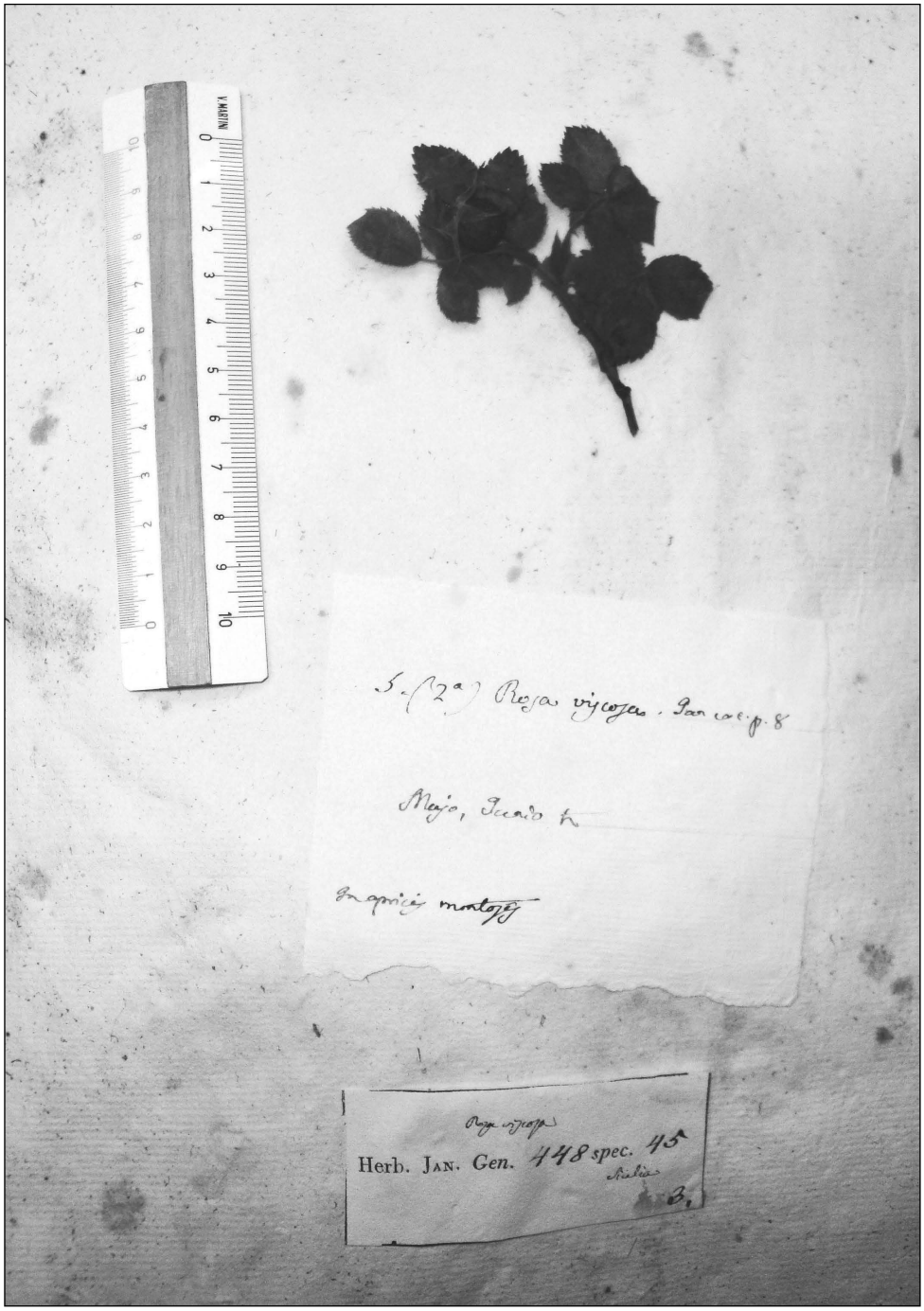


Fig. 1. Lectotype of *Rosa viscosa* (NAP; by permission of the Director of Herbarium of University Federico II of Naples).

fruit) morphologically matches Gussone's diagnosis and corresponds to the current concept of the species (see e.g., Lattanzi 2019a, 2019b). We here designate the NAP specimen as the lectotype of *Rosa viscosa*.

Rosa viscosa Jan ex Guss., Cat. Pl. Phaen.: 8. 1818.
Lectotype (designated here):—ITALY. Sicily, Madonie, *s.d.*, *Jan s.n.* (NAP, Fig. 1)

Distribution. The Portal of the Flora of Italy (2025) reports *Rosa viscosa* for Calabria region (southern Italy) and, as doubtful record, in Sicily. To note that the species was reported by mistake in Abruzzo region (central Italy); F. Bartolucci (pers. comm.) informed us that the occurrence in central Italy was based by Di Pietro & Tondi (2005: 18) who reported the species for Lazio region (indicated in Abruzzo by mistake by Bartolucci et al. 2015, 2024); the correct species was, however, *R. pulverulenta* M.Bieb. based on a revision by one of us (E. Lattanzi). Anyway, Di Pietro & Tondi (2005: 15, Appendix 4) referred to localities in Lazio region (Province of Rieti), not Abruzzo. Our research allowed to confirm the occurrence of Gussone's rose in the island of Sicily, at least as historical presence. So, this species remains to be one of the rarests rose for the Italian flora (see also Lattanzi 2012). In fact, *Rosa viscosa* is currently classified as an Endangered Species according to Rossi & al. (2020).

Aknowledgements

Thanks are due to Directors and Curators of all quoted Herbaria with special thanks to R. Vallariello (Herbarium NAP) who kindly permitted the reproduction of the images of the lectotype of *Rosa viscosa*. I also thank F. Bartolucci (University of Camerino & Floristic Research Center of the Apennines) for the information given about the record of *R. viscosa* in central Italy.
The author (Edda Lattanzi), expert in the genus *Rosa*, died (on October 17, 2025) during the preparation of the article. Due to her expertise, Edda's death is a bad loss for the scientific community, but, more important, we lost a generous, congenial, hardheaded, and hot-blooded, who we never forget. Goodbye Edda.

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Article

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Nomenclatural revision of the *Silene canopica* complex (*Caryophyllaceae*) across Middle East to the Maghreb region

Abstract

Mesbah, M., Chatelain, C., El Mokni, R. & Loup, C.: Nomenclatural revision of the *Silene canopica* complex (*Caryophyllaceae*) across Middle East to the Maghreb region. — Fl. Medit. 35: 239-252. 2025. — ISSN: 1120-4052 printed, 2240-4538 online.

The taxonomic identities of five taxa of *Silene* L. (*Caryophyllaceae*) found in Egypt have been widely confused in historic herbaria, particularly in the Boissier's Flora Orientalis herbarium (G-BOIS). To disentangle this confusion, which remains in current floras, we present a nomenclatural and taxonomic revision of the Silene canopica complex including S*ilene biappendiculata* Ehrenb. ex Rohrb., *S. canopica* Delile ex Spreng, *S. colorata* subsp. *oliveriana* (Otth ex DC.) Rohrb., *S. obtusifolia* Willd. and *S. villosa* Forssk. Moreover, we confirm that *S. biappendiculata* is a synonym of *S. canopica.* A lectotype was designated for *S. biappendiculata*, *S. canopica*, *S. mauritanica* and an epitype for *S. colorata* subsp. *oliveriana.*

Key words: Nomenclature, *Caryophyllales*, North Africa, Egypt. Syria, Jordan.

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Introduction

The genus *Silene* L. (*Caryophyllaceae*) is widely distributed in the temperate zones of the northern hemisphere. Its biodiversity is predominantly found in the Mediterranean Basin and Western Asia (Greuter 1995; Oxelman & al. 2013). Recent taxonomic studies of the genus in the Mediterranean have revealed complicated interspecific relationships, suggesting a need for nomenclatural revision (Jeanmonod 1985; Du Pasquier & Jeanmonod 2016; Đurović & al. 2018; Iamonico 2022). North Africa shows significant diversity with over 144 taxa, 55 of which are endemic (Quézel 1957, 1978; Dobignard & Chatelain 2011; Mesbah 2021). Among all sections *Silene*, sect. *Silene,* is the most species-rich and the most extensively represented in North Africa with up to 93 taxa which 23 are present in Egypt. Several taxonomic ambiguities are highlighted within this section ex. *Silene colorata* complex, *S. nocturna* complex, *S. canopica* complex (Oxelman & Lidén 1995; Jafari & al. 2020; Saez & al. 2022; Mesbah & al. unpubl. data).

The present study focuses on the revision of five taxa belonging to *Silene* sect. *Silene*: *Silene biappendiculata* Ehrenb. ex Rohrb., *S. canopica* Delile ex Spreng., *S. colorata* subsp. *oliveriana* (Otth ex DC.) Rohrb., *S. obtusifolia* Willd., and *S. villosa* Forssk. The original description of *S. biappendiculata* also mentions two varieties, α and β *latifolia*, which were never clearly differentiated or formally recognized in the literature. Owing to mixed herbarium identifications, these taxa are here referred to as the *Silene canopica* complex. They occur mainly in Egypt and also in the Arabian Peninsula, on arid and sandy environments, except for *S. obtusifolia*, which is largely restricted to the western Mediterranean. Morphologically, they are characterized by a developed indumentum, scorpioid monochasial (rarely dichasial) inflorescences, simple or bifid petals (up to two-thirds), clawed but usually not auriculate limbs, and flat to concave dorsally canaliculated seeds features often leading to confusion in herbaria and floras (Boissier 1867; Maire 1963; Mesbah & al. unpubl. data).

By designating type specimens for the taxa within the *S. canopica* complex and conducting detailed seed morphology analyses, this study provides a refined classification of this taxonomically challenging group in Egypt and adjacent regions, and proposes an identification key to identify these taxa.

Material and Methods

This revision is based on the examination of herbarium specimens from Boissier's Flora Orientalis herbarium (G-BOIS), the Geneva herbaria (G, G-DC), and the Raffeneau-Delile herbarium in Montpellier (MPU), supplemented by digitized specimens accessed via the Global Biodiversity Information Facility (http://www.gbif.org/).

Specimens of *Silene canopica, S. biapendiculata, S. oliveriana, S. villosa*, and *S. obtusifolia* were studied. Morphological characters of vegetative and reproductive organs were assessed, and geographic distribution and habitat data were compiled from specimen labels.

Seed micromorphology, a key diagnostic character in *Silene*, was examined when available. Seed images were obtained from type material using a VHX-7000 digital microscope (×200). Taxonomic literature was consulted to ensure accurate species delimitation and nomenclature. Accepted names are indicated in bold italic.

Key to the *Silene canopica* complex

1. Annual plant with agglutinating viscus glandular hairs ..... ***S. villosa***
1a. Annual or perennial plant with pubescent hairs **2**
2. Annual or perennial plant; leaves obovate or obovate-oblong; sides of the seeds deeply excavated ..... ***S. obtusifolia***
2a. Annual plant, leaves linear-oblong or lanceolate; sides of seeds not deeply excavated; dorsal edge of seeds grooved so as to create two wing-like flanges **3**
3. Leaves linear or linear-lanceolate; seeds reddish brown, 0.8–1.2 mm long .... ***S. colorata*** subsp. ***oliveriana***
3a. Leaves oblong-lanceolate, linear uppermost; seeds blackish to dark brown, 1.2–1.7 mm long ..... ***S. canopica***

Taxonomy and nomenclature

1. ***Silene canopica*** Delile ex Spreng., Syst. Veg. (ed. 16) 2: 406. 1825. – *S. canopica* Delile, Descr. Fl. Egypt, vol. 2: 62. 1812, *nom. nud.* (Art. 38.1a of ICN). – *S. canopica* Delile, Descr. Fl. Egypt, Ed. 2, vol. 19: 88. 1824, *nom. nud.* (Art. 38.1a of ICN).

Lectotype (designed here): Egypt: "Fl. Aeg. nº 443, Egypt, bord de la mer à Elarich", s.d., *Raffeneau-Delile 443* (MPU091805!) (Fig. 1).

= *S. biappendiculata* var. *latifolia* Rohrb. in Bot. Zeitung (Berlin) 25: 82. 1867. **Lectotype** (designated here): Egypt**:** "Alexandria", 23.II.1855, *Ehrenberg s.n.* (G-BOIS (G00545215!)) (Fig. 2).

= *S. canopica* Boiss., Fl. Orient. 1: 596. 1867 (nom. illeg., superfl.). **Lectotype (**designed here): Egypt: "prope Alexandria", 23.II.1858, *Samaritani 2999* (G-BOIS (G00545152!)); **isolectotype:** (JE00013347 photo !).

= *S. obtusifolia* sensu Boiss., Fl. Orient. 1: 593 1867.

– *S. ptolemaica* Ehrenb., Monogr. Silene: 105. 1869 (nom inval.).

Annual *plant* with erect, branching whitish appressed, pubescent hairs. *Leaves* oblong to oblong-lanceolate to linear in the upper leaves. *Inflorescence* terminal monochasial scorpioid cyme, 4–6 flowers per inflorescence. *Calyx* ciliate, with pubescence along nerves. *Capsule* ovoid, carpophore longer than or equal to capsule. *Seeds* dark brown to blackish, reniform, 0.8–1.2 mm long, the sides flat or slightly excavated, the dorsal edge with a wide and relatively deep longitudinal groove bearing two narrow tuberculate canals beneath each margin (Fig. 4A-G); seed coat partially tuberculate with narrow striations extending to margin.

Distribution. – Egypt, Palestine (probably also Libya, but no specimen available for confirmation).

Notes. – Silene canopica was mentioned twice without description in Raffeneau-Delile, first in his *Description de l'Égypte – Histoire Naturelle* (Raffeneau-Delile, 1812: 62) and in its second edition (Raffeneau-Delile, 1824: 88). A specimen originating from Raffeneau-Delile's herbarium deposited at MPU (MPU091805) bears the number 443 as in the original list published in 1812 (Fig. 1), this specimen is hereby designated as the Lectotype. The validation of the *Silene canopica* name was published by Sprengel (1825: 406) who provided a description referring to Raffeneau-Delile, but without citing any specimen. Later, Boissier published in his *Flora Orientalis* (1867: 596) a new species based on the specimen collected by Samaritani [*2999*] under the illegitimate later homonym *S. canopica*. He was clearly unaware that Sprengel had already validated *S. canopica* in 1825 with a collection from Delile, although he mentioned the Delile publication. He created additional confusion in proposing the specimen by Samaritani [*2999*] to describe *S. biappendiculata,* which also overlooked Rohrbach's treatment of the genus *Silene* (1867: 82). To clarify these confused identifications we propose the Lectotypification of *S. canopica* from Boissier (McNeil & al. 2014).

Moreover, the main origin of all misinterpreations come probably from Rohrbach's (1867) description of *S. biappendiculata,* because he recognized two varieties, "α" and

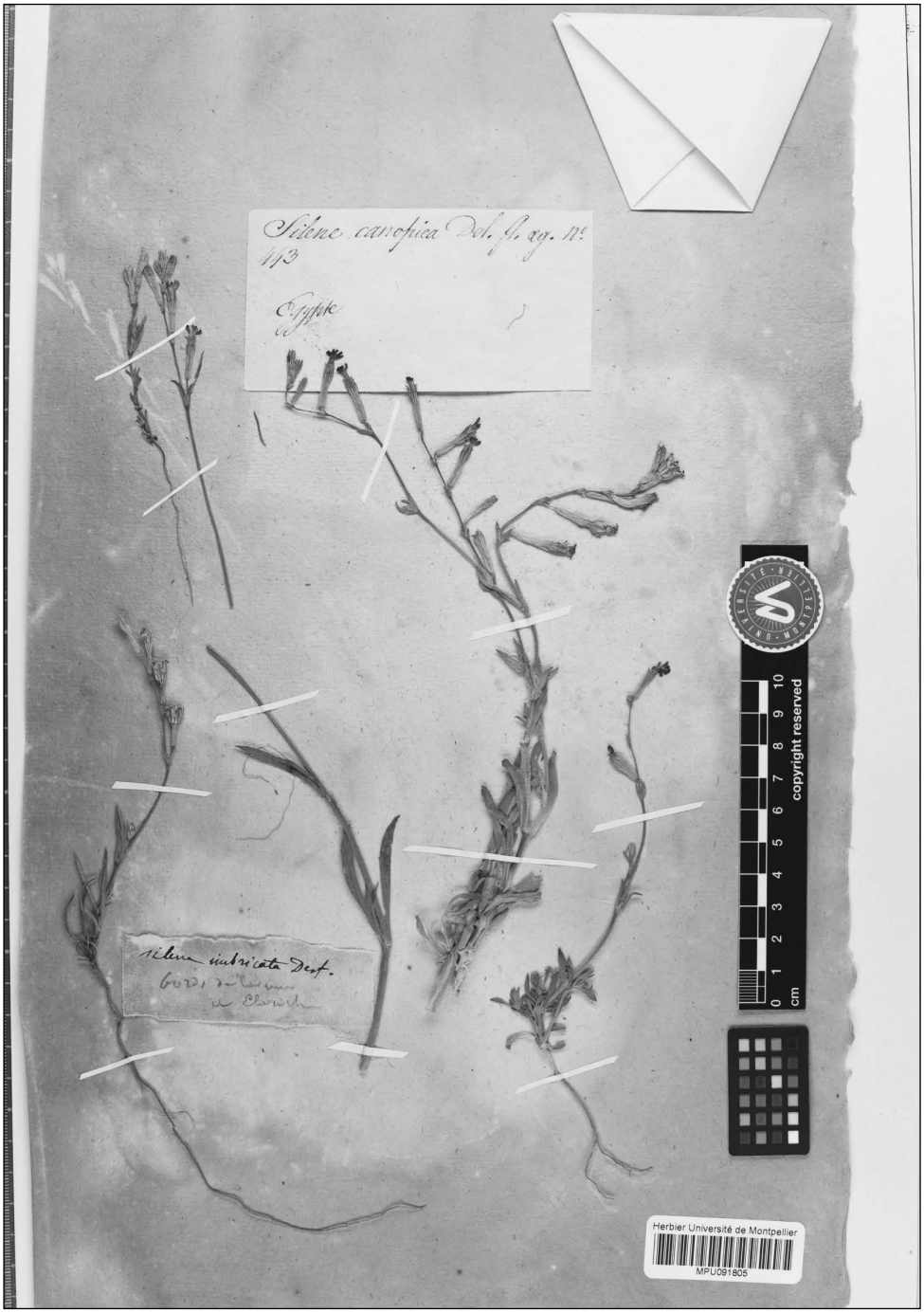


Fig.1. Lectotype of *Silene canopica* Delile, (Raffeneau-Delile, "Del. fl. Ag. n443 Egypte" (MPU091805); © Montpellier.



Fig. 2. Lectotype *Silene biappendiculata* Ehrenb. ex Rohrb. (Ehrenberg s.n., (G-BOISS G00545215); © Conservatoire et Jardin botaniques, Genève.

"β *latifolia"*, which have never been clearly distinguished nor treated as separate taxa in subsequent literature. The taxonomic history of *S. biappendiculata* has thus been characterized by significant nomenclatural confusion and overlapping morphological characters of two taxa, leading to repeated misidentifications. It could explain why specimens attributed to this species have been variously labeled as *S. canopica* Boiss., *S. colorata* Poir., *S. colorata* var. *ligulala* Viv. apud Rohrbach, *S. obtusifolia* Willd., and *S. oliveriana* Otth.

Now, with the identification of the original material of α and β varieties, we can confirm that the variety α (*S. biappendiculata* var. *biappendiculata*) corresponds to *Silene colorata* subsp. *oliveriana*, and the β *latifolia* corresponds to *S. canopica.*

Later, the *Flore d'Afrique du Nord* (Maire, 1963) provides a detailed account of *S. biappendiculata*, referencing materials from Rohrbach, Boissier, Cosson and from an incomplete specimen collected near Ramleh, Alexandria by Letourneux. This particular specimen, *Letourneux 180* (G-BOIS (G00545213)), was initially identified as *S. obtusifolia* Boiss. non Willd. Then, Maire, following Durand & Barratte (1910), listed *S. obtusifolia* Boiss. non Willd. as a synonym for *S. biappendiculata*.

Additional specimens examined. EGYPT – Alexandria: Aboumoundoud près du Nil, s.d., *Raffeneau-Delile s.n.* (MPU091803 upper part); Ramlé et Mandara propre Alexandria, II/III.1877-1878, *Letourneux 180* (G00545213); Ramleh, Alexandria, 5.III.1880, *Barbey s.n.* (G00606269). El Fayoum: El Mandarah, 6.IX.1880, *Barbey s.n.* (G00606264). Ismailia: Ismaïlia, 18.III.1880, *Barbey s.n.* (G00606262). Sharqia: Salehiha in desertis ad Salehia, 26.IV.1820, *Ehrenberg s.n.* (K005011477) photo!; s.l. Egypte, V.1869, *s.c.* (K005011478) photo!. PALESTINE – Darom: Wadi el Grafi, 25.III.1880, *Barbey s.n.* (G00606267). Southern District: Bir Saba, 29.III.1880, *Barbey s.n.* (G00606263).

2. ***Silene colorata*** subsp. ***oliveriana*** (Otth ex DC.) Rohrb., Monogr. Silene: 116. 1869.
≡ *S. oliveriana* Otth ex DC., Prodr. 1: 373. 1824.
≡ *S. colorata* var. *oliveriana* (Otth ex DC.) Durand & Barratte in Fl. Liby. Prodr. 36. 1910.
Lectotype (designed by Jafary & al. 2024: 98): Syria: "entre Alep et Mossoul", s.d., *Olivier s.n.* (G-DC (G00215019!).
Epitype (designated here): Jordan, Arabia Petraea finus Sabastina, III.1846, *Boissier s.n.* (G0060250!) (Fig. 3)
= *S. biappendiculata* Rohrb. in Bot. Zeitung (Berlin) 25: 82. 1867. **Lectotype** (designated here): Egypt: "Damiette", 1820, *Ehrenberg s.n.* (K00728430) photo!

Annual *plant*; stem pubescent. *Leaves* linear or lanceolate, all pointed. *Inflorescence* scorpioid cyme, 4–8 flower per inflorescence. *Calyx*, 6–7mm, turbinate at anthesis, covered with short, non-glandular hairs, pubescence over the nerves, lobes ciliate. *Capsule* ≥ the length of the carpophore. *Seeds* reddish-brown, 1.2–1.7mm long, reniform, granular, flatter sides slightly excavated with tubercules centrally; dorsal edge is acutely grooved with a narrow canal at the base with minute tuberculate margins. (Fig. 4B–E).

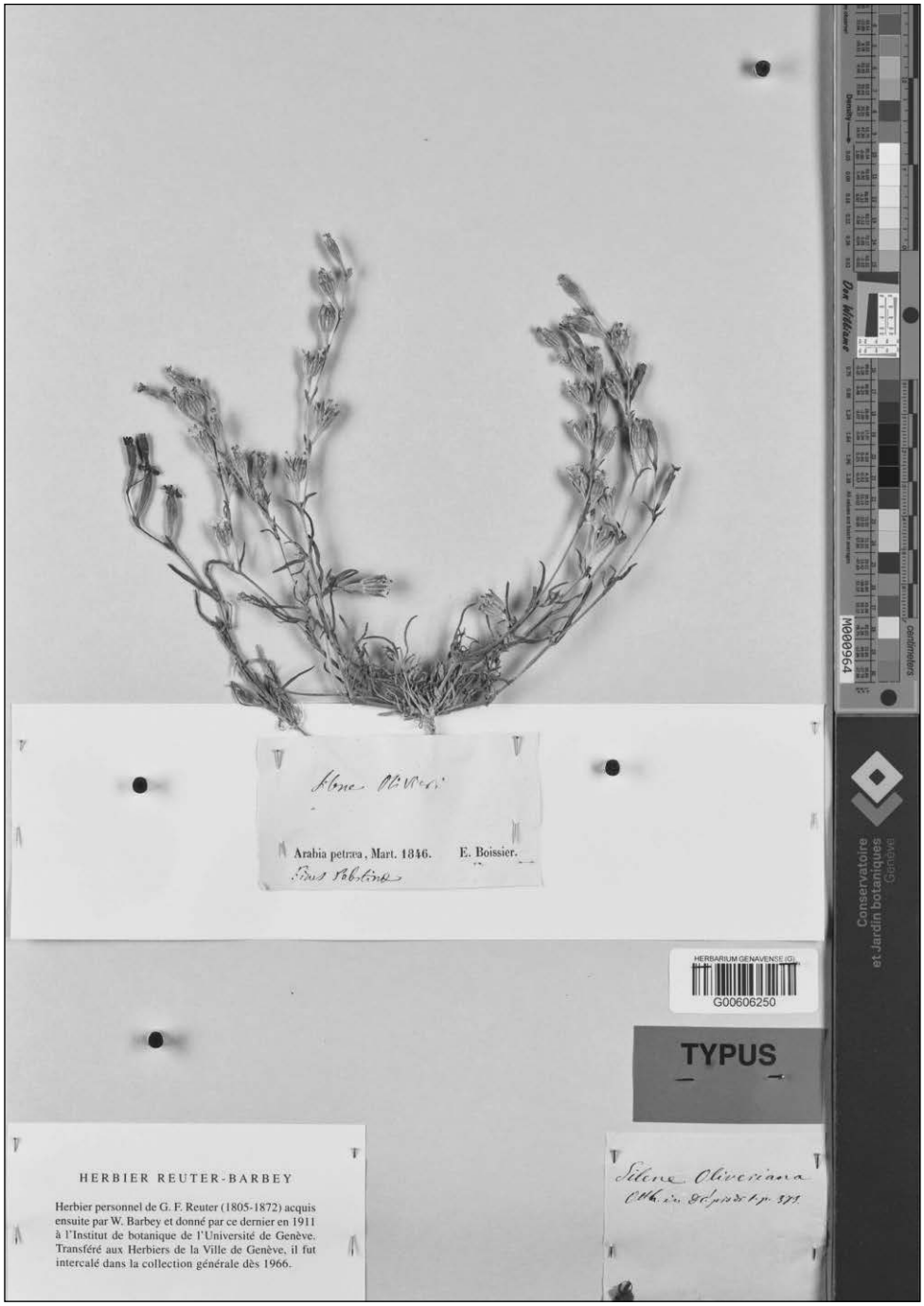


Fig. 3. Epitype of *Silene colorata* subsp. *oliveriana* (Otth ex DC.) Rohrb. (Boissier s.n., G00606250); © Conservatoire et Jardin botaniques, Genève.

Distribution and ecology. – From Iran and Turkey to Tunisia, in arid areas with predominantly sandy soils.

Notes. – Jafary & al. (2024) designated a lectotype for *Silene oliveriana* from the de Candolle herbarium (G00215019). The type specimen of *S. oliveriana* (G00215019), collected by Olivier in Syria, is unfortunately not an ideal reference, as the material bears an immature inflorescence with undeveloped capsules and seeds. Another very small specimen from Aleppo to Mosul, preserved in P (P055436625) and lacking a collector's name, is likewise immature. This incomplete specimen has likely contributed to the confusion regarding determination of this taxon. To resolve any doubts about *Silene oliveriana* and clarify the species descriptions, we have identified a specimen, *Boissier s.n.* (G0060250) from Jordan, that corresponds well and has all the characters (seeds) needed for identification, and we have designated it as an epitype. Based on morphological similarities with *S. colorata*, including a turbinate calyx at anthesis, short eglandular pubescence on the calyx and veins, an inflated capsule, and seeds with a grooved margin, *S. oliveriana* is here treated as a subspecies of *S. colorata* (i.e., *S. colorata* subsp. *oliveriana*), following historical taxonomic treatments.

Several misinterpretations are found in the historical literature; Rohrbach (1869: 105) stated *Silene oliveriana* from Boissier was based on the specimen collected by G.B. Samaritani [*2999*] non Otth, and placed this name is synonymy with *S. biappendiculata*. However, Boissier never described *S. oliveriana* nor mentionned a [*2999*] specimen for this species. Instead, in the *Flora Orientalis* (1867: 596), Boissier explicitly assigned this specimen [*2999*] to *S. canopica*. We, therefore, conclude that Rohrbach's interpretation was erroneous. Some pages after, Rohrbach (1869: 105) cited two specimens under *Silene biappendiculata*. The first specimen: *Ehrenberg s.n.* collected in "Damietta" or "Damitta" is the type of *S. biappendidulata* var. α (K00728430) but identified by us as *S. colorata* subsp. *oliveriana.* The second specimen, "pr. from Alexandriam", should correspond to the type of *S. biappendidulata* var. *β latifolia* (as syn. of *S. canopica*)**.** This specimen was received by Boissier from the Museo botanico Berolinensi (G-BOIS (G00545215)), but the original specimen from Berlin was destroyed during the Second World War, it's the reason we lectotypifing on Boissier's herbarium.

Additional specimens examined. EGYPT – Alexandria: Madinat, Borg El Arab, 14.III.1944, *Davis 6546B* (E00057097) photo! Beheira: Keluan ad Nili ripas, 27.IV.1910, *Muschler s.n.* (K005011472) photo!; Damietta: Damiette sand, 27.IV.1910, *Muschler s.n.* (K005011481) photo!; Damiette, sand, 1820, *Ehrenberg s.n.* (K00728430) photo!; Kafr el-Sheikh: Baltim (Brullus), 5.IV.1887, *Ascherson 1434* (BR028387268) photo!; Marsa-Matruh Matruh, 27.VI.1907, *Ball s.n.* (K005011475) photo!; Matruh, 10.IV.1932, *Shabetai 23* (K005011474) photo!;

IRAQ – Al-Anbar: 12 km south of Rutba, Northern Desert, 4.III.1963, *Barkley 33Ir53/3* (K005011749) photo!; Al Qādisīyah: Distr. Diwaniya desertum meridionale prope As-Salman, 22.IV.1957, *Rechinger 9289* (E00057099) photo!; Buskaya, 4.IV.1958, *Rawi & Haddad 25580* (K005011763) photo!; Al-Muthanna: 25 Km S.E. of As.-Salman, 18.III.1955, *Rawi 14903* (K005011757) photo!; Diyala: Jabal (Hanrim) (nr. Table Mt.), 30.III.1932, *Guest 1906* (K005011766) photo!; Region and District FUJ; Jabal (Hamrin),

06.III.1955, *Wheeler W308* (K005011760) photo!; Between Saugur and Jannura, left bank of the Diyala near Qoraitu, 21.III.1958, *Poore 492* (K005011762) photo!; Kirkuk: On the (Banko) of the River Zab, near Kirkuk, 15.III.1956, *Grigg 51* (K005011753) photo!; Kirkuk Liwa, 20.III.1963, *Barkley & Jumaa 4540* (NY04411061) photo!; Ninive: Falvil N.W. of Mosul, 29.III.1982, *Khayat s.n*. (K005011739) photo!; Qora Tafa, 02.IV.1931, *Guest 1474* (K005011767) photo!; Wasit: 616km. S Badra, 13.IV.1957, *Al-Rawi 18182* (K005011752) photo!; ISRAEL/OCCUPIED PALESTINIAN TERRITORY – Southern District: Tell Fara, 19.II.1930, *Harding 166* (K005011719) photo!; Tell Fara, 03.III.1930, *Harding H783/1930* (K005011717) photo!; Tell Fara, 02.IV.1930, *Harding 267* (K005011720) photo!; Tel Aviv/Jaffa: Saronae, Jaffa, 25.IV.1912, *Meyers & Dinsmore 8423b* (K005011724) photo!; JORDAN – Arabia petraea_finus Palestina, III.1846, *Boissier s.n.* (G00606250); Arabia (Petram, Palestina), 01.III.1846, *Boissier s.n*. (K005011734) photo!; Arabia Petrae, 01.III.1846, *Boissier s.n*. (K005011735) photo!; Bishra, 6 km NE Irbid, 26.IV.1975, *Boulos, Jallad & al. 8228* (E00057094) photo!. LEBANON – Beirut: Salhieh, Jardin d'Szet Pacha, 12.IV.1856, *Gaillardot 1634* (G-BOIS G00545111)!; Jardin de college d'Autoura, 18.II.1857, *Gaillardot 1637* (G-BOIS G00545142!); Nabatieh: Nabatieh, V.1938, *Gombault 5783* (P05436615) photo!; Sidon district: Jardin d'Szet Pacha à Salhieh, 12.IV.1856, *Gaillardot 1634* (G-BOIS G00545111)!; Tyr: South Liban, Naqoura, *Gombault 1036* (P05436614) photo!; LIBYA – Tripoli: Tripoli, sur les collines du sud, près du château, IV.1866, *Blanche s.n.* (P05436635); Tripoli, 22.X.1887, *Taubert & Barbey s.n.* (G00606268); Tripolitaine, Gargaresh, 25.IV.1933, *Bornmüller 614* (P05032124) photo!; PALESTINE – Jéricho: Jericho, 01.I.1863, *Lowne 3* (K005011723, K005011721) photo!; Jericho 8.IV.1880, *Barbey s.n*. (G00628107); Palestine à la frontière, IV.1846, *Boissier s.n.* (G00606224); Palestinian Territory, occupied "West Bank", 29.III.1926, *Mushak 29* (K005011726) photo!; Wuste Judah, 1858, *Roth 69* (G-BOIS G00545108!). SAUDI ARABIA – Northern Borders: Jabal Amud: S. of Turayf, 08.III.1988, *Harrat 6522* (E00648942) photo!; SYRIA – Daraa: A l'est de Saïda, 22.I.1853, *Blanche 7* (E00057103), (K005011711) photo!; Sables au Sud et près d'Abacouch, env. de Saida, 10.III.1853, *Blanche 923* (K005011716) photo!. Deir ez Zor: not far north of Iraqi border at Abu Kamal, 6.III.1955, *Helbaek 234* (K005011744) photo!. Homs: S-E. Al Qaryatayn, 13.IV.1943, *Davis 5663B* (E00057109) photo!; Syria borealis, Djebel Muhassan 12.III.1865, Iter Syr.-Armen. *Haussknecht s.n.* (G-BOIS G00545115!).

TUNISIA – Medenine: Djerba Midoun, vers Midoun, 05.IV.1975, *Van den Berghen s.n*. (BR0000028390459) photo!; Mezraia (Djerba), 06.II.1978, *Van den Berghen s.n*. (BR0000028390473) photo!; Mezraia (Djerba), 28.XII.1978, *Van den Berghen s.n.* (BR0000028390442) photo!. Medenine: Medenine, 14.III.2006, *Dobignard 13452* (G); Rass Tourgueness, 22.III.2006, *Dobignard 13641* (G). Sfax: îles Kerkennah (île Gharbi), 5.IV.2014, *Chatelain cc2386* (G00394866); TURKEY – Hatay: Antioche, *Hatay s.n*. (P05436622) photo!

3. ***Silene villosa*** Forssk., Fl. Egypt.-Arab.: 88. 1775.

Lectotype (designated by Melzheimer, 1988: 496): Egypt: "prope pyramidas Gizenses", (I.1762), *Forsskål 560* (C10003075) photo!

Annual *plant*, stems covered with agglutinating viscous glandular hairs. *Leaves* narrowly oblanceolate to linear-lanceolate. *Inflorescence* cymose with 1–3 flowers per inflorescence. *Flowers* pedicel long as twice the length of the calyx; capsule 2/3 as long as the calyx. *Seeds* small, 6–8 mm long, reniform, greyish brown, sides flat, dorsal surface with a wide, shallow groove, the seed coat patterned into roundish cells (Fig. 4C–F).

Distribution and ecology. – Common from Morocco to Pakistan in arid areas with predominantly sandy soils.

Notes. – *Silene villosa* was first published by Peter Forsskål in *Flora Aegyptiaco-Arabica* (Forsskål, 1775: 88). The original material was collected by himself during his expedition to Egypt and the Arabian Peninsula (1761–1763). There is two parts in [C] for this collection, one with the number 550 and second with 550 corrected to 560, which is the Lectotype. Because of its polymorphism, *S. villosa* was often overlooked in major floristic works or treated in a broad sense within complexes of morphologically close species, such as *S. canopica.*

Ali & Jafri (1978) in *Flora of Libya* and Boulos (1999) in *Flora of Egypt* recognized *S. villosa* as a distinct species based on consistent morphological traits; particularly dense villous indumentum on stems and calyces, a short inflorescence with up to 3 flowers, shorter petal claws, *Flowers* pedicel long, twice the length of the calyx after anthesis.

Additional specimens examined. ALGERIA – Adrar: Tit, Adrar, 01.III.2017, *Benhouhou SB17* (ENSA13020); Palmeraie Tamentit, Adrar, 10.III.2021, *Benghanem NB31* (ENSA13300). El-Oued: Mguebra dans l'oued Rir, 08.IV.1858, *Cosson s.n.* (G00642718). Ghardaia: El Goléa, 21.III.1904, *Chevallier s.n.* (G00642719); Metlili, 06.V.1897, *Chevallier 170* (G00431399). Naâma: Aïn Sefra, 17.V.1856, *Cosson s.n.* (G00642721); Aïn Sefra, 07.V.1856, *Bourgeau 229* (G00642731); Tyout, sud-ouest de la province d'Oran, V.1922, *Alleizette s.n*. (G00431410);

EGYPT – Alexandria: Mariout, Basse-Egypte, 04.III.1880, *Barbey 151* (G00642708); Ramleh, Alexandria, 1882, *Bloomfield s.n*. (G00642707); Mariut, V.1890, *Schweinfurth 35* (G00642706). Asyut: Lycopolim (Syouth), 03.III.1848, *Kralik s.n.* (G00642730). Cairo: Le Caire, 17.II.1881, *Cramer s.n.* (G00642717); El Marg, 08.V.1908, *Burdet 74* (G00642716). Giza: Sakkara, II.1846, *Boissier s.n.* (G00642729); Sakarah pyramides, 18.III.1848, *Kralik 2397* (G00642720); Près des Pyramides de Gyseh, 12.II.1880, *Cramer s.n.* (G00642725). Ismailia: Ismaïlia, 18.III.1880, *Barbey s.n*. (G00642715). North Sinai: El Arish (Sinaï), 01.V.1991, *Podlech 49928* (G00642713). Port Said: Matarich (Matarieh), 27.III.1891, *Burdet 72* (G00628105). Qalyubia: Abu-Zabel, 07.I.1855, *Wiest 76* (G00642733). Egypte (s.l.), s.d. Delile, R., s.n. (G00642727);

LYBIA – Cyrenaïque, 1826, *Pacho s.n.* (G00642732);

MOROCCO – Tan-Tan: Oued Chebeika, bordure de l'Oued Chebeika, 9km de l'océan, 22.IV.1989, *Jacquemoud 4225* (G00642714).

4. ***Silene obtusifolia*** Willd., Enum. Pl. 1: 473. 1809.

Lectotype – (designated by Bureva & al. 2006: 124) *Willdenow B-Willd 8629* (LECB0001901); iso– : s.l., s.d, *Willdenow B-Willd 8629* (B -W08629-010);

= *S. mauritanica* Pomel, Nouv. Mat. Fl. Atlant. 2: 328. 1875.; **Lectotype** (designed here): Oued Mersa bou Nouar, *s.d., Pomel s.n*. (MPU005823); **isolectotype** – (P00375406); non *S. mauritanica* Pott ex Rohrb. Monogr. Silene: 84. 1869, *nom. nud.* (Art. 38.1a of ICN).

Annual or perennial *plant* with white hairy stems. *Leaves* obovate or obovate-oblong, the upper leaves narrower and obtuse at the apex. *Gynophore* 1/3 the length of the capsule. *Seeds* blackish-brown, 6.5–7.5 mm long, lateral surface deeply excavated, dorsal surface shallowly grooved, the seed coat patterned with striations. (Fig. 4, D.H).

Distribution and ecology. – Morocco, Algeria, Spain, Portugal and Tunisia, (Egypt?). Predominantly on maritime rocks and, sometimes, on sand.

Notes. – The name *Silene obtusifolia* was first validly published by Willdenow in Enumeratio plantarum (Willdenow, 1809: 473), based on material collected from an unidentified locality (one in LECB and two sheets in B). This taxon is included in our revision because of the numerous historical misapplications associated with its name, despite its ecology not being typically linked to sandy habitats. Boissier, in *Flora Orientalis* (1867), introduced the illegitimate name *Silene obtusifolia* Boiss. (non Willd.), which does not correspond to Willdenow's protologue and was applied to Egyptian specimens that we now recognize as *S. canopica*. His interpretation, however, was not adopted in subsequent literature; notably, Durand & Barratte (1910) and Maire (1963) did not follow this usage, and the name has since generally been treated as a synonym of *S. biappendiculata.*

Silene obtusifolia Willd. is distinguished by a dense indumentum, obovate to obovate-oblong leaves with obtuse or narrowly acute apices, and seeds that differ significantly from those of *S. biappendiculata* (Fig. 3). This taxon is well represented on coastal rock in western Algeria, Morocco, and in the Iberian Peninsula. From Egypt we know only one specimen from Boissier collected in 1886, and we recently observed three new localities from Tunisia (Herb. *El Mokni*) from coastal Tunisia; it suggests that the presence of this taxon in North Africa may be greater than previously assumed, warranting further biogeographical investigation.

Concerning *S. mauritanica*, three specimens are preserved. One is handwritten by Maire as "Type" and bears a label from Munby (MPU005822), but it is from a locality not inlcuded in the protologue. The others (MPU005823 and P00375406) match the protologue's data and are original material. Following (Dmina & al. 2013) we select the specimen MPU005823 as the Lectotype of the name and the specimen P00375406 as its duplicate.

Additional specimens examined. – ALGERIA – Ain Timouchent: au bord de la Plage Madegh, 18.IV.2019, *Mesbah MM08* (ENSA13973). Oran: Oued Mersa-bou Nouar, s.d., *Munby s.n.* (MPU005822); Sur les dunes de sable rocheuse à Cap Blanc, 19.IV.2019, *Mesbah MM09* (ENSA13973). MOROCCO – Tanger: Cap Spartel, V.1849, *Boissier & Reuter s.n*. (G00642774); Cap Spartel, 19.V.1980, *Charpin, Fernández Casas & al. MAR18* (G00642775); Tanger, rivière des juifs, 08.III.1911, *Pitard 401* (G00642507); Tanger, 24.IV.1924, *Maire s.n.* (G00402712); Tanger-Tetouan: 5km E of Tanger to Ceuta, 22.VI.1989, *Podlech 46738* (G00642772). Al Hoceima: Bocoya, c. Marsa Saguira, 19.V.1927, *Font Quer 182* (G00642776). TUNISIA – Bizerta: Bizerta-city (Sidi Salem Plage), 05.IV.2022, *El Mokni s.n*. (Herb. R. El Mokni), *ibidem*, 18.IV.2023, *El Mokni s.n.* (Herb. R. El Mokni). Jendouba: Tabarka (Zone Touristique Plage), 03.V.2024, *El Mokni s.n*. (Herb. R. El Mokni).

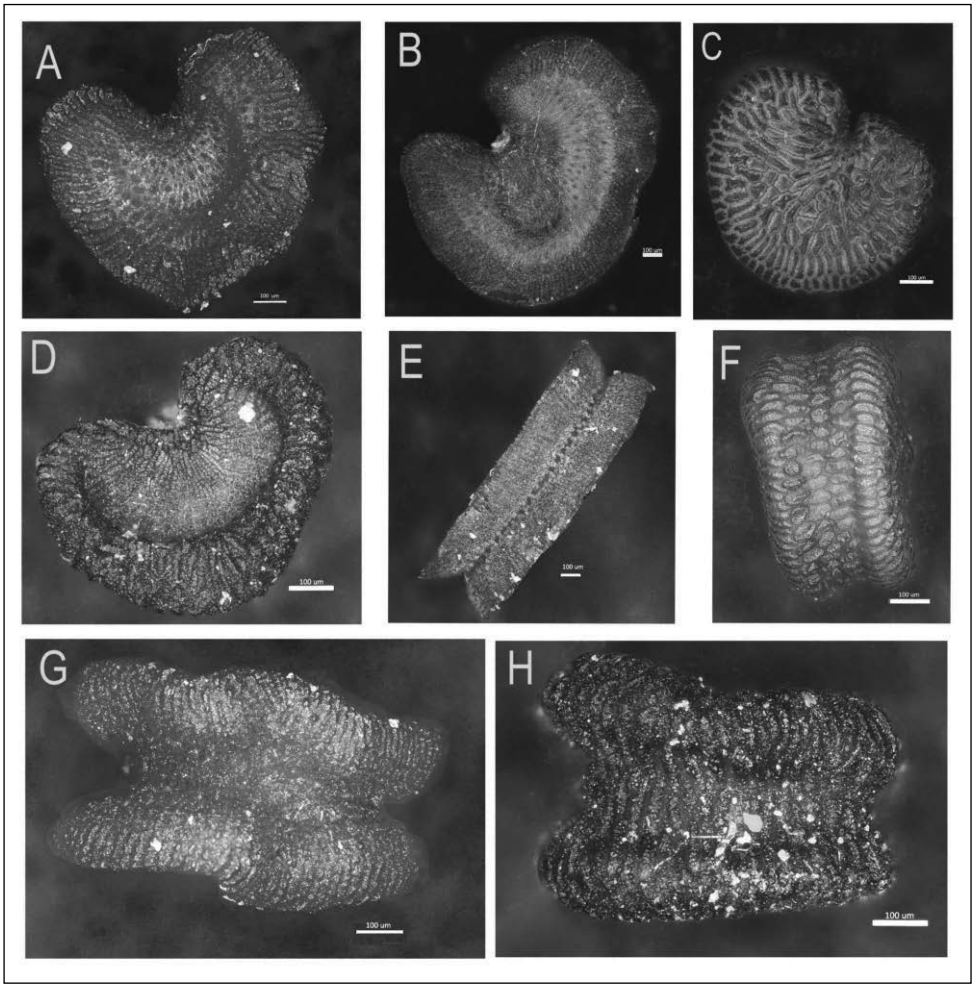


Fig.4. Seed morphology of five *Silene* species, with digital microscope VHX-7000 (×200) of: **A, G.** *Silene canopica* Delile (Ehrenberg s.n., G00545215); **B, E.** *S. colorata* subsp. *oliveriana* (Boissier s.n., G00606250); **C, F.** *S. villosa* (Podlech 33649, G00642710); **D, H.** *S. obtusifolia* (Mesbah M9, ENSA13974). Lateral view (A, B, C, D); dorsal view (E, F, G, H). (Photos: Mesbah).

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Article

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Contributions to the Flora Palaestina Region, part 2

Abstract

Ben-Natan, D., Fragman-Sapir, O. & Shemesh, B.: Contributions to the Flora Palaestina Region, part 2. — Fl. Medit. 35: 253-270. 2025. — ISSN: 1120-4052 printed, 2240-4538 online.

The Flora Palaestina is considered to be a well-studied flora in the Middle East and worldwide. Nevertheless, surveys conducted in recent years have revealed many new findings. This is our second paper to assemble and discuss some of these important findings, reporting 23 new floristic records for the region.

Key words: Floristics, endangered species, Israel, Mediterranean area.

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Introduction

The Flora Palaestina region (Israel, the Palestinian Territories, western Jordan and the Golan Heights) has been studied thoroughly since the late 19th century and until the early 21th century (Boissier 1872; Post 1896; Aaronson 1931, 1941; Dinsmore Eig & al., 1954; Zohary 1966, 1972; Feinbrun-Dothan 1978, 1986; Zohary & al. 1980-84; Danin 2000, 2004). About 2,400 species were recorded within the borders of the state of Israel and the Palestinian territories, and about 2,700 when including western Jordan (Fragman &. al. 1999). The last comprehensive work summarizing the known data on the entire local flora was published in 1991 in the Analytical flora (Feinbrun-Dothan & Danin & al. 1991). The last published checklist (Fragman & al. 1999) includes comprehensive data on all species, new findings and tagging for doubtful species. Since 2000 only sporadic updates were published: additional updates to the flora were published by Gretuter and Raus (Euro+Med Checklist Notulae) mostly by Danin (e.g. Danin 2009; Danin & al. 2011), and some in other papers and books – by local and non-local botanists (e.g. Domina & Raimondo 2009; Fragman-Sapir & Fritsch 2011; Peri 2015). Other findings were not published at all. Our previous paper (Ben-Natan & al. 2024) included 28 species newly documented in the region which were discovered or identified in the past ±20 years. In the past five years, new findings were made each year during field surveys and botanical expeditions. Some

of these findings were reported by surveyors and field botanists or by amateurs, some are based on new identifications of known plants or new treatments of previously documented species. None of these new floristic records were formally published in peer-reviewed literature. Some were published in Hebrew with partial data, without specimens being collected or vouchers being deposited in any herbaria, and some were reported only in forums and social media.

In this paper we treat further 23 species newly documented in the region from the last ±20 years. The purpose of the previous paper, this paper and the future ones, is to eventually cover all of the previously undocumented findings for the region. We have collected and assembled data on all these, along with extensive collections of plant materials which were dried, deposited in the HUJ and the TELA herbaria, and are included here as vouchers for each newly reported species. In addition, some of them were grown in the Jerusalem Botanical Gardens in order to examine their morphology in further detail, and verify their identity.

The new findings are listed here in alphabetical order of taxonomic families, and in alphabetical order within each family. For every species we bring the relevant taxonomic and discovery histories, as well as habitat information, additional remarks, and a list of vouchers deposited and examined in the local herbaria.

The new floristic records

Alismataceae Vent.

Alisma gramineum Lej.

Alisma gramineum Is first mentioned from the Flora Palaestina region in Zohary (1989), where it's recorded from Sinai and the Golan Heights. The basis for the latter claim is unclear, but it has been speculated that like some other records from the area mentioned in Zohary (1989) and later sources (such as Danin and Feinbrun-Dothan 1991), it's based on records from S Syria. Later, the species has been recorded by Prasse in Ein Yered in the Shfela in 1994 (Fragman-Sapir 1999). This and later records from the Upper Galilee (Ein Roim) have been examined and reidentified by Ben-Natan, Fragman and Shemesh (2024) as *Sagittaria subulata* (L.) Buchenau., and thus it was concluded that *Alisma gramineum* is not present in Israel.

In summer 2024, some populations of *Alisma* sp. from the NE Golan Heights were examined during the rare plant survey executed by Deshe OLI for the INPA, and identified as *Alisma gramineum* – the first verified record of this species from Israel. As this species is already known from S Syria, its presence in the Golan Heights is not surprising – although it is extremely rare there, in contrast to the more locally common and similar *A. lanceolatum* With. As of now, *A. gramineum* is known from only two localities in the Golan Heights, at the NE border of the region. The plants grow there in vernal ponds on basaltic soil, in herbaceous plant association within a wet habitat. At least one of the localities concludes a large population with a few hundreds of mature individuals.

Reference material: ISRAEL, Golan Heights, in water and on the drying mud on the shores of a trench N of Qunetra Reservoir, coor: 33°07'59.6"N 35°48'56.6"E. 25.Jul.2024, *Dar Ben-Natan, Dvora Lev-Ramati & Noam Segev* (HUJ1005804!, HUJ1005805!, HUJ1005806!, TELA4907!).

Apiaceae Lindl.

Daucus involucratus Sm. (Fig. 1a)

This delicate annual is known currently in the region only from a single location in the Judean Mts, west of Jerusalem, where it grows in a planted *Pinus brutia* Ten. forest. This species has been known for a hundred years from this site, and was misidentified up until now as *Daucus guttatus* Sm., which differs from *D. involucratus* Sm. in its bract and fruit-spines characteristics. It was reidentified by Bar Shemesh in 2024. Currently, there is no evidence of the latter occurring in the region, and all other sheets identified as *D. guttatus* in the HUJ herbarium belong to *D. broteri* Ten.

Reference material: ISRAEL, Judean Mts, kiriyat Anavim, 16.May.1925, *Noah Naftolsky* (HUJ31712!); ISRAEL, Judean Mts, kiriyat Anavim, 23.Apr.1990, O*ri Fragman-Sapir and Noam Bar-Shai* (HUJ126205!); ISRAEL, Judean Mts, near kiriyat Anavim, 5.May.2020, *Ori Fragman-Sapir* (HUJ133393!).

Ferula coskunii H.Duman & Sagiroglu

Herbaceous perennial, found several times in the Upper Galilee in Mt Meron, Mt Shazor and Manara as well as in Mt Hermon. The plant was collected to the HUJ herbarium first by Clara Heyn in 1972. It has gone unidentified for decades and was treated as *Ferula meronensis* (nom. nudum.) in the Red Data Book of Israel plants. Vol 1 (Cohen & Shmida 1992). Recently, the local populations of this species were identified by Shmuel Mazar as *F. coskunii* (Mazar & Leshner 2016), a recently described species known up until now as endemic to the Amanos Mts in southern Turkey, and known from only two locations there (Duman & Sagiroglu 2005). The species occurs in the northern margins of the region, and was collected to the HUJ herbarium from Lebanon and Jordan as well (Mazar & Leshner 2016). It might be present in Syria as well.

Reference material: ISRAEL, Upper Galilee, Mt Meron, 3.5.1972, *Clara Heyn* (HUJ135068!), ISRAEL, Mt Hermon, Wadi Asal, 1000m., 10.5.1981, G. Ne'eman (HUJ135073!), ISRAEL, Upper Galilee, Mt Shazor, *Quercus coccifera-Pistacia terebinthus* maquis on Terra rosa soil on hard limestone, 26.4.1982, *R. Berliner* (HUJ135072!), ISRAEL, Upper Galilee, Mt Shazor, 21.6.1989, *D. Kaplan & M. Asaf* (HUJ135071!), ISRAEL, Upper Galilee, top of Mt Meron, alt: 1150m, 18.8.1989, *A. Aharoni & A. Lev* (HUJ135069!), ISRAEL, Upper Galilee, near Manara, 31.7.2016, *Shmuel Mazar* (HUJ135070),

Torilis leptocarpa (Hochst.) C.C.Towns.

This species was first recorded in the Golan Heights by Zohary in 1968, and was later collected from several location in the Golan Heights by several botanists and surveyors up to the 1990's, but for some reason its occurrence in the region was never officially published in literature. In 2018, plants collected by Shmuel Mazar were identified once again as *Torilis leptocarpa* by Shimon Cohen-Sivan, and brought to the attention of the local botanist community.

Reference material: ISRAEL, Golan Heights, Mazraát El Nab (Nov Meadow), damp fields, 30.4.1968, *M. Zohary* (HUJ370750!, HUJ370751!, HUJ370752!), ISRAEL, Golan Heights, Mazraát Nab (Nov Meadow), fallow field, basalt soil, 27.5.1969, *N. Zeligman*

(HUJ370746!), ISRAEL, Golan Heights, Nov Meadow, 1.5 km SW of Ramat Magshimim, coor: 2247/2489, alt: 410 m, herbaceous flat area, heavy basalt soil, flooded seasonally in winter and extremely dry in summer, dominance of *Hordeum bubosum* L. and *Hordeum spontaneum* C. Koch, 5.5.1991, *O. Cohen* (HUJ370743!), ISRAEL, Golan Heights, Nnear Nahal El-Al, env. Of Avnei Eitan, 1.7.1991, *A. Danin* (HUJ370747!, HUJ370748!, HUJ370749!), ISRAEL, Golan Heights, Nov Meadow, 1.5 km SW of Ramat Magshimim, coor: 2247/2489, alt: 410 m, herbaceous flat area, heavy basalt soil, flooded seasonally in winter and extremely dry in summer, dominance of *Hordeum bubosum* L. and *Hordeum spontaneum* C. Koch, 8.5.1994, *O. Cohen* (HUJ370753!, HUJ370754!), ISRAEL, Golan Heights, near Fazra junction, 2 km E of Hushniya, ccor: 2278/2686, alt: 820 m, herbaceous flat area, heavy basalt soil, seasonally flooded in winter and extremely dry in summer, dominance of *Hordeum bubosum* L. and *Hordeum spontaneum* C. Koch, somewhat grazed by cows, 8.5.1994, *O. Cohen and U. Plitmann* (HUJ370744!, HUJ370745!), ISRAEL, Golan Heights, E-Dahr, 2 km SW of Meizar, coor: 2178/2403, alt: 380 m, fallow fields and edges of cultivated fields, barren places without other plants, heavy basalt soil, 8.5.2001, *O. Cohen and U. Plitmann* (HUJ321900, HUJ321901!, HUJ321902!), ISRAEL, Golan Heights, 22.5.2018, *Shmuel Mazar* (HUJ134808!), ISRAEL, Golan Heights, Avnei Eitan, coor: 271321/747575, alt: 375 m, herbaceous vegetation, 18.5.2020, *Yair Ur* (HUJ134809!).

Asteraceae Bercht. & J.Presl

Atractylis mernephthae Asch. & Schweinf. & Letourn. (Fig. 1 b)

A spreading, spiny annual of the arid desert. *Atractylis mernephthae* was recorded in the Flora Palaestina from Sinai (Feinbrun-Dothan 1986), and first noticed in Israel by Shimshon Valvatker in 2024, and identified later that year by Ori Fragman-Sapir. Later, further unidentified records were found from 2010 and earlier, and even an herbarium sheet from Hatseva area by Danin from 1975, which was identified correctly in 1990 – but the new record was not published. The species is found in Israel in extreme arid environments in the Arava Valley on loamy and sandy substrates, and occurs together with *A. carduus* (Forssk.) C.Chr., and differs from the latter by the smaller, conical flowering heads without ligulate flowers, shorter outer involucrate bracts, and reddish spines. It is probably somewhat more common in the Arava Valley then is currently known.

Reference material: ISRAEL, Arava Valley, near Hatzeva, Sandy wadi, 1.Jan.1975, Avinoam Danin (HUJ1002598!); ISRAEL, Arava Valley, S. Arava- E of Samar, shallow wadis, coor: 29°50’10.7”N 35°01’55.6”E, 4.Apr.2024, Ori Fragman-Sapir and Dar Ben-Natan (HUJ1002577!, HUJ1002585!).

Gnaphalium uliginosum L.

A small and inconspicuous annual of vernal ponds and ephemeral wet habitats, discovered for the first time in the region and identified by Zalman Baumwoll in 2017. The species was observed growing in large numbers in wet clay mud at the bottom of a dry water reservoir in the northern Golan Heights. Further populations were reported from Birkat Ram and Orvim Reservoir. *Gnaphalium uliginosum* is a widespread species throughout northern and central Asia, Europe and North America, and is recorded in Syria and Egypt as well – making its presence in the Golan Heights unsurprising.

As there are very few natural large water-bodies in the area, the habitat in which it occurs in the region is mostly man-made, excluding Birkat Ram, which is a natural Caldera. The species was probably dispersed into the region recently by migrating birds. The local populations have been observed now for several years and seem to be stable.

Reference material: ISRAEL, Golan Heights, Bene Zefat reservoir, 3.12.2017, *Zalman Baumwoll* (HUJ1002603!), ISRAEL, Golan Heights, Bene Zefat reservoir, near hushniya, 22.12.2017, *Zalman Baumwoll* (HUJ1002612!).

Brassicaceae Burnett

Crambe alutacea Hand.-Mazz. (Fig. 1 c)

The species was first discovered in Israel by Shmuel Mazar in 2016, growing in orchard margins in Tel Ram, northern Golan Heights, and originally identified as *Crambe orientalis* L. (Previously reported from N Golan Heights from a single population) and reported as such in Hebrew by Mazar and Shmida in Kalanit Israel Plant Magazine (Mazar & Shmida 2016).

In 2018 plants collected from Tel Ram were examined by the genus monographer Anibal Oscar Prina, and determined as *C. alutacea* Hand.-Mazz. The plants are perennial with distinct bright yellow flowers, stellate-branched soft hairs on the leaf blades, and tuberculate upper fruit joint. Unfortunately, the small population did not survive due to the soil disturbances caused by the tillage and repurposing of the plot for agriculture, by the local farmers (Ben-Natan in Raizner & al. 2023). A few plants are grown in the Jerusalem Botanical Gardens from seed collected there and more seeds were deposited in the Israel Gene Bank.

The closely related *Crambe orientalis* is known from the Jordanian mountains. We have checked the HUJ sheaths from Jordan and in nature and discovered that although the flowers are white, the hairiness is not scabrid as known from *C. orientalis*, but soft and stellate as in *C. alutacea*. Further research is needed in order to determine the status of these populations, which might represent intermediate forms between the two species. *Crambe orientalis* was also reported from Israel, discovered in the Tel Avital's caldera (NE Golan Heights) by Bill Kunin in 1986 and observed there up till 1990 at the margins of agricultural fields (Shmida & Pollak 2007). No specimen of this population was found in any Israeli Herbaria, and the population itself has not been observed since 1990. Thus, it is impossible to determine whether these plants belonged to *Crambe orientalis* as identified originally, or to *C. alutacea* as the Tel Ram population was eventually determined. Due to the similar habitat and relatively close vicinity of the two populations, it might be more likely that the Tel Avital population belonged to *C. alutacea* as well.

Reference material: ISRAEL, Golan Heights, Mt Ram, 6.7.2016, Smuel Mazar (HUJ134851!), ISRAEL, Golan Heights, Mt Ram, 1.9.2016, Smuel Mazar (HUJ134850!), ISRAEL, Golan Heights, Mt Ram, 30.4.2017, Smuel Mazar (HUJ134852!).

Referecence material of the Jordanian C. aff. orientalis: JORDAN, Belka, betw. El-Yaduda and Umm-El-Ámad, alt: 650 – 700 m, 26.3.1936, *A. Eig, M. Zohary, and N. Feinbrun* (HUJ134880!), JORDAN, Moav, E of Madaba, fields, alt: 770 m, 25.4.1911, *Fred S. Meyers et J. E. Dinsmore* (HUJ134881!), JORDAN, North Edom, south of Jabel Chala, South of Tafilla, alt: 1440m. In a field, 8.6.2016, *Mimi Ron and Yair Ur* (HUJ134882!), JORDAN, 20.4.2022, *Ori Fragman-Sapir* (HUJ134884!).

Eremobium lineare (Delile) Asch. & Schweinf. ex Boiss. (Fig. 1 d)

Despite mentions of this taxon (as *E. aegyptacum* var. *lineare* (Del.) Zoh.) from the Philistean Plain and the Negev by Zohary in the Flora Palaestina (1966), no correct records of this species in Israel were found in the HUJ herbarium or in other local relevant sources. Sheets containing specimen previously identified by Zohary as *E. aegyptacum* var. *lineare* (Del.) Zoh. And collected from Halutsa Sands (HUJ32057!, HUJ32058!), Nahal Secher Sands (HUJ27534!, HUJ27533!) and Wadi Nimra (HUJ27535!) represent, in our opinion, small variations within *E. aegyptacum* (Spreng.) Asch. & Schweinf. ex Boiss.

Currently, *E. lineare* is known in Israel only from a single population in Ardon Valley in Makhtesh Ramon, where it was first discovered during an INPA field survey in March 2019 by Dar Ben-Natan, Mimi Ron and Yedidya Shmuel. It is also well known from S. Jordan, especially from the Wadi Rum area. *E. lineare* is sometimes considered as a variant or a subspecies of *E. aegyptacum*, but we prefer to consider it as a separate species due to ecological and morphological differences: *E. lineare* is characterized by bright green leaves, on which accumulates sand and silt, by wider pods that are conspicuously constricted between the seeds, and by the sub-orbicular to ovoid, disciform and conspicuously winged seeds. In contrast, *E. aegyptacum* is grayish in color and does not accumulate dust and sand, has narrow and almost non-constricted pods, and elliptic-oblong, unwinged seeds (Khalik & Maesen, 2002). The Negev population consists of several hundred individuals, and occur on a steep, shifting sand dune, where *E. lineare* is often the most prominent, or the only plant around. In the Negev, the two *Eremobium* species are allopatric; *E. aegyptiacum* was not recorded in Ardon Valley or in Makhtesh Ramon in general - while *E. lineare* doesn't occur in other inland sands in the Negev and Arava Valley deserts, where *E. aegyptacum* is common. Further study of populations in the Arab Desert might help to ascertain the species limits between these taxa.

Reference material: ISRAEL, Negev Desert, Makhtesh Ramon, Ardon Valley sands, on a big dune in Nahal Geled, coor: 30.6455360 N 35.0243870 E, on shifting sand in upper parts of the dune, hundreds of plants, 5.3.2019, *Dar Ben-Natan* (HUJ133354!, TELA2057!), ISRAEL, Negev Desert, Makhtesh Ramon, Ardon Valley sands, on a big dune in Nahal Geled's confluence into Nahal Kamai, coor: 30.644669 N 35.022265 E, 30.645788 N 35.024910 E, 30.644484 N 35.020099 E on shifting sand in upper parts of the dune, hundreds of individuals, 7.4.2019, *Dar Ben-Natan* (HUJ133358!, TELA2058!).

SINAI, Upper Wadi Zeleqa, blown up sands at base of limestone hills, 6.8.1968, *N. Tadmor and G. Orshan* (HUJ52098!), SINAI, Wadi Feiran, 5km S of Oasis, Rocks, 6.3.1968, *A. Danin* (HUJ32104!).

Caprifoliaceae **Juss.**

Cephalaria setosa Boiss. & Hohen. (Fig. 1 e)

A slender, tall herb resembling *Cephalaria joppensis* (Rchb.) Coult., differing from it by the aristate involucral bracts and achene shape. *C. setosa* is a least known species that is very rare in the region, previously known only from one population on Mt Hermon (Wadi Arár). It was discovered west of the Jordan River for the first time by Shimon Cohen in 2021 and further recorded and collected by Yehuda Sar-Shalom in 2023. It occurs in large quantities on the rocky slopes of Mt Kabir in the Samaria Mts, and have yet to be recorded from other locations in the area.

Reference material: ISRAEL, Mt Hermon, *Ofer Cohen* (HUJ131873!), ISRAEL, Mt Hermon, Wadi Ali, on cliff, alt: 1100m, 27.6.1971, *A. Shmida* (HUJ135065!, HUJ135066!), ISRAEL, Mt Hermon, Wadi Arár, alt: 1250m, 10.6.1991, *Hagar Leshner, Ofer Cohen and Ori Fragman-Sapir* (HUJ135067!), ISRAEL, Samaria, Mt Kabir, North of Beit Dajan, East of Elon Moreh, coor: 32.218967 N 35.365901 E, alt: 740m, Large rock terraces, facing north-east. 24.5.2023, *Yehuda Sar shalom* (HUJ!)

***Cyperaceae* Juss.**

Bolboschoenus maritimus (L.) Palla subsp. *maritimus*

A spreading, perennial herb of seaside salt marshes.

Bolboschoenus maritimus was reported in the Flora Palaestina (Feinbrun-Dothan 1985) as *Scirpus maritimus* L., mentioning *Scirpus tuberosus* Desf. and *Scirpus maritimus* ver. *tuberosus* as synonyms. This taxon, currently accepted widely as a distinct species - *B. glaucus* (Lam.) S.G.Sm. correspond well to most of the populations studied by us in Israel.

B. maritimus subsp. *maritimus* was identified locally as a distinct taxon for the first time by Bar Shemesh in 2024. The plants were found by Bar Shemesh and Noam Segev growing in the estuary saline of Nahal Na'aman in the Coast of Galilee, and a further population was recorded the same year by Bar Shemesh and Dvora Lev-Ramati in the estuary saline of Nahal Maharal in the Coast of Carmel. *B. glaucus* (Lam.) S.G.Sm. is widely common in Israel and is very similar to *B. maritimus*, differing in inflorescence shape and seed structure characteristics. It is very possible that further populations of *B. maritimus* subsp. *maritimus* will be identified along the Coastal Plain of Israel in the future.

Reference material: ISRAEL, Coastal Carmel, Ma'agan Michael, wet heavy soil, 9.5.1967, A. Danin (HUJ4844!); ISRAEL, Akko Plain, Na'aman saltmarsh, coor: 32°54'37.3"N 35°05'17.1"E. 16.Jun.2024, Bar Shemesh and Noam Segev (HUJ1003890!).

Bolboschoenus glaucus (Lam.) S.G.Sm.: ISRAEL, Philistean plain, Mikve Israel, near water, 3.4.1922, *A. Eig*, (HUJ 0000004952!); ISRAEL, Hula valley, 18.51953, *I. Baldinger* (HUJ 0000004840!), ISRAEL, Philistean plain, Palmahim, 15.3.1954, *D. Jaffe*, (HUJ 0000004945!).

Euphorbiaceae Juss.

Euphorbia dracunculoides subsp. ***glebulosa*** (Coss. & Durieu) Maire (Fig. 1 f)

A glaucus annual or perennial herb, discovered by Dar Ben-Natan, Mimi Ron and Yedidya Shmuel in Eastern Makhtesh Ramon, during a rare plants survey for the INPA. The local populations correspond to *Euphorbia dracunculoides* subsp. *glebulosa* (Coss. & Durieu) Maire, which is currently known only from NW Africa, from Morocco to Tunisia (Plants of the World Online 2024+), and is recorded here as a new taxon for Israel and for the Middle East. The local populations differ from *Euphorbia dracunculoides* subsp. *dracunculoides*, which is recorded from the neighboring Egypt and Saudi Arabia, by the obtuse inflorescence leaves, usually perennial habit, and the unique tuberculate seed coat pattern.

This species was found between 2019 and 2020 in four adjacent localities, all in sandy wadies and rocky slopes covered by sand dunes within the eastern parts of Makhtesh Ramon.

A single plant found at the margins of a sidewalk in the Negev Highlands' Field School's yard near Mizpe-Ramon in 1997, has probably arrived there with imported soil (Shmida 1997). No further records of this species exist from the region previous to 2019, and the species was listed as casual in the Red Data Book (Shmida & al. 2011). The specimen itself couldn't be located in the HUJ herbarium, but a scan of the sheet shows a plant much similar to those observed in-situ in Ardon Valley – thus, the local population is a likely source for this casual appearance. Our finding in the eastern Makhtesh Ramon is the first evidence of sustained populations of this species in the region in a natural habitat.

Reference material: ISRAEL, Central Negev Desert, Makhtesh Ramon, small wadies east of Nahal Ramon, between Ardon and Mahmal Valleys, coor: 30.6231370 N 34.9294551 E, Sandy wadies, 3 young plants observed, 26.2.2020, *Dar Ben-Natan* (HUJ133384!, HUJ133394!), ISRAEL, Central Negev Desert, Makhtesh Ramon, Ardon Valley, small wadies and dunes over hard limestone, Nahal Geled, coor: 30.6383121 N 34.9980191 E (one plant), 30.6436709 N 35.0204089 E (10 plants), 30.642874 N 35.003174 E (seven plants), 5.3.2019, *Dar Ben-Natan* (HUJ134783!)

Fabaceae Lindl.

Astragalus echinatus Murray (Fig. 2 a)

A prostrate annual, first discovered and identified in the region by Asaf Haim in the southern Golan Heights in 2021 in two locations, and in one further nearby location in 2024. These populations are quite dense, occurring in mostly annual vegetation on clay-rich volcanic vertisol – locally a highly endangered habitat. This discovery expands the range of this species' distribution southward by more than 300 km - from southern Turkey to the Flora Palaestina region.

Reference material: ISRAEL, Golan Heights, env of Kfar Haruv, coor: 32.764167 N 35.676093 E, alt: 300m. Heavy clay soil, 2.5.2023, Dar Ben-Natan, *Bar Shemesh and Asaf Haim* (HUJ135084!, TELA4906).

Geraniaceae Juss.

Erodium brachycarpum (Godr.) Thell.

This small Mediterranean species was recorded already in the Analytical flora of Eretz-Israel (Danin & Feinbrun-Dotan, 1991) from the Golan Heights, and treated there as *Erodium botrys* (Cav.) Bertol., a closely related species that occurs in sandy and sandy clay soils in the Coastal Plains of Israel. The species was first identified correctly in Israel by Shmuel Mazar in 2018, from the Golan Heights and Upper Galilee, where it occurs sparsely on basalt clay soils in stony plains, usually near vernal ponds or shallow vernal streams. This report is the second one from the E Mediterranean and Middle East, hinting that this inconspicuous species will probably be found in other bordering countries, and in other regions in the N and S Mediterranean in future surveys.

Reference material: ISRAEL, Golan Heights, Oz military camp, 26.3.2017, *Dar Ben-Natan* (HUJ133837!), ISRAEL, Golan Heights, Hushnia reserve, coor: 33.0017590 N 35.8204730 E, 13.4.2022, *Dar Ben-Natan* (HUJ134804!).

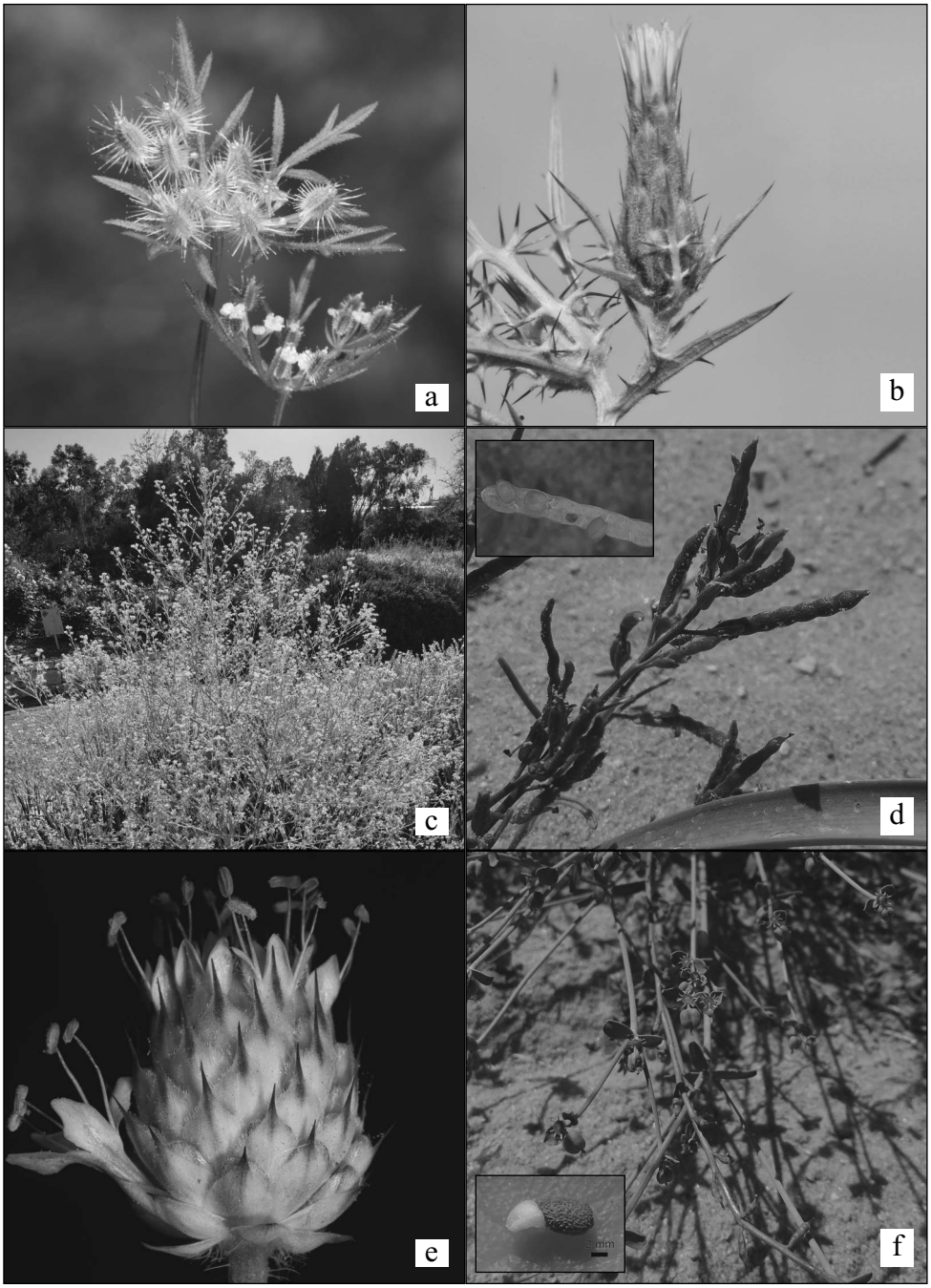


Fig. 1. **a.** *Daucus involucratus*, photo O. Fragman-Sapir; **b.** *Atractylis mernephthae*, photo O. Fragman-Sapir; **c.** *Crambe alutacea*, photo O. Fragman-Sapir; **d.** *Eremobium lineare*, photo D. Ben-Natan; **e.** *Cephalaria setosa*, photo Y. Sar-Shalom; **f.** *Euphorbia dracunculoides*, photo D. Ben-Natan.

Lamiaceae Martinov

Ziziphora persica Bunge (Fig. 2 b)

A small, fragrant annual herb, growing in the semi-arid regions of Israel. In the Flora Palaestina (Feinbrun-Dothan,ù 1977) and later publications, *Ziziphora persica* Bunge has been misidentified in Israel as *Z. tenuior* L., which occurs in higher elevations in Edom (Jordan) and in the Southern Sinai Highlands. The former species is very rare in Israel, occurring sparsely in the southern Judean Mts and the Judean Desert, growing in Batha, at the margins of traditional agriculture, and extremely rare in gravelly wadies in the Negev Highlands (Danin & Feinbrun-Dothan 1991, Shmida & Pollak 2007). The species was included in the Israeli Red Data Book of Endangered Vascular Plants (Shmida & Pollak 2007) as *Z. tenuior*, and reidentified as *Z. persica* by Bar Shemesh and Dar Ben-Natan in 2025. Currently, there is no evidence of *Z. tenuior* occurring in Israel. Although *Z. tenuior*'s presence is verified in Jordan and S. Sinai, in the HUJ herbarium, records for this species in Jordan exist only from Edom (S. Jordan) – therefore, more northern populations might turn out to belong to Z. persica as well.

Reference material: ISRAEL, Judean Desert, 4-5 Km S of Bani Na'im, 5.4.1942, *Daniel Zohary* (HUJ314701!); ISRAEL, Nahal Lotz And Nahal Elizur Junction, *Avinoam Danin*, 27.4.1966 (HUJ314699!); ISRAEL, Central Negev, Borot Loz, Above Nahal Elot, *A. Danin and A. Liston*, 6.4.1983 (HUJ314700!); ISRAEL, Judean Desert, Canub Ridge, Peney Kedem. Low shrubland at the edge of an olive orchard. Chalk. Alt: 930 n, 20.5.2005, *Yair Ur* (HUJ1008215!); ISRAEL, Judean Mts, SE of Bnei Dar ruins, margins of agricultural fields, alt: 850 m, 23.4.2009, *Yair Ur* (HUJ1008213!); ISRAEL, Judean Mts, S of Mt Hebron, S of Nebi Yakin, 13.4.2010, *Yair Ur* (HUJ122456!).

Ziziphora tenuior L.: JORDAN, Edom, Ma'an to Ein Musa, roadside, 16.4.1929, *Noah Naftolsky* (HUJ314719!); JORDAN, Aqaba area, sandstone hills, 3.6.1943, *K. Glober* (HUJ314721!); JORDAN, Edom, Bir Dabbaghat, near Shobak, open, heavily grazed ground on sandstone in open *Q. coccifera* scrub, alt: 1524 m, 23.6.1951, *H.J. Mooney* (HUJ314723!); JORDAN, Edom, Hishe, 11 km NE of Perta, alt: 1600 m, 4.7.1997, Unknown collector (HUJ12657!); JORDAN, Edom, E of Al-Hay (E of Petra), wheat fields, alt: 1480 m, 30.4.2016, Mimi Ron & Yair Ur (1008212!); SINAI, S. Sinai, St Katherine area, collected and grown in the botanical garden, 11.3.1975, *Shmida & Arbel* (HUJ1008217!); SINAI, S. Sinai, St Katherine area, collected and grown in the botanical garden, 15.4.1975, *M. Shouat* (HUJ1008218!); SINAI, S. Sinai, road from Jebel Katherine to Jebel Ahmar, 3.5 km N of St Katherine Monastery, red granite, alt: 2300 m, 1.5.1976, *Reichenstein* (HUJ314724!); SINAI, S. Sinai, Wadi Tweita, 9 km WNW of St Katherine Monastery, 16.4.1979, *A. Danin*, (HUJ314725!).

Limeaceae Shipunov ex Reveal

Limeum obovatum Vicary

This inconspicuous, spreading annual-biennial species, was first discovered in Israel in the S Arava Valley by Shimshon Valvatker in 2021, and went unidentified until 2024, when it was recorded again by Valvatker in the same locality, and identified by Ori Fargman-Sapir. The species occurs there in extreme arid desert, on sandy gavel in small, dry gulches

in alluvial fans near Timna. Currently, only two close localities are known, comprising of a small population of less than 50 individuals in total. Its closest known sites are in Egypt and Saudi Arabia, therefore it might be found in the eastern Arava Valley in Jordan as well in the future.

Reference material: ISRAEL, S. Arava, E of Timna, coor: 29°46'13.4"N 35°00'43.6"E, 14.May.2024, *Dudi Rivner and Dafna Carmeli* (HUJ1002588!).

Lythraceae J.St.-Hil.

Lythrum silenoides Boiss. & Noë (Fig. 2 c)

Tall, erect annual. This least-known species was discovered for the first time in Israel by Talia Oron and later identified by Shmuel Mazar from a single locality in the Northern Hula valley in 2019. The plants grow there in a small muddy depression near streams of fresh water, together with the rare and also newly discovered *L. thesioides* M. Bieb. A further locality was found by Hila Abraham later in the same year in Einot Bazelet in the Golan Heights, and a third locality was found by Yair Ur in the N Golan Heights in 2022. In all three localities it is threatened by grazing and groundwater levels depleting. The Hula Valley population was observed again in 2022, but the Golan Heights populations were observed only once, and might not be stable. These findings set a new western border to this species' distribution, and provide an accessible opportunity to study this rare species is the field.

Reference material: ISRAEL, Hulla Valley, Nuhaila, coor: 33.2506640 N 35.6518750 E, Wet mud in margins of a stream, in an open spot among scrub of *Rubus sanctus* Schreb., together with *Lythrum thesioides* M.Bieb., *Juncus articulates* L., and *Euphorbia microsphaera* Boiss., tall, branched plants with a central stem reaching 1.5m, 13.8.2020, *Dar Ben-Natan* (HUJ133352!, TELA2072!), ISRAEL, Hulla Valley, Nuhaila, coor: 33.250688 N 35.651813 E wet meadow in a small streamlet, 22.9.2022, *Dar Ben-Natan* (HUJ134976!).

Lythrum thesioides M.Bieb. (Fig. 2 d)

This species is known in Israel only from one locality, where it was photographed and reported for the first time by Zalman Baumwell in 2019, and mistakenly identified as *L. thymifolium* L. Later the species was identified as *L. thesioides* by Shmuel Mazar and Dr. Antoine Gazaix.

L. thesioides is a rare, endangered species in a global scale, and in the last few decades was recorded only from S France (Dr. Antoine Gazaix, personal communication). The newly discovered population in the Hula Valley represent the first record of this species in the Eastern Mediterranean, and provides an opportunity to study an accessible population of this least-known species. This population occurs within a small clearing in a dense *Rubus sanctus* Schreb. scrub, in a wet environment at close proximity to the Dan River, and together with many wet habitat species, many of them locally rare and endangered. Among them: *Lythrum silenoides* Boiss. & Noë, *Fimbristylis bisumbellata* (Forssk.) Bubani, *Euphorbia microsphaera* Boiss., and *Juncus articulatus* L. The population was observed again in 2022, and seems to be stable.

Reference material: ISRAEL, Hulla Velley, Nuhaila, coor: 33.2506640 N 35.6518750 E, Wet mud in margins of a stream, in an open spot among scrub of *Rubus sanctus* Schreb., togeth-

er with *Lythrum silenoides* Boiss. & Noë, *Juncus articulates* L., and *Euphorbia microsphaera* Boiss., about 9 individuals in total, branched and prostrate plants, 13.8.2020, *Dar Ben-Natan* (HUJ133347!, TELA2071!), ISRAEL, Hulla Valley, Nuhaila, coor: 33.250688 N 35.651813 E, wet meadow in a small streamlet, 22.9.2022, *Dar Ben-Natan* (HUJ134977!).

Montiaceae Raf.

Montia fontana L.

A tiny annual, growing in damp muddy meadows on the margins of small streams and vernal ponds. *Montia fontana* was first discovered in Israel in 2012 by Yair Ur, in a small spring in Mt Kaka (lower Mt Hermon) on sandy clay wet mud. Since then, it was further found in several other small springs in that area, and in several localities in the northern Golan Heights, on muddy basalt clay wet soil near vernal wet habitat, mainly by Yair Ur, Oz Golan and Bar Shemesh. The Golan Heights populations might not be stable, as most of them were observed only once so far, but the Mt Kata population is stable for more than ten years already.

Reference material: ISRAEL, Mt Kata (lower Mt Hermon), coor: 33.2486530 N 35.7539940 E, herbaceous, muddy meadow at the margin of a stream, 15.3.2020, *Dar Ben-Natan* (HUJ134825!).

Plantaginaceae Juss.

Misopates microcarpum (Pomel) D.A.Sutton

Misopates orontium (L.) Rafin. is quite common in northern and central Israel, extending south into the Negev Desert and east to the Judean Desert. In arid environments, this variable species creates desert forms – smaller plants with considerably smaller and paler corolla compared to Mediterranean populations. In 2024, one such population was collected by Bar Shemesh and Mimi Ron, and was identified by Bar Shemesh as *Misopates microcarpum* (Pomel) D.A.Sutton – a desert species characterized by its smaller corolla and capsule, and a unique seed coat shape. The species was found growing in rocky terrain in the northern Dead Sea area. Other populations observed previously in the southern Negev and Arava Valley are suspected as belonging to *Misopates microcarpum* as well. This species' presence in NE Egypt (Boulos, 2002) supports the possibility of a larger population extending over the Southern Negev and Sinai. The scarce records from the area might be attributed to the difficulty in distinguishing between *M. microcarpum* and the desert forms of *M. orontium*.

Reference material: ISRAEL, Dead Sea area, ascent to Ras-Fesh'ha, coor: 31°42'45.4"N 35°26'54.5"E, alt: -260 m. 5.May.2024, *Bar Shemesh* and *Mimi Ron* (HUJ1003767!).

Rubiaceae Juss.

Galium parisiense L.

Following the discovery of true *G. divaricatum* Pourr. ex Lam in Israel in 2023, populations of *Galium* sp,, attributed until that point to this name (Boissier 1875; Post 1896, Feinbrun-Dothan in Flora Palaestina 1978), were reidentified by Bar Shemesh as *G.*

parisiense L., a name unrecorded from the region until now. During the spring of 2023, two populations of *G. divaricatum* were discovered on sandy-clay substrates in the Sharon Plain and in the lower Mt Hermon by Bar Shemesh and Dar Ben-Natan. It is possible that further populations of the latter species will be discovered in the Coastal Plain of Israel in the future, however, the habitat in which they were found until now is highly threatened by urban expansion, afforestation, and competition with invasive plant species. *Galium parisiense* is quite common, mostly on calcareous substrates, and often in disturbed habitats, across the Mediterranean parts of Israel.

Reference material: ISRAEL, Mt Gilboa, Mar.1996, *Aviva Rabinovitz* (HUJ1006669!); ISRAEL, Upper Galilee, Kerem Ben-Zimra, roadside gravel on a grassy, rocky slope, 9.May.1984, *C. Heyn, U. Plitmann, I. Herrnstdat, B. Pazi & A. Liston* (HUJ122553!); ISRAEL, Mt Carmel, 10.Apr.1926, *Noah Naftolsky* (HUJ1006671!); ISRAEL, Shomeron, env. Of Daliya, 5.Apr.1950, Dani Zohary (HUJ1006672!); ISRAEL, Judean Mts, Wadi entering Nahal Arugot, Below Hirbet Kanub, rocky slope, *Sarcopoterium spinosum* (L.) Spach batha, alt: 500 m, 8.Apr.1985, *A. Liston* (HUJ1006668!); ISRAEL, Golan Heights, Nov, inundated basalt, alt: 400 m, 14.4.1985, *A. Liston* (HUJ1006667!).

Galium divaricatum: ISRAEL, Sharon Plain, Pardes-Hanna, Sandy loam hills, garigue of Calycotome, Cistus and Lavandula, 8.Apr.1946, *D. Zohary* (HUJ1006670!); ISRAEL, Sharon Plain, Illanot Forest, west of rout 4, red clay loam, in shade of *Cistus salviifolius* L., 4.Apr.2023, *Bar Shemesh and Dar Ben-Natan* (HUJ1005807!); ISRAEL, Lower Mt Hermon, Mt Kata, in a small dry wadi S of Nimrod, coor: 33°14’36.2”N 35°44’58.0”E, alt: 1050 m, brown sandy clay loam. 18.May.2023, Dar Ben-Natan (HUJ1005810!); ISRAEL, Lower Mt Hermon, Mt Kata, rocky hill SW of Nimrod, coor: 33°14’34.5”N 35°44’46.7”E, alt: 1040 m, in batha on sandstone. 18.May.2023, *Dar Ben-Natan* (HUJ1005809!); ISRAEL, Sharon Plain, Ilanot Forest, west of rout 4, coor: 32°17’33.1”N 34°54’07.8”E, red sandy clay loam, in shade of Cistus salviifolius L., 10.Apr.2024, Dar Ben-Natan (HUJ1005803!), ISRAEL, Sharon Plain, Ilanot Forest, east of rout 4, coor: 32°17’41.0”N 34°53’46.8”E, sandy red clay loam, 17.Apr.2024, *Dar Ben-Natan and Gal Lupovich* (HUJ1005808!).

Ranunculaceae Juss.

Consolida scleroclada (Boiss.) Schroedinger (Fig. 2 e)

Branched, pilose annuals, occurring in arid steppes in high elevations of southern Jordan, Syria and Lebanon, and cited by Zohary (1966, 1976) from the Central Negev Desert as well. The basis for that citation is unclear, as no material from Israel could be located in the HUJI herbarium, as well as any other kind of past records of this species’ presence in the region, and it was not recorded from Israel in any earlier works (Boissier 1867; Post 1896; Eig & al. 1954). The earliest citation of its presence in Israel is in the Flora Palaestina (Zohary 1966). As no other support for this claim was found, Shmida & al. (2007, 2011) considered *Consolida scleroclada*’s occurrence in Israel as doubtful, therefore it was excluded from the Red List of Israel’s vascular plants.

In a field expedition to upper Nahal Arugut (Judean Desert), Ofra Fridman, Ohad Binyamini and Avi Shmida discovered a large population of this rare species in a NW exposure above limestone cliffs, in a *Sarcopoterium spinosum* (L.) Spach batha, together with another locally

extremely rare species, new to the region and reported in our previous paper (Ben-Natan & al. 2024) – *Silene marschalii* C.A.May. The upper Nahal Arugot cliffs area is known locally as an important botanical hotspot for relic populations of locally rare species such as *Achillea falcata*, *Galiun canum* Req., *Bolanthus filicaulis* (Boiss.) Barkoudah, *Ferula orientalis* L. and *Silene grisea* Boiss. These occur mainly on the cliffs below, while Consolida sclerocrada and *Silene marschalii* grow together with *Astragalus cretaceus* Boiss. & Kotschy in the batha developed on the slopes above. Although they are supposedly protected in the Nahal Kanub Nature Reserve, the upper slopes of this area and the several locally extremely rare species that are confined to this local habitat are threatened by constructions of the nearby village, Ibey Hanahal.

Reference material: ISRAEL, Judean Desert, Nahal Canub Reserve, near Ibei Hanahal, coor: 31.6001630 N 35.2152940 E, 31.6002730 N 35.2150880 E, 31.6003021 N 35.2154692 E, Upper part of a northern exposed slope, in a Batha of *Sarcopoterium spinosum* (L.) Spach and *Coridothymus capitatus* (L.) Rchb.f., few individuals (about five), together with *Silene marschallii* subsp. *marschallii* C.A.May and *Astragalus cretaceus* Boiss. & Kotschy, 4.6.2020, *Dar Ben-Natan* (HUJ133349!, HUJ134771!).

Nigella oxypetala Boiss. (Fig. 2 f)

The species was first discovered in the region in 2018 in the southern Golan Heights by Shmuel Mazar, and identified by Miriam Milo (Mazar& al. 2018). Since, this species was further found in four areas: lower Galilee, Jezreel Valley, Shefela and S Hebron Mountains (S Judean Mts) (Shemesh 2021, Shemesh & al. 2020, Shemesh & al. 2024 [in press]). All populations occur in relatively deep clay vertisols in the context of traditional extensive agriculture or small residual patches of natural vegetation in the margins of modern agriculture – both are highly threatened habitats in Israel. Superficially, the species resembles the locally common *N. ciliaris* DC., and it might have been misidentified as it and overlooked over the years. Seeds were collected from the Golan Heights and grown in the Jerusalem Botanical Gardens and also deposited in the Israel Gene Bank.

Reference material: ISRAEL, Golan Heights, between Ramat Magshimim and Elád, 11.6.2018, Shmuel Mazar (HUJ134810!); ISRAEL, Shefela, S of Gal'on, coor: 31°37'00.0"N 34°52'04.0"E. A wash between chickpea fields. 30.Apr.2020, *Mimi Ron* (HUJ1000002!); ISRAEL, S Judean Mts, SE of Beit-Yatir, coor: 31°21'26.8"N 35°06'19.3"E, extensive agriculture in a small valley facing west, on brown clay vertisol. 1.Apr.2024, *Dar Ben-Natan* and *Bar Shemesh* (HUJ1003763!).

Discussion

The renewed interest in the diversity and taxonomy of plants in Israel have led to the discoveries of more than 60 species new to the region, previously unrecorded or mis-identified. 28 of which were reported in our previous paper (Ben-Natan & al. 2024), and 23 more are detailed here. These species were found all across the region, from the Southern Arava Valley in the south to the Upper Galilee, northern Golan Heights and lower Mt Hermon in the north. Interestingly, of these 23 species, nine occur in the Golan Heights – emphasizing the need for more surveys and research in this region.

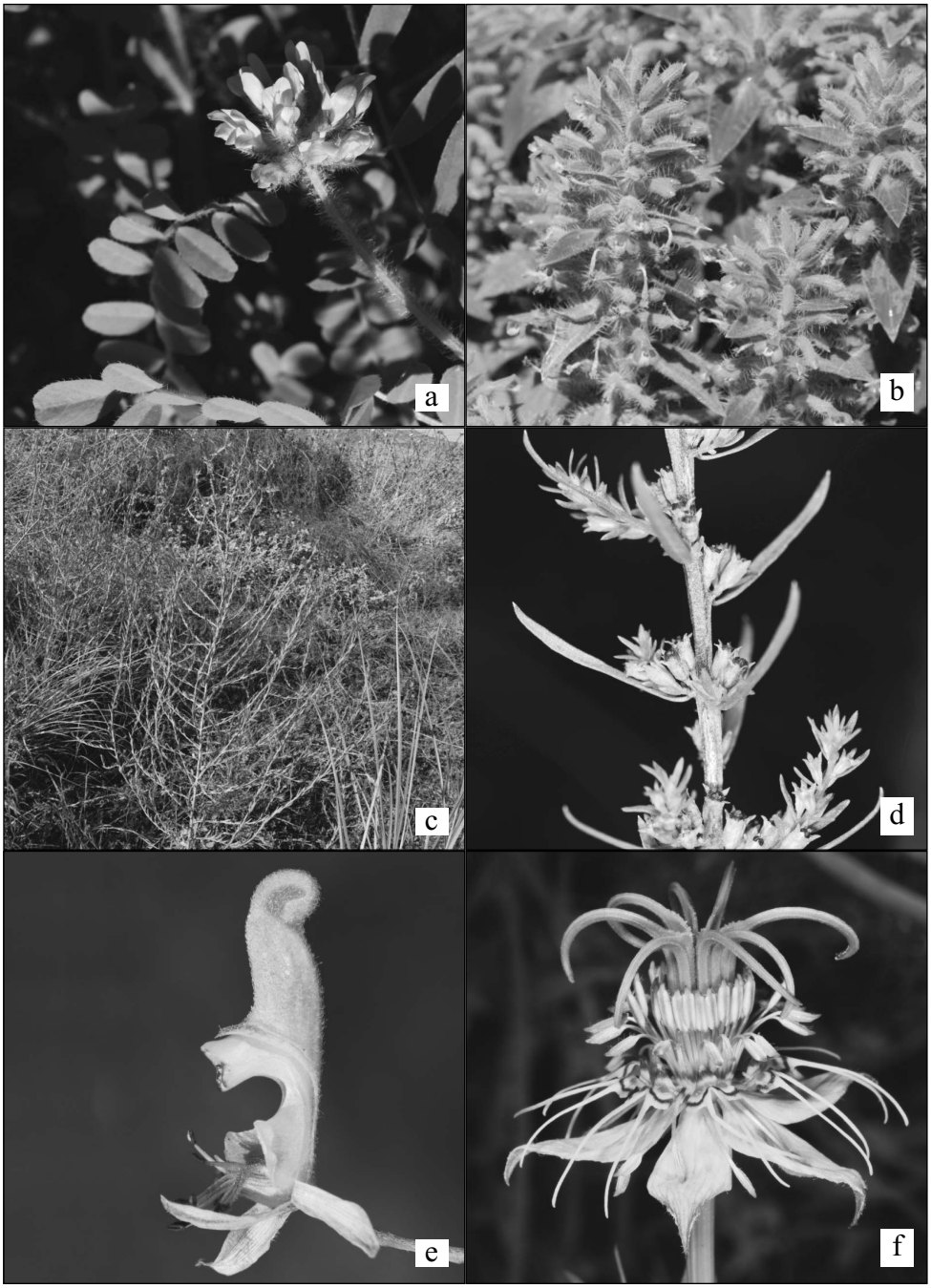


Fig.2. **a.** *Astragalus echinatus,* photo O. Fragman-Sapir; **b.** *Ziziphora persica*, photo O. Fragman-Sapir; **c.** *Lythrum silenoides*, photo O. Fragman-Sapir; **d.** *Lythrum thesioides*, photo O. Fragman-Sapir; **e.** *Consolida scleroclada*, photo O. Fragman-Sapir; **f.** *Nigella oxypetala*, photo O. Fragman-Sapir.

In accordance with the findings presented in the previous paper (Ben-Natan & al. 2024) all of the species recorded here are herbaceous, most of which (18) are annuals – further corresponding with the uniquely rich in herbaceous and particularly annual flora of the region (Fragman & al. 1999; Poppenwimer & al. 2023). The richness of annual species in many of the local microhabitats adds to the complexity and importance of their conservation.

Most of the new discoveries presented here are regarding new floristic records for the Flora Palaestina region, previously not reported from the region and sometimes familiar to local botanists and travelers from visits to bordering countries such as Jordan, Egypt and Syria (e.g., *Atractylis mernephthae*, *Limeum obovatum*, and *Consolida scleroclada*), or from the higher parts of Mt Hermon (*Cephalaria setosa*). Some of the examples presented in this paper are misidentifications of already recorded species (*Daucus involucratus*, *Galium parisiense, Ziziphora persica*). Few of the species recorded here (*Lythrum silenoides*, *L. thesioides* and *Gnaphalium uliginosum*), occurring in wet habitats, are likely to have recently been bird- or wind-dispersed into the region and established new populations. Further monitoring of these populations is needed in order to ascertain whether they are self-sustained. However, most of the species presented here are local species, overlooked until now. At any rate, all of these species occur in the region at the periphery of their global range – hence the need to locally preserve them.

The findings in this paper contribute to the updated detailed checklist of the local flora (in preparation). They showcase the vast diversity that can be found in such small regions of the eastern Mediterranean, and demonstrate the importance of thorough biodiversity surveys. Habitat conservation is of great and major importance for the conservation of this plant diversity, with special emphasis on the conservation and interface of small and vulnerable ecosystems in this densely populated and densely cultivated region.

Most of the new records in this paper, belong to species that are tagged for the first time as locally endangered in Israel. The main reason for that is habitat destruction in this very small and highly populated country, especially in its Mediterranean parts. Similar plant vulnerability occurs in Mediterranean Lebanon (especially along the populated coast plain). Lower plant vulnerability occur as one leaves the Mediterranean region Israel-Lenanon and reaches the steppes and desert in Southern Israel, Syria and Jordan, that are sparsely populated.

Since 1999 (Fragman & al. 1999) no updated checklist of the local vascular plants has been published. The estimated number of species recorded from the Flora Palaestina region, including the new additions from recent years, is approaching 2700 species. Since many of the newly discovered species are extremely rare and occur in few localities, immediate actions to conserve them both in situ and ex situ are required. Many locally rare and endangered species, including many of the species discussed here, are conserved in the Jerusalem Botanical Gardens, as well as in other botanical gardens, sanctuaries and in the Israel Gene Bank.

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Article

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Mediterranean plant germination reports – 7

Abstract

Salmeri, C., Cristaudo, A.E., Di Martino, L., Di Stefano, M., Estrelles-Perpiñá, E., García-Martínez, E., Mazzara Curcurù, G., Pipitone, G., Scafidi, F., Tantalo, F. & Magrini, S.: Mediterranean plant germination reports – 7. — Fl. Medit. 35: 271-291. 2025. — ISSN: 1120-4052 printed, 2240-4538 online.

This seventh issue of the germination report series from Mediterranean areas includes germination protocols for 17 taxa, all conserved within four seed banks belonging to the RIBES and/or GENMEDA networks. Eight of the investigated species are endemic: five restricted to the Iberian Peninsula, and three endemic to Central–Southern Italy and Sicily. Seven of the germination reports focus on Sideritis species from Spain, while four protocols address species typical of the highly specialised habitats of Mediterranean temporary ponds. The taxa and populations investigated in this issue are: *Glacium flavum* Crantz from Alicante (Spain) by García-Martínez (No. 159), *Sideritis chamaedryfolia* Cav., *S. glauca* Cav., *S. hirsuta* L., *S. incana* L., *S. pungens* Benth., *S. spinulosa* Barnadez ex Asso, *S. tragoriganum* Lag. from Valencian Community (Spain) by Estrelles-Perpiñá (Nos. 151-157), *Verbascum niveum* subsp. *garganicum* (Ten.) Murb. from Abruzzo (Italy) by Tantalo & Di Martino (No. 158), *Antinoria insularis* Parl., *Lythrum hyssopifolia* L., *Middendorfia borysthenica* (Schrank) Trautv., *Myosotis sicula* Guss. from Sicily (Italy) by Di Stefano & Cristaudo (Nos. 159-162), *Centaurea virescens* (Guss.) Domina & Raimondo, *Dianthus graminifolius* C. Presl, *Iberis semperflorens* L. and *Rhaponticum coniferum* (L.) Greuter subsp. *coniferum* from Sicily (Italy) by Scafidi, Mazzara Curcurù & Pipitone (Nos. 163-166).

Key words: endemic species, *ex-situ* conservation, protocols, Spain, Italy, Sicily, seeds.

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Introduction

Seed germination is a pivotal phase in the plant life cycle, shaping the long-term survival, recruitment, and population dynamics of most species. Understanding germination behaviour—especially for endemic, rare, or threatened taxa—is essential for both in situ and ex situ conservation strategies, as it provides fundamental insights into the ecological

requirements for seedling establishment under current and future environmental conditions. Germination studies therefore represent a cornerstone in conservation biology, guiding seed banking, habitat restoration, and propagation programmes across biodiversity-rich but vulnerable regions such as the Mediterranean Basin.

Within this framework, the present issue of the germination report series from Mediterranean areas (*sensu* Greuter 2008) offers germination protocols for 17 taxa, all conserved within four seed banks belonging to the RIBES and/or GENMEDA networks. With this contribution, the series now reaches a total of 166 published protocols, further consolidating its role as a reference resource for Mediterranean plant conservation, seed ecology, and ex situ research.

Importantly, the long-term continuity and scientific robustness of this initiative are made possible by the collaborative effort of the RIBES and GENMEDA networks, which coordinate germplasm conservation across multiple institutions, harmonise methodologies, and promote shared standards for data collection, seed handling, and protocol testing. Such networks are essential to address the conservation challenges of the Mediterranean region, enabling comparability of results, enhancing data reliability, and fostering the exchange of expertise and plant material among seed banks.

Eight of the species investigated here are endemic—five restricted to the Iberian Peninsula and three to Central–Southern Italy and Sicily—while the remaining nine taxa exhibit a broader Mediterranean distribution. Seven of the germination reports in this issue focus on Sideritis species from Spain (Nos. 152–157), providing new comparative insights into germination requirements within this taxonomically complex and ecologically diverse genus. Additionally, four protocols examine species characteristic of Mediterranean temporary ponds (Nos. 159–162), a priority habitat under the EU Habitats Directive and one that remains critically underrepresented in germination studies despite its high conservation value.

Overall, these contributions enrich the Mediterranean germination checklist available in the MPGR folder, now expanded to 166 records, and offer researchers and conservation practitioners an increasingly robust and practical tool to support plant conservation, seed banking, ecological restoration, and propagation activities throughout the region. By leveraging the coordinated efforts of the RIBES and GENMEDA networks, this growing dataset not only advances scientific knowledge but also strengthens the collective capacity to safeguard Mediterranean plant diversity.

The taxa and populations investigated in this issue are: *Glacium flavum* Cratz from Alicante (Spain) by García-Martínez (No. 159), *Sideritis chamaedryfolia* Cav., *S. glauca* Cav., *S. hirsuta* L., *S. incana* L., *S. pungens* Benth., *S. spinulosa* Barnadez ex Asso, *S. tragoriganum* Lag. from Valencian Community (Spain) by Estrelles-Perpiñá (Nos. 151-157), *Verbascum niveum* subsp. *garganicum* (Ten.) Murb. from Abruzzo (Italy) by Tantalo & Di Martino (No. 158), *Antinoria insularis* Parl., *Lythrum hyssopifolia* L., *Middendorfia borysthenica* (Schrank) Trautv., *Myosotis sicula* Guss. from Sicily (Italy) by Di Stefano & Cristaudo (Nos. 159-162), *Centaurea virescens* (Guss.) Domina & Raimondo, *Dianthus graminifolius* C. Presl, *Iberis semperflorens* L. and *Rhaponticum coniferum* (L.) Greuter subsp. *coniferum* from Siciy (Italy) by Scafidi, Mazzara Curcurù & Pipitone (Nos. 163-166).

150. *Glaucium flavum* Crantz (*Papaveraceae*)

Accession data:

HS: Valencia, Moncofar, Playa de Moncofar, Torre Caiguda (WGS84: 39.4659ºN, -0.0838ºW), 1.8 m a.s.l., 20 Oct 2023, *E. García-Martínez* (UVEG-JBVAL-BG 91B2023).

Germination data

Pre-treatments: no treatment.
Germination medium: Agar 0.6%
Sample size: 75 seeds (25 × 3 replicates)

Germination	Thermoperiod	Photoperiod [light/dark]	T_1 [d]	T_{50} [d]	T_{max} [d]	MGT [d]
86.2%	alternating 25/10ºC	0/24h	8.0	12.0	24.0	12.7

Observations

Glaucium flavum is an herbaceous species, generally biennial, with a wide distribution, mainly occurring in coastal regions of western and southern Europe, northwestern Africa, and southwestern Asia. It inhabits coastal environments, such as sandy or gravel beaches, where it tolerates adverse conditions, including salinity.

Germination tests were conducted at the Germplasm Bank of the Botanical Garden of the University of Valencia. Seed germination was evaluated under light (12/12 h) and dark (0/24 h) conditions, as well as under both alternating (25/10ºC) and constant (15ºC) temperatures. The highest germination percentage was observed in darkness under alternating temperatures (86.2%), and rather high (77.0%) value was reached at 15ºC. In contrast, germination under light conditions was markedly reduced, reaching only 33% at 25/10 ºC and 9.6% at 15 ºC. This light-induced inhibition is interpreted as a mechanism to prevent seedlings from emerging on the soil surface (Thanos & al. 1989).

E. García-Martínez

151. *Sideritis chamaedryfolia* Cav. (*Lamiaceae*)

Accession data:

Hs: Alicante, Villena, Collado de la Peñarrubia (WGS84: 38.599339ºN, -0.800554ºW), 750 m a.s.l., 25 june 1997, *F Marco, J. Riera* (UVEG-JBVAL-BG 35B1997).

Germination data

Pre-treatments: no treatment.
Germination medium: Agar 0.6%.
Sample size: 100 seeds (25 × 4 replicates).

Germination	Thermoperiod	Photoperiod [light/dark]	T_1 [d]	T_{50} [d]	T_{max} [d]	TMG [d]
94.7%	alternating 20/10 °C	0/24h	3.5	5.6	11.8	6.9

Observations

This perennial herb reaches approximately 25–45 cm in height and is woody at the base. The stems are covered with whitish hairs, and the leaves are elliptic to obovate, with prominent venation, bearing 2–3 teeth per margin, and sparsely distributed short hairs. It produces dense terminal whorls of flowers. It is endemic to southeastern Spain and typically grows on sandy, dry, calcareous soils under a Mediterranean climate. Local botanists regard the populations in this area as belonging to subsp. *chamaedryfolia*, a taxon listed in the Valencian Catalogue of Threatened Flora Species. It is assigned the conservation category "Monitored," which informs regional conservation planning and management actions (Generalitat Valenciana 2022).

Experimental results indicate that *S. chamaedryfolia* exhibits enhanced germination under dark conditions. When exposed to a 12-hour light / 12-hour dark photoperiod, a significantly lower germination rate was recorded, with a maximum value of 62.3%. This germination pattern is consistent with the species' ecological traits, suggesting an adaptation to sandy substrates, which impose greater water stress on the soil surface due to their low water-holding capacity (Thanos & al. 1991).

E. Estrelles-Perpiñá

152. *Sideritis glauca* Cav. (*Lamiaceae*)

Accession data:

Hs: Alicante, Redován, Sierra de Callosa (WGS84: 38.116084ºN, -0.903742ºW), 85 m a.s.l., 07 june 1996, *E. Estrelles, J. Riera, F Marco* (UVEG-JBVAL-BG 98B1996).

Hs: Alicante, Cox, Peñón de la Lobera (WGS84: 38.131849ºN, -0.918632ºW), 165 m a.s.l., 09 june 2016, *E. Estrelles, J. Prieto, C. Valbuena* (UVEG-JBVAL-BG 45B2016).

Hs: Alicante, Cox, Cresta del Palacio (WGS84: 38.134280ºN, -0.885503ºW), 90 m a.s.l., 09 june 2016, *E. Estrelles, J. Prieto, C. Valbuena* (UVEG-JBVAL-BG 57B2016).

Germination data

Pre-treatments: no treatment.
Germination medium: Agar 0.6%.
Sample size: 100 seeds (25 × 4 replicates).

Germination	Thermoperiod	Photoperiod [light/dark]	T_1 [d]	T_{50} [d]	T_{max} [d]	TMG [d]	Accession code
93.3%	constant 15 °C	12/12h	5.3	6.8	13.0	8.0	45B2016
90.8%	alternating 25/15 °C	12/12h	4.0	6.1	13.3	7.5	45B2016

88.8%	alternating 20/10 °C	12/12h	4.0	6.4	11.5	7.4	45B2016
82.5%	constant 20 °C	12/12h	4.0	5.3	11.5	6.1	45B2016
81.7%	constant 25 °C	12/12h	2.5	4.6	12.0	5.5	45B2016
92.9%	alternating 20/10 °C	12/12h	4.8	8.2	20.0	10.0	57B2016
84.1%	alternating 25/15 °C	12/12h	4.0	5.6	16.5	7.2	57B2016
82.6%	constant 20 °C	12/12h	4.0	5.4	12.8	6.5	57B2016
80.1%	constant 15 °C	12/12h	6.3	8.0	14.0	9.1	57B2016
81.8%	alternating 20/10 °C	12/12h	6.5	13.4	23.8	81.8	98B1996



Fig. 1. From left to right: *Sideritis glauca* habit in its natural habitat, the collection of mature seeds, detail of the inflorescence, detail of the seeds, cut test showing a properly developed embryo, and seedlings after seed germination.

Observations

It is a perennial herbaceous plant with woody, glabrous stems and densely hairy, greyish-green leaves. The inflorescences (2–7 cm) consist of clusters of white to cream-colored tubular flowers, occasionally pinkish, arranged in open, spike-like inflorescences with 2–9 whorls.

This species is endemic to the southeastern region of Spain and commonly inhabits fissures in calcareous rocky cliffs. It thrives in sunny, well-drained habitats, usually at low to mid elevations.

This species is included in several plant conservation lists, including the List of Wild Species under Special Protection and the Spanish Catalogue of Threatened Species (LESRPE-CEEA; Royal Decree 139/2011). In the Spanish Red List it was considered within the IUCN category of VU (vulnerable) until 2017, and since then NT (near threatened), according to the criteria B1ab(iv,v)+2ab(iv,v) (SEBiCoP 2025).

Germination percentages were generally high across the temperatures tested, both constant and alternating. An exception was observed in sample 57B2016, which, at 25 °C under a 12-hour light / 12-hour dark photoperiod, exhibited a significantly lower germination percentage, specifically 50.7% (T_1: 3.8; T_{50}: 5.0; T_{max}: 9.5; TMG: 6.0). It should also be noted that, a high proportion of empty seeds—exceeding 30%—was recorded in sam-

ples 98B1996 and 57B2016. Germination percentages were always calculated based on potentially viable seeds, after performing the cut test at the end of the experiment.

E. Estrelles-Perpiñá

153. *Sideritis hirsuta* L. (*Lamiaceae*)

Accession data:

Hs: Castellón, Barracas, prope el Mazorral (WGS84: 40.007882ºN, -0.705113ºW), 1020 m a.s.l., 16 june 1998, *J. Riera, F Marco, E. Estrelles* (UVEG-JBVAL-BG 102B1998).

Germination data

Pre-treatments: no treatment.
Germination medium: Agar 0.6%.
Sample size: 100 seeds (25 × 4 replicates).

Germination	Thermoperiod	Photoperiod [light/dark]	T_1 [d]	T_{50} [d]	T_{max} [d]	TMG [d]
86.2%	alternating 20/10 °C	12/12h	3.3	6.8	17.0	7.6

Observations

Perennial plant with a woody base and variable height (10–69 cm). Stems and leaves are densely pubescent. The inflorescence is elongated, consisting of 3–13 verticillasters, with an average of six flowers each, generally well-spaced.

The species grows on dry, stony, or calcareous soils, in scrublands, grasslands, and clearings of Mediterranean woodlands. It is occasionally ruderal or found in arable areas. Its distribution covers the Iberian Peninsula, southern France, northern Italy, and Morocco, with almost the entire Iberian Peninsula occupied, except for the Cantabrian coast and the western third.

As in the other studied species, no seed dormancy was observed. Germination begins almost immediately after the hydration phase.

E. Estrelles-Perpiñá

154. *Sideritis incana* L. (*Lamiaceae*)

Accession data:

Hs: Valencia, Carcaixent, Barranco de la Falzia (WGS84: 39.094674ºN, -0.374940ºW), 150 m a.s.l., 11 june 1998, *J. Riera, E. Estrelles* (UVEG-JBVAL-BG 41B1998).

Germination data

Pre-treatments: no treatment.
Germination medium: Agar 0.6%.
Sample size: 100 seeds (25 × 4 replicates).

Germination	Thermoperiod	Photoperiod [light/dark]	T_1 [d]	T_{50} [d]	T_{max} [d]	TMG [d]
82.5%	alternating 20/10 °C	12/12h	5.8	7.6	11.3	8.3

Observations

Perennial plant of variable size, ranging from 8 to 72 cm in height, with pubescent stems and linear or lanceolate leaves, usually entire and lanuginous when young. The inflorescence is 3–15 cm long, composed of verticillasters bearing four or more flowers, well-spaced from each other; bracts with distinctly marked and sometimes pungent teeth. This is a highly variable species, particularly with respect to the size and density of the indumentum. The studied population consists of tall plants with large flowers, calyx approximately 7 mm long. Such specimens have been identified by some authors as belonging to *Sideritis incana* subsp. *edetana* (Pau ex Font Quer) Mateo & M.B. Crespo.

Natural habitats include shrublands, esparto grasslands, clearings of Mediterranean forests, and cultivated fields, typically on basic, marly, or dolomitic substrates of stony or sandy nature. The species is distributed mainly in the western Mediterranean, including central, eastern, and southern Spain, as well as northern Africa.

The germination response observed is consistent with that reported for the studied *Sideritis* group.

E. Estrelles-Perpiñá

155. *Sideritis pungens* Benth. (*Lamiaceae*)

Accession data:

Hs: Castellón, Vistabella del Maestrat, cim del Penyagolosa (WGS84: 40.222809ºN, -0.349791ºW), 1810 m a.s.l., 10 september 1997, *J. Riera* (UVEG-JBVAL-BG 76B1997).

Germination data

Pre-treatments: no treatment.
Germination medium: Agar 0.6%.
Sample size: 100 seeds (25 × 4 replicates).

Germination	Thermoperiod	Photoperiod [light/dark]	T_1 [d]	T_{50} [d]	T_{max} [d]	TMG [d]
82.8%	alternating 20/10 °C	12/12h	3.8	5.3	12.5	7.8

Observations

Perennial, erect herb with stems usually 15–53 cm tall, sparsely covered with rigid hairs, and narrow, elongated leaves, some mucronate and spiny. The inflorescence is spike-like,

up to 7 cm long, composed of 3–12 verticillasters with six flowers each, densely arranged and exhibiting a prickly aspect.

This species is endemic to the northern and eastern regions of the Iberian Peninsula, occurring in shrublands on calcareous, marly, clayey, gypsiferous, or conglomerate substrates, and occasionally on fluvial gravels, sometimes along roadsides and in cultivated fields.

The germination pattern observed in this species aligns with that reported for the studied taxa of the same genus.

E. Estrelles-Perpiñá

156. *Sideritis spinulosa* Barnadez ex Asso (*Lamiaceae*)

Accession data:

Hs: Castellón, Vilafranca, La Palomita (WGS84: 40.435624ºN, -0.311291ºW), 1320 m a.s.l., 21 august 2006, *E. Estrelles* (UVEG-JBVAL-BG 86B2006).

Germination data

Pre-treatments: no treatment.
Germination medium: Agar 0.6%.
Sample size: 100 seeds (10 × 4 replicates).

Germination	Thermoperiod	Photoperiod [light/dark]	T1 [d]	T50 [d]	Tmax [d]	TMG [d]
81.2%	constant 20 °C	12/12h	4.8	6.2	11.3	7.1

Observations

Perennial plant, woody at the base and very leafy, with internodes largely covered by the leaves; stems lanate leaves 9–25 mm long, lanceolate, dentate, and more or less spiny, exhibiting variable indumentum. The inflorescence is compact, usually composed of 2–6 verticillasters, each bearing 6–10 flowers, with glabrous bracts.

The species grows in scrublands, thyme-dominated communities, and sage-dominated habitats on limestone, clay, marl, or gypsiferous marl, occasionally on skeletal soils or rocky outcrops. It is endemic to central and eastern Spain.

The germination behaviour observed in this species is comparable to that reported for the studied *Sideritis* group.

E. Estrelles-Perpiñá

157. *Sideritis tragoriganum* Lag. (*Lamiaceae*)

Accession data:

Hs: Valencia, Ayora, Casas de Madrona (WGS84: 38.978692ºN, -1.081764ºW), 690 m a.s.l., 19 june 1993, *J. Güemes, J. Riera* (UVEG-JBVAL-BG 74B1995).

Hs: Castellón, Ares del Maestrat, carretera a Catí Km. 1 (WGS84: 40.380284ºN, -0.062425ºW), 630 m a.s.l., 19 july 2006, *E. Estrelles* (UVEG-JBVAL-BG 35B2006).

Germination data

Pre-treatments: no treatment.
Germination medium: Agar 0.6%.
Sample size: 100 seeds (25 × 4 replicates).

Germination	Thermoperiod	Photoperiod [light/dark]	T_1 [d]	T_{50} [d]	T_{max} [d]	TMG [d]	Accession code
83.1%	alternating 20/10 °C	12/12h	5.8	10.1	20.0	10.8	74B1995
91.0%	constant 20 °C	12/12h	4.3	5.5	12.5	6.5	35B2006

Observations

This taxon is a small perennial subshrub, reaching up to 48 cm in height, woody at the base and covered with whitish hairs. Its leaves are entire, narrow, mucronate to spiny, and tomentose. The inflorescence is clearly whorled, with 5–17 whorls of six flowers each, variably spaced.

It is endemic to the southern and eastern Iberian Peninsula, inhabiting sunny clearings in dry, calcareous scrublands.

The two populations studied, one from the northern part of Castellón Province and the other further south in Valencia Province, are locally assigned to different subspecies. The first population (74B1995), characterized by its smaller corolla (up to 8 mm in length) and a corolla tube exceeding the calyx in length, is identified as *S. tragoriganum* subsp. *mugronensis* (Borja) Obón & D. Rivera. In contrast, the second population (35B2006) exhibits larger flowers (up to 10 mm in length) and a corolla with a shorter tube, not visible between the calyx teeth, corresponding to *S. tragoriganum* subsp. *juryi* (Peris, Stübing & Figuerola) M.B.Crespo & Mateo. These differing taxonomic assignments, however, remain doubtful and under discussion among various authors.

This species exhibits a germination response similar to that observed in the studied *Sideritis* taxa.

E. Estrelles-Perpiñá

158. *Verbascum niveum* subsp. ***garganicum*** (Ten.) Murb. (*Scrophulariaceae*)

Accession data

It: Abruzzo, Pineto (Teramo), Torre del Cerrano Marine Protected Area (WGS84: 42.587186° N, 14.087285° E); sandy dune, 0 m a.s.l.; 22 July 2024; F. Tantalo (MSB_N_20240722_286_FT).

Germination data

Pre-treatments: soaked in water for 2 h, sterilization with a solution of 3% sodium hypochlorite plus Tween 20 for 4 min, followed by 3 rinses in sterile distilled water. Before performing germination test [(1)], 80 seeds were incubated at 5 °C for 3 months (vernalization) under dark condition.

Germination medium: 1% agar, pH 5.75.

Sample size: 80 seeds (20 × 4 replicates).

Germination	Thermoperiod	Photoperiod [light/dark]	T_1 [d]	T_{50} [d]	T_{max} [d]	MTG [d]
100%	alternating 25/15°C	16/8h	2.0	2.4	11.0	6.9
91.7%	constant 20°C	12/12h	2.0	2.7	14.0	5.0
[(1)] **82.3%**	constant 20°C	12/12h	1.0	2.5	10.0	6.5

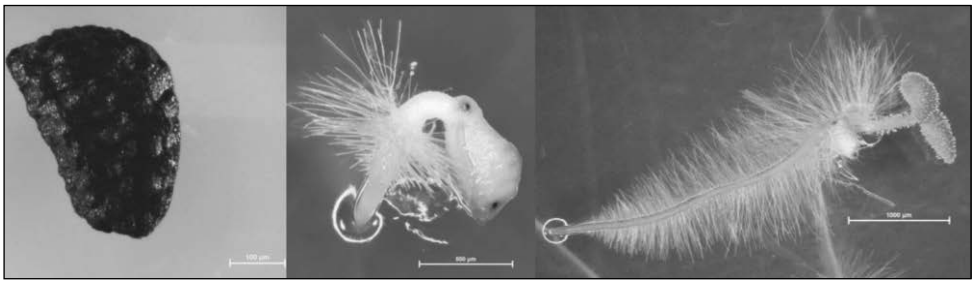


Fig. 2. Germinated seeds of *Verbascum niveum* subsp. *garganicum.*

Observations

Verbascum niveum subsp. *garganicum* is endemic to Italy and occurs only in Abruzzo, Marche, Molise, Lazio and Puglia. It is a biennial hemicryptophyte growing in dry grasslands at an elevation raging between 0 and 1000 m a.s.l. Plants flower from June to August.

It is a species included in the Italian Red List of Threatened Plants under the IUCN "Data Deficient" (DD) category (Orsenigo & al. 2018; Rossi & al. 2021).

Germination tests were performed 12 months after seed collection, using constant temperatures of 15 °C and 20 °C with a 12/12 h light-dark photoperiod, alternating temperatures of 25 °C/15 °C with a 16/8 hours light-dark photoperiod and at 5 °C in continuous darkness.

The seeds of *V. niveum* subsp. *garganicum* showed no dormancy and achieved the highest germination rate (100%) under alternating temperatures of 25 °C/15 °C with a 16/8 h light-dark photoperiod. Germination percentage was just 50% under a constant temperature of 15 °C with a 12/12h light-dark photoperiod. Seeds subjected to vernalization (5 °C for

3 months in the dark) reached 82.3% of germination at constant temperature of 20 °C with a 12/12h light-dark photoperiod. The viability of ungerminated seeds at the end of the tests was estimated through the cutting test.

These results suggest that seeds of *V. niveum* subsp. *garganicum* germinate preferentially under non-constant but relatively high temperatures sustained for several hours per day. Cold stratification does not enhance seed germination in this species.

F. Tantalo & L. Di Martino

159. *Antinoria insularis* Parl. (*Poaceae*)

Accession data:

Si: Buccheri (Siracusa), Contessa di Sopra (WGS84: 37.106078° N, 14.856931° E), Mediterranean temporary ponds on volcanic soils, 905 m a.s.l., 15 July 2023, *M. Di Stefano, A. Alecci, P. Frazzetto & D. Vitale* (BGS-CT/CT/23/02).

Germination data

Pre-treatments: four months of dry after-ripening at 20 °C and 40% RH.
Germination medium: 1% agar in 6 cm Petri dishes.
Sample size: 100 seeds (25 × 4 replicates)

Germination	Thermoperiod	Photoperiod [light/dark]	T_1 [d]	T_{50} [d]	T_{max} [d]	MTG [d]
81.8%	alternating 20/10 °C	12/12h	3	5.63	27	6.65
81.8%	alternating 25/15 °C	12/12h	2	6.57	27	8.72

Observations

Antinoria insularis is a steno-mediterranean species that in Italy is reported only for Apulia, Latium, Molise, Sardinia, and Sicily (Bartolucci & al. 2018). In Sicily, this species characterizes several communities of the small-sized ephemeral vegetation typical of Mediterranean temporary ponds (Brullo & al. 2022). In particular, it is a therophyte that colonises the intermediate belt of the ponds, where flooding can last but water depth is not excessive (Nimis & al. 2014). It is included in the Italian Red List of Threatened Plants under the IUCN "Near Threatened" (NT) category (Orsenigo & al. 2021).

Germination tests were carried out four months after seed harvesting. The seeds were incubated under 12/12 h photoperiod (with the warmer temperature provided simultaneously with the light phase) and in complete darkness, using constant temperatures of 15°C and 20°C, and alternating temperatures of 20/10 °C and 25/15°C (thermoperiod 12/12 hours).

Germination percentages of A. insularis were low at both 15 °C (56%) and 20 °C (25%) under light-dark conditions. The highest Final Germination Percentage (FGP) was

achieved at the alternating temperatures of both 20/10 °C and 25/15 °C (82%). Seeds incubated in complete darkness achieved 64% of final germination at 20/10 °C. The viability of the non-germinated seeds at the end of the tests was estimated through the cutting test.

These results suggest that A. insularis after-ripened seeds prefer alternating temperatures and light for germination, but they can also germinate, with lower rates, in darkness under alternating temperature regimes. We report the first germination data for this taxon here.

M. Di Stefano & A. Cristaudo

160. *Lythrum hyssopifolia* L. (*Lythraceae*)

Accession data:

Si: Buccheri (Siracusa), Contessa di Sopra (WGS84: 37.106078° N, 14.856931° E), Mediterranean temporary ponds on volcanic soils, 905 m a.s.l., 15 July 2023, *M. Di Stefano, A. Alecci, P. Frazzetto & D. Vitale* (BGS-CT/CT/23/03).

Germination data

Pre-treatments: four months of dry after-ripening at 20 °C and 40% RH.
Germination medium: 1% agar in 6 cm Petri dishes.
Sample size: 100 seeds (25 × 4 replicates)

Germination	Thermoperiod	Photoperiod [light/dark]	T_1 [d]	T_{50} [d]	T_{max} [d]	MTG [d]
100.0%	constant 15 °C	12/12h	4	5.53	18	6.27
98.0%	alternating 20/10 °C	12/12h	3	6.06	25	8.00
90.8%	constant 20 °C	12/12h	2	4.02	23	5.97
87.6%	alternating 25/15 °C	12/12h	2	5.90	23	7.40

Observations

Lythrum hyssopifolia is a small therophyte with a wide ecological and biogeographic range that colonizes waterlogged or briefly inundated soils (Gazaix & al. 2021). It is typically found in the intermediate and outer belt of Mediterranean temporary ponds (Nimis & al. 2014).

Germination tests were carried out four months after seed harvesting. The seeds were incubated using constant temperatures of 15 °C and 20° C, and alternating temperatures of 20/10 °C and 25/15 °C (thermoperiod 12/12 hours), under both a light-dark photoperiod of 12/12 h (with warmer temperature provided simultaneously with light) and in complete darkness.

In light/dark conditions, germination was high (>87%) at every temperature tested. However, darkness completely inhibited germination under any temperature regime.

The viability of the non-germinated seeds at the end of the tests was estimated through the cutting test.

These results suggest that a strict light requirement, but not a preference for constant or alternating temperature, regulates the germination of *L. hyssopifolia*. We report the first germination data for this taxon here.

M. Di Stefano & A. Cristaudo

161. *Middendorfia borysthenica* (Schrank) Trautv. (*Lythraceae*)

Accession data:

Si: Buccheri (Siracusa), Contessa di Sopra (WGS84: 37.106078° N, 14.856931° E), Mediterranean temporary ponds on volcanic soils, 905 m a.s.l., 06 Jun 2022, *M. Di Stefano, D. Vitale & A. Cristaudo* (BGS-CT/CT/22/01).

Germination data

Pre-treatments: five months of dry after-ripening at 20 °C and 40% RH.
Germination medium: 1% agar in 6 cm Petri dishes.
Sample size: 100 seeds (25 × 4 replicates)

Germination	Thermoperiod	Photoperiod [light/dark]	T_1 [d]	T_{50} [d]	T_{max} [d]	MTG [d]
100%	constant 15 °C	12/12h	4	5.97	9	6.48
99.8%	alternating 20/10 °C	12/12h	5	7.79	30	9.37
99.7%	alternating 25/15 °C	12/12h	3	7.38	30	9.56
99.5%	constant 20 °C	12/12h	3	4.32	19	5.44

Observations

Middendorfia borysthenica is an ephemeral Pontic-Mediterranean species that in Italy is reported only for Apulia, Latium, Piedmont, Sardinia, and Sicily (Bartolucci & al. 2018). It is typical of the areas of Mediterranean temporary ponds with shallow waters, where it usually develops dense and monospecific patches (Nimis & al. 2014; Brullo & al. 2022). In Sicily, the species is reported as rare (Giardina & al. 2007).

Germination tests were carried out five months after seed harvesting. The seeds were incubated at constant temperatures of 15 °C and 20 °C, and alternating temperatures of 20/10 °C and 25/15 °C (thermoperiod 12/12 hours), under both a light-dark photoperiod of 12/12 h (with warmer temperature provided simultaneously with light) and in complete darkness.

Under a 12/12 h photoperiod, seeds fully germinated at every tested temperature regime. Darkness completely inhibited germination under any temperature condition. The viability

of the non-germinated seeds at the end of the tests was estimated through the cutting test.

M. borysthenica showed a germination behaviour similar to the phylogenetically close *L. hyssopifolia* (Gazaix & al. 2021). In particular, the germination of the species is characterized by a strict light requirement and by the absence of a thermoperiod preference (constant or alternating). We report the first germination data for this taxon here.

M. Di Stefano & A. Cristaudo

162. *Myosotis sicula* Guss. (*Boraginaceae*)

Accession data:

Si: Buccheri (Siracusa), Contessa di Sopra (WGS84: 37.106078° N, 14.856931° E), Mediterranean temporary ponds on volcanic soils, 905 m a.s.l., 06 Jun 2022, *M. Di Stefano, D. Vitale & A. Cristaudo* (BGS-CT/CT/22/02).

Germination data

Pre-treatments: five months of dry after-ripening at 20°C and 40% RH.
Germination medium: 1% agar on 6 cm Petri dishes.
Sample size: 100 seeds (25 × 4 replicates)

Germination	Thermoperiod	Photoperiod [light/dark]	T_1 [d]	T_{50} [d]	T_{max} [d]	MTG [d]
99.8%	constant 15°C	12/12h	4	4.71	8	5.27
98.8%	alternating 20/10°C	12/12h	4	4.63	8	5.21
98.1%	alternating 25/15°C	12/12h	4	6.32	18	7.12
96.3%	constant 20°C	12/12h	2	3.89	8	4.38

Observations

Myosotis sicula is a small Mediterranean therophyte reported in Italy only for Latium, Tuscany, Sardinia, and Sicily (Bartolucci & al. 2018). It grows in the intermediate belt of Mediterranean temporary ponds, but it can also colonize wet meadows (Nimis & al. 2014; Brullo & al. 2022).

In Sicily, the species is reported as very rare, being found only in a few wetlands of western Sicily and in the Nebrodi and Hyblean mountains (Giardina & al. 2007; Brullo & al. 2022).

Germination tests were carried out five months after seed harvesting. The seeds were incubated using constant temperatures of 15°C and 20°C, and alternating temperatures of 20/10°C and 25/15°C (thermoperiod 12/12 hours) under both a light-dark photoperiod of 12/12 hours (with warmer temperature provided simultaneously with light) and in complete darkness.

Under light-dark conditions, seeds fully germinated at every tested temperature regime. Seeds also germinated in darkness under alternating temperatures, with a peak of 73.7% at 20/10°C in darkness. The viability of the non-germinated seeds at the end of the tests was estimated through the cutting test.

Seeds of *M. sicula* showed no thermoperiod preference to germinate. Full germinability can be achieved at medium temperatures after five months of after-ripening. We report the first germination data for this taxon here.

M. Di Stefano & A. Cristaudo

163. *Centaurea virescens* (Guss.) Domina & Raimondo (*Asteraceae*)

Accession data

Si: Palermo, Torretta, Piano dell'Occhio, (WGS84: 38. 38.096666°N, 13.225833°E), rocky pastures, ca. 640 m a.s.l., 09 Jul 2024, *F. Scafidi* (233_SF/24; SPGR/PA Sicilian Plant Germplasm Repository, University of Palermo, Italy)

Germination data

Pre-treatments: sterilization with commercial bleach (4% NaOCl) for 3 min, followed by 2 rinses in sterile distilled water, and imbibition in sterile distilled water for 12 h.
Germination medium: 2 sheets of sterilized filter paper (Whatmann No. 1), imbibed with 6 ml of sterilized distilled water in 9 cm Petri dishes.
Sample size: 75 seeds (25 × 3 replicates).

Germination	Thermoperiod	Photoperiod [light/dark]	T_1 [d]	T_{50} [d]	T_{max} [d]	MTG [d]
82.7%	alternating 20/15 °C	0/12h	3	7.50	30	10.29

Observations

Centaurea virescens is an heliophilous calcicolous species endemic to Palermo Mounts belonging to the *C. parlatoris* complex (Domina & al. 2021). The species is reported as Near Threatened (NT) in the in the Red List of the Italian flora sub. *C. parlatoris* Heldr. subsp. *virescens* (Guss.) Raimondo & Bancheva (Rossi & al. 2020). This is the first germination report for this taxon. The best germination percentage (82.7%) was achieved at alternating temperature regime 20/15 °C in full darkness condition, while under 12/12 h photoperiod germination dropped to a mean value of 68% ± 13.66. At the constant temperature of 15° C germination reached 73.3% in the dark and just 62.7% applying 12 hours of light exposure. Based on these results seeds of this species show a somewhat negative photoblastic behaviour and require high temperature to germinate.

F. Scafidi, G. Mazzara Curcurù & G. Pipitone

164. *Dianthus graminifolius* C. Presl (*Caryophyllaceae*)

Accession data

Si: Palermo, Torretta, Portella Torretta, (WGS84: 38.1358333°N, 13.245277°E), carbonate lithosol, ca. 561 m a.s.l., 17 Jul 2024, *F. Scafidi* (245_SF/24; SPGR/PA Sicilian Plant Germplasm Repository, University of Palermo, Italy)

Germination data

Pre-treatments: sterilization with commercial bleach (4% NaOCl) for 3 min, followed by 2 rinses in sterile distilled water, and imbibition in sterile distilled water for 12 h.
Germination medium: 2 sheets of sterilized filter paper (Whatmann No. 1), imbibed with 6 ml of sterilized distilled water in 9 cm Petri dishes.
Sample size: 75 seeds (25 × 3 replicates).

Germination	Thermoperiod	Photoperiod [light/dark]	T_1 [d]	T_{50} [d]	T_{max} [d]	MTG [d]
98.7%	constant 15 °C	12/12h	2	3.44	13	4.59
97.3%	constant 15 °C	0/24h	3	3.13	13	4.30
97.3%	alternating 20/15 °C	12/12h	3	2.92	16	4.45
88.0%	alternating 20/15 °C	0/12h	2	2.76	15	3.82

Observations

Dianthus graminifolius, which belongs to the *D. virgineus complex,* is native to Sicily and Tunisia (Domina & al. 2025). The species is classified as Least Concern (LC) in the Red List of the Italian flora (Rossi & al. 2020). It is rather common in Sicily, especially in the north-western part, growing from the sea level up to 1000 m a.s.l. The species appears adapted to different soil types and is usually found in dry grasslands dominated by *Ampelodesmos mauritanicus* (Bacchetta & al. 2010). The chromosome number of this species (2*n*=2x=30) was recently reported for the first time by (Franzoni & al. 2024). This is the first germination report for this species. Likewise other Sicilian populations of *Dianthus* species (Lantieri & al. 2012; Salmeri & al. 2023), seed are non-dormant and the highest and faster germination rate occurred at the constant temperature of 15°C. High values were also observed under the alternating regime of 20/15 °C. Seeds are not photosensitive, though germination resulted slightly improved under 12/12h photoperiod.

F. Scafidi, G. Mazzara Curcurù & G. Pipitone

165. *Iberis semperflorens* L. (*Brassicaceae*)

Accession data

Si: Palermo, Santa Flavia, Capo Zafferano, (WGS84: 38.110555°N, 13.538611°E), sea cliffs, ca. 34 m a.s.l., 29 May 2024, *F. Scafidi* (348_SF/24; SPGR/PA Sicilian Plant Germplasm Repository, University of Palermo, Italy)

Germination data

Pre-treatments: sterilization with commercial bleach (4% NaOCl) for 3 min, followed by 2 rinses in sterile distilled water, and imbibition in sterile distilled water for 12 h.
Germination medium: 2 sheets of sterilized filter paper (Whatmann No. 1), imbibed with 6 ml of sterilized distilled water in 9 cm Petri dishes.
Sample size: 50 seeds (25 × 2 replicates).

Germination	Thermoperiod	Photoperiod [light/dark]	T_1 [d]	T_{50} [d]	T_{max} [d]	MTG [d]
84.0%	constant 20 °C	12/12h	1	1.92	10	3.12
82.0%	constant 20 °C	0/24h	1	3.25	15	5.07
82.0%	constant 15 °C	12/12h	2	2.96	11	4.20
82.0%	constant 15 °C	0/24h	2	2.94	6	3.63

Observations

Iberis semperflorens L. is a subendemic perennial shrub to southern Italy, Sicily and Zembra (Tunisia) (Pignatti & al. 2017-2019). In Sicily, the species grows along the coastal areas of Sicily in dry calcareous soils and in partially shaded calcareous rock crevices (Iapichino & Bertolino 2009a). Germination tests on this taxon were previously carried out by Iapichino & Bertolino (2009b) on a selected cultivated clone, providing optimal germination (91%) at 20°C under 12/12h photoperiod, while germination decreased under full dark conditions and at both lower and higher temperatures, with 38% and 27% at 14°C with light and total darkness conditions respectively. We carried out our germination experiments on seeds collected from a wild population close to the locus classicus, near Palermo. Differently form literature data, tests at constant temperature of 20 °C and 15 °C provided a final mean germination of 84 and 82% respectively, without any substantial difference between 12/12h and 0/24 h photoperiod, except for higher speed rates under light conditions at 20°C, while on the contrary at 15°C.

F. Scafidi, G. Mazzara Curcurù & G. Pipitone

166. *Rhaponticum coniferum* (L.) Greuter subsp. ***coniferum*** (*Asteraceae*)

Accession data

Si: Palermo, Monreale, Cozzo di Fratantoni, (WGS84: 38.001388°N, 13.25166°E), garrigue, ca. 970 m a.s.l., 21 Jul 2023, *F. Scafidi* (104_SF/23; SPGR/PA Sicilian Plant Germplasm Repository, University of Palermo, Italy)

Germination data

Pre-treatments: sterilization with commercial bleach (4% NaOCl) for 3 min, followed by 2 rinses in sterile distilled water, and imbibition in sterile distilled water for 12 h.
Germination medium: 2 sheets of sterilized filter paper (Whatmann No. 1), imbibed with 6 ml of sterilized distilled water in 9 cm Petri dishes.
Sample size: 75 seeds (25 × 3 replicates).

Germination	Thermoperiod	Photoperiod [light/dark]	T_1 [d]	T_{50} [d]	T_{max} [d]	MTG [d]
97.3%	constant 15 °C	0/24h	9	12.63	26	13.73
96.0%	constant 15 °C	12/12h	7	12.96	23	13.18
93.3%	alternating 20/15 °C	0/12h	8	14.60	32	16.04
82.7%	alternating 20/15 °C	12/12h	8	15.50	33	18.68

Observations

Rhaponticum coniferum subsp. *coniferum* is a perennial herbaceous species growing in the W Mediterranean area (Lekouaghet & al. 2020). In Italy, its presence was reported in Piedmont, Liguria, Tuscany, Sardinia and Sicily, but as uncertain in Apulia (Bartolucci & al. 2024). In Sicily, *R. coniferum* subsp. *coniferum* is a very rare taxon, only occurring in the Mounts of Palermo and Madonie Mountains (Cambria & Di Gregorio 2024). No germination data from Italian populations of this taxon were previously available. Seeds from Spain provided 95% of germination at constant temperature of 21 °C at 12/12 h photoperiod (Society for Ecological Restoration 2025). Our experiments showed best germination results at the constant temperature of 15°C, both under light and full darkness conditions. Application of alternating thermoperiod (20/15 °C) lowered the germination rate to 93.3% under complete darkness, dropping to 82.7% with the presence of light. In general, seed germination was rather slow, with the radicles emerging after 7-9 days light seems understimulate seed germination

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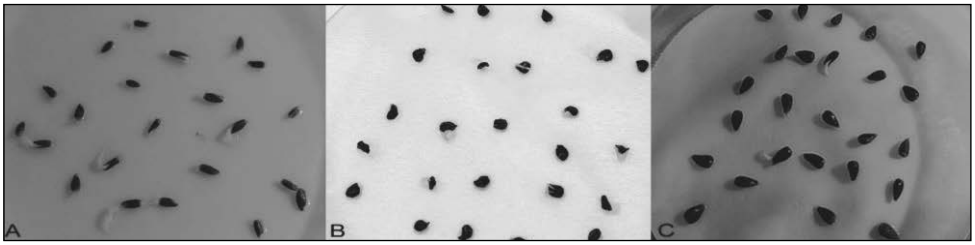


Fig. 3 Germinated seeds of *Centaurea virescens* (A), *Dianthus graminifolius* (B) and *Rhaponticum coniferum* subsp. *coniferum* (C) from Sicily. Green background is due to inactinic light (510 nm) for checking germination tests under full dark conditions.

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Mediterranean plant karyological data – 35

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Mediterranean plant karyological data – 35/1

Contribution to the karyological knowledge of some representatives of the family *Asteraceae* in the Pyrenean flora, III

T. Garnatje, I. Pérez-Lorenzo, J. Vallès, S. Siljak-Yakovlev

Abstract

General distribution, localities, chromosome numbers, ploidy levels, and selected previous chromosome counts are provided for eight taxa belonging to the *Asteraceae* family growing in the Pyrenees.

Keywords: *Anacyclus*, *Chondrilla*, *Cota*, chromosome number, distribution, *Crepis*, *Erigeron*, ploidy level, *Scorzoneroides*, *Sonchus*, *Urospermum*.

Introduction

Asteraceae or *Compositae* are one of the biggest plant families in the World and, consequently, are among those more studied from many different points of view. It is also highly species rich the Pyrenees, and various ongoing projects focus on them in this area. Chromosome numbers and ploidy levels are two basic karyological and cytogenetic characters, which are crucial for understanding the processes undergone by the species constituting the flora in any area.

This is the third paper published in this section, following Garnatje & al. (2023, 2024), aiming at increasing the current karyological datasets by providing additional information about chromosome numbers and ploidy levels of some taxa, some of them reported for the first time in populations of the Pyrenean area. To verify previous or complementary counts, we have consulted the Index to chromosome numbers in *Asteraceae* database (https://togodb.biosciencedbc.jp/db/index_chr_num_asteraceae#en, Semple & Watanabe 2023), and the Chromosome database of the flora of the Catalan Countries (https://sites.google.com/view/cromocat/home?authuser=0, Simon & al. 2023).

All plants studied have been collected in the Catalan Pyrenees (Iberian Peninsula), including their low-altitude foothills. Vouchers have been deposited in the herbarium BC, of the Botanical Institute of Barcelona. The information provided about their taxonomic status, general distribution area and ecology has been obtained in all cases from Plants of the World Online (POWO, https://powo.science.kew.org, accessed November 22, 20245) and Flora iberica (Devesa & al. 2014; Talavera & al. 2016; Benedí & al. 2019), and the Flora manual dels Països Catalans (Bolòs & al. 2005) has also been consulted.

2051. ***Anacyclus clavatus*** (Desf.) Pers. **—** 2*n* = 2x = 18 (Fig. 1A).

Hs: Catalonia, Alt Empordà, Avinyonet de Puigventós, surroundings of la Torre farmhouse, alt. 70 m, 42° 14' 37" N, 2° 54' 29" E, 8 Aug 2024, leg. *J. Vallès* (BC).

The native range of this annual species, growing primarily in the subtropical biome, is the Canary Islands (Lanzarote) and the Mediterranean region. It grows along roadsides between 0 and 1100 m a.s.l.

Although all studies on *A. clavatus* report a constant *n* = 9 or 2*n* = 18 chromosome number, two genetically distinct groups appear to exist, differing significantly in genome size. Based on the species' distribution, the current population falls within the so-called "GC1" group (Agudo & al. 2023), which is distributed across the central-northern Iberian Peninsula and is characterized by a genome size exceeding 2C = 10 pg DNA (Agudo & al. 2019; Pérez-Lorenzo in prep.). This count, agreeing with the previous ones, is the first one in the Pyrenean area (https://sites.google.com/view/cromocat/home?authuser=0), accessed November 15, 2025).

2052. ***Chondrilla juncea*** L. **—** 2*n* = 2x = 15 (Fig. 1B).

Hs: Catalonia, Alt Empordà, Avinyonet de Puigventós, roadside close to a field, near Mas Pau farmhouse, alt. 90 m, 42° 14' 14" N, 2° 54' 17" E, 16 Aug 2024, leg. *J. Vallès* (BC).

The native range of this species is Canary Islands, Europe to central Asia and Arabian Peninsula. It is a perennial and grows primarily in the temperate biome, along roadsides between 0 and 1250 m a.s.l.

Several chromosome numbers have been reported for this species, among which the current one (2*n* = 15), in some cases presented as 2*n* = 14 + 1B. Counts suggesting polyploidy (*n* = 15) have also been published, as well as diploid 2*n* = 14 (https://togodb.biosciencedbc.jp/db/index_chr_num_asteraceae#en, accessed November 18, 2025). Battaglia (1949) reports 2*n* = 15, indicating alterations in meiosis, with only univalents in diakinesis. The present count is the first one in the Pyrenean area (https://sites.google.com/view/cromocat/home?authuser=0), accessed November 15, 2025).

2053. ***Cota triumfetti*** (L.) J.Gay **—** 2*n* = 2x = 18 (Fig. 1D).

Hs: Catalonia, Ripollès, Feitús, alt. 1268 m, 42°21'05"N, 2°21'09"E, 7 Aug 2021, leg. *T. Garnatje (GR 746)* (BC).

The native range of this biennial or perennial species, growing primarily in the temperate biome, encompasses from Europe to Iran. In the Pyrenees, this species grows between 50 and 1800 m a.s.l.

The present chromosome number agrees with those previously published for this taxon, including one from the Iberian area (González & Elena-Rosselló 1986 and references therein, as *Anthemis triumfetti* DC.), but no counts were known to date from the Pyrenees (https://sites.google.com/view/cromocat/home, accessed November 18, 2025). The same authors also reported 2*n* = 18 for a variety (*A. triumfetti* var. *aligulata* (Losa) J.Sánchez), for which they also found 2*n* = 26 (27), suggesting a triploid level.

2054. *Crepis bursifolia* L. — 2*n* = 2x = 8 (Fig. 1C).

Hs: Catalonia, Alt Empordà, Avinyonet de Puigventós, surroundings of la Torre farmhouse, alt. 70 m, 42° 14' 37" N, 2° 54' 29" E, 8 Aug 2024, leg. *J. Vallès* (BC).

This taxon is distributed all along western Mediterranean including the Iberian Peninsula (https://powo.science.kew.org/taxon/urn:lsid:ipni.org:names:199744-1, accessed November 13, 2025), and North Africa, where its populations represent natural occurrences (López & al. 2013). In Catalonia, the species was collected for the first time by Sennen in 1917 (BC-Sennen 878361).

This chromosome number agrees with numerous previous counts from different areas (https://togodb.biosciencedbc.jp/db/index_chr_num_asteraceae#ja, accessed November 12, 2025), including the classical monograph of the genus *Crepis* by Babcock (1947). However, Berjano & al. (2014) reported two ploidy levels (2*n* = 2x = 8 and 2*n* = 4x = 16) in Moroccan populations. This is the first report of the chromosome number of this taxon in a Pyrenean area population (https://sites.google.com/view/cromocat/home, accessed November 12, 2025).

2055. *Erigeron acris* L. — 2*n* = 2x = 18 (Fig. 2A).

Hs: Catalonia, Ripollès, La Farga, Queralbs, alt. 1332 m, 42° 21' 06.3" N, 2° 10' 25.9" E, 15 Aug 2021, leg. *Iván Pérez-Lorenzo (IPL 408)* (BC).

The native range of this biennial or perennial species, which grows primarily in the temperate biome, is basically North America and Eurasia. It is found from 600 (occasionally less, until 100) to 1500 (occasionally more, up to 2200) m a.s.l.

Several counts (in some cases as *Erigeron acer* L.) previously recorded for this taxon agree with the present one, even if in some cases the number is indicated as 2*n* = ca. 18. A tetraploid 2*n* = 36 count has also been published. To date, no reports from the Pyrenean area were available (https://sites.google.com/view/cromocat/home, accessed November 15, 2025).

2056. *Scorzoneroides duboisii* (Sennen ex Widder) Greuter — 2*n* = 2x = 12 (Fig. 2B).

Hs: Catalonia, Ripollès, Bastiments, alt. 2371 m, 42° 25' 13" N, 2° 14' 57" E, 18 Aug 2023, leg. *J. de Montaigne*, *T. Garnatje (GR899bis)*, *O. Hidalgo & I. Pérez-Lorenzo* (BC).

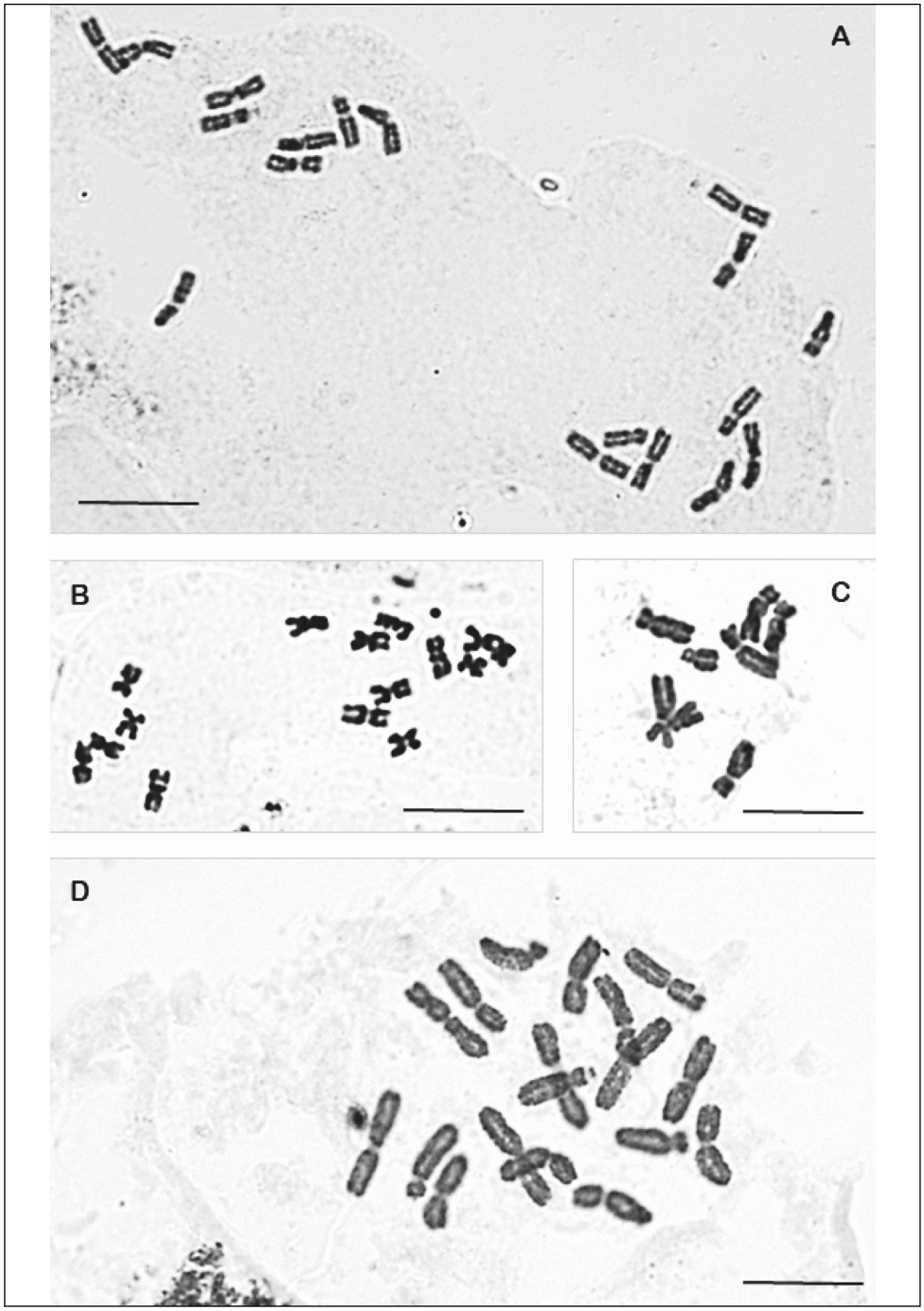


Fig. 1. Mitotic metaphase chromosome plates: **A**, *Anacyclus clavatus*, 2*n* = 18; **B**, *Chondrilla juncea*, 2*n* = 15; **C**, *Crepis bursifolia*, 2*n* = 8; **D**, *Cota triumfetti*, 2*n* = 18. – Scale bars = 10 μm.

The distribution area of this perennial herb, which grows primarily in the temperate biome, is limited to the Pyrenean (Andorra, France, Spain) and the Cantabrian (Spain) ranges.

The chromosome number here reported agrees with a few previous counts in this species (as *Leontodon duboisii* (Sennen ex Widder)). One of them is from a population from the same Catalan district as the present one, but located at much lower altitude, 1400 m a.s.l. (Izuzquiza & Nieto Feliner 1991).

2057. *Sonchus oleraceus* L. — 2*n* = 2x = 32 (Fig. 2C).

Hs: Catalonia, Ripollès, Setcases, camí de Tregurà, alt. 1267 m, 42° 22' 29" N, 2° 18' 00" E , 13 Aug 2023, leg. *T. Garnatje (GR 881) & J. Luque (BC)*.

The native range of this annual or biennial species, growing primarily in the temperate biome, is basically Europe and northern and central Africa, and the Mediterranean basin, being introduced in many Asian, African, American and Oceanian areas. It grows between 0 and 1500 m, often in cultivated fields and ruderal grasslands.

Numerous counts on this taxon offer a variety of chromosome numbers (https://sites.google.com/view/cromocat/home, accessed November 16, 2025). Some of them (*n* = 16 or 2*n* = 32) are coincidental with the present one and suggest a basic chromosome number of x = 8 or, since no *n* = 8 or 2*n* = 16 counts are recorded, x = 16, the latter probably fruit of an old event of polyploidy. The recorded 2*n* = 64 would indicate a higher polyploid cytotype. Conversely, some available counts (*n* = 9, *n* = 18, 2*n* = 18, 2*n* = 36) would indicate x = 9 as a basic chromosome number, with *n* = 10 suggesting x = 10. Further research with detailed karyotype analysis, completed with genome size data, would shed light on this diversity of chromosome numbers attributed to this species. The present count is the first one in the Pyrenean area (https://sites.google.com/view/cromocat/home, accessed November 16, 2025).

2058. *Urospermum dalechampii* (L.) Scop. ex F.W.Schmidt — 2*n* = 2x = 14 (Fig. 2D).

Hs: Catalonia Alt Empordà, Avinyonet de Puigventós, roadsides near the hermitage of Santa Eugènia, alt. 62 m, 42° 14' 23" N, 2° 55' 02" E, 8 Aug 2024, leg. *J. Vallès* (BC).

The native range of this perennial herbaceous species, growing primarily in the subtropical biome, is western and central Mediterranean region. It grows from 0 to 1100 m a.s.l., particularly in mesoxerophilous pastures, wastelands, roadsides and ruderal places.

Our count is coincidental with those already published for this taxon (Larsen 1956; Pellicer & al. 2022, and references therein). The same chromosome number (*n* = 7) was counted in a population of the same low altitude Pyrenean foothill Catalan district (Luque & al. 1984), located at 6 km from the present one.

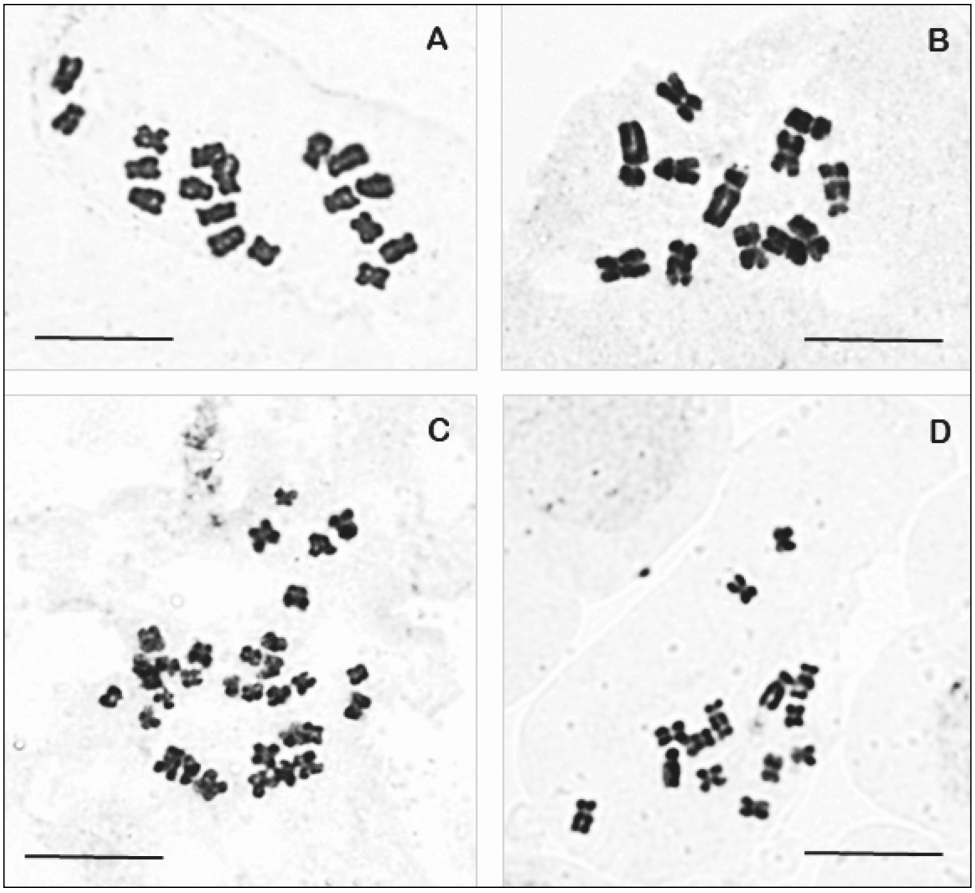


Fig. 2. Mitotic metaphase chromosome plates: **A**, *Erigeron acris*, 2*n* = 18; **B**, *Scorzoneroides duboisii*, 2*n* = 12; **C**, *Sonchus oleraceus*, 2*n* = 32; **D**, *Urospermum dalechampii*, 2*n* = 14. – Scale bars = 10 µm.

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Mediterranean plant karyological data – 35/2

Chromosome numbers and ploidy levels in selected *Asteraceae* from the Western Balkans, part I

S. Siljak-Yakovlev, F. Pustahija, N. Takvorian, S. Le Prieur & E. Muratović

Abstract
Chromosome numbers, ploidy levels and metaphase plates are reported for seven *Asteraceae* (*Compositae*) species from Bosnia and Herzegovina (*Arctium lappa*, *Buphthalmum salicifolium*, *Cirsium eriophorum*, *Cota tinctoria*, *Hieracium sabandum*, *Lapsana communis*, *Tripleurospermum inodorum*) and one species from Croatia (*Urospermum picroides*). Detailed localities (including GPS coordinates) of the collected material are also provided, along with a general overview of the distribution of the species studied.

Keywords: Karyology, *Arctium*, *Buphthalmum*, *Cirsium*, *Cota*, *Hieracium*, *Lapsana*, *Tripleurospermum*, *Urospermum*, Bosnia and Herzegovina, Croatia.

Introduction

In an upcoming project focused on the *Asteraceae* of the Western Balkans, one of the initial steps will be to determine the chromosome number, ploidy level, and genome size for as many species as possible. These essential biological characteristics are crucial for conducting a thorough study of the regional flora.

The chromosome numbers identified in this study are compared with those previously reported in the relevant literature.

To verify the previously reported chromosome number for the studied species, we consulted the existing chromosome counts databases: Rice & al. 2015), which includes the Index to chromosome numbers in *Asteraceae* database (https://togodb.biosciencedbc.jp/db/index_chr_num_asteraceae#en, Semple & Watanabe 2023); Fedorov (1969); IPCN by Goldblatt & Johnson (1979).

The information on the taxonomic status and general distribution area of the studied species has been sourced from Plants of the World Online (POWO, https://powo.science.kew.org). We checked all these databases on November 2025. The vouchers for all collected species have been deposited in the herbarium of the Laboratory for research and protection of endemic resources at the Faculty of Sciences, University of Sarajevo (HOBY_ GeSDaBaF).

The results obtained from the studied species, along with the data on their genome sizes currently being collected, will enhance the existing database on Balkan flora: Genome Size Database of Balkan Flora (GeSDaBaF) (http://www.pmf.unsa.ba/gesdabaf).

2059. ***Arctium lappa*** L. — 2*n* = 36 (Fig. 1A).

BH: Mt. Igman, limestones, 43° 44' 22" N, 18° 16' 30" E, 1256 m a.s.l., 13 Sept 2023, leg. *E. Muratovic & F. Pustahija* (HOBY_ GeSDaBaF).

Arctium lappa L. is a perennial plant that grows primarily in the temperate biome, with a native range in Temperate Eurasia (POWO 2025).

A previously reported chromosome number for the species was 2*n* = 18 (Astanova 1989) and 2*n* = 36 (Probatova & al. 2006; Ankova & Zykova 2017; Bhatt & al. 2025), where the tetraploid cytotype (2*n* = 36) is the most common and which we also found in the population of Mt. Igman from Bosnia.

2060. ***Buphthalmum salicifolium*** L. — 2*n* = 20 (Fig. 1B).

BH: Mt. Igman, limestones, 43° 45' 55" N, 18° 14' 54" E, 1209 m a.s.l., 13 Sept 2023, leg. *E. Muratovic & F. Pustahija* (HOBY_ GeSDaBaF).

Buphthalmum salicifolium L. is a perennial plant growing primarily in the temperate biome, with a native range in Central & South Central Europe (POWO 2025).

The most frequent chromosome number reported for the species was 2*n* = 20 (Druskovic & Lovka 1995; Temsch & al. 2010). While Bechi & al. (1996) reported a chromosome number of 2*n* = 22. Our study found the chromosome count to be 2*n* = 20.

2061. ***Cirsium eriophorum*** (L.) Scop. — 2*n* = 34 (Fig. 1C).

BH: Mt. Trebević, limestones, 43° 47' 45" N, 18° 30' 36" E, 1155 m a.s.l., 12 Sept 2023, leg. *E. Muratovic & F. Pustahija* (HOBY_ GeSDaBaF).

Cirsium eriophorum (L.) Scop. is a perennial plant that primarily grows in the temperate biome, with a native range extending from Europe to Turkey (POWO 2025).

The chromosome count observed in this study, 2*n* = 34, aligns with existing literature (Bures & al. 2004; Bennet & Leitch 2011).

2062. ***Cota tinctoria*** (L.) J. Gay — 2*n* = 36 (Fig. 1D).
(Syn. *Anthemis tinctoria* L. 1753)

BH: Dariva, Sarajevo, limestones, 43° 51' 31" N, 18° 26' 48" E, 574 m a.s.l., 27 Sept 2023, leg. *E. Muratovic & F. Pustahija* (HOBY_ GeSDaBaF).

Cota tinctoria (L.) J. Gay is a biennial or perennial plant that grows primarily in the temperate biome. It is native to Europe, the Mediterranean, Western Asia, and naturalised in scattered locations in North America (POWO 2025).

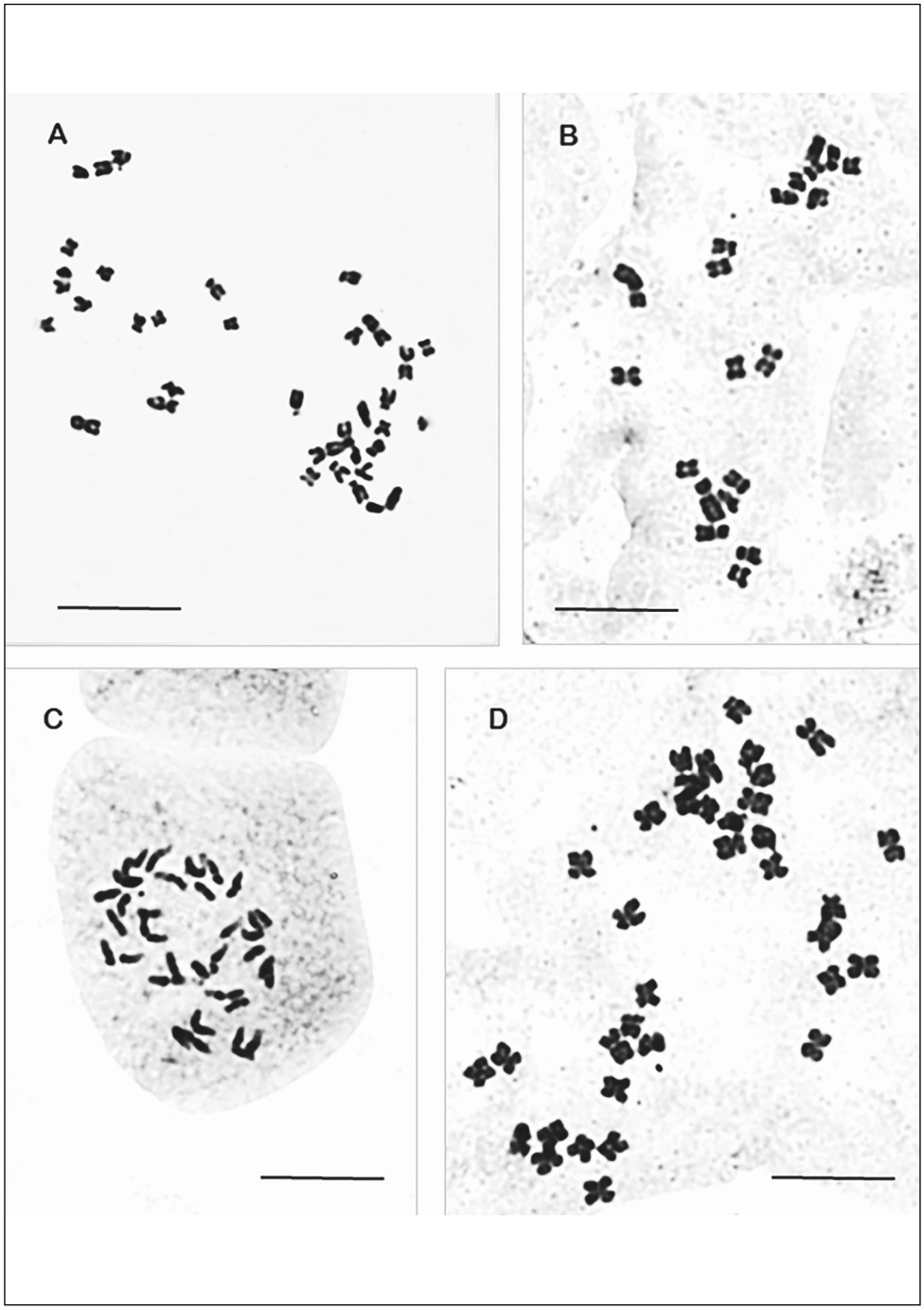


Fig. 1. Mitotic metaphase chromosome plates: **A**, *Arctium lappa*, 2*n* = 36; **B**, *Buphthalmum salicifolium*, 2*n* = 20; **C**, *Cirsium eriophorum*, 2*n* = 34; **D**, *Cota tinctoria*, 2*n* = 36. – Scale bars = 10 μm.

The tetraploid chromosome number 2*n* = 36, obtained in this study, is the first report on the tetraploid level for this species. Previous reports indicated only diploid chromosome number 2*n* = 18 (Blanché & al. 1985; Inceer & Hayirlioglu-Ayaz 2007).

2063. *Hieracium sabaudum* L. — 2*n* = 3x = 27 (Fig. 2A).

BH: Lapišnica, Sarajevo, limestones, 43° 51' 10" N, 18° 27' 47" E, 609 m a.s.l., 27 Sept 2023, leg. *E. Muratovic & F. Pustahija* (HOBY_ GeSDaBaF).

Hieracium sabaudum L. is a perennial plant that mainly grows in the temperate biome, with a native range from Europe to Turkey (POWO 2025).

Three chromosome numbers corresponding to three ploidy levels, 2*n* = 18, 27, and 36 have been reported for this species (Hrušovská-Osuská 1988; Chrtek 2004; Szelag & Vladimirov 2005; respectively). In our population, we observed the triploid chromosome number 2*n* = 3x = 27.

2064. *Lapsana communis* L. — 2*n* = 14 (Fig. 2B).

BH: Lapišnica, Sarajevo, limestones, 43° 51' 10" N, 18° 27' 47" E, 609 m a.s.l., 27 Sept2023, leg. *E. Muratovic & F. Pustahija* (HOBY_ GeSDaBaF).

Lapsana communis L. is an annual plant that grows primarily in the temperate biome, with a native range from Macaronesia, Europe to Siberia and Iran (POWO 2025).

The most frequently reported chromosome number for this species was 2*n* = 14 (Kiehn & al. 1991; Gemeinholzer & Faustmann 2005; Garnatje & al. 2024), but 2*n* = 16 has also been reported (Pak & Bremer 1995; Albers & Pröbsting 1998; Gemeinholzer & Faustmann 2005). Given that B chromosomes have been reported (Lövkvist & Hultgård 1999), the 2*n* = 16 could be an erroneous count involving 2 B-chromosomes.

2065. *Tripleurospermum inodorum* (L.) Sch. Bip. — 2*n* = 36 (Fig. 2C).

BH: Mt. Trebević, limestones, 43° 50' 36" N, 18° 25' 28" E, 869 m a.s.l., 12 Sept 2023, leg. *E. Muratovic & F. Pustahija* (HOBY_ GeSDaBaF).

Tripleurospermum inodorum (L.) Sch. Bip. is an annual or biennial plant that grows primarily in the temperate biome, with a native range from Europe to Siberia and Xinjiang (POWO 2025).

Two chromosome numbers have been reported: diploids with a chromosome number of 2*n* = 18 (Carr & al. 1999; Certner & al. 2019) and tetraploids with a chromosome number of 2*n* = 4x = 36 (Arora & Madhusoodana 1981; Samatadze & al. 1998; Inceer & al. 2018; Certner & al. 2019). In our population, we found only tetraploid individuals.

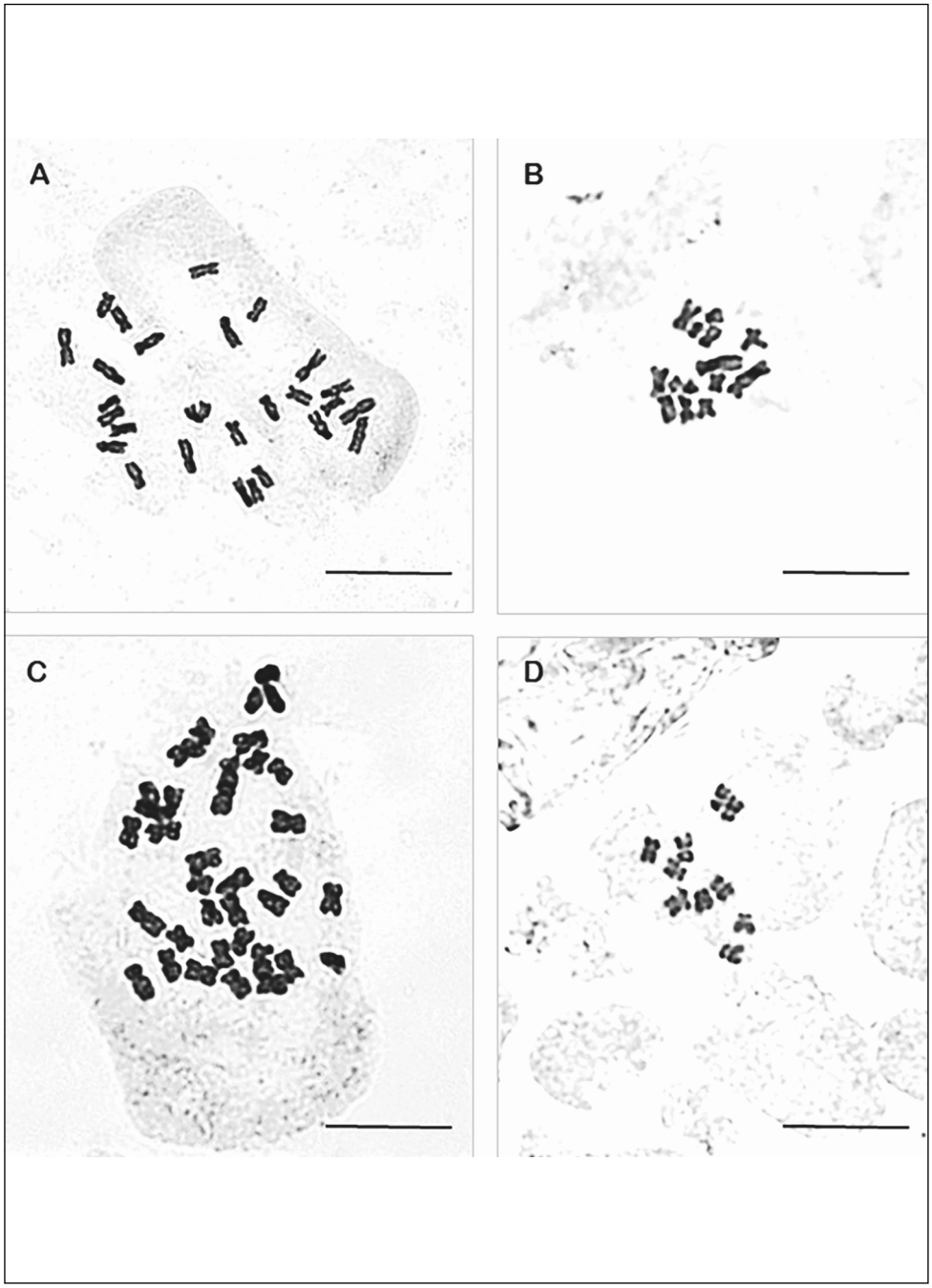


Fig. 2. Mitotic metaphase chromosome plates: **A**, *Hieracium sabaudum*, 2*n* = 27; **B**, *Lapsana communis*, 2*n* = 14; **C**, *Tripleurospermum inodorum*, 2*n* = 36; **D**, *Urospermum picroide*s, 2*n* = 10. – Scale bars = 10 μm.

2066. ***Urospermum picroides*** (L.) F. W. Schmidt — $2n = 10$ (Fig. 2D).

Cro: Baćina, near Gradac, limestones, 43° 04' 55" N, 17° 22' 00" E, 58 m a.s.l., 16 May 2025, leg. *S. Siljak-Yakovlev & M. Maksimović* (HOBY_ GeSDaBaF).

Urospermum picroides (L.) F. W. Schmidt is an annual plant that grows primarily in the subtropical biome, with a native range from Macaronesia, the Mediterranean to Iran and the Arabian Peninsula (POWO 2025).

The chromosome number $2n = 10$ have been reported several times (Vogt & Aparicio 1999; Baltisberger & Widmer 2006; Pellicer & al. 2022). We confirm the same chromosome number ($2n = 10$), which we also previously observed in two other populations from Croatia (Vallès & al. 2017).

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